UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

PRELIMINARY SAFETY EVALUATION REPORT

TRANSNUCLEAR, INC.

STANDARDIZED ADVANCED NUHOMS® HORIZONTAL MODULAR STORAGE SYSTEM FOR IRRADIATED NUCLEAR FUEL

DOCKET NO. 72-1029

AMENDMENT NO. 3

TABLE OF CONTENTS

ACRONYMS

AHSM	advanced horizontal storage module
AHSM-HS	advanced horizontal storage module (high burnup and high seismic)
APSRAs	axial power shaping rod assemblies
BPRAs	burnable poison rod assemblies
CC	control components
CE	Combustion Engineering
CEAs	control element assemblies
CFR	U.S. Code of Federal Regulations
CoC	certificate of compliance
CRAs	control rod assemblies
DSC	dry shielded canister
DSS	dry storage system
FSAR	final safety analysis report
GWd/MTU	gigawatt days per metric ton uranium
HLZC	heat load zoning configurations
IFBA	Integral Fuel Burnable Absorber
ISFSI	independent spent fuel storage installation
LCO	limiting conditions for operations
MMC	metal matrix composite
NRC	U.S. Nuclear Regulatory Commission
NSAs	neutron source assemblies
ORAs	orifice rod assemblies
PWR	pressurized water reactor
QA	quality assurance
RAI	request for additional information
SER	safety evaluation report
SNF	spent nuclear fuel
SR	surveillance requirements
SSC	structures, systems, and components
TPAs	thimble plug assemblies
TS	technical specifications
VSIs	vibration suppressor inserts

PRELIMINARY SAFETY EVALUATION REPORT

Docket No. 72-1029
Standardized Advanced NUHOMS® Horizontal Modular Storage
System For Irradiated Nuclear Fuel
Amendment No. 3

SUMMARY

By letter dated December 15, 2011, and as supplemented (see Section 1.1 for details), Transnuclear, Inc. (TN) submitted an application to the U.S. Nuclear Regulatory Commission (NRC) for approval of an amendment to Certificate of Compliance (CoC) No. 1029 for the Standardized Advanced NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, in accordance with U.S. Code of Federal Regulations, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste and Reactor-Related Greater than Class C Waste," Title 10, Part 72 (10 CFR Part 72), Subparts K and L.

TN requested a change to the CoC for the Standardized Advanced NUHOMS® System, including its attachments, and revision of the final safety analysis report (FSAR). The primary changes requested are as follows:

- Add a new canister to the Standardized Advanced NUHOMS® System. The NUHOMS® 32PTH2 System consists of a new transportable dry shielded canister (DSC) designated the 32PTH2. The 32PTH2 DSC is similar to the 32PTH1 DSC licensed under CoC No. 1004 Amendment No. 10, except the shell is thicker for better corrosion protection. The NUHOMS® 32PTH2 system is designed to accommodate up to 32 pressurized water reactor (PWR) intact (or up to 16 damaged and the balance intact) Combustion Engineering (CE) 16 x 16 class spent fuel assemblies with or without control components.
- The NUHOMS® 32PTH2 System consists of a modified version of the Standardized Advanced NUHOMS® AHSM storage module, designated the AHSM-HS (high burnup and high seismic). The AHSM-HS modules are similar to the HSM-HS modules licensed under CoC 1004 Amendment 10, except the components have been upgraded for higher seismic values.
- The transfer cask to be used for the 32PTH2 DSC is the OS200FC TC, licensed under CoC No. 1004 Amendment No. 10.

The NRC staff has reviewed the application, and supplemental information, in accordance with the applicable NRC regulations in 10 CFR Part 72. The staff performed its review using the guidance in NUREG-1536, Revision 1, "Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility," July 2010. Based on the statements and representations in the application, as supplemented, the staff concludes that the Standardized Advanced NUHOMS® System, as amended, meets the requirements of 10 CFR Part 72.

1 GENERAL INFORMATION

By application dated December 15, 2011 (Ref. 1), as supplemented, Transnuclear, Inc. (TN) submitted an application to amend Certificate of Compliance (CoC) No. 1029 for the Standardized Advanced NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, under the provisions of 10 CFR Part 72, Subparts K and L. The application, as supplemented, is listed in the following table:

Date	Document Title	Document Type	Accession No.
12/15/2011	Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance (CoC) No. 1029, Docket No. 72-1029	Initial Application- letter	ML12004A156
	Enclosure 7 to TN E-31647, Standardized Advanced NUHOMS® System UFSAR Pages and Drawings, Showing Proposed Amendment 3 Changes, B.5 Shielding Evaluation.	Initial Application-proprietary	ML12004A160
	Enclosure 7 to TN E-31647 - Standardized Advanced NUHOMS® System UFSAR Pages and Drawings, Showing Proposed Amendment 3 Changes.	Initial Application-proprietary	ML12004A159
	Enclosure 8 to TN E-31647 - Public Versions of Standardized Advanced NUHOMS® System UFSAR Pages and Drawings, Showing Proposed Amendment 3 Changes.	Initial Application-proposed changes	ML12004A157
2/24/2012	Revision 1 to Transnuclear, Inc. Application for Amendment 3, CoC No. 1029, Response to Request for Supplemental Information. (Docket No. 72-1029; TAC No. L24607)	Response to the RSI and the observations	ML12059A297
	Enclosure 2 to TN E-32348, RSI and Observations Items and Responses (Proprietary Version) and Enclosure 3, CoC 1029 Amendment 3, Revision 1, Changed UFSAR Pages.	Enclosure 2 to TN E-32348, RSI and Observations Items and Responses (Proprietary Version)	ML12059A298
5/24/2012	Revision 2 to Transnuclear, Inc. Application for Amendment 3, CoC No. 1029, Supplemental Information (Docket No. 72-1029; TAC No. L24607)	Enclosure 5 to TN E-32690, Public Version of UFSAR Chapter B.5 pages	ML12158A103
	Enclosure 2, Changed Pages for UFSAR Chapter B.5 (Proprietary).	Enclosure 2 to TN E-32690, Changed Pages for UFSAR Chapter B.5 (proprietary)	ML12158A104
9/7/2012	Revision 3 to Transnuclear, Inc. Application for Amendment 3, CoC No. 1029 (Docket No. 72-1029; TAC No. L24607)	Responses to Round #1 RAIs (except Items 4-7 and 9-1)	ML12254B039
	Certificate of Compliance No. 1029 Amendment 3, Revision 3, Changed UFSAR Pages, TN Calculation	Enclosure 6 to TN E-33290, CoC 1029	ML12254B040

Date	Document Title	Document Type	Accession No.
	13206-0231, and Revision 1 to TN Report E-32402.	Amendment 3, Revision 3, Changed UFSAR Pages (Proprietary Version)	
10/15/2012	Transnuclear, Inc., Response to Request for Additional Information, Items 3-2 and 4-7 to Revision 4 to Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029.	Response to RAI Items 3-2 and 4-7	ML12297A205
11/16/2012	Revision 5 to Transnuclear, Inc. Application for Amendment 3, CoC No. 1029 ; Response to Request for Additional Information. (Docket No. 72-1029; TAC No. L24607).	Confinement RAI responses re: Chap 7, 8, TS-1)	ML12325A069
	Enclosure 6 to TN E-33846, CoC 1029 Amendment 3, Revision 5 Changed UFSAR Pages	Drawing (proprietary)	ML12325A070
12/11/2012	Enclosure 2 to TN E-34062, CoC 1029 Amendment 3, Revision 6, TN Calculation 13206-0415, Rev. 1, " NUHOMS® 32PTH2: Effective Conductivities for Homogenized Basket Plates and DSC End Plates."	RAI response to item 4-7 ---calculation (proprietary)	ML12352A231
	Revision 6 to Transnuclear, Inc. Application for Amendment 3, CoC No. 1029 (Docket No. 72-1029; TAC No. L24607), Computational Fluid Dynamic Files (Docket No. 72-1029; TAC No. L24607)	Letter, Affidavit: RAI response to item 4-7	ML12352A230
3/18/2013	CoC-1029, Amd. No. 3 Discussion of RAI 9-1 Response (Thermal) (Docket No. 72-1029 –Transfer cask airflow	Conversation Record	ML13100A331
3/26/2013	CoC-1029, Amd. No. 3 Discussion of RAI 3-1 Response (Structural) (Docket No. 72-1029) contour plot of stress intensity	Conversation Record	ML13100A319
5/9/2013	Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information.	Themal response	ML13133A034
6/10/2013	Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information.	Resubmittal or RAI response 3-1	ML13182A044
6/21/2013	NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, RAI 3-1 Request-Weld	Conversation Record	ML13255A209
7/16/2013	NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, Appendix A to Certificate of Compliance No. 1029 - Technical Specifications for the Standardized Advanced NUHOMS®—appendix A to CoC-1029 changes	Conversation Record	ML13198A396

TN requested a change to the CoC for the Standardized Advanced NUHOMS® System, including its attachments, and revision of the Final Safety Analysis Report (FSAR). The primary changes were as follows:

- Add a new canister to the Standardized Advanced NUHOMS® System. The NUHOMS® 32PTH2 System consists of a new transportable dry shielded canister (DSC) designated the 32PTH2. The 32PTH2 DSC is similar to the 32PTH1 DSC licensed under CoC 1004 Amendment 10. The NUHOMS® 32PTH2 system is designed to accommodate up to 32 pressurized water reactor (PWR) intact (or up to 16 damaged and the balance intact) Combustion Engineering (CE) 16 x 16 class spent fuel assemblies with or without control components.
- The NUHOMS® 32PTH2 System consists of a modified version of the Standardized Advanced NUHOMS® AHSM storage module, designated the AHSM-HS (high burnup and high seismic). The AHSM-HS modules are similar to the HSM-HS modules licensed under CoC No. 1004 Amendment No. 10.
- The transfer cask to be used for the 32PTH2 DSC is the OS200FC TC, licensed under CoC No. 1004 Amendment No. 10.

The objective of the review of the general description of the application is to ensure that TN has provided sufficient information to allow all reviewers, regardless of their specific review assignments, to understand the changes to the Standardized Advanced NUHOMS® System, including the principal functions and design features of the NUHOMS® 32PTH2 dry storage system (DSS). A non-proprietary version of the initial application, and its supplements, has been provided by TN.

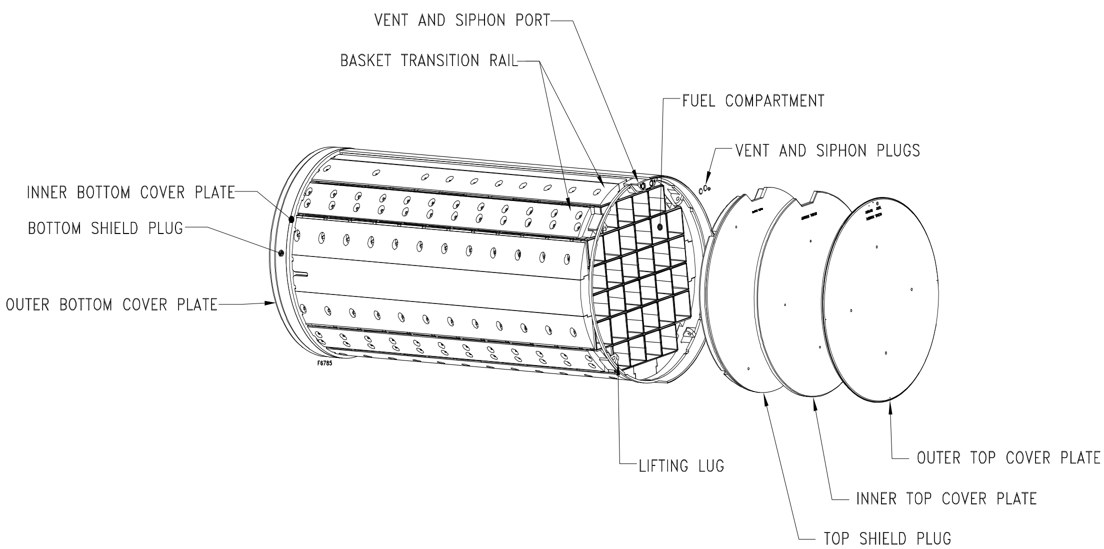
The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the application using the guidance provided in NUREG-1536, "Standard Review Plan (SRP) for Spent Fuel Dry Storage Systems at a General License Facility" (Ref. 4). The NRC staff performed a detailed evaluation of the proposed changes, which is documented in this safety evaluation report (SER). Only those SRP chapters with a corresponding application revision or change are addressed in the NRC staff's SER. There is no chapter related to Decommissioning included in this SER because there were no related revisions in the application. Specific DSS evaluations are discussed in Chapters 3 through 12 of this SER.

Based on the statements and representations in the application, as supplemented, the NRC staff concludes that the TN Standardized NUHOMS® System, as amended, meets the requirements of 10 CFR Part 72.

1.1 DSS Description and Operation Features

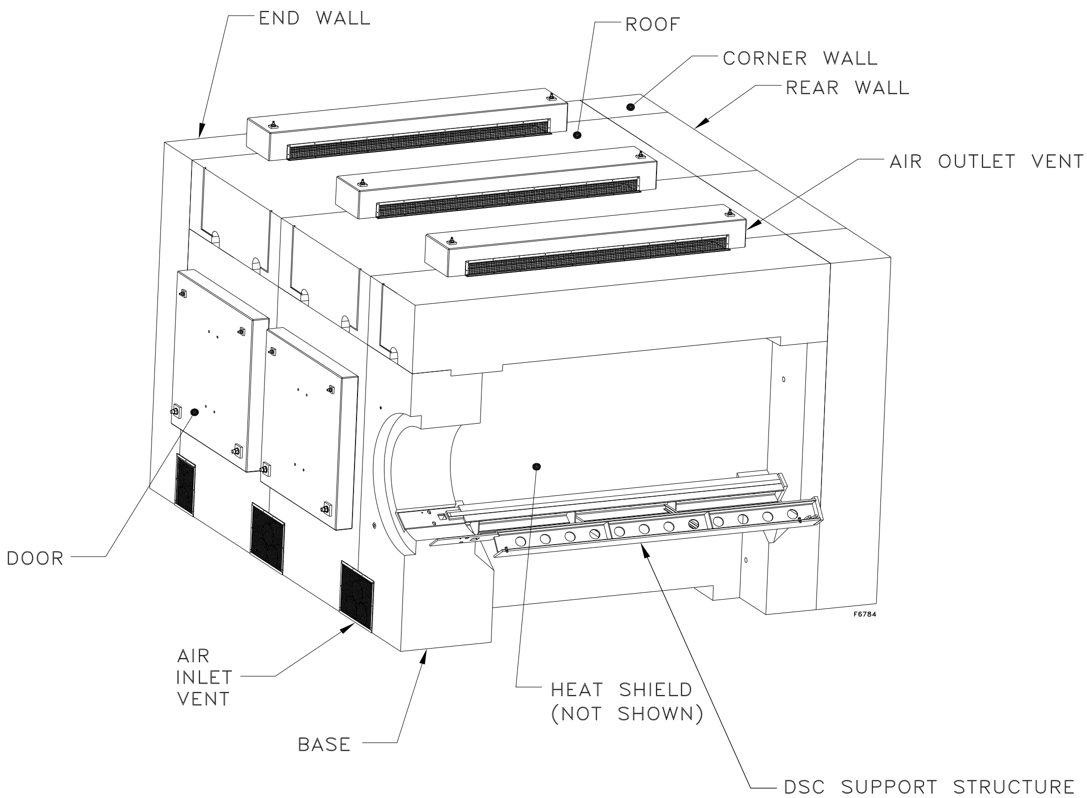
The Standardized Advanced NUHOMS® System is described in the Updated Final Safety Analysis Report (UFSAR) for Certificate of Compliance (CoC) No. 1029. The NUHOMS® 32PTH2 System consists of a new transportable dry shielded canister (DSC) designated the 32PTH2 and a modified version of the Standardized Advanced NUHOMS® AHSM storage module, designated the AHSM-HS. The 32PTH2 DSC is similar to the 32PTH1 DSC licensed under CoC No. 1004 Amendment No. 10. The AHSM-HS modules are similar to the HSM-HS

modules licensed under CoC No. 1004 Amendment No. 10. The design requirements for the NUHOMS® 32PTH2 system are described in FSAR Appendix B (Chapters 1 through 13). The transfer cask to be used for the 32PTH2 DSC is the OS200FC TC, licensed under CoC No. 1004 Amendment No. 10.



FSAR Figure B.1.1-2

NUHOMS® 32PTH2 DSC



FSAR Figure B.1.1-1
NUHOMS® AHSM-HS

Key Design Parameters of the NUHOMS® 32PTH2 System Components[1]

32PTH2 DSC	
Overall Length (in)	198.5 (max)
Outside Diameter (in)	69.75
Cavity Length (in)	178.65 (min)
Shell Thickness (in)	5/8 (includes 1/8 corrosion allowance)
Design Weight of Loaded 32PTH2 (lbs.)	110,000 (dry)
Materials of Construction	Stainless steel (shell assembly, cover plates and internals), carbon steel shield plugs, and aluminum rails
Neutron Absorbing Material	Metal Matrix Composite (MMC)
Internal Atmosphere	Helium

AHSM-HS	
AHSM-HS Overall Length (without shield walls and door)	20’-8”
AHSM-HS Overall Width (without shield walls)	9’-8”
AHSM-HS Overall Height (without outlet vent covers)	18’-6”
AHSM-HS Single Module Average Weight, Empty (lbs)	331,000
AHSM-HS Single Module Average Weight, Loaded (lbs)	437,000
Materials of Construction	Reinforced Concrete and Structural Steel

[1] SAR Table B.1.2-1

A brief description of the Amendment 3 changes is provided below.

- Editorial changes to nomenclature and spelling made for clarity and consistency. (e.g., “B-10,” “transfer,” “U-235,” “FSAR,” “Zircaloy,” “wt. %,” “inches,” etc.).
- For clarity, discussions of fuel assembly enrichment limits are made consistent regarding the use of the terms “maximum planar” and “assembly average,” as they relate to criticality and to shielding, respectively.
- Added “Standardized” to be consistent with the CoC language.
- Updated Table of Contents, List of Tables, List of Figures.
- Definition of ADVANCED HORIZONTAL STORAGE MODULE updated to add the AHSM-HS.
- Existing DAMAGED FUEL ASSEMBLY definition applies to the 24PT1-DSC and 24PT4-DSC only. Added a separate DAMAGED FUEL ASSEMBLY definition for the 32PTH2 DSC only.
- Definition of DRY SHIELDED CANISTER (DSC) updated to include the 32PTH2 DSC.
- Definition of INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI) updated to add the AHSM-HS.
- Definition of RECONSTITUTED FUEL ASSEMBLY updated to be clear that the fuel assembly could, or could not, be further irradiated.
- Definition of STORAGE OPERATIONS updated to add the AHSM-HS.
- Definition of TRANSFER CASK (TC) updated to include the OS200FC onsite transfer cask and the AHSM-HS.
- Definition of TRANSFER OPERATIONS updated to remove the stipulation that a DSC only contains INTACT or DAMAGED fuel assemblies, and to include AHSM-HS.
- Definition of UNLOADING OPERATIONS updated to remove the stipulation that a DSC only contains INTACT or DAMAGED fuel assemblies, and to include AHSM-HS.
- Numbering in Section 1.4 which is in the format “12.3”, “12.3.0.x” etc., which refers to original SAR locations, is changed to “3”, “3.0.x” etc. to be consistent with the TS numbering scheme.
- Added a new section, for fuel to be stored in the 32PTH2 DSC.
- Editorial change to update numbering from “2.3” to “2.4”.

- Corrected “2.1” to “2.0” because Section 2.1 is specific to the 24PT1 DSC, whereas this specification is intended to apply to all DSCs.

- Changed “Maximum Fuel Enrichment” to “Maximum Planar Average Fuel Enrichment” to improve clarity and consistency with FSAR analyses.

- Added a top row to the table to specify the zones, for consistency and clarity.

- Added new table providing PWR fuel specification for the fuel to be stored in the 32PTH2 DSC. (Reference FSAR Appendix B, Table B.2.1-1.)

- Added new table providing thermal and radiological characteristics for control components stored in the 32PTH2 DSC. (Reference FSAR Appendix B, Table B.2.1-2.)

- Added new table providing PWR fuel assembly design characteristics for the 32PTH2 DSC. (Reference FSAR Appendix B, Table B.2.1-3.)

- Added new table providing maximum planar average initial enrichment versus neutron poison requirements for the 32PTH2 DSC (intact fuel assembly). (Reference FSAR Appendix B, Table B.2.1-4.)

- Added new table providing maximum planar average initial enrichment versus neutron poison requirements for the 32PTH2 DSC (damaged fuel assembly). (Reference FSAR Appendix B, Table B.2.1-5.)

- Added new table providing allowable fuel burnup and enrichment combinations for the 32PTH2 DSC. (Reference FSAR Appendix B, Table B.2.1-6.)

- Added new table providing fuel assembly decay heat determination specifications for the 32PTH2 DSC. (Reference FSAR Appendix B, Table B.2.1-7.)

- Added new table providing additional cooling times (ΔT) in years for fuel assemblies with up to 7 fuel rods reconstituted with irradiated stainless steel. (Reference FSAR Appendix B, Table B.2.1-8.)

- Added new table providing B-10 specification for the 32PTH2 poison plates. (Reference FSAR Appendix B, Table B.2.1-9)

- Added new figure providing heat load zoning configurations for the 32PTH2 DSC. (Reference FSAR Appendix B, Figure B.2.1-1.)

- Added 32PTH2 DSC to the LCO.

- Based on NUREG-1745, LCO 3.0.5 is changed to “not applicable to a spent fuel storage cask” and LCOs 3.0.6 and 3.0.7 are removed.

- Added new LCO section providing requirements for 32PTH2 DSC bulkwater removal medium and vacuum drying pressure.

- Added new LCO section providing requirements for 32PTH2 DSC helium backfill pressure.

- Added new LCO providing requirements for the time limit for completion of DSC transfer for the 32PTH2 DSC.

- Added new LCO providing requirements for 32PTH2 DSC criticality control.

- The wording "this FSAR is" is changed to "these specifications are" because the section applies to the TS.

- Clarified Section 4.2.2 to distinguish between the FSAR tables associated with the 24PT1 and 24PT4 DSCs, and discussion is added associated with the 32PTH2 DSC and the AHSM-HS.

- Added discussion regarding 32PTH2 DSC basket types and requirements for neutron absorbers.

- Added information regarding the 32PTH2 DSC not requiring fuel spacers.

- Added an explanatory note to Figure 4-1regarding ligament width dimensions, and expanded the figure title to indicate applicability to the 24PT1 and 24PT4-DSCs.

- Added AHSM-HS requirements to the Codes and Standards section for the horizontal storage modules.

- Added 32PTH2 requirements to the Codes and Standards section dry shielded canisters.

- Added OS200FC requirements to the Codes and Standards section on transfer casks.

- Clarified the current ASME code alternatives to specify that they apply to the 24PT1 and 24PT4-DSCs. Added 32PTH2 ASME code alternatives tables to Section 4.3.4. Also revised item No. 2 following the code alternatives tables to make it applicable to the previously licensed DSCs and the new 32PTH2 DSC.

- Added storage configuration requirements for the AHSM-HS, specifying 8 feet for the minimum distance between the AHSM-HS and the ISFSI pad edge.

- Added a 10th requirement to Section 4.4.3, involving requirements for DSC support structure material composition for certain AHSM-HS components when the ISFSI is located in a coastal saltwater marine atmosphere.

- Added requirements for the minimum information content of the fuel removal procedure.

- Added AHSM-HS to the Thermal Monitoring Program.

- Add pertinent new FSAR Appendix B references to the training program requirements.

- Specification 5.2.3(c), is removed, based on 1) the specification cites 10 CFR 72.212(b)(2), but the words are associated with 10 CFR 72.44(d)(3); 2) per 10 CFR 72.13, 10 CFR 72.44(d)(3) is applicable to specific licenses, but not general licenses or certificates of compliance.

- For the radiation protection program Section 5.2.4: added Item c. to establish controls for draining when using a TC with a liquid neutron shield; added Item d. revised to add the AHSM-HS to the basis for DSC contamination limits; added Item f. for TC/32PTH2 DSC dose rate limits, configurations, and measurement requirements; added Item g. for 32PTH DSC inner top cover plate weld leak testing.

- Section 5.2.5, Subsections “a)” and “b)” are reversed. By reversing TS Section 5.2.5 Subsections a) and b) and therefore putting the conditional requirements for AHSM/AHSM-HS Air Temperature Difference verification first, followed by the AHSM/AHSM-HS Concrete Temperature monitoring, and then the visual inspection of AHSM/AHSM-HS Air Vents, this change creates a more logical sequencing of these subsections. This subsection (now 5.2.5 b) is clarified as to when the requirements become effective, thereby providing specificity that is necessary to avoid false alarms during initial AHSM/AHSM-HS heatup, when (renumbered) 5.2.5 (a) is in effect and (renumbered) 5.2.5 (b) is not yet in effect. Added 32PTH2 DSC and AHSM-HS requirements to this specification.

- Renamed Specification 5.2.5 b) to Specification 5.2.5 a). This subsection is renamed “AHSM Air Temperature Difference Verification.” The title change makes the title more indicative of the purpose of the subsection. Added 32PTH2 DSC and AHSM-HS requirements to this specification.

