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February 28, 2018
E-50408

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

Subject: Application for Revision 9 to Certificate of Compliance No. 9302 for the Model No. NUHOMS®-MP197 Packaging, Docket No. 71-9302

References: [1] Revision 8 to Certificate of Compliance No. 9302 for the Model No. NUHOMS®-MP197 Packaging

[2] NUHOMS®-MP197 Transportation Package Safety Analysis Report, Revision 18, April 2017

In accordance with 10 CFR 71.31(b) TN Americas LLC, an Orano subsidiary, submits an application for revision to the Certificate of Compliance (CoC) No. 9302 for the Model No. NUHOMS®-MP197 Packaging.

There are five proposed changes to the Safety Analysis Report (SAR) as described below:

1. Add a Dismantling and Decommissioning Radioactive Waste Container (RWC-DD) variant of the RWC design configuration.
2. Internal Sleeve enhancements.
3. Fabrication and Operation enhancements.
4. Leak Testing Criteria and Consideration with respect to ANSI N14.5-2014.
5. Editorial Corrections.

Details regarding each of the above five proposed changes are detailed in Enclosure 1.

This submittal contains the following enclosures:

- Enclosure 1 provides a description of the safety analysis report (SAR) proposed changes and includes the reason for each change.
- Enclosure 2 provides the NUHOMS®-MP197 Transportation Package SAR, Revision 18A, specifically the affected chapters and appendices resulting from the changes described in Enclosure 1. A listing of the specific chapters

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and appendices of the SAR, associated with this application and included in this enclosure, are contained on page 2 of the enclosure cover page. This enclosure is proprietary.

- Enclosure 3 provides a public version of Enclosure 2. This enclosure is non-proprietary.
- Enclosure 4 provides a markup of Revision 8 for CoC No. 9302, changed pages only, for the proposed changes discussed in Enclosure 1.
- Enclosure 5 provides an affidavit, in accordance with 10 CFR 2.390, specifically requesting that you withhold proprietary information included in Enclosure 2 of this submittal from public disclosure. That information may not be used for any purpose other than to support the review of the application for revision to the NUHOMS®-MP197 CoC.

The changed areas in the SAR are marked as follows:

- New or changed pages show "Revision 18A" in the header.
- Changed areas are indicated using revision bars in the right-hand margin. Newly inserted or revised text is shown by italics.

Based on communications with the NRC during the course of this licensing action, TN Americas LLC respectfully requests to be notified once the NRC has completed the safety review and determines that no additional information is required for issuance of the CoC. TN Americas LLC will then submit a consolidated Revision 19 to the NUHOMS®-MP197 SAR (both the proprietary and the non-proprietary versions), which incorporates all the changes completed during the course of this application for revision.

TN Americas LLC respectfully requests that a review schedule be planned in order for Revision 9 to CoC 9302 NUHOMS®-MP197 Packaging to become effective on or before January 15, 2019 in order to support a future business need.

Should the NRC staff have any questions or require additional information to support review of this application, please contact Mr. Glenn Mathues by telephone at 410-910-6538 or by e-mail at Glenn.Mathues@areva.com. For any written correspondence, please include "To the Attention of Glenn A. Mathues."

Sincerely,

W. Scott Edwards
Director of Transportation
TN Americas LLC

cc: Pierre Saverot, U.S. Nuclear Regulatory Commission
One paper copy of this transmittal letter
One electronic copy of this transmittal letter and Enclosures 1, 2, and 4 on six DVDs

Enclosures:

1. Description and Justification of Changes, SAR NUHOMS®-MP197, Revision 18A
2. NUHOMS®-MP197 SAR Revision 18A (Proprietary)
3. NUHOMS®-MP197 SAR Revision 18A (Non-Proprietary)
4. Proposed Changes to CoC 9302 Revision 8
5. Affidavit Pursuant to 10 CFR 2.390

AFFIDAVIT PURSUANT TO 10 CFR 2.390

TN Americas LLC)
State of Maryland) SS.
County of Howard)

I, Jayant Bondre, depose and say that I am Chief Technical Officer of TN Americas LLC, duly authorized to execute this affidavit, and have reviewed or caused to have reviewed the information that is identified as proprietary and referenced in the paragraph immediately below. I am submitting this affidavit in conformance with the provisions of 10 CFR 2.390 of the Commission's regulations for withholding this information.

The information for which proprietary treatment is sought meets the provisions of paragraph (a) (4) of Section 2.390 of the Commission's regulations. The information is contained in 2, as listed below:

- Enclosure 2 - Portions of chapters and appendices of the Safety Analysis Report (SAR) for the NUHOMS®-MP197, Revision 18A.

I have personal knowledge of the criteria and procedures utilized by TN Americas LLC in designating information as a trade secret, privileged or as confidential commercial or financial information.

Pursuant to the provisions of paragraph (b) (4) of Section 2.390 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure, included in the above referenced document, should be withheld.

1) The information sought to be withheld from public disclosure involves portions of the Model NUHOMS®-MP197 transportation packaging SAR, related to the design of the Model NUHOMS®-MP197 transportation packaging, which are owned and have been held in confidence by TN Americas LLC.

2) The information is of a type customarily held in confidence by TN Americas LLC, and not customarily disclosed to the public. TN Americas LLC has a rational basis for determining the types of information customarily held in confidence by it.

3) Public disclosure of the information is likely to cause substantial harm to the competitive position of TN Americas LLC, because the information is related to the design and analysis of the Model NUHOMS®-MP197 transportation packaging, the application of which provides a competitive economic advantage. The availability of such information to competitors would enable them to modify their product to better compete with TN Americas LLC, take marketing or other actions to improve their product's position, or impair the position of TN Americas LLC's product, and avoid the development of similar data and analyses in support of their processes, methods, or apparatus.

Further the deponent sayeth not.

Jayant Bondre
Chief Technical Officer, TN Americas LLC

Subscribed and sworn before me this 28th day of February 2018.

Notary Public

My Commission Expires 10/16/19

RONDA JONES
NOTARY PUBLIC STATE OF MARYLAND
My Commission Expires October 16, 2019

E-50408
Application for Revision 9 to Certificate of Compliance No. 9302 for the Model No. NUHOMS®-MP197 Packaging, Docket No. 71-9302

Revision 18A
February 2018

TN AMERICAS LLC

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Enclosure 1 to E-50408

Description and Justification of Changes, SAR NUHOMS®-MP197, Revision 18A

Description and Justification of Proposed Changes
(Safety Analysis Report, MP197, Revision 18A)

This enclosure is intended to provide a summary of the proposed changes to assist in understanding the affected sections of the safety analysis report (SAR). Part A of this enclosure provides a general description of proposed changes in the safety analysis report (SAR). Part B provides details of the Chapters and Sections revised with a brief description and justification for the changes described in Part A. Changes in Part B are keyed to the outline of changes described in Part A, are itemized and numbered sequentially within a section. For example, all changes in Part B.1 relate to the general description of changes in Part A.1, and these changes are itemized, B.1-1, B.1-2, and so on.

Part B provides a more detailed description of changes and justifications for the change. The SAR was reviewed for all instances where a design feature appears that is added or modified. These affected sections of the SAR (Chapter, Appendix, Sections, Drawings) are identified in Part B. Furthermore, the changes are grouped by the affected chapters of the SAR (A.1 General Description, A.2 Structural Evaluation, A.3 Thermal Evaluation, A.4 Containment, A.5 Shielding, A.6 Criticality, A.7 Operations, A.8 Maintenance). Note that the SAR section numbering in Part B refers to the Appendices for the MP197HB SAR that bears no relation to Part A of this enclosure.

Each item in Part B corresponds to a description of change that affects one or more sections in the SAR. Each "Description of change" is itemized and may be associated with one or more affected sections in the SAR. Each affected section associated with an item may have a separate justification, or a single justification is provided at the end of the item that applies to all the affected sections. The "Description of change" may also include excerpts from an affected section of the SAR that are shown in *italics*. The affected design feature is indicated by ***bold underline*** in the excerpts from the SAR. An affected section of the SAR that requires no revision is indicated in Part B as "SAR: (no change required)" with excerpts from the SAR to support the justification for making no change. Affected sections that require changes may also include an excerpt from the SAR in the "Description of change," in addition to the change pages that are provided in Enclosure 2. In these excerpts, deletions are indicated in ~~***bold strike through***~~ and additions are indicated in ***bold***. A SAR page number is provided to assist in finding the affected section in the SAR or within the change pages provided as Enclosure 2.

Part A

There are five substantive changes proposed to the SAR, as described below. The changes affect all sections of the SAR shielding evaluation, structural evaluation, and operations and maintenance. A review of the SAR has been done to identify all affected sections and evaluates any affect the change may have on the performance of the package. No changes were identified that required revision to technical evaluations.

A.1 Dismantling and Decommissioning Radioactive Waste Container (RWC-DD)

The RWC-DD is a variant of the RWC design configurations that are approved for use with the MP197HB transport cask. The RWC-DD canister's nominal diameter is the same as the approved RWC configurations, but longer in length. The RWC-DD is intended to be a reusable canister for transport of secondary liners containing waste or single use, with or without secondary liners, for disposal of low level waste in shallow earth disposal sites. The RWC-DD

consists of a bolted top closure design that allows for the re-use of the canister for multiple loadings, transportation, and unloading of the authorized contents.

The RWC-DD canister is designed to transport reactor related dry irradiated or contaminated non-fuel bearing solid materials or both, and to facilitate on-site operation with ancillary equipment. The RWC-DD operating system consists of the RWC-DD canister, the optional secondary waste liner(s), the shielded transfer cask and the MP197HB transport cask with an internal sleeve. The RWC-DD operating system is designed to allow transfer of radioactive waste in the RWC-DD canister to the MP197HB transport cask for off-site transportation. The ancillary equipment is used for loading and transfer operations from a shielded transfer cask to the MP197HB transport cask in accordance with the requirements of 10 CFR Part 50, by the plant licensee utilizing the provisions of 10 CFR 50.59. The RWC-DD canister with MP197HB transport cask is designed for off-site transportation in accordance with the requirements of 10 CFR Part 71.

A.2 Internal Sleeve

There are two different outside diameters (ODs) for the DSC. An inner sleeve is used to accommodate the smaller diameter DSC and the RWCwithin the MP197HB transport cask. The inner sleeve is designed with slots to accommodate the existing rails inside the cask and to provide rails inside the sleeve on which the smaller diameter DSC or RWC slide during horizontal loading or unloading of the cask. The design features for the inner sleeve that are important for package performance are the diameter dimensions and material thermal properties. The inner sleeve design as previously approved is retained in the SAR with an option added to use stainless steel and aluminum materials for an inner sleeve used only for transport of the RWC.

A.3 Fabrication and Operation

Fabrication of the first MP197HB transport cask is progressing in parallel with planning for the first use of the MP197HB to transport LLW generated from reactor dismantling and decommissioning activities to a disposal site. Both the fabrication and the planning for operations using the RWC-DD have initiated design changes that affect the licensing documents including the engineering drawings for package approval (i.e., SAR drawings), operations, and maintenance and acceptance tests. The revisions to the SAR drawings include changes as recommended in NRC SFST ISG-20 (i.e., material specifications, dimensions, details, optional parts) that provide flexibility to make design changes without requiring prior NRC approval. Improvements are made to design features for handling removable parts (i.e., lid, ram cover, trunnion attachment block plugs, and shear key plug). The handling design features are indicated with flexibility to allow changes without NRC prior approval and provided on the SAR drawings for information only to assist in understanding the operation and maintenance activities.

A.4 Leak Testing Criteria and Consideration with respect to ANSI N14.5-2014

The NUHOMS®-MP197HB transport cask is designed and tested for a leak rate of 1×10^{-7} ref cm^3/s, defined as "leak tight" per ANSI N14.5. The RWC contents does not require the cask to be leak tight for containment. Solid activated and contaminated waste is confined to the RWC

Description and Justification of Proposed Changes
(Safety Analysis Report, MP197, Revision 18A)

which is a closed container. The RWC is not part of the containment boundary, but will limit any release of any contamination that spalls from the waste. A reference air leak rate that allows testing to less than leak tight is established that satisfies containment requirements with the RWC contents.

Affected sections of the SAR are revised to take into account NRC IN-2016-04, ANSI N14.5-2014 Revision and Leakage Rate Testing Considerations. Changes are limited to leak rate testing of the MP197HB transportation cask. The impact of any changes from consideration of ANSI N14.5-2014 on previously loaded DSC or RWC in interim dry storage requires further investigation and clarification of requirements for transport of canisters that have been in storage and leak tested prior to storage under prior editions of ANSI N14.5. Consideration of ANSI N14.5-2014 as it relates to leak testing for DSC or RWC contents, will be addressed in a future revision to the SAR.

A.5Editorial Corrections

There are 4 editorial corrections to specific pages in the SAR and detailed in Section B.

Description and Justification of Proposed Changes
(Safety Analysis Report, MP197, Revision 18A)

Part B

B.1 Dismantling and Decommissioning Radioactive Waste Container (RWC-DD)

Item	Chapter/Appendix/ Section	Description and Justification
	Chapter A.1	**General Information**
B.1-1	A.1.2 Package Description	Description of change: Added a new configuration for RWC for dismantling and decommissioning.
	A.1.2.1 Packaging	SAR (no changes required): *The dry irradiated and/or contaminated non-fuel bearing solid materials are contained in a secondary container (Radioactive Waste Canister (RWC)). The safety analysis of this configuration takes no credit for the containment provided by the RWC.* Justification: RWC-DD configuration does not affect the package evaluation for containment.
	A.1.2 Package Description A.1.2.1 Packaging	Description of change: Specify inert gas atmosphere only for DSC SAR **Page A.1-2** *A NUHOMS®-MP197HB transport cask consists of a containment boundary, structural shell, gamma shielding material, and solid neutron shield. The containment boundary consists of a cylindrical inner shell, a bottom plate with a ram access closure plate with seal and bolts, a cask body flange, a top lid with seal and bolts, vent and drain ports with closure bolts and seals, and all containment welds. The transport cask cavity also contains an inert gas atmosphere* ***when transporting DSCs.*** **Page A.1-4** *The containment vessel prevents leakage of radioactive material from the cask cavity. It also maintains an inert atmosphere (helium) in the cask cavity* ***when transporting DSCs.*** *Helium within the DSCs assists in heat removal and provides a non-reactive environment to protect fuel assemblies against fuel cladding degradation. To preclude air in-leakage* ***when transporting DSCs***

Description and Justification of Proposed Changes
(Safety Analysis Report, MP197, Revision 18A)

Item	Chapter/Appendix/ Section	Description and Justification
	A.1.2.1 Packaging (con't)	*, the cask cavity is pressurized with helium to above atmospheric pressure.* Justification RWC and contents does not require inert atmosphere.
	A.1.2.1.1 NUHOMS®-MP197HB Transport Cask	SAR (no changes required): *RWCs with dry irradiated and/or contaminated non-fuel bearing solid materials are shipped dry in an air, nitrogen or inert gas environment. When a wet load procedure (i.e., in-pool) is followed for cask loading, the RWC and cask cavities are drained and dried in order to ensure that free liquids do not remain in the package during transport. The heat generated by the contents of the RWC is rejected to the environment by conduction, convection and radiation. No forced cooling is required.* Justification: RWC-DD configuration does not affect the package evaluation for heat transfer.
	A.1.2.3.2 Radioactive Waste Canister	SAR (no change required): *The NUHOMS MP197HB packaging is also licensed to transport a RWC. The RWC is designed to carry dry irradiated and/or contaminated non-fuel-bearing solid materials. Details of the RWC are provided in Appendix A.1.4.9A.*
	A.1.2.3.2 Radioactive Waste Canister (con't)	Justification: RWC-DD configuration does not affect the allowed contents.
	Appendix A.1.4.9A **Radioactive Waste Canister**	SAR (no changes required): Appendix A.1.4.9A is revised with changes marked. Justification: RWC-DD description added and other RWC descriptions revised to emphasize differences between RWC-W, RWC-B, and RWC-DD.
	Appendix A.1.4.10 **NUHOMS®-MP197HB**	SAR:

Description and Justification of Proposed Changes
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Item	Chapter/Appendix/ Section	Description and Justification
	SAR Drawings **NUHRWC-71-1001** **NUHRWC-71-1002** **NUHRWC-71-1003**	*A.1.4.10.11 Radioactive Waste Canister Drawing* *The following drawings for the Radioactive Waste Canister are included in Section A.1.4.10.11.* *Drawing Number Title* *NUHRWC-71-1001 Rev ~~1~~ 2* NUHOMS® *System ~~RWC~~ Radioactive Waste Canister - ~~Welded Top Shield Plug~~* *Design Main Assembly ~~(5 sheets)~~ (2 sheets)* ~~*NUHRWC-71-1002 Rev 1*~~ NUHOMS® ~~*System RWC Canister - Welded Top Shield Plug*~~ ~~*Design Inner Liner (3 sheets)*~~ ~~*NUHRWC-71-1003 Rev 0*~~ NUHOMS® ~~*System RWC Canister - Bolted Top Shield Plug Design*~~ ~~*Main Assembly (4 sheets)*~~ Justification: RWC drawing NUHRWC-71-1001 revised to show general arrangement and include detail of features for the RWC-W, RWC-B, and RWC-DD lid configurations. Separate drawings for the basket used with the RWC-W, NUHRWC-71-1002, and RWC-B, NUHRWC-71-1003, are superseded by NUHRWC-71-1001.
	Chapter A.2	**Structural Evaluation**
B.1-2	 A.2.1.1 Discussion	Description of change: The RWC-DD is longer in length and provides a reusable closure configuration for the RWC as described in Chapter A.1 and Appendix A.1.4.9A. SAR (no changes required): *The NUHOMS®-MP197HB transport package consists of three major structural components: the cask body, one of several transportable dry shielded canisters (DSCs) or a radioactive waste*

Description and Justification of Proposed Changes
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Item	Chapter/Appendix/ Section	Description and Justification
	A.2.1.1 Discussion (con't)	*container (RWC), and the impact limiters (front and rear). Each DSC consists of a shell assembly and a basket assembly. These components are described in Chapter A.1 and are shown on drawings provided in Appendix A.1.4.10.* *The cask body and a DSC or RWC, together with the two impact limiters, form the packaging designed to meet all of the applicable 10 CFR Part 71 requirements for a Type B(U) packaging.* Justification: The RWC-DD is a configuration for the RWC that includes three closure options.
	A.2.1.1.4 Radioactive Waste Canister	SAR (no changes required): *A radioactive waste canister (RWC) is also included as an authorized payload of the MP197HB cask. As described in Chapter A.1, Appendix A.1.4.9A, the RWC is bounded by the DSCs in terms of weight and decay heat. Also, the RWC does not provide containment for its contents. Therefore, the analyses provided in this chapter for the DSCs are considered bounding for the RWC and no analyses for the RWC are necessary.* Justification: RWC-DD is longer and weighs more than the currently approved RWC-W and RWC-B. The RWC-DD total weight limit including the contents is the same as for other RWC configurations. The structural analysis for the DSCs remains bounding for the RWC-DD.
	A.2.13.1.2 Description of the MP197HB Cask C. Payload and Cask Component Weight Data Used in the Analysis	SAR: The table on page A.2.13.1-3 currently indicates that the weight of the *RWC is less than 110 kips. The bounding payload used for cask structural evaluation is 118.5 kips.* Change the RWC weight to less than or equal to 112 kips. SAR page provided with changes marked. Page A.2.13.1-3 is provided with change marked. Justification: Weight of the RWC payload for MP197HB transport cask (TC) may be less than or equal to 112 kips (56 ton) including the weight of the RWC, cask internal sleeve, and contents. The structural evaluation assumes a weight of 118.5 kips.

Description and Justification of Proposed Changes
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Item	Chapter/Appendix/ Section	Description and Justification
	Chapter A.3	**Thermal Evaluation**
B.1-3	 *A.3.1.2 Content's Decay Heat* *A.3.3.2 Heat and Cold*	Description of change: Add a new configuration for RWC for dismantling and decommissioning. SAR: (no changes required) *The MP197HB TC is designed to transport a payload of up to 56.0 tons of dry irradiated and/or contaminated non-fuel bearing solid materials in secondary containers. The decay heat load of the radioactive material is limited to 5 kW, which is well below the heat loads specified for the cask loaded with DSCs.* *The heat load of the secondary containers is limited to 5 kW and is bounded by the DSC heat loads of 18.3 kW to 32 kW.* Justification: The RWC heat load is less than 5 kW, well below the limit of 26 kW for the DSC contents in the MP197HB TC without external cooling fins. RWC-DD heat load is same as for RWC-W and RWC-B. All RWC configurations have no impact on the thermal evaluation.
	Chapter A.5	**Shielding Evaluation**
B.1-4	 A.5.1 Description of the Shielding Design	Description of change: Added a new configuration for RWC for dismantling and decommissioning. The RWC-DD configuration is longer than the RWC-W and RWC-B. Shielding material thicknesses and the contents specification are the same. SAR (no changes required): *Chapter A.1, Section A.1.2.3.2 (also in Appendix A.1.4.9A) provides a description of the irradiated and/or contaminated non-fuel bearing solid materials authorized for transport in the RWC as well as its respective physical dimensions.* Justification: Contents approved for RWC-W and RWC-B is the same for RWC-DD.

