PRELIMINARY SAFETY EVALUATION REPORT

TRANSNUCLEAR, INC.

STANDARDIZED NUHOMS® HORIZONTAL MODULAR STORAGE

SYSTEM FOR IRRADIATED NUCLEAR FUEL

DOCKET NO. 72-1004

CONVERSION OF TECHNICAL SPECIFICATIONS TO STANDARD

FORM AND ADDITION OF LIGHT WEIGHT TRANSFER CASK (OS197L)

AMENDMENT NO. 11

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Docket No. 72-1004
Standardized NUHOMS® Modular Storage System for Irradiated Nuclear Fuel
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Conversion of Technical Specifications to Standard Form and
Addition of Light Weight Transfer Cask
Amendment No. 11

SUMMARY

By application dated April 10, 2007, and as supplemented (see Section 1.1 for details), Transnuclear, Inc. (TN) submitted an amendment request to Certificate of Compliance (CoC) No. 1004 for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, under the provisions of 10 CFR Part 72, Subparts K and L.

TN requested a change to the CoC, including its attachments, and revision of the Final Safety Analysis Report (FSAR). The primary changes were to revise the CoC No. 1004 technical specifications to follow the format contained in NUREG-1745, "Standard Format and Content for Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance" and to make changes to the FSAR and technical specifications (TS) to allow use of a light weight transfer cask (TC) designated the OS197L for use with the 32PT and 61BT dry shielded canisters (DSCs) under specific loading conditions (maximum total decay heat of the dry shielded canisters is limited to 13kW/DSC, and 12kW/DSC respectively, and the decay heat of the peripheral fuel assemblies is limited to 400 watts per fuel assembly).

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the application using the guidance provided in NUREG-1536, "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 TN Standardized NUHOMS® System, as amended, meets the requirements of 10 CFR Part 72.

1.0 GENERAL INFORMATION

1.1 Background

By application dated April 10, 2007 (Ref. 1), as supplemented, Transnuclear, Inc. (TN) submitted an amendment request to amend Certificate of Compliance (CoC) No. 1004 for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, under the provisions of 10 CFR Part 72, Subparts K and L. The application has been supplemented as follows:

- August 23, 2007 (ML072410293) three shielding calculations and four thermal calculations. (Ref. 2)
- December 21, 2007 (ML080020420 (proprietary), ML080020446 (proprietary) and ML110320385 (non-proprietary)), Responses to the first Request for Additional Information (RA1 #1) (Ref. 3)
- June 12, 2008 (ML081700238), Missing pages from the Updated Final Safety Analysis Report (UFSAR) for RAI #1 response (Ref. 4)
- August 14, 2009 (ML13149A438 (proprietary)) and (ML092330146, non-proprietary)), RAI #2 responses (Ref. 5)
- August 5, 2010 (ML102230097 (non-proprietary)), RESTART RAI #1 responses (Ref. 6)
- August 5, 2010 (ML102230099 (proprietary)), RESTART RAI #1 responses (Ref. 7)
- February 25, 2011 (ML110590060), RESTART RAI #2 responses (Ref. 8).

TN requested a change to the CoC, including its attachments, and revision of the Final Safety Analysis Report (FSAR). The amendment application included the necessary engineering analyses and proposed FSAR page changes. The proposed FSAR revisions will be incorporated into the FSAR. The primary changes were: (1) to revise the CoC No. 1004 technical specifications to follow the format contained in NUREG-1745, "Standard Format and Content for Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance;" (Ref. 9) and (2) to make changes to the FSAR and technical specifications to allow use of a light weight transfer cask (TC) designated the OS197L.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the FSAR amendment application using the guidance provided in NUREG-1536, "Standard Review Plan [SRP] for Spent Fuel Dry Storage Systems at a General License Facility" (Ref. 10). The 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 applicant request for revision or changes are addressed in the staff's SER. Chapters related to Quality Assurance and to Decommissioning are not included in this SER because there were no related revisions in the amendment request.

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

1.1.1 History

In 2004, Omaha Public Power District (OPPD) met with NRC's Region IV (RIV) to discuss their plans to build an Independent Spent Fuel Storage Installation (ISFSI) in the 2006 time-frame. In 2006, RIV queried OPPD regarding how they planned to lift a 100-ton transfer cask with their 75-ton crane. OPPD responded that they had plans to use a light weight transfer cask. TN prepared a 10 CFR 72.48 evaluation adding a light weight transfer cask to their system(Ref. 11). NRC did not agree with the 72.48 evaluation, and issued a notice of violation (NOV) (Ref. 12). Following a series of interactions, including a public meeting to discuss an impending exemption request to allow use of the light weight transfer cask (Ref. 13), and a letter from NRC documenting expectations relative to an exemption submittal (Ref. 14), OPPD applied for an exemption to use a light weight transfer cask (<75 tons) to transfer fuel into spent fuel storage casks (32PT dry shielded canisters (DSCs)) at the Fort Calhoun station (Ref. 15). NRC issued the exemption on July 19, 2006, but it was limited to 4 canisters; limited to old cold fuel; and limited to OPPD (Ref. 16). The SER stated specifically that issuing the exemption did not constitute approval for the use of the light weight transfer cask at other sites.

In December 2006, TN responded to the November 9, 2006, NOV and committed to revising CoC No. 1004 through an amendment process to allow the use of the light weight transfer cask (Ref. 17). TN submitted the amendment request, Standardized NUHOMS® System, Amendment 11 on April 10, 2007 (Ref. 1). The amendment request added a light weight transfer cask (LWTC) to the Standardized NUHOMS® System set of equipment. In addition, the amendment revised the Technical Specifications to change the format to standardized technical specifications, in accordance with the Division of Spent Fuel Storage and Transportation (SFST) guidance provided in NUREG-1745 (Ref. 9).

When the amendment was originally submitted, the LWTC, the OS197L, consisted of the previously approved OS197 TC with the lead shielding stripped out, so that it would weigh 75 tons. This change was designed to allow Fort Calhoun, as well as other sites, to use the Standardized NUHOMS® System with a 75-ton crane. Initially, NRC determined that there was insufficient information provided in the Amendment 11 submittal in the areas of shielding and radiation protection. TN provided a more complete evaluation with their responses to Request for Additional Information #1 (Ref. 3). During the review, Fort Calhoun updated the crane to one with sufficient capacity that the LWTC was no longer necessary. As a result of the staff's review, particularly with respect to shielding and potential occupational and public dose, TN decided to change the design of the LWTC (Ref. 5) to a de-rated OS197L transfer cask with a nominal weight of 85 tons, and a restricted maximum total DSC decay heat of 13kW for the 32PT and 12kW for the 61BT. The revised LWTC design also restricts the decay heat of the peripheral fuel assemblies to approximately 400 watts per fuel assembly and uses supplemental shielding, remote handling operations, and controls on fuel loading to further limit external dose. This SER provides staff's analysis of the revised design.

1.2 General Description of the Light Weight Transfer Cask

The OS197L transfer cask is designed with a nominal weight of 85 tons, for transfer of the 32PT and 61BT DSCs. See Figure 1.1. As noted above, the maximum total decay heat of the DSC is limited to 13kW/DSC for the 32PT and 12kW/DSC for the 61BT, and the decay heat of the peripheral fuel assemblies is limited to approximately 400 watts per fuel assembly to limit external dose. Supplemental shielding is installed on the OS197L skid to compensate for the reduced shielding capability. Three-dimensional views of the supplemental skid shielding are shown in SAR Figure W.1-3, and reproduced in Figure 1.2 below. The decontamination area shielding is illustrated in SAR Figure W.1-2, which is reproduced in Figure 1.3.

The OS197L transfer cask consists of a 2.68-inch thick steel shell, a removable 3.5-inch thick liquid neutron shield assembly, a 6-inch thick steel decontamination area supplemental shield placed around the cask for personnel shielding during fuel loading operations, and supplemental transfer trailer shielding used for personnel shielding during transfer operations.

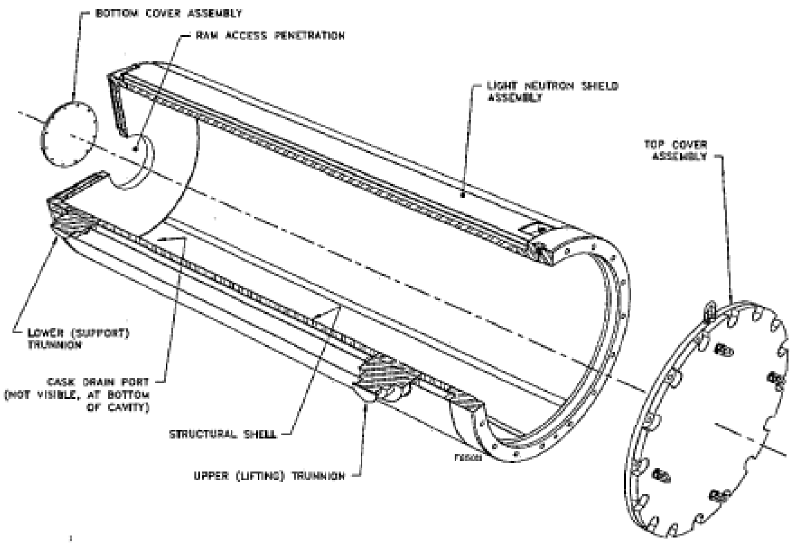

Figure 1.1. OS197L TC Configuration

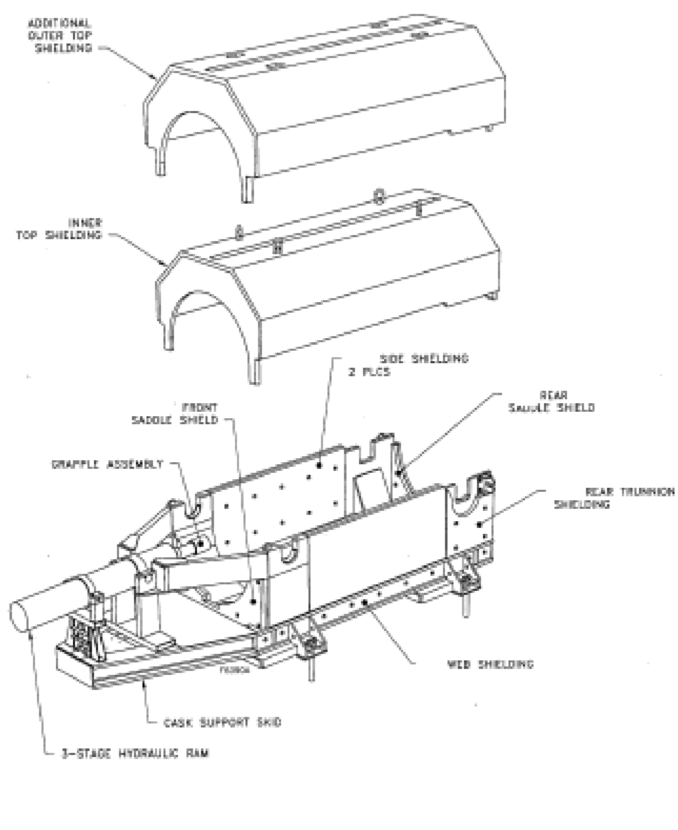

Figure 1.2. NUHOMS® OS197L TC System Supplemental Shielding

The total water thickness of the neutron shield is 3 inches and the inner and outer stainless steel shells of the tank are 0.25 inches thick. The supplemental transfer trailer shielding consists of 3 sections. The lower section is a series of plates attached to the sides and ends of a typical transfer skid structure to provide the required shielding. Dual upper sections fit like clamshells over the cask and skid after the cask is placed on the transfer skid. The support legs on the skid provide an approximately 6.75-inch high clearance under the I-beams of the skid. Ambient air enters the enclosure, flows around the OS197L TC, and exits the enclosure through a shielded opening at the top. In addition, remote cask handling is used to provide further protection. The decontamination area shielding has a lower part into which the TC is placed, and an upper part which is placed around the TC and rests on the lower shielding part (see Figure 1.3).

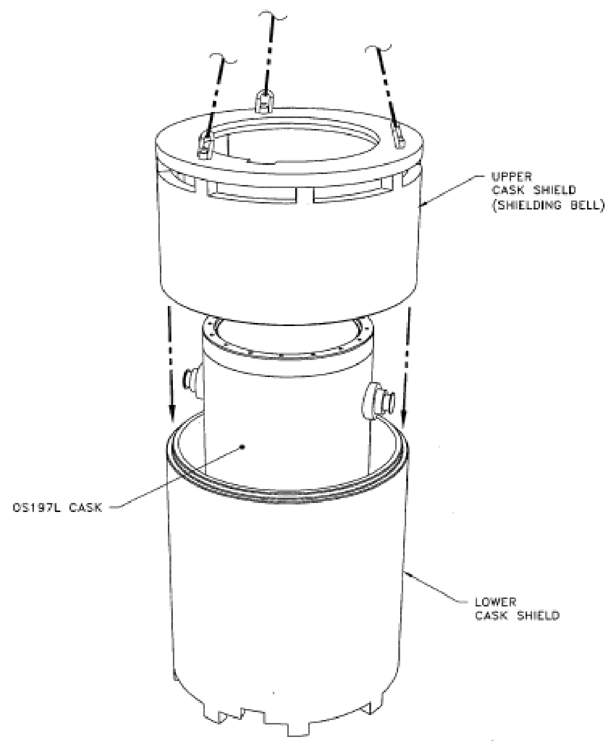

Figure 1.3 NUHOMS® OS197L TC System Decontamination Area Shielding

1.3 Standardized Technical Specifications

The existing Technical Specifications (TS) have been converted to a format and content consistent with NRC guidance in NUREG-1745, “Standard Format and Content for Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance” (Ref. 9). The previously approved payloads, and the corresponding TS have been retained “as-is” in the new format of the proposed TS, including tables and figures. In addition, this change removes the bases from the TS and relocates the bases for the Limiting Conditions for Operation (LCOs) and Surveillance Requirements to UFSAR Chapter 10. Specific changes to the TS are described in detail in the appropriate SER sections, and in Chapter 12.

1.4 Drawings

Appendix W, Chapter 1 of the Updated Final Safety Analysis Report (UFSAR) contains the drawings for the OS197L TC, including drawings of the structures, systems and components (SSC) important to safety (ITS). The staff determined that the drawings contain sufficient detail on dimensions, materials, and specifications to allow for a thorough review of the OS197L TC. Specific SSCs are evaluated in Sections 3 through 10 of the SER.

1.5 Evaluation Findings

F1.1 A general description of the OS197L is presented in Appendix W, Chapter 1 of the SAR. The new TC is adequately described in the Amendment.

F1.2 The staff concludes that the information presented in Appendix W, Chapter 1 of the SAR satisfies the requirements for the general description under 10 CFR Part 72. This finding is reached on the basis of 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. 18) and accepted practices.

1.6 References

1. Transnuclear, Inc., Application for Amendment 11 of the NUHOMS® Certificate of Compliance No. 1004 for Spent Fuel Storage Casks, Revision 0, April 10, 2007, (ML071240088 (letter), ML071240110 (non-proprietary version), and ML071240124 (proprietary version)).
2. Transnuclear, Inc., Supplemental Information Regarding the Application for Amendment 11 of the NUHOMS® Certificate of Compliance No. 1004 for Spent Fuel Storage Casks, Revision 0, Docket No. 72-1004, (TAC No. L24080), August 23, 2007, (ML072410293 (non-proprietary version), ML072420501 (affidavit, dated August 28, 2007), and ML072560076 (non-proprietary version), September 11, 2007).
3. Transnuclear, Inc., Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System (Docket No. 72-1004; TAC No. L24080), December 21, 2007, (ML080020420 (proprietary version), ML080020446 (proprietary version) and ML110320385 (non-proprietary version)).
4. Transnuclear, Inc., Additional UFSAR pages for Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System (Docket No. 72-1004; TAC No. L24080), June 12, 2008 (ML081700238 (non-proprietary version)).
5. Transnuclear, Inc., Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System, Response to Second Request for Additional Information (Docket No. 72-1004; TAC No. L24080), August 14, 2009, ((ML13149A438, proprietary) and (ML092330146, non-proprietary)).
6. Transnuclear, Inc., Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System, Response to First (Restart) Request for Additional Information (Docket No. 72-1004; TAC No. L24080), August 5, 2010, (ML102230097).
7. Transnuclear, Inc., Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System, Response to First (Restart) Request for Additional Information (Docket No. 72-1004; TAC No. L24080), August 5, 2010 (ML102230099 (proprietary version)).
8. Transnuclear, Inc., Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System, Response to Second (Restart) Request for

Additional Information (Docket No. 72-1004; TAC No. L24380), February 25, 2011, (ML110590060 (non-proprietary)).
9. U.S. Nuclear Regulatory Commission, NUREG-1745, “Standard Format and Content for Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance,” 2001.
10. U.S. Nuclear Regulatory Commission, NUREG-1536, “Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility,” 2010.
11. Transnuclear, Inc., “Submittal of Biennial Report of 72.48 Evaluations Performed for the Standardized NUHOMS® System, CoC 1004, for the Period 02/04/06 to 07/25/08, Docket 72-1004”, July 25, 2008 (ML082110243).
12. Letter, R.Lewis, USNRC, to T. Neider, TN, “NRC Inspection Report No. 72-1004/2006-204 and Notice of Violation,” November 9, 2006 (ML063130354).
13. Letter, J. Sebrosky, USNRC, to W. Ruland, USNRC, “Summary Of May 24, 2006, Meeting With Omaha Public Power District To Discuss An Impending Exemption Request To Certificate Of Compliance 1004,” June 5, 2006 (ML061560556).
14. Letter, J. Strosnider, USNRC, to R. Ridenoure, OPPD, “Fort Calhoun Station, Unit No. 1 - Pending 10 CFR 72.7 Exemption Request for Loading Spent Fuel in Dry-Shielded Canisters,” June 7, 2006 (ML061560394).
15. “Fort Calhoun Station-Request for Exemption from NUHOMS® Certificate of Compliance No. 1004, Amendment No. 8,” June 9, 2006 (ML061650157).
16. Letter, W. Ruland, USNRC, to R. Ridenoure, OPPD, “Exemption From 10 CFR 72.48, 10 CFR 72.212 and 72.214 for Dry Spent Fuel Storage Activities - Fort Calhoun (TAC No. L23984),” July 19, 2006 (ML062000153).
17. Letter, T. Neider, TN, to USNRC, “Reply to a Notice of Violation,” December 1, 2006 (ML063450121).
18. 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.

2 PRINCIPAL DESIGN CRITERIA

The objective of evaluating the principal design criteria related to the systems, structures, and components (SSC) important to safety (ITS) is to ensure that they comply with the relevant general criteria established in 10 CFR Part 72 (Ref. 1).

2.1 Structures, Systems and Components Important to Safety

The design of the OS197L transfer cask (TC) adds the following new components that are important to safety:

- the onsite transfer cask structural steel and cover plates,
- the onsite transfer cask trailer shielding, and
- the onsite transfer cask decontamination area shielding.

The SSCs important to safety for the NUHOMS® OS197L TC are discussed in the Safety Analysis Report (SAR) Section W2.5. The decontamination area shielding was not originally included as an ITS component, but TN added it as an ITS component in CoC Condition 3.d, "Basic Components," and in the SAR, in response to staff comments over the course of the Amendment review.

2.2 Spent Fuel Specifications

2.2.1 NUHOMS® -61BT DSC Contents

The allowable contents of the 61BT dry shielded canister (DSC) when using the OS197L TC include 61 intact (including reconstituted) and/or damaged boiling water reactor (BWR) fuel assemblies meeting the parameters specified in the Technical Specifications (TS), Tables 1-1c and 1-1j, and the Fuel Qualification Tables provided in TS Tables 1-6a and 1-6b. The physical characteristics of the intact and damaged spent fuel assemblies are described in Tables W.2-2 and W.2-3 of the SAR. The heat load is limited to 12kW or less. The Fuel Qualification Tables for the Zone 1 and Zone 2 fuel assemblies are provided in Tables W.2-4 and W.2-5 of the SAR. In addition, TS Figure 1-29 for the 61BT in the OS197L provides decay heat limits depending on location in the DSC.

2.2.2 NUHOMS® -32PT DSC Contents

The allowable contents of the 32PT DSC when using the OS197L TC include 32 intact pressurized water reactor (PWR) fuel assemblies, with or without Control Components, meeting the parameters specified in the Technical Specifications, Table 1-1e, and the Fuel Qualification Tables (TS Tables 1-6c and 1-6d). The physical characteristics of the intact spent fuel assemblies are described in Table W.2-6 of the SAR. The heat load is limited to 13kW or less. The Fuel Qualification Tables for the Zone 1 and Zone 2 fuel assemblies are provided in Tables W.2-7 and W.2-8 of the SAR. In addition, TS Figure 1-30 for the 32PT in the OS197L provides decay heat limits depending on location in the DSC.

2.3 External Conditions

Section W.2.2 of the SAR identifies the bounding site environmental conditions and natural phenomena for which the OS197L was analyzed. Differences in handling for the OS197L TC include:

- remote operations for movements of the TC
- supplemental decontamination area shielding
- supplemental trailer shielding.

The operating/handling procedures are discussed in Chapter 9 of this SER. There were no other changes in Design Criteria for Environmental Conditions.

2.4 Design Criteria for Safety Protection Systems

A summary of the design criteria for the safety protection systems of the OS197L is presented in Section W.2.3 of the SAR. Only radiological protection is different from the OS197. The safety protection systems for radiological protection for the OS197L include remote handling and supplemental shielding. Details of the design are provided in Sections W.3 though W.11 of the SAR.

2.5 Evaluation Findings

The staff concludes that the principal design criteria for the NUHOMS® OS197L, and related changes for the 61BT DSC and the 32PT DSC are acceptable with regard to meeting the regulatory requirements of 10 CFR Part 72. This finding is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices. A more detailed evaluation of design criteria and an assessment of compliance with those criteria are presented in Sections 3 through 13 of the SER.

Based on the review of the submitted material, the staff makes the following findings:

F2.1 The SAR 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 in 10 CFR 72.236.

F2.2 The SAR and docketed materials relating to the design bases and criteria for shielding, confinement, radiation protection, and ALARA (As Low As Reasonably Achievable) 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); and 10 CFR 72.126(a).

F2.3 The SAR 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 supbarts 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.”

2.6 References

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

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3 STRUCTURAL EVALUATION

This amendment application did not involve any change in cask contents; only the revision to the Standardized NUHOMS® Certificate of Compliance (CoC) No. 1004 and associated Technical Specifications (TS), and the addition of the new light weight transfer cask. Therefore, this section of the evaluation centers on those changes only for the structural discipline and does not cover unaffected or other areas. Staff reviewed the original amendment request, supplemental information, and the responses to three rounds of Requests for Additional Information (RAIs). There were no structural issues in the final RAI (Ref. 1).

3.1 Technical Specifications Changes

The staff reviewed the technical specifications (TS) for Amendment 11 with respect to structural issues for the Standardized NUHOMS® system, and concludes that the relocated TS, the deleted TS, the new TS, and the movement of a few of the TS Bases to the FSAR, provide reasonable assurance that the cask will allow safe transfer and storage of the spent fuel, as explained further in sections 3.1.1 and 3.1.2 below.

Applicable changes to the TS were reviewed by the staff: Several technical specifications related to the structural performance of the Standardized NUHOMS® System were relocated, deleted, or moved to the FSAR due to the standardization of the TS consistent with NUREG-1745 (Ref. 2). The staff reviewed these changes as follows.