- Added 32PTH2 DSC and AHSM-HS requirements to 5.2.5(c) specification.

- Added new 5.2.6 section providing requirements for hydrogen gas monitoring for the 32PTH2 DSC.

- Clarified Section 5.3.1 and 5.3.2 to indicate that the “cask” is the “transfer cask” and that the “transporter” is the “transfer trailer.”

- Added a new Section 5.4 providing requirements for an AHSM-HS dose rate evaluation program.

- Added new Section 5.5 providing requirements for concrete testing of the AHSM-HS.

- Added new Section 5.6 providing requirements for AHSM-HS configuration changes.

1.2 Drawings

Chapter B.1.5.2 of the FSAR contains the proprietary drawings for the NUHOMS® 32PTH2 System, including drawings of the structures, systems, and components (SSC) important to safety. The NRC staff determined that the drawings contain sufficient detail to allow the reviewer to understand the operations, to perform a thorough evaluation, and the option to develop an analysis model for confirmatory calculations for the NUHOMS® 32PTH2 System.

1.3 DSS Contents

The spent fuel to be stored in the 32PTH2 DSC consists of intact (including reconstituted) and/or damaged CE 16x16 class fuel assemblies clad with a zirconium based alloy and UO_2 or (UO_2, Er_2O_3) or (UO_2,Gd_2O_3) or (UO_2, ZrB_2) fuel pellets. Assemblies are with or without Integral Fuel Burnable Absorber (IFBA) rods.

The fuel to be stored is limited to a maximum assembly average initial enrichment of 5.00 wt. % U-235 as a result of the shielding analysis. The fuel is limited to a maximum planar average initial enrichment of 5.00 wt. % U-235 as a result of the criticality analysis.

The maximum allowable assembly average burnup is limited to 62.5 GWd/MTU. The minimum cooling time is 5 years.

1.4 Quality Assurance Program

No change to Chapter 13 due to the addition of 32PTH2 and the AHSM-HS module to the Standardized Advanced NUHOMS® system.

1.5 Technical Qualifications of Applicant

Section B.1.3 of the FSAR states that there is no change to the identification of agents and contractors. The applicant provides the design, analysis, licensing and quality assurance for the NUHOMS® 32PTH2 systems. Fabrication of the casks is performed by one or more fabricators qualified under TN's quality assurance (QA) program. The TN QA program is addressed in Chapter 13 of this SER.

1.6 Evaluation Findings

Based on the NRC staff's review of the information provided in the application, the NRC staff concludes the following:

F1.1 A general description and discussion of the DSS is presented in Section B.1.2 of the FSAR, with special attention to design and operating characteristics, unusual or novel design features, and principal considerations important to safety. The changes to the NUHOMS® 32PT DSC contents are adequately described in the application.

F1.2 Drawings for SSCs important to safety are presented in Section B.1.5 of the FSAR. A listing of those reference documents with drawings (including dates and revision numbers) that were relied upon as a basis for approval appears in Section 1.0 and is included in references in Sections 1.8 and 1.9 of the Safety Evaluation Report (SER).

F1.3 Technical Specifications for the Spent Nuclear Fuel (SNF) to be stored in the DSS are provided in Section B.12 of the FSAR. Additional details concerning these specifications are presented in Chapter 13 of the SER.

The NRC staff concludes that the information presented in Chapter 1, "General Information" of the FSAR satisfies the requirements for the general description under 10 CFR Part 72 (Ref. 2). This conclusion is based on a review that considered the regulation itself, Regulatory Guide 3.61, "Standard Format and Content for a Topical Safety Analysis Report for a Spent Fuel Dry Storage Cask," (Ref. 3) and accepted practices.

1.7 References

1. Transnuclear, Inc., "Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0," non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Supplemental Information (ML12059A297), February 24, 2012.

4. Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Supplemental Information (ML12158A103), May 24, 2012.

5. Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12254B039), September 7, 2012.

6. Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information, Items 3-2 and 4-7 (ML12297A205), October 15, 2012.

7. Revision 5 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12325A069), November 16, 2012.

8. Revision 6 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Computational Fluid Dynamic Files (ML12352A230), December 11, 2012.

9. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 9-1 (Thermal) Response (ML13100A331), Mar 18, 2013.

10. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 3-1 (Structural) Response (ML13100A319), Mar 26, 2013.

11. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

12. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), Jun 10, 2013.

13. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, RAI 3-1 Request-Weld, June 21, 2013.

14. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, Appendix A to Certificate of Compliance No. 1029 - Technical Specifications for the Standardized Advanced NUHOMS® System (ML13198A416), Jul 16, 2013.

15. Safety Evaluation Report for the Standardized NUHOMS® Modular Storage System for Irradiated Nuclear Fuel, Certificate of Compliance No. 1004, Amendment No. 10.

16. U.S. Nuclear Regulatory Commission, NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems - Final Report," U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards”, Revision 1, July 2010.

17. U.S. Nuclear Regulatory Commission, Regulatory Guide 3.61, “Standard Format and Content for a Topical Safety Analysis Report for a Spent Fuel Dry Storage Cask,” February 1989.

18. NRC Certificate of Compliance 1004, NUHOMS® General License Spent Fuel Storage System, Amendment No. 10, August 24, 2009, US NRC Docket No. 72-1004.

19. U.S. Nuclear Regulatory Commission, Office of the Nuclear Material Safety and Safeguards, "Safety Evaluation of VECTRA Technologies' Response to Nuclear Regulatory Commission Bulletin 96-04 for NUHOMS® -24P and NUHOMS®-7P Dry Spent Fuel Storage System," November 1997 (Dockets 72-1004, 72-3, 72-4, 72 8, and 72-14).

1.8 Drawings

1.8.1 NUHOMS® 32PTH2 DSC Drawings:

1. ANUH-01-4002: NUHOMS® 32PTH2 Transportable Canister for PWR Fuel Main Assembly

2. ANUH-01-4003: NUHOMS® 32PTH2 Transportable Canister for PWR Fuel Shell Assembly

3. ANUH-01-4004: NUHOMS® 32PTH2 Transportable Canister for PWR Fuel Basket Assembly

4. ANUH-01-4005: NUHOMS® 32PTH2 Transportable Canister for PWR Fuel Transition Rails

5. ANUH-01-4006: NUHOMS® 32PTH2 Transportable Canister for PWR Fuel Damaged Fuel End Caps

1.8.2 AHSM-HS Drawings:

1. NUH-03-4012: Standardized Advanced NUHOMS® Advanced High Seismic HSM (AHSM-HS) Main Assembly

2. NUH-03-4013: Standardized Advanced NUHOMS® Advanced High Seismic HSM (AHSM-HS) Transition Roof and Transition Walls Assemblies

2 PRINCIPAL DESIGN CRITERIA

The objective of evaluating the principal design criteria related to the system, structures, and components (SSC) important to safety is to ensure that they comply with the relevant general criteria established in 10 CFR Part 72 (Ref. 2).

2.1 SSCs Important to Safety

The SSCs important to safety for the NUHOMS® 32PTH2 System are discussed in FSAR Chapter B.2.5 (Ref. 1). The section describes the quality category of components that are important to safety and those that are deemed not important to safety as shown in Table B.2.5-1 for the NUHOMS® 32PTH2 System. The NRC staff agrees with the determinations stated in the drawings in FSAR Section B.1.5.2, for the NUHOMS® 32PTH2 dry shielded canister (DSC).

2.2 Design Bases for SSCs Important to Safety

2.2.1 SNF Specifications

The spent fuel to be stored in the 32PTH2 DSC consists of intact (including reconstituted) and/or damaged CE 16x16 class fuel assemblies clad with a zirconium based alloy and UO_2 or (UO_2, Er_2O_3) or (UO_2,Gd_2O_3) or (UO_2, ZrB_2) fuel pellets. Assemblies are with or without Integral Fuel Burnable Absorber (IFBA) rods.

According to Section B.2 of the FSAR, the 32PTH2 DSC is designed to store intact (including reconstituted) and/or damaged CE 16x16 class PWR fuel assemblies as specified in FSAR Table B.2.1-1 and Table B.2.1-3. The fuel to be stored is limited to a maximum assembly average initial enrichment of 5.00 wt. % U-235 as a result of the shielding analysis, and limited to a maximum planar average initial enrichment of 5.00 wt. % U-235 as a result of the criticality analysis. The maximum allowable assembly average burnup, according to the applicant, is limited to 62.5 GWd/MTU and the minimum cooling time is 5 years. The DSC is designed to store up to 12 Control Components (CCs). The CCs include burnable poison rod assemblies (BPRAs), control rod assemblies (CRAs), thimble plug assemblies (TPAs), axial power shaping rod assemblies (APSRAs), control element assemblies (CEAs), vibration suppressor inserts (VSIs), orifice rod assemblies (ORAs), neutron source assemblies (NSAs), and neutron sources. Non-fuel hardware that is positioned within the fuel assembly after the fuel assembly is discharged from the core (such as Guide Tubes or Instrument Tube Tie Rods) or Anchors, Guide Tube Inserts, BPRA Spacer Plates, or other devices that are positioned and operated within the fuel assembly during reactor operation are also considered as CCs.

According to Section B.2 of the FSAR, a 32PTH2 DSC containing less than 32 fuel assemblies may contain dummy assemblies in the remaining slots or those slots may remain empty. If dummy assemblies are used, they are unirradiated stainless steel structures that approximate the weight and center of gravity of a fuel assembly. Empty slots must be positioned in the outer part of the 32PTH2 basket grid, in locations allotted for damaged fuel, symmetrically toward the 0°-180° and 90°-270° basket axes.

As described in Section B.2 of the FSAR, the 32PTH2 DSC stainless steel basket consists of an “egg-crate” plate design. The 32PTH2 DSC is similar to the 32PTH1 DSC licensed under CoC-

1004 with minor changes made due to different fuel sizes. The fuel assemblies are housed in 32 stainless steel fuel compartments. The basket assembly structure, including the fuel compartments, is held together with stainless steel support plates that form the "egg-crate" structure. The basket structure is connected to perimeter transition rail assemblies, made of aluminum. The neutron poison/aluminum plates are located between the fuel compartments.

The 32PTH2 DSCs may store up to 32 CE 16x16 class fuel assemblies arranged in any of the four alternate heat load zoning configurations (HLZC), described in the application, with the maximum decay heat per fuel assembly and the maximum DSC heat load allowed for each HLZC. The maximum heat load allowed is 37.2 kW (HLZC 1), 35.2 kW (HLZC 2), 32.0 kW (HLZC 3) and 31.2 kW (HLZC 4).

The 32PTH2 DSC basket is provided with Metal Matrix Composite (MMC) neutron absorber plate material (poison material) for criticality control. The applicant's criticality analysis takes credit for 90% of the B-10 content present in the MMC neutron poison plates. The 32PTH2 DSC basket is analyzed for three alternate basket types for criticality control, depending on the boron loadings analyzed (designated as "B" basket for the lowest B-10 loading to "D" basket for the highest B-10 loading).

The 32PTH2 DSC is inerted and backfilled with helium at the time of loading. As described in Section B.2 of the FSAR, the maximum fuel cladding temperature limit of 400ºC (752ºF) is applicable to normal conditions of storage and all short term operations from the spent fuel pool to the ISFSI pad, including vacuum drying and helium backfilling of the 32PTH2 DSC. Repeated thermal cycling of the fuel cladding is not permitted (limited to less than 10 cycles) with cladding temperature differences greater than 65°C (117°F) during DSC drying, backfilling and transfer operations. The maximum fuel cladding temperature limit of 570°C (1058°F) is applicable to accidents or off-normal storage conditions.

2.2.2 External Conditions

The NUHOMS® 32PTH2 system, consisting of the 32PTH2 DSC and AHSM-HS, form a self-contained, independent, passive system, which does not rely on any other systems or components for its operation when in storage. The DSC and AHSM-HS design criteria include the effects of normal operation, natural phenomena and postulated man-made accidents. The criteria are defined in terms of loading conditions imposed on the 32PTH2 DSC. The loading conditions are evaluated to determine the type and magnitude of loads induced on the 32PTH2 DSC. External conditions are further evaluated in Chapters 3 through 12 of this SER.

2.3 Design Criteria for Safety Protection Systems

A summary of the design criteria for the safety protection systems of the 32PTH2 DSC are addressed in Section B.2.3 of the FSAR. Details of the design are provided in Sections B.3 through B.11 of the FSAR.

PWR Fuel Specification for the Fuel to be Stored in the 32PTH2 DSC[2]	
PHYSICAL PARAMETERS: Fuel Class	Intact or damaged unconsolidated CE 16x16 class fuel assemblies (with or without control components) that are enveloped by the fuel assembly design characteristics listed in Table B.2.1-3. Reload fuel manufactured by other vendors but enveloped by the design characteristics listed in Table B.2.1-3 is also acceptable. Damaged fuel assemblies beyond the definition contained below are not authorized for storage.
Fuel Damage	Damaged fuel assemblies are assemblies containing missing or partial fuel rods or fuel rods with known or suspected cladding defects greater than hairline cracks or pinhole leaks. The extent of damage in the fuel assembly is to be limited such that a fuel assembly is able to be handled by normal means.
RECONSTITUTED FUEL ASSEMBLIES: A) With Irradiated Stainless Steel Rods • Maximum Number of Reconstituted Assemblies per DSC with Irradiated Stainless Steel Rods	Option 1:8, in selected locations in Zone 2 of Figure B.2.1-1 Option 2: 32 (Additional cooling time requirements per Table B.2.1-8 apply.)
• Maximum Number of Irradiated Stainless Steel Rods per Reconstituted Fuel Assembly	Option 1: 11 Option 2: 7
B) With All Other Alternate Rod Materials • Maximum Number of Reconstituted Assemblies per DSC with Unlimited Number of Low Enriched UO_2 Rods, or Zircaloy Rods or Unirradiated Stainless Steel Rods	32
Control Components (CCs)	• Up to 12 CCs are authorized for storage only in Zone 2 locations as shown in Figure B.2.1-1. • Authorized CCs include Burnable Poison Rod Assemblies (BPRAs), Control Rod Assemblies (CRAs), Thimble Plug Assemblies (TPAs), Axial Power Shaping

[2] FSAR Table B.2.1-1

PWR Fuel Specification for the Fuel to be Stored in the 32PTH2 DSC[2]	
	Rod Assemblies (APSRAs), Control Element Assemblies (CEAs), Vibration Suppression Inserts (VSIs), Orifice Rod Assemblies (ORAs), Neutron Source Assemblies (NSAs), and Neutron Sources. Nonfuel hardware that is positioned within the fuel assembly after the fuel assembly is discharged from the core (such as Guide Tubes or Instrument Tube Tie Rods) or Anchors, Guide Tube Inserts, BPRA Spacer Plates or other devices that are positioned and operated within the fuel assembly during reactor operation are also considered as CCs. • Design basis thermal and radiological characteristics for the CCs are listed in Table B.2.1-2.
Number of Intact Fuel Assemblies	≤ 32
Maximum Assembly plus CC Weight	1550 lbs
Number and Location of Damaged Fuel Assemblies	Up to 16 damaged fuel assemblies. Balance may be intact fuel assemblies, or dummy assemblies which are authorized for storage in 32PTH2 DSC. Damaged fuel assemblies are to be placed in the outer 16 fuel compartments as shown in Figure B.2.1-1. The DSC fuel compartments which store damaged fuel assemblies are provided with top and bottom end caps.
THERMAL/RADIOLOGICAL PARAMETERS: Fuel Assembly Average Burnup, Assembly Average Enrichment and Cooling Time	 Per Table B.2.1-6, Table B.2.1-7, and Table B.2.1-8.
Decay Heat per DSC	Per Figure B.2.1-1.
Maximum Planar Average Fuel Initial Enrichment	Per Table B.2.1-4 or Table B.2.1-5.
Minimum B-10 Content in Neutron Poison Plates	Per Table B.2.1-9.

Thermal and Radiological Characteristics for Control Components Stored in the 32PTH2 DSC[3]

Parameter	CC Source[(1)]
Maximum Gamma Source (γ/sec/assembly)	8.74E+14
Decay Heat[(2)] (Watts/assembly)	20
Minimum Cooling Time[(3)] (years)	10

Notes:

(1) Up to 8 Neutron Sources and NSAs are allowed in any location within Zone 2 of Figure B.2.1-1 except at the four corner locations.

(2) The decay heat for the CCs for cooling time greater than 15 years is well within the uncertainty of the decay heat equation shown in Table B.2.1-7.

(3) The decay heat value of 20 watts per CC shall be included to determine thermal and radiological qualification of fuel assemblies for CC cooling times between 10 years and 15 years.

[3] FSAR Table 2.2.21-2

PWR Fuel Assembly Design Characteristics for the 32PTH2 DSC[4]

Assembly Class(3)	**CE 16x16 (Westinghouse)**	**CE 16x16 (Areva)**
Maximum Unirradiated Length (inches)(1)	178.3	178.3
Fissile Material	UO_2 or (UO_2, Er_2O_3) or (UO_2,Gd_2O_3) or (UO_2, ZrB_2)	UO_2 or (UO_2,Gd_2O_3)
Maximum MTU/Assembly(2)	0.456	0.456
Maximum Number of Fuel Rods	236	236
Maximum Number of Guide Tubes	5	5

Notes:

(1) Maximum Assembly + CC Length (unirradiated)

(2) The maximum MTU/assembly is based on the shielding analysis. The listed value is higher than the actual.

(3) Reload fuel from other manufacturers with these parameters are also acceptable.

[4] FSAR Table B.2.1-3

Maximum Planar Average Initial Enrichment versus Neutron Poison Plate Requirements for the 32PTH2 DSC (Intact Fuel Assembly)[5]

Fuel Assembly Class	Minimum Soluble Boron ppm	Maximum Planar Average Initial Enrichment[(2)] (wt. % U-235) as a Function of Basket Type (Fixed Neutron Poison Plate Loading)			
			Basket Type[(1)]		
			B	C	D
CE 16x16	2600	With CC	4.75	4.95	5.00
	2600	Without CC	4.80	5.00	5.00

Notes:

(1) The neutron poison plate loading requirements as a function of Basket Type are per FSAR Table B.2.1-9.

(2) The maximum planar average initial enrichments are design nominal values. For the maximum planar average initial enrichment of 5.00 wt. % U-235, the criticality analysis is actually performed using 5.05 or 5.10 wt. % U-235.

[5] FSAR Table B.2.1-4

Maximum Planar Assembly Average Initial Enrichment versus Neutron Poison Plate Requirements for the 32PTH2 DSC (Damaged Fuel Assembly)[6]

<table>
<tr><th rowspan="3">Fuel Assembly Class</th><th rowspan="3">Minimum Soluble Boron ppm</th><th colspan="4">Maximum Planar Average Initial Enrichment[(2)] (wt. % U-235) as a Function of Basket Type (Fixed Neutron Poison Plate Loading)</th></tr>
<tr><th rowspan="2"></th><th colspan="3">Basket Type[(1)]</th></tr>
<tr><th>B</th><th>C</th><th>D</th></tr>
<tr><td rowspan="2">CE 16x16</td><td>2600</td><td>With CC</td><td>4.45</td><td>4.60</td><td>4.90</td></tr>
<tr><td>2600</td><td>Without CC</td><td>4.50</td><td>4.70</td><td>5.00</td></tr>
</table>

Notes:

(1) The neutron poison plate loading requirements as a function of Basket Type are per FSAR Table B.2.1-9.

(2) The maximum planar average initial enrichments are design nominal values. For the maximum planar average initial enrichment of 5.00 wt. % U-235, the criticality analysis is actually performed using 5.05 or 5.10 wt. % U-235.

According to Section B.2 of the FSAR, the NUHOMS® 32PTH2 system is designed to provide long term storage of spent fuel. The 32PTH2 DSC materials are selected such that degradation is not expected during the storage period. The 32PTH2 DSC pressure retaining confinement boundary for the spent fuel is described in detail in Chapter B.7. The 32PTH2 DSC is equipped with top and bottom shield plugs to minimize occupational doses at the ends during drying, sealing, and handling operations.

As described in Section B.2 of the FSAR, the NUHOMS® 32PTH2 system is designed for safe and secure, long-term confinement and dry storage of spent fuel assemblies. The key elements of the NUHOMS® 32PTH2 system and their operation which require special design consideration are:

A. Minimizing the contamination of the 32PTH2 DSC exterior by fuel pool water.
B. Providing the 32PTH2 DSC with a confinement boundary to maintain a helium atmosphere.
C. Minimizing personnel radiation exposure during 32PTH2 DSC loading, closure, and transfer operations.
D. The coating materials used in the design of the 32PTH2 DSC are chosen to minimize hydrogen generation.
E. Design of the AHSM-HS and 32PTH2 DSC for postulated accidents.
F. Design of the AHSM-HS passive ventilation system for effective decay heat removal to ensure the integrity of the fuel cladding. The AHSM-HS is designed with no active safety systems.
G. Design of the 32PTH2 DSC to ensure subcriticality.

[6] FSAR Table B.2.1-5

2.4 Evaluation Findings

Based on the NRC staff's review of the information provided in the application, the NRC staff concludes the following:

F2.1 The application and docketed materials adequately identify and characterize the SNF to be stored in the DSS in conformance with the requirements given in 10 CFR 72.236.

F2.2 The application and the docketed materials relating to the design bases and criteria meet the general requirements as given in 10 CFR 72.122(a), (b), (c), (f), (h)(1), (h)(4), (i), and (l).

F2.3 The application and docketed materials relating to the design bases and criteria for structures categorized as important to safety meet the requirements given in 10 CFR 72.122(a), (b)(1), (b)(2) and (b)(3), (c), (f), (h)(1), (h)(4), and (i); and 10 CFR 72.236.

F2.4 The application and docketed materials meet the regulatory requirements for design bases and criteria for thermal consideration as given in 10 CFR 72.122 (a), (b)(1), (b)(2) and (b)(3), (c), (f), (h)(1), (h)(4), and (i).

F2.5 The application and docketed materials relating to the design bases and criteria for shielding, confinement, radiation protection, and ALARA considerations meet the regulatory requirements as given in 10 CFR 72.104(a) and (b); 10 CFR 72.106(b); 10 CFR 72.122(a), (b), (c), (f), (h)(1), (h)(4), and (i); 10 CFR 72.126(a).

F2.6 The application and docketed materials relating to the design bases and criteria for criticality safety meet the regulatory requirements as given in 10 CFR 72.124(a) and (b).

F2.7 The application and docketed materials relating to the design bases and criteria for retrieval capability meet the regulatory requirements as given in 10 CFR 72.122(a), (b)(1), (b)(2), and (b)(3), (c), (f), (h)(1), (h)(4), and (l).

F2.8 The application and docketed materials relating to the design bases and criteria for other SSCs not important to safety but subject to NRC approval meet the general regulatory requirements as given in the following subparts of 10 CFR Part 72: Subpart E, "Siting Evaluation Factors" 72.104 and 72.106; Subpart F, "General Design Criteria" 72.122, 72.124, and 72.126; and Subpart L, "Approval of Spent Fuel Storage Casks."

The NRC staff concludes that the principal design criteria for the NUHOMS® 32PTH2 System are acceptable with regard to meeting the regulatory requirements of 10 CFR Part 72. This conclusion is reached based on a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices. A more detailed evaluation of the design criteria and an assessment of compliance with those criteria are presented in Chapters 3 through 14 of the SER.

2.5 References

1. Transnuclear, Inc., “Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0,” non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Supplemental Information (ML12059A297), February 24, 2012.

4. Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Supplemental Information (ML12158A103), May 24, 2012.

5. Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12254B039), September 7, 2012.

6. Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information, Items 3-2 and 4-7 (ML12297A205), October 15, 2012.

7. Revision 5 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12325A069), November 16, 2012.

8. Revision 6 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Computational Fluid Dynamic Files (ML12352A230), December 11, 2012.

9. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 9-1 (Thermal) Response (ML13100A331), March 18, 2013.

10. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 3-1 (Structural) Response (ML13100A319), March 26, 2013.

11. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

12. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), June 10, 2013.

13. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, Appendix A to Certificate of Compliance No. 1029 - Technical Specifications for the Standardized Advanced NUHOMS® System (ML13198A416), July 16, 2013.

3 STRUCTURAL EVALUATION

The objectives of this review were to assess the safety analysis of the structural design features, the structural design criteria, and the structural analysis methodology used to evaluate the expected structural performance capabilities under normal operations, off-normal operations, accident conditions, and natural phenomena events for those SSCs important to safety included in this application. The acceptance criteria for the design system are to successfully preclude the following negative consequences:

- Unacceptable risk of criticality,
- Unacceptable release of radioactive materials,
- Unacceptable radiation levels,
- Impairment of retrievablity or recovery.

The review was performed using the appropriate regulations as described in 10 CFR 72.124(a), 72.234(a) and (b), 72.236(b), (c), (d), (g), (h) and (l).

The application change that has a direct bearing on the structural aspects of the spent fuel cask storage system is the addition of the 32PTH2 dry shielded canister (DSC) and the advanced horizontal storage module, high burnup and high seismic (AHSM-HS).

This structural safety evaluation report is written in a format that is consistent with NUREG-1536, Rev. 1.