Description and Justification of Proposed Changes
(Safety Analysis Report, MP197, Revision 18A)

Item	Chapter/Appendix/ Section	Description and Justification
	A.5.2 Source Specification	SAR (no changes required): *There are three source configurations used in the evaluation of the shielding performance of the MP197HB transportation package. These configurations are selected because of their respective bounding parameters on all authorized contents. The bounding configurations are as follows:* • *8,182 A2 (90,000 Ci of Co-60) in the RWC,* • *69 GE-2,3 7x7 Type G2A BWR spent fuel assemblies in the 69BTH DSC, and* • *37 B&W 15x15 Mark B-10 PWR spent fuel assemblies in the 37PTH DSC.* Justification: The bounding configuration for RWC applies to RWC-DD.
	A.5.2.1 Gamma Source A.5.2.1.5 RWC	SAR (no changes required): *The* NUHOMS®*-MP197HB is designed to transport a payload of 56.0 tons of dry irradiated and/or contaminated non-fuel bearing solid materials in the RWC. The safety analysis of the cask takes no credit for the containment provided by the RWC. The quantity of radioactive material is limited to a maximum of 8,182 A2 (90,000 Ci of Co-60). A list of typical components and their associated*
	A.5.2.1 Gamma Source A.5.2.1.5 RWC (con't)	*activities is shown in Section A.1.4.9A.3.* *Co-60 emits two photons per disintegration, one at 1.17 MeV and one at 1.33 MeV. Because Co- 60 emits highly energetic photons, 90,000 Ci Co-60 bounds any potential non-fuel bearing solid material for the purposes of dose rate calculations.* *The decay heat load of the radioactive material is expected to be less than 5 kW, which is well below the 26 kW limit for the cask.* Justification: The payload limits and gamma source allowed in the RWC-DD is the same as for RWC-W and RWC-B.
	A.5.3.1 Configuration of Source and Shielding A.5.3.1.3 RWC	SAR (no changes required): *The geometry of the RWC and the volume occupied by the irradiated\contaminated hardware are specified in MCNP models using the following assumptions. The canister is modeled as a carbon steel cylinder with 70.50" diameter and 189.19" height. The*

Description and Justification of Proposed Changes
(Safety Analysis Report, MP197, Revision 18A)

Item	Chapter/Appendix/ Section	Description and Justification
	A.5.3.1.3 (con't)	*cylinder is centered at the cask axis and it is 2.71" from the cask bottom plug. The thickness of the cylindrical shell on side of the canister is 1.75". Thickness of shield plugs on bottom and top of the canister is 5.75" and 7.00", respectively, as specified in Appendix A.1.4.9A. Radioactive waste occupies only a portion of the inner volume of the canister. It is assumed that the waste is distributed within a cylindrical volume with 66.0" diameter and 168" height. The bottom of that cylindrical region is in contact with the bottom plug of the canister. The rest of the inner volume of the canister is occupied with air.* Justification: The shielding provided by the RWC-DD is equivalent to the RWC-W and RWC-B (1.75" shell thickness, 5.75" bottom plug, 7.0" top plug). However, the cavity length of the RWC-DD is 184.75" compared to 167.3" for the RWC-W/B. As a result, the source could be closer to the bottom or top end of the MP197HB TC cavity when using the RWC-DD. Given the length of the source, the effect on the dose rate would be small and additional calculations are not required.
	A.5.3.2 *Material Properties* *A.5.3.2.2 RWC Assumed Composition*	SAR (no changes required): *It is assumed the elemental composition of the smeared material in the RWC is identical to that of carbon steel. The density of smeared material is 1.0 g/cc in MCNP models. The material modeling consideration employed reasonably represents irradiated non-fuel hardware.* Justification: The RWC-DD has no effect on the 1.0 g/cc smeared material density, which was simply assumed.
	Table A.5-34 Summary of Maximum Dose Rates of the Cask Containing the Radioactive Waste Canister	SAR (no changes required): Table A.5-34 Justification: The dose rates computed for the RWC-W/B will be similar to the dose rates for the RWC-DD if similar input assumptions are utilized. Because the source in the RWC-DD could be closer to the ends of the package due to the longer cavity length, dose rates through the ends may increase slightly when using the RWC-DD.

Description and Justification of Proposed Changes
(Safety Analysis Report, MP197, Revision 18A)

Item	Chapter/Appendix/ Section	Description and Justification
	Table A.5-34 (con't)	However, this increase is expected to be negligible due to the length of the source. Therefore, the dose rates in Table A.5-34 are applicable to the RWC-DD.
	Chapter A.6	**Criticality Evaluation**
B.1-5	A.6.1.3 Summary of Criticality Evaluations *A.5.3.2.2 RWC Assumed Composition*	<u>Description of change:</u> Added a new configuration for RWC for dismantling and decommissioning. The RWC-DD configuration is longer than the RWC-W and RWC-B. <u>SAR (no changes required):</u> *Due to the absence of any fissile material payload content in the RWC, no criticality calculations are required for this DSC. Therefore, no further discussion of the criticality of this canister is necessary.* <u>Justification:</u> The content allowed in the RWC-DD is the same as for RWC-W and RWC-B.
	Chapter A.7	**Package Operations**
B.1-6	A.7.1 NUHOMS® MP197HB Package Loading	*<u>Description of design change:</u>* *Added a new configuration for RWC for dismantling and decommissioning (RWD-DD). The RWC-DD is intended to be a reusable transport canister and not intended for extended storage. The RWC may be unloaded with the cask in vertical position.* *<u>SAR (no changes required):</u>* ***Page A.7-1*** *The use of the NUHOMS®-MP197HB cask to transport dry irradiated and/or contaminated nonfuel bearing solid materials in **radioactive waste canisters (<u>RWCs</u>)** involves (1) preparation of the cask for use, (2) verification that the waste to be loaded meet the criteria set forth in this document, and (3) loading of the **<u>RWC</u>** and waste into the cask.* *During shipment, the packaging contains any one of the DSCs as described in Chapter A.1, Appendices A.1.4.1 through A.1.4.9 or an **<u>RWC</u>** as described in Appendix A.1.4.9A. Type and*

Description and Justification of Proposed Changes
(Safety Analysis Report, MP197, Revision 18A)

Item	Chapter/Appendix/ Section	Description and Justification
	A.7.1 (con't)	**Page A.7-1a** *form of the content and their maximum quantity to be loaded in any of the nine DSCs are specified in Table A.7-2a. Type and form of the content and their maximum quantity to be loaded in an* ***RWC*** *are specified in Table A.7-2b. Procedures are provided in this section for (1) transport of the cask/DSC/****RWC*** *directly from the plant spent fuel pool and (2) transport of a DSC/****RWC*** *which was previously stored in a NUHOMS® horizontal storage module (HSM). Section A.7.7 contains an appendix for each DSC model detailing its loading procedures. Table A.7-3 lists these appendices.*
	A.7.1.2.1 DSC/**RWC** Wet Loading	**Page A.7-3** The procedures for loading, vacuum drying, and sealing the DSC/**RWC** are described in detail in Appendices A.7.7.1 through A.7.7.10 as listed in Table A.7-3. **Page A.7-3a** Following the completion of the wet loading activities described in a specific appendix listed in Table A.7-3, the MP197HB cask is prepared for downending as described in the next section.
	A.7.2.2.2 Unloading the NUHOMS®-MP197HB Cask to a Fuel Pool	**Page A.7-9** *The procedure for unloading the cask and DSC/****RWC*** *to a fuel pool is summarized in this section. Site specific conditions and requirements may require the use of different equipment and ordering of steps than those descried below to accomplish the same objectives or acceptance criteria which must be met to ensure the integrity of the package. Note that the NUHOMS®-MP197HB cask or an alternate suitable cask may be used for onsite movements of the DSC/****RWC****.* **Page A.7-10** *9. If the cask contains any one of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) or an* ***RWC****, remove the cask spacer ring at the top of the aluminum sleeve as shown in Drawing MP197HB-71-1014, Appendix A.1.4.10.1.*
	A.7.6 Glossary	SAR (no changes required): **horizontal storage module (HSM):** Concrete shielded structure used for onsite storage of DSCs. HSM references herein refer to all models of HSM (e.g., HSM Model 80, Model 102, Model 152, Model 202, HSM-H, HSM-HS, AHSM, etc.) HSM also includes any other overpack authorized to accept a DSC or **RWC** via a horizontal transfer.

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B.1-7	Table A.7-2b	*Applicable Content Specification for* ***RWC*** Justification: RWC includes the RWC-DD configuration as described in Appendix A.1.4.9A, and content specification is same for RWC-DD configuration Description of design change: Reviewed to take into consideration operations specific to use of RWC for dismantling and decommissioning activities and editorial changes made to improve the intent of operation requirements
	A.7.1.2 NUHOMS®MP197HB Cask Wet Loading	SAR change: Chapter A.7 is provided with changes marked. See **Page s A.7-2 and A.7-3.** Justification: Specify operational steps as applicable to DSC, RWC or both.
	A.7.1.2.3 NUHOMS®-MP197HB Cask Downending	SAR change: Chapter A.7 is provided with changes marked. See **Page A.7-4.** Justification: Allow use of transfer skid or specialized handling frame for downending operations.
	A.7.1.3 NUHOMS®-MP197HB Cask Dry Loading (Transferring a Loaded DSC or **RWC** from an Overpack into an MP197HB Cask)	SAR change: (Chapter A.7 is provided with changes marked. See **Page A.7-6** Justification: Specify operational steps as applicable to DSC, RWC or both.
	A.7.1.4.1 Placing the NUHOMS®-MP197HB Cask onto the Conveyance	SAR change: Chapter A.7 is provided with changes marked.See **Page A.7-7.**

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	A.7.1.4.1 (con't)	Justification: Step 1; deleted "*and onsite transfer trailer.*" Not all sites will utilize a transfer trailer.
	A.7.2 NUHOMS®-MP197HB Package Unloading	SAR change: Chapter A.7 is provided with changes marked. See **Page A.7-8**. Justification: Allow vertical unloading operations for RWC.
	A.7.2.1 Receipt of Loaded NUHOMS®-MP197HB Package from Carrier	SAR change: Chapter A.7 is provided with changes marked.See **Page A.7-8 amd A.7-9.** Justification: Allow transfer in staging or transfer areas for unloading RWC.
	A.7.2.2.1 Unloading the NUHOMS®-MP197HB Cask to a Suitable Overpack	SAR change: Chapter A.7 is provided with changes marked.See **Page A.7.9.** Justification: Specify sampling cask cavity after transport of DSC only. RWC does not contain fission product gases that could be released to the cask cavity. RWC is not required to be leak tight for transport or disposal.
	A.7.2.2.4 Vertical Unloading of RWC-DD contents from the NUHOMS®-MP197HB Cask	SAR change: Chapter A.7 is provided with changes marked.See **Page A.7-10** and **Page A.7-11**. Justification: Replace the horizontal unloading of RWC procedure with a new procedure to allow vertical unloading. Horizontal unloading of RWC is covered in A.7.2.2.1 Unloading the NUHOMS®-MP197HB Cask to a Suitable Overpack.

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Item	Chapter/Appendix/ Section	Description and Justification
	A.7.4 Other Operations *A.7.4.1 Cask Cavity Vacuum Drying and Dryness Verification Test*	SAR change: Chapter A.7 is provided with changes marked.See **Page A.7-11**. Justification: Cask cavity and dryness verification operations added.
	Appendix A.7.7.10 Radioactive Waste Canister (**RWC**) Wet Loading Procedures	SAR change: Appendix 7.7.10 is provided with changes marked. Justification: Loading, drying, and sealing operations specific to RWC-DD configuration
B.1-8	Table A.7-1 DSC, Fuel, and Basket Spacer Nominal Heights for Each Type of DSC	Description of design change: Allow option to use aluminum and steel materials for internal sleeve design that is intended for use with the RWC only. Internal sleeve may include components that function as an axial spacer. SAR change: Table A.7-1 provided with changes marked.See **Page A.7-17** Justification: Specify a shorter spacer length for the RWC-DD and include internal sleeve components in specified spacer height.
B.1-9	A.7.1.1 NUHOMS®-MP197HB Cask Preparation for Loading A.7.1.2.2 Preparing the NUHOMS®-MP197HB Cask for Downending	Description of design change: a) Allow use of a ram access plate design that uses elastomeric seals for RWC shipments instead of the metallic seals required for DSC shipments. b) Allow reuse of elastomer o-ring seals, inspect for each use, and verify replacement with last 12 months. c) Allow reuse of metallic seals for shipping MP197HB empty SAR change: Chapter A.7 is provided with changes marked.See **Page A.7-4.** Justification:

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	A.7.1.1 (con't)	a) Ram access temperatures with RWC-DD contents are below the service temperature limit for elastomer O-rings. b) The radiation dosage level remains below 10^6 rad, a level normally attained after years of operation. Practically all elastomers suffer no change of their physical properties at radiation levels up to 1 M rad. Elastomer o-ring seals are inspected for each shipment and replaced within 12 months of a shipment. c) 49 CFR 173.428, Empty Class 7 (radioactive) materials packaging, requires only that package is securely closed so that there will be no leakage of Class 7 (radioactive) material under conditions normally incident to transportation. No leakage test is required.
B.1-10		Description of design change: Reviewed to take into consideration operations specific to use of RWC for dismantling and decommissioning activities and editorial changes made to improve the intent of operation requirements.
	A.7.1.2 NUHOMS®-MP197HB Cask Wet Loading	SAR change: Chapter A.7 is provided with changes marked. See **Page s A.7-2 and A.7-3.** Justification: Specify operational steps as applicable to DSC, RWC or both.
	A.7.1.2.3 NUHOMS®-MP197HB Cask Downending	SAR change: Chapter A.7 is provided with changes marked. See **Page A.7-4.** Justification: Allow use of transfer skid or specialized handling frame for downending operations.

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Item	Chapter/Appendix/ Section	Description and Justification
	A.7.1.3 NUHOMS®-MP197HB Cask Dry Loading (Transferring a Loaded DSC or RWC from an Overpack into an MP197HB Cask)	SAR change: (Chapter A.7 is provided with changes marked. See **Page A.7-6** Justification: Specify operational steps as applicable to DSC, RWC or both.
	A.7.1.4.1 Placing the NUHOMS®-MP197HB Cask onto the Conveyance	SAR change: Chapter A.7 is provided with changes marked.See **Page A.7-7**. Justification: Step 1; deleted "*and onsite transfer trailer.*" Not all sites will utilize a transfer trailer.
	A.7.2 NUHOMS®-MP197HB Package Unloading	SAR change: Chapter A.7 is provided with changes marked. See **Page A.7-8**. Justification: Allow vertical unloading operations for RWC.
	A.7.2.1 Receipt of Loaded NUHOMS®-MP197HB Package from Carrier	SAR change: Chapter A.7 is provided with changes marked.See **Page A.7-8 amd A.7-9.** Justification: Allow transfer in staging or transfer areas for unloading RWC.
	A.7.2.2.1 Unloading the NUHOMS®-MP197HB Cask to a Suitable Overpack	SAR change: Chapter A.7 is provided with changes marked.See **Page A.7.9.** Justification: Specify sampling cask cavity after transport of DSC only. RWC does not contain fission product gases that could be released to the cask cavity. RWC not required to be leak tight for transport or disposal.

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Item	Chapter/Appendix/ Section	Description and Justification
	A.7.2.2.4 Vertical Unloading of RWC-DD contents from the NUHOMS®-MP197HB Cask	SAR change: Chapter A.7 is provided with changes marked.See **Page A.7.11.** Justification: Replace the horizontal unloading of RWC procedure with a new procedure to allow vertical unloading. Horizontal unloading of RWC is covered in A.7.2.2.1 Unloading the NUHOMS®-MP197HB Cask to a Suitable Overpack.
	A.7.4 Other Operations *A.7.4.1 Cask Cavity Vacuum Drying and Dryness Verification Test*	SAR change: Chapter A.7 is provided with changes marked.See **Page A.7.11** Justification: Cask cavity and dryness verification operations added.
	Appendix A.7.7.10 Radioactive Waste Canister (**RWC**) Wet Loading Procedures	SAR change: Appendix 7.7.10 is provided with changes marked. Justification: Loading, drying, and sealing operations specific to RWC-DD configuration.
	A.7.1.2.2 Preparing the NUHOMS®-MP197HB Cask for Downending A.7.1.2.3 NUHOMS®-MP197HB Cask Downending	SAR: **Pages A.7-4, A.7-6** Replace *. . . place a cask spacer ring at the top of the aluminum sleeve as shown on DrawingMP197HB-71-1004, Chapter A.1, Appendix A.4.1.10.* with *. . .remove the unloading flange* Justification: A previous step installed the unloading flange, which prevents the sleeve from sliding out, so this step had to be remove it prior to installing the lid. The spacer ring is a separate component that is a level of detail not required to understand operations in Chapter A.7.

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Item	Chapter/Appendix/ Section	Description and Justification
	Chapter A.8	**Acceptance Tests and Maintenance Program**
B.1-11	A.8.2.3.3 Valves, Rupture Discs, and Gaskets on Containment Vessel A.8.2.3.3 (con't)	Description of design change: a) Allow use of a ram access plate design that uses elastomeric seals for RWC shipments instead of the metallic seals required for DSC shipments. b) Allow reuse of elastomer O-ring seals, inspect for each use, and verify replacement with last 12 months. c) Allow reuse of metallic seals for shipping MP197HB empty SAR change: Chapter A.8 is provided with changes marked. See **Page A.8-16**. Justification: a) Ram access temperatures with RWC-DD contents are below the service temperature limit for elastomer O-rings. b) The radiation dosage level remains below 10^6 rad, a level normally attained after years of operation. Practically all elastomers suffer no change of their physical properties at radiation levels up to 1 M rad. Elastomer o-ring seals are inspected for each shipment and replaced within 12 months of a shipment. c) 49 CFR 173.428, Empty Class 7 (radioactive) materials packaging, requires only that package is securely closed so that there will be no leakage of Class 7 (radioactive) material under conditions normally incident to transportation. No leakage test is required.

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B.2Internal Sleeve

Item	Chapter/Appendix/ Section	Description and Justification
	Chapter A.1	General Information
B.2-1		Description of change: Aluminum and steel materials are used for inner sleeve design that is intended for use with the RWC only. The material used for the sleeve that is used with the DSCs and RWC is described in the Appendices for Chapter A.1 that describes each DSC and RWC (Appendices A.1.4.2 through A.1.4.9A).
	A.1.2 Package Description A.1.2.1 Packaging	SAR: *Because there are two different outside diameters (ODs) for the DSCs and secondary containers, an ~~**aluminum**~~ inner sleeve is used for smaller diameter DSCs and secondary containers. The inner sleeve is designed with slots to accommodate the existing rails inside the cask and to provide rails inside the sleeve on which the smaller diameter DSCs or secondary containers slide during horizontal loading or unloading of the cask.* Chapter A.1 is provided with changes marked. See **Page A.1-.2** Justification: Delete the material used for inner sleeve in the general description.
	A.1.2.1.1 NUHOMS®-MP197HB Transport Cask	SAR (no changes required): **Page A.1-3** *The overall dimensions of the* NUHOMS®*-MP197HB packaging are 271.25 inches long and 126.00 inches in diameter with both impact limiters installed. The transport cask body is 210.25 inches long and 84.50 inches in diameter. [more]….. The minimum length of cask cavity is 199.25 inches and 70.50 inches in diameter without the sleeve or 68 inches with the sleeve. Detailed design drawings for the* NUHOMS®*-MP197HB packaging are provided in Appendix A.1.4.10, Section A.1.4.10.1. The materials used to fabricate the packaging are shown in the Parts List on Drawing MP197HB-71-1002. Where more than one material has been specified for a component, the most limiting properties are used in the analyses in the subsequent sections of this appendix to the SAR.* Justification: Inner sleeve intended for use only with the RWC has an inner diameter that maintains the 68 inch dimensions.

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Item	Chapter/Appendix/ Section	Description and Justification
	Appendix A.1.4.1 NUHOMS®-24PT4 DSC A.1.4.1.1 NUHOMS®-24PT4 DSC Description **Appendix A.1.4.2 NUHOMS®-32PT DSC** A.1.4.2.1 NUHOMS®-32PT DSC Description **Appendix A.1.4.3 NUHOMS®-24PTH DSC** A.1.4.3.1 NUHOMS®-24PTH DSC Description **Appendix A.1.4.7 NUHOMS®-61BT DSC** A.1.4.7.1 NUHOMS®-61BT DSC Description **Appendix A.1.4.8 NUHOMS®-61BTH DSC** A.1.4.8.1 NUHOMS®-61BTH DSC Description	SAR (no changes required): *Under normal transport conditions, the canister rests on four canister rails, attached to the inside surface of the **aluminum inner sleeve** of the transport cask.* Justification: Aluminum inner sleeve intended for use with DSCs remains unchanged.
	Appendix A.1.4.9A adioactive Waste Canister A.1.4.9A.1 Radioactive Waste Canister Description	SAR: *Under normal transport conditions, the canister rests on four canister rails, attached to the inside surface of the **~~aluminum~~ inner sleeve** of the* NUHOMS®*-MP197HB transport cask.* Appendix A.1.4.9A is provided with changes marked.See **Page A.1.4.9A8-1.** Justification: Remove reference to material of construction. Changes to sleeve design have no impact on technical evaluations or operations.
	Appendix A.1.4.10 NUHOMS®-MP197HB SAR Drawing **MP197HB-71-1014**	SAR: *MP197HB-71-1014 Rev 1* NUHOMS®*-MP197HB Packaging Internal Sleeve Design ~~(2 sheets)~~ **(1 sheet)*** Appendix A.1.4.10 is provided with change marked. See **Page A.1.4.10-1.** Justification: Drawing MP197HB-71 -1014 revised to show options for materials.