3.1.1 Revision of TS

The staff reviewed the proposed revision of former TS 1.1.4, “Heavy Loads Requirements“, with respect to the structural performance of the Standardized NUHOMS® system. This requirement is now part of the proposed CoC, Condition 7, “each lift of a DSC [dry shielded canister] and TC [transfer cask] must be made in accordance with the existing heavy loads requirements and procedures of the licensed facility at which the lift is made.” A plant-specific safety review (under 10 CFR 50.59 or 10 CFR 72.48, as applicable) is required to show operational compliance with NUREG-0612 and/or existing plant-specific heavy loads requirements. This CoC condition has been moved from the Amendment 10 TS (1.1.4, “Heavy Loads Requirements”). The staff has determined that this change is acceptable, as the operational requirements comply with the applicable regulations of 10 CFR Part 72.

The staff reviewed the addition of CoC, Condition 8, “Pre-Operational Testing and Training Exercise” with respect to the structural performance of the Standardized NUHOMS® system and since nothing was changed in the Condition 8 content from the previous amendment, has determined that these revisions and new additions are acceptable. Condition 8 was previously included in Amendment 10 TS 1.1.6. Some of the information previously included in Amendment 10 TS 1.1.6, but not included in Amendment 11 CoC Condition 8 is available in Amendment 11 TS 5.2.2 “Training Program.”

The staff reviewed the proposed revision of the CoC requirements (previously in Condition 6 of the Amendment 10 CoC) for concrete testing to TS 5.5, “Concrete Testing for HSM-H [Horizontal Storage Module, Model H]”. Additional language was added with the responses to RAI #1 (Ref. 3). Based on the adequacy of the responses to RAI Round #2 (Ref. 4), staff determined that the proposed revision was acceptable as the TS 5.2.5 “HSM or HSM-H Thermal Monitoring Program” assumes that positive means exist to identify conditions which threaten to approach the temperature criteria for proper HSM or HSM-H and allow for correction of the off-normal thermal condition that could be exceeding the concrete temperature criteria.

3.1.2 Deletion of TS

Some of the deleted TSs were relocated to the FSAR or were replaced by new TSs. The staff revisited this issue after it received responses to RESTART RAI #1 (Refs. 5 and 6), and as these changes adequately reflected the new design, concluded that these changes were acceptable.

3.2 FSAR Changes (W.3 Structural Evaluation)

The staff reviewed the proposed changes to the FSAR with respect to the OS197L TC as described in FSAR Section W.3. Similar to the OS197 TC, the OS197L TC is designed to meet the stress allowed under the ASME Code Subsection NC for Class 2 Components (Ref. 7). The OS197L TC requires the use of supplemental shielding when the transfer cask is in the decontamination area during handling operations, and when the transfer cask is placed on the transfer trailer skid. The structural evaluation of the supplemental shielding is summarized in FSAR Section W.3.9.

The total weight of the OS197L TC, including neutron shield water, but without any loaded fuel, is approximately 62,000 lb. This compares with the corresponding weight of 111,250 lb for the OS197 TC. The OS197L TC weights as described in FSAR Table W.3-1 are to be used in conjunction with the payload weights for the 61BT and 32PT DSCs as described in the applicable sections in FSAR Appendices K.3 and M.3. Each user must evaluate the total under-the-hook lift weights against plant specific crane capacity limits in accordance with the requirements of 10 CFR 72.212. The evaluation of the OS197L TC is based on critical lift weights of 250,000 lb (125 tons). All of the cask accident drop results reported in FSAR Section 8.2, and FSAR Appendices K.3 and M.3 remain bounding and, thus, are not affected.

When the OS197L TC is placed in the decontamination area, the supplemental shielding consists of an upper cask shield (shielding bell) and a lower cask shield (shielding sleeve) made from carbon steel plate 6” thick. The supplemental shielding, when the transfer cask is mounted on the trailer’s skid, consists of carbon steel plates (2.5” thick combined with additional 3” thick) which are integral (i.e., welded) to the skid or bolted to each other. The supplemental shielding components are evaluated using the stress allowable criteria of AISC Code, Manual of Steel Construction 9th Edition (Ref. 8), as summarized in FSAR Table W.3-5 (see also TS Table 4.2.3). The decontamination area shielding is evaluated for deadweight, lifting, and seismic loads. The skid-mounted supplemental shielding is evaluated for deadweight and conservatively defined (2g) handling loads. Conservatively evaluated bounding stresses are summarized in FSAR Table W.3-6 and Table W.3-7.

The above evaluations assume that the supplemental shielding components are handled using a single failure proof crane when these components are handled inside the fuel/reactor building. If a single failure proof crane is not used, the licensee must evaluate the accidental drop of these shielding components under 10 CFR 50.59, 10 CFR 72.48, and 10 CFR 72.212, and evaluate the consequences of the accident drops.

The only component that may be handled outside the fuel/reactor building is the top trailer shielding. The accidental drop of this component was adequately addressed in section W.1.1.5 in Revision 3 of the SAR (Ref. 5) and therefore the use of a single failure proof crane inside the fuel/reactor building to handle the supplemental shielding components was found acceptable by the staff.

3.3 Evaluation Findings

Based on the review of the submitted material, the staff makes the following findings. The structural evaluation in this amendment, including FSAR Section W.3, Revision 3, dated August 5, 2010, provides reasonable assurance that the Standardized NUHOMS® System will allow safe storage of spent fuel. This finding was reached on the basis of staff review that considered the requirements in 10 CFR Part 72, appropriate Regulatory Guides, applicable codes and standards, and accepted engineering practices. The structural design of the storage cask system design meets the relevant requirements.

F3.1 The SAR adequately describes all structures, systems, and components (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 72.122(b) and (c). The SSCs are designed to accommodate the combined loads of normal, off-normal, accident, and natural phenomena events with an adequate margin of safety. Stresses at various locations of the cask for various design loads were 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 72.236(b), "Specific requirements for spent fuel storage cask approval." The structural design and fabrication of the NUHOMS® 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 specific requirements of 10 CFR 72.236(g), (h), (and (l), as applicable to the structural design for spent fuel storage cask approval.

The Standardized NUHOMS® Systems were described in sufficient detail to enable an evaluation of their structural effectiveness and are designed to accommodate the combined loads of normal, off-normal, accident, and natural phenomena events. The Systems are designed to allow handling and retrieval of spent nuclear fuel for further processing or disposal. The staff concludes that no accident or off-normal events analyzed will result in damage of the new transfer cask that will prevent retrieval of the DSC. A complete structural evaluation of the OS197L TC has been performed by the applicant. The structural evaluation shows that the Standardized NUHOMS® Systems design is compatible with the requirements of 10 CFR 72.236.

3.4 References

1. U.S. Nuclear Regulatory Commission, “Second (Restart) Request For Additional Information For Review Of Amendment 11 to the Standardized NUHOMS® System (TAC No. L24380),” February 10, 2011 (ML110410100).
2. U.S. Nuclear Regulatory Commission, NUREG-1745, “Standard Format and Content for Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance,” 2001.
3. Transnuclear, Inc., Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System (Docket No. 72-1004; TAC No. L24080), December 21, 2007 (ML080020420 (proprietary version), ML080020446 (proprietary version) and ML110320385 (non-proprietary version)).
4. Transnuclear, Inc., “Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System, Response to Second Request for Additional Information (Docket No. 72-1004; TAC No. L24080),” August 14, 2009, ((ML13149A438, proprietary) and (ML092330146, non-proprietary)).
5. Transnuclear, Inc., “Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System, Response to First (Restart) Request for Additional Information (Docket No. 72-1004; TAC No. 24080),” August 5, 2010 (ML102230097 (non-proprietary version; withheld under SUNSI (Sensitive Unclassified Non-Safeguards Information)).
6. Transnuclear, Inc., “Revision 3 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System, Response to First (Restart) Request for Additional Information (Docket No. 72-1004; TAC No. 24080),” August 5, 2010 (ML102230099 (proprietary version)).
7. American Society of Mechanical Engineers, “ASME Section 3 Division 1 Subsection NC Class 2 Components Rules for Construction of Nuclear Facility Components (Section III)”, 2007.
8. American Institute of Steel Construction, “AISC Manual of Steel Construction: Allowable Stress Design,” 9th Edition, 1989.

4. MATERIALS EVALUATION

4.1 Technical Specifications Changes

The applicant proposed reformatting the Technical Specifications (TS) to the standard format delineated in NUREG-1745, “Standard Format and Content to Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance” (Ref. 1). The staff reviewed the TS dealing with materials issues to assure that all requirements in the approved TS were captured in the new format and all changes were evaluated.

Amendment 10 to CoC No. 1004, TS 1.1.1(8), “Corrosion of Dry Shielded Canister (DSC) Support Steel in Coastal Salt Marine Environment” was transferred verbatim to Amendment 11, TS 4.2.1. Additional text was added to the new TS with the response to RAI #2 (Ref. 2).

The previous TS 1.2.1, “Fuel Specifications,” consisted of a number of tables that were transferred verbatim to Section 2.1 of the proposed TS. The basis for the TS was moved to chapter 10 of the FSAR in the form of a table that guided one to the appropriate appendices for the details. The detail in the basis indicating the approved content for each DSC was moved to Section 10.2.

Section 4.1 on canister criticality control in the proposed TS has footnotes with respect to the incorporation of the appropriate sections in the FSAR with regard to testing for the boron density of the absorber plates for the 61BTH and 32PTH1 models. Because testing on the boron density of the 61 BTH and 32PTH1 were already in the FSAR, for consistency, similar footnotes requiring testing were added for the other models in the table.

The previous TS 1.2.2, “DSC Vacuum Pressure During Drying,” was moved to TS Section 3.1.1, “DSC Bulkwater Removal Medium and Vacuum Drying Pressure,” in the proposed TS. The pressure limits and hold times for vacuum drying were the same in both cases. The only change was that the new TS requires that helium be used for any canister blow down in accordance with the recommendations in ISG-22 “Potential Rod Splitting Due to Exposure to an Oxidizing Atmosphere During Short-Term Cask Loading Operations in LWR or Other Uranium Oxide Based Fuel” (Ref. 3). Statements were added that during both wet and dry loading, steps would be taken consistent with the criteria defined in ISG-22 to prevent any fuel oxidation. The basis and surveillance sections were paraphrased and moved to Chapter 10 of the FSAR.

Amendment 10, TS 1.2.5, “DSC Dye Penetrant Test of Closure Welds,” was moved to Section 5.2.4(b) of the Amendment 11 TS verbatim. The basis has been moved to Chapter B.10.5.2.4B of the FSAR.

The applicant proposed that Conditions 6 and 7 from the Amendment 10 to CoC No. 1004, regarding “Concrete testing for HSM-H [Horizontal Storage Module, Model H],” and “HSM-H Configuration Changes,” be incorporated verbatim into Amendment 11 to CoC No. 1004, TSs 5.5 and 5.6 respectively. Additional language was added to TS 5.5 with the responses to RAI #1 (Ref. 2).

The staff concludes that, based on its review of the changes descrbied above, the materials portions of the TSs for Amendment 10 have been adequately reformatted into the standard format.

4.2 Evaluation of Findings

The applicant requested authority to use a light weight transfer cask designated model OS197L. A comparative chart in SAR Section W.3.1 is presented to show that the same materials are used in each component of the light weight transfer cask model OS197L as the regular weight transfer cask model OS197 with the exception of the lead shielding that is omitted from the light weight transfer cask.

F4.1 Because the materials for the model OS197 transfer cask were previously found acceptable, and all the materials in the light weight transfer cask model OS197L are the same except for the removal of the lead in the shielding, the staff concludes that the light weight transfer cask design meets the materials requirements of 10 CFR Part 72.

4.3 References

1. U.S. Nuclear Regulatory Commission, NUREG-1745, “Standard Format and Content to Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance,” 2001.
2. Transnuclear, Inc., Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System, Response to Second Request for Additional Information (Docket No. 72-1004; TAC No. L24080), August 14, 2009 ((ML13149A438, proprietary) and (ML092330146, non-proprietary)).
3. U.S. Nuclear Regulatory Commission, Interim Staff Guidance #22 (ISG-22) “Potential Rod Splitting Due to Exposure to an Oxidizing Atmosphere During Short-Term Cask Loading Operations in LWR or Other Uranium Oxide Based Fuel,” Rev. 0.

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5.0 THERMAL EVALUATION

The thermal evaluations presented in the applicant's Safety Analysis Report (SAR) include steady-state and transient analyses of the thermal response of the OS197L light weight transfer cask (TC), shown in Figure 1.1. This transfer cask is designed with a nominal weight of 85 tons, for transfer of the 32PT and 61BT Dry Shielded Canisters (DSCs). While the maximum design heat load for the 32PT DSC is 24 kW and 18.3 kW for the 61BT DSC, the maximum heat load for the 32PT DSC when loaded into the OS197L is 13 kW, and the maximum heat load for the 61BT is 12kW. The OS197L is designed to meet a defined set of operating conditions that envelope the thermal conditions expected during all normal, off-normal, and postulated accident conditions during loading, transfer and storage, as defined in Chapter W.4 of the SAR.

The thermal performance of the OS197L TC within the supplemental skid shielding is evaluated using computational fluid dynamics (CFD) analysis with the outer surface of the transfer cask treated as a uniform heat flux boundary, for bounding decay heat load values of 24 kW and 18.3 kW. These analyses are described in Sections W.4.4 and W.4.5 of the SAR, and result in two sets of bounding surface temperatures for the OS197L TC. These surface temperatures are used as boundary conditions for a detailed ANSYS model of the OS197L TC, which is described in Section W.4.6 of the SAR. In the ANSYS analyses, the inner surface of the DSC outer shell is treated as a uniform heat flux boundary, for bounding decay heat load value of 13 kW.

The outer surface temperatures on the DSC shells obtained in the calculations with the ANSYS model of the OS197L TC are subsequently used as boundary conditions for detailed ANSYS models of the DSC internal components. Calculations with these detailed models are presented in Chapter W.4.7 of the SAR for the 32PT and 61BT DSCs. The analysis methodologies used by the applicant for the analyses of the 32PT and 61BT DSCs in the OS197L TC are provided in particular Appendices to Revision 9 of the NUHOMS® SAR (NUHOMS® base SAR (Ref. 1)), in accordance with Table 5.1 provided below. A description of the thermal review completed for the OS197L TC containing the 32PT and 61BT DSCs for normal, off-normal, and accident conditions of storage and transfer is provided in SAR Sections W.4.7.1, W.4.7.2 and W.4.7.3.

Table 5.1

DSC	Appendix; Section
32PT	M; Section M.4.4.1.1
61BT	K; Section K.4.4.1

The applicant's thermal evaluation concludes that the OS197L TC meets all of the applicable design criteria for thermal performance. The staff has conducted an evaluation of the applicant's submittal to determine if it meets the applicable regulations in 10 CFR Part 72.

5.1 OS197L TC Thermal Performance

The applicant provided descriptions of the thermal analyses conducted to demonstrate the ability of the OS197L to meet the regulatory requirements for normal conditions and accident conditions while being utilized for loading and transferring of spent fuel. In SAR Section W.4.4, the applicant briefly examined the effects of the decontamination shield, used during vacuum drying and helium backfilling operations. In SAR Section W.4.5, the applicant describes the evaluation of the thermal effects of the added external shielding around the transfer cask on the transport skid, which is needed to reduce the occupational doses from the OS197L during the transfer evolution.

5.1.1 Effect of Decontamination Shield on OS197L TC Thermal Performance

An evaluation was performed by the applicant to confirm that the radial gap between the OS197L TC and the inner diameter of the decontamination shield is sufficiently large, and that the top and bottom cut-out openings are of sufficient size as to not adversely affect the thermal performance of the OS197L TC. The decontamination area shielding is illustrated in SAR Figure W.1-2, and reproduced in Figure 1.3.

The applicant's evaluation is based on analysis of the free convection turbulent boundary layer development along the outer OS197L TC surface during vacuum drying and helium backfilling operations. The applicant states that the results of the evaluation confirm that the DSC shell-decontamination shield gap and the area of the inlet and outlet openings are adequate and, thus, the decontamination area shield does not adversely impact the cask boundary conditions assumed in the thermal analysis. No details of the analysis conducted by the applicant were provided in the SAR; however, in response to staff RAIs the applicant provided additional details for staff review.

5.1.2 Effect of Supplemental Skid Shielding on OS197L TC Thermal Performance

As discussed above, supplemental shielding is installed on the OS197L transfer skid to compensate for the reduced shielding capability of the OS197L TC. Three-dimensional views of the supplemental skid shielding are shown in SAR Figure W.1-3, and reproduced in Figure 1.2. The shielding enclosure is provided with openings between the skid beams and the trailer deck to allow air to enter the enclosure, flow around the OS197L TC, and exit the enclosure through a shielded opening at the top. To address the potentially offsetting effect of the supplemental skid shielding on the thermal performance of the OS197L TC with a 13 kW payload heat load in the DSC payload, a three-dimensional CFD analysis model of the supplemental shielding enclosing the OS197L cask on the transfer skid, based on geometry details shown in the drawings provided in the SAR Section W.1.5, was created by the applicant using the FLUENT code. Although a three-dimensional mesh was developed for the supplemental shielding on the transfer skid, the CFD analysis was performed on a "quasi 2-D thermal model" using a 12-inch segment at the center of the OS197L TC on the shielded transfer trailer. The computational mesh for this model extends 150 inches in the horizontal direction (x-direction) and 200 inches in the vertical direction (y-direction) to evaluate convection and radiation heat transfer from the outer surface of the supplemental shielding to ambient, as well as convection, conduction, and thermal radiation from the OS197L neutron shield outer surface to the inner surface of the supplemental shielding. Radiation exchange is modeled using the discrete ordinate methodology. This model is described in the SAR in Section W.4.5 and illustrated in Figures W.4-5 and W.4-6 with perspective and elevation views of the computational mesh, including the boundary layer mesh on the cask neutron shield outer shell and the inner surfaces of the supplemental shield plates.

In this model, the applicant represents the OS197L cask as a surface with a uniform heat flux simulating the outer shell of the liquid neutron shield. (A separate model of the transfer cask is used by the applicant to evaluate the heat transfer within the cask using the computed temperatures on the neutron shield as a boundary condition. This is described in Section W.4.6 of the SAR, and discussed in Section 5.1.4 of this SER.) Based on a 183.85-inch length water cavity in the neutron shield, an outside radius of 40.18 inches for the neutron shield shell, and a decay heat loading of 13 kW for the 32PT DSC, the uniform heat flux applied over the surface area of the shell in the applicant's model is computed as:

$$\ddot{q} = \frac{13\,kW \cdot 3412.1415 \frac{Btu/hr}{kW}}{\left(2 \cdot \pi \cdot 40.18\,in \cdot 183.85\,in/144 \frac{in^2}{ft^2}\right)} = 137.62 \frac{Btu}{hr \cdot ft^2}$$

The applicant states that a grid sensitivity study, conducted as part of the analysis for a variant of the OS197L TC design, demonstrated that the meshing used for this evaluation was appropriate. However, no specific reference is provided for this study, nor is the “variant” of the OS197L identified by the applicant.

5.1.2.1 Assumptions Used in CFD Modeling

The general assumptions used by the applicant in the CFD modeling of the OS197L are provided below:

1. Heat removed through the cask end plugs and by conduction via trunnion contact with the transfer skid is conservatively neglected.

2. The total decay heat is considered to be evenly distributed over the outer surface of the cask's liquid neutron shield shell. The assumption of uniform heat flux is consistent with previous OS197 analysis methodology (See Chapter M.4) and reflects the axial spreading of the decay heat load due to the high axial conductivity of the DSC basket and rails, and the water filled neutron shield.

3. The CFD modeling need only address the geometry of the OS197L TC and its shielded transport skid as it exists between the front and rear trunnion towers. The applicant justifies the two-dimensional analysis as appropriate because the convective air flow over the transfer cask is primarily in the vertical direction, and end effects are not significant in this geometry. According to the applicant, since the relatively short axial segment appropriately represents the flow resistances in the vertical air flow path within the supplemental shielding, the model will not over-estimate the prototypic air flow in the three-dimensional geometry.

4. The outer surfaces of the auxiliary shielding on the transfer skid are assumed to be finished with a 'dark blue' color coating that yields a solar absorptivity of 0.90 or less and an emissivity of 0.85 or greater. Similarly, the inner surface of the auxiliary shielding is assumed to have a similar finish that yields an emissivity of 0.85 or greater.

   Note that for the fuel compartment openings in the basket, two sides are covered with Al-boral plates, and two sides are the bare XM-19 steel of the basket frame. The TN model homogenizes these materials into one material. Staff modeled the materials explicitly in their confirmatory analyses; for the COBRA-SFS model, staff used 0.85 emissivity for the Al-boral plates and 0.46 for the bare steel.

5. The applicant conservatively applied the regulatory insolation values from Part 71 [10 CFR Part 71(c)(1)] averaged over 24 hours and applied to the outer surfaces of the auxiliary shielding. The thickness of the auxiliary shielding, combined with the thermal mass of the OS197 cask and payload, justifies the use of 24-hour averaged values. The 24-hour average insolation on the roof of the transfer skid is assumed to be 122.9 Btu/hr-ft^2, 30.75 Btu/hr-ft^2 on the vertical surfaces, and 61.45 Btu/hr-ft^2 on the angled portion of the auxiliary shielding. These incident heating values are reduced by 10% to account for the assumed solar absorptivity of 0.90 for the coating used on the shields (see Assumption 4).

6. The ground is conservatively treated as an adiabatic surface.

The analysis for the off-normal ambient condition of 117°F is conducted assuming a 24 hour average steady-state ambient temperature of 107°F. A steady-state analysis at this temperature level has been shown by previous analyses to bound the transient thermal performance achieved using a diurnal cycle for ambient air with a peak temperature of 117°F.

5.1.3 CFD Analysis Results

The applicant's FLUENT CFD model of the supplemental shielding around the OS197L cask and transfer skid described above was used to determine the flow and temperature distribution of the bounding normal and off-normal hot conditions of transfer and with a decay heat load of 13 kW. The model utilized the following characteristics:

- second order discretization scheme for energy, momentum, turbulence, and the discrete ordinate calculation,
- the PRESTO solution scheme for pressure,
- the realizable turbulence model with enhanced wall functions (used to compute the turbulent heat transfer at the surface of the cask, since the boundary layer mesh yields y+ values of approximately 1.0).

SAR Figures W.4-7 and W.4-8 present the temperature distribution for the surface of the cask exterior shell and the supplemental shielding, respectively, for normal ambient condition of 100°F with insolation and with a 13 kW decay heat loading. A temperature distribution for off-normal conditions of 117°F (only for the cask shell exterior surface) is shown in SAR Figure W.4-11 for the 13 kW decay heat load.

The applicant's model predicted the peak temperature on the cask shell to occur at the point where the flow begins to separate from the cask, rather than at the centerline at the very top of the cask, as is seen in free convection from a heated cylinder in an infinite medium. The predicted behavior of the cask shell temperature reaching a peak and then decreasing slightly at the very top of the cask is attributed to flow recirculation in this region, due to the convoluted flow path around the exit shield plate just below the exit slot. Because of this recirculation, the surface flow does not stagnate at the top center of the cask as it would for an isolated cask, and as a result, a lower surface temperature is achieved. Instead, the peak temperature occurs away from the centerline of the cask, where the flow separation point is predicted to occur.

SAR Figure W.4-9 illustrates the velocity profiles at the centerlines of the model. The minimum gap between the cask exterior shell surface and the supplemental shielding for the modeled section of the OS197L cask and transfer skid combination is approximately 3.3 inches. The gap between the top of the cask exterior shell surface and the steel plate shielding the exit slot is approximately 10.33 inches. SAR Figure W.4-10 illustrates an enlarged view of the velocity profile at the exit from the auxiliary shielding enclosure. The predicted flow velocity vectors in this region can be seen in the figure. The peak neutron shield shell temperature with a 13 kW decay heat loading and a normal 100°F ambient condition is predicted to be 248°F, while the area-weighted average temperature is predicted to be 217°F.