3.1 32PTH2 DSC

3.1.1 Scope

The 32PTH2 DSC is a dual purpose canister that, according to the applicant, is designed to accommodate up to 32 intact PWR fuel assemblies (or up to 16 damaged assemblies, with the remaining intact) with a total maximum heat load of 37.2 kW. The maximum burnup of a 32PTH2 fuel assembly is 62.5 GWd/MTU per Table 3-6 of Enclosure 6 to TN E-31647 (Technical Specifications). The application describes the ability of the 32PTH2 DSC to perform its intended design function during normal and off-normal operating conditions, as well as under postulated accident conditions and extreme natural phenomena events.

For purposes of structural analysis, the 32PTH2 DSC is divided into the 32PTH2 DSC shell assembly and the internal basket assembly. The DSC shell assembly includes the pressure retaining confinement boundary and consists primarily of a cylindrical shell and top and bottom assemblies. The DSC basket assembly consists of the fuel compartment structure, made up of steel tubes, and the transition rails.

The confinement boundary (shown in FSAR Figure B.3.1-2) consists of the cylindrical shell, top and bottom inner cover plates, the vent and siphon block, the vent and siphon cover plates and associated welds. The outer top cover plate provides a redundant confinement boundary. The DSC shell thickness is 5/8" and has only one cavity length option of 178.65 inches. The weight of a fully loaded DSC is 106,000 lbs, as listed in FSAR Table B.3.2-1. FSAR Section B.3.1.1.1

provides additional general information regarding the 32PTH2 DSC. FSAR Table B.2.5-1 tabulates the 32PTH2 items important to safety.

The 32PTH2 is loaded inside a OS200FC transfer cask (TC) for onsite transfer to the AHSM-HS location. The OS200FC TC has already been approved by the NRC and the safety analyses are contained in Appendix U, Section U.3.6.1.5 of CoC No. 1004.

3.1.2 Structural Design Criteria and Design Features

As previously stated, the 32PTH2 is divided into the shell assembly, and the basket assembly. The shell assembly is designed to conform with the requirements of ASME Section III, Division 1, Subsection NB stress requirements. If elastic stress intensity limits cannot be met for Service Level D conditions, then Appendix F may be used to evaluate the DSC shell against elastic-plastic limits. The use of elastic-plastic analysis is permitted per Section 3.5.1.4 ii 1 of NUREG-1536, Rev. 1.

RAI responses 3-1 and 3-9 of Enclosure 2 of E-33290 discuss the method of determining weld flaw depth and stress ratios associated with applicable load conditions (with elastic-plastic limits) for the associated welds that form the confinement boundary. This methodology is consistent with ISG-15, ISG-18, NUREG-1536 and ASME Code Section XI criteria. NRC staff had additional questions, with regards to the use of elastic-plastic methodology for the confinement boundary welds and associated finite element analysis. Therefore, further documentation was provided, by the applicant, in Enclosure 1 to E-35274 (ML13182A044) to clarify and revise the original (Enclosure 2 of E-33290 (ML12254B040)) RAI 3-1 response.

32PTH2 DSC Design Criteria

The 32PTH2 basket assembly is designed to satisfy the requirements of ASME Section III, Division 1, Subsection NG stress requirements. FSAR Table 3.1-4 summarizes the stress criteria for the 32PTH2 basket assembly, and states that for Service Level D requirements, the applicant must evaluate the basket in accordance with Appendix F for elastic-plastic limits.

FSAR Table B.3.1-14 tabulates all the alternatives to the ASME Code pertaining to the DSC shell assembly, and FSAR Table B.3.1-15 tabulates all the alternatives to the ASME Code pertaining to the DSC basket assembly. The applicant must conform with the ASME Code completely for design, fabrication, and acceptance testing, unless it is listed in the alternatives tables in the FSAR. These alternatives are also listed in Section 4.3 of Enclosure 6 to TN E-31647 (Technical Specifications).

DSC stress criteria are tabulated in FSAR Table B.3.1-2 through Table B.3.1-4.
The 32PTH2 Design Criteria is consistent with Section 3.5.1.2 of NUREG 1536, Rev. 1 for design, fabrication and testing of steel confinement casks.

32PTH2 DSC Loads and Load Combinations

Loads and load combinations for normal, off normal, and postulated accident conditions are listed in FSAR Table B.3.1-5. Throughout, this safety evaluation report evaluates normal, off-normal, and accident conditions related to the handling, transfer, and storage of spent nuclear fuel.

32PTH2 DSC Structural Design Features

The 32PTH2 DSC structural design features are adequately described in FSAR Section B.1 (General) and B.3.1.1.1. Drawings are provided in FSAR Section B.1.5.2. The FSAR contains necessary information to fully define the structural features of the cask, as required by Section 3.5.1 ii of NUREG 1536, Rev. 1.

3.1.3 Structural Analysis

Load Conditions – Evaluation of 32PTH2 against Normal, Off-normal, and Accident Conditions

Per FSAR Section B.3.1.2.1.3, the applicant has determined that normal operating design conditions consist of events that occur regularly. Off-normal operating design conditions are events that occur with moderate frequency or as specified by NUREG 1536, Rev. 1. Analysis was also provided for a range of hypothetical accidents in accordance with 10 CFR Part 72. This applicant's determination of normal, off-normal, and accident conditions is consistent with the classification in Section 3.5.1.4 in NUREG 1536, Rev. 1.

FSAR Section B.3.6.1 details the DSC Structural Analysis. The 32PTH2 DSC shell assembly was analyzed using two ANSYS models.

1. 2D axisymmetrical model (FSAR Figure B.3.6-1)
2. 3D 180-degree symmetrical model (FSAR Figure B.3.6-2)

The details of these models are described in FSAR Section B.3.6.1.1.1. The 2D axisymmetrical model was used for the analysis of the vertical deadweight load, vertical transfer/handling loads, top and bottom end drop loads, and internal/external pressure loads. The 3D model is used to analyze pull on the grapple ring, side drop, horizontal deadweight, seismic effects in the horizontal configuration, and the horizontal transfer/handling loads. NRC staff concludes that based on the information submitted in the FSAR and consistent with previous licensing basis for the NUHOMS® systems, the applicant has provided enough detail to satisfy the guidance requirements of Appendix 3A of NUREG 1536, Rev. 1.

The thermal loads and conditions are discussed and analyzed in FSAR Chapter B.4 and evaluated in the thermal section of this safety evaluation report. FSAR Table B.3.6-1 tabulates the thermal load cases analyzed for storage and FSAR Table B.3.6-2 tabulates the load cases analyzed for transfer. FSAR Table B.3.6-3 provides the maximum thermal stress results for normal and off-normal accident conditions.

The DSC shell assembly enveloped stresses for each load during normal, off-normal, and accident condition load cases and results are provided in FSAR Tables B.3.6-4 through B.3.6-7. All listed stress results are less than ASME Code allowables.

The 32PTH2 basket assembly was analyzed using ANSYS models for all of the structural analyses except for the 80 inch accidental drop case and deadweight vertical transfer load case. A hand calculation was used to evaluate the deadweight vertical loading scenario, assuming a 75g quasi-static loading condition.

The ANSYS model used to analyze the 32PTH2 basket assembly is described in FSAR Section B.6.1.2.1. ANSYS was used to evaluate horizontal deadweight in transfer, transfer/handling loads (listed in FSAR B.3.6-9), and deadweight in storage. NRC staff concludes that based on the information submitted in the FSAR and consistent with previous licensing basis for the NUHOMS® systems, the applicant has provided enough detail to satisfy the guidance requirements of Appendix 3A of NUREG 1536, Rev. 1. The stress results for transfer loads are listed in FSAR Table B.3.6-11, and storage loads are listed in FSAR Table B.3.6-13. All results are less than ASME Code allowables.

The 80 inch accidental drop case was modeled in LS-DYNA. The model included soil, cement, the OS200FC transfer cask, and the 32PTH2 DSC. The properties of the soil and concrete target are consistent with the billet impact target as listed in NUREG CR-6608. NRC staff had several questions regarding LS-DYNA's and the applicant's capabilities for post processing basket assembly stress intensities consistent with ASME Section III, Subsection NB requirements. The applicant has provided report TN E-32402, Revision 2 (Enclosure 7 to TN E-33381), titled "Benchmark of LS-DYNA in Transient Dynamic Analysis," dated September 18, 2012. The report details the applicant's and LS-DYNA's ability to extract stress intensity values when an element is subjected to a state of triaxial stress (benchmarked against a known solution). The report details LS-DYNA's ability to solve a benchmarked problem against a theoretical solution and an equivalent ANSYS analysis for different loading cases. The report benchmarks the applicant's new methodology of using LS-DYNA to analyze the basket assembly (with canister shells, rails, and fuel assemblies) at a drop height of 80 inches, compared to their typical methodology of using an ANSYS quasi static analysis with a 75g acceleration input.

The NRC staff agrees that the applicant and LS-DYNA possess the ability to adequately capture the nonlinear structural response and post processing to determine ASME stress intensity values for the 37PTH canister shell, the internal basket assembly, aluminum rails, and fuel assemblies (inside the transfer cask) when subjected to a horizontal transfer canister drop accident. The submitted information is consistent with the approach described in NUREG-1536, Appendix 3A in that it provides a complete discussion on modeling techniques and practices, discussion of computer model development, computer model validation, justification of bounding conditions/scenarios, description of boundary conditions and assumptions, documentation of material properties, description of model assembly, discussion and justification of selected loads and time steps, and sensitivity studies. Note that the NRC approval of this side drop methodology is limited to this specific licensing action and subsequent licensing actions must be consistent with the processes described in NUREG-1536.

Seismic analysis was performed assuming a 6g Vertical + 6g Transverse + 6g Axial loading onto the 32PTH2 DSC (shell and canister). The Square Root of the Sum of the Squares method, consistent with Regulatory Guide 1.92 Chapter 1.1.1 was used. The AHSM-HS was assumed to be subject to the Regulatory Guide 1.60 compatible spectra with a 1.5g horizontal, 1.0g vertical zero period acceleration response spectra. The assumed 6g Vertical + 6g Transverse + 6g Axial loading on the DSC is conservative based on commonly observed spectral accelerations associated with the Regulatory Guide 1.60 spectra. Stress results of the seismic loads on the DSC storage basket are listed in Table B.3.6-13. All listed stress results are less than ASME Code allowables. A Technical Specifications bounding analysis was done to evaluate integrity of the fuel cladding against a 75g horizontal side drop, and 80 inch corner drop. The 75g side drop was evaluated using ANSYS. The ANSYS model and methodology is identical to the one used in CoC 1004 Amendment 10 for the 32PTH1 DSC fuel evaluation. The 80 inch corner drop was done in LS-DYNA. Note that the material properties of high burnup fuel

were used. The NRC staff recognizes that the analysis performed for the fuel is conservative because the pellet is not included in the structural response and the analyzed drop heights/acceleration inputs are bounding (Per Tech Spec - Section 5.3.1 of Enclosure 6 to TN E-31647) with a special lifting device that has at least twice the normal stress design factor for handling heavy loads, or a single failure proof handling system. Therefore, the NRC staff concludes that the discussed methodology, assumptions, finite element model description, and results are appropriate for the analyses that were performed.

3.2 AHSM-HS

3.2.1 Scope

The AHSM-HS is a massive reinforced concrete storage module that houses and provides environmental protection, spent fuel decay heat rejection, and shielding to the 32PTH2 DSC while in storage. As indicated above, the 32PTH2 DSC is placed inside the AHSM-HS, via the OS200FC TC. The AHSM-HS has two primary components, a base (where the DSC is stored), and the roof. The AHSM-HS roof is tied to the base by concrete keys. A minimum of three modules are required in a storage array, per Chapter 4.4.1 of Enclosure 6 to TN E-31647 (Technical Specifications).

The DSC is supported by 2 rails inside the AHSM-HS base, which are procured of stainless steel or weathering steel, defined as carbon steel with a minimum of 0.20 percent copper content. Additionally, load bearing welds for weathering steel may be made with weld material bearing 1 percent or more nickel as an alternate to the copper-bearing weld material. Technical Specification 4.4.3 Item 10 of Enclosure 3 to TN E-33625 (RAI 3-2 amended response) confirms the AHSM support structure material designated for construction.

FSAR Section B.3.1.1.2 provides additional general information regarding the AHSM-HS

3.2.2 Structural Design Criteria and Design Features

FSAR Table B.3.1-1 lists applicable codes and standards for the AHSM-HS design. These design criteria are appropriate and are consistent with design codes of structural components important to safety (not confinement), as described in NUREG-1536, Rev. 1.

Loads and Load Combinations

FSAR Tables B.3.1-10, B.3.1-11, and B.3.3-13 tabulates the loads and load combinations for the design of the AHSM-HS. Overall, these load combinations are consistent with Table 3-3 of NUREG 1536, Rev. 1.

3.2.3 Structural Analysis

FSAR Table B.3.1-1 lists the applicable codes and standards for the AHSM-HS.
The AHSM-HS is constructed of reinforced concrete. Since the reinforced concrete is not part of the confinement boundary, per Section 3.5.2.2 (2) NUREG-1536, Rev. 1, the use of ACI-349 Code is appropriate for AHSM-HS design and fabrication requirements. Per Chapter 4.3.1 of Enclosure 6 to TN E-31647 (Technical Specifications), the AHSM-HS is designed to meet the requirements of ACI-06. FSAR Section B.3.6.2.4.1 discusses the method of determining the capacities of the concrete needed for the AHSM-HS.

Drawings are provided in FSAR Section B.1.5.2. The FSAR contains necessary information to fully define the structural features of the AHSM-HS, as required of Section 3.5.2 ii of NUREG 1536, Rev. 1.

Load Conditions – Evaluation of AHSM-HS against Normal, Off-normal, and Accident Conditions

FSAR Section 3.6.2 discusses the structural analysis of the AHSM-HS against design loads in normal, off-normal, and postulated accident scenarios. The applicant performed analyses of the 32PTH2 loaded into the AHSM-HS against dead load, live load, thermal loads, tornado generated loads, handling loads, earthquake loads, and flood loads.

A single AHSM-HS module was analyzed against normal, off-normal, and accident loads, which is conservative. A minimum installation array of three adjacent and connected AHSM-HS modules is required, per FSAR Section B.3.1.1 and per Chapter 4.4.1 of Enclosure 6 to TN E-31647 (Technical Specifications), which is more stable than a single AHSM-HS module, as analyzed.

The AHSM-HS system was analyzed using three ANSYS models.

1. 3D AHSM-HS model (FSAR Figure B.3.6-12)
2. 3D Support Structure Rail Assembly - Model 1 (FSAR Figure B.3.6-13)
3. 3D Support Structure Rail Assembly - Model 2 (FSAR Figure B.3.6-14)

The 3D AHSM-HS model was used to analyze the entire AHSM-HS system against normal, off-normal, and accident loads that were applied. Internal forces and moments were computed by performing linear elastic finite element analysis. A description of the 3D AHSM-HS model was provided in FSAR Section B.3.6.2.3.1.

The AHSM-HS support structure rail assembly was analyzed using two different models. Model 1 was developed for stress analysis against all load cases, except for the seismic load cases, which were analyzed using Model 2. Descriptions of the 3D support structure rail assembly models were provided in FSAR Section B.3.6.2.3.2.

The applicant further clarified their approach in RAI response 3-7 contained in Enclosure 2 to E-33290.

NRC staff concludes that based on the information submitted in the application and consistent with previous licensing basis for the NUHOMS® systems, the applicant has provided enough detail to satisfy the guidance requirements of NUREG 1536, Rev. 1.

3.3 Evaluation Findings

The NRC staff concludes that the applicant has provided reasonable assurance that the cask system will allow the safe storage of spent nuclear fuel. This conclusion was reached on the basis of a review that considered 10 CFR 72 regulations, appropriate Regulatory Guides, applicable codes and standards, and acceptable engineering practices.

F3.1 The application adequately describes all SSCs that are important to safety, providing drawings and text in sufficient detail to allow evaluation of their structural effectiveness.

F3.2 The applicant has met the requirements of 10 CFR Part 72.236(b). The SSCs important to safety are designed to accommodate the combined loads of normal or off-normal operating conditions and accidents or natural phenomena events with an adequate margin of safety. Stresses at various locations of the cask for various design loads are determined by analysis. Total stresses for the combined loads of normal, off-normal, accident, and natural phenomena events are acceptable and are found to be within limits of applicable codes, standards, and specifications.

F3.3 The applicant has met the requirements of 10 CFR Part 72.236(c), for maintaining subcritical conditions. The structural design and fabrication of the dry storage system includes structural margins of safety for those SSCs important to nuclear criticality safety. The applicant has demonstrated adequate structural safety for the handling, packaging, transfer, and storage under normal, off-normal, and accident conditions.

F3.4 The applicant has met the requirements of 10 CFR 72.236(l). The design analysis and submitted bases for evaluation acceptably demonstrate that the cask and other systems important to safety will reasonably maintain confinement of radioactive material under normal, off-normal, and credible accident conditions.

F3.5 The applicant has met the requirements of 10 CFR 72.236 with regard to inclusion of the following provisions in the structural design:

- Design, Fabrication, Erection, and Testing to Acceptable Quality Standards.
- Adequate Structural Protection Against Environmental Conditions and Natural Phenomena, Fires, and Explosions.
- Appropriate Inspection, Maintenance, and Testing.
- Adequate Accessibility in Emergencies.
- Confinement Barrier that Acceptably Protects the Cladding During Storage.
- Structures that are Compatible with Appropriate Monitoring Systems.
- Structural Designs that are Compatible with Retrievablity of SNF.

F3.6 The applicant has met the specific requirements of 10 CFR 72.236(g) and (h) as they apply to the structural design for spent fuel storage cask approval. The cask system structural design acceptably provides for the following required provisions:

- Storage of the Spent Fuel for a Minimum of 20 years.
- Compatibility with Wet or Dry Loading and Unloading Facilities.

The NRC staff concludes that the structural properties of the structures, systems, and components of the Standardized Advanced NUHOMS® CoC No. 1029 Amendment No. 3 are in compliance with 10 CFR Part 72, and that the applicable design and acceptance criteria have been satisfied. The evaluation of the structural properties provides reasonable assurance that the Standardized Advanced NUHOMS® CoC No. 1029 Amendment No. 3 will allow safe storage

of SNF for a certified life of 20 years. This conclusion is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices.

3.4 References

1. Transnuclear, Inc., "Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0," non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Supplemental Information (ML12059A297), February 24, 2012.

4. Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Supplemental Information (ML12158A103), May 24, 2012.

5. Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12254B039), September 7, 2012.

6. Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information, Items 3-2 and 4-7 (ML12297A205), October 15, 2012.

7. Revision 5 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12325A069), November 16, 2012.

8. Revision 6 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Computational Fluid Dynamic Files (ML12352A230), December 11, 2012.

9. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 9-1 (Thermal) Response (ML13100A331), March 18, 2013.

10. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 3-1 (Structural) Response (ML13100A319), March 26, 2013.

11. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

12. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), June 10, 2013.

13. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, RAI 3-1 Request-Weld, June 21, 2013.

14. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, Appendix A to Certificate of Compliance No. 1029 - Technical Specifications for the Standardized Advanced NUHOMS® System (ML13198A416), July 16, 2013.

4 THERMAL EVALUATION

The thermal review of the application ensures that the cask components and fuel material temperatures of the NUHOMS® 32PTH2 spent fuel storage system (32PTH2) will remain within the allowable values or criteria for normal, off-normal, and accident conditions. These objectives include confirmation that the fuel cladding temperature will be maintained below specified limits throughout the storage period to protect the cladding against degradation that could lead to gross ruptures. This portion of the review also confirms that the cask thermal design has been evaluated using acceptable analytical techniques and/or testing methods. The review was conducted against the appropriate regulations as described in 10 CFR 72.236 that identify the specific requirements for spent fuel storage cask approval and fabrication. The unique characteristics of the spent fuel to be stored are identified, as required by 10 CFR 72.236(a), so that the design basis and the design criteria that must be provided for the structures, systems, and components important to safety can be assessed under the requirements of 10 CFR 72.236(b). The application was also reviewed to determine whether the 32PTH2 design fulfills the acceptance criteria listed in Sections 2, 4, and 12 of NUREG-1536 as well as associated Interim Staff Guidance (ISG) documents.

4.1 Decay Heat Removal System

As described in Section B.1of the FSAR, the 32PTH2 DSC consists of a cylindrical shell, inner top and bottom cover plates, siphon and vent block, siphon and vent port cover plates, and shield plugs at the top and bottom ends. The 32PTH2 DSC basket structure consists of 32 stainless steel fuel compartments with aluminum and neutron absorber plates sandwiched in the space between adjacent compartments. The aluminum plates, together with the neutron absorber plates, provide a heat conduction path from the fuel assemblies to the 32PTH2 DSC shell. The fuel compartments are welded together at selected elevations along the axial length of the basket through stainless steel support plates, which separate the aluminum and poison plates arranged in an egg crate configuration. Aluminum transition rails made from aluminum Type 6061 provide the transition between the basket structure and the cylindrical 32PTH2 DSC shell.

Section B.1 of the FSAR states that the AHSM-HS consists of a thick concrete base and concrete roof. Separate concrete end/rear shield walls provide substantial biological shielding and structural capacity to ensure the safe dry storage of the spent fuel. The width and length of the module is increased to accommodate the larger dimensions of the 32PTH2 DSC. The diameter of the access door is increased to accommodate the larger 32PTH2 DSC. The air inlet and outlet passageways have been modified to minimize frictional losses in the air flow. The interior cavity of the AHSM-HS has a flat roof versus a dome shaped roof provided in the AHSM. Each of these design features results in increasing the heat rejection capacity of the AHSM-HS relative to the AHSM. An array of 6-inch nominal length pipes is provided in the front inlets or top outlets of the AHSM-HS module. This optional feature assists in a reduction of the AHSM-HS dose rates.

The 32PTH2 spent fuel storage system uses the NUHOMS® OS200FC Transfer Cask (TC) previously licensed under Certificate of Compliance No. 1004. Details of the TC are provided in Appendix U, Chapter U.1 of the Standardized NUHOMS® FSAR.

Based on the information provided in the application regarding description of the decay heat removal system, the staff determines that the application is consistent with guidance provided in NUREG-1536. Therefore, the NRC staff concludes that the description of the decay heat removal system is acceptable because the description satisfies NUREG-1536 and the requirements in 10 CFR 72.122(h)(1), 72.122(l), 72.236(b), 72.236(f), 72.236(g), and 72.236(h).

4.2 Material and Design Limits

The applicant adopted certain guidelines of NRC, "Standard Review Plan for Dry Cask Storage Systems," NUREG-1536, and NRC, ISG-11, Revision 3, "Cladding Considerations for the Transportation and Storage of Spent Fuel", to demonstrate the safe storage of the material content described in Chapter 2 of the Final Safety Analysis Report and in the CoC for those aspects relevant to the 32PTH2 design. The applicant established several thermal design criteria for the 32PTH2 spent fuel storage system:

1. Pressures within the 32PTH2 Dried Shielded Canister (DSC) cavity are within design values considered for structural and confinement analyses. The maximum DSC cavity internal design pressures for normal, off-normal and accident conditions are 15 psig, 20 psig and 140 psig, respectively.

2. Maximum and minimum temperatures of the confinement structural components must not adversely affect the confinement function.

3. Maximum fuel cladding temperature limit of 400ºC (752ºF) is applicable to normal conditions of storage, transfer operations from spent fuel pool to ISFSI pad, and all short term operations including vacuum drying and helium backfilling of the 32PTH2 DSC per NUREG-1536 or ISG-11. In addition, NUREG-1536 or ISG-11 do not permit repeated thermal cycling of the fuel cladding with temperature differences greater than 65ºC (117ºF) during drying and backfilling operations.

4. Maximum fuel cladding temperature limit of 570ºC (1058ºF) is applicable to storage or transfer accidents and off-normal storage conditions.

5. Thermal stresses for the 32PTH2 DSC, when appropriately combined with other loads, will be maintained at acceptable levels to ensure the confinement integrity of the 32PTH2 system (see FSAR Chapters B.3 and B.7). FSAR Chapter B.2 presents the principal design bases for the 32PTH2 system.

Based on the information provided in the application regarding material and design limits, the staff determines that the application is consistent with guidance provided in NUREG-1536. Therefore, the NRC staff concludes the material and design limits are acceptable because the design limits satisfy NUREG-1536 and the requirements in 10 CFR 72.122(h)(1), 72.122(l), 72.236(b), 72.236(f), 72.236(g), and 72.236(h).

4.3 Thermal Loads and Environmental Conditions

No change.

4.4 Analytical Methods, Models, and Calculations

4.4.1 Configuration

According to Section B.2.3.1 of the application, the design features of the 32PTH2 spent fuel storage system components are intended to simplify and reduce the on-site spent nuclear fuel loading and handling work effort, to minimize the burden of in-use monitoring, to provide utmost radiation protection to the plant personnel, and to minimize the site boundary dose. The 32PTH2 system is stored at the ISFSI pad in a horizontal orientation. Air flow through inlet and outlet vents by natural convection cools the DSC exterior. Figure 3-1 of the Technical Specifications provides the heat load zoning configurations for the 32PTH2 DSC. The following table summarizes the heat load data.