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Item	Chapter/Appendix/ Section	Description and Justification
	Chapter A.2	**MP197HB Structural Evaluation**
B.2-2		Description of change: Aluminum and steel materials are used for inner sleeve design that is intended for use with the RWC only. Drawing MP197HB-71 - 1014 revised to show options for materials.
	A.2.1.1.1 Transportation Package (Cask)	SAR (no change required): **Page A.2-2** *The external fin and **internal sleeve** are shown on drawings MP197HB-71-1011 and -1014.*
	A.2.6.1.2 Differential Thermal Expansion	SAR (no change required): ***Page A.2-20*** *The thermal expansion evaluations of the MP197HB cask cavity and DSCs in both the radial and the axial directions are described in Appendix A.2.13.10. Based on the results of these analyses, there is adequate clearance between the various components of the DSC and cask to allow free thermal expansion. Consequently, no significant stress will develop in the NUHOMS-MP197HB transport cask due to thermal expansion. The following table summarizes the thermal expansion calculation results from the above analyses.* (This table is shown on Page A.2-20 of Chapter A.2.)
	Table A.2.13.8-39	SAR (no change required): **Page A.2.13.8-72** Summary of Spacer **Sleeve** Analysis from End Drops.
	A.2.13.8.7 NUH24PTH A.2.13.8.7.1 Basket Side Drop A. Finite Element Model	SAR (no change required): **Page A.2.13.8-15** *The gap elements (CONTACT 52) are used to simulate the interface between the fuel compartments, basket rails and the inner side of the canister as well as between the outer side of the canister and the inside of the cask/**sleeve** or **sleeve** rails (for 180-degree drop). Each gap element contains two nodes; one on each surface of the structure. The gap nodes specified at the inner side of the cask/**sleeve** and **sleeve** rails are restrained in the x, y and z*

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	A.2.13.8.7.1 (con't)	*directions. The gap size at each gap element is determined by the difference between the basket rails radius and the inside radius of the DSC shell; and by the difference between the outer side of the DSC shell radius and the inside radius of the cask/**sleeve** or **sleeve** rails.*
	Appendix A.2.13.10 MP197HB Transport Package Thermal Expansion Evaluation A.2.13.10.1, Purpose, A.2.13.10.2 Radial Thermal Expansion, A.2.13.10.4 Results and Conclusions	SAR (no change required): *Volumetric average temperatures of the DSC shell, transport cask inner shell and **sleeve** are obtained using ANSYS [1] from 100°F ambient NCT thermal analysis results from Chapter A.3. The results are listed in the following table. The average volumetric temperatures for DSC shell, MP197HB **sleeve** and inner shell from the hottest cross section of the DSC are used in computing the radial hot gaps. Axial hot gaps are computed using the average volumetric temperature computed over the full length of the DSC*
	Appendix A.2.13.10 (con't)	*shell and TC inner shell.* (This table is shown on Page A.2.13.10-1.) Justification: The OD of the DSC after thermal expansion is 67.458 inch Section A.2.13.10.2. The ID of the sleeve is 68 inch there is no impact due to changing material. The OD of the RWC after thermal expansion would be smaller due to the lower heat load and temperatures.
	Chapter A.3	**Thermal Evaluation**
B.2-3		Description of change: Aluminum and steel materials are used for inner sleeve design that is intended for use with the RWC only. Inner and outer diameters of the cask sleeve remains unchanged (ID_{sleeve}=68 *in* and OD_{Sleeve} = *70.5 in.*).
	A.3.1.1 Design Features A.3.1.1.1 MP197HB TC	SAR (no change required): **Page A.3-3** *The MP197HB transport cask includes optional features such as an aluminum **internal sleeve** to accommodate DSC types with outer diameters smaller than 69.75" and an aluminum shell with external circular fins. The external circular fins are used for heat loads greater than 26 kW. The TC design features for different DSC types .... in MP197HB TC are listed in the table below.*

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Item	Chapter/Appendix/ Section	Description and Justification
	Figure A.3-12	*Assumed Geometry of **Internal Sleeve** in Thermal Model.* (Figure A.3-12 is shown on Page A.3-194.)
	A.3.2 Material Properties and Component Specifications A.3.2.1 Material Properties	**Page A.3-22** *26. Radial Effective Conductivity for Helium in DSC Shell/TC **Internal Sleeve** Gap* *(See Section A.3.3.1.3 for calculation of effective properties)* **Page A.3-26** *31. Effective Conductivity of **Internal Sleeve*** *(See Section A.3.3.1.3 for calculation of effective properties)*
	A.3.3 Thermal Evaluation under Normal Conditions of Transport A.3.3.1 Thermal Models A.3.3.1.1 MP197HB TC Model	**Page A.3-31** *Radiation heat exchange is considered between the DSC and the cask inner shell/**internal sleeve** by calculating effective conductivities for helium in this region.* *The following gaps are considered in the MP197HB TC model:* *h) 0.01" radial gaps between the cask inner shell and aluminum sleeve,* **Page A.3-33** *Radiation and conduction between the DSC and the TC inner shell / **internal sleeve** is considered by calculating effective conductivities for helium gaps between the components listed above.* **Page A.3-35** *During transportation, the DSC shell rests on four slide rails in the TC. These rails are Nitronic 60 stainless steel plates welded to the inner shell of the TC. The thickness of the slide rail is 0.12" when no **internal sleeve** is used. The slide rail at the 180 ° orientation is 0.06" thick and is not in contact with the DSC shell. The same configuration is considered for the small diameter DSC and the **internal sleeve**.* **Page A.3-36 and 37** *To reduce the complexity of the model, effective conductivities are calculated for the internal sleeve in axial and radial directions. The methodology to calculate the effective conductivity of the **internal sleeve** is described in Section A.3.3.1.3. These effective conductivities are conservative since the number and the assumed gaps between the internal sleeve pieces are larger than those*

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Item	Chapter/Appendix/ Section	Description and Justification
	A.3.3.1.1 MP197HB TC Model (con't)	*considered for the proposed **internal sleeve**.*
	A.3.3.1.3 Effective Thermal Properties in MP197HB TC Model	**Page A.3-46** *2) Effective Conductivity for Helium Gap between DSC and TC/Sleeve* *Effective conductivities are calculated for helium between the DSC and the TC inner shell /**internal sleeve** to account for conduction and radiation between these components. Based on discussion in Section A.3.2.1, a conservative emissivity of 0.587 is considered for the DSC shell and TC inner shell.* *The inner surface of the **internal sleeve** is anodized. Based on discussion in Section A.3.2.1, a conservative emissivity of 0.7 is considered for the anodized/painted surface of the **internal sleeve**.* **Page A.3-47** *As shown in Section A.3.3.1.1, the gap size between the 61BTH or 61BT DSC shell and the **internal sleeve** is equal to the gap size between the large diameter DSC shells (69BTH, 37PTH, 32PTH, and 32PTH1) and the TC inner shell. Since the assumed emissivity of 0.587 for TC inner shell is lower than the emissivity of anodized aluminum, the above effective conductivity calculated for the gap between the large diameter DSC and TC inner shell can be used conservatively for the gap between the DSC and the **internal sleeve** for DSC types 61BTH and 61BT.* *For small diameter DSC types, 32PT, 24PTH, and 24PT4, an effective conductivity is calculated for the gap between the DSC shell and TC **internal sleeve** using the same methodology described above with the following data.* $Di_{,sleeve}$ *= inner diameter of TC **internal sleeve** = 68.0"* $Do_{,DSC}$ *= outer diameter of small diameter DSC types = 67.19"* ε_{dsc}*= 0.587 (emissivity of steel or stainless steel, see Section A.3.2.1)* ε_{Sleeve}*= 0.7 (emissivity of anodized aluminum, see Section A.3.2.1)* *The effective conductivity values for the helium within the gap between the small DSC shell and the TC **internal sleeve** are listed in Section A.3.2.1, material # 26.* *This analysis uses the effective conductivity values from Section A.3.2.1, material # 26 for the gaps between the DSC shell and TC **internal sleeve** for 32PT, 24PTH, and 24PT4 DSC types only in*

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	A.3.3.1.3 Effective Thermal Properties in MP197HB TC Model (con't)	*radial direction. The conductivity in axial direction is set equal to helium conductivity for conservatism.* **Page A.3-49 and 50** ***5) Effective Conductivity for <u>Internal Sleeve</u>*** *The designed shape of the aluminum internal sleeve is shown in the drawings in Chapter A.1, Appendix A.1.4.10. As seen in this drawing, there is virtually no gap between the segments of the **<u>internal sleeve</u>**. A different shape is considered for the **<u>internal sleeve</u>** in the TC model. The assumed shape includes 120 individual aluminum pieces with 39 radial gaps and three axial gaps. The thicknesses of the radial and axial gaps are respectively 0.25" and 0.188" as shown in Figure A.3–12. In addition, the material properties of the inner shell elements in contact with the cask slide rails are changed to those of helium to avoid any direct conduction between these two components. Since the considered shape of the **<u>internal sleeve</u>** in the TC model includes more gaps, it is conservative to use it for thermal analysis of the transport cask under NCT.* *To reduce the complexity of the TC model, an effective conductivity is calculated for the assumed shape of the **<u>internal sleeve</u>** shown in Figure A.3–12. The following dimensions are considered for the **<u>internal sleeve</u>** in the thermal model.* *Sleeve ID = 68 in.* *Sleeve OD = 70.5 in.* *Total length = 196 in.* *No. of pieces in axial direction = 4 in.* *No. of segments in radial direction = 40 in.* *Axial gap = 0.188 in.* *Radial gap = 0.25 in.* ***Axial Effective Conductivity*** *Along one segment of the **<u>sleeve</u>**, there are four sections of aluminum pieces with 0.1875" gaps between them in the axial direction (see Figure A.3–12, at bottom). The thermal resistance through these serial pieces is:* *…(equations)* *Rearranging the above equations gives:* *…(equations)*

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	A.3.3.1.3 Effective Thermal Properties in MP197HB TC Model (con't)	*The axial segments are parallel to each other. Due to low conductivity of helium in comparison to aluminum, helium conductivity can be conservatively ignored. The total axial effective conductivity is then proportional to the ratio of the surface area for the aluminum segments in cross section to the total cross-sectional area of the **internal sleeve**, which is equivalent to the ratio of aluminum segment angle to the nominal angle (see Figure A.3–12).* **Page A.3-51** **Radial Effective Conductivity** ... (equation) *The effective conductivity values calculated for the **sleeve** are summarized in Section A.3.2.1, material # 31.*
	A.3.3.3 Maximum Normal Operating Pressure A.3.3.3.1 MP197HB TC Operating Pressure	**Page A.3-74,** *Length of the **sleeve** is conservatively assumed equal to the length of the TC cavity.* **Page A.3-75** *Table "**Data used in Calculation of Maximum Pressures in TC Cavity"*** **Page A.3-76** *ID_{sleeve}, Inner diameter of the cask sleeve for DSCs with **sleeve**, in*
	A.3.4.2 Fire Test Conditions	**Page A.3-88** *The following modifications are considered for the MP197HB TC model to maximize the heat input from the fire toward the cask during fire period and bound the maximum temperatures during the cool-down period.* *c) As noted in Section A.3.3.1.1, axial and radial gaps are considered for the **internal sleeve**. These gaps are removed during the fire period by changing the material properties of the **internal sleeve** to those of aluminum 6061. The assumed gaps within the **internal sleeve** are restored for the cool-down period by changing its material properties to the effective values calculated in Section A.3.4.2.1.*

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Item	Chapter/Appendix/ Section	Description and Justification
	A.3.4.2 Fire Test Conditions (con't)	**Page A.3-91** *Based on thermal analysis presented in Section A.3.3.1.1 and results shown in Table A.3–8 and Table A.3–9 for NCT, the maximum seal temperatures of MP197HB TC are bounded by the 69BTH DSC with 32 kW heat load in TC with external fins, the 69BTH DSC with 26 kW heat load in TC without* ***internal sleeve****, and the 24PTH DSC with 26 kW heat load in TC with an* ***internal sleeve*** *and without external fins.*
	A.3.4.2.1 Effective Properties in the MP197HB TC HAC Model	**Page A.3-93, 94** ***Effective Density for the Cask Internal Sleeve*** *The effective conductivities for the cask* ***internal sleeve*** *were calculated in Section A.3.3.1.3. Since no density and no specific heat is considered for helium, the specific heat for the* ***internal sleeve*** *is equal to specific heat of aluminum.[more]* Justification: The decay heat load for an RWC is expected to be less than 5 kW which is well below the 26 kW limit for the DSCs transported in the MP197HB TC with the inner sleeve design. The impact of the inner sleeve design change on temperatures remains bounded by the design basis thermal evaluation in Chapter A.3 for the 26 kW heat load using only aluminum for the sleeve material.
	A.3.6.4 Acceptance Criteria for Coating Damages for MP197HB TC	**Page A.3-107** *The finite element models of the MP197HB TC described in Section A.3.3.1.1 containing 69BTH DSC are used in this evaluation for cases when no* ***internal sleeve*** *is used. The un-finned MP197HB TC model is used with the maximum heat load of 26 kW and the MP19HB TC model with external fins is used with the maximum heat load of 32 kW. These models represent the maximum heat loads when no* ***inner sleeve*** *is used in MP197HB TC.* *The finite element model of the MP197HB TC described in Section A.3.3.1.1 with 24PTH DSC is used for the case that an* ***internal sleeve*** *is used to load a small diameter DSC. This model with the maximum heat load of 26 kW represents the maximum heat load when an* ***internal sleeve*** *is used in MP197HB TC.*

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Item	Chapter/Appendix/ Section	Description and Justification
	A.3.6.4 Acceptance Criteria for Coating Damages for MP197HB TC (con't)	**Page A.3-108, 109** ***Large Areal Damage – Case 1*** *It is considered that the area of the damaged anodized coating is 250 in^2 for the anodized surface of the **internal sleeve**, 500 in^2 for the painted shield shell, and 2,000 in^2 for the coated surface of the external fins. The damaged coating area is located at the top of the cask in the middle of the maximum peaking factor region to maximize its effect on the DSC shell and fuel cladding temperatures.[more]* **Page A.3-113** **Scattered Multiple Scratches and Small Peel-off Spots – Case 2** *Since the temperature rises are limited to 1 °F, the effects of the coating damages on the thermal and structural performance of MP197HB are insignificant, if the accumulated coating damages are limited to:* • *2,000 in^2 for coating on external fins,* • *500 in^2 for paint on shield shell, and* • *250 in^2 for coating on **internal sleeve**.* Justification: The internal sleeve for use with RWC has no coatings.
	Chapter A.6	**Criticality Evaluation**
B.2-4	Figure A.6.5.5-6 Criticality Calculational KENO Model Figure A.6.5.6-7 *Criticality Calculational KENO Model*	Description of change: Aluminum and steel materials are used for inner sleeve design that is intended for use with the RWC only. SAR (no change required): Figures on page A.6.5.5-36 and A.6.5.6-36 show the aluminum sleeve material in the canister-cask gap. Justification: Contents for RWC in non-fissile or fissile excepted. Criticality evaluation applies only to DSCs. Changes to sleeve design have no impact on criticality safety evaluation.

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Item	Chapter/Appendix/ Section	Description and Justification
	Chapter A.7	**Package Operations**
B.2-5	A.7.1.1 NUHOMS®-MP197HB Cask Preparation for Loading A.7.1.2.2 Preparing the NUHOMS®-MP197HB Cask for Downending A.7.1.3 NUHOMS®-MP197HB Cask Dry Loading (Transferring a Loaded DSC or RWC from an Overpack into an MP197HB Cask) A.7.2.2.2 Unloading the NUHOMS®-MP197HB Cask to a Fuel Pool	<u>Description of change:</u> Sleeve may be made entirely of aluminum or a combination of aluminum and stainless steel. Replace "aluminum sleeve" with "sleeve" where referenced for package operations. <u>SAR:</u> Chapter A.7 is provided with changes. See **Pages A.7-2, A.7-4, A.7-6, and A.7-10.** <u>Justification:</u> Changes to sleeve design have no impact on operation. Refer to sleeve without reference to material of construction.

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B.3Fabrication and Operations

Item	Chapter/Appendix/ Section	Description and Justification
	Chapter A.1	**General Description**
B.3.1-	MP197HB-71-1001 SHEET 1 OF 2 MP197HB-71-1004 SHEET 1 OF 1 A-7 MP197HB-71-1006 SHEET 1 OF 1 MP197HB-71-1009 SHEET 1 OF 1	Description of changes: Delete General Note 9, Renumber notes 15 and 16 to be notes 9 and 10. 9. ALL MACHINED SURFACES TO BE 250 RMS, UNLESS OTHERWISE SPECIFIED Delete125 RMS surface finish specification from item 12 in Detail E. Delete General Note 4 4. ALL MACHINED SURFACES TO BE 250 RMS, UNLESS OTHERWISE SPECIFIED Justification: Surface-finish specifications for closure devices for the containment system are included in the drawings. All seal contact surfaces are stainless steel and are machined to a 32 RMS or finer surface finish. Outer shell or outer packaging surface-finish is specified in Note 4 on MP197HB-71-1001 as a painted surface, except for stainless steel surfaces. The painted surface specification permits control of radioactive contamination on the external surfaces of the package as low as is reasonably achievable (ALARA), and within the limits specified in DOT regulation 49 CFR 173.443. [10 CFR 71.87(i)]. Stainless steel components that are not painted are polished. This change does not affect the performance of the cask.
B.3-2	MP197HB-71-1001 SHEET 1 OF 2, 2 OF 2 MP197HB-71-1002 SHEET 1 OF 2, 2 OF 2 MP197HB-71-1003 SHEET 1 OF 1 MP197HB-71-1004 SHEET 1 OF 1 MP197HB-71-1005 SHEETS 1, 2, AND 3, OF 3	Description of change: Dimensions on the engineering drawings included in the general description are depicted as a nominal size with no tolerance, nominal size with a specific tolerance, or reference dimension. Dimensions not used for manufacturing or inspection and not important to package performance are provided as reference information to assist in reviewing the package evaluations. Reference dimensions are indicated by enclosing the dimension value in parentheses. Dimensions details, and information that are not relevant to the package evaluation are removed from the drawings.

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Item	Chapter/Appendix/ Section	Description and Justification
	MP197HB-71-1006 SHEET 1 OF 1 **MP197HB-71-1007 SHEET 1 OF 1** **MP197HB-71-1008 SHEET 1 OF 1** **MP197HB-71-1009 SHEET 1 OF 1** **MP197HB-71-1011 SHEET 1 OF 1**	Justification: Dimensions are provided to specify design features in sufficient detail to assure that the package which conforms to the drawing specifications will be consistent with the design evaluated in the application. This change does not affect the performance of the cask.
B.3-3	**MP197HB-71-1001 SHEET 2 OF 2**	Description of change: Add note: "DESIGN FEATURES FOR THE TRANSPORT FRAME MAY VARY FROM THE GENERAL REPRESENTATION SHOWN ON THIS DRAWING. THE GENERAL REPRESENTION OF THE TIE-DOWN SYSTEM IS INTENDED ONLY TO INDICATE THE ATTACHMENT POINTS TO THE PACKAGE." Justification: The transport frame is shown a s a general representation of the tie-down system for the package. The transport frame is the connecting component between the package attachment points and conveyance ancho points, and does not contribute to the package performance. The attachment points on the package are designed to meet the tie-down requirements in 10 CFR 71.45 (b). The general representation provides flexibility to allow changes to the transport frame with prior NRC approval.
B.3-4	**MP197HB-71-1004 SHEET 1 OF 1 G-2**	Description of change: Add holes for alignment targets to View A-A and add Note 1-" Holes for alignment targets may be added as required. Maximum depth 0.50". Justification: *Alignment targets required for operations.* This change results in the insignificant removal material and is not expected to alter the structural, thermal, and shielding performance of the cask.