5.1.4 Thermal Analysis of OS197L TC with 13 kW Heat Load

A two-dimensional model of the OS197L TC and DSC shell was developed by the applicant using the ANSYS Computer Code. The 2D model considers the hottest cross-section of the fuel and conservatively neglects heat transfer in the axial direction. The model represents the neutron shield, the cask structural shell, cask rails, and the DSC shell. The applicant's OS197L TC model is shown in SAR Figure W.4-12. The TC thermal model and analysis methodology are consistent with the methodology described in Appendix M, Section M.4.4.1.6 of the NUHOMS® base SAR for the OS197 TC with a 32PT DSC payload, with changes implemented to account for the configuration changes in the OS197L TC relative to the OS197 TC.

As discussed in SAR Section W.4.5, the CFD analyses consider the effect of the supplementary shielding and insolance on the OS19 7L TC thermal performance. A separate analysis of the OS197L TC loaded with a 13 kW heat load (32PT DSC or 61BT DSC) is performed using the temperature distribution over the neutron shield outer skin of the OS197L calculated from the CFD analysis (which incorporate the effects of the supplemental skid shielding and insolance as discussed in SAR Section W.4.5 and Section 4.1.2 above) as boundary conditions.

The temperatures of the neutron shield outer skin obtained from the applicant's CFD analysis are applied as boundary conditions over the outermost nodes of the 2D model of the OS197L TC and analyses are performed for normal, off-normal and accident conditions. The CFD analysis for off-normal 117°F ambient temperature case includes the effect of insolation on the supplemental shielding, which is considered conservative.

Based on operational procedures described for the OS197L cask in SAR Chapter W.8, the openings in the trailer shields are visually monitored for the presence of steam to detect a leakage of neutron shield water during the transfer operation. In addition, the OS197L TC will not remain within the supplementary shielding for an extended period of time after an accident. Therefore, the loss of liquid neutron shielding by itself is not a credible accident.

The loss of sun shield and liquid neutron shield in the OS197L TC represents the controlling accident transfer case under maximum ambient temperature and insolation when the supplementary shielding is removed.

The results of the analysis in terms of maximum TC component temperatures, with the supplemental skid shielding effects included, are summarized in SAR Table W.4-2 for the 13 kW case. The maximum temperatures at the top, side, and bottom of the DSC shell retrieved from the 2D model of the TC are also summarized in SAR Table W.4-2. These temperatures are used to define the boundary conditions for the analysis of the 3D models of the DSC shell/basket assemblies as discussed in Section W.4.7 of the SAR.

The 2D model analysis results of the 117°F ambient with insolance and accident case for the OS197L TC are also shown in SAR Figure W.4-13 for the 13 kW case. The applicant's analysis results for this model are summarized in Tables 5.2 and 5.3 below.

Table 5.2				
Maximum Temperatures (°F) of Key TC/32 PT DSC Components With 13 kW Heat Load				
TC/DSC Component		**Normal Transfer (with insolation)**	**Off-Normal Transfer (without Insolation)**	**Accident Transfer[1]**
TC Structural Shell		*251*	*256*	*430*
Neutron shield (max)		*246*	*251*	*418*
DSC outer shell	**Top**	*359*	*362*	*469*
	Side	*332*	*336*	*455*
	Bottom	*291*	*297*	*460*
DSC Basket[2]		*588*	*591*	*697*
Fuel cladding[2]		*606*	*609*	*710*

[1]Loss of sun shade and liquid neutron shield - with supplementary shielding intact
[2]Temperatures for these components were derived from the applicant's detailed 3-dimensional 32PT DSC analysis model

Table 5.3				
Maximum Temperatures (°F) of Key TC/61 BT DSC Components With 13 kW Heat Load				
TC/DSC Component		**Normal Transfer (with insolation)**	**Off-Normal Transfer (without Insolation)**	**Accident Transfer[1]**
TC Structural Shell		*250*	*255*	*415*
Neutron shield (max)		*246*	*251*	*404*
DSC outer shell	**Top**	*349*	*353*	*454*
	Side	*323*	*327*	*439*
	Bottom	*286*	*291*	*444*
DSC Basket[2]		*538*	*542*	*644*
Fuel cladding[2]		*561*	*565*	*666*

[1]Loss of sun shade and liquid neutron shield - with supplementary shielding intact
[2]Temperatures for these components were derived from the applicant's detailed 3-dimensional 61BT DSC analysis model

5.2 Thermal Analysis of NUHOMS® DSCs

The thermal evaluation in SAR Section W.4 support the OS197L for loading and transfer of the DSCs currently licensed under CoC No. 1004. These are identified in SAR Section W.4.1 as the 32PT and 61BT. Detailed thermal analyses of the DSCs within the OS197L TC are presented in SAR Section W.4.7, for the 32PT and 61BT.

5.2.1 Thermal Analysis of 32PT DSC Inside the OS197L TC

The maximum temperatures at the top, side, and bottom of the DSC shell, calculated as described by the applicant in SAR Section W.4.6, define the boundary conditions for the analysis of the 3D ANSYS model of the DSC shell and basket assembly described in Appendix M, Section M 4.4.1.1 of the NUHOMS® base SAR. The methodology used for the analysis, including the application of the temperature boundary conditions on the DSC shell, is identical to that used for the 32PT DSC and documented in Appendix M.

Based on the results documented in Appendix M, heat load zoning configuration (HLZC) No. 1 is assumed to remain the bounding configuration for the 32PT in the OS197L. The applicant uses this configuration in their analysis to determine the bounding basket components and fuel cladding temperatures.

The fuel cladding and DSC components maximum temperatures for the controlling (bounding) conditions are summarized in SAR Table W.4-3, and in Table 5.4 below. Thermographs of the temperature distributions on half-length sections of the basket plates and support rails are shown in SAR Figure W.4-14 for the off-normal 117°F ambient condition. The average cavity gas temperatures are determined from the analysis model results using the same methodology as that used in Appendix M.

Table 5.4

Maximum Temperatures (°F) of Key Components of 32PT DSC

DSC Component	Normal Transfer (with Insolation)	Off-Normal Transfer (without Insolation)	Accident Transfer[1]
DSC Basket/AL	*588*	*591*	*696*
DSC SS Rail	*372*	*376*	*487*
DSC Shell[2] (MAX)	*359*	*362*	*469*
Fuel cladding	*606*	*609*	*710*

[1]Loss of sun shade and liquid neutron shield - with supplementary shielding intact
[2]These are maximum boundary temperatures on the DSC outer shell from the 2D model of the OS197L TC (see Table 5.2)

Based on the Ideal Gas Law, the DSC internal pressure is proportional to the absolute temperature. Thus, the 32PT DSC pressures evaluated in Appendix M are multiplied by the ratio of the absolute temperatures obtained from this analysis (for the OS197L) to those in Appendix M (for the OS197) to determine the pressures when the DSC is transferred in the OS197L TC. The resulting maximum pressures are tabulated in SAR Table W.4-4 and Table 5.5 below.

Table 5.5		
Maximum DSC Pressures in psig (32PT in OS197L TC)		
Normal	**Off-Normal**	**Accident**
4.0	10.8	86.4

5.2.2 Thermal Analysis of 61BT DSC Inside the OS197L TC

The maximum temperatures at the top, side, and bottom of the DSC shell calculated by the applicant in SAR Section W.4.6 define the boundary conditions for the analysis of the 3-dimensional, 180° symmetric model of the DSC shell and basket assembly documented in Appendix K, Section K.4.4.1 of the NUHOMS® Base SAR. The same maximum decay heat load of 0.3 kW per assembly (18.3 kW total per DSC) and peaking factor profile used in Appendix K is used in this analysis to provide bounding basket and fuel cladding temperatures. The thermal analysis methodology used, including the application of the temperature boundary conditions (from the 2D model of the TC) on the DSC shell in the 3D model, is identical to that used for the 32PT DSC and documented in Appendix M.

The fuel cladding and DSC components maximum temperatures for the controlling (bounding) conditions are summarized in SAR Table W.4-5 and in Table 5.6 below. Thermographs of temperature distributions in the fuel assemblies, basket plates, and support rails are shown in SAR Figure W.4-15 for the off-normal 117°F ambient condition.

Table 5.6			
Maximum Temperatures (°F) of Key Components of 61BT DSC			
61BT DSC Component	**Normal Transfer**	**Off-Normal Transfer**	**Accident Transfer[1]**
DSC Basket/AL	538	542	644
DSC SS Rail	430	434	533
DSC Shell[2] (MAX)	349	353	454
Fuel cladding	561	565	666

[1]Loss of sun shade and liquid neutron shield - with supplementary shielding intact
[2]These are maximum boundary temperatures on the DSC outer shell from the 2D model of the OS197L TC (see Table 5.3)

The average cavity gas temperatures are determined from the analysis model results using the same methodology as that used in Appendix K. Based on the Ideal Gas Law, the DSC internal pressure is proportional to the absolute temperature. Thus the 61BT DSC pressures evaluated in Appendix K are multiplied by the ratio of the absolute temperatures obtained from this analysis (OS197L) to those in Appendix K (OS197) to determine the pressures when the DSC is transferred in the OS197L TC. The resulting maximum pressures are tabulated in SAR Table W.4-7, and Table 5.7 below.

Table 5.7		
Maximum DSC Pressures in psig (61BT in OS197L TC)		
Normal	**Off-Normal**	**Accident**
6.2	8.5	36.9

5.3 Effect of Modification of Loading Procedures on OS197L TC Thermal Performance

The applicant states that when the OS197L TC is not inside the supplemental decontamination area shield or the supplemental trailer shields, its thermal performance during such operations, including vacuum drying operations, is bounded by the thermal analysis presented in the revised pages of SAR Sections 8.1, 8.2, K.4.7, L.4.7, M.4.7 and N.4.7 included with this application for Amendment.

The applicant has, as a weight saving measure for transfer from the decontamination area to the trailer, allowed for the neutron shield to be drained. To maintain DSC shell temperatures within previously analyzed conditions for the DSC during vacuum drying, helium backfilling, and welding operations, the applicant requires that the DSC/TC annulus be maintained full of water during this transfer. The DSC/TC annulus is maintained at atmospheric pressure by venting.

The staff reviewed the applciant's proposed procedures and determined that this procedure should ensure that the temperatures of the various DSC components, as well as the fuel cladding, remain at or below previously analyzed maximum temperatures; it is therefore acceptable to the staff.

5.4. Thermal Performance of Various DSCs during Vacuum Drying Operation

As described in Chapter W.8 of the SAR, helium will be used for the blow down/drain down of water in the DSC cavity. Therefore, subsequent vacuum drying operations occur with a helium environment in the DSC cavity. Water will be maintained in the DSC/TC annulus during vacuum drying operations. Therefore, the staff concludes the fuel cladding temperatures calculated when the OS197L TC is loaded with a DSC during transfer conditions and with the supplemental trailer shields in place will bound the vacuum drying condition.

5.4.1 Accident Analyses of OS197L TC

The OS197L TC was evaluated by the applicant for accident conditions by a comparison with the performance of the original OS197 TC design. As discussed in Section W.4.1 of the SAR, the thermal resistance of the OS197 TC is approximately 6% higher than the thermal resistance of the OS197L TC. Therefore, the staff concludes the maximum temperatures for OS197L TC after an extended period of time are bounded by the steady state temperatures obtained for accident conditions of the OS197 TC discussed in Appendix K, Chapter K.4, Appendix L, Chapter L. 4, Appendix M, Chapter M 4, and Appendix N, Chapter N. 4.

5.5 Staff Confirmatory Analyses

Staff efforts to confirm several aspects of the design of the OS197L TC included a CFD model to determine the temperatures and flow associated with the OS-197L TC and the associated supplemental shielding required for the transfer evolution.

5.5.1 Confirmatory Analysis of the OS197L in Decontamination Shielding

The applicant provided brief description in Section W.4.4 of the applicant's evaluation to determine the effect of the decontamination area shielding on the OS197L TC thermal performance. The staff performed confirmatory calculations to verify the assertion that the additional shielding does not adversely impact the cask boundary conditions assumed in the thermal analysis.

A one-dimensional model balancing momentum and heat transfer effects within the air annulus formed by the vertical OS197L TC within the decontamination area shielding was developed and evaluated for a range of ambient temperatures. These calculations confirm that the annulus is large enough to allow natural circulation to produce steady-state wall temperatures only 20-30% higher than would be obtained in free convection from a vertical cylinder. Furthermore, operational procedures specify that the DSC/TC annulus will be water-filled during helium backfilling and vacuum drying, such that free convection from the TC external surface would not be the major mode of heat transfer. Therefore, based on this analysis, the staff finds acceptable the applicant's conclusion that the decontamination area shielding does not adversely affect the thermal performance of the OS197L TC during vacuum drying and helium backfilling operations.

5.5.2 Confirmatory Analysis of the OS197L in Supplemental Skid Shielding

The staff constructed a 3D CFD model using the FLUENT CFD code, of the OS197L with supplemental shielding, using the transfer conditions provided in the applicant's SAR. The purpose of the CFD analysis was to confirm the adequacy of the applicant's approach to represent the neutron shield using an effective thermal conductivity based on the method of evaluation described in Calculation NUH32PT.0403, Rev. 2, "NUHOMS®-32PT DSC Thermal Evaluation for 10 CFR Part 72 Storage Conditions" (Ref. 2). The OS197L transfer cask is designed without a lead gamma shield, but features a removable water-filled neutron shield and external supplemental shielding. The supplemental shielding prevents direct insolation heating and affects the convection and radiation heat transfer on the cask outer surface.

The OS197L transfer cask consists of a 2.68-inch thick steel cask body and a removable 3.5-inch thick liquid neutron shield assembly. The total water thickness of the neutron shield is 3 inches and the inner and outer stainless steel shells of the tank are 0.25 inches thick. The supplemental shielding consists of 3 sections. The lower section is a series of plates attached to the sides and ends of a typical transfer skid structure to provide the required shielding. Dual upper sections fit like clamshells over the cask and skid after the cask is placed on the transfer skid. The support legs on the skid provide an approximately 6.75-inch high clearance under the I-beams of the skid. Ambient air enters the enclosure through this clearance, flows around the transfer cask, and exits via a 6-inch wide slot at the top, which extends 184 inches along the axial length of the supplemental shielding. (See Figures 5.1 and 5.2)

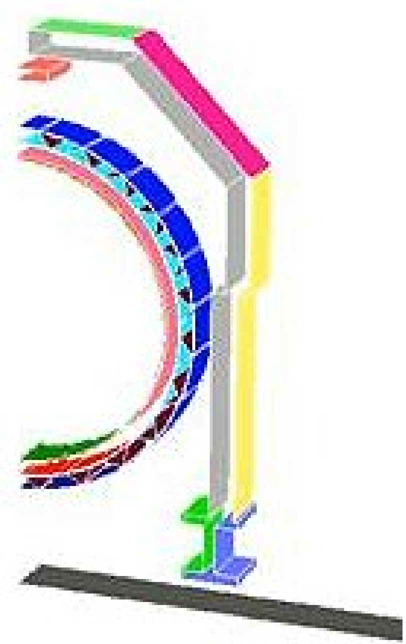

Figure 5.1. FLUENT Model of NUHOMS® OS197L TC System with Supplemental Shielding

The staff's CFD analysis was performed for ambient conditions of 100°F and 24 kW of total decay heat, based on the decay heat evaluated by the applicant in earlier revisions of their SAR. The applicant later reduced the allowable decay heat load in the OS 197L TC to 13kW. A three-dimensional (3-D) FLUENT CFD model was prepared to represent a 12-inch section of the cask and the transfer skid. The representative transfer cask includes the DSC outer shell, the TC cask rails, the TC cask structural shell, and the liquid water neutron shield. Within the TC, the DSC sits on top of two cask rails, which are located 18.5° from vertical downward below the DSC. The thickness of the cask rails is assumed to be 0.12 inches. The air gap between the DSC shell and the transfer cask structural shell at the bottom closes from 0.405 inches to 0.105 inches. This air gap is also included in the analysis. A uniform 0.01-inch air gap between the cask structural shell and the neutron shield inner skin is modeled as well. The heat load of the fuel assemblies is applied as a uniform heat flux over the inner surface of the DSC shell. All material properties, including liquid water, are obtained from the applicant's SAR.

Three modes of heat transfer are included in the analysis including conduction, natural convection, and radiation. Radiation heat transfer is based on the Discrete Ordinates (DO) method. The staff performed the CFD analysis for normal conditions of transfer and obtained temperatures and a temperature distribution which are generally consistent with the trends found in the applicant's results. Therefore, based on the CFD analysis, the staff concludes that the applicant's approach to represent the heat transfer through the OS197L transfer cask is acceptable.

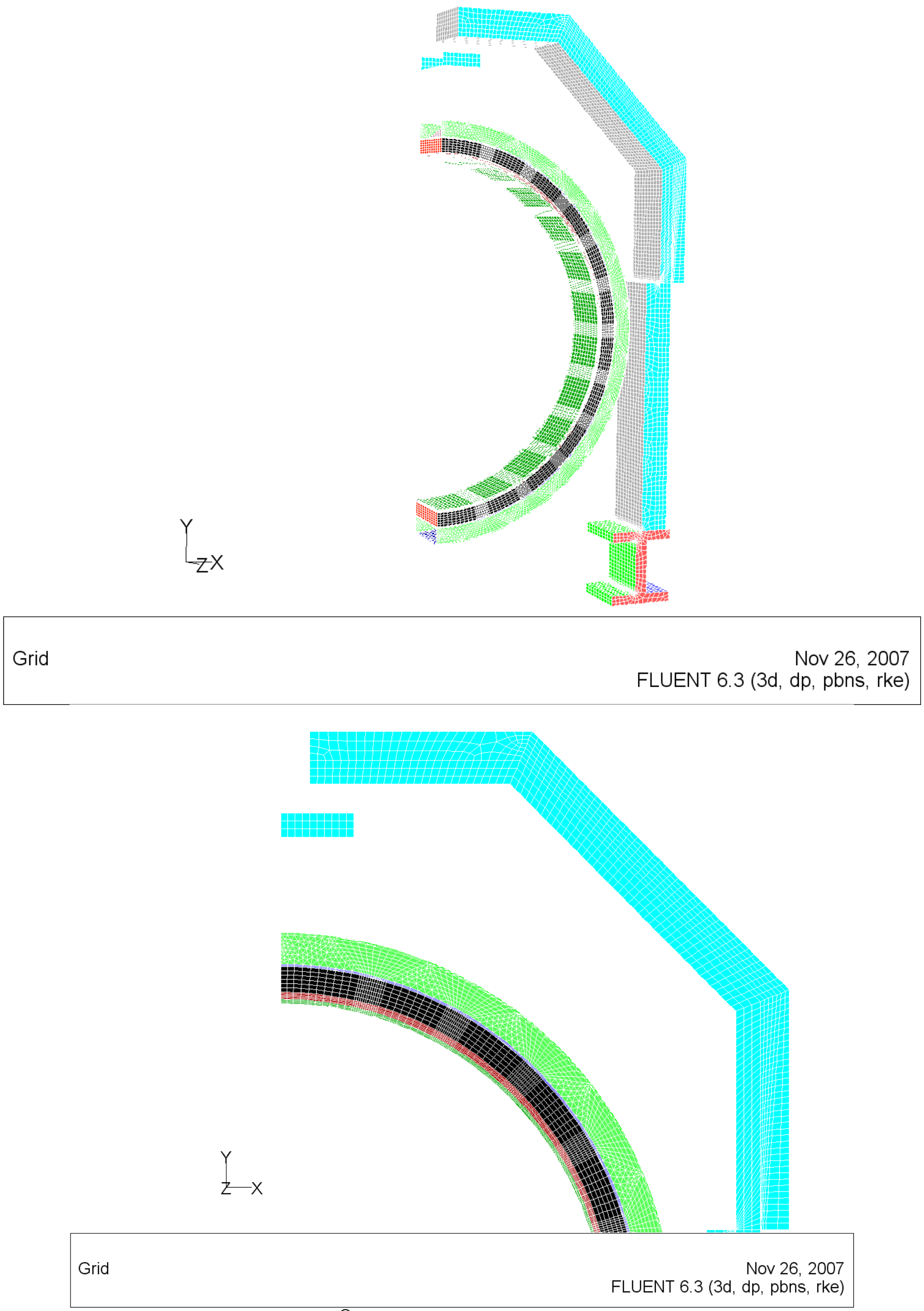

Figure 5.2. NUHOMS® OS197L TC System FLUENT Model Mesh

5.5.3 Confirmatory Analysis of the 32PT DSC in OS197L

Confirmatory evaluations of the performance of the 32PT in the OS197L transfer cask were also undertaken using the COBRA-SFS thermal-hydraulic analysis code, for a detailed model of the 32PT DSC within the OS197L. The system was represented using a three-dimensional model of a half-section of symmetry of the DSC within the TC, including:

- Detailed rod-and-subchannel representation of fuel assemblies (conduction, convection, and thermal radiation heat transfer),
- Aluminum liner plates, neutron poison plates, and aluminum neutron poison plate covers modeled with solid conduction nodes within each basket opening,
- Steel basket plates and steel backplates for R90 rails modeled in detail with solid conduction nodes,
- R90 and R45 solid aluminum rails modeled with detailed resolution 4 layers deep to capture details of radial heat flow,
- DSC shell modeled with 2 layers of nodes, to capture inner and outer surface temperatures,
- Gaps between DSC components represented as in ANSYS model of DSC (taken from Appendix M (see p. M.4-11)),
- All material properties for DSC and TC components taken from Appendix W,
- Neutron shield effective conductivity taken from Table W.4-1 in Appendix W.

The boundary conditions for the COBRA-SFS calculations are effectively the same as those used in the SAR Section W.4.7.1 evaluations, and therefore, the results should be directly comparable.

The thermal analyses of the 32PT DSC inside the OS197L TC reported in Appendix W were performed using the thermal analysis methodology from Appendix M, with the model of the DSC shell and basket assembly documented in the NUHOMS® Base SAR Section M.4.4.1.1. Appendix M includes the thermal evaluation of the 32PT within the OS197 transfer cask, which does not require supplemental shielding. Table 5.10 compares the results obtained in the confirmatory evaluations with COBRA-SFS to the results reported for the 32PT in the OS197L from Appendix W. The results for this DSC within the OS197, as reported in Appendix M, are also included in this comparison.

There is a difference of approximately 44°F between the peak cladding temperatures predicted in the confirmatory calculations and those obtained by the applicant using the ANSYS model of the 32PT DSC. The confirmatory calculations indicate that the steady-state peak cladding temperature in the 32PT DSC within the OS197L with a decay heat loading of 24 kW would exceed the regulatory limit of 752°F (400°C) during normal or off-normal transfer conditions. The main source of this difference appears to be in the differences in the temperature behavior predicted within the DSC. The results are in fairly close agreement for the TC component temperatures, and for the DSC shell and internal support rails. However, the DSC basket component temperatures and peak cladding temperatures are significantly different. This is illustrated by the plots in Figure 5-3 (for off-normal conditions) and in Figure 5-4 (for normal conditions). These figures compare peak component temperatures in the DSC and TC predicted with the confirmatory calculation model to the results of the SAR Appendix W models.

The temperature profile comparisons in Figures 5-3 and 5-4 show very good agreement in the results obtained for the OS197L transfer cask, and the peak DSC shell temperatures differ by only about 16°F. The peak temperatures predicted for the aluminum support rails differ by approximately the same amount, with the confirmatory calculation results the more conservative of the two. (This is also in contrast to the results for the DSC model shown in Section 4.5.4, in which the SAR model results are more conservative than the confirmatory calculations.) Figure 5-5 shows this conclusively, with confirmatory calculation results with a COBRA-SFS model of the DSC only compared to Appendix W results for the detailed DSC model. In this comparison, both calculations use the same boundary temperatures on the DSC outer shell.