Number of Fuel Assemblies	4	12	16	
	Zone 1	Zone 2	Zone 3	
Heat Load Zone Configuration (HLZC)	Maximum decay heat/fuel assembly (kW)	Maximum decay heat/fuel assembly (kW)	Maximum decay heat/fuel assembly (kW)	Maximum decay heat/DSC (kW)
1	0.8	1.5	1.0	37.2
2	0.9	1.3	1.0	35.2
3	1.0	1.0	1.0	32.0
4	0.8	1.0	1.0	31.2

The applicant's thermal model of the 32PTH2 DSC considers a poison plate paired with an aluminum (Al 1100) sheet. The thickness of the poison plate and the paired aluminum sheets can be varied within a maximum neutron absorber thickness. To maintain the thermal performance of the basket assembly, the minimum thermal conductivity is taken so that the total thermal conductance (sum of conductivity x thickness) of the poison plate and aluminum sheet is equal to the conductance assumed in the thermal analysis. The applicant stated that since the conductivity of the poison plate generally increases at higher temperatures, testing at room temperature is adequate to qualify the poison plate.

Based on the information provided in the application regarding analytical methods, models, and calculations, the staff determines that the application is consistent with the guidance provided in NUREG-1536. Therefore, the NRC staff concludes the description of the configuration is acceptable because the description satisfies NUREG-1536 and the requirements in 10 CFR 72.122(h)(1), 72.122(l), 72.236(b), 72.236(f), 72.236(g), and 72.236(h).

4.4.2 Material Properties

Material property tables for the 32PTH2 components are included in FSAR Section B.4.2. Materials present in the 32PTH2 system include irradiated UO_2, Zircaloy-4, stainless steel types 304, 316, and XM19, carbon steel, aluminum 6061, aluminum 1100, neutron absorber poison plates (metal matrix composite), lead, NS-3 (neutron shield material), concrete, soil, water, helium, and air. Thermal properties provided in the FSAR include thermal conductivity, density, heat capacity, gas viscosity, and emissivity (as applicable).

Based on the information provided in the application regarding material properties, the staff determines that the application is consistent with the guidance provided in NUREG-1536. Therefore, the NRC staff concludes the material properties used by the applicant in the thermal analyses are acceptable based on NUREG-1536 and the requirements stated in 10 CFR 72.236.

4.4.3 Boundary Conditions

No change.

4.4.4 Computer Codes

The applicant used ANSYS computer code to perform the thermal analyses of 32PTH2 system. ANSYS is a comprehensive thermal, structural and fluid flow analysis package. ANSYS is a finite element analysis code capable of solving steady state and transient thermal analysis problems in one, two or three dimensions. Heat transfer via a combination of conduction, radiation and convection can be modeled by ANSYS.

The applicant developed a half symmetry, three dimensional, ANSYS finite element model of the AHSM-HS loaded with a 32PTH2 DSC, as shown in FSAR Figure B.4.4-1. The AHSM-HS ANSYS model consists of SOLID70 conduction elements that represent concrete and steel support structures of the AHSM-HS, heat shields, DSC shell, and homogenized basket. SHELL57 elements superimposed on SOLID70 elements, as required, for generation of radiating surfaces for the MATRIX50 super elements. Radiation between the DSC shell, heat shields, and AHSM-HS walls is modeled using the ANSYS /AUX12 methodology. The SHELL57 elements used as radiation surfaces are unselected prior to solving the model. To reduce the number of nodes associated with the model's super-elements, the web of the supporting beam is modeled using only SHELL57 elements. As such, conservatively, radiation is not applied on the web of the supporting beam. The applicant states that this methodology is valid since the supporting beam's web is greatly shielded from the DSC radiation via its own flanges. The properties and dimensions of the support beam, such as the thickness of the web, are given as real constants to the appropriate SHELL57 elements

The applicant developed a half symmetry, three-dimensional (3-D) ANSYS finite element model of OS200FC TC loaded with 32PTH2 DSC. The model includes the cask shells, cask bottom plate, cask lid, DSC shell, and DSC end plates with a homogenized basket assembly. The OS200FC TC model with 32PTH2 DSC is shown in FSAR Figures B.4.5-2 and B.4.5-3. SOLID70 elements are used to model the components, including the gaseous gaps. SURF152 surface elements are used for applying the insolation boundary conditions. Radiation along the gap between the DSC and TC inner liner is modeled using the AUX12 processor with SHELL57 elements used to compute the form factors. Decay heat load is applied as a uniform volumetric heat generated throughout the homogenized region of the basket assembly. The homogenized basket assembly is centered axially in the 32PTH2 DSC. A uniform gap of 0.75" is considered between the homogenized basket assembly and the top/bottom ends of the 32PTH2 DSC.

The applicant developed a half symmetry, 3-D model representing the 32PTH2 DSC and basket using ANSYS computer code, as shown in FSAR Figure B.4.6-1 through Figure B.4.6-4. The 32PTH2 DSC model comprises the shell assembly (including the shell, top/bottom cover plates, and shield plug plates), the basket assembly (including fuel compartments, aluminum and neutron absorber basket plates, and transition rails) and the homogenized fuel assemblies. All

of these DSC components are modeled using SOLID70 elements. The fuel assemblies contained in the DSC basket are intact fuel assemblies. Since the damaged fuel assemblies are loaded in the outermost fuel compartment cells, they do not affect the maximum temperatures or the maximum temperature gradients in this evaluation. The applicant performed a sensitivity analysis to capture the effect of the damaged fuel assemblies on the thermal performance of the 32PTH2 DSC, in which the damaged fuel assemblies become rubble. No convection is considered within the canister cavity. Only helium conduction is considered from the basket upper surface to the canister top shield plug. Radiation is considered only implicitly between the fuel rods and the fuel compartment walls in the calculation of effective fuel thermal conductivity. No other radiation heat exchange is considered within the DSC model. Based on fuel assembly characteristics provided in FSAR Chapter A.3, Table A.3.5-2, an active fuel length of 150.0 inches is considered for CE 16x16 class fuel assemblies in 32PTH2 DSC. The position of the active fuel in the 32PTH2 DSC model is assumed to begin 4.0 inches from the bottom end of the 32PTH2 DSC cavity. The fuel assembly beyond the active fuel region is modeled as helium. Radial and axial gaps are assumed in the model, consistent with the design drawings.

Based on the information provided in the application regarding computer codes used in the thermal analysis, the staff determines that the application is consistent with the guidance provided in NUREG-1536. Therefore, the staff concludes the description of the models is acceptable because the description satisfies NUREG-1536 and the requirements in 10 CFR 72.122(h)(1), 72.122(l), 72.236(b), 72.236(f), 72.236(g), and 72.236(h).

4.4.5 Temperature Calculations

4.4.5.1 Thermal Evaluation for Normal Conditions of Storage

The applicant used the 3-D ANSYS models described in the previous section to determine temperature distributions under long-term normal storage conditions for the NUHOMS® 32PTH2 spent fuel storage cask. FSAR tables B.4.4-3, B.4.6-14, B.4.6-16, and B.4.7-1 provide key thermal and pressure results. From the presented results it can be concluded that that the temperature field in the NUHOMS® 32PTH2 spent fuel storage system complies with all regulatory temperature limits, as specified in FSAR Table B.4.1.1. In other words, the thermal environment in the NUHOMS® 32PTH2 spent fuel system is in compliance with FSAR Chapter 2 Design Criteria. Per FSAR Chapter 3, all NUHOMS® 32PTH2 storage module and DSC materials of construction will satisfactorily perform their intended function in the storage mode under a minimum temperature condition of -40°F.

The applicant performed a grid convergence study to obtain the discretization error for the bounding storage configuration. The discretization error is determined using the five steps specified in Section 2-4.1 of ASME V&V 20-2009 (American Society of Mechanical Engineers, “Standard for Verification and Validation in Computational Fluid Dynamics and Heat Transfer,” ASME V&V 20-2009, November 30, 2009).

Based on the information provided in the application regarding the thermal evaluation for normal conditions of storage, the staff determines that the application is consistent with NUREG-1536. Therefore, the staff concludes the thermal evaluation for normal conditions of storage is acceptable because the thermal evaluation satisfies NUREG-1536 and the requirements in 10 CFR 72.122(h)(1), 72.122(l), 72.236(b), 72.236(f), 72.236(g), and 72.236(h).

4.4.5.2 Thermal Evaluation for Short-Term Operations

Prior to storing in the AHSM-HS storage module, Section B.4.8 of the application specifies that the DSC will be loaded with fuel, outfitted with closures, dewatered, dried, backfilled with helium and transported to the storage pad. If the fuel needs to be returned to the spent fuel pool, these steps would be performed in reverse. All of the above operations are short duration events.

4.4.5.3 Vacuum Drying

After completion of the fuel loading, the TC and DSC are removed from the pool and the DSC is drained, dried, sealed, and backfilled with helium. These operations occur with the annulus between the TC and DSC filled with water. The applicant states that the water in the annulus is replenished with fresh water to prevent boiling and maintain the water level if excessive evaporation occurs. Presence of water within the annulus maintains the maximum DSC shell temperature below the boiling temperature of water in open atmosphere (212°F). The staff reviewed this assumption and determined that in order to have water evaporation the DSC shell should be maintained above 212°F and therefore does not agree with the applicant's assumption that the DSC shell temperature is at 212°F. However, based on the applicant's assumption of a DSC at a temperature of 212°F, the applicant obtained a maximum fuel cladding temperature of 572°F, which compensates for any uncertainty in the DSC assumed temperature.

Helium is used as the medium to remove water and subsequent vacuum drying occurs with a helium environment in the DSC cavity. The applicant states that the vacuum does not reduce the pressure sufficiently to reduce the thermal conductivity of the helium in the DSC cavity. With helium being present during vacuum drying operations and a DSC shell temperature equal to water boiling temperature of 212°F, the applicant performed a steady-state analysis to determine the maximum fuel cladding temperature during vacuum drying. The applicant obtained a maximum fuel cladding temperature of 572°F and 540°F for 37.2 kW and 32.0 kW decay heat loads, respectively.

Based on the information provided in the application regarding the thermal analysis during vacuum drying, the staff determines that the application is consistent with the guidance provided in NUREG-1536. Therefore, the staff finds the description of the analysis models and the models themselves acceptable because the description and the models satisfy NUREG-1536 and the regulatory requirements in 10 CFR 72.122 and 10 CFR 72.236.

4.4.5.4 On-Site Transfer

The applicant used the 3-D ANSYS models described in the previous section to determine temperature distributions under long-term normal storage conditions for the 32PTH2 DSC inside OS200FC TC. Table B.4.5-1 of the FSAR lists the operating conditions that the applicant analyzed thermal performance of OS200FC TC with 32PTH2 DSC. The applicant assumed ambient temperatures in the range of 0 to 104°F as normal, outdoor transfer conditions and an ambient temperature of 117°F for the off-normal, hot transfer condition and for transfer accident conditions. The applicant noted that the daily average ambient temperatures of 97°F and 107°F correspond to the normal and off-normal hot storage ambient temperatures of 104°F and 117°F, respectively. The applicant did not assume a daily average for the ambient temperature inside the fuel building. Instead, the maximum temperature of 120°F is considered for the analysis.

The 32PTH2 DSC shell temperatures in the TC thermal analysis are then used as boundary conditions in a subsequent 32PTH2 DSC basket thermal analysis.

The applicant developed two finite element models using ANSYS to analyze the thermal performance of the OS200FC TC with the 32PTH2 DSC, as described below.

Based on the information provided in the application regarding the thermal analysis during onsite transfer, the staff determines that the application is consistent with the guidance provided in NUREG-1536. Therefore, the staff finds that the description of the analysis models and the models themselves acceptable because the description and the models satisfy NUREG-1536 and the regulatory requirements in 10 CFR 72.122 and 10 CFR 72.236.

4.4.5.5 Normal/Off-Normal Transfer Conditions without Air Circulation

For the OS200FC TC model without air circulation, which includes the accident conditions, the applicant used a half-symmetric 3-D thermal model to analyze the thermal performance for steady state and transient operations. A detailed description of the ANSYS thermal model is provided in FSAR Section B.4.5.3.2. The analyses results for vertical loading operations within the fuel building for heat loads ≤ 31.2 kW (HLZC #4) assigned as Load Case T5A per FSAR Table B.4.5-1 and for off-normal transfer conditions for heat loads ≤ 32.0 kW (HLZCs #3 and #4) assigned as Load Case T3 per FSAR Table B.4.5-1 are summarized in FSAR Table B.4.5-4. From this table it can be seen that the maximum temperatures of the OS200FC TC components for these two cases are below the allowable limits. For heat loads > 31.2 and ≤ 32.0 kW (HLZC #3), based on the transient thermal analysis a maximum duration of 75 hours is allowed for the vertical loading operations (Load Case T5 per FSAR Table B.4.5-1) once the water in TC/DSC annulus is drained. FSAR Table B.4.5-4 summarizes the maximum temperatures for the OS200FC TC components and shows that the maximum TC component temperatures are below the allowable limits for the duration of 75 hours. FSAR Table B.4.5-5 summarizes the maximum temperatures for the OS200FC TC components, for heat loads > 32 kW and ≤ 37.2 kW. This table shows that the maximum TC component temperatures are below the allowable limits for 36 hours for these two load cases T6 and T7, per FSAR Table B.4.5-1.

Based on the information provided in the application regarding the thermal analysis during normal/off-normal transfer conditions without air circulation, the staff determines that the application is consistent with NUREG-1536. Therefore, the staff finds that the description of the analysis models and the models themselves acceptable because the description and the models satisfy NUREG-1536 and the regulatory requirements in 10 CFR 72.122 and 10 CFR 72.236.

4.4.5.6 Normal/Off-Normal Transfer Conditions with Air Circulation

For the OS200FC TC model with air circulation, the applicant performed a steady state thermal evaluation using a half-symmetric 3-D ANSYS FLUENT CFD model of the TC, DSC, basket and fuel assemblies to determine the maximum component temperatures. The applicant's CFD model used to simulate the thermal response of the OS200FC TC represents a 180° segment of the cask. The use of a 180° model permits the accurate simulation of the temperature distribution within the cask when the cask is in the horizontal orientation and the axis of the DSC is eccentric to that of the cask. An airflow rate of 450 cfm with a daily average temperature of 107 °F is considered for this evaluation, which results in a mass flow rate of 0.12085 kg/s for the half symmetric model. This mass flow rate is specified as the inlet boundary condition and

pressure outlet boundary condition is specified at the cask lid slots. To achieve the specified air flow rate, the TC support skid is modified by adding two motor-driven redundant industrial blowers and associated hoses which are connected via a cone adapter to the ram access opening. All surfaces are defined as walls except for interfaces and symmetry. The symmetry surface is defined as a symmetry boundary condition.

The maximum fuel cladding and component temperatures during normal/off-normal transfer with air circulation are listed in Tables B.4.6-15, B.4.6-17, and B.4.6-18 of the FSAR. All predicted temperatures remain below allowable material limits. The applicant performed a grid convergence study to obtain the discretization error for the transfer condition with air circulation. The discretization error is determined using the five steps specified in Section 2-4.1 of ASME V&V 20-2009 (American Society of Mechanical Engineers, "Standard for Verification and Validation in Computational Fluid Dynamics and Heat Transfer," ASME V&V 20-2009, November 30, 2009)

Based on the information provided in the application regarding the thermal analysis during normal/off-normal transfer conditions with air circulation, the staff determines that the application is consistent with the guidance in NUREG-1536. Therefore, the staff finds the description of the analysis models and the models themselves acceptable because the description and the models satisfy NUREG-1536 and the regulatory requirements in 10 CFR 72.122 and 10 CFR 72.236.

4.4.5.7 Accident Events

The applicant used the finite element model of the AHSM-HS described in the previous section to determine maximum temperatures of the AHSM-HS and the 32PTH2 DSC shell for the blocked vent accident case. The applicant modified the AHSM-HS model for transient conditions with no convection in the AHSM-HS cavity. Temperature distributions for the blocked vent accident case with 37.2 kW decay heat load at 40 hours after blockage of the vents are shown in FSAR Figure B.4.4-7. The time-temperature histories of AHSM-HS components for this transient model are shown in FSAR Figure B.4.4-8. The results of the blocked vent accident condition show that the maximum concrete temperature at the end of 40 hours is 408ºF. This is above the 350ºF limit given in Section A.4 of ACI-349 for accident conditions. The applicant stated that to account for the effect of higher concrete temperature on the concrete compressive strengths, the structural analysis of AHSM-HS concrete components in FSAR Section B.3 is based on a 10% reduction in concrete material properties. The applicant stated that testing will be performed to document that concrete compressive strength will be greater than that used in the structural analysis documented in Chapter B.3.

The applicant stated that, as noted in FSAR Section B.4.5.2, the loss of neutron shield and loss of air circulation is bounding for the fire accident case. The maximum temperatures for the bounding loss of neutron shield and loss of air circulation steady-state accident condition (Load Case T9) are presented in FSAR Table B.4.5-8. As seen in this table, maximum component temperatures are below the allowable limits.

The maximum fuel cladding temperatures during accident conditions of storage and transfer are listed in Table B.4.6-14 and Table B.4.6-15, respectively. The maximum temperatures of the basket assembly components are listed in Table B.4.6-16 and Table B.4.6-17 for storage and transfer conditions, respectively. As seen in this table, maximum fuel cladding temperatures are below the allowable limits.

Based on the information provided in the application regarding the thermal analysis during accident events, the staff determines that the application is consistent with the guidance provided in NUREG-1536. Therefore, the staff concludes the description of the accident conditions and the results of the analyses to be acceptable because the descriptions and the results satisfy NUREG-1536 and the regulatory requirements in 10 CFR 72.122 and 10 CFR 72.236.

4.4.6 Pressure Analysis

FSAR Section B.4.7.1 provides a description of the free DSC cavity volume calculation. The applicant calculated the DSC maximum gas pressure for a postulated release of fission product gases from fuel rods into the DSC cavity. For this scenario, the amounts of each of the release gas constituents in the DSC cavity are summed and the resulting total pressures determined from the ideal gas law. The maximum computed gas pressures reported in FSAR Table B.4.7-1 is below the DSC internal design pressure for normal conditions of storage.

NUREG-1536 provides the relationship of regulations and areas of review along with guidance on how the application can meet the regulatory requirements. Based on the information provided in the application regarding pressure analysis, the staff determines that the application is consistent with the guidance provided in NUREG-1536. Therefore, the staff concludes the description of the pressure analysis to be acceptable because the description of the pressure analysis, the analysis itself, and the results satisfy the regulatory requirements of 10 CFR 72.122 and 10 CFR 72.236.

4.4.7 Confirmatory Analysis

The staff reviewed the applicant's models and calculation options to determine the adequacy of the proposed NUHOMS® 32PTH2 thermal design. The staff checked the code input in the calculation packages and confirmed that the proper material properties and boundary conditions were applied. The engineering drawings were also consulted to verify that proper geometry dimensions were translated to the analysis model. The material properties presented in the FSAR were reviewed to verify that they were appropriately referenced and used.

4.5 Evaluation Findings

Based on the staff's review of the information provided in the application, the staff concludes the following:

F4.1 Chapter 2 of the FSAR describes structures, systems, and components (SSCs) important to safety to enable an evaluation of their thermal effectiveness. Cask SSCs important to safety remain within their operating temperature ranges.

F4.2 The NUHOMS® 32PTH2 spent fuel storage system is designed with a heat-removal capability having verifiability and reliability consistent with its importance to safety. The cask is designed to provide adequate heat removal capacity without active cooling systems.

F5.3 The spent fuel cladding is protected against degradation leading to gross ruptures under long-term storage by maintaining cladding temperatures below 752°F (400°C).

Protection of the cladding against degradation is expected to allow ready retrieval of spent fuel for further processing or disposal.

F4.4 The spent fuel cladding is protected against degradation leading to gross ruptures under off-normal and accident conditions by maintaining cladding temperatures below 1058°F (570°C). Protection of the cladding against degradation is expected to allow ready retrieval of spent fuel for further processing or disposal.

The staff concludes that the thermal design of the NUHOMS® 32PTH2 spent fuel storage system is in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria have been satisfied. The evaluation of the thermal design provides reasonable assurance that the NUHOMS® 32PTH2 system will allow safe storage of spent fuel. This conclusion is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices.

4.6 References

1. Transnuclear, Inc., "Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0," non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Supplemental Information (ML12059A297), February 24, 2012.

4. Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Supplemental Information (ML12158A103), May 24, 2012.

5. Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12254B039), September 7, 2012.

6. Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information, Items 3-2 and 4-7 (ML12297A205), October 15, 2012.

7. Revision 5 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12325A069), November 16, 2012.

8. Revision 6 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Computational Fluid Dynamic Files (ML12352A230), December 11, 2012.

9. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 9-1 (Thermal) Response (ML13100A331), March 18, 2013.

10. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 3-1 (Structural) Response (ML13100A319), March 26, 2013.

11. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

12. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), June 10, 2013.

13. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, Appendix A to Certificate of Compliance No. 1029 - Technical Specifications for the Standardized Advanced NUHOMS® System (ML13198A416), July 16, 2013.

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5 CONFINEMENT EVALUATION

The confinement review of the NUHOMS® 32PTH2 system ensures that radiological releases to the environment will be within the limits established by the regulations and that the spent fuel cladding and fuel assemblies will be sufficiently protected during storage against degradation that might otherwise lead to gross ruptures. The staff reviewed the information provided in this application to determine whether the NUHOMS® 32PTH2 system fulfills the acceptance criteria listed in Section 5.4 of NUREG 1536, Standard Review Plan for Dry Storage Systems at a General License Facility.

5.1 Confinement Design Characteristics

5.1.1 Design Criteria

As described in Section B.7 of the FSAR, the confinement vessel NUHOMS® 32PTH2 DSC is designed to provide confinement of all radionuclides under normal and accident conditions. The DSC is designed, fabricated and tested in accordance with the applicable requirements of the ASME B&PV Code, Division 1, Section III, Subsection NB, with alternatives to the code as discussed in Chapter B.3, Section B.3.1.2.3.

5.1.2 Design Features

According to Section B.1 of the application, the NUHOMS® 32PTH2 system is a modular canister based spent fuel storage and transfer system which uses the NUHOMS® OS200FC TC during 32PTH2 DSC loading and closure operations and on-site transfer to AHSM-HS. The NUHOMS® 32PTH2 DSC is a high integrity austenitic stainless steel welded vessel that provides confinement of radioactive materials within the limits and encapsulates the fuel in a helium atmosphere under normal, off-normal, and credible accident conditions.

The confinement boundary is formed by the base material (the cylindrical shell, the inner top and bottom cover plates, the vent and siphon block, the vent and siphon cover plates) and the confinement welds (the vent/siphon block-to-shell weld, the circumferential/longitudinal seam welds, the weld of inner bottom cover plate to shell, and the welds of vent/siphon port covers, and the weld connecting the inner top cover plate and the vent/siphon block).

5.2 Confinement Monitoring Capability

As described in Section B.7 of the FSAR, the 32PTH2 DSC is entirely closed by welding and thus, no closure devices are utilized for confinement per IV-4 Acceptance Criteria in Interim Staff Guidance (ISG)-5. However as described in Section B.12 of the FSAR, the applicant indicates that the periodic surveillance and monitoring of the storage module performance, as well as the licensee's use of radiation monitors are adequate to ensure the continued effectiveness of the confinement boundary and to enable the licensee to detect any closure degradation and take appropriate corrective actions to maintain safe storage conditions. The staff reviewed the limiting condition for operation (LCO) and surveillance requirements (SR) described in Section B.12, and concludes that the LCO and SR addressed in the Technical Specifications is sufficient to provide monitoring of confinement performance.

5.3 Nuclides with Potential for Release

According to Section B.7 of the FSAR, the 32PTH2 DSC is designed, fabricated and tested to meet the leak tight criteria of 1.0x10^{-7} ref-cm^3/sec, and there is no contribution to the radiological consequences due to a potential release of canister contents. The staff agrees with this statement because, as stated above, the cask is designed to the leak light criteria.

5.4 Confinement Analyses

5.4.1 Normal Conditions

Section B.7 of the FSAR indicates that the 32PTH2 DSC is designed, fabricated and tested to meet the leak tight criteria of 1.0x10^{-7} ref-cm^3/sec, and there is no significant release of radioactive material under normal conditions of storage. Since the cask is designed to the leak criteria, the staff agrees that the applicant does not need to provide a confinement analysis. The maximum internal pressure in the 32PTH2 DSC during normal operations is 9.4 psig which is below the DSC cavity internal design pressure of 15.0 psig.

5.4.2 Off-Normal Conditions (Anticipated Occurrences)

Section B.7 of the FSAR indicates that the 32PTH2 DSC is designed, fabricated and tested to meet the leak tight criteria of 1.0x10^{-7} ref-cm^3/sec, and there is no significant release of radioactive material under off-normal conditions of storage. The maximum internal pressure in the 32PTH2 DSC during off-normal operations is 18.2 psig which is below the DSC cavity internal design pressure of 20 psig.

5.5 Design-Basis Accident Conditions (Including Natural Phenomenon Events)

According to the applicant, the 32PTH2 DSC is designed, fabricated and tested to meet the leak tight criteria of 1.0x10^{-7} ref-cm^3/sec, and there is no significant release of radioactive material under accident conditions of storage. The maximum internal pressure in the 32PTH2 DSC during accidental conditions is 124 psig which is below the DSC cavity internal design pressure of 140 psig.