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Item	Chapter/Appendix/ Section	Description and Justification
B.3-5	MP197HB-71-1004 SHEET 1 OF 1	Description of change: Add the hydraulic ram frame holes into section A-A of drawing MP197HB-71-1004 Justification: Hydraulic ram frame holes are necessary for operations. This change results in the removal of roughly 0.04% of the bottom material maximum and is not expected to alter the structural, thermal, and shielding performance of the cask.
B.3-6	MP197HB-71-1005 SHEET 3 OF 3 G-8	Description of change: a) Add lifting & handling holes to item 33 (ram access cover plate). b) Add new (diamond) note to state "ALTERNATE LIFTING/HANDLING HOLES QUANTITY AND PATTERN MAY BE USED BY FABRICATOR WITH WRITTEN TN APPROVAL. THREAD LUBRICATION IS PERMITTED." Add note callout to the lifting holes callouts described above. Justification: Handling/lifting holes are needed on this item during fabrication and operations. This change does not affect the performance of the cask.
B.3-7	MP197HB-71-1005 SHEET 2 OF 3 D8-D4	Description of change: Update items 14 and 63 to scale lip on trunnions, and 'min' to one trunnion dimension. Justification: Lip diameter might interfere with lifting yoke. Shoulder diameter might exceed client specification with current tolerances. This change does not affect the performance of the cask.
B.3-8	MP197HB-71-1002, MP197HB-71-1005 SHEET 1 OF 3 G-1	Description of change: Recess neutron shield pressure relief valve (item 66) inside the neutron shield as follows: a) Add new item (69) to drawing MP197HB-71-1002, quantity 1, nomenclature "valve adaptor", material ASME SA-240 Type 304, quality category A, code criterion NF. b) Update section E-E of drawing MP197HB-71-1005 to show the valve (item 66) recessed within the neutron shield using this new item 69 so that the tip of the valve is flush with the outer surface of

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		item 10. Item 69 to be welded to item 10 using an all-around 1/4" groove weld. Justification: To prevent interference with impact limiter (the gap between the end of the neutron shield shell and impact limiter is only ½"). This change would result in the local removal of approximately 3 cubic inches of neutron shielding, out of a total of roughly 270,000 cubic inches, which represents roughly 0.001% of the neutron shielding and is negligible. Furthermore, this removal occurs towards the ends of the cask, away from the center of the fuel active region. Therefore, this change is not expected to have any detrimental effect on design, either for neutron shielding or heat removal. This change does not affect the performance of the cask
B.3-9	**MP197HB-71-1002,** **MP197HB-71-1005 SHEET 1 OF 3**	Description of change: Add new item (70, lifting/handling boss) to shear key plug as follows: a) Add new item (70) to drawing MP197HB-71-1002, quantity 2, nomenclature "shear key plug lifting / handling boss," material SST, quality category NITS, code criterion NON-CODE. b) Add new items 70 to the shear key plug detail on drawing MP197HB-71-1005. Each item 70 to be welded to item 30 using a ¼" all-around groove weld. Justification: A handling/lifting interface is needed on this item during fabrication and operations. This change would result in the local removal of approximately 3.1 cubic inches of neutron shielding, out of a total of roughly 270,000 cubic inches, which represents roughly 0.001% of the neutron shielding and is negligible. It is not expected to result in a significant increase of the dose rate received by the people working on the cask. Therefore, this change is not expected to have any detrimental effect on design, either for neutron shielding or heat removal. This change does not affect the performance of the cask.

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Item	Chapter/Appendix/ Section	Description and Justification
B.3-10	MP197HB-71-1002 SHEET 1, 2 OF 2 MP197HB-71-1005 SHEET 3 OF 3	Description of change: Add elastomer seals design in the ram access cover plate at the bottom of the cask, as an authorized alternative to the metallic seal when shipping RWC contents. Added note 3 to MP197HB-71-1002 to allow use of elastomer O-ring with alternate ram access cover plate shown on MP197HB-71-1005. Justification: A metallic seal must be replaced every time the ram access cover plate is opened. Not only are these seals very expensive, but using a new one every time also requires the leak test to be performed at maintenance levels. Elastomer seals are much may be reused multiple times thus allowing assembly criteria with less sensitive leak test methods. The heat load of the RWC contents is very low, and will result in almost no temperature elevation at the location of the ram access bottom plate seal. A metallic seal is only required at higher temperatures for DSC shipments. Therefore, the elastomer seals design is adequate when shipping RWCs. This change does not affect the performance of the cask
B.3-11	MP197HB-71-1006 SHEET 1 OF 1 F-6	Description of change: Add lifting & handling holes to the lid as follows: a) Include the details for the lid lifting & handling holes, and assign note 7 to all hole callouts. b) New note to read "ALTERNATE LIFTING/HANDLING HOLES QUANTITY AND PATTERN MAY BE USED BY FABRICATOR WITH WRITTEN TN APPROVAL. THREAD LUBRICATION IS PERMITTED." Justification: The lid needs lifting features so that they can be handled during fabrication and operation. This change does not affect the performance of the cask.
B.3-12	MP197HB-71-1002 MP197HB-71-1003 MP197HB-71-1004	Description of change: Change test port bolts from hex head to socket head bolts. Replace brass material specification with ASTM B36. Update cask ports bolts / plugs design features as follows: a) For items 40 and 60 on drawing MP197HB-71-1002: mention only "port bolt" in the nomenclatures/descriptions, and replace "brass" with "ASTM B36" in the material specifications.

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Item	Chapter/Appendix/ Section	Description and Justification
	MP197HB-71-1005 SHEET 3 OF 3 E-1, B8- B6 MP197HB-71-1006 SHEET 1OF 1 C8-C2	b) Update all ports details on drawings MP197HB-71-1003, MP197HB-71-1004, MP197HB-71-1005 and MP197HB-71-1006 with updated item 39 and socket head bolts instead of hex heads. Justification: a) The reason for the change to the vent/drain/test port plug fastener from a hex head to a socket head is for compatibility with the helium leak test tool that will be used during operations for cask cavity evacuation, helium filling and leak testing. The helium leak test tool will utilize a hex key (in lieu of a hex socket) to perform various stages of tightening and loosening of the vent/drain/test port plugs during leak testing. The thread size, thread engagement, and required torque during tightening are unaffected by this change. There is no adverse impact to the plug's capability to meet the leak tightness acceptance criterion specified in the SAR, and hence no adverse impact to the confinement design function as a result of this change. b) ASTM B36 has been reviewed and found to be an acceptable material for this application. c) The purpose of item 39 is to protect the port bolt during transportation. Item 39 is a NITS item. d) This change does not affect the performance of the cask.
B.3-13	MP197HB-71-1008 SHEET 1 OF 1 D-1, F-1	Description of change: Lengthen the impact limiter bolt to ensure it fully engages in its threaded hole and clarify note 18. Added description to indicate threaded holes for thermal shield (item 58). Justification: The first change positions the threads of the impact limiter attachment bolts fully inside the threaded inserts (items 18) in order to fully engage the threads in order to reach the required thread engagement length. The clarification on note 18 provides flexibility to make any required adjustments needed on the bolt taper. This change does not affect the performance of the cask.The second change indicates the purpose of the feature shown on view A-A of the impact limiter.

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Item	Chapter/Appendix/ Section	Description and Justification
B.3-14	**MP197HB-71-1008 SHEET 1 OF 1 B-6** **MP197HB-71-1009 SHEET 1 OF 1 F-7**	Description of change: Dimensions indicated on the drawing are incorrect; shifting the bolt tube plug welds by 1 inch positions them more evenly along their length. Correct the length of item 23F, the length of item 23T in detail K, the opening in item 23C, and the distance to the first plug weld on MP197HB-71-1009. Based on the corrections, update note 15 on MP197HB-71-1008. Justification: This change fixes dimension errors and ensures that the plug welds are more evenly positioned along the length of item 23V. This change does not affect the performance of the cask.
B.3-15	**MP197HB-71-1002**	Description of change: Change material of item 23K (impact limiter fusible plug) in MP197HB-71-1002 to "RILSAN BMG G8 OR NYLON." Justification: The current specification for the fusible plug's material is steel, but this plug is meant to melt during a fire event to prevent pressure build-up within the impact limiter shell. A steel fusible plug does not meet the design intent. Using a nylon-like material with a melting temperature below 300C fulfills the design intent. This change also provides sufficient information to fabricate the part. This change does not affect the performance of the cask.
B.3-16	**MP197HB-71-1002 SHEET 2 OF 2** **MP197HB-71-1005 SHEET 2 OF 3**	Description of change: Add lifting features to trunnion plugs. Justification: The trunnion plugs need lifting features so that they can be handled during fabrication and operation. The use of item 67 is not necessary because the neutron absorbing material within each trunnion plug is securely seal-welded within its SST shell. The amount of neutron shielding material removed to install the threading boss is very small compared to the total volume of neutron shielding in the cask. Therefore, this change will have no significant effect on the dose rates around the cask. This change does not affect the performance of the cask.
B.3-17	**MP197HB-71-1002**	Description of change: Allow the use of metric-equivalent thickness plates for the

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Item	Chapter/Appendix/ Section	Description and Justification
		fabrication of the impact limiters. Justification: The option to use metric-equivalent thickness plate for MP197HB impact limiters is needed to fabricate the impact limiters in other countries. The resulting thickness variations are very small and will have no impact on the package performance since the wood absorbs over 90% of the impact energy. The small difference between US customary units and metric equivalents on the steel dimensions is bounded by the uncertainties due to the range of wood properties. This change does not affect the performance of the cask.
	Chapter A.2	**Structural Evaluation**
B.3-18	MP197HB-71-1002 A.2.1.1.1 Transportation Package (Cask) (A.2-3) A.2.5.1 Lifting Devices Appendix A.2.13.2 MP197HB Cask Lid Bolt Analysis Appendix A.2.13.5 MP197HB Cask Lifting and Tie Down Devices Structural Evaluation Appendix A.2.13.12 MP197HB Transport Package Impact Limiter Analysis Using LS-DYNA Appendix A.2.13.14 MP197HB Lid Closure Evaluation Due to Delayed Impact Chapter A.4 Containement A.4.1.5 Closure	Description of change: Add flexibility to SAR to allow B23 or B24 for the grade of material allowed for lid bolts, ram access cover bolts, and trunnion bolts for MP-197HB. All references to SA-540 Gr. B23 Cl.1 are revised to add Gr. B24 Cl.1 SAR Page A.2-16A is provided with the change marked. Pages A.2.13.2.1, A.2.13.2-4, A.2.13.2-13, A.2.13.2-15, A.2.13.2-18, A.2.13.2-30, and A.2.13.2-31 are provide with the change marked. Page A.2.13.5-18 is provided with the change marked. Pages A.2.13.12-10 and A.2.13.12-18 are provided with the change marked. Page A.2.13.14-5 is provided with the change marked. Chapter A.4 is provided with the change marked. See **Page A.4-3**

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Item	Chapter/Appendix/ Section	Description and Justification
		Justification: Design stress values for bolting materials for ASME BPVC Subsection NB (Section III, Class 1) are found in Section II, Part D, Table 4 for SA-540, B23 and B24, Class 1. Table 3 provides stress values for Subsection NF (Section III, Class 3). The design stress values are the same for Type/Grade B23 and B24, and are the same values in Table 3 and Table 4. Excerpts from Table 4 as follows show that the stress intensity values are the same for Grade B23 and B24. The technical evaluations specify SA-540 Gr B24 Cl. 1 steel for bolts used on the trunnions, lid, and ram access cover. Specifying B23 or B24 allows suppliers more flexibility in meeting material requirements including tests for fracture toughness at -40 °F. The difference in composition may affect the fracture toughness.

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TABLE 4 (CONT'D)
SECTION III, CLASS 1 AND SECTION VIII, DIVISION 2*
DESIGN STRESS INTENSITY VALUES S_m FOR BOLTING MATERIALS
(*Use With Appendices 4, 5, and 6 of Section VIII, Division 2)

Line No.	Nominal Composition	Spec No.	Type/ Grade	Alloy Designation/ UNS No.	Class/ Condition/ Temper	Size/ Thickness, in.
	Ferrous Materials (Cont'd)					
1	2Ni–3/4Cr–1/3Mo	SA-540	B23	H43400	4	≤9 1/2
2	2Ni–3/4Cr–1/3Mo	SA-540	B23	H43400	3	≤9 1/2
3	2Ni–3/4Cr–1/3Mo	SA-540	B23	H43400	2	≤9 1/2
4	2Ni–3/4Cr–1/3Mo	SA-540	B23	H43400	1	≤8
5	2Ni–3/4Cr–1/3Mo	SA-540	B24	K24064	5	6<t≤9 1/2
6	2Ni–3/4Cr–1/3Mo	SA-540	B24	K24064	3	6<t≤9 1/2
7	2Ni–3/4Cr–1/3Mo	SA-540	B24	K24064	5	≤6
8	2Ni–3/4Cr–1/3Mo	SA-540	B24	K24064	4	≤9 1/2
9	2Ni–3/4Cr–1/3Mo	SA-540	B24	K24064	3	≤9 1/2
10	2Ni–3/4Cr–1/3Mo	SA-540	B24	K24064	2	≤9 1/2
11	2Ni–3/4Cr–1/3Mo	SA-540	B24	K24064	1	≤8

PART D — PROPERTIES (CUSTOMARY) Table 4

TABLE 4 (CONT'D)
SECTION III, CLASS 1 AND SECTION VIII, DIVISION 2*
DESIGN STRESS INTENSITY VALUES S_m FOR BOLTING MATERIALS
(*Use With Appendices 4, 5, and 6 of Section VIII, Division 2)

Line No.	Min. Tensile Strength, ksi	Min. Yield Strength, ksi	Applicability and Max. Temperature Limits (NP = Not Permitted) III	VIII-2	Notes
					Ferrous Materials (Cont'd)
1	135	120	700	700	G3
2	145	130	700	700	G4
3	155	140	700	700	G4
4	165	150	600	650	G2
5	115	100	700	NP	G5
6	145	130	NP	700	G5
7	175	165	700	700	G5
8	135	120	700	700	G3
9	145	130	700	700	G4, G5
10	155	140	700	700	G4
11	165	150	600	600	G2

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Item	Chapter/Appendix/ Section	Description and Justification

Table 4 2004 SECTION II

TABLE 4 (CONT'D)
SECTION III, CLASS 1 AND SECTION VIII, DIVISION 2*
DESIGN STRESS INTENSITY VALUES S_m FOR BOLTING MATERIALS
(Use with Appendices 4, 5, and 6 of Section VIII, Division 2)

Line No.	Design Stress Intensity, ksi (Multiply by 1000 to Obtain psi), for Metal Temperature, °F, Not Exceeding									
	-20 to 100	200	300	400	500	600	650	700	750	800
	Ferrous Materials (Cont'd)									
1	40.0	38.2	36.9	35.9	34.7	33.1	...	31.1	...	...
2	43.3	41.4	40.2	38.8	37.6	35.9	...	33.7	...	...
3	46.7	44.6	43.1	41.8	40.5	38.7	...	36.3	...	...
4	50.0	47.8	46.2	44.8	43.4	41.4	...	...	...	...
5	33.3	31.8	30.9	29.8	28.9	27.6	...	25.9	...	...
6	33.3	31.8	30.7	29.8	28.9	27.6	...	25.9	...	...
7	35.0	33.4	32.4	31.3	30.3	29.0	...	27.2	...	...
8	40.0	38.2	36.9	35.9	34.7	33.1	...	31.1	...	...
9	43.3	41.4	40.2	38.8	37.6	35.9	...	33.7	...	...
10	46.7	44.6	43.1	41.8	40.5	38.7	...	36.3	...	...
11	50.0	47.8	46.2	44.8	43.4	41.4	...	...	...	...

Item	Chapter/Appendix/ Section	Description and Justification
	Chapter A.7	**Operations**
B.3-20	A.7.1.1 NUHOMS®-MP197HB Cask Preparation for Loading A.7.1.2.2 Preparing the NUHOMS®-MP197HB Cask for Downending A.7.1.3 NUHOMS®-MP197HB Cask Dry Loading (Transferring a Loaded DSC or RWCfrom an Overpack into an MP197HB Cask) A.7.4.2 Pre-shipment Verification Leakage Testing of the NUHOMS®-MP197HB Cask Containment Boundary	Description of change: Reference drawing for torque specifications. SAR: Chapter A.7 is provided with changes marked. See **Pages A.7-2, A.7-4, A.7-6a, and A.7-8.** Replace *. . . and torque them to (specified) ft-lbs following the torqueing sequence shown in Figure A.7-1.* with *. . .and torque the bolts as specified in Drawing MP197HB-71-1002, Chapter A.1, Appendix A.1.4.10.1, following the sequence shown in Figure A.7.1..* Justification: Eliminate specification of the same torque values in multiple places in the SAR.

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B.4Leak Testing **Criteria and Consideration with respect to ANSI N14.5-2014**

	Chapter/Appendix/ Section	Description and Justification
	Chapter A.4	**Containment Evaluation**
B.4-1	Chapter A.4 Containment A.4.2.3 Containment Criteria A.4.3.2 Containment Criteria Appendix A.4.1.6	Description of change: Add containment criteria for RWC contents and a calculation to specify a leak rate criteria for the RWC contents to allow test methods less sensitive than the helium leak test. SAR Change : Chapter A.4 is provided in Enclosure 2 with changes marked. See **Page A.4-4** Appendix A.4.6.1 (new) is provide in Enclosure 2 Justification: Allows flexibility for performing leak tests using methods less sensitive than the helium leak test required to demonstrate leak tightness required for DSC contents.
	Chapter A.7	**Package Operations**
B.4-2	A.7.4 Other Operations *A.7.4.2* Assembly Verification Leakage Testing of the NUHOMS®-MP197HB Cask Containment Boundary (page A.7-11a thru A.7.13, and A.7-21)	Description of change: a) Specify pre-shipment leakage test criteria and reference to A.8.2.2 for allowed .reference air leakage rate. b) Replace detailed steps for leak test procedure, including a process flow chart in Figure A.7-2, with a more generic description of the leak test operation SAR: Chapter A.7 is provided in Enclosure 2 with changes marked. See **Page A.7-11a through A.7-13, and A.7-21.** Justification: a) The acceptance criterion for pre-shipmnet leakage rate tesing shall be either (a) a leakage rate of not more than the reference air leakage rate, or (2) no detected leakage when tested to a sensitivity of at least 10^{-3} ref-cm^3/s (ANSI N14.5). b) Leakage rate testing procedures are developed and approved by personnel who have obtained the appropriate level of certification for ASNT nondestructive testing (NDT) in leak testing. Detailed steps provided previously in the SAR may not allow the flexibility for certified leak test personnel to develop procedures.

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	Chapter/Appendix/ Section	Description and Justification
	Chapter A.8	**Acceptance Tests and Maintenance Program**
B.4-3	A.8.1.4.1 MP197HB Cask Leakage Tests	Description of Change: Remove reference to Chapter A.7, Operations, for leakage testing. SAR: *The tests will be performed as described* ~~***in Chapter A.7, Section A.7.4.2.1,***~~ *in accordance with the ANSI N 14.5 [4] or ISO-12807 [11].Chapter A.8 is provide with the change marked. See* ***Page A.8-3.*** Justification: Fabrication leakage tests are performed using procedures that are written by the fabricator and reviewed for acceptance by the TN fabrication engineering.
B.4-4	A.8.2.2 Leakage Tests	Description of design change: Leak rate criteria for RWC allows a leak rate that permits use of test methods with lower sensitivity. SAR change: Chapter A.8 is provided with changes marked. See **Page A.8-15.** Justification: Allowable leakage rate for RWC contents is less restrictive than for DSC shipments.
B.4-5	Chapter A.4 Chapter A.7 Chapter A.8 (Sections detailed below)	Description of change: Revise the year edition of ANSI N14.5, "American National Standard for Radioactive Material - Leakage Tests on Packages for Shipmen" for "-1997" to "-2014" in various locations within this safety analysis report (SAR). SAR:
	Sections A.4.2.1, A.4.3.1, A.4.3.3, and A.4.5	Added the reference number "[4]" after "ANSI N14.5" and changed "-1997" to "-2014." Chapter A.4 is provided in Enclosure 2 with the chapge marked. See **Pages A.4-3 and A.4-6**.
	Section A.7.1.3 and Section A.7.5	Added the reference number "[4]" after "ANSI N14.5" and changed "-1997" to "-2014." Chapter A.7 is provided in Enclosure 2 with the change marked.

Description and Justification of Proposed Changes
(Safety Analysis Report, MP197, Revision 18A)

	Chapter/Appendix/ Section	Description and Justification
		See **Pages A.7-5b and A.7-14**.
	Section A.8.1.4.2 and Section A.8.3	Deleted "[4]"and "[11]" and added "standard in effect at the time of leak testing. Changed "-1997" to "-2014." Chapter A.8 is provided in Enclosure 2 with the chapge marked. See **Pages A.8-3 and A.8-17**. Justification for the Change: ANSI N14.5-2014 became effective in 2016. This edition did not have any effects on the analysis within the MP197HB packaging SAR. The effects of the changes to the standard from -1997 to -2014 are to the details of leak testing procedures as follows: a) Leak testing procedures would need to be approved by SNT-TC-1A leak testing level III personnel. b) Leak testing procedures would need to be performed by SNT-TC-1A leak testing Level II or III personnel. c) Helium leak test procedures would need to include provision for system calibration and dwell time determination. d) Leak test procedures would need to include the entire confinement or containment boundary, including base metal e) Calibration must include probe speed and distance if sniffer probe method of helium leak detection is used. The above details regarding the leak testing procedures are not included in the MP197HB packaging SAR. The leaking testing procedures are maintained as a controlled procedure under the TN Americas LLC Quality Assurance (QA) program. The MP179HB packaging SAR requires in Chapter A.7 and in Chapter A.8 that the containment boundary leakage tests be performed in accordance with ANSI N14.5. The leakage tests are performed with an acceptance criterion of $\leq 1x10^{-7}$ ref cm^3/s, which is in accordance with ANSI N14.5-2014.