<table>
<tr><th colspan="5">Table 5.10</th></tr>
<tr><th colspan="5">Peak Cladding Temperature (°F) Comparison of 32 PT in OS197L TC and OS197 TC</th></tr>
<tr><th></th><th><u>Normal</u>
(100°F)</th><th><u>Off-Normal</u>
(117°F)</th><th><u>Accident</u>
(117°F)</th><th>Source</th></tr>
<tr><td>SAR results (24 kW)</td><td>720</td><td>715</td><td>863</td><td>Appendix M, Tables M.4-2 and M.4-8 (UFSAR9)</td></tr>
<tr><td>SAR results (24 kW)</td><td>728</td><td>731</td><td>812</td><td>Appendix W, Rev. 0, Table W.4-8</td></tr>
<tr><td>SAR results (16 kW)[1]</td><td>606</td><td>609</td><td>710</td><td>Appendix W, Rev. 2, Table W.4-3</td></tr>
<tr><td colspan="5">[1] Reported as 13 kW; detailed ANSYS model of DSC assumed loading configuration with 16 central assemblies at 0.6 kW and 16 peripheral assemblies at 0.4 kW for total decay heat load of 16 kW; however, boundary temperatures on DSC shell were obtained from the ANSYS model of the TC, assuming 13 kW total decay heat load in DSC.</td></tr>
<tr><td rowspan="4">COBRA-SFS results</td><td>772</td><td>774</td><td></td><td>Confirmatory calculations: DSC-in-TC model (24 kW)</td></tr>
<tr><td></td><td>657</td><td></td><td>Confirmatory calculations: DSC-in-TC model (16 kW)[2]</td></tr>
<tr><td></td><td>621.2</td><td></td><td>Confirmatory calculations: DSC-in-TC model (13 kW)[3]</td></tr>
<tr><td></td><td>641</td><td></td><td>Confirmatory calculations: DSC-only model (16 kW)[4]</td></tr>
<tr><td colspan="5">[2] Boundary temperatures on TC outer shell from FLUENT analysis, DSC loading configuration same as in ANSYS model, as reported in Appendix W, Rev. 2.
[3] Boundary temperatures on TC outer shell from FLUENT analysis, DSC loading configuration assuming 16 central assemblies at 0.6 kW, top 6 peripheral assemblies at 0.4 kW, and remaining 10 peripheral assemblies at 0.1 kW, to yield total decay heat load of 13 kW; consistent with Figure W.4-1 in Appendix W, Rev. 2.
[4] Boundary temperatures on DSC outer shell from ANSYS model of TC, DSC loading configuration same as in ANSYS model of DSC, from Appendix W, Rev. 2.</td></tr>
</table>

The plots in Figures 5-3, 5-4, and 5-5 show that the difference between the SAR Appendix W results and the confirmatory calculations are due two main causes. These are (1) differences in the detailed DSC model, in which the SAR model predicts a higher rate of heat transfer through the basket, and (2) decoupling of the DSC and TC heat transfer solution in the two-step approach used in the SAR methodology. The two effects are additive, in that both result in lower predicted peak component temperatures within the DSC. The differences in the detailed DSC model result in a higher predicted rate of heat removal from the basket, and the decoupling of the DSC and TC results in lower boundary temperatures on the DSC shell.

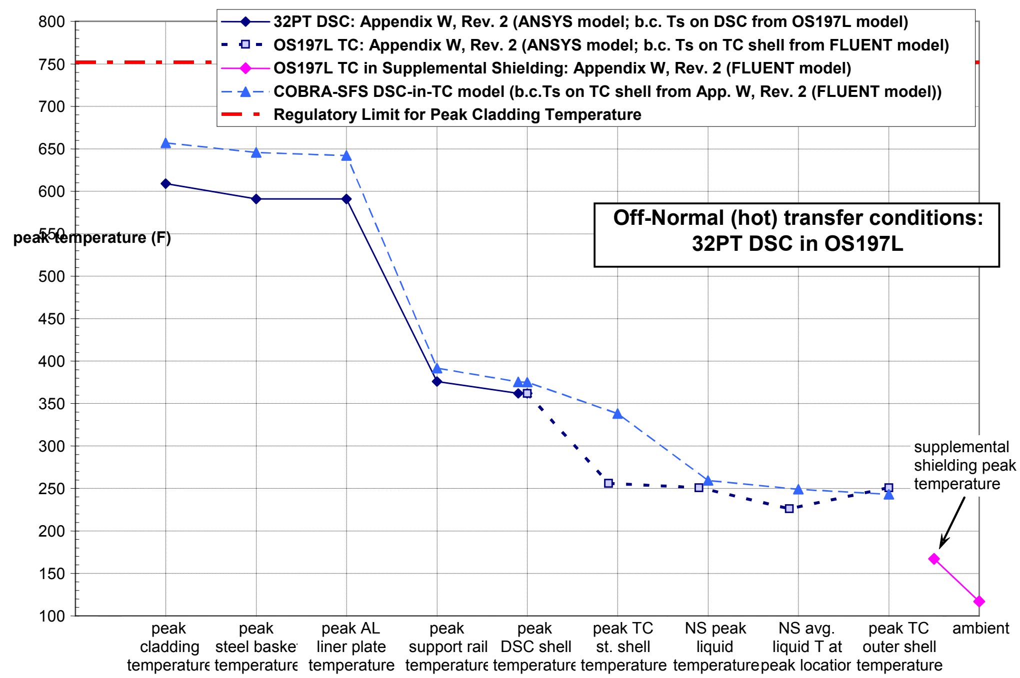

Figure 5-3 Peak Component Temperatures for 32PT DSC in OS197L TC: Off-Normal Conditions of Transfer (117°F ambient)

As indicated in Figure 5.3 above, the non-conservative results obtained with the SAR model compared to the confirmatory calculations can be further illustrated by comparison with results reported in Appendix M, for the 32PT within the original (heavier) OS197. Figure 5-6 shows the results for the 32PT using the DSC shell temperatures reported in Appendix M. As with the comparison for Appendix W (shown in Figure 5-5), the confirmatory calculation results are more conservative than those obtained with the ANSYS model documented in Appendix M. The peak cladding temperature predicted in the confirmatory calculations is approximately 24°F higher than the value obtained with the ANSYS model and reported in the SAR. However, for the 32PT DSC within the OS197, which does not require supplemental shielding, the peak cladding temperature obtained in the confirmatory calculations is 13°F below the temperature limit, and therefore the results obtained with the methodology documented in Appendix M were deemed acceptable.

For application to the analysis of the 32PT within the OS197L as presented in Appendix W, however, the non-conservatism of the methodology from Appendix M with respect to the confirmatory calculations is unacceptable, because the peak cladding temperatures are predicted to be much closer to the limit. The results obtained in the confirmatory calculations predict peak cladding temperatures that are above the regulatory limit for normal and off-normal

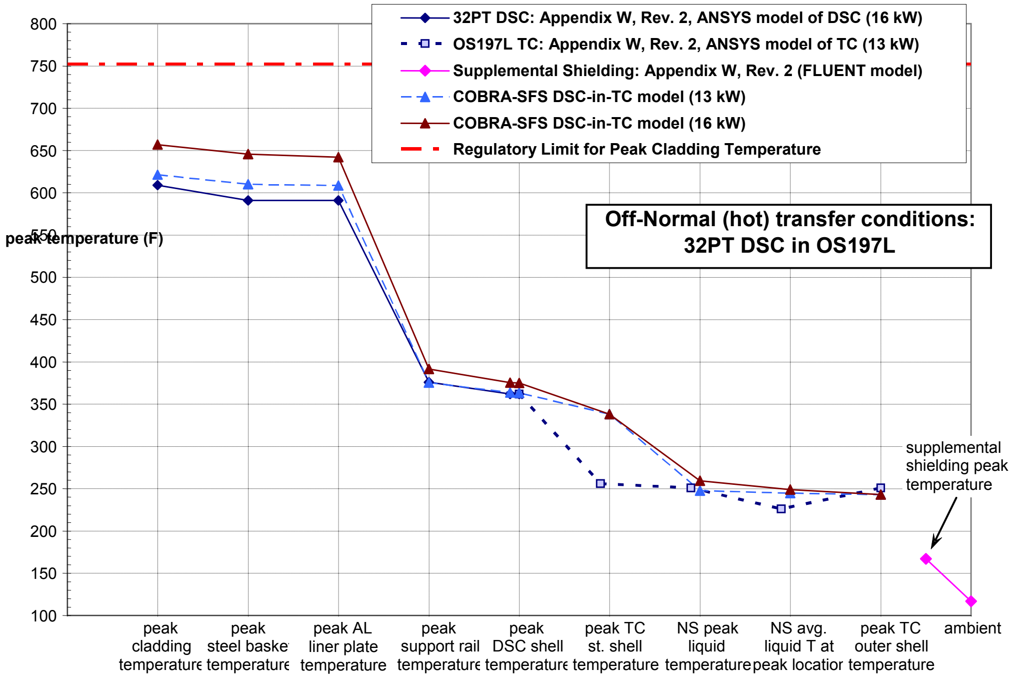

Figure 5-4 Peak Component Temperatures for 32PT DSC in OS197L TC: Normal Conditions of Transfer (100°F ambient)

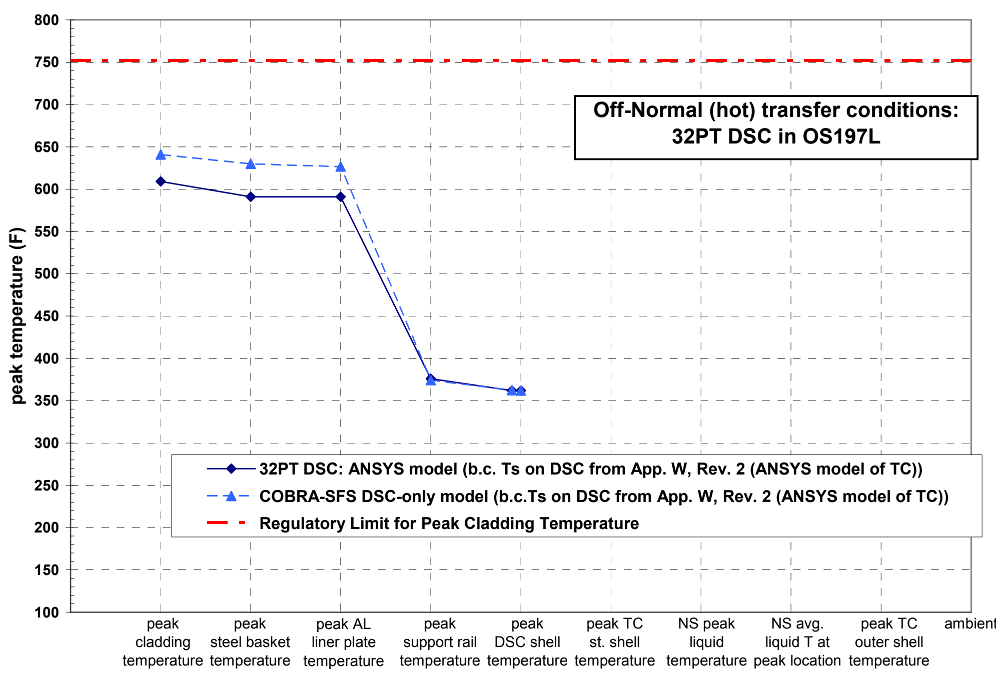

Figure 5-5 Peak Component Temperatures for 32PT DSC with DSC shell boundary temperatures from OS197L TC model in Appendix W: Off-Normal Conditions (117°F ambient)

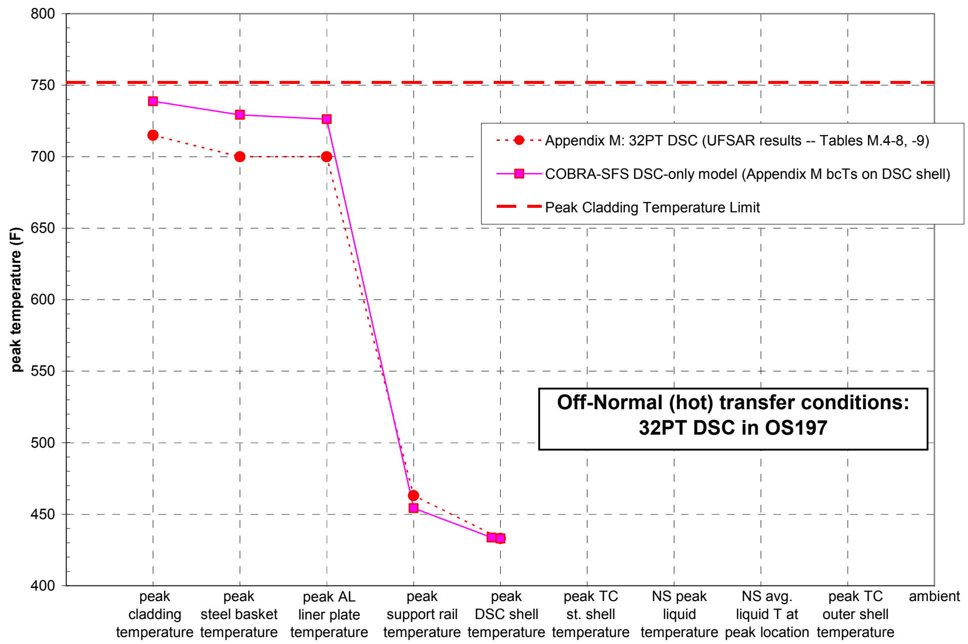

Figure 5-6 Peak Component Temperatures for 32PT DSC with DSC shell boundary temperatures from OS197 TC model in Appendix M: Off-Normal Conditions (117°F ambient)

conditions of transport for a heat load of 24 kW. These results were obtained using the boundary temperatures calculated by the applicant, using their FLUENT model of the TC within the supplemental shielding.

Direct evaluation of the effect of the supplemental shielding is not possible with the COBRA-SFS code, used in the confirmatory calculations. However, a bounding condition can be obtained by evaluating the thermal performance of the 32PT within the OS197L *without* supplemental shielding. This calculation was performed assuming a free convection boundary condition on the external surface of the OS197L, using the correlation of McAdams (Ref. 3) for turbulent free convection heat transfer from a horizontal cylinder;

$$Nu_D = 0.13(Gr_D \Pr)^{1/3}$$

Where Gr_D = Grashof number (characteristic length is cylinder diameter)
Pr = Prandtl number of the fluid
(all fluid properties evaluated at $T_f = (T_{wall} + T_{ambient})/2$)

The results obtained for this case are compared to the SAR Appendix W results in Figure 5-7. The confirmatory calculations indicate that without the supplemental shielding, the peak temperature on the OS197L external surface would be more than 100°F lower than the value predicted in the SAR Appendix W with the FLUENT model. As a result, the peak cladding temperature in the confirmatory calculation is only about 727°F, which is 4°F below the value predicted with the SAR methodology *with* the supplemental shielding in place. This further illustrates the non-conservatism of the detailed DSC model in the SAR.

During the course of the staff's review, the applicant chose to revise the maximum decay heat loading for the 32PT DSC downward from 24 kW to 13 kW. Additional calculations were submitted showing the results obtained with the FLUENT model of the OS197L within the supplemental shielding, with a 13 kW decay heat load represented as a uniform surface heat flux on the TC outer shell. Figure 5-8 shows the effect on the predicted TC surface temperatures, in which the reduced heat load results in the reduction of the TC surface temperature by approximately 60 ºF (33.3ºC).

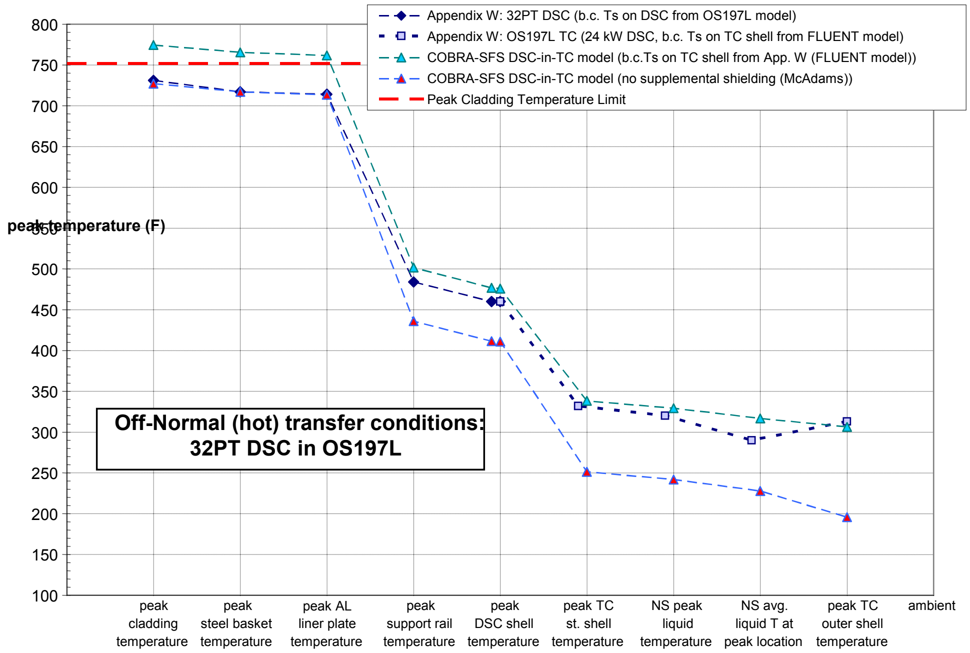

Figure 5-7 Peak Component Temperatures for 32PT DSC within OS197 TC, with and without supplemental shielding: Off-Normal Conditions (117°F ambient)

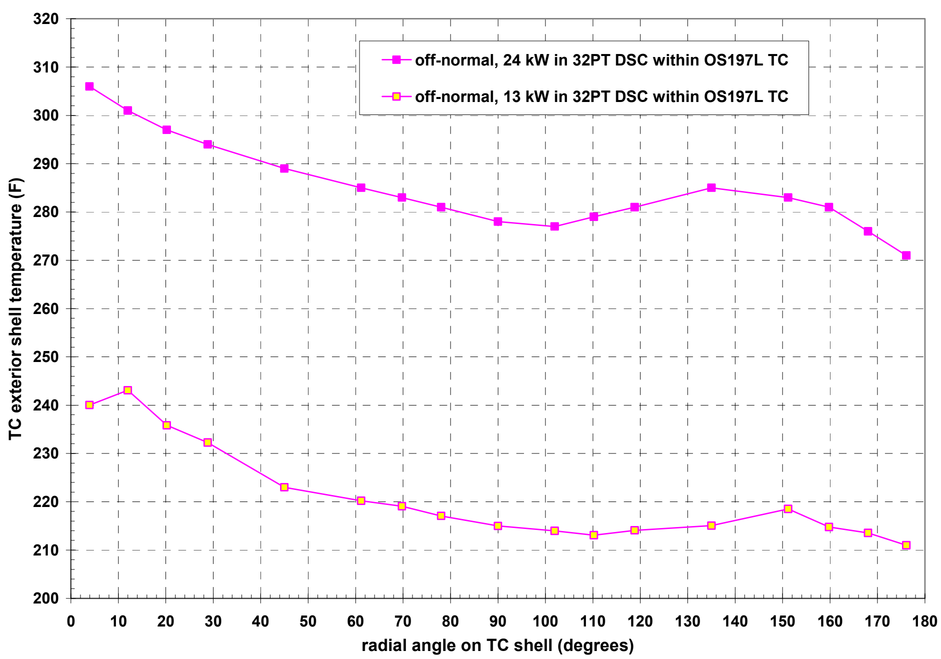

Figure 5-8 Surface Temperatures from FLUENT model for OS197 TC within supplemental shielding: Off-Normal Conditions (117°F ambient)

Confirmatory calculations using the COBRA-SFS model described above were performed using the new boundary temperatures on the TC surface and the reduced decay heat load of 13 kW. The 13 kW total decay heat was applied in the COBRA-SFS model as an overall reduction, maintaining the limiting non-uniform loading pattern identified as Configuration #1 in the Appendix W submittal. In addition, Configuration #3 (uniform loading) was also checked with confirmatory calculations for the 13 kW decay heat load. The results are summarized in Table 5.10.

The results shown in Table 5.10 indicate that the 32PT DSC can meet the peak cladding temperature limit for transport in the OS197L if the total decay heat load is limited to 13 kW or less. For these conditions, the limiting loading configuration is #3 (uniform loading), rather than #1 (non-uniform loading).

5.5.4 Confirmatory Analysis of the 61BT DSC Inside the OS197L TC

In addition to the 32PT DSC, the OS197L is also able to transfer the 61BT. Table 5.11 summarizes the peak cladding temperatures for normal, off-normal, and accident conditions for this DSC in the OS197, as reported in various sections of the SAR. The reported peak cladding temperatures for this DSC are approximately 115°F below the regulatory limit of 752°F with the supplemental shielding in place. The analysis for this DSC uses the same non-conservative multi-step approach as noted in Section 5.5.3 above for the 32PT DSC, but it is unlikely to result in a large enough under-estimate of the peak cladding temperature, that would exceed the 115^{o} margin and approach the regulatory limit.

Table 5.11				
Comparison of Peak Cladding Temperatures (°F) for the 61BT in the OS197L TC and OS197 TC				
DSC	**Normal (100°F)**	**Off-Normal (117°F)**	**Accident (117°F)**	**Source**
61BT	638	not reported	827[1]	Appendix K, Tables K.4-2 and K.4-4 (UFSAR Rev. 9)
61BT	634	638	757[2]	Appendix W, Table W.4-6
Change in PCT for 61BT	-4	N/A	N/A	App. W – App. K
[1]Ambient temperature of 215°F; limiting condition is vacuum drying transient, with water-filled DSC/TC annulus. [2]Ambient temperature is 117°F for accident conditions in Appendix W evaluations; limiting accident is loss of sunshield, loss of neutron shield.				

5.6 Changes to Technical Specifications

The staff's evaluation of the conversion to Standardized Technical Specifications focused on any changes made to the technical specifications from what was previously approved and any aspects of the new transfer cask design that could adversely affect the thermal performance of the DSCs.

The Staff reviewed the proposed standardized technical specifications and determined that the thermal criteria remained largely unchanged from what was previously approved. The applicant removed TSs addressing vacuum drying duration limits for various DSCs, which was a change approved based on the use of helium for the blowdown phase of the DSC loading process. Removal of these TSs is therefore acceptable.

5.7 Evaluation Findings

The OS197L is acceptable for use for the 32PT and 61BT DCs for a maximum decay heat load of 13 kW. At this reduced decay heat loading, the 32PT and 61BT DSCs can be transferred in the OS197L without exceeding the regulatory limit of 752°F for the peak cladding temperature. However, it should be noted that the non-conservative values for peak cladding temperature reported by the applicant in the original submittal (with decay heat of 24 kW) do not appear to be related to the supplemental shielding, but instead appear to result mainly from non-conservatism in the Appendix M methodology for the detailed DSC model. The cause appears to be a non-conservative simplification in the modeling of the thermal conductivity of the fuel basket. This non-conservatism would have to be addressed if higher heat loads are sought for the OS197L TC.

F5.1 The staff concludes that the thermal SSCs important to safety are described in sufficient detail in Sections W.1 and W.4 of the SAR to enable an evaluation of their effectiveness. Based on the applicant's analyses, there is reasonable assurance that the system is designed with a heat removal capability consistent with its importance to safety. The staff also concludes that there is reasonable assurance that analyses of the systems demonstrate that the applicable design and acceptance criteria have been satisfied for the storage of the authorized fuel assemblies.

F5.2 The staff has reasonable assurance that the temperatures of the cask SSCs important to safety will remain within the predicted operating temperature ranges and that cask pressures under normal and accident conditions were determined correctly.

F5.3 The staff has reasonable assurance that the system provides adequate heat removal capacity without active cooling systems.