The staff reviewed Section B.7 of the FSAR and determined that the confinement design of the 32PTH2 DSC is similar to that for the 32PTH1 DSC which was approved by NRC. After further evaluation, including coordination with the structural evaluation review (FSAR Section B.3) and the thermal evaluation review (FSAR Section B.4), the staff concludes that the 32PTH2 DSC is adequate to maintain its confinement effectiveness under normal, off-normal, and accident conditions.

5.6 Supplemental Information

Consistent with other approved NUHOMS® DSCs, one of the steps in the operating procedures for the 32PTH2 DSC, as described in Section B.8.1.1.3 of the FSAR, is a procedure to verify that the hydrogen concentration does not exceed a safety limit of 2.4% during welding of the inner top cover plate.

5.7 Evaluation Findings

The conclusions below consider the regulation itself, the appropriate regulatory guides, applicable codes and standards. Based on the staff's review of the information provided in the application, the staff concludes the following:

F5.1 Chapter B.7 of the FSAR describes confinement structures, systems, and components important to safety in sufficient detail to permit evaluation of their effectiveness.

F5.2 The design of the NUHOMS® 32PTH2 DSC adequately protects the spent fuel cladding against degradation that might otherwise lead to gross ruptures. Chapter 4 of the SER discusses the relevant temperature considerations.

F5.3 The design of the NUHOMS® 32PTH2 DSC provides redundant sealing of the confinement system closure joints using dual welds on the canister lid and closure.

F5.4 The confinement system is leaktight for normal conditions and hypothetical accident conditions, thus the confinement system will reasonably maintain confinement of radioactive material.

F5.5 The quantity of radioactive nuclides postulated to be released to the environment has been assessed as discussed above. In Chapter 11, "Radiation Protection Evaluation," of the SER, the dose from these releases will be added to the direct dose to show that the NUHOMS® 32PTH2 DSC satisfies the regulatory requirements of 10 CFR 72.104(a) and 10 CFR 72.106(b).

F5.6 The confinement system has been evaluated by appropriate tests to demonstrate that it will reasonably maintain confinement of radioactive material under normal, off-normal, and hypothetical accident conditions.

The staff concludes that the design of the confinement system of the NUHOMS® 32PTH2 is in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria have been satisfied. The evaluation of the confinement system design provides reasonable assurance that the NUHOMS® 32PTH2 will allow safe storage of spent fuel per the applicant's analyses, the staff's review, and acceptable engineering practices.

5.8 References

1. Transnuclear, Inc., "Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0," non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information, Items 3-2 and 4-7 (ML12297A205), October 15, 2012.

4. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

5. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), June 10, 2013.

6 SHIELDING EVALUATION

6.1 Shielding Design Description

The applicant submitted an application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance (CoC) No. 1029, Docket No. 72-1029. The application adds the NUHOMS® 32PTH2 system, which consists of a new transportable Dry Shielded Canister (DSC) designated as 32PTH2, storage modification of the currently licensed Advanced NUHOMS® AHSM horizontal storage module, designated as AHSM-HS. The NUHOMS® 32PTH2 system will use the NUHOMS® OS200FC TC which has been previously licensed under CoC No. 1004, for movement of the DSC to the ISFSI.

The purpose of the shielding evaluation is to verify that the NUHOMS® 32PTH2 system demonstrates adequacy of the shielding design for the content described below.

6.1.1 Design Criteria

According to Section 6.1of the FSAR, the NUHOMS® 32PTH2 system, consisting of the 32PTH2 DSC and the AHSM-HS, form a self-contained, independent, passive system, which does not rely on any other systems or components for its operation when in storage. According to the applicant, the criterion used in the design of the 32PTH2 DSC and AHSM-HS ensures that their exposure to the normal operation environment and credible site hazards does not impair their safety functions.

The spent fuel to be stored in this 32 PTH2 DSC consists of intact (including reconstituted) and or/ damage Combustion Engineering (CE) 16×16 class fuel assemblies clad with a zirconium based alloy and UO_2 or (UO_2, ER_2O_3) or (UO_2,Gd_2O_3) or (UO_2, ZrB_2) fuel pellets. Also, assemblies are with or without Integral Fuel Burnable Absorber (IFBA) rods. The heavy concrete walls and roof of the Standardized Advanced Horizontal Storage Module (AHSM-HS) will provide the bulk of the shielding for the 32 PTH2 DSC and the authorized contents in the storage conditions. The transfer cask (TC) used in the NUHOMS® 32PTH2 system will provide shielding and protection from potential hazards during 32 PTH2 DSC loading and closure operations and onsite transfer to the AHSM-HS.

Section B.2.3 of the FSAR discusses some criteria to minimize radiation exposure. The applicant states that the NUHOMS® 32PTH2 system was designed for safe and secure long-term confinement and dry storage of spent fuel assemblies. The key elements of the NUHOMS® 32PTH2 system and their operation which require special design consideration are: minimizing the contamination of the 32PTH2 DSC exterior by fuel pool water, and minimizing personnel radiation exposure during 32PTH2 DSC loading, closure, and transfer operations.

As described in Section 6.1 of the FSAR, the NUHOMS® 32PTH2 system ISFSI was designed to maintain on-site and off-site doses as low as is reasonably achievable (ALARA) during transfer operations and long-term storage conditions. ISFSI operating procedures, shielding design, and access controls provide the necessary radiological protection to assure radiological exposures to station personnel and the public are ALARA.

6.1.2 Design Features

According to Section 6.1 of the FSAR, the fuel to be stored in the 32PTH2 DCS is limited to a maximum assembly average enrichment of 5.0 wt% U-235. The maximum allowable assembly average burnup is limited to 62.5 GWd/MTU and the minimum cooling time is 5 years. The DSC is designed to store up to 12 Control Components (CCs) with thermal and radiological characteristics as listed in Table B.2.1-2 of the FSAR. Reconstituted assemblies containing replacement irradiated stainless steel rods or an unlimited number of lower enrichment UO_2 rods, or Zircaloy rods, or unirradiated stainless steel rods are also acceptable for storage on this system. The 32 PTH2 DCS can accommodate up to a maximum of 16 damaged fuel assemblies placed in the outer fuel compartments. If there is less than 32 assemblies, the remaining slots can be filled with dummy assemblies or may remain empty. The design basis PWR source term were derived for the CE 16×16 assembly design as described in Section B.5.2 of the FSAR.

Table B.2.1-6 of the FSAR showed the allowable burnup and enrichment combinations for the 32 PTH2 DCS. These combinations were used by the applicant to qualify the fuel assemblies for meeting cask radiation shielding design requirements. On Table B.2.1-7 of the FSAR, a correlation (Decay Heat Equation) for calculating the decay heat of the fuel was provided with specific cooling time, burnup and initial enrichment parameters. Tables B.5.5-31, B.5.5-32, and B.5.5-33 of the FSAR showed the correlation between the burnup, enrichment and cooling time with the dose rates for the different configurations. According to the applicant, these results indicate that any fuel assembly that is qualified form the thermal standpoint is also qualified from a radiological standpoint. Staff verified the results using ORIGEN-ARP depletion code of the SCALE6.1 package.

The maximum dose rates are shown in Tables B.5.5-2 through B.5.5-8 of the FSAR. The bounding dose rate for the NUHOMS® 32PTH2 DSC in the AHSM-HS at the side shield wall surface is 2.00 mrem/hr. At the front of the AHSM-HS, the maximum dose rates are 10.70 mrem/hr. The maximum dose rates for the TC for transfer operations are 511 mrem/hr at the top surface and 202 mrem/hr at the side surface.

According to the applicant, the AHSM-HS was designed to limit the surface dose rates on the cask for all MPC designs as defined in B.1 of the FSAR. The AHSM-HS was also designed to maintain occupational exposures ALARA during MPC transfer operations, with considerations of 10 CFR Part 20 requirements. The calculated AHSM-HS dose rates are provided in Chapter B.10 of the FSAR.

The applicant states that the 32 PTH2 DSC basket structure consists of 32 stainless steel fuel compartments with aluminum and neutron absorber plates sandwiched to form the cell wall between adjacent compartments. The 32 PTH2 DSC shield plugs at the top and the bottom ends minimize occupational doses at the ends during drying, sealing, handling, and transfer operations. During these operations, the combination of thick steel and lead shield plugs at the ends of the 32 PTH2 DSC and heavy/lead/neutron shield material of the OS200FC Transfer Cask (TC) provide shielding for personnel loading and transferring the 32 PTH2 DSC for the storage in the AHSM-HS.

The design basis source terms employed in the shielding analysis of the AHSM-HS were based on the use of bounding neutron and bounding gamma sources. The design basis source terms for the shielding analysis for loading and transfer were determined obtaining the bounding total

dose rates near the OS200FC TC. The design basis fuel for this application corresponds to the fuel assembly with burnup of 33 GWd/MTU, an enrichment of 1.7 wt% U-235 and a cooling time of 5.2 years in Zone 1 and 3 and a burnup of 33 GWd/MTU, an enrichment of 1.7 wt% U-235, and a cooling time of 5.0 years in Zone 2. These zones were based on the total decay heat up to 37.2 kW per canister.

Part of the design feature for this application is the use of a composite CE 16×16 assembly with the maximum initial heavy metal and cobalt in each region as the bounding fuel assembly design from the shielding standpoint. Four axial regions were used in the source term calculations. The regions are: the top (nozzle) region, the active fuel region, the (gas) plenum region, and the bottom (nozzle) region. The applicant explained that the neutron flux during reactor operations is peaked in the active fuel (in-core) region of the fuel assembly and drops off rapidly outside the active fuel region. To account for this reduction in neutron flux, the fuel assembly was divided to four exposures. The elemental compositions of the fuel assembly are listed in Tables B.5.5-10 and B.5.5-11 of the FSAR.

The staff reviewed the design criteria and feature and found them acceptable because the operating procedures of this cask require the users to protect personnel and minimize dose is in accordance with ALARA principles and the regulations of 10 CFR Part 20.

6.2 Radiation Source Definition

6.2.1 Computer Codes for Radiation Source Definition

The design-basis source specifications for bounding calculations were presented in Section B.5.2 of the FSAR. A composite CE 16x16 assembly with the maximum initial heavy metal and cobalt content in each region were identified as the bounding fuel assembly design from a shielding standpoint. Design basis radioactive source terms were calculated with the TRITON/DEPL module of SCALE 6.0. The elemental compositions of the fuel assembly were listed in Table B.5.5-10 and Table B.5.5-11 of the FSAR, respectively. The design basis source terms were generated using a heavy metal loading of 0.456 MTU per assembly. Bounding radiological sources for the authorized control components (CCs) were shown in Table B.5.5-19 of the FSAR.

Simplified shielding analysis models were created by the applicant to generate a set of spatial and energy dependent dose rate equivalent values representing the shielding attenuation per source particle per energy group. The source terms were ranking by the applicant using Burnup, Enrichment, and Cooling Time (BECT) combinations that result in bounding gamma, neutron, and the toral dose rate.

The methodology used by the applicant for fuel qualification was to determine an acceptable combination of burnup and enrichment for the spent fuel assemblies as shown in Table B.2.1-6 of the USFAR. The cooling times employed for these evaluations were such that the resulting fuel assembly satisfies the decay heat limitations per Figure B.2.1-1 of the FSAR, with a minimum cooling time of 5.0 years. The source terms were calculated using a constant cycle average specific power of 30 MW to maximize actinide production rate. According to the applicant, one day of down time was conservatively assumed in the depletion models. The cobalt concentration up to 2000 ppm was used in the various hardware materials for the entire fuel assembly to maximize the gamma source terms.

Staff performed confirmatory analysis using ORIGEN-ARP depletion code within SCALE6.1 package. Confirmatory analysis confirmed that the combinations of burnup and enrichment for a given cooling time were in agreement with the numbers calculated by the applicant. The staff reviewed the source term analyses and found them acceptable because these calculation methods and assumptions are conservative for shielding design and the results are bounding for all allowable contents.

6.2.2 Gamma Source

The gamma source terms were determined by the applicant using four TRITON/T-DEPL models for the four exposure regions of interest for each fuel assembly; the bottom, active fuel, plenum, and top regions. The applicant included in each model the light element specification for the regions being evaluated and the source term output from ORIGEN-S provided the total gamma source from the active fuel region and the gamma source term from the light elements in the plenum, top, and bottom nozzle regions. The gamma source terms used in the MCNP5 shielding models were calculated by multiplying the assembly sources by the number of assemblies, in this case 32 assemblies for a fully loaded 32PTH2 DSC.

Based on the analysis of the gamma spectrum, almost 100% of the gamma spectrum from light elements is in the range of 0.70 MeV to 1.33 MeV, which corresponds exactly to two of the most prominent lines of Co-60 in the spectrum. The principal fission product isotopes that contribute greater than 5% to the gamma source term in the energy range of 0.01 to 0.90 MeV are: Sr-90, Y-90, Rh-106, Cs-137, Pr-144, Eu-154, and Eu-155. Contributions from Y-90, Rh-106, Cs-137, Pr-144, and Eu-154 are dominant in the range of 0.90 to 1.50 MeV. Rh-106, Sm-147, and Ce-142 are the strongest emitters at energies greater than 2.0 MeV.

Staff reviewed the output files submitted by the applicant and confirmed that these isotopes are the major contributors to the gamma source terms.

6.2.3 Neutron Source

To determine the total design basis neutron source term for the active fuel region, the applicant used one TRITON/T-DEPL model. The results indicated that the neutron spectrum for cooling times greater than or equal to 5 years is dominated by Cm-244 in both spontaneous fission and (α,n) reactions. The design basis neutron source terms for the shielding analysis of the 32PTH2 DSC in the AHSM-HS are shown in Table B.5.5-21 of the FSAR. The design basis neutron source terms for the shielding analysis of the 32PTH2 DSC in the OS200FC TC are shown in Table B.5.5-22 and Table B.5.5-23 of the FSAR. Total neutron source terms used in the MCNP5 shielding models were calculated by multiplying the neutron source for each fuel assembly by the total number of assemblies.

Using the ORIGEN/ARP depletion code, the staff reviewed the source term analyses provided by the applicant and confirmed the applicant’s results that, at 5 years or more of cooling time, the neutron source terms were dominated by Cm-244.

6.2.4 Other Parameters Affecting the Source Term

Non-Fuel Hardware

The applicant stated that the 32PTH2 DSC is designed to accommodate up to 32 CE 16 x 16 class fuel assemblies with and without control components (CCs). Authorized CCs include Burnable Poison Rod Assemblies (BPRAs), Control Rod Assemblies (CRAs), Thimble Plug Assemblies (TPAs), Axial Power Shaping Rod Assemblies (APSRAs), Control Element Assemblies (CEAs), Vibration Suppression Inserts (VSIs), Orifice Rod Assemblies (ORAs), Neutron Source Assemblies (NSAs), and Neutron Sources. Nonfuel hardware that is positioned within the fuel assembly after the fuel assembly is discharged from the core such as Guide Tubes or Instrument Tube Tie Rods or Anchors, Guide Tube Inserts, BPRA Spacer Plates or other devices that are positioned and operated within the fuel assembly during reactor operation are also considered as CCs. According to the applicant's analysis, the dose rates due to design basis radiological source terms without CCs remain bounding if the location of fuel assemblies containing CCs is limited to only the 12 fuel compartments designated as zone 2. Figure B.2.1-1 shows the different zones that the fuel assemblies can be stored.

The staff performed confirmatory analysis of the source terms of the spent fuel assemblies with non-fuel hardware using ORIGEN-ARP depletion code (SCALE6.1) which confirmed the applicant's analysis. The source terms for the incorporation of control components in the assemblies were found acceptable because these source terms, when they are used in the MCNP code, result in calculated dose rates under the regulatory limits established in 10 CFR 72.104 and 72.106.

6.3 Shielding Model Specification

The applicant used MCNP5 computer models to determine the dose rates along the front wall surface, the rear shield wall surface, the vent openings, the roof surface, and on the surfaces of the side shield walls of the AHSM-HS. Also, neutron and gamma dose rates on the surface, 1, and 3 feet from the surface of the OS200FC TC were evaluated with the same code.

6.3.1 Configuration of the Shielding and Source

The applicant stated that the geometry and material design features of the AHSM-HS were modeled explicitly in MCNP5. One of the MCNP5 models was developed to calculate the gamma source terms containing a detailed segmentation of the thicker 32PTH2 DSC steel shield plugs and cover lids and AHSM-HS door, and the other model was utilized to calculate the neutron dose rates. The dose rates at the surface, 1.5 feet and 3 feet from the surface of the 32PTH2 DSC/OS200FC TC were determined using MCNP5. Four different configurations associated with loading/unloading of the spent fuel were analyzed. These configurations were (1) transfer (normal), (2) decontamination, (3) welding, and (4) accident.

The fuel assembly was homogenized within the assembly volume, assuming fresh fuel with no blankets, burnable absorbers, or fission product poisons. According to the applicant, this assumption is conservative as it minimizes self-shielding in the source regions. In terms of accident conditions, the OS200FC TC was assumed to lose the liquid neutron shield and steel skin (neutron shield was torn off), maximizing the possible credible dose rate under an accident scenario. The fuel was analyzed as both intact and failed (fuel reconfiguration). For modeling the fuel as rubble, it was assumed that the entire fuel assembly mass was free to redistribute

during the event, and therefore a single homogenized region containing all assembly materials was modeled. Dose rate results for these four configurations were provided in Table B.5.5-4 through Table B.5.5-8 of the FSAR.

6.3.2 Material Properties

The applicant stated that the fuel assembly layout within the 32PTH2 DSC is a Cartesian array inside the fuel compartments surrounded by sheets of poison material which were modeled as aluminum in the shielding calculations. The fuel assembly was homogenized within the assembly volume, assuming fresh fuel with no blankets, burnable absorbers, or fission product poisons. According to the applicant, this assumption is conservative as it minimizes self-shielding in the source regions. The homogenized material compositions were shown in Table B.5.5-25 and Table B.5.5-26 for dry and wet fuel, respectively. The composition and density are specified in Table 5.3.2 of the FSAR. The staff reviewed the applicant's analysis and confirmed that the assumption made by the applicant is conservative.

Staff Evaluation

Based on the information and representation provided in the application, the staff concludes that the design of the shielding system for the 32PTH2 DSC system is in compliance with 10 CFR Part 72 and the applicable design and acceptance criteria have been satisfied. The evaluation of the shielding system provides reasonable assurance that the 32PTH2 DSC system will provide safe storage of spent fuel. This conclusion is based on a review that considered the specifications in this application, the regulations, appropriate regulatory guides, staff confirmatory analysis (including calculations and modeling), and accepted engineering practices. The staff reviewed the external radiation levels under normal and conditions design basis accident conditions and found reasonable assurance that they satisfy 10 CFR 72.

6.4 Shielding Analyses

6.4.1 Computer Codes

The applicant used the Monte Carlo N-Particle (MCNP5) computer program for all of the shielding analyses. Several fixed source components for 32 fuel assemblies were evaluated as part of the shielding analyses. The applicant used axial distributions (axial peaking factors) for both neutron and gamma sources in the active fuel regions. These distributions were employed to describe radiological source terms strength along the Z axis of the active fuel region in MCNP5 models for bounding shielding evaluation and calculation of response functions used during the ranking of assemblies.

The peaking factors mentioned above were used to correct the discrepancy in the shielding models based on the fact that the computer codes utilized herein to calculate source terms intrinsically assume that the power was generated uniformly throughout the active fuel region of fuel assemblies. The total intensity of the neuron source calculated with the depletion models utilized herein needs to be multiplied by the factor of 1.183 to account for normalization of the neutron source. The physical meaning of this multiplication factor is the ratio of the true total strength of the neutron radiation source due to a fuel assembly with an axially non-uniform distribution to the strength from the assembly with a uniform distribution.

The applicant used measurements from a loaded NUHOMS® 24P in the HSM Model 80 loaded with B&W 15x15 Mark B fuel to compare against an MCNP model of the same. The MCNP model was developed to calculate dose rates at the locations where the dose rates were measured on the real system.

Table B.5.5-29 of the FSAR showed the results of the comparison between the MCNP5 model and the NUHOMS® 24P. The staff evaluated this comparison and noticed that MCNP conservatively predicts total dose rates compared to the measured data.

In term of source terms validation, the applicant used two different computer codes. The first, SAS2H/ORIGEN-S, was used for ranking the fuel assemblies and generating decay heat source utilized in the regression analysis to determine parameters of the DHE. It was selected for its computational efficiency and appropriate fidelity required to rank the assemblies based on their respective BECT combinations. TRITON/T-DEPL was employed to calculate the design basis source terms at the BECT combination resulting in the highest dose rate based on the response functions from ranking.

Confirmatory analyses using ORIGEN-ARP within SCALE6.1 depletion code package were performed by staff to verify that the source terms were properly calculated.

6.4.2 Flux-to-Dose-Rate Conversion

MCNP calculates neutron or photon flux and these values can be converted into dose by the use of dose response functions. The rate conversion factors used in these calculations as listed in Table B.5.5-24 of the FSAR from the values of the 1977 version of ANSI/ANS 6.1.1, 1977, which is endorsed by the staff.

6.4.3 Dose Rates

Normal Conditions

For normal conditions, the applicant assumed the 32PTH2 DSC and annulus between the 32PTH2 DSC and OS200FC TC to be dry. The neutron shield was also assumed to be full. The 32PTH2 DSC top shield plug, inner and outer top cover plates, and the OS200FC TC lid were installed. The MCNP5 model for this configuration was shown in Figure B.5.5-20 of the FSAR.

In accordance with ALARA practices, design objective dose rates were established for the NUHOMS® 32PTH2 system in Table B5.5-2 of the FSAR.

Off-site Dose Calculations

The dose limit for unrestricted areas given in 10 CFR 20.1301(a)(2) is 2 mrem in any one hour. Considering the doses at distance for the bare TC and neglecting any shielding that may be afforded by the spent fuel/reactor building, the nearest distance to any unrestricted area would be about 100 meters. This estimate does not include the contributions from any loaded HSM-HSs or other site operations that would also contribute to the dose. For other operations configurations, the unrestricted areas may be closer to the TC. Thus, consistent with 10 CFR 72.13 and 72.212, a consideration for using the OS200FC TC is the licensee’s site and the

ability to establish and enforce the necessary size(s) of restricted areas to ensure compliance with 10 CFR 20.1301(a)(2).

Accident Conditions

For accident conditions, the applicant assumed that the OS200FC TC loses the liquid neutron shield and steel skin. This assumption maximizes a possible credible dose rate under an accident scenario. The fuel was analyzed as both intact and failed (fuel reconfiguration). For modeling the fuel as rubble, it was assumed that the entire fuel assembly mass was free to redistribute during the event, and therefore a single homogenized region containing all assembly materials was modeled. A uniform, combined spatial source distribution was used without axial peaking. The final reconfiguration volume was assumed to be compacted to 50% of the original fuel assembly volume. The MCNP5 model for the accident configuration was shown in Figure B.5.5-23 of the FSAR without reconfiguration and Figure B.5.5-24 of the FSAR with reconfiguration. Dose rate results for these four configurations are provided in Table B.5.5-4 through Table B.5.5-8 of the FSAR.

6.4.4 Confirmatory Calculations

Staff Evaluation

The staff reviewed the dose rate calculations for normal operations and found them acceptable because the calculations demonstrate that the dose rates meet the regulatory requirements in 10 CFR 72.104. Dose rates were calculated for the 32PTH2 DSC loaded with design-basis contents. The staff has reasonable assurance that compliance with 10 CFR Part 20 and 10 CFR 72.104(a) from direct radiation can be achieved by general licensees. The actual doses to individuals beyond the controlled area boundary depend on several site specific conditions such as fuel characteristics, cask-array configurations, topography, demographics, and distances. In addition, 10 CFR 72.104(a) includes doses from other fuel cycle activities, such as reactor operations. Each general licensee is responsible to verify compliance with 10 CFR 72.104(a) in accordance with 10 CFR 72.212. In addition, a general licensee will also have an established radiation protection program as required by 10 CFR Part 20, Subpart B and will demonstrate compliance with dose limits to individual members of the public and workers (including for excavation activities), as required, by evaluation and measurements.

The staff reviewed the accident evaluation and found it acceptable for the design changes requested in the application because the dose rate calculations demonstrate that the regulatory requirements will be satisfied. The staff concludes that there is reasonable assurance that any direct radiation from the storage module satisfies 10 CFR 72.106(b) at or beyond a controlled boundary of 100 meters from the design-basis accidents.

6.5 Evaluation Findings

Based on the NRC staff's review of information provided in the application, the staff concludes the following:

F6.1 The application sufficiently describes shielding design features and design criteria for the structures, systems, and components important to safety.

F6.2 Radiation shielding features of the NUHOMS® 32PTH2 system are sufficient to meet the radiation protection requirements of 10 CFR Part 20, 10 CFR 72.104, and 10 CFR 72.106.

F6.3 Operational restrictions to meet dose and ALARA requirements in 10 CFR Part 20, 10 CFR 72.104 and 72.106 are the responsibility of each general licensee. The NUHOMS® 32PTH2 system shielding features are designed to satisfy these requirements.

The staff concludes that the design of the radiation protection system of the NUHOMS® 32PTH2 system can be operated in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria have been satisfied. The evaluation of the radiation protection system design provides reasonable assurance that the NUHOMS® 32PTH2 system will provide safe storage of spent fuel. This conclusion is based on a review that considered the regulation itself, the appropriate regulatory guides, applicable codes and standards, the applicants analyses, the staff's confirmatory analyses, and acceptable engineering practices.