Description and Justification of Proposed Changes
(Safety Analysis Report, MP197, Revision 18A)

B.5 Editorial Corrections

	Chapter/Appendix/ Section	Description and Justification
	Chapter A.2	**General Information**
B.5-1	A.2.1.2.1 Basic Design Criteria	SAR change **Page A.2-6** *The components of each DSC including the shell assembly, the top outer/inner cover plates, the inner bottom cover plate, the siphon vent block, and the siphon/vent port cover plate are designed, fabricated and inspected in accordance with the ASME Code Subsection NB to the maximum practical extent (Code alternatives are given in Section A.2.1.4 and Appendix A.2.13.13* ~~***below***~~*).* Justification: Deleted the word "below" as the locations are now further within the chapter than when this section was initially written. **Page A.2-7** *The baskets for all of the DSCs are designed, fabricated and inspected in accordance with the ASME Code Subsection NG to the maximum practical extent with the applicable Code year again depending on the storage license of the applicable DSC. (Code alternatives are given in Section A.2.1.4 and Appendix A.2.13.13* ~~***below***~~*).* Justification: Deleted the word "below" as the locations are now further within the chapter than when this section was initially written.
	A.2.6.4 Increased External Pressure	SAR Change **Page A.2-23** In addition, Table A.2.12.1-25 lists the combined stresses under....... Is changed to "In addition, Table A.2.13.1-25 lists the combined stresses under......." Justification: The table number was incorrect at *A.2.12.1-25* and should be Table *A.2.**13**.1-25.*

Description and Justification of Proposed Changes
(Safety Analysis Report, MP197, Revision 18A)

	Chapter/Appendix/ Section	Description and Justification
	Chapter A.7	**Operations**
B.5-2	A.7.1.4 NUHOMS®-MP197HB Cask Preparation for Transport	SAR Change: **Page A.7-7** *2. Verify that the assembly verification leakage rate testing **has been performed** as specified in Section A.7.4.**2**. This test must be performed within 12 months prior to the shipment.* Justification: Editorial. Minor changes to point to the correct section for leak testing (A.7.4.2) and sample survey points (Figure A.7.4).

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NON-PROPRIETARY

NUHOMS®-MP197 TRANSPORTATION PACKAGE SAFETY ANALYSIS REPORT

Revision *18A*

February 2018

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Revision Log

Rev. No.	Date	Description
0	4/2001	Original Issue for CoC Revision 0
1	1/2002	Various Changes CoC Revision 0
2	2/2002	Various Changes CoC Revision 0
3	4/2002	Various Changes CoC Revision 0
4	5/2002	Various Changes CoC Revision 0
5	3/2009	Application for CoC Revision 3 Added Appendix A for the MP197HB
6	6/2009	Various Changes for CoC Revision 3
7	4/2010	Various Changes for CoC Revision 3
8	7/2010	Various Changes for CoC Revision 3
9	3/2011	Various Changes for CoC Revision 3
10	8/2011	Consolidated SAR Submittal for CoC Revision 3
11	9/2011	Various Changes for CoC Revision 4
12	2/2012	Application for CoC Revision 7
13	8/2012	Various Changes for CoC Revision 7
14	8/2013	Various Changes for CoC Revision 7
15	1/2014	Various Changes for CoC Revision 7
16	3/2014	Various Changes for CoC Revision 7
17	4/2014	Various Changes for CoC Revision 7
18	4/2017	Application for CoC Revision 8 Revised pages as follows: SAR pages A.1.4.8-3a, A.1.4.8.13a, A.1.4.8-14, A.1.4.9-i, A.1.4.9-2, A.1.4.9-2a, A.1.4.9-3, A.1.4.9-9, A.1.4.9-9a, A.1.4.9-10, A.1.4.10-1, A.1.4.10-6 SAR pages A.2.13.11-ii, A.2.13.11-1 through A.2.13.11-6, A.2.13.11-12, A.2.13.11-13, A.2.13.11-18, A.2.13.11-22 through A.2.13.11-24, A.2.13.11-31, A.2.13.11-41, A.2.13.11-43 SAR pages A.3-i through A.3-v, A.3-1, A.3-3, A.3-4, A.3-6, A.3-7, A.3-28, A.3-55, A.3-62, A.3-77, A.3-78, A.3-80, A.3-81, A.3-97, A.3-98, A.3-99, A.3-102, A.3-175, A.3-176 SAR pages A.5-i through A.5-v, A.5-1, A.5-2, A.5-3, A.5-5, A.5-7, A.5-8, A.5-11, A.5-12d, A.5-16, A.5-16a, A.5-16b, A.5-20b, A.5-29a, A.5.-29c, A.5-29d through A.5-29h, A.5-32b, A.5-34, A.5-37, A.5-38, A.5-40, A.5-41, A.5-41a, A.5-70, A.5-75, A.5-80l, A.5-80m, A.5-80p, A.5-80q, A.5-80t, A.5-105

Revision Log

Rev. No.	Date	Description
		Revised drawings as follows: Drawing MP197HB-71-1005 Drawing NUH69BTH-71-1004 New pages as follows: Proprietary Information Notice Revision Log Appendix A Master Table of Contents, pages i through xix SAR pages A.1.4.9-9b through A.1.4.9-9g, A.1.4.9-15a SAR pages A.3-60a, A.3-102a, A.3-102b SAR pages A.5-2a, A.5-29i, A.5-38a, A.5-41b, A.5-41c, A.5-42a, A.5-79b, A.5-102a
18A	*2/2018*	*Application for Revision 9* *Revised pages as follows:* *SAR pages A.1-2, A.1-4, A.1.4.9Ai, A.1.4.9A-1 through A.1.4.9A-4, A.1.4.10-i, A.1.4.10-1, A.1.4.10-6, and A.1.4-10-307* *A.2-3, A.2-6, A.2-7, A.2-16, A.2-23, A.2.13.1-3, A.2.13.2-1, A.2.13.2-4, A.2.13.2-13, A.2.13.2-15, A.2.13.2-18, A.2.13.2-30, A.2.13.2-31, A.2.13.5-18, A.2.13.12-10, A.2.13.12-18, and A.2.13.14-5* *A.4-i, A.4-1, A.4-3, A.4-4, A.4-5, and A.4-6* *A.7i, A.7.ii, A.7-2, A.7-3, A.7-4, A.7-5b, A.7-6, A.7-7, A.7-8, A.7-8a, A.7-9 through A.7-14, A.7-17, A.7-21, A.7.7.10.i, and A.7.7.10-1 through A.7.7.10-3* *A.8-i, A.8-3, A.8-15, A.8-16, and A.8-17* *Revised drawings as follows:* *Drawings MP197HB-71-1001 through MP197HB-71-1009, MP197HB-71-1011* *MP197HB-71-1014* *NUHRWC-71-1001*

Revision Log

Rev. No.	Date	Description
		New pages as follows: *A.1.4.9A-5* *A.4.6.1-i and A.4.6.1-1 through A.4.6.1-11* *A.7-3a, A.7-4a, and A.7-6a* *A.8-15a*

Chapter A.1
General Information

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Chapter A.1
General Information

NOTE: References in this Chapter are shown as [1], [2], etc. and refer to the reference list in Section A.1.3.

A.1.1 Introduction

This Appendix A to the Safety Analysis Report (SAR) for the NUHOMS®-MP197 Transport Cask presents the evaluation of a modified version of the NUHOMS® MP197. This modified version is a Type B(U) spent fuel transport packaging developed by Transnuclear, Inc. and designated as Model Number NUHOMS®-MP197HB packaging. Appendix A of this SAR describes the design features and presents the safety analyses which demonstrate that the NUHOMS®-MP197HB packaging complies with applicable requirements of 10 CFR *Part* 71 [1]. The format and content of Appendix A follow the guidelines of Regulatory Guide 7.9 [2].

The NUHOMS®-MP197HB packaging consists of the NUHOMS®-MP197HB Transport Cask *and* one of several NUHOMS® Dry Shielded Canisters (DSCs) *used to transport used nuclear fuel assemblies* or a secondary container with dry irradiated and/or contaminated non-fuel bearing solid materials in accordance with 10 CFR *Part* 71 [1]. *The licensing approach used to demonstrate compliance with 10 CFR Part 71 is described in Appendix A.1.4.A.* The packaging is intended to be shipped as exclusive use. The criticality safety index (CSI) for nuclear criticality control for the packaging when transporting fuel is determined to be zero (0) in accordance with 10 CFR 71.59 [1]. See Chapter A.6 for details of this determination.

Transnuclear, Inc. has an NRC approved quality assurance program (Docket Number 71-0250) which satisfies the requirements of 10 CFR 71 Subpart H [1].

A.1.2 Package Description

A.1.2.1 Packaging

The NUHOMS®-MP197HB packaging can be used to transport several types of boiling water reactor (BWR) fuel assemblies with or without fuel channels or pressurized water reactor (PWR) fuel assemblies with or without control components. The fuel assemblies are contained in a single NUHOMS® DSC. In addition, the NUHOMS®-MP197HB packaging can be used to transport a secondary container with dry irradiated and/or contaminated non-fuel bearing solid materials. The NUHOMS®-MP197HB packaging is designed for a maximum heat load of 32 kW depending on the NUHOMS® DSC being transported and cask configuration. The fuels that may be transported in the NUHOMS®-MP197HB packaging are presented in Section A.1.2.3. The dry irradiated and/or contaminated non-fuel bearing solid materials that may be transported in the NUHOMS®-MP197HB packaging are also presented in Section A.1.2.3.

The NUHOMS®-MP197HB packaging, shown in Figure A.1-1, consists of the following components:

- A NUHOMS®-MP197HB transport cask consists of a containment boundary, structural shell, gamma shielding material, and solid neutron shield. The containment boundary consists of a cylindrical inner shell, a bottom plate with a ram access closure plate with seal and bolts, a cask body flange, a top lid with seal and bolts, vent and drain ports with closure bolts and seals, and all containment welds. The transport cask cavity also contains an inert gas atmosphere *when transporting DSCs*.

- Because there are two different outside diameters (ODs) for the DSCs and secondary containers, an inner sleeve is used for smaller diameter DSCs and secondary containers. The inner sleeve is designed with slots to accommodate the existing rails inside the cask and to provide rails inside the sleeve on which the smaller diameter DSCs or secondary containers slide during horizontal loading or unloading of the cask.

- To accept the varying lengths of the DSCs and secondary containers, stainless steel or aluminum spacers are provided to limit axial movement of the payload.

- For a NUHOMS®-69BTH DSC with heat load greater than 26 kW, use of removable external fins is required. The aluminum fins are attached to an outer aluminum sleeve, which is fabricated in two halves that are bolted together around the cask between the impact limiters.

- Sets of removable front and rear trunnions, which are bolted to the outer shell of the cask, provide support, lifting, and rotation capability for the NUHOMS®-MP197HB cask.

- Impact limiters consisting of balsa and redwood encased in stainless steel shells are attached to each end of the NUHOMS®-MP197HB cask during shipment. A thermal shield is provided between each impact limiter and the cask to minimize heat transfer to the impact limiters. Each impact limiter is held in place by 12 attachment bolts.

- A personnel barrier is mounted to the transport frame to prevent unauthorized access to the cask body.

- There are nine DSC designs *that constitute a portion of* the NUHOMS®-MP197HB packaging. All of the DSCs consist of a cylindrical shell, and top and bottom shielded closure assemblies. Details for each DSC type are provided in Appendices A.1.4.1 through A.1.4.9. After loading, each DSC is vacuum dried and back-filled with an inert gas. Each DSC includes a fuel basket assembly, located inside the DSC. The basket assembly locates and supports the fuel assemblies, transfers heat to the DSC wall, and provides neutron absorption to satisfy nuclear criticality requirements. For some DSC designs, a basket hold down ring is installed on top of the basket, after fuel loading, to prevent axial motion of the basket within the DSC.

- The dry irradiated and/or contaminated non-fuel bearing solid materials are contained in a secondary container (Radioactive Waste Canister (RWC)). The safety analysis of this configuration takes no credit for the containment provided by the RWC.

A.1.2.1.1 NUHOMS®-MP197HB Transport Cask

The cask is fabricated primarily of nickel-alloy steel (NAS). Other materials include the cast lead shielding between the containment boundary inner shell and the structural shell, the O-ring seals, the borated resin neutron shield and the carbon steel closure bolts. Socket headed cap screws (bolts) are used to secure the lid to the cask body and the ram access closure plate to the bottom of the cask. The body of the cask consists of a 1.25 inch thick, 70.50 inch inside diameter NAS inner (containment) shell and a 2.75 inch thick, 84.50 inch outside diameter NAS structural shell which sandwich the 3.00 inch thick cast lead shielding material.

The overall dimensions of the NUHOMS®-MP197HB packaging are 271.25 inches long and 126.00 inches in diameter with both impact limiters installed. The transport cask body is 210.25 inches long and 84.50 inches in diameter. The cask diameter including the radial neutron shield is 97.75 inches or 104.25 inches with the fins. The minimum length of cask cavity is 199.25 inches and 70.50 inches in diameter without the sleeve or 68 inches with the sleeve. Detailed design drawings for the NUHOMS®-MP197HB packaging are provided in Appendix A.1.4.10, Section A.1.4.10.1. The materials used to fabricate the packaging are shown in the Parts List on Drawing MP197HB-71-1002. Where more than one material has been specified for a component, the most limiting properties are used in the analyses in the subsequent sections of this appendix to the SAR.

The maximum gross weight of the loaded package is 152.0 tons including a maximum payload of 56.0 tons. Table A.1-1 summarizes the dimensions and weights of the NUHOMS®-MP197HB packaging components. Trunnions, attached to the cask body, are provided for lifting and handling operations, including rotation of the packaging between the horizontal and vertical orientations. The NUHOMS®-MP197HB packaging is transported in the horizontal orientation, on a specially designed shipping frame, with the lid end facing the direction of travel.

DSCs with a spent fuel payload are shipped dry in a helium atmosphere. Both the transport cask cavity and the DSC cavity are filled with helium. The heat generated by the spent fuel assemblies

is rejected to the environment by conduction, convection and radiation. No forced cooling is required.

RWCs with dry irradiated and/or contaminated non-fuel bearing solid materials are shipped dry in an air, nitrogen or inert gas environment. When a wet load procedure (i.e., in-pool) is followed for cask loading, the RWC and cask cavities are drained and dried in order to ensure that free liquids do not remain in the package during transport. The heat generated by the contents of the RWC is rejected to the environment by conduction, convection and radiation. No forced cooling is required.

A. Containment Vessel

The cask containment boundary consists of the inner shell, a 6.50 inch thick bottom plate with a 28.88 inch diameter, 2.50 inch thick ram access closure plate with seal and bolts, a cask body flange, a 4.50 inch thick lid with seal and bolts, vent and drain ports with closure bolts and seals, and all containment welds. A 70.50 inch diameter, 199.25 inch long cavity is provided.

The containment vessel prevents leakage of radioactive material from the cask cavity. It also maintains an inert atmosphere (helium) in the cask cavity *when transporting DSCs*. Helium within the DSCs assists in heat removal and provides a non-reactive environment to protect fuel assemblies against fuel cladding degradation. To preclude air in-leakage *when transporting DSCs*, the cask cavity is pressurized with helium to above atmospheric pressure.

The inner containment shell is SA-203, Grade E, and the bottom and top flange materials are SA-350-LF3. The lid is constructed from SA-350-LF3 or SA-203, Grade E. The NUHOMS®-MP197HB packaging containment vessel is designed, fabricated, examined and tested in accordance with the requirements of Subsection NB [3] of the ASME Code to the maximum practical extent. In addition, the design meets the requirements of Regulatory Guides 7.6 [5] and 7.8 [6]. Alternatives to the ASME Code are discussed in Chapter A.2, Appendix A.2.13.13. The construction of the containment boundary is shown in Drawings MP197HB-71-1002, -1003, -1004, -1005 and -1006 provided in Appendix A.1.4.10, Section A.1.4.10.1. The design of the containment boundary is discussed in Chapter A.2 and the fabrication requirements (including examination and testing) of the containment boundary are discussed in Chapter A.4.

B. Gamma and Radial Neutron Shielding

The lead and steel shells of the transport cask provide shielding between the fuel and the exterior surface of the package for the attenuation of gamma radiation (Drawings MP197HB-71-1002, -1003, -1004, -1005 and -1006).

Neutron shielding is provided by a borated resin compound surrounding the outer shell. The resin compound is cast into long, slender aluminum containers. The containers are constructed from 6063-T651 aluminum. The total thickness of the resin and aluminum is 6.25 inches. The array of resin-filled containers is enclosed within a 0.375 inch thick outer steel shell (coated SA-516-70). In addition to serving as resin containers, the aluminum provides a heat conduction path from the cask body to the neutron shield shell.

Noncontainment welds are inspected in accordance with the NDE acceptance criteria of ASME B&PV Code Subsection NF [8].

The structural analysis of the NUHOMS®-MP197HB cask body is presented in Chapter A.2.

A.1.2.1.2 Tiedown and Lifting Devices

There are four trunnion sockets on the cask; two front trunnion sockets, and two rear trunnion sockets. They accommodate removable trunnions for handling, lifting, and rotating the cask. These trunnion sockets are attached to the structural shell. Two types of trunnions are provided for the NUHOMS®-MP197HB transport package lifting. One type of trunnion has a double shoulder (non-single failure proof). The other type of trunnion has a single shoulder (single failure proof). The front (lifting) set of trunnions could be either type, depending on site and transfer operation requirements. The rear set of trunnions may also be of either type. The trunnions are fabricated and tested in accordance with ANSI N14.6 [7]. During transport, four trunnion plugs, containing neutron shielding material, are bolted to the four trunnion sockets.

When the cask is in the horizontal position, a shear key receptacle on the bottom of the cask reacts the longitudinal tiedown loads. The shear key receptacle is welded to the structural shell and protrudes through the neutron shield. During transport the receptacle interfaces with the shear block attached to the transport skid.

A.1.2.1.3 Impact Limiters

The front and rear impact limiters, shown in Drawings MP197HB-71-1001, -1002, -1003, -1008, and -1009, absorb energy during impact events by crushing balsa and redwood. The two impact limiters are identical. Each has an outside diameter of 126 inches and a height of 58 inches. The inner and outer shells are Type 304 stainless steel joined by radial gussets of the same material. The gussets limit the stresses in the 0.25 in. thick stainless steel outer cylinder and end plates due to pressure differentials caused by elevation and temperature changes during normal transport. The metal structure locates, supports, confines, and protects the wood energy absorption material.

Each impact limiter is attached to the NUHOMS®-MP197HB cask by twelve (12) attachment bolts. The attachment bolts are designed to keep the impact limiters attached to the cask body during all normal conditions of transport and hypothetical accident conditions.

Each impact limiter is provided with seven fusible plugs that are designed to melt during a fire accident, thereby relieving excessive internal pressure. Each impact limiter has three hoist rings for handling, and two support angles for supporting the impact limiter in a vertical position during storage. The hoist rings are threaded into the impact limiter shell, while the support angles are welded to the shell. Prior to transport, the impact limiter hoist rings are removed and replaced with bolts.

An aluminum thermal shield is added to each impact limiter to reduce the impact limiter wood temperature. The details of the thermal shield are included in Drawing MP197HB-71-1002, -1003 and -1009.

The functional description as well as the performance analysis of the impact limiters is provided in Chapter A.2, Appendix A.2.13.12. The description and results of the impact limiter dynamic testing program are also provided in that Appendix.

Packaging markings are specified on Drawing MP197HB-71-1007.

A.1.2.2 Operational Features

The NUHOMS®-MP197HB package is not considered to be operationally complex and is designed to be compatible with spent fuel pool loading/unloading methods. All operational features are readily apparent from inspection of the General Arrangement Drawings provided in Appendix A.1.4.10, Section A.1.4.10.1. The sequential steps to be followed for cask loading, testing, and unloading operations are provided in Chapter A.7.

A.1.2.3 Contents

A.1.2.3.1 NUHOMS® DSCs

As noted above, there are nine DSC designs authorized for transport in the NUHOMS®-MP197HB packaging. Details for each DSC type are provided in Appendices A.1.4.1 through A.1.4.9. The maximum weight of the payload (DSC including the fuel) is limited to 56.0 tons.

Table A.1-2 lists each DSC type authorized for transport along with the required sleeves, spacers and a recommendation regarding fins to be used on the cask. In addition, the table lists the SAR appendix where the payload details can be found for each DSC. Loaded DSCs that are currently in storage, or DSCs which will be transported directly from the spent fuel pool, will only be shipped if the gaps between the fuel assemblies and the inner surfaces of the ends of the cavity meet the gaps specified in Appendix A.2.13.14, Table A.2.13.14-2.

A.1.2.3.2 Radioactive Waste Canister

The NUHOMS®-MP197HB packaging is also licensed to transport a RWC. The RWC is designed to carry dry irradiated and/or contaminated non-fuel-bearing solid materials. Details of the RWC are provided in Appendix A.1.4.9A.

A.1.3 References

1. 10 CFR *Part* 71, Packaging and Transportation of Radioactive Material.

2. USNRC Regulatory Guide 7.9, "Standard Format and Content of Part 71 Applications for Approval of Packages for Radioactive Material," Rev. 2, March 2005.

3. American Society of Mechanical Engineers, ASME Boiler And Pressure Vessel Code, Section III, Division 1 - Subsection NB, 2004 edition including 2006 Addenda.

4. Not Used.

5. USNRC Regulatory Guide 7.6, "Design Criteria for the Structural Analysis of Shipping Cask Containment Vessel," Rev. 1, March 1978.

6. USNRC Regulatory Guide 7.8, "Load Combinations for the Structural Analysis of Shipping Cask," Rev. 1, March 1989.

7. ANSI N14.6-1993, "American National Standard For Radioactive Materials-Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 Kg) or More," American National Standards Institute, Inc., New York, New York.