F5.4 The staff has reasonable assurance that the spent fuel cladding will be protected against degradation that leads to gross ruptures by maintaining the clad temperature below maximum allowable limits and by providing an inert environment in the cask cavity.

F5.5 The staff concludes that the thermal design of the 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 system will allow safe storage of spent fuel for a certified life of 20 years. This finding is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted engineering practices.

5.8 References

1. Transnuclear, Inc., NUH-003,Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, Rev. 10, February 11, 2008 ((ML080390201 (proprietary version)).
2. Transnuclear, Inc., Supplemental Information Regarding the Application for Amendment 11 of the NUHOMS® Certificate of Compliance No. 1004 for Spent Fuel Storage Casks, Revision 0, Docket No. 72-1004 (TAC No. L24080), August 23, 2007 (ML072410293 (non-proprietary version), and ML072560076 (non-proprietary version, partly withheld under SUNSI) dated September 11, 2007).
3. McAdams, W.H., "Heat Transmission," 3rd ed., McGraw-Hill Book Company, New York, 1954.

6.0 SHIELDING EVALUATION

The purpose of this amendment application was to include the addition of a light weight transfer cask (OS197L TC) to the Standardized NUHOMS® System and to modify the Technical Specifications (TS) to be consistent with the guidance provided in NUREG-1745 (Ref. 1). The OS197L is a modified version of the previously approved OS197 TC specifically intended to accommodate facilities with a reduced crane capacity. Initially, the OS197L TC was designed with a nominal weight of 75 tons to accommodate cranes with limited weight capacities. However, with the addition of limitations and controls for operations with this TC, the final OS197L TC design has a nominal weight of 85 tons with a maximum weight limit of 90 tons. This nominal weight does not include supplemental shielding, but does include water in all areas of the cask (i.e., Dry Shielded Canister (DSC) cavity, DSC/TC annulus, and TC neutron shield) as specified in Table W.3-1 of the SAR (Ref. 2).

This is a unique and first of a kind amendment request and a complex review given the operational challenges involved with use of this cask. Unlike the standard cask designs, use of the OS197L TC presents unique risks, in terms of high radiation fields, to personnel involved in the loading, unloading, and transfer operations proposed as part of this amendment. It should be noted that, as stated in Chapter 1 of this SER, an exemption was granted for limited use of a lightweight transfer cask for dry storage operations at the Omaha Public Power District (OPPD) Ft. Calhoun station (Ref. 3). The staff used the review of that exemption request to inform its review efforts for the OS197L TC portion of the proposed amendment.

Given the extensive dose rates on the surface of the bare cask, the staff requested that more design and operational requirements be provided in the Certificate of Compliance (CoC), Technical Specifications, and Safety Analysis Report (SAR) portions of the application. To address issues regarding the proper specification of the cask, the staff determined that the CoC should characterize the TC system as including the bare TC and the additional supplemental shielding features maintained in the SAR. The staff determined that it was necessary to clarify that the transfer cask is a part of the cask or dry storage system. Therefore, regulatory requirements applicable to the dry storage system apply to the TC as well. The transfer cask is used as a means of loading and transporting a DSC with spent fuel to the Horizontal Storage Module (HSM). The duration of the operations with the transfer cask is not a criterion for defining it as part of the dry storage system. The staff also concludes that, whereas the currently approved Standardized NUHOMS® System transfer casks provide shielding sufficient for biological protection at the cask surface, the same is not true of the OS197L TC. The OS197L TC requires the use of supplemental shielding to provide a similar level of protection to that provided by the other system TCs. Therefore, the transfer cask system is defined, for the OS197L TC, so that it includes the supplemental shielding used in the decontamination area and on the transfer trailer. As a result, this definition has been included in the description of the OS197L TC system given in the CoC.

The staff also requested that the applicant address off-normal occurrences such as crane hang ups. The applicant included requirements in the TS for the user to perform evaluations of off-normal events and to develop and follow written procedures to address recovery from such events. The applicant also added discussions in the SAR that outline procedures for using manual crane operations and temporary shielding to relocate the cask safely to an area as a means of immediate resolution. As part of this revision, the applicant revised the TS to include dose rate limits and measurements for the OS197L TC while in the decontamination area. Axial and radial dose rate limits are specified in the TS for the approved transfer casks in this system. The dose rate limits listed in TS 5.2.4 for the OS197L TC are taken with the decontamination area shielding present; the radial limits are for the surface of this supplemental shielding. This is consistent with normal operations, as required in TS 4.4, which specify that this supplemental shielding is to be used for all normal condition loading operations when the cask is not on the crane or in the pool. TS 4.4 also requires that the bare OS197L cask is only to be handled using remote handling operations, which are discussed in detail in the operations procedures of SAR Chapter W.8. Therefore, the staff finds that limits for, and associated measurements taken with, decontamination shielding present are acceptable.

The initial amendment request included approval of this transfer cask (OS197L) for use with the 24P, 52B, 24PT2, 61BT, 32PT, and 24PHB DSCs with a maximum heat load limit of 24 kW. However, staff questioned the extreme dose rates in the vicinity of the cask under these conditions. Staff expressed concerns about potential impacts to the public and to workers, whether directly involved in loading and transfer operations or involved in facility operations not related to dry storage operations (10 CFR 20.1301(a)(2) and 10 CFR 72.104(a)), during off-normal conditions. As a result the applicant restricted approved content to the 32PT and 61BT DSCs and revised the heat load limit to 13 kW and 12 kW for each DSC, respectively. This resulted in surface dose rates decreasing significantly (from about 53 rem/hr to about 10 rem/hr). When supplemental shielding is in place, as required in the TS for operations with personnel present around the TC under normal conditions, the dose rates are similar to those on the surface of currently approved TCs. Additional evaluations were performed by the applicant to address dose consequences as a result of off-normal and accident conditions where the possibility exists that supplemental shielding may not be present. These are discussed in detail in both this chapter and the Radiation Protection chapter (Chapter 10) of the SER.

Given the purpose of the OS197L TC design (i.e., to provide a TC for dry storage operations useable at sites with limited spent fuel building crane capacities) and the radiation protection concerns associated with the design, the staff initially determined that the use of this TC should be limited to only those sites with such limited crane capacities that a standard TC could not be used. The applicant, however, modified the proposed design by limiting the allowable contents and modifying the operations as partial reasoning for justifying that such a restriction was not necessary. The dose rates on the bare TC are still significantly high (~10 rem/hr on contact); thus, operations with this TC still need to include supplemental shielding and remote operations. However, the design dose rates have significantly decreased versus the dose rates for the initially proposed design. Given the applicant's analyses, the staff's evaluations and findings described in other sections of the SER (e.g., Section 10.3.1), and the conditions that have been added to the technical specifications for the operations with the OS197L TC at these dose rates, the staff ultimately determined that a restriction need not be placed on the sites where this TC can be used. However, staff finds that a licensee that considers using the OS197L TC for a site that has the crane capacity to use a standard TC should inform that decision with careful consideration of ALARA and the associated regulatory requirements (e.g., 10 CFR 72.104(b) and (c) and 10 CFR Part 20). The staff expects that such a consideration should lead the user to select the design affording the greatest shielding that its facility is able to support (i.e., which crane capacity and other considerations allow).

Due to the significant dose rates on the surface of the bare cask, the staff also requested more clarification on certain operational assumptions used in the shielding analysis. Initially there was a lack of clarity regarding whether the DSC was to be drained during periods of normal operations. This led to questions as to the amount of water being retained in the annulus of the DSC/TC. The applicant added a requirement in the TS that the water would be at least to the level of the top of the fuel assembly. The shielding analysis takes no credit for water in these regions and assumes no water is present. The staff considers this to be conservative when evaluating potential occupational and public exposure for those operations where water is present.

As part of the initial application request, the staff observed from the application that the neutron shield and DSC/TC annulus and the DSC cavity were allowed to be drained to accommodate crane load restrictions. However, as part of the latest revision to the SAR, the operations have been modified so that the neutron shield is filled throughout normal loading operations and water is present within the DSC and annulus regions, at least up to the height of the fuel, up until DSC drying and backfill operations are begun in the decontamination area. Surface dose rate measurements taken for the OS197L cask in the decontamination area are done with the TC in the configurations specified by TS 5.2.4.

The specification of the decontamination area supplemental shielding in TS 5.2.4.e), as initially proposed, indicated that shielding equivalent to a nominal 6 inches of steel would be used. Staff had concerns with what could constitute 'equivalent' and all the implications associated with that term, especially for an SSC important to safety. Accordingly, the shielding was defined by the applicant as steel of a nominal 6-inch thickness. However, the staff was also concerned that use of minimum thickness could lead to an incorrect understanding of the measurement configuration. Thus, the applicant specified a nominal thickness in the TS. This shielding is included in the configuration for the radial dose rate measurements for the OS197L TC. For purposes of these measurements, shielding of greater thickness, beyond a reasonable tolerance as established in industry codes for fabrication of steel components, may not be used or credited for the measurements used to demonstrate compliance with the TS dose rate limit for the OS197L TC. While a licensee may use additional supplemental shielding for ALARA purposes, this additional shielding should not be a part of the TS dose rate measurement configuration.

During the initial stages of the review process the staff requested that the supplemental shielding be specified as part of the basic components of the OS197L TC system. However, in its response to the staff's RAIs, the applicant provided its rationale for not including the supplemental shielding as a component of the TC. This rationale included how the supplemental shielding was to be used; supplemental shielding was only to be used for draining, drying, sealing, and testing of the cask. Once the OS197L was sealed and awaiting transfer, the temporary shielding would no longer be used. Furthermore, the applicant stated that operations within the building are only governed by regulations in 10 CFR Part 50, and that the dose rate limits in 10 CFR 72.104 and 10 CFR 72.106 do not apply until after the transfer cask is loaded and is outside of the fuel building where it will be shielded by the transfer trailer.

The staff reviewed the applicant's response and determined that the requirements of 10 CFR Part 72 (specifically 10 CFR 72.104) are applicable regardless of location. This was predicated on the fact that 10 CFR 72.234 and 72.236 establish requirements for the fabrication of cask systems. The regulations in 10 CFR 72.236(d) state that "radiation and confinement features must be provided sufficient to meet the requirements in 72.104 and 72.106" (Ref. 4). No exceptions or distinctions are made with respect to whether the TC is inside or outside a 10 CFR Part 50 building. The staff's position is consistent with various statements of consideration for rulemakings involving relevant sections of 10 CFR Part 72 (Ref.5), and the relationship between 10 CFR Part 50 and 10 CFR Part 72 (Ref. 6). Therefore, the applicant revised the description of the OS197L TC system to include the supplemental shielding in the decontamination area and on the transfer trailer. In addition, the applicant has demonstrated, as part of their shielding and radiation protection evaluations, compliance with the requirements in 10 CFR Part 20, 10 CFR 72.104, 10 CFR 72.106, and 10 CFR 72.236(d). This chapter and chapter 10 of this SER describe the information and analyses the applicant provided to demonstrate compliance with these regulations and the staff's evaluation of that compliance.

6.1 Certificate of Compliance (CoC) Changes

In response to staff requests for additional information, the applicant specified in the proposed Certificate of Compliance (CoC) the maximum loaded weight limits and details on the construction (i.e., materials and their arrangement) for each of the TCs and the operational requirements (i.e., neutron shield and supplemental shielding) for the OS197L TC. As stated in the CoC, each TC is a multi-layered cylindrical cask with steel, lead and steel layers for gamma shielding, except for the OS197L TC, which has only steel for gamma shielding. The maximum loaded weights of the TCs are 110 and 130 tons except for the OS197L, which is 90 tons. Additionally, the decontamination area shielding, and the transfer trailer's support skid supplemental shielding for the OS197L TC, are also listed among the NUHOMS® system's basic components that are important to safety. Related to this designation, the TS have also been modified to ensure that these components meet the proper design considerations (see TS 4.2.3).

6.1.1 Technical Specification (TS) Changes

The staff reviewed the technical specifications with respect to shielding and radiation protection issues for the Standardized NUHOMS® System. Staff requested revisions to portions of the technical specifications to address normal and off-normal exposure to the public and plant personnel. As a result, the applicant revised TS 5.2.4 to require that an analysis be performed to ensure compliance with 10 CFR Part 20 and 10 CFR 72.104 under site loading conditions, and that a dose assessment be performed to evaluate occupational and public exposures under off-normal and accident conditions. TS 5.3.4 was also revised to add a requirement that the shielding on the DSC, TC, and trailer be inspected for further use after an accidental drop.

The applicant initially proposed a modified radiation protection program in TS 5.2.4 that does not include transfer cask dose rate limits. However, the staff determined that transfer cask dose rate limits for each DSC are important for a number of reasons; thus, they were retained in the technical specifications as part of the TS radiation protection program. TS dose rate limits for the transfer cask ensure that transfer cask features remain sufficient to enable the user to meet regulatory requirements. Also, TS dose rate limits for the transfer cask provide the user with the information necessary to perform a thorough ALARA evaluation and establish appropriate operational restrictions for anticipated cask work to minimize personnel exposure, thus aiding the effectiveness of the user's implementation of its 10 CFR Part 50 and Part 20 programs with respect to spent fuel handling (such as ensuring that TS affecting operations in the fuel handling building are met). Additionally, the transfer cask surface dose rate limits also serve as a check against potential mis-loading of a DSC. These functions are necessary for compliance with 10 CFR 72.236(d) and 72.104(b), and 10 CFR 20.1101(b). Staff further notes that user radiation protection personnel may be required to make multiple measurements during cask loading operations; therefore, measurements that verify compliance with TS dose rate limits will be among those performed by these personnel and will thus be readily available. It should also be noted that the guidance in NUREG-1745 identifies dose rate limits as one of the criteria, the verification of which address SAR commitments and regulatory requirements as part of a cask loading, unloading and preparation program. NUREG-1745 guidance indicates that the program requirements are to be completed prior to leaving the 10 CFR Part 50 building; thus, limits are applied to the transfer cask.

The staff concludes that, to be effective, the dose rate limits and associated measurements should have the following features. First, the limits should be derived from the shielding evaluation for TC configurations encountered during normal operations. The values of the limits should be supported by the dose rates determined in the applicant's shielding analyses. The inclusion of some margin, to account for measurement uncertainties, is acceptable provided the additional margin is appropriate (i.e., not excessive). Limits in TS should be set for important and significant features of the TC, specifically for the axial top and radial side of the TC in this case, since these areas have been shown to be the most important to personnel dose due to likely personnel locations during various operations for preparing a DSC for storage and transporting it to a HSM. Thus, dose rate limits for the top and side are needed to ensure the proper shielding performance of these TC features. Additionally, a dose rate limit on the TC side can serve to check against a mis-load of contents in a peripheral DSC basket location. This limit would not be effective for mis-loads in interior basket locations. Dose rate limits on the TC top would be useful to check against mis-loads of contents in the DSC basket's interior locations. Finally, each measurement should be compared against the proper limit, and be performed on a TC in the configuration that is the basis for the limit. Averaging of measured dose rates is not acceptable since this can mask high dose rates in one area of the TC feature with lower measured dose rates in other areas of the TC, diminishing the effectiveness of the measurements and limits to identify potential problems.

In view of the preceding considerations, the staff has reviewed the proposed TC dose rate limits in TS 5.2.4, and the associated measurements proposed by the applicant, and concludes that they are acceptable. This finding is also based on the understanding that the configuration specification of "bulk water removed from the DSC cavity" means that the DSC is basically empty of water. While there may be some residual water in the DSC, the amount is small, and doesn't contribute to any shielding of the DSC contents. For the OS197L TC, staff also concludes that specifying side dose rate limits for, and performing measurements for, the TC in the decontamination area shielding is acceptable, given that personnel are not around the cask under normal conditions, and that verifying compliance with limits for this configuration is in line with ALARA principles (vs. limits on a bare TC). The applicant modified the operations chapters throughout the SAR and its appendices to include procedures for verifying compliance with the TS dose rate limits, at the appropriate stages in the operations sequences, so that the TC configurations at the times of dose rate measurements are consistent with the measurement configurations specified in the TS.

Dose rate limits and the associated measurements for HSMs were also modified. The staff concludes that similar considerations apply to the selection of HSM dose rate limits as apply to the TC dose rate limits. In addition, however, significance relative to impacts on exposures to the public must also be considered (though this latter consideration may also be important for the TC too, as in the case of a high dose rate TC like the OS197L). For the HSM, this consideration mostly targets off-site exposures. As a result of the review, dose rate limits were established for the surfaces of the HSM front bird screens, the HSM door, and the end shield wall. While some limits had previously been set for a distance away from the HSM surface, all HSM dose rate limits were set for the HSM surface in this amendment. Staff notes that, among other things, this is consistent with the guidance provided in NUREG-1745 (Ref. 1).

Staff notes that limits for one HSM surface are insufficient. Therefore, the applicant retained a limit on the maximum dose rate on the end shield wall surface in the TS for each DSC. Average dose rate limits were at one time proposed as part of this amendment. However, given staff concerns regarding dose rate averaging (as stated earlier in the discussion for TC dose rate limits) and the analyses used to support these limits, the applicant proposed HSM dose rate limits that are derived from calculations of maximum dose rates. The licensee using this dry storage system will compare the dose rates from each measurement to the limit value to demonstrate TS compliance. Based upon these considerations, staff finds the limits and measurements proposed by the applicant to be acceptable. Any failure to meet the limits will result in the user performing the actions specified in the TS. The applicant modified the operations chapters throughout the SAR and its appendices to include procedures for verifying compliance with the TS dose rate limits and to reference the correct TS paragraph. The staff also notes that the TS measurements for an HSM apply to all HSM models (including HSM-H models), unless explicitly stated otherwise in the TS (e.g., birdscreen limits and measurements differ between the HSM-H models and the other HSM models, but the door and end shield wall measurements are the same for all models). A DSC is only loaded in a HSM model for which there is an applicable TS dose rate limit.

The staff concludes that, considering the relocated TS, the deleted TS, the new TS, and movement of the TS bases to the Final Safety Analysis Report, the technical specifications provide reasonable assurance that the cask will allow safe transfer and storage of the spent fuel. Other significant changes to the technical specifications were made that relate to radiation protection concerns. These specifications are addressed in the radiation protection chapter of this SER.

Based upon the considerations described here and in the following subsections as well as in the radiation protection chapter of this SER as they relate to the changes to the technical specifications, the staff concludes that these changes (revision, modification and addition of specifications along with the relocation of the bases to the SAR), are acceptable.

6.1.2 Revision of Technical Specifications

Several technical specifications related to the shielding performance of the Standardized NUHOMS® System were relocated and revised as needed, due to the standardization of the technical specifications. The staff reviewed the technical specifications related to shielding performance. These specifications include:

- Item 6 of TS 4.3.3, "Site Specific Parameters and Analyses" (formerly TS 1.1.9, "Supplemental Shielding")
- TS 4.3.1, "Storage Configuration," (formerly TS 1.1.10, "HSM-H [Horizontal Storage Module, Model H] Storage Configuration")
- TS 5.4, "HSM [Horizontal Storage Module] or HSM-H Dose Rate Evaluation Program" (formerly TS 1.2.7, 1.2.7a, 1.2.7b, 1.2.7c, 1.2.7d, 1.2.7e, 1.2.7f, and 1.2.7g)
- TS 5.2.4d, "Radiation Protection Program" (formerly TS 1.2.12, "Maximum DSC Removable Surface Contamination")
- Several tables specifying the parameter limits for the allowable contents.

This last item involved the proper definition of parameter limits for the allowable contents. These parameters include those that define the spent fuel contents radiation source term. The TS should define the maximum allowable radiation source term for the basket compartments. For commercial spent fuel this is done by specifying a combination of the minimum initial enrichment, maximum burnup and minimum decay or cooling time. Several tables had parameter specifications that were incorrect (e.g., maximum initial enrichment) or unclear (e.g., whether or not burnup was maximum assembly average). As part of revising the TS, the applicant updated this information.. The applicant also updated the equivalent tables in the

SAR to correctly and clearly define the parameters for defining the spent fuel radiation source term.

Additionally, the TS were modified to limit the allowable basket compartments for storing neutron sources and neutron source assemblies (NSAs). The staff found this limitation to be necessary when the neutron source terms for NSAs with long-lived isotopes were considered. These kinds of NSAs have neutron source strengths that are similar to that of a spent fuel assembly. Thus, neutron sources and NSAs are restricted to the interior compartments of the DSC basket, meaning those compartments that are entirely surrounded by other basket compartments such that no part of the compartment, including its corners, is on the basket periphery. Based on evaluations for other cask systems with similar loading restrictions for NSAs and the similarity of the configurations evaluated for those systems and the configurations considered for the NUHOMS system, the staff finds that the proposed restriction regarding NSA contents is acceptable.

6.1.3 Addition of Technical Specifications

The staff reviewed the addition of TS 4.4, "Transfer Cask Design Features," and 5.2.4, "Radiation Protection Program," with respect to the shielding performance of the Standardized NUHOMS® System. TS 4.4 was revised in accordance with the new requirement that the OS197L TC shall only be used with DSC models 61BT and 32PT with a maximum heat load of 12 kW and 13 kW, respectively. As part of TS 5.2.4, administrative controls were put in place to limit personnel dose; including an assessment of occupational exposure associated with dose rates at locations to include the surface of the OS197L TC. These controls are consistent with those that the staff, in its judgment, finds are necessary for adequate personnel protection when handling the OS 197L TC; thus, the staff finds the controls in TS 5.2.4 to be acceptable.

6.1.4 SAR Changes

Appendix W of the SAR includes revised descriptions of the OS197L TC and revised parameters used in the shielding evaluation (e.g., assumptions, dose rate values). Items were revised in the radiation protection and operations sections in support of the proposed design change to 'de-rate' (i.e., lower the allowable decay heat of) the TC, and address staff concerns. It should be noted that a number of the appendices and other sections of the SAR were revised to be consistent with sections of Appendix W regarding use of the OS197L TC.

The staff reviewed the revised changes to the CoC, Technical Specifications, and the SAR. Based on its evaluations, which are described in the following sections, the staff determined the revised changes to be acceptable since they clearly specify the bases for assumptions used in the shielding evaluations and the requirements used to ensure that dose rates remain ALARA.

6.2 Shielding Design Features and Design Criteria

The currently approved OS197 TC has a steel/lead/steel wall to provide gamma shielding around the cask, as described in previous amendments. The OS197L TC is similar to the OS197 TC design, but includes the following exceptions:

- The OS197L has a 2.68-inch nominal steel shell. It does not contain the 3.5-inch lead shielding which is used in the OS197 in combination with a steel shell and inner liner. This was done to achieve the desired weight reduction.

- As part of loading and transfer operations the OS197L TC will be used in conjunction with a 6-inch thick (nominal) steel shield while in the decontamination area and a support skid which provides shielding (5.5-inch thick steel) while on the transfer trailer.

In addition to modifications in the cask design, changes in operations are considered a major difference in the cask systems. Operations involving movement of the OS197L TC, when not in the decontamination area or ready for transfer operations on the transfer trailer, will involve remote handling operations (i.e., crane handling, remote targeting system, etc.). The OS197L transfer cask consists of a 2.68-inch thick structural shell steel cask body, a removable 3.5-inch thick liquid neutron shield assembly, a 6-inch thick steel decontamination area supplemental shield placed around the cask for personnel shielding during fuel loading operations, and 5.5-inch thick steel supplemental transfer trailer shielding used for personnel shielding during transfer operations. The total water thickness of the neutron shield is 3 inches and the inner and outer stainless steel shells of the tank are 0.25 inches thick.