6.6 References

1. Transnuclear, Inc., "Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0," non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Supplemental Information (ML12059A297), February 24, 2012.

4. Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Supplemental Information (ML12158A103), May 24, 2012.

5. Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12254B039), September 7, 2012.

6. Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information, Items 3-2 and 4-7 (ML12297A205), October 15, 2012.

7. Revision 5 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12325A069), November 16, 2012.

8. Revision 6 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Computational Fluid Dynamic Files (ML12352A230), December 11, 2012.

9. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 9-1 (Thermal) Response (ML13100A331), March 18, 2013.

10. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 3-1 (Structural) Response (ML13100A319), March 26, 2013.

11. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

12. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), June 10, 2013.

13. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, Appendix A to Certificate of Compliance No. 1029 - Technical Specifications for the Standardized Advanced NUHOMS® System (ML13198A416), July 16, 2013

7 CRITICALITY EVALUATION

This section provides the criticality evaluation of Amendment No. 3 to the Standardized Advanced NUHOMS® System design. The purpose of this evaluation is to verify that the amended spent fuel contents remain subcritical under the normal, off normal, and accident conditions involving handling, packaging, transfer, and storage. Only those features of the application that affect the criticality safety of the system are discussed in this section, which include adding a NUHOMS® 32PTH2 system to the authorized contents of the Standardized Advanced NUHOMS® System. As part of this application, the applicant provided supporting criticality safety analyses similar to analyses previously reviewed by the staff for Amendment No. 10 to the Standardized NUHOMS® System (Ref. 1).

The staff reviewed the application to ensure that the Standardized Advanced NUHOMS® System meets the regulatory requirements of 10 CFR Part 72, including the following: 10 CFR 72.124(a), 72.124(b), 72.236(c), and 72.236(g) (Ref. 2). In reviewing this application, the staff followed the guidance in Section 7 of NUREG-1536, “Standard Review Plan for Dry Cask Storage Systems” (Ref. 3). The applicant’s evaluation and the staff’s confirmatory review of the requested changes are described in the following sections.

7.1 Criticality Design Criteria and Features

The major components of the NUHOMS® 32PTH2 System are a new transportable Dry Shielded Canister (DSC) designated the 32PTH2 and a modified version of the Standardized Advanced NUHOMS® AHSM storage module, designated the AHSM-HS (high burnup and high seismic). Criticality safety of the NUHOMS® 32PTH2 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 during loading and unloading operations. The spent fuel pool is credited in the applicant’s criticality safety analyses for having a minimum soluble boron concentration of 2600 ppm. The staff confirmed that the applicant has appropriate Technical Specifications (TS) limits and surveillance requirements for soluble boron concentrations within the 32PTH2 DSC during loading and unloading operations. Administrative control on the soluble boron concentration during loading and unloading of the 32PTH2 DSC consists of frequent and independent measurements.

Figure B.6.6-1 of FSAR Appendix B shows the cross section of the 32PTH2 DSC. The fuel assemblies are placed in 32 square, stainless steel fuel tubes with aluminum and neutron absorber plates sandwiched in the space between adjacent tubes in an egg-crate type basket design. The 32PTH2 DSC basket uses an aluminum/B_4C metal matrix composite (MMC) as its fixed neutron poison material. The applicant stated that 90% credit was taken for the minimum B-10 content in the aluminum/B_4C MMC panels, which exceeds the guidance in NUREG-1536. To justify the higher credit for B-10 content, the applicant subjects the MMC panels made of these materials to a comprehensive program of qualification and acceptance testing as described in FSAR Chapter B.9, which specifically addresses verifying the presence and uniformity of the neutron absorber as prescribed in NUREG-1536. The staff concludes that, based upon the qualification and acceptance testing, the increased credit taken for the minimum B-10 content has been adequately addressed by the applicant and is acceptable.

Each NUHOMS® 32PTH2 DSC uses one of three different baskets (designated as types B, C, and D) depending on the boron content in the basket poison plates required to accommodate

the various enrichment levels of the allowed fuel assemblies. FSAR Table B.6.6-1 lists the minimum B-10 poison loading required for the poison materials and the corresponding poison content modeled in the analysis for each basket type.

The staff reviewed FSAR Sections B.1, B.2, and B.6 and verified that the design criteria and features important to criticality safety are clearly identified and adequately described. The staff also verified that the application 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 because FSAR Section B.3 shows that the basket will remain intact during all normal, off-normal, and accident conditions. Based on the information provided in the application, the staff concludes that the Standardized Advanced NUHOMS® System design with the 32PTH2 DSC meets the double contingency requirements of 10 CFR 72.124(a).

7.2 Fuel Specification

The NUHOMS® 32PTH2 system is designed to accommodate up to 32 intact (including reconstituted) or up to 16 damaged (and the balance intact) CE 16 x 16 class spent fuel assemblies with or without control components with characteristics as described in Section B.2 of the FSAR. Table B.6.6-4 of the FSAR lists the CE 16x16 class fuel assembly design characteristics for the NUHOMS® 32PTH2 DSC.

The staff viewed the information in Sections B.1 and B.6 of the FSAR and verified that the description of the fuel used in the criticality analysis bounds that of the allowable fuel contents. In addition, the applicant does not take credit for burn-up. All assemblies are assumed to be fresh fuel. The staff finds this conservative and acceptable.

In Section B.3.5.3 of the FSAR, the applicant showed that the fuel cladding will not fail during the cask drop accidents, which bound all storage conditions. Thus, the criticality analysis only considered intact fuel pins for the undamaged fuel.

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 B.1, B.2, and B.12 of the FSAR and in the TS.

7.3 Model Specification

The applicant performed sensitivity studies evaluating the effects of fabrication tolerances. These studies showed that the combined tolerance model significantly increases system reactivity and produces the maximum reactivity configuration. The applicant discusses the maximum reactivity configuration in FSAR Section B.6.4.2.1. The staff concludes that this has been adequately addressed by the applicant and that its maximum reactivity model is acceptable because the model provides for the most reactive tolerance combinations and is therefore conservative.

7.3.1 Configuration

The Standardized Advanced NUHOMS® System evaluated in this analysis consists of the 32PTH2 DSC, the OS200FC transfer cask (TC), and the AHSM-HS. The applicant used three-dimensional calculation models in its criticality analyses. The bounding model for each basket type, soluble boron loading, 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 B.6.6-1 through B.6.6-20 of the FSAR. The models were based on the engineering drawings in Section B.1 of the FSAR and consider the worst-case dimensional tolerance values. According to the application, the design-basis off-normal events do not affect the criticality safety design features of the cask system. The neutron shield and stainless steel neutron shield jacket of the TC were not included in the criticality model; however, un-borated 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 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 CE 16x16 class fuel assembly, modeled in the 32PTH DSC over only a 13.48-inch axial section of the basket (actual is 15.0-inches), including the 11.73-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. According to the application, the applicant conservatively reduced the actual poison height for each section by 1.52 inches. The applicant contends that using a shorter poison height in the model ensures that the model is conservative since the amount of poison per unit length is minimized. The applicant's calculation models also, according to the applicant, 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 planar average initial fuel enrichment modeled uniformly throughout the assembly (i.e., no axial or radial enrichment zones or natural uranium blankets) and assumed as the maximum enrichment of the fuel assembly anywhere in the fuel assembly, including all manufacturing tolerances;
5. Omission of spacer grids in the fuel assembly;
6. 90% credit for the B-10 content in the aluminum/B_4C MMC poison plates;
7. Flooding of the fuel rod gap regions with full density water;
8. Water in the 32PTH2 DSC cavity contains a minimum of 2600 PPM soluble boron at optimum density; and
9. CCs that extend into the active fuel region, such as BPRAs, CRAs, APSRAs, CEAs,and NSAs are conservatively assumed to exhibit the neutronic properties of B_4C.

The applicant performed a series of calculations to determine the most reactive configuration for the system with 32 CE 16x16 class fuel assemblies loaded without CCs at 2600 ppm minimum soluble boron concentration in the spent fuel pool or DSC cavity. The most reactive credible configuration was determined to be an infinite array of flooded systems, each containing 32 fuel assemblies, with minimum fuel compartment tube ID, nominal fuel compartment tube thickness, poison thickness of 0.075 inches, minimum assembly-to-assembly pitch, maximum pellet OD, minimum fuel clad thickness, and maximum clad OD.

The applicant's damaged fuel model used the most reactive configuration from the normal condition model as the baseline model for the damaged fuel criticality calculations. The applicant used this configuration to evaluate various postulated damaged fuel configurations, such as single shear, double shear, optimum pitch, axial fuel shifting beyond the poison plates and missing rods. The damaged fuel criticality configurations also, according to the application, conservatively assumed the following:

1. Gross damage resulting from a cask-drop accident is assumed to be either a single-ended or double-ended rod shear with flooding in borated water (during fuel loading and unloading operations). A maximum of 4 inches of fuel may be uncovered by the poison plates due to shifting of the sheared rods.
2. Cases with bare fuel (no clad) and rubble are not modeled since replacing the clad with borated water results in an increase in absorption. Hence, damaged fuel cases are modeled with the presence of the clad around the fuel pellet.
3. Bent or bowed fuel rod cases after the drop accidents assume that the fuel is intact but that the rod pitch is allowed to vary from its nominal fuel rod pitch.
4. Single-ended fuel rod shear cases assume that fuel rods that form one assembly face shear in one place and are displaced to new locations. The fuel pellets are assumed to remain in the fuel rods.
5. Double-ended fuel rod shear cases assume that fuel rods that form one assembly face, shear in two places and the sheared fuel rod pieces are separated from the parent fuel rods.

Because CE 16x16 class fuel assemblies have five guide tubes, the calculational KENO model for damaged fuel criticality analysis also included the most reactive guide tube modeling and was used to determine the maximum allowable initial enrichment as a function of basket type for a minimum soluble boron concentration of 2600 ppm in the spent fuel pool or DSC cavity.

Based on the applicant's analysis, the most reactive damaged fuel configuration occurs in the double-shear scenario, at maximum sheared row displacement, with the five guide tubes. All damaged assembly calculations model 32 damaged assemblies in the 32PTH2 DSC for simplicity and assume the most reactive credible configuration that was modeled in the normal condition model.

Using the most reactive credible configurations, each determined for intact and damaged assemblies, the applicant determined the maximum allowable initial enrichment (with and without CCs) as a function of basket type (Types B through D) for a minimum soluble boron concentration of 2600 ppm in the spent fuel pool or DSC cavity.

The staff reviewed the applicant's criticality models for the Standardized Advanced NUHOMS® System and agrees that they are consistent with the description of the cask and contents given in Sections B.1 and B.2 of the FSAR, 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 B.1 of the FSAR. Models of the cask system and its contents created by the staff were similar to those presented by the applicant.

7.3.2 Material Properties

The applicant's analysis used the values from the SCALE 6 standard composition library for the stainless steel and carbon steel components in the cask's structure. No changes were made to the material properties as a result of this application.

7.4 Criticality Analysis

7.4.1 Computer Codes

The applicant used the three dimensional Monte Carlo SCALE6 (Ref. 4) package to explicitly model the cask and canister configurations analyzed using the 44-GROUP ENDF/B-V cross section set with the KENO V, a multigroup code. The staff reviewed the applicant's analysis and concludes that the applicant appropriately considered the neutron spectrum of the NUHOMS® 32PTH2 DSC.

7.4.2 Multiplication Factor

The applicant performed calculations showing that the Standardized Advanced NUHOMS® System will meet the design criterion of k_{eff} + 2 sigma $\leq$ Upper Sub-critical Limit (USL) when loaded with the allowed contents as specified in the application and proposed TS. The staff reviewed the applicant's calculated k_{eff} values and confirmed that they have been appropriately adjusted to include all biases and uncertainties at a 95% confidence level or better.

The staff verified that the applicant provided representative input files. The staff also verified that the information regarding the model configuration, material properties and cross sections is properly represented in the input files. The staff reviewed the key input data for the criticality calculations specified in the input files and finds them acceptable because the data adequately represents the fuel models used in the analyses. The staff also viewed the output files provided and determined that they have proper convergence and that the calculated k_{eff} values from the output files agree with those reported in the text. All of the calculated k_{eff} values meet the sub-criticality criterion of $k_{eff} < 0.95$ and therefore the staff finds them acceptable.

7.4.3 Benchmark Comparisons

The applicant used the CSAS5 module of the SCALE6 package to perform their criticality analysis using the 44-GROUP ENDF/B-V cross-section library because it yielded a small bias as determined by 118 benchmark calculations. The benchmark problems used were representative of commercial light water reactor fuels and utilized water moderation, boron neutron absorbers, un-irradiated fuel, close reflection, and uranium oxide fuel. The problems encompassed a wide range of uranium enrichments, fuel pin pitches, assembly separation, and fixed neutron absorbers in order to test the ability of the code to accurately calculate k_{eff}.

Using NUREG/CR-6361, "Criticality Benchmark Guide for Light-Water-Reactor fuel in Transportation and Storage Packages" (Ref. 5), the applicant calculated the USL and added an administrative margin of 0.05 to arrive at a minimum USL of 0.9410.

The staff reviewed the applicant's benchmark analysis and determined that the critical experiments chosen are relevant to the cask design. The staff concludes the applicant's method for determining the USL acceptable.

7.5 Criticality Evaluation Summary

The applicant used three-dimensional calculation models in its criticality analyses. Sketches of the models are given in the application, as discussed above. The models are based on the engineering drawings in the application. The design-basis off-normal and accident events do not affect the design of the cask from a criticality standpoint. Therefore, the calculation models for the normal, off-normal, and accident conditions are the same.

NRC staff used the CSAS/KENO-VI codes in the SCALE suite of analytical codes to perform confirmatory analyses using the 44-group and the 238-group (ENDF/B-V) cross-section sets. The staff's model is similar to the applicant's in that it included fresh water in the fuel rod gap and used the appropriate boron credit of up to 90% for the fixed neutron poison plates. The staff selected the most reactive cases demonstrated by the applicant's analysis for the 32PTH2 DSC. The results of the staff's confirmatory calculations were bounded by or closely resembled the applicant's results. All of the staff's results fell below the acceptance criterion of k_{eff} less than 0.95.

Based on the information provided in the application and the staff's own confirmatory analyses, the staff concludes that the NUHOMS® 32PTH2 DSC meets the acceptance criteria specified in 10 CFR Part 72.

7.6 Evaluation Findings

Based on the staff's review of the information provided in the application, the staff concludes the following:

F7.1 Structures, systems, and components important to criticality safety are described in sufficient detail in Sections B.1, B.2, and B.6 of the FSAR to enable an evaluation of their effectiveness.

F7.2 The Standardized Advanced NUHOMS® System with the 32PTH2-DSC is designed to be subcritical under all credible conditions.

F7.3 The criticality design is based on favorable geometry, fixed neutron poisons, and soluble poisons of the spent fuel pool. An appraisal of the fixed neutron poisons has shown that they will remain effective for the term requested in the CoC application and there is no credible way for the fixed neutron poisons to significantly degrade during the requested term in the CoC application; therefore, there is no need to provide a positive means to verify their continued efficacy as required by 10 CFR 72.124(b).

F7.4 The analysis and evaluation of the criticality design and performance have demonstrated that the cask will enable the storage of spent fuel for the term requested in the CoC application.

The staff concludes that the criticality design features for the Standardized Advanced NUHOMS® System with the 32PTH2-DSC are in compliance with 10 CFR Part 72, and that the applicable design and acceptance criteria have been satisfied. The evaluation of the criticality design provides reasonable assurance that the Standardized Advanced NUHOMS® System with the 32PTH2-DSC will allow safe storage of spent nuclear fuel. This conclusion considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices.

7.7 References

1. Transnuclear, Inc., "Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0," non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Supplemental Information (ML12059A297), February 24, 2012.

4. Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Supplemental Information (ML12158A103), May 24, 2012.

5. Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12254B039), September 7, 2012.

6. Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information, Items 3-2 and 4-7 (ML12297A205), October 15, 2012.

7. Revision 5 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12325A069), November 16, 2012.

8. Revision 6 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Computational Fluid Dynamic Files (ML12352A230), December 11, 2012.

9. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 9-1 (Thermal) Response (ML13100A331), March 18, 2013.

10. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 3-1 (Structural) Response (ML13100A319), March 26, 2013.

11. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

12. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), June 10, 2013.

13. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, Appendix A to Certificate of Compliance No. 1029 - Technical Specifications for the Standardized Advanced NUHOMS® System (ML13198A416), July 16, 2013

8 MATERIALS EVALUATION

8.1 General Review Considerations

This section provides the materials evaluation of the application for Amendment No. 3 to the Standardized Advanced NUHOMS® System design. The purpose of this evaluation is to verify that the amended materials ensure adequate material performance of components important to safety of a dry cask storage system (DSS), including the spent fuel canister or cask, under normal, off-normal, and accident-level conditions. Only those features of the application that affect the materials safety of the system are discussed in this section, which include adding a NUHOMS® 32PTH2 DSC to the Standardized Advanced NUHOMS® System.

The staff reviewed the application to ensure that the Standardized Advanced NUHOMS® System meets the regulatory requirements of 10 CFR Part 72. The staff followed the guidance in NUREG-1536, “Standard Review Plan for Dry Cask Storage Systems.”

The staff performed its materials evaluation by comparing the materials properties of the 32PTH2 DSC in this application to those of the 32PTH1 DSC, previously accepted under CoC No. 1004, Amendment No. 10. The 32PTH2 DSC contains several material changes from the 32PTH1, which are described in Section B.3.3 of the FSAR.

The DSC shell is 0.125-inches thicker and fabricated from ASME SA-240, Type 316 Stainless Steel. The Outer Top Cover Plate is fabricated from ASTM A240, Type 316 Stainless Steel and the Top Shield Plug is reduced by 2-inches in thickness to 6-inches. The Inner Bottom Cover Plate is reduced by 0.25-inches in thickness to 2-inches and allows fabrication from SA-182 (Bar), Type F316, and SA-240 (Plate), Type 316 Stainless Steels. The Bottom Shield Plug increases by 0.75-inches in thickness to 5.25-inches. The Outer Bottom Cover Plate is now fabricated by A240, Type 316 Stainless Steel.

The Basket Assembly length has increased by 8.15-inches to 177.15-inches and its fuel compartment width has decreased by 0.05-inches to 8.65-inches. The Basket Rails are now fabricated from solid Aluminum. The Fusion Weld Capacity has decreased by 10-kips to 35-kips. The Fuel Compartment has decreased in thickness with little statistical significance and the Poison Plates are fabricated from MMC (metal matrix composites). Finally, the maximum burn-up has been increased by 0.5 GWd/MTU to 62.5 GWd/MTU, however the maximum heat load has been decreased by 3.6 kW to 37.2 kW’s, compared to the 32PTH1, licensed under CoC 1004, Amendment 10.

In addition, the AHSM-HS module technical specifications, paragraph 4.4.3, site specific parameters and analysis has been changed to reflect staff guidance for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance, of material used for load-bearing support structure components and load bearing welds.

The staff recognizes that Type 316 Stainless Steel provides increased corrosion resistance against many industrial chemicals and solvents, inhibits pitting caused by chlorides, and is particularly resistant to salt water. The staff concludes, based on the information provided in the application and the staff’s independent evaluation, the materials described above are consistent with current industry use and sufficient with use under 10 CFR Part 72.

8.2 Evaluation Findings

Based on the staff's review of the information provided in the application, the staff concludes the following:

F8.1 The application describes the materials that are used for structures, systems, and components important to safety and the suitability of those materials for their intended functions in sufficient detail to evaluate their effectiveness.

F8.2 The applicant has met the requirements of 10 CFR 72.122(a). The material properties of SSCs important to safety conform to quality standards commensurate with their safety function.

F8.3 The applicant has met the requirements of 10 CFR 72.104(a), 72.106(b), and 72.124. Materials used for criticality control and shielding are adequately designed and specified to perform their intended function.

F8.4 The applicant has met the requirements of 10 CFR 72.122(h)(1) and 72.236(h). The design of the DSS and the selection of materials adequately protects the SNF cladding against degradation that might otherwise lead to damaged fuel.

F8.5 The applicant has met the requirements of 10 CFR 72.236(h) and 72.236(m). The material properties of SSCs important to safety will be maintained during normal, off-normal, and accident conditions of operation so the SNF can be readily retrieved without posing operational safety problems.

F8.6 The applicant has met the requirements of 10 CFR 72.236(g). The material properties of SSCs important to safety will be maintained during all conditions of operation so the SNF can be safely stored for a minimum of 20 years and maintenance can be conducted as required.

F8.7 The applicant has met the requirements of 10 CFR 72.236(h). The TN 32PTH2 DSC employs materials that are compatible with wet and dry SNF loading and unloading operations and facilities. These materials should not degrade over time or react with one another during any conditions of storage.

The staff concludes the material properties of the structures, systems, and components of the TN 32PTH2 DSC are in compliance with 10 CFR Part 72, and that the applicable design and acceptance criteria have been satisfied. The evaluation of the material properties provides reasonable assurance the TN 32PTH2 DSC will allow safe storage of SNF for a licensed certified life of 20 years. This conclusion is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices.

8.3 References

1. Transnuclear, Inc., "Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0," non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Supplemental Information (ML12059A297), February 24, 2012.

4. Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Supplemental Information (ML12158A103), May 24, 2012.

5. Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12254B039), September 7, 2012.

6. Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information, Items 3-2 and 4-7 (ML12297A205), October 15, 2012.

7. Revision 5 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12325A069), November 16, 2012.

8. Revision 6 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Computational Fluid Dynamic Files (ML12352A230), December 11, 2012.

9. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 9-1 (Thermal) Response (ML13100A331), March 18, 2013.

10. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 3-1 (Structural) Response (ML13100A319), March 26, 2013.

11. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

12. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), June 10, 2013.

13. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, Appendix A to Certificate of Compliance No. 1029 - Technical Specifications for the Standardized Advanced NUHOMS® System (ML13198A416), July 16, 2013.

14. Safety Evaluation Report for the Standardized NUHOMS® Modular Storage System for Irradiated Nuclear Fuel, Certificate of Compliance No. 1004, Amendment No. 10.

9 OPERATING PROCEDURES EVALUATION

The review of the technical bases for the operating procedures is to ensure that the applicant's application (Ref. 1) presents acceptable operating sequences, guidance, and generic procedures for key operations. The review also ensures that the application incorporates, and is compatible with, the applicable operating control limits in the technical specifications.

The procedures for the 32PTH2 DSC, as described in Section B.8.1 of the FSAR, are similar to those previously approved by the staff for the 24PT1 DSC and 24PT4 DSC. The application identifies and describes the sequence of significant operations and actions that are important to safety for cask loading, cask handling, storage operations, and cask unloading for the NUHOMS® 32PTH2 system. Areas reviewed include: Loading Operations, which addresses fuel specifications, damaged fuel, subcriticality features, ALARA, offsite release, draining and drying, filling and pressurization, welding and sealing, and administrative programs; Cask Handling and Storage Operations; and Cask Unloading, which addresses damaged fuel, cooling, venting, and reflooding, fuel crud, ALARA, and offsite release.

The generic NUHOMS® 32PTH2 system procedures outlined in FSAR Section B.8 are developed to minimize the amount of time required to complete the subject operations, to minimize personnel exposure, and to assure that all operations required for the 32PTH2 DSC loading, closure, transfer, storage, retrieval, and unloading are performed safely. Plant specific ISFSI procedures are to be developed by each licensee in accordance with the requirements of 10 CFR 72.212(b) and the guidance of Regulatory Guide 3.61 [B8.1]. The generic procedures presented in FSAR Chapter B.8 are provided as a guide for the preparation of plant specific procedures and serve to demonstrate how the NUHOMS® 32PTH2 system operations are to be accomplished.

Chapter B.8 presents the operating procedures for the NUHOMS® 32PTH2 system described in previous chapters and shown on the drawings in Chapter B.1, Section B.1.5.2. The procedures include preparation, fuel loading, and closure of the 32PTH2 DSC, transfer to the ISFSI, transfer into the AHSM-HS, monitoring operations, and retrieval from the AHSM-HS. The Standardized Advanced NUHOMS® System transfer equipment and the existing plant systems and equipment are used to accomplish these operations. Procedures delineated in Chapter B.8 describe how these operations are to be performed. Standard fuel assembly and NUHOMS® OS200 FC Transfer Cask (TC) handling operations performed under the licensee's 10 CFR Part 50 operating license are described in less detail. The licensee may revise existing operational procedures and new ones may be developed according to the requirements of the plant, provided that the limiting conditions of operation specified in the Technical Specifications and the Functional and Operating Limits of the Standardized Advanced NUHOMS® CoC are not exceeded.

There are no changes to the following FSAR Chapter B.8 sections: Other Operating Systems, Component/Equipment Spares, Operation Support System, Instrumentation and Control System, System and Component Spares, Control Room and/or Control Areas, Analytical Sampling.

9.1 Cask Loading

Section B.8.1 outlines the typical operating procedures for loading the 32PTH2 DSC into the TC. Flowcharts of loading operations of the NUHOMS® 32PTH2 system are provided in FSAR Figure B.8.1 1.

9.2 Cask Handling and Storage Operations

Section B.8.1 outlines the typical operating procedures for transferring the loaded 32PTH2 DSC to the AHSM-HS.