8. American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Subsection NF, 2004 edition including 2006 Addenda.

A.1.4 Appendices

A.1.4.A Licensing Approach for the NUHOMS®-MP197HB Package

A.1.4.1 NUHOMS®-24PT4 DSC

A.1.4.2 NUHOMS®-32PT DSC

A.1.4.3 NUHOMS®-24PTH DSC

A.1.4.4 NUHOMS®-32PTH DSC

A.1.4.5 NUHOMS®-32PTH1 DSC

A.1.4.6 NUHOMS®-37PTH DSC

A.1.4.7 NUHOMS®-61BT DSC

A.1.4.8 NUHOMS®-61BTH DSC

A.1.4.9 NUHOMS®-69BTH DSC

A.1.4.9A Radioactive Waste Canister

A.1.4.10 Drawings of Transport Packaging, DSCs, and RWC.

Table A.1-1
Nominal Dimensions and Weights of the NUHOMS®-MP197HB Packaging

Nominal Dimensions (in.)	
NUHOMS®-MP197HB packaging overall length with impact limiters and thermal shield	271.25
NUHOMS®-MP197HB packaging overall length without impact limiters and thermal shield	210.25
NUHOMS®-MP197HB cask impact limiter outside diameter	126.00
NUHOMS®-MP197HB cask outside diameter (w/o impact limiters and fins)	97.75
NUHOMS®-MP197HB cask outside diameter with fins (w/o impact limiters)	104.25
NUHOMS®-MP197HB cask cavity inner diameter	70.50
NUHOMS®-MP197HB cask cavity length (minimum)	199.25
NUHOMS®-MP197HB cask inner shell radial thickness	1.25
NUHOMS®-MP197HB cask lead gamma shield radial thickness	3.00
NUHOMS®-MP197HB cask body outer shell	2.75
NUHOMS®-MP197HB cask lid thickness	4.50
NUHOMS®-MP197HB cask bottom thickness	6.50
NUHOMS®-MP197HB cask resin and aluminum box thickness	6.25
Nominal Weights (lb x 1000)	
Weight of Contents (maximum)	112.0
Empty weight of NUHOMS®-MP197HB Packaging without lid or impact limiters	157.5
Cask lid	6.0
Outer sleeve with fins	3.1
Weight of impact limiters, thermal shield, and attachments	25.0
Total loaded weight of NUHOMS-MP197HB® Packaging (without transport skid)	303.6

Table A.1-2
DSC Configuration in the NUHOMS®-MP197HB Package

DSC Type	Sub Type	Bottom Spacer Required	Sleeve Required	Fins *Required*	Detailed Contents Description in Appendix
NUHOMS®-24PT4	–	Yes	Yes	No	A.1.4.1
NUHOMS®-32PT	S-100	Yes	Yes	No	A.1.4.2
	S-125	Yes	Yes	No	
	L-100	Yes	Yes	No	
	L-125	Yes	Yes	No	
NUHOMS®-24PTH	-S	Yes	Yes	No	A.1.4.3
	-L	Yes	Yes	No	
	-S-LC	Yes	Yes	No	
NUHOMS®-32PTH	–	Yes	No	No	A.1.4.4
	Type 1	Yes	No	No	
NUHOMS®-32PTH1	-S	Yes	No	No	A.1.4.5
	-M	Yes	No	No	
	-L	No	No	No	
NUHOMS®-37PTH	-S	Yes	No	No	A.1.4.6
	-M	Yes	No	No	
NUHOMS®-61BT	–	Yes	Yes	No	A.1.4.7
NUHOMS®-61BTH	Type 1	Yes	Yes	No	A.1.4.8
	Type 2				
NUHOMS®-69BTH	–	Yes	No	*Yes*(1)	A.1.4.9

(1) For Heat Loads Greater than 26kW

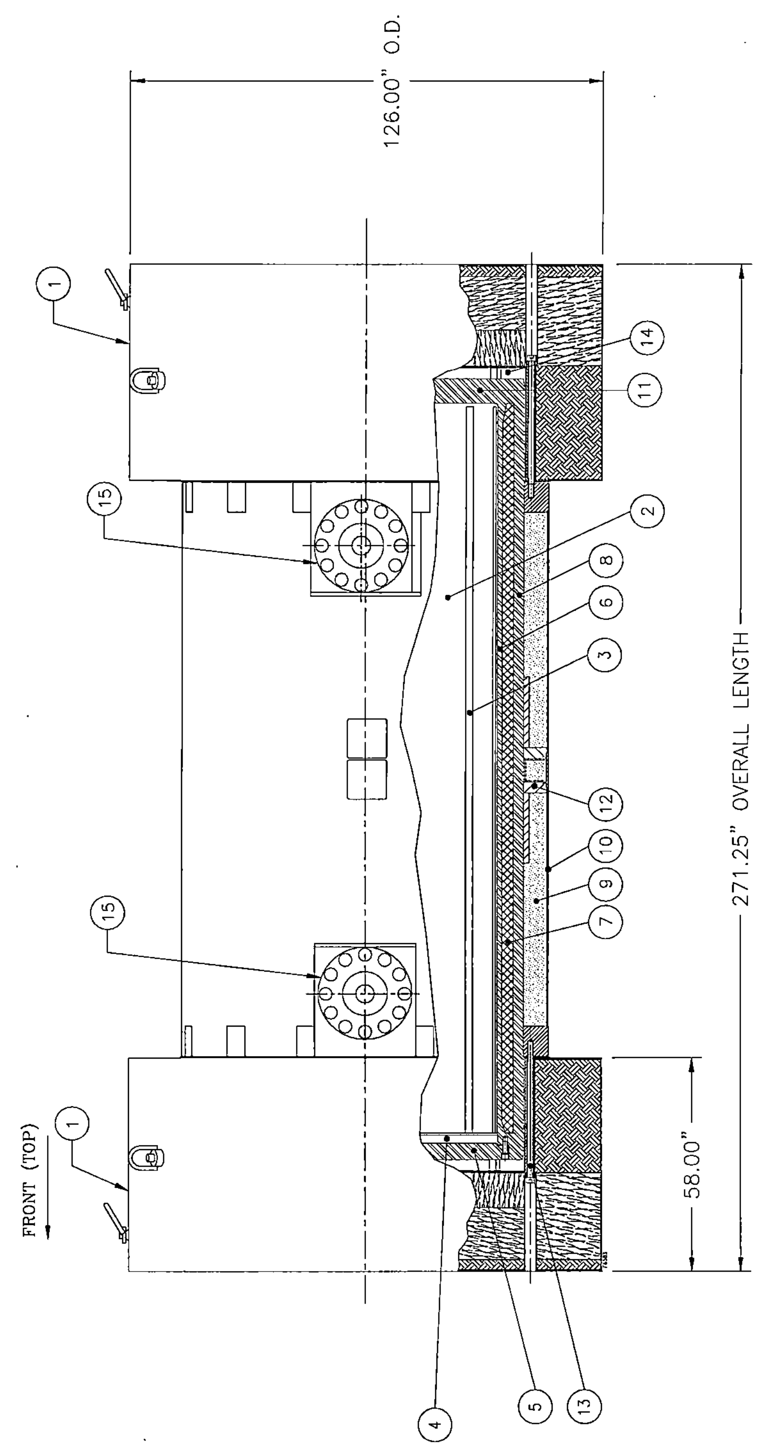

Figure A.1-1
General Arrangement of the NUHOMS®-MP197HB Packaging

Notes to Figure A.1-1:

A. Some details exaggerated for clarity.

B. Components are listed below:

1. Impact Limiter
2. Transport Cask Cavity
3. Transport Cask Slide Rail
4. Hold Down Ring (if required)
5. Transport Cask Lid
6. Transport Cask Inner Shell
7. Transport Cask Gamma (Lead) Shield
8. Transport Cask Outer Shell
9. Transport Cask Neutron (Resin) Shield
10. Transport Cask Shield Shell
11. Transport Cask Bottom
12. Transport Cask Bearing Block
13. Impact Limiter Attachment Bolt
14. Thermal Shield
15. Trunnion

Appendix A.1.4.9A
Radioactive Waste Canister

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Appendix A.1.4.9A
Radioactive Waste Canister

NOTE: References in this appendix are shown as [1], [2], etc., and refer to the reference list in Section A.1.4.9A.*3*.

A.1.4.9A.1 Radioactive Waste Canister Description

The radioactive waste canister (RWC) is designed to contain dry irradiated and/or contaminated non-fuel-bearing solid materials (described further in paragraph A.1.4.9A.*2*). Under normal transport conditions, the canister rests on four canister rails, attached to the inside surface of *an* inner sleeve of the NUHOMS®-MP197HB transport cask. The RWC is designed to transport its payload dry and in an air or inert gas environment. When a wet-load procedure (i.e., in-pool) is followed for cask loading, the RWC and transport cask cavities are drained and dried in order to ensure that free liquids do not remain in the package during transport. The heat generated by the contents of the RWC is transferred through the transport cask to the environment by conduction, convection and radiation. No forced cooling is required.

Each RWC assembly consists of a cylindrical shell, top shield plug, outer top cover plate, bottom shield plug, and outer bottom cover plate. As shown in Table A.1.4.9A-1, the RWC system consists of *three* design configurations:

- Welded Top Shield Plug Design (RWC-W)
- Bolted Top Shield Plug Design (RWC-B)
- *Dismantling and Decommissioning Design (RWC-DD)*

Table A.1.4.9A-1 provides the overall dimensions for each RWC configuration. The details of each configuration are included in the drawings contained in Section A.1.4.10.11 of Appendix A.1.4.10.

The RWC assembly is constructed of steel materials with welded or bolted configurations that provide for handling the contents and biological shielding. The RWC assembly provides a minimum steel thickness of 1.75 inches in the radial direction. The RWC assembly provides a minimum steel thickness of 5.75 inches below the payload and a minimum steel thickness of 7.00 inches above the payload in the axial directions.

Material properties are listed in Chapter A.2, Table A.2-4. All internal structural components and payloads are the same or similar alloys of stainless steel or carbon steel. These materials are not subject to chemical or galvanic interaction. No hydrogen gas generation is induced by chemical, galvanic, thermal, or radiolytic reactions.

All RWC welding procedures, welders, and welding are performed in accordance with the requirements of AWS D1.1 [1] and AWS D1.6 [2]. All inspections are performed in accordance with AWS D1.1 [1] and AWS D1.6 [2].

A.1.4.9A.1.1 Welded Top Shield Plug Design (RWC-W)

The RWC-W shell assembly is a 1.25 inch thick steel welded configuration that provides confinement of radioactive materials, encapsulate the contents in an air or inert atmosphere, and provide biological shielding. The RWC-W shell has redundant seal welds that join the shell and the top and bottom cover plate assemblies to seal the canister. The bottom end assembly welds are made during fabrication of the RWC-W shell. The top end closure welds are made after content loading. Both top plug penetrations (siphon and vent ports) are sealed after the RWC-W drying and backfilling operations are complete.

An inner liner assembly that is used with the RWC-W is a 0.50 inch thick steel welded cylinder with a bottom plate. The bottom plate is designed with drain holes on the bottom to allow liquid from the inner liner to drain into the bottom of the RWC for dewatering. Four lifting lugs are provided on the inner liner for lifting the inner liner either empty or loaded. The lugs are designed, fabricated and tested to the requirements of ANSI N14.6 [3]. The inner liner is manufactured with a keyway for alignment in the outer RWC-W canister.

A.1.4.9A.1.2 Bolted Top Shield Plug Design (RWC-B)

The RWC-B shell and bottom are the same as the RWC-W, except the RWC-B provides an option for a bolted top shield plug and does not utilize an inner liner. The bolted top shield plug allows for multiple loadings. Both the top shield plug and outer lid are seal welded after final loading. The RWC-B cylindrical shell is 1.75 inch thick to provide the same shielding as the RWC-W 1.25 inch thick shell used with the 0.50 inch thick inner liner.

A.1.4.9A.1.3 Dismantling and Decommissioning Design (RWC-DD)

The RWC-DD is a variant of the RWC design configurations that are approved for use with the MP197HB. The RWC-DD canister nominal diameter is the same as the approved RWC configurations, but longer in length. The RWC-DD is intended to be a reusable canister for transport of secondary liners containing waste or single use for disposal of low level waste in shallow earth disposal sites. The RWC-DD configuration not intended for extended dry storage like the RWC -W and RWC-B. The RWC-DD shield plug and outer lid are an integral bolted construction without seal welding an outer lid. This bolted outer lid configuration allows reuse of the canister for loading, transport, and unloading for disposal of contents resulting from decommissioning activities.

A.1.4.9A.2 RWC Contents

The NUHOMS®-MP197HB packaging is designed to transport a payload of up to 56.0 tons of dry irradiated and/or contaminated non-fuel bearing solid materials in the RWC. The safety analysis of the cask takes no credit for the containment provided by the RWC.

The quantity of radioactive material is limited to a maximum of 8,182 A_2. This is equivalent to 90,000 Ci of cobalt-60. The radioactive material is typically in the form of neutron activated metals, or metal oxides in solid form. Surface contamination may also be present on the irradiated components. When a wet-load procedure (i.e., in-pool) is followed for cask loading, the cask cavity and RWC are drained and dried to ensure that there are no free liquids in the package during transport.

The RWC shall contain dry irradiated and/or contaminated nonfuel bearing solid materials. The dry irradiated and/or contaminated non-fuel bearing solid materials whose total RWC payload meets concentration requirements as low level radioactive waste (LLRW) per 10 CFR 61.55. Waste characterization per 10 CFR 61.55 is the basis for demonstrating compliance with activity limits for transportation. The contents will not include liquid wastes, sludge, resins, or organic material. Waste containing fissile material is acceptable provided the quantity of fissile material is limited such that it can be exempted from being classified as fissile material per 10 CFR 71.15 (e.g., fission chambers for in-core detectors).

A.1.4.9A.2.1 Type and Form of Material

The NUHOMS®-MP197HB packaging is designed for shipment of various types of irradiated and contaminated reactor hardware. The payload will vary from shipment to shipment. Typical composition of the payload consists of the following components either individually or in combinations:

The typical cobalt-60 specific activity ranges for these items are as follows:

1. *BWR* Control Rod Blades	$1.3 \times 10^{-4} - 1.1 \times 10^{-2}$ Ci/g
2. *BWR Local Power Range Monitors (LPRMs)*	$1.0 \times 10^{-2} - 4.8 \times 10^{-2}$ Ci/g
3. *BWR* Fuel Channels	$7.8 \times 10^{-5} - 2.0 \times 10^{-4}$ Ci/g
4. *BWR* Poison Curtains	$6.2 \times 10^{-4} - 4.0 \times 10^{-2}$ Ci/g
5. *PWR Burnable Poison Rod Assemblies (BPRAs)*	$3.8 \times 10^{-4} - 1.3 \times 10^{-3}$ Ci/g
6. *BWR and PWR* Reactor Vessel and Internals	$2.0 \times 10^{-5} - 1.3 \times 10^{-2}$ Ci/g

A.1.4.9A.2.2 Decay Heat load

The RWC heat load does not exceed 5kw, well below the limit of 26 kW limit for the DSC contents in MP197HB without external cooling fins.

A.1.4.9A.2.3 Loading

Components with high specific activity are generally placed near the center of the RWC. For each shipment, the RWC is normally filled to capacity, which prevents shifting of the contents during transport. If the RWC is not full, appropriate component spacers or shoring is used to prevent significant movement of the contents.

A.1.4.9A.2.4 Maximum Quantity of Material per Package

The quantity of radioactive material is limited to a maximum of 8,182 A2. The radioactive material is primarily in the form of neutron activated metals, or metal oxides in solid form. Surface contamination may also be present on the irradiated components. When a wet load procedure (i.e., in-pool) is followed for cask loading, the cask cavity and RWC are drained and dried to ensure that there are no free liquids in the package during transport.

The NUHOMS®-MP197HB packaging is designed to transport a payload of up to 56.0 tons of dry irradiated and/or contaminated non-fuel bearing solid materials in the RWC. The payload of up to 56.0 tons includes the weight of the cask sleeve plus the RWC and its contents.

The maximum quantity of non-fuel bearing radioactive material loaded into a package shall not exceed 8,182 A2 (90,000 Ci of Co-60).

A.1.4.9A.3 References

1. American Welding Society, D1.1-98, Structural Welding Code-Steel
2. American Welding Society, D1.6-99, Structural Welding Code-Stainless Steel
3. ANSI N14.6, Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More, 1993

Table A.1.4.9A-1

Nominal Dimensions of the RWC

	RWC Design Parameters		
	RWC-W	**RWC-B**	***RWC-DD***
Shell Thickness (in)	1.25	1.75	*1.75*
Canister Length (in.)	186.50	186.50	*196*
Outside Diameter (in.)	67.19	67.19	*67.25*
Cavity Length (in.)	167.30	167.30	*183.25*
Cavity Diameter (in.)	64.69	63.69	*63.75*

Table A.1.4.9A-2

Nominal Dimensions of the RWC Inner Liner

	RWC-W Inner Liner Design Parameters
Shell Thickness (in.)	0.50
Outside Length (in.)	166.30
Outside Diameter (in.)	63.69
Cavity Length (in.)	162.11
Cavity Diameter (in.)	62.69

Appendix A.1.4.10
Drawings of Transport Packaging and DSCs

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Appendix A.1.4.10
NUHOMS®-MP197HB SAR Drawings

The following drawings for the NUHOMS®-MP197HB Cask are included in Section A.1.4.10.1.

Drawing Number	Title
MP197HB-71-1001 Rev *4*	NUHOMS®-MP197HB Packaging Transport Configuration (2 sheets)
MP197HB-71-1002 Rev *7*	NUHOMS®-MP197HB Packaging Parts List (2 sheets)
MP197HB-71-1003 Rev *3*	NUHOMS®-MP197HB Packaging General Arrangement (1 sheet)
MP197HB-71-1004 Rev *5*	NUHOMS®-MP197HB Packaging Cask Body Assembly (1 sheet)
MP197HB-71-1005 Rev *6*	NUHOMS®-MP197HB Packaging Cask Body Details (3 sheets)
MP197HB-71-1006 Rev *3*	NUHOMS®-MP197HB Packaging Lid Assembly and Details (1 sheet)
MP197HB-71-1007 Rev *1*	NUHOMS®-MP197HB Packaging Regulatory Plate (1 sheet)
MP197HB-71-1008 Rev *2*	NUHOMS®-MP197HB Packaging Impact Limiter Assembly (1 sheet)
MP197HB-71-1009 Rev *2*	NUHOMS®-MP197HB Packaging Impact Limiter Details (1 sheet)
MP197HB-71-1011 Rev *1*	NUHOMS®-MP197HB Packaging Transport Configuration Outer Sleeve With Fins Option (1 sheet)
MP197HB-71-1014 Rev *2*	NUHOMS®-MP197HB Packaging Internal Sleeve Design (*1* sheet)

The following drawings for the NUHOMS® 24PT4 DSC are included in Section A.1.4.10.2.

Drawing Number	Title
NUH24PT4-71-1001 Rev 0	NUHOMS® 24PT4 Transportable Canister For PWR Fuel Basket Assembly (5 sheets)
NUH24PT4-71-1002 Rev 0	NUHOMS® 24PT4 Transportable Canister For PWR Fuel Main Assembly (8 sheets)
NUH24PT4-71-1003 Rev 0	NUHOMS® 24PT4 Transportable Canister For PWR Fuel Failed Fuel Can (4 sheets)

The following drawings for the NUHOMS® 69BTH DSC are included in Section A.1.4.10.10.

Drawing Number	Title
NUH69BTH-71-1001 Rev 3	NUHOMS® 69BTH Transportable Canister For BWR Fuel Main Assembly (4 sheets)
NUH69BTH-71-1002 Rev 3	NUHOMS® 69BTH Transportable Canister For BWR Fuel Basket – Shell Assembly (4 sheets)
NUH69BTH-71-1003 Rev 3	NUHOMS® 69BTH Transportable Canister For BWR Fuel Shell Assembly (4 sheets)
NUH69BTH-71-1004 Rev 6	NUHOMS® 69BTH Transportable Canister For BWR Fuel Alternate Top Closure (7 sheets)
NUH69BTH-71-1011 Rev 3	NUHOMS® 69BTH Transportable Canister For BWR Fuel Basket Assembly (5 sheets)
NUH69BTH-71-1012 Rev 4	NUHOMS® 69BTH Transportable Canister For BWR Fuel Transition Rail Assembly And Details (6 sheets)
NUH69BTH-71-1013 Rev 4	NUHOMS® 69BTH Transportable Canister For BWR Fuel Holddown Ring Assembly (2 sheets)
NUH69BTH-71-1014 Rev 2	NUHOMS® 69BTH Transportable Canister For BWR Fuel Damaged Fuel Modification (1 sheet)
NUH69BTH-71-1015 Rev 2	NUHOMS® 69BTH Transportable Canister For BWR Fuel Damaged Fuel End Caps (1 sheet)

The following drawings for the Radioactive Waste Canister are included in Section A.1.4.10.11.

Drawing Number	Title
NUHRWC-71-1001 Rev *2*	NUHOMS® System *Radioactive Waste* Canister (*2* sheets)

A.1.4.10.1 NUHOMS®-MP197HB DRAWINGS

This section contains drawings for the NUHOMS®-MP197HB.

Proprietary and Security Related Information on the Drawings in Section A.4.10.1 Withheld Pursuant to 10 CFR 2.390

A.1.4.10.11 Radioactive Waste Canister Drawing

This section contains drawings for the Radioactive Waste Canister.