Design features for the OS197L TC are described in Appendix W of the SAR. Design characteristics for intact and damaged BWR assemblies approved for loading into the 61BT DSC are shown in Tables 1-1c, 1-1d, 1-6a, and 1-6b of the technical specifications and in Tables W.2-2 through W.2-5 of the SAR. Design characteristics for intact pressurized water reactor (PWR) assemblies approved for loading into the 32PT DSC are shown in Tables 1-1e, 1-1f, 1-6c, and 1-6d of the technical specifications and in Tables W.2-6 through W.2-8 of the SAR.

The OS197L TC will be used in conjunction with supplemental shielding while in the decontamination area and while being maintained on the trailer skid. The decontamination area shielding consists of an upper cask shield (shielding bell) and a lower cask shield (shielding sleeve) both made from 6-inch thick carbon steel plates. The supplemental shielding used when the TC is mounted on the transfer trailer consists of an arrangement of combined 2.5 and 3 inches thick, carbon steel plates bolted or mounted together to increase shielding.

For lifts of the supplemental shielding and the TC in the fuel building, the facility’s heavy loads requirements and procedures must be met. In addition, there are some further limitations imposed on the lifts of these dry storage system features to ensure that the system can comply with the requirements of 10 CFR 72.106(b) for accidents, including potential drops. These conditions are placed in TS 5.3.1, which requires measures to be taken (e.g., limit the TC lift heights) when the TC is handled with a crane without redundant drop protection such that potential TC drops will not result in g-loads that exceed the design basis loads analyzed in the SAR (75g for vertical and side drops and 25g for corner drops). The TS capture this analysis, and thus the g-loads, with TS 4.3.2. TS 5.3.4 restricts the lift height for the outer top trailer shield such that the bottom of this shield’s body is less than 4 inches above the inner top trailer shield. Additionally, the decontamination area shielding will only be lifted to the height necessary to move it to the decontamination area and to place it over/around the TC. The staff finds that these limits and operational controls provide reasonable assurance that the OS197L TC system design basis will be met, and that it is sufficient to meet 10 CFR 72.106(b).

6.3 Source Specification

An evaluation was performed to determine the bounding source terms based on an established decay heat limit of 12 kW (for the 61BT DSC) and 13 kW (for the 32PT DSC) and an established 10 rem/hr dose rate limit on the surface of the cask, which is based on normal conditions of transfer. Since sources in the peripheral fuel regions add a significant contribution to the dose rates on the side of the cask, the primary gamma radiation is determined using steps described in Section W.5.2.1 of the SAR. Comparing burnup, enrichment, cooling time (BECT) combinations limited by decay heat, the design basis source terms were determined for both assemblies within the central fuel region and in the peripheral fuel region. Using SAS2H/ORIGEN-S for the spent fuel contents of the OS197L bare transfer cask containing 32PT and 61BT DSCs, the gamma and neutron source strength is determined that would yield the highest dose rates that do not exceed the dose rate limit for the cask and the appropriate decay heat limits.

The dose rates in the vicinity of the OS197L cask are dominated by the primary gamma radiation source for normal conditions. The neutron source is comprised mainly of Curium-244 (Cm-244). Therefore, in order to perform the MCNP dose rate analyses, the applicant used the Cm-244 energy spectrum to represent the neutron spectrum for the spent fuel contents. The neutron source is assumed to be the most bounding, which would be consistent with the highest burnup and the lowest enrichment for burnup, enrichment, and cooling time (BECT) combinations within the decay heat limits.

Once the total combined dose rates are determined to be less than the dose rate limit, cooling times for fuel assemblies in the decay heat fuel qualification tables (FQTs) intended for peripheral positions within the cask are adjusted to ensure they are bounded by the bounding sources used in the analysis. Furthermore, contents allowed in the 61BT and 32PT DSCs must meet the Heat Load Zoning requirements specified in Figures 1-29 and 1-30 of the TS and Figures W.2-1 and W.2-2 of the SAR. This method for developing specificiations for the allowable DSC contents (and thus, the DSC's radiation source) is consistent with the method used in the NUHOMS system SAR for the currently approved DSCs when loaded using the currently approved transfer casks. Based on this consideration, the staff finds the method to be acceptable. The parameters that constrain the proposed allowable source have been modified for the DSCs that are proposed to be loaded using the OS 197L. The following sections of this SER chapter evaluate the shielding performance of the OS 197L for the proposed source (i.e., contents).

6.4 Shielding Analysis

The applicant's shielding analysis grouped fuel assemblies in radial zones within the cask. The model also assumed that the radiological sources and decay heat values are uniform within each radial zone. Sources were developed for all axial regions including the active fuel region, plenum, and top and bottom end fitting regions. Borated neutron absorber plates were modeled as aluminum in the model. Axial peaking factors for the 32PT and 61BT DSCs in the standard OS197 TC were applied to the sources in the fuel region as described in Table M.5-15 and Table K.5.2-3 of the SAR, respectively. It should be noted that the axial shielding design was not changed as part of the design change from the OS197 TC to the OS197L TC. Shielding contributions from the radial neutron shield are not expected to contribute to the dose rate for areas on top of the cask that are within the radius of the cask. As a result of this, the dose rates for the OS197 TC found in Chapter M.5 of the SAR were shown to bound those for the OS197L TC for areas above the top surface of the cask but within the radius of the cask. The maximum top end dose rate for the OS197 TC with the 32PT DSC is 107 mrem/hr as specified in Appendix M, and the maximum for the 61BT DSC is 132 mrem/hr as specified in Appendix K. The bottom end dose rates for the 32PT and 61BT DSCs are 1710 mrem/hr and 2540 mrem/hr, respectively. Since these dose rates were determined using design basis source terms as discussed above, the staff finds that they can be applied conservatively to the OS197L TC shielding analysis.

For most of the normal operations sequence, water is present in the DSC/TC annulus of the cask. However, the applicant assumed the annulus region to be dry for the dose rate calculations used in this analysis. For the design basis accident case, the cask neutron shield and the supplemental trailer shield are assumed to be lost.

Given a specific decay heat per assembly, the bounding gamma and neutron sources were determined for each radial zone in the 32PT and 61BT DSCs as discussed in Sections W.5.2.2 and W.5.2.4 of the SAR, respectively. The dose rate contributions from the plenum and end regions were also calculated in MCNP at various locations around the cask. Dose rates were computed at different distances from the cask for varying shielding configurations and it was determined that dose rates were highest along the cask side.

6.4.1 Computer Programs

The applicant used the SAS2H/ORIGEN-S modules of SCALE 4.4 to calculate the bounding source terms and MCNP with the continuous energy ENDF/B-VI cross section library for the shielding calculations. The MCNP three-dimensional Monte Carlo particle transport code is a standard in the nuclear industry for performing neutron and photon shielding analyses. Based on its knowledge of the codes and cross section data used by the applicant, the staff finds that they are appropriate for this particular application and fuel system.

6.4.2 Flux-to-Dose-Rate Conversion

As listed in the SAR, the applicant used the ANSI/ANS Standard 6.1.1-1977 flux-to-dose rate conversion factors to calculate dose rates, which is consistent with the staff's review guidance. Thus, the staff finds the use of the standard to be acceptable.

6.5 Normal Conditions

Initially, normal operations involved the cask (DSC cavity, DSC/TC annulus and TC neutron shield) being drained in order to accommodate light weight crane capacity. However, the proposed design and operations were modified so that, as part of normal conditions of operation the OS197L TC is maintained with the cask internals (DSC cavity and DSC/TC annulus) and the neutron shield filled with water. These changes contributed to the significant dose rate decrease described earlier in this SER chapter. Normal operations also require use of supplemental shielding. The applicant's analysis assumed that for all loading, unloading, normal and off-normal operations the neutron shield is filled, and any instances where the shield is not filled would be due to accident conditions. To prevent inadvertent draining of the neutron shield, an administrative TS has been added to require verification of the neutron shield's condition (i.e., that it is filled, and remains filled) when draining operations are performed for other areas of the DSC and TC. The staff found this requirement to be necessary given a recent event with a NUHOMS® TC where several gallons of water were inadvertently drained from the TC neutron shield. This requirement is captured in the last two paragraphs of TS 5.2.4.a, and includes verification of the neutron shield condition before, during, and after any draining operations. Monitoring during the first five minutes of draining operations, as specified in the TS, should be sufficient to confirm the neutron shield is not being inadvertently drained. Operations procedures should include steps to perform this verification at the applicable stages of operations with the TC. Different shielding configurations were used to evaluate dose consequences for different aspects of the loading process. A bare OS197L TC loaded with a

32PT DSC was found to be the most bounding configuration, as stated in Section W.5.4.7, and was used in the normal and accident condition calculations.

Shielding configurations with water in the neutron shield and supplemental shielding were used to evaluate the dose consequences during normal conditions when the TC is in the decontamination area. The supplemental shielding was also removed (bare cask) in subsequent cases to evaluate potential off-normal effects during loading before the TC is loaded into the decontamination area. It should be noted that although these operations are to be carried out using remote crane handling operations, during recovery from off-normal and accident events it may be necessary for workers to be in the vicinity of the cask. This evaluation was also done to understand the dose rates at a distance for the purposes of evaluating public exposure for both normal and off-normal conditions. Cases were also generated to evaluate the effects of supplemental shielding during the loading phase when the TC is placed on the trailer skid.

It should be noted that as part of this analysis, some of the cases involved varying degrees of reduced supplemental shielding. The staff determined that this is a conservative approach for evaluating the effectiveness of the steel shielding material used in some of the loading process. However, staff notes that this conservatism may not be applicable throughout the entire process because the outer top trailer shield is left off the trailer until it is moved to a location that is able to handle the entire load of a TC and the full trailer shielding, a condition that may exist for a few hours.

As with the OS197 TC, the OS197L TC employs the use of a two piece removable neutron shield. The two piece neutron shield consists of inner and outer shells with a 1.5-inch seam between them, filled with carbon steel. The MCNP models did not explicitly model the neutron shield as two pieces, but rather assumed a continuous shield material. The applicant stated that modeling the neutron shield as water without the steel seam is acceptable and even conservative. This statement is based on the fact that the normal conditions dose rates on the bare TC surface are dominated by gamma radiation (greater than 95%). While the steel seam is a streaming path for neutrons, it is an excellent gamma shield. Thus, an increase in neutron dose due to the steel seam would be more than compensated for by the reduction in gamma dose. The applicant used a comparison of the bare TC dose rates under normal conditions with the case of the TC enclosed by steel of the thickness of the inner top transfer trailer shielding (2.5 inches), with the neutron shield dry. A better comparison is the dose rates for the bare TC under normal conditions versus the bare TC under accident conditions (loss of the neutron shield without any supplemental shielding). The neutron dose rate increases from about 320 mrem/hr (see SAR Table W.5-3, Case # 3-3) to about 4.2 rem/hr (see SAR Table W.5-4, Case # 4-5). Based on these arguments, staff concludes that modeling the neutron shield without explicitly including the steel seam is acceptable.

Dose rates for configurations evaluating normal conditions were taken at varying distances from the cask surface. These dose rates are listed for each phase of the loading process and compared with dose rates for the OS197 TC as shown in Table W.5-3 of the SAR. These dose rates represent normal conditions which would include water in the neutron shield. The bounding dose rates are equivalent to those for the bare OS197L (having no supplemental shielding), consistent with some normal operations configurations, which could exist for extended periods of time as a result of an off-normal event. The dose rate at 100 meters is shown to be 1.42 mrem/hr for this case.

The dose rates for the bare TC configuration provide a sense of the dose rates that may be encountered during off-normal conditions, such as crane malfunction. Table W.5-6 of the SAR indicates that dose rates at 1 meter from the TC would be about 4.16 rem/hr while they would be about 1.51 rem/hr at 3 meters from the TC. Thus, the times that personnel could be around the TC and still meet regulatory occupational dose limits (10 CFR 20.1201(a)) and any user-established administrative limits would be quite short. Regarding dose rates at distance, SAR Table W.5-9 indicates that dose rates at 50.8 meters would be about 8.12 mrem/hr and those at 100 meters would be about 1.42 mrem/hr. For the dose limit in unrestricted areas for members of the public (10 CFR 20.1301(a)(2)), the nearest unrestricted area would need to be about 100 meters from the cask loading operations based upon this calculation. For purposes of 10 CFR 72.104, ignoring other dose-contributing activities, the limit (25 mrem in a year to the whole body) would be exceeded in about 17.6 hours for a TC remaining in this configuration, as noted for the normal (and off-normal) conditions, at a distance of 100 meters. Just as a note for purposes of comparison, the normal condition dose rates for the bare OS197L TC with the initially proposed contents with the 24 kW decay heat limit were significantly higher, and reached approximately 4.53 mrem/hr at 100 meters from the bare TC, which would have resulted in greater impacts on occupational dose and dose to members of the public.

Supplemental analyses were performed to assess potential occupational dose consequences introduced as a result of off-normal conditions. Reference 7 evaluated, as off-normal conditions, crane failure during various stages of the loading and transfer operations. This evaluation describes various actions that may be associated with the recovery from such an event and provides dose estimates for personnel involved in the recovery. The analysis used assumptions regarding steps required for personnel to climb a ladder, traverse the walkway and crane bridge leading to a position directly above the crane, manually operate the crane, and lower the cask to the floor area with the purpose of being relocated to a low dose position or being placed on the transfer trailer. Along with descriptions of postulated activities, each step assumed two personnel for each task and the times required to perform the functions during recovery of the crane. The staff notes that recovery from an off-normal event is complete only when the bare TC is again handled by remote operations or is placed in supplemental shielding, consistent with the TS that specify the requirements for TC handling under normal conditions. This analysis covered crane failure scenarios during movement of the bare OS197L TC from the pool to the decontamination area, loading of the bare TC horizontally onto the transfer trailer, and a combination of these two cases. The applicant determined that the last scenario bounds the previous two because the last scenario involves the cask being positioned in a way which would expose workers more directly to the cask side.

To address staff concerns, the applicant also evaluated potential backscatter effects on the overall dose rates involved in this activity. In one scenario, the applicant assumed the cask was suspended 15 ft from the building ceiling, floor, and wall. The staff finds this to be a reasonable assumption; but notes that a licensee should appropriately account for the potential configurations that could occur in its facility in order to adequately account for backscatter in its evaluations of off-normal conditions involving crane malfunction and remote operations equipment failures during handling of the OS197L TC at its facility. The applicant added correction factors to the dose rate calculations to account for backscattering effects in its evaluation.

The applicant created a dose rate field using bounding surface dose rates for a bare OS197L TC with a 32PT DSC and logarithmic interpolation. The analysis showed that postulated activity involved with reaching the area to perform crane operations results in higher dose rates. However, lowering of the crane takes up most of the time involved with recovery, thus resulting in more of the collective dose (man-mrem) for the two individuals. The dose shown to be bounding for recovery efforts involved with this off-normal condition was 1534 man-mrem, which was the dose calculated for the third (bounding) crane hang up scenario.

It should be noted that the applicant performed this evaluation assuming a bounding source term consistent with a 24 kW heat load limit. However, since completion of this analysis, the applicant has restricted the allowable heat load per cask to 13 kW (32PT) and 12 kW (61BT). An evaluation for the OS197L TC loaded with these lower heat load DSCs is provided in the FSAR, Section W.10.1. That evaluation estimated an exposure of about 190 mrem for a single worker involved in the recovery operations, though with different assumptions from those used in the evaluations discussed in this SER section.

The applicant also suggests several steps in the application that can be taken to minimize personnel exposure during off-normal and accident conditions, such as maximizing personnel distance from the TC, limiting the time personnel are near the TC, and using a temporary staging area.

Based on the conservatisms used in this analysis (see previous paragraph) and the fact that the applicant has placed a more limiting restriction on the payload, the staff has determined that the applicant has adequately evaluated potential crane hang ups as a bounding off-normal condition and that this approach to off-normal events evaluations is acceptable given that the dose rates on the bare TC do not exceed 10 rem/hr on contact.

6.6 Accident Conditions

Accident conditions are considered to be those where the OS197L TC is loaded with fuel in the DSC, the DSC cavity and DSC/TC annulus are dry, and the TC experiences a loss of water in the neutron shield. These conditions are similar to cases generated for normal conditions, with the exception that air is replacing water in the neutron shield. The shielding configurations consist of cases with supplemental shielding and loss of water, cases where part of the supplemental shielding is eliminated but with water in the neutron shield, and cases with no water in the neutron shield and no supplemental shielding. The staff finds these scenarios acceptable for evaluating potential accident conditions specific to each of the stages in the loading process.

Dose rates for configurations evaluating accident conditions were taken at varying distances from the cask surface. These dose rates are listed for each phase of the loading process and compared with dose rates for the OS197 TC as shown in Table W.5-4 of the SAR. The bounding dose rates are found to be those for the bare OS197L (having no supplemental shielding). The dose rate at 100 meters as a result of the design basis accident is shown to be 2.48 mrem/hr for the bare cask. It is approximately 18.2 rem/hr at the TC surface. For purposes of comparison, the accident condition dose rates corresponding to the initially proposed 24 kW decay heat limit were extremely high and reached approximately 138 rem/hr at the cask surface of the bare OS197L TC and 12.9 mrem/hr at 100 meters from the TC.

Assuming recovery from an accident event (such as that discussed in Section W.5.4.9 of the SAR) requires 30 days, and considering the dose rates calculated at 100 meters from the cask, the cumulative dose at this distance would be about 1.8 rem. The limit for public doses due to accidents is specified in 10 CFR 72.106(b) to be 5 rem. The accident dose calculated by the applicant is well below this limit. In comparison, the total dose corresponding to the initially proposed 24 kW decay heat limit would have been about 9.3 rem at 100 meters using the same assumptions for the accident and recovery.

6.7 Evaluation Findings

Staff reviewed the shielding evaluation for the Standardized NUHOMS® Modular Storage System for Irradiated Nuclear Fuel, Amendment 11, to support the addition of the Light Weight Transfer Cask (OS197L). The applicant initially sought approval for the use of OS197L TC to be used with multiple DSCs (24P, 52B, 24PT2, 61BT, 32PT, and 24PHB). The applicant later revised the SAR to propose that the OS197L TC only be approved for use with the 32PT and 61BT DSCs containing intact and damaged fuel with a maximum heat load of 12 kW for the 61BT DSC and 13 kW for the 32PT DSC. The OS197L Cask is added as a reduced weight transfer cask (nominal weight of 85 tons) that can be used with lower rated capacity cranes for specific payloads.

F6.1 Sections 1 through 3 of Appendix W of the Safety Analysis Report (SAR), along with technical drawings (Section W.1.5), describe the shielding structures, systems, and components (SSCs) important to safety in sufficient detail to allow evaluation of their effectiveness. The SSCs important to safety include the decontamination area shielding and the transfer trailer supplemental shielding for the OS197L TC.

F6.2 Section 5 of Appendix W of the SAR evaluate(s) these shielding SSCs important to safety with the objective of assessing the impact on health and safety resulting from operation of the independent spent fuel storage installation (ISFSI). The evaluations provided in this section of the SAR provide reasonable assurance that the radiation shielding features of the OS 197L TC system, together with the operational restrictions included in the CoC technical specifications for using this TC system which include limiting the use of this TC to 62BT and 32PT DSCs, among others, are sufficient to assist cask users in meeting the radiation protection requirements in 10 CFR Part 20 and 10 CFR 72.104 and 72.106 (per 72.236(d)). Chapter 10 of this SER describes staff's further evaluation of this TC system and the operational restrictions with respect to radiation protection.

Based upon its review, the staff has reasonable assurance that the design of the shielding system associated with the OS197L light weight transfer cask (a component of the Standardized NUHOMS® System), as currently proposed, and when limited to use of the 61BT and 32PT DSCs, is in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria, including 10 CFR Part 20, have been satisfied. The evaluation of the shielding design provides reasonable assurance that the OS197L light weight transfer cask will allow safe transfer of spent fuel to dry storage in accordance with 10 CFR 72.236(d). 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. Since there are no changes to the HSM design, the use of the light weight transfer cask is not expected to impact previous findings regarding the safety of spent fuel storage in the Standardized NUHOMS® System after the DSC has been placed in the HSM. The user should, however, consider the impacts of using the OS197L TC in its evaluation to ensure overall dry storage system compliance with the requirements in 10 CFR 72.104 per TS 5.2.4(a).

6.8 References

1. U.S. Nuclear Regulatory Commission, NUREG-1745, “Standard Format and Content for Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance,” June 2001.
2. Transnuclear, Inc., Revision 4 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System, Response to Second (Restart) Request for Additional Information (Docket No. 72-1004; TAC No. L24380), February 25, 2011 (ML110590060).
3. Letter, W. Ruland, USNRC, to R. Ridenoure, OPPD, “Exemption From 10 CFR 72.48, 10 CFR 72.212 and 72.214 for Dry Spent Fuel Storage Activities - Fort Calhoun (TAC No. L23984),” July 19, 2006 (ML062000153).
4. Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor - Related Greater than Class C Waste, Title 10 of the Code of Federal Regulations, Part 72.
5. U.S. Nuclear Regulatory Commission, “10 CFR Part 72, Expand Applicability of Part 72 to Holders of, and Applicants for, Certificates of Compliance, Final Rule,” Oct 15, 1999, *Federal Register*, (64 FR 56114).
6. U.S. Nuclear Regulatory Commission, “10 CFR Part 50, Criticality Control of Fuel Within Dry Storage Casks or Transportation Packages in a Spent Fuel Pool, Direct Final Rule,” November 16, 2006, *Federal Register*, (71 FR 66648).
7. Transnuclear, Inc., Revision 0 to Transnuclear, Inc. Calculation NUH06L-0503, “OS197L Occupational Exposure due to Remote Handling Device Failure” April 5, 2007 (ML072410307 (proprietary)).

7.0 CRITICALITY EVALUATION

This amendment application did not change the cask contents in any way, but did revise the NUHOMS® Certificate of Compliance (CoC) 1004 and the Technical Specifications (TS), and added a new light weight transfer cask design. This evaluation considers any changes that may affect the criticality safety of the package. Staff reviewed the original amendment request, supplemental information, and the responses to the RAI questions.

7.1 Technical Specifications Changes

The staff reviewed the technical specifications for Amendment 11 with respect to the criticality safety issues for the Standardized NUHOMS® system, and concludes that the five proposed changes (Ref. 1) continue to provide reasonable assurance that the cask will continue to allow the safe transfer and storage of spent nuclear fuel. The five proposed changes, (summarized) are:

- Change No. 1 converts the existing TS of CoC No. 1004 Amendment 10 TS (Ref. 2), to the "Improved Technical Specification" (ITS) format and content consistent with NUREG-1745 (Ref. 3) requirements.
- Change No. 2 deletes the transfer cask (TC) dose rates for all currently licensed payloads (TS 1.2.11, 1.2.11 a, 1.2.11 b, 1.2.11 c, 1.2.11d and 1.2.11e). These TS are considered by the applicant to be redundant to TS 1.2.7 which regulates dose limits for a loaded DSC when stored inside a Horizontal Storage Module (HSM) where a payload resides during its 20 year licensed life span.
- Change No. 3 deletes DSC vacuum drying duration limits for all the licensed payloads (TS 1.2.17, 1.2.17a, 1.2.17b and 1.2.17c).
- Change No. 4 implements several NRC requested actions:
    - Sections 4.4.1 and 4.4.2 are added to the proposed TS to reflect additional restrictions for the use of the OS197L TC.
    - Section 5.2.4, "Radiation Protection Program" of the proposed TS is revised to include dose assessment for occupational exposures during loading operations. If remote handling devices are used for movement of a TC during loading, then the dose assessment shall include recovery from a potential malfunction of these devices.
    - Section 4.2.1 of the proposed TS is added to reflect the additional restrictions for all Horizontal Storage Modules if an Independent Spent Fuel Storage Installation (ISFSI) is located in a coastal salt water marine environment.
- Change No. 5 revises the CoC.
    - CoC Condition 6 has been revised to clarify that general licensees may use either the original issue of the certificate or use previously approved amendments of this certificate for storage under the provisions of 10 CFR 72.210.
    - CoC Conditions 7 and 8 have been deleted, as they have been moved to proposed Technical Specifications 5.5 and 5.6, respectively.