9.3 Cask Unloading

Section B.8.2 outlines the procedures for retrieving the 32PTH2 DSC from the AHSM-HS and for removing the fuel assemblies from the 32PTH2 DSC. A flow chart of the unloading operations of the 32PTH2 system is provided in FSAR Figure B.8.2 1.

9.4 Evaluation Findings

Based on the staff's review of the information provided in the application, the staff concludes the following:

F9.1 The 32PTH2 DSC is compatible with wet loading and unloading. General procedure descriptions for these operations are summarized in Section B.8 of the applicant's FSAR. Detailed procedures will need to be developed and evaluated on a site-specific basis.

F9.2 The welded lids of the cask allow ready retrieval of the spent fuel for further processing or disposal as required.

F9.3 The smooth surface of the cask is designed to facilitate decontamination. Only routine decontamination will be necessary after the cask is removed from the spent fuel pool.

F9.4 No significant radioactive waste is generated during operations associated with the independent spent fuel storage installation (ISFSI). Contaminated water from the spent fuel pool will be governed by the 10 CFR Part 50 license conditions.

F9.5 No significant radioactive effluents are produced during storage. Any radioactive effluents generated during the cask loading will be governed by the 10 CFR Part 50 license conditions.

F9.6 The content of the general operating procedures described in the application are adequate to protect health and minimize damage to life and property. Detailed procedures will need to be developed and approved on a site-specific basis.

F9.7 The radiation protection chapter of this SER assesses the operational restrictions to meet the limits of 10 CFR Part 20. Additional site-specific restrictions may also be established by the site licensee.

The staff concludes that the generic procedures and guidance for the operation of the NUHOMS® 32PTH2 system are in compliance with 10 CFR Part 72 and that the applicable acceptance criteria have been satisfied. The evaluation of the operating procedure descriptions provided in the application offers reasonable assurance that the cask will enable safe storage of spent fuel. This conclusion is based on a review that considered the regulations, appropriate regulatory guides, applicable codes and standards, and accepted practices.

9.5 References

1. Transnuclear, Inc., "Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0," non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Supplemental Information (ML12059A297), February 24, 2012.

4. Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Supplemental Information (ML12158A103), May 24, 2012.

5. Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12254B039), September 7, 2012.

6. Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information, Items 3-2 and 4-7 (ML12297A205), October 15, 2012.

7. Revision 5 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12325A069), November 16, 2012.

8. Revision 6 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Computational Fluid Dynamic Files (ML12352A230), December 11, 2012.

9. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 9-1 (Thermal) Response (ML13100A331), March 18, 2013.

10. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 3-1 (Structural) Response (ML13100A319), March 26, 2013.

11. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

12. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), June 10, 2013.

13. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, Appendix A to Certificate of Compliance No. 1029 - Technical Specifications for the Standardized Advanced NUHOMS® System (ML13198A416), July 16, 2013

10 ACCEPTANCE TESTS AND MAINTENANCE PROGRAM EVALUATION

The acceptance tests and maintenance program review ensures that the applicant's final safety analysis report (FSAR) includes the appropriate acceptance tests and maintenance programs for the system. A clear, specific listing of these commitments will help avoid ambiguities concerning design, fabrication, and operational testing requirements when the U.S. Nuclear Regulatory Commission (NRC) staff conducts subsequent inspections. Acceptance tests may also be described in the applicable chapter of this Safety Evaluation Report (SER).

The acceptance tests demonstrate that the cask has been fabricated in accordance with the design criteria and that the initial operation of the cask complies with regulatory requirements. The maintenance program describes actions that the licensee needs to implement during the storage period to ensure that the cask performs its intended functions.

Areas reviewed include the following: Acceptance Tests, which addresses structural/pressure tests, leak tests, visual and nondestructive examination inspections, shielding tests, neutron absorber tests, thermal tests and cask identification; and Maintenance Program, which addresses inspection, tests, repair, replacement, and maintenance.

In general, the acceptance tests and maintenance programs outlined in the application cite appropriate authoritative codes and standards.

10.1 Acceptance Tests

10.1.1 Structural/Pressure Tests

According to the application, all weld inspection is performed using qualified processes and qualified personnel according to the applicable code requirements, e.g., ASME or AWS. Non-destructive examination (NDE) requirements for welds are specified on the drawings provided in FSAR Section B.1; acceptance criteria are as specified by the governing code. NDE personnel are qualified in accordance with SNT-TC-1A.

The application states that the confinement welds on the 32PTH2 DSC are inspected in accordance with ASME B&PV Code Subsection NB including alternatives to ASME Code specified in FSAR, Section B.3.1.2.3.

The 32PTH2 DSC non-confinement welds are inspected to the NDE acceptance criteria of ASME B&PV Code Subsection NG or NF, based on the applicable code for the components welded.

The 32PTH2 DSC confinement boundary, except the inner top cover/shield plug to the DSC shell weld, is pressure tested at the fabricator's shop in accordance with ASME Article NB-6300, according to the application. The test pressure is set between 17.0 to 19.0 psig for the 32PTH2 DSC, which bounds the 1.1 x 32PTH2 DSC design pressure of 15 psig, required by NB-6321.

The inner top cover/shield plug to the DSC shell weld is also pressure tested between 17.0 and 19.0 psig for the 32PTH2 DSC following completion of closure welding, after the fuel assemblies are loaded. This test is in accordance with the alternatives to the ASME Code specified in FSAR Section B.3.1.2.3.

The reinforced concrete AHSM-HS is designed in accordance with ACI 349-06, and the level of testing, inspection, and documentation provided during construction and maintenance is in accordance with the quality assurance requirements as defined in 10 CFR Part 72, Subpart G, paragraph 72.140(b) and as described in FSAR Section B.13.

10.1.2 Leak Tests

The application states that the 32PTH2 DSC confinement boundary is tested in accordance with the requirements of ANSI N14.5. Personnel performing the leakage test are qualified in accordance with SNT-TC-1A.

The application states that during fabrication, the 32PTH2 DSC cavity is evacuated and a helium leakage test is performed using a port in the seal plate. A bag or other enclosure is placed around the outside of the entire 32PTH2 DSC and it is filled with helium. This test is used to show that the entire 32PTH2 DSC confinement boundary tested is leak tight ($1x10^{-7}$ ref cm^3/s).
After the 32PTH2 DSC has been loaded with the fuel assemblies, a helium leakage test is performed using a test port in the temporary test cover or in the outer top cover plate. The leakage test thus includes the weld attaching the inner top cover plate to the 32PTH2 DSC shell, the vent and siphon port cover plate welds, the vent/siphon block-to-shell weld and the base metal of the inner top cover plate and vent and siphon port cover plates. The test also verifies that the tested welds and cover plates are leaktight to $1x10^{-7}$ ref-cm^3/s.

10.1.3 Visual and Nondestructive Examination Inspections

FSAR Section B.9.1.1 describes Visual Inspection. Visual inspections are performed at the fabricator's facility to ensure that the 32PTH2 DSC and the AHSM-HS conform to the drawings and specifications. The visual inspections include weld, dimensional, surface finish, and cleanliness inspections.

According to the application, neutron absorbers shall be 100% visually inspected in accordance with the Certificate Holder's QA procedures. Blisters shall be treated as non-conforming. Inspection of MMCs with an integral aluminum cladding shall also include verification that the matrix is not exposed through the faces of the aluminum cladding and that solid aluminum is not present at the edges. Material that does not meet these criteria shall be reworked, repaired, or scrapped.

Other Visual Inspections Criteria (non-Technical Specifications) are described in FSAR Section B.9.1.7.3. According to the application, visual inspections shall follow the recommendations in Aluminum Standards and Data, Chapter 4, “Quality Control, Visual Inspection of Aluminum Mill Products” [B9.4]. Local or cosmetic conditions such as scratches, nicks, die lines, inclusions, abrasion, isolated pores, or discoloration are acceptable.

10.1.4 Shielding Tests

The gamma and neutron shielding materials of the storage system are limited to concrete AHSM-HS components and steel shield plugs in the 32PTH2 DSC. The integrity of these shielding materials is assured by the control of their fabrication in accordance with the appropriate ASME, ASTM or ACI criteria.

10.1.5 Neutron Absorber Tests

According to the application, the neutron absorber used for criticality control in the 32PTH2 DSC basket is a Boron Carbide/Aluminum Metal Matrix Composite (MMC). To assure performance of the neutron absorber's design function only the presence of B-10 and the uniformity of its distribution need to be verified, with testing requirements specific to each material. The boron content for these materials is given in FSAR Table B.9-1.

Prior to use in the 32PTH2 DSC, MMCs shall pass the qualification testing specified in FSAR Section B.9.1.7.6, and shall subsequently be subject to the process controls specified in FSAR Section B.9.1.7.7.

10.1.6 Thermal Tests

Thermal Conductivity Testing is described in FSAR Section B.9.1.7.4. According to the application, testing shall conform to ASTM E1225, ASTM E1461, or equivalent method, performed at room temperature on coupons taken from the final production material.

The measured thermal conductivity values shall satisfy the minimum required conductivities as specified in FSAR Section B.4.3. In cases where the specified thickness of the neutron absorber may vary, the equations introduced in FSAR Section B.4.3 shall be used to determine the minimum required effective thermal conductivity.

Non-conforming material shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures.

Required Qualification Tests and Examinations to Demonstrate Mechanical Integrity is discussed in FSAR Section B.9.1.7.6.4. At least three samples, one each from approximately the two ends and middle of the qualification material run shall be subject to: a) room temperature tensile testing (ASTM- B557) demonstrating that the material has the following tensile properties: Minimum yield strength, 0.2% offset (1.5 ksi), Minimum ultimate strength (5 ksi), Minimum elongation in 2 inches (0.5%). As an alternative to the elongation requirement, ductility may be demonstrated by bend testing per ASTM E290.

b) Testing to verify more than 98% of theoretical density for non-clad MMCs and 97% for the matrix of clad MMCs. Testing or examination for interconnected porosity on the faces and edges of unclad MMC, and on the edges of clad MMC shall be performed by a means to be approved by the Certificate Holder. The maximum interconnected porosity is 0.5 volume %.

Required Tests and Examinations to Demonstrate B-10 Uniformity are addressed in FSAR Section B.9.1.7.6.5. According to the application, uniformity of the boron distribution shall be verified either by: a) neutron radioscopy or radiography (ASTM E94, E142, and E545 of

material from the ends and middle of the test material production run, verifying no more than 10% difference between the minimum and maximum B-10 areal density; or b) quantitative testing for the B-10 areal density, B-10 density, or the boron carbide weight fraction, on locations distributed over the test material production run, verifying that one standard deviation in the sample is less than 10% of the sample mean. Testing may be performed by a neutron transmission method similar to that specified in FSAR Section B.9.1.7.5, or by chemical analysis for boron carbide content in the composite.

10.2 Maintenance Program

Pre-Operational Testing and Maintenance Program is addressed in FSAR Section B.9.2. Section B.9.2.1.1 addresses Inspection of the OS200FC TC Only.

There are no application changes in the sections pertaining to Routine Inspection, Annual Inspection, Pre-Operational Tests, Pre-Operational Test Discussion, Repair, Replacement, and Maintenance, Maintenance of Records, Maintenance of Thermal Monitoring System, Valves, Rupture Discs, and Gaskets on Confinement Vessel.

There are no FSAR changes to Section B.9.3, Training Program.

10.3 Evaluation Findings

Based on the staff's review of the information provided in the application, the staff concludes the following:

F10.1 Section B.9.2 of the FSAR describes the applicant's proposed program for preoperational testing and initial operations of the 32PTH2 DSC and the proposed maintenance program.

F10.2 SSCs important to safety will be designed, fabricated, erected, tested, and maintained to quality standards commensurate with the importance to safety of the function they are intended to perform. Section B.2 of the FSAR identifies the safety importance of SSCs, and the applicable standards for their design, fabrication, and testing.

F10.3 The applicant will examine and/or test the 32PTH2 DSC to ensure that it does not exhibit any defects that could significantly reduce its confinement effectiveness. Section B.9 of the FSAR describes this inspection and testing.

F10.4 The applicant will mark the cask with a data plate indicating its model number, unique identification number, and empty weight. Drawing No. ANUH-1-4003, Sheet 2 of 3 (Detail 6 and 7) in FSAR Section B.1.5 illustrates this data plate.

The staff concludes that the acceptance tests and maintenance program for the (cask designation) are in compliance with 10 CFR Part 72 and that the applicable acceptance criteria have been satisfied. The evaluation of the acceptance tests and maintenance program provides reasonable assurance that the cask will allow safe storage of throughout its licensed or certified term. This conclusion is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted practices.

10.4 References

1. Transnuclear, Inc., “Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0,” non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Supplemental Information (ML12059A297), February 24, 2012.

4. Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Supplemental Information (ML12158A103), May 24, 2012.

5. Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12254B039), September 7, 2012.

6. Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information, Items 3-2 and 4-7 (ML12297A205), October 15, 2012.

7. Revision 5 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12325A069), November 16, 2012.

8. Revision 6 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Computational Fluid Dynamic Files (ML12352A230), December 11, 2012.

9. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 9-1 (Thermal) Response (ML13100A331), March 18, 2013.

10. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 3-1 (Structural) Response (ML13100A319), March 26, 2013.

11. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

12. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), June 10, 2013.

13. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, Appendix A to Certificate of Compliance No. 1029 - Technical Specifications for the Standardized Advanced NUHOMS® System (ML13198A416), July 16, 2013

11 RADIATION PROTECTION EVALUATION

The purpose of this chapter is to evaluate the radiation protection program and the requirements proposed in this application. To ensure that occupational radiation exposures are ALARA for the 32PTH2 DCS, the applicant has identified two primary factors: (1) minimizing occupational exposure during 32PTH2 DSC loading and transfer, and (2) minimizing storage dose rates when the 32PTH2 DSC is stored in the AHSM-HS at the ISFSI. There are some policy considerations that the applicant has discussed in this chapter. The applicant stated that the licensee's existing radiation safety and ALARA policies for the plant should be applied to the ISFSI. The Regulatory Guides 1.8, 8.8, 8.10, and 10 CFR 20 contains the guidelines for the ALARA program that has to be followed by the licensee.

Staff reviewed Section B.9 of the FSAR which describes the operating procedures. In this chapter, operating procedures were adequately described and also mentioned the importance of following ALARA program to limit the radiation exposure to workers. The applicant stated that the occupational exposure is minimized by shielding design of the 32PTH2 DSC and the OS200FC TC as well as procedures associated with loading and transfer operations. Storage dose rates were minimized by thick concrete shielding present in the AHSM-HS roof, use of self-shielding by placing AHSM-HSs directly adjacent to one another, and by facing the lowest dose rate side of the AHSM-HS arrays toward the controlled area boundary of the facility, where possible. Direct radiation dose rate calculations preformed in Chapter B.5 were used in this chapter to justify the bases for various exposure times, personnel locations relative to the cask and number of personnel required on each operation.

The staff reviewed the radiation protection design features, design criteria, and supporting operating procedures and concludes that they meet the regulatory dose requirements of 10 CFR Part 20, 10 CFR 72.104, 10 CFR 72.106, and 10 CFR 72.126.

11.1 Radiation Protection Design Criteria and Features for the Transfer and Storage Casks

To ensure a high degree of integrity for the confinement of radioactive materials and reduction of direct radiation exposures to ALARA, the applicant established the following criteria and features: (1) the 32PTH2 DSCs will be loaded, sealed, and leak-tested prior to transfer to the ISFSI, (2) the fuel will not be unloaded nor will the 32PTH2 DSCs be opened at the ISFSI unless the ISFSI is specifically licensed for these purposes, (3) the fuel will be stored in a dry inert environment inside the 32PTH2 DSCs so that no radioactive liquid is available for leakage, (4) the 32PTH2 DSCs will be sealed and tested leak-tight with a helium atmosphere to prevent oxidation of the fuel. The leak-tight design features were described in Section B.7 of the FSAR, (5) the 32PTH2 DSCs will be heavily shielded on both ends to reduce external dose rates, the shielding design features were discussed in Section B.5 of the FSAR, and (6) no radioactive material will be discharged during storage since the 32PTH2 DSC is designed, fabricated and tested to be leak-tight. In Section B.10.1.2 of the FSAR, the applicant discusses other design considerations. Shield plugs at the ends of the 32PTH2 DSC provide shielding for welding operations and during onsite 32PTH2 DSC transfer. OS200FC TC lead shielding and neutron shielding provide required shielding during transfer activities. The AHSM-HS walls, roof and shield walls provide shielding during storage. The 32PTH2 DSC will not be opened nor fuel removed while at the ISFSI, unless the ISFSI is specifically licensed for these purposes.

As part of the design, two different configurations were analyzed by the applicant: (1) a 2x10 back-to-back array of AHSM-HSs and two 1x10 front-to-front arrays of AHSM-HSs. Figure B.10.2-1 and Figure B.10.2-2 of the FSAR provide a sketch of the general configurations, respectively, and (2) the AHSM-HS arrays were modeled as a box enveloping the AHSM-HSs and 3 foot shield walls on the back (for the two 1x10 arrays only) and two sides. Source particles were then started on the surfaces of the box.

Confirmatory analyses performed by staff on source terms calculations conclude that the dose rates values satisfy the regulatory requirement for the dose limits to individuals located beyond the controlled area boundary specified in 10 CFR 72.104.

11.2 Occupational Exposures

The applicant stated that the licensees may elect to use different equipment and/or different procedures than assumed in the evaluation. It is important to mention that specific steps are sometimes necessary at the individual site to load the canister, complete closure operations, and place the canister in the AHSM-HS. The licensee may choose to modify the sequence of operations in order to achieve reduced dose rates for a larger number of steps, with the end result of reduced total exposure. The licensee is required under 72.104(b) to practice ALARA with respect to the total exposure received for a loading campaign. The estimated occupational exposures to ISFSI personnel during loading, transfer, and storage of the 32PTH2 DSC was presented in Table B.10.3-1 of the FSAR.

There are some areas of highest operational dose (potential streaming paths) such as the front of a loaded AHSM-HS at the air inlet vent, at the OS200FC TC side surface with a dry 32PTH2 DSC (outer top cover plate welding, transfer operations) and at the 32PTH2 DSC/OS200FC TC annulus. Consistent with 10 CFR Part 20, operating procedures and personnel training must be in place in order to minimize personnel exposure in these areas.

Procedures detailing the process for loading the DSCs into the Standardized Advanced Horizontal Storage Module (AHSM-HS) with the OS200FC TC are shown in Section B.8 of the FSAR.

Dose to the occupational workers come from the direct and skyshine radiation of the ISFSI. Table B.10.2-5 and Table B.10.2-6 of the FSAR showed the radiation dose rates in the vicinity of a 2x10 back-to-back array of AHSM-HSs. Table B.10.2-7 and Table B.10.2-8 show the radiation dose rates in the vicinity of two 1x10 front-to-front arrays of AHSM-HSs. Staff evaluated the dose rate on these areas and found them acceptable based on the regulatory limits in 10 CFR Part 20 and Regulatory Guide 8.34.

11.3 Exposures at or Beyond the Controlled Area Boundary

The annual exposure at various distances from the back and side of the two 1x10 arrays were presented in Table B.10.2-10 and Figure B.10.2-4 of the FSAR. The applicant performed calculations for exposure at the distance of at least 300 m from the front of the 2x10 array and 200 m from the sides of both arrays and the back of the two 1x10 arrays to verify if they meet the annual dose rate limit for both configurations. Staff review of these evaluations is described in the following sections of this SER.

11.3.1 Normal Conditions

Normal and Off-Normal Conditions

The applicant stated that the average distance for a given operation takes into account that the operator may be in contact with the OS200FC TC, but this duration will be limited. However, given the nature of the dose rates associated with the OS200FC TC, particularly for the configurations where the TC is outside the spent fuel pool and the supplemental shielding, concerns arise over and greater attention is needed to the impacts that operations with this TC will have on doses to members of the public. The shielding chapter of this SER discusses the different configurations of the TC during normal operations and the dose rates associated with the configuration resulting in the bounding dose rates for the whole operations sequence (i.e., the bare TC).

For draining activities, vacuum drying, and leak testing, the attachment of fittings will take place closer to the OS200FC TC than the operations of the pump and vacuum drying system. For decontamination activities, although operators could be near the OS200FC TC for some activities, other parts of the operations could be performed by remote operations. For this reason, the applicant's evaluation uses 1 foot to 3 feet as an appropriate average distance for these operations.

The dose limit for unrestricted areas given in 10 CFR 20.1301(a)(2) is 2 mrem in any one hour. Considering the doses at distance for the bare TC and neglecting any shielding that may be afforded by the spent fuel/reactor building, the nearest distance to any unrestricted area would be about 100 meters. This estimate does not include the contributions from any loaded HSM-HSs or other site operations that would also contribute to the dose. For other operations configurations, the unrestricted areas may be closer to the TC. Thus, a consideration for using the OS200FC TC is the licensee's site and the ability to establish and enforce the necessary size(s) of restricted areas to ensure compliance with 10 CFR 20.1301(a)(2).

11.3.2 Accident Conditions and Natural Phenomenon Events

Accident Conditions Specific to the OS200FC TC

It was assumed by the applicant that during an accident the OS200FC TC completely loses its liquid neutron shield and steel skin. This assumption, according to the applicant, maximizes a possible credible dose rate under an accident scenario. The fuel was analyzed as both intact and failed (fuel reconfiguration). For modeling the fuel as rubble, the applicant assumed that the entire fuel assembly mass was free to redistribute during the event, and therefore a single homogenized region containing all assembly materials was modeled. The MCNP5 model for the accident configuration was shown in Figure B.5.5-23 of the FSAR without reconfiguration and Figure B.5.5-24 with reconfiguration.

11.4 ALARA

The applicant stated that the ISFSI personnel should be trained in the proper operation of the NUHOMS® 32PTH2 system and updated on ALARA practices and dose reduction techniques. This training includes operations, inspections, repair, and maintenance. Proper training of personnel helps to minimize exposure to radiation such that the total individual and collective

exposure to personnel in all phases of operation and maintenance are kept ALARA. Consistent with 10 CFR Part 20, and 72.104(b), implementation of ISFSI systems and equipment procedures must be reviewed by the licensee to ensure exposures are ALARA during all phases of operations, maintenance and surveillance.

11.5 Evaluation Findings

The staff finds with reasonable assurance that the design of the radiation protection system of the NUHOMS® 32PTH2 System has been demonstrated to be in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria have been satisfied. The evaluation of the radiation protection system design provides reasonable assurance that the NUHOMS® 32PTH2 System will allow safe storage of spent fuel. This conclusion is reached on the basis of a review of the applicant's submittals that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted health physics practices.

Based on the staff's review of the information provided in the application, the staff concludes the following:

F11.1 The NUHOMS® 32PTH2 System provides radiation shielding and confinement features that are sufficient to meet the requirements of 10 CFR 72.104 and 72.106.

F11.2 The design and operating procedures of the NUHOMS® 32PTH2 System provide acceptable means for controlling and limiting occupational radiation exposures within the limits given in 10 CFR Part 20 and for meeting the objective of maintaining exposures ALARA.

The staff concludes that the design of the radiation protection system of the NUHOMS® 32PTH2 System is in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria have been satisfied. The evaluation of the radiation protection system design provides reasonable assurance that the NUHOMS® 32PTH2 System will allow safe storage of SNF. This conclusion is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted health physics practices.

11.6 References

1. Transnuclear, Inc., "Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0," non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Supplemental Information (ML12059A297), February 24, 2012.

4. Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Supplemental Information (ML12158A103), May 24, 2012.

5. Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12254B039), September 7, 2012.

6. Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information, Items 3-2 and 4-7 (ML12297A205), October 15, 2012.

7. Revision 5 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12325A069), November 16, 2012.

8. Revision 6 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Computational Fluid Dynamic Files (ML12352A230), December 11, 2012.

9. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 9-1 (Thermal) Response (ML13100A331), March 18, 2013.

10. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 3-1 (Structural) Response (ML13100A319), March 26, 2013.

11. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

12. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), June 10, 2013.

13. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, Appendix A to Certificate of Compliance No. 1029 - Technical Specifications for the Standardized Advanced NUHOMS® System (ML13198A416), July 16, 2013

12 ACCIDENT ANALYSES EVALUATION

Section B.11 of the FSAR addresses accident analyses, which describe the postulated off-normal and accident events that might occur during storage of the 32PTH2 DSC in an AHSM-HS at an ISFSI. Portions of Section B.11 have been identified as “No change” due to the addition of the NUHOMS® 32PTH2 system to the Standardized Advanced NUHOMS® System. For those sections, the description or analysis presented in the corresponding sections of the UFSAR for the Standardized Advanced NUHOMS® System with a 24PT1-DSC or 24PT4-DSC loaded in the AHSM is also applicable to the system with a 32PTH2 DSC loaded in the AHSM-HS.

Chapter B.11 also addresses the potential causes of these events, their detection and consequences, and the corrective course of action to be taken by ISFSI personnel. Accident analyses demonstrate that the functional integrity of the system is maintained by:

- Maintaining sub-criticality within margins defined in Chapter B.6
- Maintaining confinement boundary integrity
- Ensuring fuel retrievability and
- Maintaining doses within 10 CFR 72.106 limits (< 5 rem).