Proprietary and Security Related Information on the Drawings in Section A.4.10.11 Withheld Pursuant to 10 CFR 2.390

against yield stress or ten against ultimate stress, whichever is most restrictive. Only one set of trunnions will be used depending on site and transfer operation requirements. Both the front and rear trunnions are bolted to the cask body through a flange connection, using 12-1¼ in. diameter bolts made of SA-540 Gr B23 Cl.1 *or Gr B24 Cl. 1* steel. The front trunnions are designed to meet the requirements of ANSI N14.6 [2]. The trunnions are shown in Drawing MP-197HB -71-1005.

The shield shell around the neutron shield consists of a cylindrical shell with end caps at each end. The end caps are welded to the outer surface of the cask body outer shell. The shield shell and end caps provide a sealed enclosure for the resin-filled aluminum boxes, and retain the resin in the proper location with respect to the fuel assemblies transported in the cask cavity. The shell and end caps are made of SA-516 Gr 70 alloy steel.

A.2.1.1.2 Impact Limiters

The NUHOMS®-MP197HB packaging includes an impact limiter at each end of the cask body. The limiters are identical, consisting of a stainless steel shell that contains balsa and redwood blocks. These blocks provide the energy absorbing capabilities of the limiters. The inside diameter of the limiter is determined by the outside diameter of the cask body. The length and outside diameter of the limiters are sized to limit the cask impact loads resulting from the 1 foot NCT and 30 foot HAC drop events so that the containment vessel (and the non-containment structures) meets the design criteria.

The impact limiter stainless steel cylinders, gussets, and end plates, are designed to position and confine the balsa and redwood blocks to minimize the impact forces and to prevent excessive deformation of the limiters. The stainless steel shell is also designed to support and isolate the wood blocks from ambient moisture and pressure during normal operation.

The impact limiter and attachments are designed to withstand the impact loads and to prevent separation of the limiters from the cask during an impact. The design of the impact limiters and attachments are specified in Appendix A.2.13.12.

A.2.1.1.3 Dry Shielded Canister Assemblies

The MP197HB will accommodate several different dry shielded canisters (DSCs) each containing a unique payload. The DSCs consist of an outer shell assembly that contains a basket which, in turn, supports the spent fuel assemblies. A detailed description of each DSC is provided in Chapter A.1, Appendices A.1.4.1 through A.1.4.9.

The details of each shell are shown on drawings provided in Appendix A.1.4.10. The shell assembly is a welded stainless steel pressure vessel that provides containment of radioactive material, maintains inert atmosphere inside the shell (the DSC is backfilled with helium before being seal welded closed) and provides biological shielding in the axial direction.

The details of the NUHOMS® Baskets are shown in drawings also contained in Appendix A.1.4.10. The basket (except for the 24PT4) is a welded assembly of stainless steel fuel compartments and is designed to accommodate various numbers of BWR fuel assemblies or PWR fuel assemblies. The basket structure consists of an assembly of stainless steel tubes (fuel compartments) separated by poison plates and surrounded by support rails, depending on the

the exterior neutron shielding is removed, has been performed. This analysis shows that the accident dose rates are not exceeded. These accident shielding analyses are described in Chapter A.5.

Dry Shielded Canister (DSC)

The NUHOMS ® MP197HB is designed to carry several different DSCs. Some of these are currently licensed under 10CFR72 for storage of spent nuclear fuel. A table of DSCs with the licensing information is provided below.

DSC Design	Applicable Storage License CoC	ASME B&PV Code Year
NUHOMS® 32PTH	1030	1998 w/ 2000 Addenda
NUHOMS® 32PTH1	1004	1998 w/ 2000 Addenda
NUHOMS® 37PTH	Note (1)	2004 w/2006 Addenda
NUHOMS® 69BTH	Note (1)	2004 w/2006 Addenda
NUHOMS® 24PT4	1029	1992 thru1994 Addenda
NUHOMS® 24PTH	1004	1998 w/ 2000 Addenda
NUHOMS® 32PT	1004	1998 w/ 2000 Addenda
NUHOMS® 61BT	1004	1998 w/ 1999 Addenda
NUHOMS® 61BTH	1004	1998 w/ 2000 Addenda
NUHOMS® 61BTH with failed fuel, (61BTHF)	Note (1)	1998 w/2000 Addenda
NUHOMS® 24PTH with failed fuel, (24PTHF)	Note (1)	1998 w/2000 Addenda

Note: (1) These DSCs are currently not a part of CoC 1004 but will be added at a later date via amendment.

DSC Shell Assembly

The DSC shell assembly forms a second containment boundary, supplementing the cask containment boundary discussed above. This second containment boundary is necessary to justify the moderator exclusion approach taken as part of the criticality evaluation in this application. As a consequence, the components making up the DSC containment boundary are evaluated to the same ASME Code requirements as are the cask containment boundary components.

The components of each DSC including the shell assembly, the top outer/inner cover plates, the inner bottom cover plate, the siphon vent block, and the siphon/vent port cover plate are designed, fabricated and inspected in accordance with the ASME Code Subsection NB to the maximum practical extent (Code alternatives are given in Section A.2.1.4 and Appendix A.2.13.13). Note that the applicable Code year varies depending on the storage license of the specific DSC. The basis for the allowable stresses is Article NB-3200 for NCT (Level A) loads, and Appendix F for HAC (Level D) loads. Stress limits for NCT (Level A) and HAC (Level D) are given in Table A.2-1. When evaluating the results from the non-linear elastic-plastic analysis for the accident conditions, the general primary membrane stress intensity, P_m, shall not exceed 0.7 S_u and the maximum stress intensity at any location ($P_m + P_b$) shall not exceed 0.9 S_u.

DSC Basket

The baskets for all of the DSCs are designed, fabricated, and inspected in accordance with the ASME Code Subsection NG to the maximum practical extent with the applicable Code year again depending on the storage license of the applicable DSC. (Code alternatives are given in Section A.2.1.4 and Appendix A.2.13.13).

The basket is designed to meet the heat transfer, nuclear criticality, and the structural requirements. The basket structure must provide sufficient rigidity to maintain a subcritical configuration under all applied loads. The 304 stainless steel members in DSC baskets are the primary structural components. The neutron poison plates are the primary heat conductors, and provide the necessary criticality control.

The stress analyses of the basket for normal and accident conditions do not take credit for the aluminum and poison plates except for through-thickness-compression. Therefore, the materials are not required to be code materials. The quality assurance requirements of NQA-1 are imposed in lieu of NCA-3800. The basket is not code stamped. Therefore the requirements of NCA are not imposed. Fabrication and inspection surveillance is performed by the design organization in lieu of an authorized nuclear inspector.

The stress limits for the basket are summarized in Table A.2-3. The basis for the allowable stresses for the 304 stainless steel fuel compartments and rails is Section III, Division I, Subsection NG of the ASME Code [3]. The primary membrane stress and primary membrane plus bending stress are limited to S_m (S_m is the code allowable stress intensity) and 1.5 S_m, respectively, at any location in the basket for normal (Design and Level A) load conditions.

The HAC events are evaluated as short duration, Level D conditions. The stress criteria are taken from Section III, Appendix F of the ASME Code for the applicable year as discussed above. For elastic quasi-static analysis, the primary membrane stress intensity (P_m) is limited to the smaller of 2.4 S_m or 0.7 S_u, and membrane plus bending stress intensities ($P_m + P_b$) are limited to smaller of 3.6 S_m or S_u. When evaluating the results from the non-linear elastic-plastic analysis for the accident conditions, the general primary membrane stress intensity, P_m shall not exceed 0.7 S_u and the maximum stress intensity at any location ($P_m + P_b$) shall not exceed 0.9 S_u.

The fuel compartment response to compressive loads is also evaluated to ensure that buckling will not occur. Basket assembly allowable buckling loads are evaluated based on non-linear, large displacement quasi-static analysis models using ANSYS and LS-DYNA.

The basket hold down ring is set between the top of the basket assembly and inside surface of the lid assembly in some of the BWR fuel DSCs. The hold down ring is used to prevent the basket assembly from sliding freely in the axial direction during the NCT or HAC. The basket hold down ring is designed, fabricated, and inspected in accordance with the applicable year of ASME Code Subsection NF to the maximum practical extent.

Impact Limiters

The NUHOMS®-MP197HB packaging is provided with an impact limiter at each end of the cask body. The limiters are identical. The impact limiter stainless steel cylinders, gussets, and end

limiters and security seal described in Section A.2.4.2 provide further protection against unintentional opening.

A.2.5 Lifting and Tie-down Standards for All Packages

A.2.5.1 Lifting Devices

The NUHOMS®-MP197HB cask includes removable front and rear trunnions, as shown on drawing MP197HB-71-1005, which are used for on-site lifting and transfer operations. The detailed structural evaluations of the trunnions are contained in Appendix A.2.13.5. This section provides a summary of the structural analysis of the NUHOMS®-MP197HB cask trunnions.

10CFR71.45(a) requires that a minimum factor of safety of three against yield is required for all lifting attachments which are structural parts of the package. In addition, the package must be designed such that failure of any lifting device under excessive load would not impair the ability of the package to meet the other requirements of 10CFR71. Two sets of trunnions will be provided for the NUHOMS®-MP197HB transport package lifting. One set of trunnions has double shoulders (non single failure proof). The other set of trunnions has a single shoulder (single failure proof). Only one set of trunnions will be used depending on the site and transfer operation requirements.

Appendix A.2.13.1 provides the global stresses in the cask wall due to the lifting loads on the trunnions. The maximum global stress intensities in the containment vessel and outer shell are presented in Table A.2.13.1-7. The local stress intensities in the cask wall due to the 3G (double shoulder trunnion) and 6G (single shoulder trunnion) lifting load are presented below. The maximum 3G local stress intensity is 20.6 ksi (Table A.2.13.5-5). The maximum stress intensity due to the 6G lifting load is 26.0 ksi (Table A.2.13.5-7). These stresses are less than the yield stress of the outer shell material (35.4 ksi, SA-203 Gr. E at 300 °F). Therefore the requirements of 10CFR71.45(a) are met. The stress analyses of the front trunnion and trunnion flange bolts are also provided in the following sections.

Stress at Trunnion/Cask Outer Shell Intersection

The local stresses induced in the outer shell cylinder by the trunnions are calculated using "Bijlaard's" method. The neutron shield and thin outer shell are not considered to strengthen either the trunnions or outer shell. The trunnion is approximated by an equivalent attachment so that the curves of the Reference WRC 107 [13] can be used to obtain the necessary coefficients. These resulting coefficients are inserted into blanks in the column entitled "Read Curves For," in a standard computation form. The stresses are calculated by performing the indicated multiplication in the column entitled "Compute Absolute Values of Stress and Enter Result". The detailed calculation is shown in Table A.2.13.5-5 and Table A.2.13.5-7 of Appendix A.2.13.5.

Trunnion Bolt Stresses

The trunnion flange is attached to the outer shell by twelve 1.25-7UNC bolts constructed from SA-540 Gr. B23 Cl. 1 *or Gr. B24 Cl. 1* material. The bolted flange is tightly fitted into the trunnion attachment block, which is welded to the cask outer shell. This trunnion block recess provides a bearing area between the outside perimeter of the trunnion flange and the block. The radial clearance between

In addition, Table A.2.1*3*.1-25 lists the combined stresses under –20 °F thermal conditions where the load combination is performed for the –20 °F thermal stresses (bounding values of –20 °F and –40 °F thermal stresses are used for the load combinations). Lid bolt pre-load and external pressure are also included.

As shown in these tables, all the calculated stress values are well below the code allowables.

The transport truck shock loading used to evaluate the NUHOMS®-MP197HB cask are based on truck bed accelerations in ANSI N14.23 [14] which are:

- Vertical 3.5G
- Longitudinal 2.3G
- Lateral 1.6G

The resultant transverse load is $(3.5^2 + 1.6^2)^{1/2} = 3.85$ G

The truck shock loadings are less than the rail car shock loadings; therefore, the rail car shock loadings are used for structural analysis of the cask body.

Vibration

The input loading conditions used to evaluate the NUHOMS®-MP197HB cask for transport rail vibration are obtained from NUREG 766510 [15]. The peak inertia values used are:

- Vertical 0.37G
- Longitudinal 0.19G
- Lateral 0.19G

The resultant transverse load is $(0.37^2 + 0.19^2)^{1/2} = 0.416$ G

The stresses due to the transport rail vibration load cases are obtained from combined load cases (Load Cases 17 and 18) as indicated in Table A.2-8. Table A.2.13.1-22 lists the combined stresses under hot thermal conditions where the load combination is performed for the maximum temperature thermal stresses. Lid bolt pre-load, internal pressure and the thermal effects are included. In addition, Table A.2.13.1-23 lists the combined stresses under –20 °F thermal conditions where the load combination is performed for the –20 °F thermal stresses (bounding values of –20 °F and –40 °F thermal stresses are used for the load combinations). Lid bolt pre-load and external pressure are also included.

The input truck transport vibration loading conditions used to evaluate the NUHOMS®-MP197HB cask for are also obtained from truck bed accelerations given in ANSI N14.23 [14]. The peak inertia values used are:

- Vertical 0.60G
- Longitudinal 0.30G
- Lateral 0.30G

The resultant transverse load is $(0.6^2 + 0.3^2)^{1/2} = 0.67$ G

The load path from the saddles or straps of the transport skid to the outer shell component of the cask consists of a set of steel blocks (the impact limiter attachment blocks, shown as part 11 on drawings MP197HB-71-1002 in Appendix A.1.4.10), these blocks are welded to the cask body. The MOD20TI model also includes the basic components of the neutron shield assembly (the neutron shield shell, and the neutron shield end caps), as well as a simplified representation of the two saddles and straps. The interface between the skid saddles and straps, and the cask is modeled by surface contact elements CONTA173.

The MOD20TI finite element model is shown in Figures A.2.13.1-5 and A.2.13.1-6.

C. Payload and Cask Component Weight Data Used in the Analysis

The payload of the MP197HB package may consist of any of the DSCs types listed in the following table, along with their respective loaded weights:

DSC Type	**Weight**
NUHOMS® 32PTH DSC	110 kips
NUHOMS® 32PTH1 DSC	**112 kips**
NUHOMS® 37PTH DSC	110 kips
NUHOMS® 69BTH DSC	105 kips
NUHOMS® 24PT4 DSC	90 kips
NUHOMS® 24PTH DSC	99 kips
NUHOMS® 32PT DSC	107 kips
NUHOMS® 61BT DSC/ NUHOMS® 61BTH DSC	110 kips
RWC	Less than *or equal to 112* kips
Bounding payload used for cask structural evaluation	**118.5 kips**

The structural evaluations of the package use a bounding DSC payload weight of 118.5 kips. This bounding weight envelops the weight of the expected payloads for the MP197HB cask (112,000 lbs as specified in Chapter A.2, Section A.2.1.3).

Loads applied to the cask model use a total weight of the front impact limiter of 16,000 lb and a total weight of the rear impact limiter of 16,000 lb. These weight values bound the calculated weights of the front and rear impact limiters (12,500 lb as specified in Chapter A.2, Section A.2.1.3).

The neutron shield shell assembly located outside of the structural cask shell is not explicitly included in the stress analysis model (the stress analysis of the neutron shield shell structural evaluation is performed separately, as described in Appendix A.2.13.4). However, because of its large mass, it has a significant contribution to the structural response of the cask. Therefore, the mass of the neutron shield assembly was distributed over the interface area of cask body.

D. Baseline g Loads Used for the Drop Analysis

The baseline g loads used for the cask drop analyses are established in Appendix A.2.13.12 and are listed in the following table.

Appendix A.2.13.2
MP197HB Cask Lid Bolt Analysis

NOTE: References in this appendix are shown as [1], [2], etc. and refer to the reference list in Section A.2.13.2.11.

A.2.13.2.1 Purpose

This appendix analyzes the ability of the cask closure bolts to maintain a leak–tight seal under events defined by normal conditions of transport (NCT) and the hypothetical accident conditions (HAC). Also evaluated in this section are the stresses in the bolt threads and in the internal threads, and the lid bolt fatigue. The stress analysis is performed in accordance with NUREG/CR–6007 [1].

Appendix A.1.4.10 contains reference drawings for the lid bolt.

The closure lid has a diameter of 77.18 in. and consists of a 4.50 in. thick plate with a 3.94 in. thick outer flange. The lid is bolted directly to the end of the containment vessel flange by 48 high-strength alloy steel 1.5 in. diameter bolts on a 74.81 in. diameter bolt circle. Close fitting alignment pins ensure that the lid is centered in the vessel. The bolts material is SA–540 Gr. B23 Cl. 1 *or Gr B24 Cl. 1*, which has a yield strength of 139.1 ksi and a tensile strength of 165.0 ksi at 350 °F.

The bolt material (SA-540 Gr. B23 Cl. 1 *or Gr B24 Cl. 1*) used to fabricate the lid bolt will have a minimum tensile strength of 175 ksi as specified in the SAR drawing (Dwg No. MP197HB-71-1002, sheet 2 of 2, rev. 2, note 16). Fine thread series will be used (1½-12 UNF, Dwg No. MP197HB-71-1002, sheet 1 of 2, rev. 2, item 21), which has a tensile stress area of 1.58 in^2.

The lid bolt analysis presented in this appendix is in accordance with NUREG/CR-6007 and conservatively uses a 1½-6 UNC (coarse thread) lid bolt with a tensile strength of 165 ksi. The lid bolt evaluation due to delayed impact is presented in Appendix A.2.13.14.

The following ways to minimize bolt forces and bolt failures for shipping casks are taken directly from [1], page xiii. All of the following design methods are employed in the NUHOMS®–MP197HB closure system:

- Protect closure lid from direct impact to minimize bolt forces generated by free drops (use impact limiters).
- Use materials with similar thermal properties for the closure bolts, the lid, and the cask wall to minimize the bolt forces generated by a fire accident.
- Apply sufficiently large bolt preload to minimize fatigue and loosening of the bolts by vibration.
- Lubricate bolt threads to reduce required preload torque and to increase the predictability of the achieved preload.
- Use closure lid design which minimizes the prying actions of applied loads.

The fixed edge closure lid force is:

$$F_f = \frac{D_{lb} \times (P_{li} - P_{lo})}{4} = \frac{74.81 \times (30 - 0)}{4} = 562 \text{ lb/in}$$

The fixed edge closure lid moment is:

$$M_f = \frac{(P_{li} - P_{lo}) \times D_{lb}^2}{32} = \frac{30 \times 74.81^2}{32} = 5{,}247 \text{ in.lb/in}$$

The shear bolt force per bolt is:

$$S_s = \frac{\pi \times E_l \times t_l \times (P_{li} - P_{lo}) \times D_{lb}^2}{2 \times N_b \times E_c \times t_c \times (1 - N_{ul})}$$

$$S_s = \frac{\pi \times 27.9 \times 10^6 \times 4.5 \times (30 - 0) \times 74.81^2}{2 \times 48 \times 27.9 \times 10^6 \times 7 \times (1 - 0.3)} = 5{,}046 \text{ lb/bolt}$$

The lid shoulder takes this shear force, so $F_s = 0$.

A.2.13.2.2.4 Temperature Load

The analysis is described in Table 4.4 of [1].

The bolt material is SA–540 Gr. B23 Cl. 1 *or Gr B24 Cl. 1*; the lid and its flange are made of SA–203 Grade E or SA–350 Grade LF3, and the cask walls are made of SA–350 Grade LF3.

The coefficient of thermal expansion of the bolts at 350°F is 7.0×10^{-6} in/in/°F, and the coefficient of thermal expansion of the lid, its flange and of the cask is 7.0×10^{-6} in/in/°F.

Since the lid, its flange and the cask walls are made of the same material, the only load caused by thermal expansion is the non–prying tensile bolt force per bolt F_a. Since the coefficients of thermal expansion of the lid and the bolts is identical, $F_a = 0$ lb/bolt.

A.2.13.2.2.5 Impact Load

The analysis is described in Tables 4.5 and 4.6 of [1].

The non-prying tensile bolt force per bolt, F_a, is:

$$F_a = \frac{1.34 \times \sin(xi) \times DLF \times ai \times (W_l + W_c)}{N_b}$$

The drop angle xi is 60.3°. Only the accident conditions drop is considered in this Appendix. The acceleration ai is 40 g for the accident conditions. This g load used is higher than the baseline g load calculated of 37g in Appendix A.2.13.12, Section A.2.13.12.10.

An elastic finite element analysis is performed to determine the status of the lid / cask seal during a CG over corner 30 foot drop.

A.2.13.2.7.1 Assumptions

- The details of the finite element model, material properties and other details are described in detail in Appendix A.2.13.1.
- The lid / cask seal is investigated in this section, so CG over corner drop towards the lid end is deemed critical.
- The force to seat the seals is 0 lb.
- The maximum allowable decompression of the seal is 0.040 in.
- A spring stiffness value of 10 lb/in. is assumed for the real elastomer.

A.2.13.2.7.2 Analysis

The 3D finite element model from Appendix A.2.13.1 is modified to include the seal elastomer modeling using contact elements (CONTAC52). A pressure of 30 psig is applied on all internal surfaces. Bolt preload is applied using link and pretension elements

A.2.13.2.7.3 Results

Figure A.2.13.2-1 plots the decompression of the seal as a function of circumferential location. As can be seen there is no decompression of the seal; based on preload of 50 kips (minimum preload is 56.3 kips). Figure A.2.13.2-2 shows the zoomed deformation plot near the lid-flange region.