The proposed changes to the technical specifications do not directly impact the criticality safety of the package. The staff confirmed that the conversion of the existing technical specifications to a Standardized Technical Specification format consistent with NUREG-1745 (Ref. 3) did not change the criticality safety basis. The second change addressed dose rates and does not impact the criticality safety of the package. Change three removed the vacuum drying duration limits for all payloads and is addressed in the thermal section. Change number four was reviewed for any criticality safety impact and was found to be acceptable since changes are in reference to shielding, radiation protection, and corrosion requirements and do not impact criticality safety. The staff also reviewed the fifth proposed change covering changes to the CoC. Those changes were found to be acceptable from a criticality safety standpoint since the deleted conditions relate only to the thermal performance of the HSM and the administrative uses of previous amendments.

7.2 FSAR Changes

The staff initially reviewed the proposed changes to the Final Safety Analysis Report (FSAR) with respect to the OS197L TC and had questions for the applicant that were addressed in the initial Request for Additional Information (RAI) responses (Ref. 4). Although the changes proposed in this amendment did not alter the orientation of the fuel, or the contents allowed, the modifications to the outer surface of the cask could potentially affect the reactivity of the system. However, based on the responses from the applicant, since the criticality safety of the DSC/TC system is primarily dependent on the fuel assembly basket design, the proposed modified design OS197L TC does not negatively impact the reactivity of the system. The major differences between the OS197 TC and the OS197L TC are due to the absence of the lead gamma shield and the presence of a larger amount of steel in the OS197L TC. The amount of water used as neutron shielding in both transfer cask designs is the same. Also, the larger amount of steel in the OS197L TC design increases the potential for neutron absorption in the cask body, which would tend to reduce the reactivity of the system. In light of these conservative aspects of the proposed design, the staff concludes that the proposed changes in the FSAR are acceptable.

7.3 Evaluation of Findings

F7.1 Structures, systems, and components important to criticality safety continue to be described in sufficient detail in the SAR to enable an evaluation of effectiveness.

F7.2 The OS197L TC and its spent fuel transfer systems continue to be adequately designed to be subcritical under all credible conditions.

F7.3 The criticality design remains based on favorable geometry, fixed neutron poisons, and soluble poisons of the spent fuel pool, as applicable. 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 of 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 continue to demonstrate that the cask will enable the storage of spent fuel for the term requested in the CoC application.

The staff concludes that the criticality safety design of the OS197L TC when used as described in the FSAR and in conjunction with the Technical Specifications is in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria have been satisfied. The evaluation of the modified transfer cask design will provide safe storage of spent fuel. This finding is based on a review that considered the regulation itself, the appropriate regulatory guides, applicable codes and standards, the applicant's analysis and responses to Requests for Additional Information, and acceptable engineering practices.

7.4 References

1. Transnuclear, Inc., Application for Amendment 11 of the NUHOMS® Certificate of Compliance No. 1004 for Spent Fuel Storage Casks, Revision 0, April 10, 2007 (ML071240088 (letter)).
2. Amendment 10 to Certificate of Compliance No. 1004 for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, August 24, 2009 (ML092290199, letter).
3. U.S. Nuclear Regulatory Commission, NUREG-1745, "Standard Format and Content for Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance," June, 2001.
4. Transnuclear, Inc., Additional UFSAR Pages for Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System (Docket No. 72-1004; TAC No. L24080), June 12, 2008 (ML081700238, letter).

8.0 CONFINEMENT EVALUATION

Amendment 11 to the Standardized NUHOMS® System certificate addresses two main areas. First, it converts the technical specifications to the NUREG-1745 standard format and content, secondly, it adds a new light weight transfer cask designated OS197L as an Appendix W.

8.1 Changes to the Technical Specifications

The staff's containment evaluation of this amendment focused on any changes made to the standardized technical specifications from what was previously approved and any aspects of the new transfer cask design that could adversely affect the confinement integrity of the dry shielded canister (DSC).

The staff reviewed the proposed standardized technical specifications and determined that certain confinement criteria (e.g. leak rate testing, pressure testing of the DSC and its contents) remained unchanged from what was previously approved and is therefore acceptable. Note that the applicant continues to perform in shop pressure testing and leak testing of the DSC shell. Also, pressure testing and leak testing are performed in the field for the closure weld.

8.2 Changes to the FSAR

For the light weight transfer cask, the applicant states in Appendix W that it has no confinement features since the transfer cask is designated as a non-pressure retaining system and the DSC is the confinement system. The abbreviated confinement section of Appendix W had no other information. The staff verified that the pressure within the DSC (documented in Tables W.4-5, W.4-7, & W.4-9) is still within the design pressure rating of the various DSCs utilized in this certificate.

8.3 Evaluation Findings

F8.1 Based on the review described above and the adequate resolution of the Requests for Additional Information, the staff concludes that NUHOMS® Amendment 11 continues to meet the confinement regulations of 10 CFR Part 72.

8.4 References

1. U.S. Nuclear Regulatory Commission, NUREG-1745, "Standard Format and Content for Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance," June, 2001.

9.0 OPERATING PROCEDURES

The review of the technical bases for the operating procedures is to ensure that the applicant's SAR presents acceptable operating sequences, guidance, and generic procedures for key operations.

As part of this proposed amendment, in addition to the inclusion of the proposed OS197L TC, the applicant modified the technical specifications (TS) to put them into a format that is consistent with NUREG-1745. The operations descriptions in the operations chapters in the SAR and its appendices refer to specific TS paragraphs. Therefore, the applicant needed to revise the operations descriptions in all the operations chapters to align the references to the correct TS paragraphs for the reformatted TS.

9.1 Transfer Cask Operating Procedures

In general, the steps for using the OS197L transfer cask (TC) are similar to those for the previously approved OS197 TC. The OS197L TC operating procedures add remote crane operation and an optical targeting system with remote camera monitoring to minimize personnel exposure due to the reduced shielding configuration during cask lifting from the spent fuel pool. The operating procedures also add instructions for using the decontamination area shielding, inner top trailer shielding, and the additional outer top trailer shielding. Regarding the targeting system, the applicant had proposed that language be included for allowing “any other appropriate targeting system” or a “similar system” to that described in the SAR; however, due to staff concerns, the applicant removed discussion of similar or other appropriate targeting systems from the operations descriptions in the SAR and from the technical specifications.

Representative operating procedures for the NUHOMS® OS197L TC are provided in Section W.8 of the SAR. Detailed loading procedures will need to be developed by each user, including specific procedures for recovery from a crane malfunction and failure of other remote operations equipment such as the optical targeting system, cameras, etc.

9.2 Fuel Specifications

9.2.1 NUHOMS® -61BT DSC Contents

The allowable contents of the 61BT dry shielded canister (DSC) when using the OS197L TC include 61 intact (including reconstituted) and/or damaged boiling water reactor (BWR) fuel assemblies meeting the parameters specified in the Technical Specifications, Tables 1-1c and 1-1j, and the Fuel Qualification Tables provided in TS Tables 1-6a and 1-6b. The physical characteristics of the intact and damaged spent fuel assemblies are described in Tables W.2-2 and W.2-3 of the SAR. The heat load is limited to 12kW or less (see TS Figure 1-29). The Fuel Qualification Tables for the Zone 1 and Zone 2 fuel assemblies are provided in Tables W.2-4 and W.2-5 of the SAR.

9.2.2 NUHOMS® -32PT DSC Contents

The allowable contents of the 32PT DSC when using the OS197L TC include 32 intact pressurized water reactor (PWR) fuel assemblies, with or without Control Components, meeting the parameters specified in the Technical Specifications, Table 1-1e, and the Fuel Qualification Tables provided in TS Tables 1-6c and 1-6d. The physical characteristics of the intact spent fuel assemblies are described in Table W.2-6 of the SAR. The heat load is limited to 13kW or less (see TS Figure 1-30). The Fuel Qualification Tables for the Zone 1 and Zone 2 fuel assemblies are provided in Tables W.2-7 and W.2-8 of the SAR.

9.3 ALARA (As Low As Reasonably Achievable)

The ALARA practices utilized during operations are discussed in Section 10.4 of this SER. The supplemental shielding designed for the OS197L, and the remote handling practices for using the TC are specifically designed to ensure adequate radiation protection for personnel, and to promote ALARA for operations with this TC. Operational considerations for ALARA are described in Section W.8 of the SAR. In addition, each cask user will need to develop detailed cask handling and storage procedures that incorporate ALARA objectives of their site-specific radiation protection program. Further discussion of ALARA is provided in SAR Sections 7.1, W.5 and W.10, and in TS Sections 5.2.4 and 5.4.3. Refer to Chapters 6 and 10 of this SER for a description of staff's review of system operations with the OS197L TC with respect to shielding and radiation protection, including ALARA.

9.4 Evaluation Findings

Based on a review of the submitted material, staff makes the following findings:

F9.1 The OS197L TC is compatible with wet loading and unloading. General procedure descriptions for these operations are summarized in Appendix K, Section K.8.1 of of the applicant's SAR. Detailed procedures will need to be developed and evaluated on a site-specific basis.

F9.2 No significant radioactive waste is generated during operations associated with the ISFSI. Contaminated water from the spent fuel pool will be governed by the 10 CFR Part 50 license conditions.

F9.3 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.

F9.4 The content of the general operating procedures described in the SAR 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.

F9.5 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 OS197L TC 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 SAR offers reasonable assurance that the cask will enable safe storage of spent fuel. This finding is based on a review that considered the regulations, appropriate regulatory guides, applicable codes and standards, and accepted practices.

10.0 RADIATION PROTECTION EVALUATION

The purpose of the proposed amendment was to modify the technical specifications in line with the guidance in NUREG-1745 (Ref. 1) for standardized technical specifications (TS) and to include a lightweight transfer cask (TC), the OS197L, as part of the Standardized NUHOMS® dry storage system. As part of the modifications of the technical specifications, various TS were proposed to be deleted or changed. Some of these deletions and changes are discussed in the shielding chapter of this SER. Others are discussed in this chapter. The inclusion of a lightweight transfer cask presents unique risks, in terms of high radiation fields to personnel involved in the loading, unloading and transfer operations associated with dry storage, as well as additional considerations for ensuring adequate protection of public health and safety.

The initially proposed OS197L was to weigh 75 tons and was intended to be used for 6 dry shielded canister (DSC) types with the same contents as currently approved when loaded using the currently approved Standardized NUHOMS® System transfer casks. However, due to concerns over the very high dose rates for the bare cask (53 rem/hr surface dose rates for normal conditions), the OS197L TC design and operations were modified to increase the design weight to a nominal 85 tons (maximum of 90 tons) and reduce the allowed contents to 2 DSC types containing spent fuel with significantly lower decay heat limits. The additional weight is the result of modifying operations to require that normal operations be performed with the neutron shield always filled with water and with the DSC cavity and the DSC/TC annulus filled with water for significant portions of the operations (e.g., movement from the spent fuel pool to the decontamination area). The dose rates for this "de-rated" TC are still significantly high (about 10 rem/hr on contact). As a result of concerns regarding public and worker doses, keeping doses as low as reasonably achievable (ALARA), and potential off-normal and accident conditions, additional controls, conditions and evaluations are found to be necessary, as described in this chapter of the SER.

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

10.1 Design Criteria and Features

Appendix W of the Safety Analysis Report (SAR) defines the shielding and radiological protection design and operational features for the OS197L TC that provide radiation protection to operational personnel and members of the public. The radiation protection design features and operational procedures include the use of supplemental shielding (for the decontamination area and transfer trailer) and remote handling operations (laser/optical targeting and camera equipment). The OS197L TC must be used in conjunction with approved supplemental shielding and remote handling equipment to provide radiation protection to personnel and members of the public. Technical specifications require the user to have procedures in place to address normal, off-normal, and accident conditions and the potential impacts introduced to plant operations as a result of the potential for increased radiation levels from use of the bare OS197L TC. These requirements address, in part, the high radiation fields in using the transfer cask. The staff's review and findings regarding the radiation protection design and operational features for the OS197L TC are described in the remaining sections of this SER chapter.

10.2 Occupational Exposures

The differences between the OS197L and the other transfer casks result in important differences in the handling of the transfer cask. With the OS197L, personnel could be exposed to significantly higher dose rates in dealing with off-normal events than they are exposed to during normal operations. This is a significant departure from the transfer casks for existing storage systems, including the Standardized NUHOMS® System, and, given the dose rates for off-normal conditions, necessitates that greater attention be given to radiation protection issues associated with recovery from these events than has been given for other certified systems' transfer casks.

Procedures detailing the process for loading the DSCs into the Horizontal Storage Module (HSM) with the OS197L TC are shown in Section W.8.1 of the SAR. Transferring the loaded TC to the decontamination area will be done using remote crane handling and a laser/optical targeting and camera system. Although this operation carries the potential for high doses, it is short in duration and handled remotely, so personnel doses are expected to be minimal. Should an off-normal event occur causing failure of the crane during these operations, the duration of this operation could increase. As part of recovery efforts, procedures are followed to repair the crane and manually position the cask in a safe, shielded position while implementing steps to ensure proper personnel exposures are kept ALARA. Bounding dose rate distributions for ALARA planning of repair and recovery operations are shown in Tables W.5-6 and W.5-9.

Cask decontamination is performed with the TC inside of the decontamination shield. The decontamination process is similar to that described for the OS197 TC in Appendix M of the SAR, accounting for the presence of the decontamination area shielding and its effects on accessibility to the DSC. To address the step of inspecting the upper and lower openings of the decontamination area shield for blockage, the radial dose rates as a function of axial height for a bare OS197L TC are used to determine the dose rates at the upper and lower openings of the decontamination shield. Staff determined that using the radial dose rates, listed in Tables W.5-8 and W.5-11, with respect to the axial height is conservative and would bound dose rates at the height of the openings.

It should also be noted that the TC radial dose rates on the surface of the decontamination area shielding are to be measured and verified to be within the limits specified in the TS.

The applicant asserts that the welding and sealing operations, which take place while in the decontamination area, are identical to the operations approved in earlier amendments and described in Appendix M of the SAR. Staff concludes that these operations are acceptable for use with the OS197L TC under the requirements specified in the TS and the SAR.

After decontamination, the TC is placed on the transfer trailer, which contains a three-piece supplemental shielding configuration. The lower shielding consists of a combination of 2.5-inch and 3-inch thick carbon steel plates. The inner top shielding consists of 2.5-inch thick carbon steel. An additional outer 3-inch thick steel top shielding is added to the transfer trailer to further compensate for reduced TC shielding. Figure 1.2 of this SER illustrates the configuration of the transfer trailer shielding. The top shield can be placed on the transfer trailer inside the building, or outside if there is a weight load restriction. Due to concerns regarding dose impacts due to this configuration and keeping doses ALARA, staff finds that the time duration for which the outer top trailer shield is not in place should be minimized. Therefore, TS 4.4.3 states that "[i]f the placement of the Outer Top Shield is delayed due to building load limits, it must occur as soon as the Transfer Trailer has been moved to an area with acceptable load limits. The user must plan accordingly to minimize, to the greatest extent practicable, the delay of the placement of this Outer Top Shield."

The MCNP models used to analyze the TC loaded onto the transfer trailer conservatively neglected shielding effects given by the lower supplemental shielding on which the TC rests while on the transfer trailer, with the exception of a 0.25-inch thick steel plate on top of the trailer platform. This resulted in increased dose rates, but only within the immediate vicinity of the cask. This was determined to be due to radiation scattering effects from below the cask. It was shown that around 2 meters, the dose rates start to diminish out to around 10 meters as shown in Table W.5-13.

Staff considers the dose rate calculations to be adequate given that when the TC is loaded horizontally onto the transfer trailer, remote operations are used, which requires no need for personnel within the vicinity of the cask.

After loading is complete, the TC, with the transfer trailer supplemental shielding in place, is transferred to the HSM, which takes place outside of the fuel building. Given concerns with the OS197L TC, the user is required (TS 5.2.4) to have procedures in place to address recovery of off-normal events. Prior to use, the user is required to perform dry runs of cask loading operations to include manual operation of the crane in order to ensure ALARA when handling such events.

The OS197L TC is used only for the loading process; storage conditions once the DSC is in the HSM have been addressed in previous amendments. Occupational doses and controlled area boundary dose rates for the DSCs within each HSM storage configuration are shown in Sections K.10 and M.10 of the SAR. Staff finds acceptable the applicant's assertion that the use of supplemental shielding and remote operations work to minimize personnel exposure. However, staff finds that the need for these features goes beyond just ALARA. They are necessary features to provide adequate protection for personnel performing any work in the vicinity of the cask, and are thus captured as part of the OS197L TC system.

Occupational dose analyses included evaluation of occupational dose consequences due to off-normal events occurring during the operations sequence and recovery from these events. As part of this analysis, three different failure scenarios involving crane hang up were evaluated. The applicant determined that these scenarios adequately cover possible stages in the loading process where crane hang up could occur. The analysis assumed no supplemental shielding is present. The analysis also used bounding dose rates from the 32PT DSC assumed at a decay heat of 24 kW. Since this DSC, when used in the OS197L TC, has since been restricted to a 13 kW decay heat limit, staff finds this to be conservative. The applicant's analysis included an assessment of occupational exposure resulting from a crane hang up, and specified a dose rate expected for workers performing manual crane operations involved with recovery from a crane hang up. It should be noted that the assumptions used in the analysis are not intended to address operations at any particular facility. Procedural conditions are different for different facilities because they are based on operational parameters (i.e., facility mode of operations, cask content, building geometry, etc.). Thus, the applicant's evaluation serves as guidance to the user for evaluating off-normal conditions at its facility.

As previously discussed in this SER, and as required in TS 5.2.4, users need to assess exposure to personnel due to off-normal events, such as crane hang ups, to ensure the limits of 10 CFR Part 20 are satisfied. The user should consider facility operations and evaluate the consequences associated with any potential off-normal conditions at its site. The user should perform a thorough evaluation of off-normal events as part of its 10 CFR 72.212 evaluation, ensuring that credible events are identified, procedures are developed, and dose estimates are performed. Pre-operational dry run exercises should be used to inform the development of procedures and dose estimates as well as to make occupational doses ALARA in the recovery from an off-normal event. The shielding scenarios used for off-normal conditions assume that the neutron shield remains filled. The user should evaluate operational procedures and establish any necessary operational controls, consistent with TS requirements (see TS 5.2.4.a)) in order to ensure inadvertent draining of the neutron shield is not a credible off-normal event.

It is recognized that the high dose rates associated with the bare TC during normal operations (and off-normal events) may have additional impacts beyond those operations directly associated with TC loading and transfer. Potential impacts could include the need (1) to modify area radiation monitor alarm points, and (2) to preclude other facility operations that normally take place in the spent fuel pool building and that may be required by facility technical specifications.

10.3 Public Exposures

In Sections W.5 and W.10 of the SAR, the applicant evaluated dose consequences to the public during normal, off-normal, and accident conditions of operations. Staff review of these evaluations is described in the following sections of this SER.

10.3.1 Normal and Off-Normal Conditions

Given the nature of the dose rates associated with the OS197L TC, particularly for the configurations where the TC is outside the spent fuel pool and the supplemental shielding, greater attention is needed to the impacts that operations with this TC will have on doses to members of the public. In particular, staff focused mainly on the dose limits set forth in 10 CFR 20.1301(a)(2) and 10 CFR 72.104(a). However, the user needs to ensure compliance with the other relevant dose limits in 10 CFR 20.1301. 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).

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 HSMs 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 OS197L TC is the user'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).

Operations with the OS197L TC may have significant impacts with regard to compliance with the annual dose limit given in 10 CFR 72.104(a). Using the dose rates from the bare TC and assuming the controlled area boundary is 100 meters from the TC, it would take fewer than 25 hours to reach the annual dose limit. Since the TC is not in this configuration for the whole operations sequence, but only for a short duration, the actual time to reach the limit is longer than this. However, it does highlight the impact that TC operations can have regarding compliance with the annual dose limit. Thus the user should ensure that its 10 CFR 72.212

evaluation properly accounts for the operations involving this lightweight TC for demonstrating compliance with 10 CFR 72.104 per TS 5.2.4(a).

The dose rates at distance from the TC have various implications for how a user would be able to meet the annual dose limits. One potential impact is the need to limit the number of DSCs that are loaded into dry storage in a year. Another is the establishment of an appropriately sized controlled area(s) for dry storage operations, including operations with the TC. Supplemental shielding in the form of shield walls, berms or other engineered features may be necessary. (This may also be true for compliance with dose limits in unrestricted areas already discussed.) As described in TS 4.3.3, item 6, these features are considered important to safety and will need to be dealt with accordingly.

The dose rates also give a sense of the impacts of off-normal events involving the OS197L TC (e.g., crane malfunction, or hangup, and malfunctions or failures of remote operations), which also must be considered in evaluating for compliance with the dose limits discussed in this section. For example, recovery from a crane malfunction with a bare TC would need to be accomplished in fewer than 17.6 hours, if only this single event is considered for compliance with 10 CFR 72.104(a) limits. However, consideration of the dose contributions from DSC loadings that are planned (and/or have already occurred), HSMs that are already loaded and other fuel cycle operations on site (and in the area), as well as the expected frequency of off-normal events gives a sense of the need to limit the duration of any off-normal conditions to the shortest possible time while still ensuring proper protection of personnel involved in recovery actions.

Given the concerns already noted and the discussion provided here, requirements for the OS197L TC have been added to several technical specifications. These requirements address various aspects of operations with this TC, including conditions on certain aspects of normal operations, recovery from off-normal events and necessary evaluations with regard to public doses. Based upon the inclusion of these requirements in the technical specifications and that the dose rates on the bare TC are less than 10 rem/hr, the staff finds there is reasonable assurance that the regulatory dose limits can be met for dry storage operations that use the OS197L TC, in compliance with 10 CFR 72.236(d).

10.3.2 Accident Conditions Specific to the OS197L TC

As part of the accident analyses, the applicant evaluated a cask drop. This analysis assessed the effects of the OS197L cask drop from a crane where all supplemental shielding and radial neutron shielding is considered to be lost. The evaluated scenario is a cask drop during loading of the TC onto the transfer trailer. It was assumed as part of this scenario that all trailer shielding is lost. The applicant makes the assertion that the trailer shielding is likely to be damaged but not likely to become fully detached as a result of a postulated cask drop. In the event that such an unlikely scenario occurs, recovery efforts have to be put in place to recover the shields or provide other temporary supplemental shielding to reduce dose rates to within reasonable rates until a long term recovery plan is in place.

Accident analyses involve the assumption of some reasonable time duration to address/recover from the accident conditions. A standard assumption, accepted by the NRC staff in various applications, has been 30 days. As noted in the shielding chapter of this SER, the cumulative dose for this timeframe is about 1.8 rem at 100 meters from the TC. This dose is below the limit set in 10 CFR 72.106(b). The user should, however, consider means to reduce the duration of recovery from accident events and minimize personnel exposures for those involved in the recovery actions. An example of a means to reduce the recovery time is the concept used by TN in its evaluation of pre-positioning hardware/equipment that can be used for lifting items such as dropped supplemental shielding or a dropped TC. Based on its evaluation and a recovery time of 8 hours, TN estimates the dose at 100 meters would be about 20 mrem, significantly less than the 30-day accident estimate.