12.1 Cause of the Event

FSAR Section B.11.1 addresses off-normal operations. Off-normal operations are design events of the second type (Design Event II) as defined in ANSI/ANS 57.9 [B11.1]. Design Event II conditions consist of that set of events that, although not occurring regularly, can be expected to occur with moderate frequency, or on the order of once during a calendar year of ISFSI operation. For the Standardized Advanced NUHOMS® System, off-normal events could occur during fuel loading, trailer towing, 32PTH2 DSC transfer and other operations. The two off-normal events, which bound the range of off-normal conditions, are:

1. A “jammed” 32PTH2 DSC during loading or unloading of the AHSM-HS
2. The extreme ambient temperatures of -40°F (winter) and +117°F (summer)

These two events envelop the range of expected off-normal structural loads and temperatures acting on the Standardized Advanced NUHOMS® System.

There are no application changes to the Off-Normal Transfer Loads and Postulated Cause of the Event sections as described in Section B.11.1.1.

12.2 Detection of the Event

FSAR Section B.11.1.1.2 addresses if the 32PTH2 DSC were to jam or bind during transfer, the hydraulic pressure in the ram, and the maximum ram design force sufficient to overcome any potentially higher resistance loads due to sticking of the 32PTH2 DSC in either the OS200FC TC or the AHSM-HS.

12.3 Summary of Event Consequences and Regulatory Compliance

The analysis of effects and consequences for the 32PTH2 DSC and the AHSM-HS are addressed in B.11.1.1.3. According to the application, the 32PTH2 DSC and the AHSM-HS are designed and analyzed for off-normal transfer loads for maximum force that the ram is able to develop, during insertion (loading) and during retrieval (unloading) operations. These analyses are discussed in Chapter B.3. For either loading or unloading of the 32PTH2 DSC under off-normal conditions, the stresses on the shell assembly components are demonstrated to be within the ASME Service Level B allowable stress limits.

Thermal analyses of the NUHOMS® 32PTH2 system with the 32PTH2 DSC and CE 16x16 Class fuel for extreme ambient conditions are presented in Chapter B.4. The effects of extreme ambient temperatures on the NUHOMS® 32PTH2 system are discussed in Chapter B.3. There are no changes to the Extreme Ambient Temperatures, Postulated Cause of the Event, Detection of Event, and Radiological Impact from Off-Normal Operations sections in Chapter B.11.1.2.

12.4 Corrective Course of Action

FSAR Section B.11.1.1.4 provides that the required corrective action is to reverse the direction of the force being applied to the 32PTH2 DSC by the ram, and return the 32PTH2 DSC to its previous position. Since no permanent deformation of the 32PTH2 DSC occurs, the sliding transfer of the 32PTH2 DSC to its previous position is unimpeded. The transfer cask alignment is then rechecked, and the transfer cask repositioned as necessary before attempts at transfer are renewed.

12.5 Evaluation Findings

Based on the staff's review of the information provided in the application, the staff concludes the following:

F12.1 Structures, systems, and components of the 32PTH2 DSC are adequate to prevent accidents and to mitigate the consequences of accidents and natural phenomena events that do occur.

F12.2 Table 13-1 of the SER lists the Technical Specifications for the Standardized Advanced NUHOMS® System. These Technical Specifications are further discussed in Chapter 13 of the SER.

F12.3 The applicant has evaluated the 32PTH2 DSC to demonstrate that it will reasonably maintain confinement of radioactive material under credible accident conditions.

F12.4 An accident or natural phenomena event will not preclude the ready retrieval of SNF for further processing or disposal.

F12.5 The SNF will be maintained in a subcritical condition under accident conditions.

F12.6 Neither off-normal nor accident conditions will result in a dose to an individual outside the controlled area that exceeds the limits of 10 CFR 72.104(a) or 72.106(b), respectively.

F12.7 No instruments or control systems are required to remain operational under accident conditions.

The staff concludes that the accident design criteria for the 32PTH2 DSC are in compliance with 10 CFR Part 72, and the accident design and acceptance criteria have been satisfied. The applicant's accident evaluation of the cask adequately demonstrates that it will provide for safe storage of SNF during credible accident situations. This conclusion is reached on the basis of a review that considered independent confirmatory calculations, the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices.

12.6 References

1. Transnuclear, Inc., "Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0," non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Supplemental Information (ML12059A297), February 24, 2012.

4. Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Supplemental Information (ML12158A103), May 24, 2012.

5. Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12254B039), September 7, 2012.

6. Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information, Items 3-2 and 4-7 (ML12297A205), October 15, 2012.

7. Revision 5 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12325A069), November 16, 2012.

8. Revision 6 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Computational Fluid Dynamic Files (ML12352A230), December 11, 2012.

9. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 9-1 (Thermal) Response (ML13100A331), March 18, 2013.

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11. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

12. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), June 10, 2013.

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13 TECHNICAL SPECIFICATIONS AND OPERATING CONTROLS AND LIMITS EVALUATION

The purpose of the review of the technical specifications for the cask is to determine whether the applicant has assigned specific controls to ensure that the design basis of the cask system is maintained during loading, storage, and unloading operations.

The Standardized Advanced NUHOMS® System is described in the UFSAR for CoC-1029. The NUHOMS® 32PTH2 System consists of a new transportable Dry Shielded Canister (DSC) designated the 32PTH2 and a modified version of the Standardized Advanced NUHOMS® AHSM storage module, designated the AHSM-HS. The 32PTH2 DSC is similar to the 32PTH1 DSC licensed under CoC 1004 Amendment 10, except the shell is thicker for better corrosion protection. The AHSM-HS modules are similar to the HSM-HS modules licensed under CoC No. 1004 Amendment No. 10, except the components have been upgraded for higher seismic values. The design requirements for the NUHOMS® 32PTH2 system are described in FSAR Appendix B (Chapters 1 through 13). The transfer cask to be used for the 32PTH2 DSC is the OS200FC TC, licensed under CoC No. 1004 Amendment No. 10.

The scope of the application includes four separate changes. These changes are:

- Add a NUHOMS® 32PTH2 system to the Standardized Advanced NUHOMS® System.

- Incorporate transition details from the existing AHSM array to the new AHSM-HS array. The AHSM-HS array can be coupled to existing AHSM arrays.

- Update the Technical Specifications (TS) to achieve consistency and clarity, to enhance the staff's review, based on recent interactions with the NRC staff on other TN licensing actions.

- The application does not propose any technical changes regarding the previously licensed Standardized Advanced NUHOMS® System DSCs (the 24PT1 DSC and the 24PT4 DSC). However, certain TS changes made for clarification affect these DSCs.

13.1 Approved Contents

The spent fuel to be stored in the 32PTH2 DSC consists of intact (including reconstituted) and/or damaged CE 16x16 class fuel assemblies clad with a zirconium based alloy and UO_2 or (UO_2, Er_2O_3) or (UO_2,Gd_2O_3) or (UO_2, ZrB_2) fuel pellets. Assemblies are with or without Integral Fuel Burnable Absorber (IFBA) rods.

The fuel to be stored is limited to a maximum assembly average initial enrichment of 5.00 wt. % U-235 as a result of the shielding analysis, and limited to a maximum planar average initial enrichment of 5.00 wt. % U-235 as a result of the criticality analysis.

The maximum allowable assembly average burnup is limited to 62.5 GWd/MTU. The minimum cooling time is 5 years.

FSAR Section B.12, Conditions For Use: Operating Controls and Limits or Technical Specifications and Bases for Technical Specifications incorporates the addition of the NUHOMS® 32PTH2 system to the Standardized Advanced NUHOMS® System. FSAR Section B.12.2 describes the basis for the proposed technical specifications (TS) related to the NUHOMS® 32PTH2 system.

Based on the addition of the NUHOMS® 32PTH2 system to the Standardized NUHOMS® Storage System, the TS have been revised to accommodate the new DSCs and the fuel types to be stored in the DSC. These changes have been identified in the TS attachment to the CoC.

Table 13-1 lists the TS changes for use of the NUHOMS® 32PTH2 systems, in concert with the Standardized NUHOMS® system.

FSAR reference sections include the following: B.2, B.3, B.4, B.5,. B.6, and B.11.

Area Changed	Table 13-1: Description and Justification for Change	Staff Finds Acceptable	
		YES	NO
Throughout	Amendment level changed to 3.	√	
	Editorial changes to nomenclature and spelling made for clarity and consistency. (e.g., “B-10,” “transfer,” “U-235,” “UFSAR,” “Zircaloy,” “wt. %,” “inches,” etc.).	√	
	Fully spelled abbreviated words such as “Maximum,” “Number,” and “including.”	√	
	Because it is not a defined term, the term “fuel assembly” or “fuel assemblies” was de-capitalized unless it was used as part of one of the defined terms.	√	
	The term “(continued)” was added to pages for consistency and clarity.	√	
	Added “Part” to 10 CFR 50, 10 CFR 71, etc.	√	
	For clarity, discussions of fuel assembly enrichment limits are made consistent regarding the use of the terms “maximum planar” and “assembly average,” as they relate to criticality and to shielding, respectively.	√	
Cover page	Added “Standardized” to be consistent with the CoC language.	√	
Table of Contents List of Tables List of Figures	Updated.	√	
Definitions	Definition of ADVANCED HORIZONTAL STORAGE MODULE updated to add the AHSM-HS.	√	

Area Changed	Table 13-1: Description and Justification for Change	Staff Finds Acceptable	
		YES	NO
Definitions	Existing DAMAGED FUEL ASSEMBLY definition applies to the 24PT1-DSC and 24PT4-DSC only. Added a separate DAMAGED FUEL ASSEMBLY definition for the 32PTH2 DSC only.	√	
Definitions	Definition of DRY SHIELDED CANISTER (DSC) updated to include the 32PTH2 DSC.	√	
Definitions	Definition of INDEPENDENT SPENT FUEL STORAGE INSTALLATION (ISFSI) updated to add the AHSM-HS.	√	
Definitions	Definition of RECONSTITUTED FUEL ASSEMBLY updated to be clear that the fuel assembly could, or could not, be further irradiated.	√	
Definitions	Definition of STORAGE OPERATIONS updated to add the AHSM-HS.	√	
Definitions	Definition of TRANSFER CASK (TC) updated to include the OS200FC onsite transfer cask and the AHSM-HS.	√	
Definitions	Definition of TRANSFER OPERATIONS updated to remove the stipulation that a DSC only contains INTACT or DAMAGED fuel assemblies, and to include AHSM-HS.	√	
Definitions	Definition of UNLOADING OPERATIONS updated to remove the stipulation that a DSC only contains INTACT or DAMAGED fuel assemblies, and to include AHSM-HS.	√	
1.2	Editorial change to update numbering, to be consistent with the EXAMPLES explanation.	√	
1.4	Numbering in Section 1.4 which is in the format “12.3”, “12.3.0.x” etc., which refers to original SAR locations, is changed to “3”, “3.0.x” etc. to be consistent with the TS numbering scheme.	√	
2.3	Added a new section, for fuel to be stored in the 32PTH2 DSC.	√	
2.4	Editorial change to update numbering from “2.3” to “2.4”. Corrected “2.1” to “2.0” because Section 2.1 is specific to the 24PT1 DSC, whereas this specification is intended to apply to all DSCs.	√	
Tables 2-2, 2-6, 2-7, 2-8	Changed “Maximum Fuel Enrichment” to “Maximum Planar Average Fuel Enrichment” to improve clarity and consistency with SAR analyses..	√	
Figure 2-2	Added a top row to the table to specify the zones, for consistency and clarity.	√	
Table 3-1	Added new table providing PWR fuel specification for the fuel to be stored in the 32PTH2 DSC. (Reference Appendix B, Table B.2.1-1.)	√	

Area Changed	Table 13-1: Description and Justification for Change	Staff Finds Acceptable	
		YES	NO
Table 3-2	Added new table providing thermal and radiological characteristics for control components stored in the 32PTH2 DSC. (Reference Appendix B, Table B.2.1-2.)	√	
Table 3-3	Added new table providing PWR fuel assembly design characteristics for the 32PTH2 DSC. (Reference Appendix B, Table B.2.1-3.)	√	
Table 3-4	Added new table providing maximum planar average initial enrichment versus neutron poison requirements for the 32PTH2 DSC (intact fuel assembly). (Reference Appendix B, Table B.2.1-4.)	√	
Table 3-5	Added new table providing maximum planar average initial enrichment versus neutron poison requirements for the 32PTH2 DSC (damaged fuel assembly). (Reference Appendix B, Table B.2.1-5.)	√	
Table 3-6	Added new table providing allowable fuel burnup and enrichment combinations for the 32PTH2 DSC. (Reference Appendix B, Table B.2.1-6.)	√	
Table 3-7	Added new table providing fuel assembly decay heat determination specifications for the 32PTH2 DSC. (Reference Appendix B, Table B.2.1-7.)	√	
Table 3-8	Added new table providing additional cooling times (ΔT) in years for fuel assemblies with up to 7 fuel rods reconstituted with irradiated stainless steel. (Reference Appendix B, Table B.2.1-8.)	√	
Table 3-9	Added new table providing B-10 specification for the 32PTH2 poison plates. (Reference Appendix B, Table B.2.1-9)	√	
Figure 3-1	Added new figure providing heat load zoning configurations for the 32PTH2 DSC. (Reference Appendix B, Figure B.2.1-1.)	√	
LCO 3.0.4	Added 32PTH2 DSC to the LCO.	√	
LCO 3.0.5, 3.0.6, 3.0.7	Based on NUREG-1745, LCO 3.0.5 is changed to “not applicable to a spent fuel storage cask” and LCOs 3.0.6 and 3.0.7 are removed.	√	
LCO 3.1.1.c	Added new LCO section providing requirements for 32PTH2 DSC bulkwater removal medium and vacuum drying pressure.	√	

Area Changed	Table 13-1: Description and Justification for Change	Staff Finds Acceptable	
		YES	NO
LCO 3.1.2.c	Added new LCO section providing requirements for 32PTH2 DSC helium backfill pressure.	√	
LCO 3.1.3	Added new LCO providing requirements for the time limit for completion of DSC transfer for the 32PTH2 DSC.	√	
LCO 3.2	Added new LCO providing requirements for 32PTH2 DSC criticality control.	√	
4.1.1	"this FSAR is" is changed to "these specifications are" because the section applies to the TS.	√	
4.2.2	This section is clarified to distinguish between the FSAR tables associated with the 24PT1 and 24PT4 DSCs, and discussion is added associated with the 32PTH2 DSC and the AHSM-HS.	√	
4.2.3	Added discussion regarding 32PTH2 DSC basket types and requirements for neutron absorbers.	√	
4.2.5	Added information regarding the 32PTH2 DSC not requiring fuel spacers.	√	
Figure 4-1	Added an explanatory note regarding ligament width dimensions, and expanded the figure title to indicate applicability to the 24PT1 and 24PT4-DSCs.	√	
4.3.1	Added AHSM-HS requirements to the Codes and Standards section for the horizontal storage modules.	√	
4.3.2	Added 32PTH2 requirements to the Codes and Standards section dry shielded canisters.	√	
4.3.3	Added OS200FC requirements to the Codes and Standards section on transfer casks.	√	
4.3.4	Clarified the current ASME code alternatives to specify that they apply to the 24PT1 and 24PT4-DSCs. Added 32PTH2 ASME code alternatives tables to this section. Also revised item No. 2 following the code alternatives tables to make it applicable to the previously licensed DSCs and the new 32PTH2 DSC.	√	
4.4.1	Added storage configuration requirements for the AHSM-HS, specifying 8 feet for the minimum distance between the AHSM-HS and the ISFSI pad edge.	√	
4.4.3	Added a 10th requirement, involving requirements for DSC support structure material composition for certain AHSM-HS components when the ISFSI is located in a coastal saltwater marine atmosphere.	√	
5.1	Added requirements for the minimum information content of the fuel removal procedure.	√	
5.2	Added AHSM-HS to the Thermal Monitoring Program.	√	
5.2.2	Add pertinent new FSAR Appendix B references to the training program requirements.	√	

Area Changed	Table 13-1: Description and Justification for Change	Staff Finds Acceptable	
		YES	NO
5.2.3 c)	This specification, is removed, based on the following: • The specification cites 10 CFR 72.212(b)(2), but the words are associated with 10 CFR 72.44(d)(3) • Per 10 CFR 72.13, 10 CFR 72.44(d)(3) is applicable to specific licenses, but not general licenses or certificates of compliance.	√	
5.2.4	Added Item c. to the radiation protection program section to establish controls for draining when using a TC with a liquid neutron shield. Item d. revised to add the AHSM-HS to the basis for DSC contamination limits. Added Item f. for TC/32PTH2 DSC dose rate limits, configurations, and measurement requirements. Added Item g. for 32PTH DSC inner top cover plate weld leak testing.	√ √ √ √	
5.2.5 a)	Subsections "a)" and "b)" are reversed. By reversing TS Section 5.2.5 Subsections a) and b) and therefore putting the conditional requirements for AHSM/AHSM-HS Air Temperature Difference verification first, followed by the AHSM/AHSM-HS Concrete Temperature monitoring, and then the visual inspection of AHSM/AHSM-HS Air Vents, this change creates a more logical sequencing of these subsections. This subsection (now 5.2.5 b) is clarified as to when the requirements become effective, thereby providing specificity that is necessary to avoid false alarms during initial AHSM/AHSM-HS heatup, when (renumbered) 5.2.5 a) is in effect and (renumbered) 5.2.5 b) is not yet in effect. Added 32PTH2 DSC and AHSM-HS requirements to this specification.	√ √ √	
5.2.5 b)	This is now Specification 5.2.5 a). This subsection is renamed "AHSM Air Temperature Difference Verification." The title change makes the title more indicative of the purpose of the subsection. Added 32PTH2 DSC and AHSM-HS requirements to this specification.	√ √ √	
5.2.5 c)	Added 32PTH2 DSC and AHSM-HS requirements to this specification.	√	
5.2.6	Added new section providing requirements for hydrogen gas monitoring for the 32PTH2 DSC.	√	
5.3.1 and 5.3.2	Clarified this section to indicate that the "cask" is the "transfer cask" and that the "transporter" is the "transfer trailer."	√	

Area Changed	Table 13-1: Description and Justification for Change	Staff Finds Acceptable	
		YES	NO
5.4	Added a new section providing requirements for an AHSM-HS dose rate evaluation program.	√	
5.5	Added new section providing requirements for concrete testing of the AHSM-HS.	√	
5.6	Added new section providing requirements for AHSM-HS configuration changes.	√	

13.2 Limiting Conditions for Operation (LCO)

FSAR Section B 12.3 establishes in LCO 3.0.1, 3.0.2, and 3.0.4 the general requirements applicable to all TS in B.12.3.1 and B.12.3.2 related to the NUHOMS® 32PTH2 system.

13.3 Surveillance Requirements (SR)

FSAR Section B 12.3 establishes in SR 3.0.1 through 3.0.4 the general requirements applicable to all TS related to the NUHOMS® 32PTH2 system.

13.4 Evaluation Findings

Based on the staff's review of the information provided in the application, the staff concludes the following:

F13.1 The staff concludes that the conditions for use for Advanced NUHOMS® System 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 Standardized Advanced NUHOMS® System will allow safe storage of spent nuclear fuel. This conclusion is based on the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted practices

13.5 References

1. Transnuclear, Inc., "Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0," non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Supplemental Information (ML12059A297), February 24, 2012.

4. Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Supplemental Information (ML12158A103), May 24, 2012.

5. Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12254B039), September 7, 2012.

6. Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information, Items 3-2 and 4-7 (ML12297A205), October 15, 2012.

7. Revision 5 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12325A069), November 16, 2012.

8. Revision 6 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Computational Fluid Dynamic Files (ML12352A230), December 11, 2012.

9. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 9-1 (Thermal) Response (ML13100A331), March 18, 2013.

10. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 3-1 (Structural) Response (ML13100A319), March 26, 2013.

11. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

12. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), June 10, 2013.

13. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, Appendix A to Certificate of Compliance No. 1029 - Technical Specifications for the Standardized Advanced NUHOMS® System (ML13198A416), July 16, 2013

14 QUALITY ASSURANCE EVALUATION

There is no change to FSAR Section B.13, Quality Assurance, resulting from the addition of the 32PTH2 DSC and the AHSM-HS module to the Standardized Advanced NUHOMS® System. The staff recognizes from their review of ANUH-01.0150, Standardized Advanced NUHOMS® Updated Final Safety Analysis Report (UFSAR), Revision 5, that TN utilizes the standard 18 quality criteria and organizational structure from the review of Figure 13.1 and Table 13.1 in the FSAR in controlling their quality activities. The staff noted that TN provided a description of the categories used for quality items, systems and components, as well as services, and the staff concludes that they are consistent with current industry use and in alignment with use under 10 CFR Part 72.

The staff concludes that TN has clearly demonstrated that, according to the TN QA Manual, activities affecting quality are prescribed in approved, written procedures, instructions, or drawings and will be implemented to control activities performed under the TN QA Program which affect quality for design, purchase, fabrication, handling, shipping, storing, cleaning, assembly, inspection, testing, operation, maintenance, repair, and modification of the Standardized Advanced NUHOMS® System. In addition, TN Management has indicated that these procedures, instructions, and drawings shall be followed.

The staff's review has identified that TN has adequately described that the TN QA Manual and the associated implementing procedures control essentially all of the quality criterion listed in 10 CFR Part 72 including, organizational structure, training, procurement controls, procedures, records, traceability, special processes, inspection and testing, corrective actions and non-conforming items and services, as well as audit and surveillance activities.

14.1 Evaluation Findings

Based on the staff's review and evaluation of the QA program description contained in the ANUH-01.0150, Standardized Advanced NUHOMS® Updated Final Safety Analysis Report (UFSAR), Revision 5, the staff concludes that:

- The licensee's description of the QA program indicates requirements, procedures, and controls that, when properly implemented, should comply with the requirements of 10 CFR 72, Subpart G.

- The licensee's description of the QA program covers activities affecting SSCs important to safety as identified in the Safety Analysis Report.

- The licensee's description of the QA program describes organizations and persons performing QA functions indicating that sufficient independence and authority should exist to perform their functions without undue influence from those directly responsible for costs and schedules.

- The licensee's description of the QA program is in compliance with applicable

NRC regulations and industry standards, and the acceptance of the QA program description by NRC allow implementation of the associated QA program for the Standardized Advanced NUHOMS® system.

14.2 References

1. Transnuclear, Inc., "Initial Application for Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revision 0," non-proprietary ((ML12004A157) and (ML12004A156)), proprietary ((ML12004A159) and (ML12004A160)), December 15, 2011.

2. U.S. Code of Federal Regulations, Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater Than Class C Waste, Title 10, Part 72.

3. Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Supplemental Information (ML12059A297), February 24, 2012.

4. Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Supplemental Information (ML12158A103), May 24, 2012.

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7. Revision 5 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML12325A069), November 16, 2012.

8. Revision 6 to Transnuclear, Inc. (TN) Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Computational Fluid Dynamic Files (ML12352A230), December 11, 2012.

9. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 9-1 (Thermal) Response (ML13100A331), March 18, 2013.

10. NRC Form 699 Conversation Record - CoC-1029, Amd. No. 3 Discussion of RAI 3-1 (Structural) Response (ML13100A319), March 26, 2013.

11. Revision 7 to Transnuclear, Inc., Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Response to Request for Additional Information (ML13133A034), May 9, 2013.

12. Revision 8 to Transnuclear, Inc. Application for Amendment 3 to Standardized Advanced NUHOMS® Certificate of Compliance No. 1029, Revised Response to Request for Additional Information (ML13182A044), June 10, 2013.

13. NRC Form 699 - Conversation Record/E-mail with Don Shaw, Transnuclear, Inc., AREVA, re CoC No. 1029, Amend. No. 3, Appendix A to Certificate of Compliance No. 1029 - Technical Specifications for the Standardized Advanced NUHOMS® System (ML13198A416), July 16, 2013

15 CONCLUSIONS

The NRC staff has performed a comprehensive review of the Amendment 3 to the Standardized Advanced NUHOMS® Certificate of Compliance No. 1029 application. Where staff was silent on a process, method, etc. this does not mean that staff endorses the process, method, etc. The NRC staff has found that the following changes do not reduce the safety margin for the Standardized Advanced NUHOMS® System:

- Add a NUHOMS® 32PTH2 system to the Standardized Advanced NUHOMS® System.

- Incorporate transition details from the existing AHSM array to the new AHSM-HS array. The AHSM-HS array can be coupled to existing AHSM arrays.

- Update the Technical Specifications (TS) to achieve consistency and clarity, to enhance the staff's review, based on recent interactions with the NRC staff on other TN licensing actions.

- The application does not propose any technical changes regarding the previously licensed Standardized Advanced NUHOMS® System DSCs (the 24PT1 DSC and the 24PT4 DSC). However, certain TS changes are made for clarification affect these DSCs.

The areas of review addressed in U.S. Nuclear Regulatory Commission, Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility, NUREG-1536, Revision 1, July 2010, are consistent with the applicant's proposed changes. Tacit approval of a method of evaluation is not implied where the SER is silent. This SER only approves those methods of evaluation that have been specifically identified in this SER as having been approved by the staff. Only the affected SRP sections were included in the SER.

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 changes described above to the approved contents of the Standardized Advanced NUHOMS® System meets the requirements of 10 CFR Part 72.

Issued with Certificate of Compliance No. 1029, Amendment No. 3 on ____TBD____ .