In Section W.3.9 of the SAR, the applicant states that the structural evaluation of the OS197L TC supplemental shielding components assumes that these components are handled using a single failure proof crane when handled inside of the fuel/reactor building. Assumptions used in the shielding evaluation are usually based on or bound the results of structural testing. Given the applicant's treatment of the TC in its shielding analysis, the staff determined that the shielding analysis for accidents is based on the assumption that the bare TC and the supplemental shielding will be handled by a single-failure proof crane or otherwise handled so that the impacts analyzed in the SAR bound the impacts of potential drop accidents. For the TC, the bounding evaluation is for a drop height of 80 inches onto a reinforced concrete storage pad. As stated in Section 6.2 of this SER, restrictions on lifts of the TC have been included in the TS to ensure that the design basis established in the SAR for the TC will be met and that it is sufficient to meet 10 CFR 72.106(b). Also, lift restrictions have been included on the supplemental shielding for this same purpose.

Staff notes that a user must consider as part of its 10 CFR 72.212 evaluation whether the facilities and equipment it will use for dry storage operations are such that the effects of potential accident events at its site are enveloped by the cask design bases considered in the cask SAR referenced in the Certificate of Compliance (CoC) and captured in the TS. Appropriate evaluations of accident conditions, including identification of all credible accident scenarios, recovery from these events and estimates of occupational exposures and exposures to members of the public, should be performed. These evaluations are subject to inspection by the NRC. In addition, as specified in TS 5.2.4, approved written procedures shall be followed that address accident conditions. Specifically, these procedures shall address the impact on plant operations due to potentially increased radiation levels from the loaded OS197L TC that is unshielded and has been damaged as a result of the accident event.

10.4 ALARA

Given the dose rates associated with the OS197L TC, staff had questions regarding whether or not the design, operation, and use of this TC could meet ALARA principles. Even with the TC being 'de-rated' such that surface dose rates are less than 10 rem/hr, concerns remain with regard to ALARA. These concerns arise, in part, due to the need to keep personnel away from areas near the TC during crane movements, and the need to employ substantial supplemental shielding both in the decontamination area and on the transfer trailer to enable personnel to perform work on the DSC and TC. The need for these kinds of operations and controls represents a significant deviation from concepts used in the design of transfer casks for approved dry storage systems. It introduces a system for which there are possible impacts on other facility operations not connected with the dry storage operations that are prolonged in the event some off-normal situation occurs, such as a crane malfunction. It also introduces a system for which the off-normal and normal conditions differ with regard to radiation exposure conditions. Personnel engaged in recovery operations may be exposed to higher dose rates than in normal conditions. Even the potential impact for public exposures must be considered for ensuring dry storage operations meet the dose limits in 10 CFR 72.104.

In all these aspects, greater reliance has been placed on ALARA in operations and less on ALARA in the system design. Staff finds that while ALARA is a concept that needs to be applied to operations, it also needs to be applied in the design of systems used to handle, transfer and store spent nuclear fuel and radioactive materials associated with fuel assemblies. To this end, several technical specifications were developed specifically for the OS197L TC design and for the OS197L TC operations. These TS include limiting the contents more than is done for the other NUHOMS® TCs; requirements on the equipment used for remote operations; requirements on how operations are performed; and requirements for the development of procedures, performance of evaluations and performance of training for normal, off-normal and accident conditions particular to using the OS197L. Based on these technical specifications, together with the additional evaluations included in the SAR, for the OS197L TC, the staff finds there is reasonable assurance that the use of the OS197L can meet the requirements of 10 CFR Part 20 and the radiation protection requirements of 10 CFR Part 72, including maintaining exposures ALARA.

10.5 Additional Radiation Protection Items

The staff review also considered the various changes to the Updated Final Safety Analysis Report (UFSAR), the CoC and the Technical Specifications. Dose rate limits on both the TC and the HSM for each DSC are important aspects of the radiation protection program. Thus, these limits have been retained as part of the TS Radiation Protection Program and in a TS HSM Dose Rate Evaluation Program. The staff's review and findings regarding the TS dose rate limits are described in the shielding chapter of this SER. The staff also reviewed the decontamination TS (see TS 5.2.4.d)). The initial TS description for checking DSC contamination levels and the level of decontamination needed in the case of DSC contamination exceeding the limits required further clarification. The TS was modified to address concerns regarding these aspects of the decontamination process. Staff finds the modified TS to be acceptable since the changes are in alignment with what staff considers to be appropriate for these aspects of the process.

The staff also reviewed the operations procedure descriptions given in Section W.8 of the SAR. The applicant provided operations descriptions that are consistent with TS requirements, including those for remote handling, and are consistent with the configurations considered in the shielding and radiation protection evaluations. Based upon a review of those descriptions, and discussions regarding operations and the shielding and radiation protection evaluations associated with the operations for the OS197L TC, the staff finds that, with the proposed TS regarding system operations for the OS197L, the operations take into account the unique design requirements of the OS197L TC, and demonstrate adequate consideration of ALARA. Additionally, reasonable and adequate consideration has been given (in Section W.10 of the SAR) to off-normal recovery operations, given the dose rates on the currently proposed TC design and operations. The staff finds that the licensee that uses the OS197L TC should perform a thorough evaluation of off-normal events as described in Section 10.2 of this SER in accordance with TS 5.2.4.a) and to ensure compliance with 10 CFR Part 20 limits.

10.6 Evaluation Findings

F10.1 The staff finds that the design of the radiation protection system of the Standardized NUHOMS® System (including the OS197L TC) 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 Standardized NUHOMS® System will allow safe storage of spent fuel. This finding 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.

10.7 References

1. U.S. Nuclear Regulatory Commission, NUREG-1745, "Standard Format and Content for Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance," June, 2001.

11.0 ACCIDENT ANALYSIS EVALUATION

The purpose of the review of the accident analyses is to evaluate the applicant's identification and analysis of hazards, as well as the summary analysis of systems responses to both off-normal and accident or design-basis events. This ensures that the applicant has conducted thorough accident analyses as reflected by the following factors:

- identified all credible accidents,
- provided complete information in the SAR,
- analyzed the safety performance of the cask system in each review area, and,
- fulfilled all applicable regulatory requirements.

Only accident analyses for the new light weight transfer cask, the OS197L will be addressed in this section. Note that the applicable normal, off-normal and accident conditions for the transfer of the 61BT and 32PT DSCs when using the OS197L TC remain unchanged from those defined in the UFSAR for the transfer of these payloads when using the OS197 TC, except that applicable off-normal conditions include crane malfunctions and remote handling equipment malfunctions or failures when using the OS197L TC.

11.1 Off-Normal Conditions

Off-normal operations are categorized as Design Event II as defined by ANSI/ANS 57.9 (Ref. 1). These events can be described as not occurring regularly, but can be expected to occur with moderate frequency.

11.2 Accident Events and Conditions

Accident events and conditions are categorized as Design Event III and IV as defined in Reference 1. They include natural phenomena and human-induced low probability events. The accident events that were reviewed and updated and the associated safety evaluation are provided in Table 11-1 below. Details of the staff review of the off-normal events and accidents evaluation with respect to shielding and radiation protection can be found in Chapters 6 and 10 of this SER.

Table 11-1 Accident Event Safety Evaluation

Accident Event	Safety Analysis Report Sections	Safety Evaluation
Accidental Transfer Cask Drop	SAR Sections 8.2, K.3, M.3 W3.5, W11	SER Chapters 3, 6 and 10
Effect of Increased OS197L Temperatures on DSC Shell and Basket Components	SAR Section W.3.8	SER Chapter 5
Fire and Explosion	SAR Section W.4.10	SER Chapter 5
Loss of Neutron Shield and Loss of Sun Shade	SAR Section W4.6	SER Chapter 5

Table 11-1 Accident Event Safety Evaluation		
Accident Event	**Safety Analysis Report Sections**	**Safety Evaluation**
Loss of Shielding	SAR Section W.5.1.3, W5.2, W5.4.6.2, W5.4.7, and W5.4.9, W5.4.10.4, W5.4.10.5, W11	Chapters 6 and 10

11.3 Evaluation Findings

Based on a review of the submitted information, the staff makes the following findings:

F11.1 Structures, systems, and components of the OS197L Transfer Cask are adequate to prevent accidents and to mitigate the consequences of accidents and natural phenomena events that do occur.

F11.2 The applicant has evaluated the Standardized NUHOMS® System with the OS197L Transfer Cask to demonstrate that it will reasonably maintain confinement of radioactive material under credible accident conditions.

F11.3 The Standardized NUHOMS® System with the OS197L TC provides radiation shielding and confinement features that are sufficient to meet the requirements of 10 CFR 72.104 and 72.106 in accordance with 10 CFR 72.236(d).

F11.4 The staff concludes that the accident design criteria for the OS197L Transfer Cask 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 spent fuel during credible accident situations. This finding 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.

11.4 References

1. ANSI/ANS 57.9-1984, “Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type),” Reaffirmed 2000.

12.0 CONDITIONS FOR CASK USE - TECHNICAL SPECIFICATIONS (TS)

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. Chapters 6 and 10 of this SER describe the staff's review of the CoC and Technical Specifications with respect to shielding and radiation protection.

12.1 Conditions for Use

The conditions for use of the OS197L transfer cask, in conjunction with the Standardized NUHOMS® Storage System, are defined in the Certificate of Compliance (CoC) and TS.

12.2 Changes to Technical Specifications

The TS have been revised (1) to follow the format contained in NUREG-1745, "Standard Format and Content for Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance;" (Ref. 1) and (2) to allow use of a light weight transfer cask (TC) designated the OS197L.

12.2.1 Standardized Technical Specifications

The existing Technical Specifications (TS) have been converted to a format and content consistent with NRC guidance in NUREG-1745, "Standard Format and Content for Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance," (Ref. 1). The previously approved payloads, and the corresponding TS have been retained "as-is" in the new format of the proposed TS, including tables and figures. In addition, this change removes the bases from the TS and relocates the bases for the Limiting Conditions for Operation (LCOs) and Surveillance Requirements to UFSAR Chapter 10. Staff has reviewed these changes and concludes that they are consistent with the instructions and intent of NUREG-1745, and that they remove unnecessary detail from the technical specifications, move less significant requirements to the FSAR, and maintain consistency with 10 CFR Part 72.

12.2.2 Technical Specification Sections

Additional specific changes to the TS are listed below. Note that TS that have been moved, but not changed, are not specifically addressed here. A table listing the changes from the Standardized NUHOMS® System Amendment 10 (Ref. 2) to the revised Amendment 11 TS is available in the Amendment 11 Application Cover Letter (Ref. 3).

- Amendment 10, TS Section 1.1.7, "Special Requirements for First System in Place," has been deleted. It is no longer necessary given that NUHOMS® systems have been in use for some time at various utilities, and more than 300 NUHOMS® canisters have been loaded. This change is acceptable to staff.
- Amendment 10 TS 1.2.17, "Vacuum Drying Duration Limits for Various DSCs," has been deleted due to use of helium during blow down/drain down operations. (See also Amendment 11 TS 3.1.1, "DSC Bulkwater Removal Medium and Vacuum Drying Pressure.") The time limits shown in these TS were based on the use of air or nitrogen for DSC bulk water removal prior to initiation of vacuum drying. However, the Amendment 11 TS require that helium be used for any canister blow down in accordance with the recommendations in Interim Staff Guidance-22 (ISG-22), "Potential Rod Splitting Due to Exposure to an Oxidizing Atmosphere During Short-Term Cask

Loading Operations in LWR or Other Uranium Oxide Based Fuel" (Ref. 4). In addition, TN has proposed to revise the fuel cladding thermal acceptance criteria for the 61BT, 32PT and 24PHB DSCs to be consistent with the guidance in ISG-11, Rev. 3, "Cladding Considerations for the Transportation and Storage of Spent Fuel" (Ref. 5). This change results in steady state fuel cladding temperatures during vacuum drying which meet the staff guidance provided in ISG-11 for the 61BT, 32PT and 24PHB DSCs. For the currently licensed designs of 24P, 52B and 24PT2 DSCs, this change results in steady state fuel cladding temperatures which are bounded by the existing analysis and thus continue to meet the existing fuel cladding thermal acceptance criteria. This change is acceptable to staff.

- Amendment 11 TS 2.1, "Fuel to be Stored in the Standardized NUHOMS® System" has been moved from Amendment 10 TS 1.2.1, "Fuel Specifications." The basis for the TS was moved to Chapter 10 of the FSAR. This change is evaluated in Section 4.1 of the SER.
- Amendment 11 TS 3.1.1, "DSC Bulkwater Removal Medium and Vacuum Drying Pressure," was moved from Amendment 10 TS 1.2.2. The pressure limits and hold times for vacuum drying were the same in both cases. The only change was that the new TS requires that helium be used for any canister blow down in accordance with the recommendations in ISG-22 "Potential Rod Splitting Due to Exposure to an Oxidizing Atmosphere During Short-Term Cask Loading Operations in LWR or Other Uranium Oxide Based Fuel" (Ref. 4). Statements were added that during both wet and dry loading, steps would be taken consistent with the criteria defined in ISG-22 to prevent any fuel oxidation. The basis for the LCO and the surveillance section were paraphrased and moved to Chapter 10 of the FSAR. This change is evaluated in Section 4.1 of the SER.
- Amendment 11, TS 4.1, "Canister Criticality Control," has footnotes to an unnumbered table with respect to the incorporation of the appropriate sections in the FSAR with regard to testing for the boron density of the absorber plates for the 61BTH and 32PTH1 models. For consistency, during the review, similar footnotes requiring testing were added for the other models in the table (32PT, 24PTH, and 61BTH). This change is evaluated in Section 4.1 of the SER.
- Amendment 11, TS 4.2.1, was transferred verbatim from Amendment 10 to CoC No. 1004, TS 1.1.1(8), "Corrosion of Dry Shielded Canister (DSC) Support Steel in Coastal Salt Marine Environment." Additional text was added to the new TS with the response to RAI #2 (Ref. 6). This change is evaluated in Section 4.1 of the SER.
- Amendment 11 TS 4.4, "Transfer Cask Design Features," was added to the proposed TS to reflect additional restrictions for the use of the OS197L TC in accordance with discussions during the January 25, 2007 meeting (Ref. 7). These restrictions include only limiting its use to the 61BT and 32PT DSCs with a maximum heat load of 12 kW per DSC and 13 kW per DSC, respectively. This change is evaluated in Sections 6.1.3 and 7.1 of the SER.
- Amendment 11 TS 5.2.4, "Radiation Protection Program," replaces Amendment 10 TS 1.2.4, 1.2.4a, 1.2.5, and 1.2.12, and has been revised to include dose assessment for occupational exposures during loading operations. If remote handling devices are used for movement of a TC during loading, then the dose assessment shall include recovery from a potential malfunction of these devices. Section W.10 of the SAR provides an assessment of the incremental occupational exposure during recovery operations in the event of a failure of a remote handling device used with the OS197L TC. This change is evaluated in Sections 6.1.1, 6.1.2, 6.1.3, 7.1 and 10.5 of the SER. TS 5.2.4 also

includes dose rate limits for NUHOMS® TCs loaded with the different DSCs, evaluation of which is described in Section 6.1.1 of the SER.

- Amendment 11 TS 5.3.4 adds a requirement that the shielding on the DSC, TC and trailer be inspected for further use after an accidental drop. This change is discussed in Section 6.1.1.
- Amendment 11 TS 5.2.4(b), was moved from “Amendment 10, Section 1.2.5, “DSC Dye Penetrant Test of Closure Welds,” verbatim. The basis has been moved to Chapter B.10.5.2.4B of the FSAR. This change is evaluated in Section 4.1 of the SER.
- Amendment 11 TS 5.4, “HSM [Horizontal Storage Module] or HSM-H Dose Rate Evaluation Program” replaces Amendment 10 TS 1.2.7, 1.2.7a, 1.2.7b, 1.2.7c, 1.2.7d, 1.2.7e, 1.2.7f, and 1.2.7g. This change is evaluated in Sections 6.1.1 and 6.1.2 of the SER.
- Amendment 11 TS 5.4.1 and 5.4.2, replace Amendment 10 TS 1.2.7, “HSM Dose Rates with a Loaded 24P, 52B or 61BT DSC.” The revised TS regulates dose rate limits for a loaded DSC when stored inside an HSM. This change is acceptable to staff.
- Amendment 11 TS 5.5, “Concrete Testing for HSM-H [Horizontal Storage Module, Model H]” was moved verbatim from Amendment 10 CoC Condition 7. Additional language was added with the responses to RAI #1 (Ref. 8). This change is evaluated in Sections 3.1.1 and 4.1 of the SER.
- Amendment 11 TS 5.6, “HSM-H Configuration Changes,” was moved verbatim from Amendment 10 Condition 8. This change is evaluated in Section 4.1 of the SER.

12.3 Changes to Standardized NUHOMS® Certificate of Compliance

The Certificate of Compliance has been revised as follows:

- Amendment 10 Conditions 6 and 7, regarding “Concrete testing for HSM-H [Horizontal Storage Module, Model H],” and “HSM-H Configuration Changes,” were incorporated verbatim into Amendment 11 to CoC No. 1004, TS 5.5 and 5.6 respectively. Additional language was added to TS 5.5 with the responses to RAI #1 (Ref. 8).
- CoC New Condition 6, “Quality Assurance,” has been updated and moved from Amendment 10 TS 1.1.3. This change is acceptable to staff.
- CoC New Condition 7, “Heavy Loads Requirements,” has been moved from Amendment 10 TS 1.1.4. This change is evaluated in SER Section 3.1.1.
- CoC New Condition 8, “Pre-Operational Testing and Training Exercise” was previously included in Amendment 10 TS 1.1.6. Some of the information previously included in Amendment 10 TS 1.1.6, but not included in Amendment 11 CoC Condition 8 is available in Amendment 11 TS 5.2.2 “Training Program.” This change is evaluated in SER Section 3.1.1.
- The transfer cask description has been revised in accordance with the addition of the OS197L.

12.4 Evaluation of Findings

Based on a review of the submitted information, the staff makes the following findings:

F12.1 Staff concludes that the conversion to Standardized Technical Specifications, in accordance with NUREG-1745 is consistent with the instructions and intent of NUREG-1745, and removes unnecessary detail from the technical specifications, moves less significant requirements to the FSAR, and maintains consistency with 10 CFR Part 72.

F12.2 The staff concludes that the conditions for use of the OS197L TC in conjunction with the Standardized NUHOMS® System identify necessary TS to satisfy 10 CFR Part 72 and that the applicant's acceptance criteria have been satisfied. The TS provide reasonable assurance that the cask system will provide for safe storage of spent fuel. This finding is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted practices.

F12.3 The staff concludes that the CoC for the Standardized NUHOMS® System provides reasonable assurance that the cask system will provide for safe storage of spent fuel. This finding is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, and accepted practices.

12.5 References

1. U.S. Nuclear Regulatory Commission, NUREG-1745, "Standard Format and Content for Technical Specifications for 10 CFR Part 72 Cask Certificates of Compliance," June, 2001.
2. Amendment 10 to Certificate of Compliance No. 1004 for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, August 24, 2009 (ML092290199, letter).
3. Transnuclear, Inc., Application for Amendment 11 of the NUHOMS® Certificate of Compliance No. 1004 for Spent Fuel Storage Casks, Revision 0, April 10, 2007 (ML071240088 (letter)).
4. U.S. Nuclear Regulatory Commission, Interim Staff Guidance #22 (ISG-22) "Potential Rod Splitting Due to Exposure to an Oxidizing Atmosphere During Short-Term Cask Loading Operations in LWR or Other Uranium Oxide Based Fuel," Rev. 0.
5. U.S. Nuclear Regulatory Commission, Interim Staff Guidance #11 (ISG-11) "Cladding Considerations for the Transportation and Storage of Spent Fuel," Rev 3.
6. Transnuclear, Inc., Revision 2 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System, Response to Second Request for Additional Information (Docket No. 72-1004; TAC No. L24080), August 14, 2009 ((ML13149A438, proprietary) and (ML092330146, non-proprietary)).
7. U.S. Nuclear Regulatory Commission, "Summary of January 25, 2007 Meeting with Transnuclear, Inc. to Discuss Plans for Amendment 11 to the Standardized NUHOMS® Design," January 31, 2007 (ML070330206).
8. Transnuclear, Inc., Responses to RAI for Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 11 to the Standardized NUHOMS® System (Docket No. 72-1004; TAC No. L24080), December 21, 2007 (ML080020420 (non-proprietary version), ML080020446 (proprietary version) and ML110320385 (non-proprietary version)).

13.0 ACCEPTANCE TEST AND MAINTENANCE PROGRAMS

13.1 Shielding Acceptance Testing and Maintenance

The staff has reviewed the proposed acceptance testing of the shielding features of the OS197L transfer cask (TC) system, to include the supplemental shielding. These tests include inspection to ensure that the shielding dimensions are consistent with those given in the technical drawings and that the shielding features are free of significant defects. Testing of the neutron shielding features are the same as for the currently approved Standardized NUHOMS® System TCs. Based on its review of the OS197L shielding design and the fact that the gamma shielding is composed of standard materials, staff finds the proposed acceptance testing to be acceptable to ensure proper fabrication of the TC shielding features. The user should also perform appropriate acceptance testing of the equipment used to perform remote operations to ensure they meet the quality standards assigned to them.

The staff also reviewed the description of the proposed maintenance program. The maintenance program actions relevant to shielding and radiation protection include routine visual inspections for damage of the TC and supplemental shielding. Additionally, visual and functional inspections will be performed for lift yokes and other hardware used for remote operations. Based on its review, and in consideration of the items discussed in the shielding and radiation protection chapters of this safety evaluation report (SER), the staff concludes that the proposed maintenance program is acceptable for purposes of ensuring adequate shielding and radiation protection performance of the OS197L TC system and equipment used in connection with this TC system.

13.2 Evaluation Findings

F13.1 Staff concludes that the proposed acceptance testing is acceptable to ensure proper fabrication of the TC shielding features.

F13.2 Staff concludes that the proposed maintenance program is acceptable for purposes of ensuring adequate shielding and radiation protection performance of the OS197L TC system and equipment used in connection with this TC system.

14.0 CONCLUSION

The NRC staff has performed a comprehensive review of the CoC amendment request and found that the following changes do not reduce the safety margin for the Standardized NUHOMS® System:

- addition of a light weight transfer cask (TC) NUHOMS® OS197L TC and accompanying changes to accommodate this TC, and,

- conversion of the Technical Specifications (TS) to the Standardized Technical Specifications format.

The areas of review addressed in NUREG-1536, "Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility," July 2010, are consistent with the applicant's proposed changes. The Certificate of Compliance has been revised to include TN's 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 Standardized NUHOMS® System meet the requirements of 10 CFR Part 72.

Issued with Certificate of Compliance No. 1004, Amendment No. 11 on Draft________ .

APPENDIX A
LIST OF ABBREVIATIONS AND ACRONYMS

ALARA	As low as reasonably achievable
BECT	Burnup, Enrichment, Cooling Time
BWR	Boiling Water Reactor
CFD	Computational Fluid Dynamics
Cm-244	Curium-244
CoC	Certificate of Compliance
DO	Discrete Ordinates
DSC	Dry Shielded Canister
FSAR	Final Safety Analysis Report
FQT	Fuel Qualification Table
HLZC	Heat load zoning configuration
HSM-H	Horizontal Storage Module, Model H
ISFSI	Independent Spent Fuel Storage Installation
ISG	Interim Staff Guidance
ITS	Improved Technical Specification
kW	kilowatts
LCO	Limiting Condition for Operation
LWTC	Light weight transfer cask
NRC	Nuclear Regulatory Commission
NOV	Notice of Violation
OPPD	Omaha Public Power District
PWR	Pressurized Water Reactor
RAI	Request for Additional Information
RIV	NRC Region IV
SAR	Safety Analysis Report (applicant)
SER	Safety Evaluation Report (NRC staff)
SFST	Division of Spent Fuel Storage and Transportation, USNRC
SRP	Standard Review Plan
SSC	Structures, Systems, and Components
SUNSI	Sensitive Unclassified Non-Safeguards Information
TC	Transfer Cask
TN	Transnuclear, Inc.
TS	Technical Specifications
UFSAR	Updated Final Safety Analysis Report