From the analysis results it can be concluded that there is no decompression in the seal during the CG over corner drop impact scenario with internal pressure and bolt preload. Since the seal exists all along the circumference of the MP197HB Transport cask, the internal contents will not leak during the worst case loading condition.

A.2.13.2.8 Minimum Engagement Length for Bolt and Flange

For the 1 ½–6UNC bolt, the material is SA–540 Gr. B23 Cl. 1 *or Gr B24 Cl. 1* which has a yield strength of 139.1 ksi and a tensile strength of 165.0 ksi at 350°F. The flange material is SA–350 LF3 or SA–203 Gr. E, with S_u = 70.00 ksi (at 350°F).

The minimum engagement length L_e for the bolt and flange is ([3], page 1490):

$$L_e = \frac{2 \times A_t}{3.1416 \times K_{n\max} \times \left[\frac{1}{2} + .57735 \times n \times \left(E_{s,\min} - K_{n\max} \right) \right]}$$

Therefore:

$$A_s = 3.1416 \times 6 \times 1.09 \times 1.3500 \times \left[\frac{1}{2 \times 6} + 0.57735 \times (1.3772 - 1.3500)\right] = 2.750\,\text{in}^2$$

$$A_n = 3.1416 \times 6 \times 1.09 \times 1.4703 \times \left[\frac{1}{2 \times 6} + 0.57735 \times (1.4703 - 1.4075)\right] = 3.616\,\text{in}^2$$

So:

$$J = \frac{2.750 \times 165.0}{3.616 \times 70.0} = 1.79\,.$$

Therefore, the minimum required engagement length $Q = J \times L_e = 1.79 \times 1.09 = 1.96$ in.

The actual minimum engagement length is equal to:

5.00 (bolt length) – 2.24 (thickness of the closure lid under the screw head) – 0.17 (washer thickness) = 2.59 in > 2.25 in (length of lid bolt insert) > 1.96 in.

The above calculation bounds the minimum required engagement length if inserts are used because S_u of inserts is higher than the S_u for the lid, thus lowering the J value.

A.2.13.2.9 Ram Closure Plate Bolts Analysis

This section analyzes the ability of the ram closure plate bolts to maintain a leak–tight seal under events defined by Normal Conditions of Transport (NCT) and the Hypothetical Accident Conditions (HAC). Also evaluated in this section are the stresses in the bolt threads and in the internal threads. The stress analysis is performed in accordance with NUREG/CR–6007 [1].

The ram closure plate has a diameter of 28.88 in. and consists of a 5.00 in. thick plate with a 2.50 in. thick outer flange. The ram closure plate is bolted directly to the bottom of the containment vessel by 12 high–strength alloy steel 1 in. diameter bolts on a 27.00 in. diameter bolt circle. The bolts material is SA–540 Gr. B23 Cl. 1 *or Gr B24 Cl. 1,* which has a yield strength of 137.9 ksi and a tensile strength of 165.0 ksi at 400°F.

The following evaluations are made in this section:

- Bolt preload
- Gasket seating load
- Internal pressure loads
- Temperature load
- Impact load
- Puncture load

Temperature Load

The analysis is described in Table 4.4 of [1].

The cover plate bolt material is SA-540 Gr. B23 Cl. 1 *or Gr B24 Cl. 1*, the cask bottom is made of SA-350 Gr. LF3, and the ram closure plate is made of SA-203 Gr. E.

The coefficient of thermal expansion of the bolts at 400°F is 7.1×10^{-6} in/in/°F, and the coefficient of thermal expansion of the cask bottom and of the ram closure plate is 7.1×10^{-6} in/in/°F.

Since the coefficients of thermal expansion of the ram closure plate and cask bottom are identical, the only load caused by thermal expansion is the non–prying tensile bolt force per bolt F_a. Since the coefficients of thermal expansion of the ram closure plate and the bolts are identical, $F_a = 0$ lb/bolt.

Impact Load

The analysis is described in Tables 4.5 and 4.6 of [1].

The non-prying tensile bolt force per bolt, F_a, is:

$$F_a = \frac{1.34 \times \sin(xi) \times DLF \times ai \times (W_l + W_c)}{N_b}$$

The drop angle xi is 60.3°. Only the accident conditions drop is considered in this Appendix. The acceleration ai is 40 g for the accident conditions.

Only the weight of the ram closure plate W_p is considered since the contents of the cask do not weigh on the plate.

The weight of the plate is conservatively taken equal to the sum of the weights of two plates, both of them 2.5 in. thick, one of them having a 28.88 in. diameter, and the other one a 9.00 in. diameter.

The resulting volume is equal to:

$$V = 0.25 \times \pi \times 2.5 \times (28.88^2 + 9.00^2) = 1{,}796.71 \text{ in}^3$$

The resulting ram closure plate weight W_p is equal to:

$$W_p = V \times \rho = 1{,}796.71 \times 0.29 = 522 \text{ lb}$$

The weight of the plate is conservatively taken equal to 530 lb.

$$F_a = \frac{1.34 \times \sin(60.3°) \times 1.1 \times 40 \times 530}{12} = 2{,}262 \text{ lb/bolt}$$

Table A.2.13.2-3
Allowable Stresses in Closure Bolts for Normal Conditions

(Bolt Material: SA–540 Gr. B23 Cl. 1, SA–540 Gr. B23 C1.1 *or Gr B24 Cl. 1*)

Temperature (°F)	**Yield Stress[3] (ksi)**	**Normal Condition Allowable Stresses (ksi)**		
		F_{tb}[4,6]	**F_{vb}[5,6]**	**S.I.[7]**
300	140.3	93.5	56.1	126.3
350	139.1	92.7	55.6	125.2
400	137.9	91.9	55.2	124.1

[3] Yield stress values are from ASME Code [2].
[4] Allowable tensile stress: $F_{tb} = 2/3\ S_y$ ([1]).
[5] Allowable shear stress: $F_{vb} = 0.4\ S_y$ ([1]).

[6] Tension and shear stresses must be combined using the following interaction equation: $\frac{\sigma_{tb}^2}{F_{tb}^2} + \frac{\tau_{yb}^2}{F_{yb}^2} \le 1.0$ [1].

[7] Stress intensity from combined tensile, shear and residual torsion loads: S.I. $\le 0.9\ S_y$ ([1], Table 6.1).

Table A.2.13.2-4
Allowable Stresses in Closure Bolts for Accident Conditions

(Bolt Material: SA–540 Gr. B23 Cl. 1 *or Gr B24 Cl. 1*)

Temperature (°F)	**Yield Stress**[8] **(ksi)**	**Accident Condition Allowable Stresses (ksi)**		
		0.6 S_y	F_{tb}[9]	F_{vb}[10]
300	140.3	84.2	115.5	69.3
350	139.1	83.5	115.5	69.3
400	137.9	82.7	115.5	69.3

[8] Yield and tensile stress values are from ASME Code [2], note that S_u = 165 ksi at all temperatures of interest.
[9] Allowable Tensile stress, F_{tb} = MINIMUM(0.7 S_u, S_y), where S_u = 165 ksi [1].
[10] Allowable shear stress, F_{vb} = MINIMUM(0.42 S_u, 0.6 S_y), where S_u = 165 ksi [1].

Table A.2.13.5-1
Steel Structural Properties at 300 °F (ksi)

Part	Material	S_y	S_u	E
Double shoulder trunnions	**SA-182 F316N**	**28.5**	**77.0**	**N/A**
Trunnions attachment blocks	**SA-182 F316N**	**28.5**	**77.0**	**N/A**
Outer shell	**SA-203 Gr. E**	**35.4**	**70.0**	**N/A**
Trunnion bolts	**SA-540 Gr. B23 Cl. 1** ***or Gr B24 Cl. 1***	**140.3**	**165.0**	**26,700**
Shear key bearing block and single shoulder trunnions	**SA-182 F6NM**	**84.6**	**115.0**	**N/A**
Pad plate	**SA-516-70**	**33.6**	**70.0**	**N/A**

Note: Material properties are taken from ASME Code [10]. Material properties and allowable stresses are based on 300 °F, which bound -40 °F, -20 °F, and 100 °F ambient conditions.

H. Bolt and Alignment Tubes

There are 12 bolts that attach each impact limiter to the cask model. The following elastic, linearly plastic material properties are used for the bolts.

SA-540 Grade B23 Class 1 *or Grade B24 Class 1* at room temperature and -20 °F
$E = 27.8 \times 10^6$ psi
$v = 0.3$
$S_y = 150.0$ ksi
Tangent Modulus, $E_T = 2\%\ E = 5.56 \times 10^5$ psi

Bolts at the symmetry plane are modeled as hollow circular cross section beams with modified dimensions to represent approximately half the area and moment of inertia.

Each bolt has a bolt alignment tube and a welded bolt tube. The following elastic, linearly plastic material properties are used for the bolt tubes:

SA-312 Type 304 at room temperature and -20 °F

$E = 28.3 \times 10^6$ psi
$v = 0.3$
$S_y = 30.0$ ksi
Tangent Modulus, $E = 10^5$ psi

Bolt alignment tubes are modeled as tube beams. Bolt alignment tubes at the plane of symmetry represent approximately half the area and moment of inertia.

Welded bolt alignment tubes are modeled as tube beams. Welded bolt alignment tubes at the plane of symmetry represent approximately half the area and moment of inertia.

I. Boundary and Initial Conditions

Because of symmetric one-half of the cask and impact limiters are modeled with symmetry boundary conditions used to simulate the full structure. The initial velocity is computed by equating potential and kinetic energies. For a 30 foot drop, the initial velocity is 527.5 in/sec. For a 1 foot drop, the initial velocity is 96.3 in/sec.

An automatic surface to surface (contact_automatic_single_surface) contact definition is applied between all parts where contact is feasible. An interior (contact_interior) contact definition is also applied to the wood parts to prevent elements from inverting and becoming negative volumes. Hourglass controls are applied to all materials. A conservatively low coefficient of friction (static and kinetic) of 0.25 is applied between all contact surfaces.

Non-reflecting boundaries are applied to the bottom and sides of the modeled concrete not aligned with the plane of symmetry (bottom, left side, right side, and back) to prevent artificial stress waves from reflecting. Both dilatation and shear waves are damped.

The impact limiter bolts are evaluated using two approaches. The first evaluation is made using the maximum tensile force from the LS-DYNA analysis taken from Figure A.2.13.12-51 for a bolt during a shallow angle slap–down drop, which is about 200,000 lb. The maximum tensile force F in a bolt considered in this case will be conservatively taken equal to 210,000 lb.

In order to benchmark the above method, a second evaluation is made where the tensile force in the bolts is calculated by considering the equilibrium of moments each bolt is subjected to, conservatively assuming that:

1. The lateral force exerted on the impact limiter by the cask comes from the full weight of the cask (306,500 lbs) and is centered in the middle of the impact limiter cavity (at a distance 15.375 in from the bottom of the impact limiter);
2. The g load for the second impact of a shallow angle slap–down drop is conservatively taken equal to 35 g (see Section A.2.13.12.10, baseline g load is 32 g);
3. The friction coefficient μ between the cask and the impact limiter and between the impact limiter and the impact surface is 0.42 [6], based on hard steel against hard steel friction properties.

Since the bottom impact limiter crushes during the first impact, the top impact limiter impacts with a slight angle during the second impact, and its bottom edge crushes first. Therefore, the reaction force on the impact limiter is located close to the bottom edge of the impact limiter. However, to maximize bolt forces, we conservatively assume that the reaction force is exerted on the other side of the lateral force exerted by the cask, at a distance from that lateral force equal to 10% of the depth of the impact limiter cavity.

Material mechanical properties for the impact limiter and attachment bolts are taken at 200°F, and at 300°F for the attachment bolts blocks and for the cask shell. However, material properties used for checking thread engagement length are taken at room temperature.

Nut factor for empirical relation between the applied torque and achieved preload is 0.135 for neolube lubricant.

A.2.13.12.11.1 Stress Calculations

A. Evaluation Based on the Calculated Tensile Force

A.1 Bolt Stress

The 1 ½ – 6UNC attachment bolts are made of SA–540 Gr. B23, Cl. 1 *or Gr B24 Cl. 1* (see Appendix A.1.4.10), which has an ultimate strength S_u = 165.0 ksi at 200°F [7].

The diameter D of the shank is 1.293 in. Its maximum diameter is 1.50 in (see Appendix A.1.4.10).

The critical tensile area of the attachment bolt is in the bolt shank since the threads are 1 ½ – 6UNC. The minimum tensile area of the bolt is:

$$A = 0.25 \times \pi \times D^2 = 0.25 \times \pi \times 1.293^2 = 1.313 \text{ in}^2.$$

Proprietary Information on This Page
Withheld Pursuant to 10 CFR 2.390

Chapter A.4
Containment

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Chapter A.4
Containment

NOTE: References in this chapter are shown as [1], [2], etc. and refer to the reference list in Section A.4.5.

A.4.1 Description of Containment System

A.4.1.1 Containment Boundary

The containment boundary for the NUHOMS®-MP197HB cask consists of a cylindrical inner shell, a bottom plate with a ram access closure plate with seal and bolts, a cask body flange, a top lid with seal and bolts, vent and drain ports with closure bolts and seals, and all containment welds. The containment boundary is shown in Figure A.4-1. The construction of the containment boundary is shown on the drawings provided in Appendix A.1.4.10, Section A.1.4.10.1. The containment vessel prevents leakage of radioactive material from the cask cavity. It also maintains an inert atmosphere (helium) in the cask cavity.

Additionally, each of the welded *dry shielded* canisters (DSCs) with used fuel as authorized contents contains helium. Thus, the welded canister provides a second containment boundary. A typical containment boundary of a DSC is shown in Figure A.4-2. Helium assists in heat removal and provides a non-reactive environment to protect fuel assemblies against fuel cladding degradation that might otherwise lead to gross rupture. *Radioactive waste canisters are not a containment feature and provide no secondary containment boundary.*

A.4.1.2 Containment Vessel

The NUHOMS®-MP197HB containment vessel consists of the inner shell, a 6.50 inch thick bottom plate with a 28.88 inch diameter, 2.50 inch thick ram access closure plate with seal and bolts, a cask body flange, a 4.50 inch thick lid with seal and bolts, vent and drain ports with closure bolts and seals, and all containment welds. A 70.50 inch diameter by 199.25 inch long cavity is provided.

The inner containment shell is SA-203 Grade E nickel-alloy steel. The bottom and cask body flange materials are SA-350-LF3. The lid is constructed from SA-203 Grade E or SA-350-LF3. The NUHOMS®-MP197HB packaging containment vessel is designed, fabricated, examined and tested in accordance with the requirements of Subsection NB of the ASME Code [1] to the maximum practical extent. In addition, the design meets the requirements of Regulatory Guides 7.6 [2] and 7.8 [3]. Alternatives to the ASME Code are discussed in Section A.2.1.4. The design of the containment boundary is discussed in Chapter A.2.

The cask design, fabrication and testing are performed under Transnuclear's Quality Assurance Program, which conforms to the criteria in Subpart H of 10 CFR Part 71.

The materials of construction meet the requirements of Section III, Subsection NB-2000 and Section II, material specifications or the corresponding ASTM specifications. The containment vessel is designed to the ASME Code, Section III, Subsection NB, Article 3200.

The containment vessel is fabricated and examined in accordance with NB-2500, NB-4000 and NB-5000. Also, weld materials conform to NB-2400 and the material specification requirements of Section II, Part C of ASME B&PV.

The containment vessel is hydrostatically tested in accordance with the requirements of the ASME B&PV Code, Section III, Article NB-6200.

Even though the code is not strictly applicable to transport casks, it is the intent to follow Section III, Subsection NB of the Code as closely as possible for design and construction of the containment vessel. The casks may, however, be fabricated by other than N-stamp holders and materials may be supplied by other than ASME Certificate Holders. Thus the requirements of NCA are not imposed. TN's quality assurance requirements, which are based on 10CFR71 Subpart H and NQA-1 are imposed in lieu of the requirements of NCA-3850. This SAR is prepared in place of the ASME design and stress reports. Surveillances are performed by TN and other personnel rather than by an Authorized Nuclear Inspector (ANI).

Paragraph NB-4213 requires the rolling process used to form the inner vessel be qualified to determine that the required impact properties of NB-2300 are met after straining by taking test specimens from three different heats. If the plates are made from less than three heats, each heat will be tested to verify the impact properties.

The materials of the NUHOMS®-MP197HB packaging will not result in any significant chemical, galvanic or other reaction as discussed in Chapter A.2.

A.4.1.3 Containment Penetrations

The only penetrations into the containment boundary are the drain and vent ports, RAM *access* closure plate and the top closure plate (lid). Each penetration is designed to maintain a leak rate not to exceed $1x10^{-7}$ ref cm^3/sec, defined as "leak tight" per ANSI N14.5 [4]. To obtain these seal requirements, each penetration has an O-ring face seal type closure.

A.4.1.4 Seals and Welds

All containment boundary welds are full penetration bevel or groove welds to ensure structural and sealing integrity. These full penetration welds are designed per ASME III Subsection NB and are fully examined by *radiographic* or ultrasonic methods in accordance with Subsection NB.

Additionally, a liquid penetrant examination is performed on these welds.

Containment seals are located at the RAM access closure plate, lid, the drain plug and the vent plug. The inner seal in all cases is the primary containment seal. The outer, secondary seals, facilitate leak testing of the inner containment seal of the RAM *access* closure plate and the lid. There are also test ports provided for these two closures. The test ports are not part of the containment boundary.

All the seals used in the NUHOMS®-MP197HB cask containment boundary are static face seals. The seal areas are designed for no significant plastic deformation under normal and accident

loads as shown in Chapter A.2. The bolts are torqued to maintain a seal load during all load conditions as shown in Appendix A.2.13.2. The seals used for the penetrations are either fluorocarbon elastomer or metallic O-rings. All seal contact surfaces are stainless steel and are machined to a 32 RMS or finer surface finish. The dovetail grooves in the cask lid are intended to retain the seals during installation. The volume of the grooves is controlled to allow the mating metal surfaces to contact under bolt loads, thereby providing uniform seal deformation in the final installation condition.

A fluorocarbon elastomeric seal was chosen for use on the MP197HB package because it has acceptable characteristics over a wide range of parameters. The fluorocarbon compound specified is VM835-75 or equivalent which meets the military rubber specification MIL-R-83485. (Note that this specification has been *superseded* by AMS-R-83485). Fluorocarbon O-rings are used in applications where temperatures are between -15 °F and 400 °F. The VM835-75 compound as listed on page 8-4 of the Parker O-ring Handbook [5] is specially formulated for use at temperatures as low as -40 °F while maintaining the upper temperature limit of 400°F.

The metallic seal for the RAM closure plate is a Helicoflex® aluminum jacketed seal designed to maintain a maximum helium leak rate of $1x10^{-9}$ cc/sec-atm with an operating temperature from cryogenic to a maximum temperature of 644 °F (340 °C) as specified in Helicoflex® Catalogue [6].

The metallic seal for the drain plug is a Parker O-ring made of alloy X-750 with a maximum operating temperature of 1100 °F (593 °C) as specified in Section D of Parker Design Guide [7]. The cold ambient temperature of -40 °F does not have any adverse effect on the sealing function of this O-ring.

A.4.1.5 Closure

The containment vessel contains an integrally-welded bottom closure and a bolted and flanged top closure plate (lid). The lid plate is attached to the cask body with forty eight (48), SA-540, Grade B23, Class 1, 1 ½ inch diameter bolts. Closure of the RAM closure plate is accomplished by twelve (12), SA-540, Grade B23, Class 1 *or Grade B24 Class1*, 1 inch diameter cap screws. The bolt torque required for the lid and RAM closure plate are provided in Drawing MP197HB-71-1002 in Appendix A.1.4.10, Section A.1.4.10.1. The closure bolt analysis is presented in Appendix A.2.13.2.

Closure of each of the vent and drain ports is accomplished by a single 3/4 inch brass or A193 B8 bolt with a seal under the head of the bolt.

A.4.2 Containment under Normal Conditions of Transport (Type B Packages)

A.4.2.1 Containment of Radioactive Material

As described earlier, the NUHOMS®-MP197HB is designed and tested for a leak rate of $1x10^{-7}$ ref cm^3/s, defined as "leak tight" per ANSI N14.5 *[4]*. Additionally, the structural and thermal analyses presented in Chapters A.2 and A.3, respectively, verify that there is no release of radioactive materials under any of the normal and accident conditions of transport.

A.4.2.2 Pressurization of Containment Vessel

The NUHOMS®-MP197HB contains either a canister (DSC) containing irradiated fuel or a secondary container containing dry irradiated and/or contaminated non-fuel bearing solid materials.

The DSCs are sealed (welded) canisters which have been tested to a "leak tight" criteria. Therefore, the pressure in the NUHOMS®-MP197HB when loaded with a DSC is from helium that has been backfilled into an evacuated cask cavity to a pressure of 3.5 psig at the end of loading. If the NUHOMS®-MP197HB contains design basis fuel at thermal equilibrium, the cask cavity helium temperature with 100 °F ambient air and maximum solar load is 339 °F. The maximum normal operating pressure is calculated in Chapter A.3 to be 12.7 psig. The analyses in Chapters A.2 and A.3 demonstrate that the NUHOMS®-MP197HB effectively maintains containment integrity with a cavity pressure of 30 psig.

A.4.2.3 Containment Criteria

The NUHOMS®-MP197HB is designed to be "leak tight." The acceptance criterion for fabrication verification and periodic verification leak test of the NUHOMS®-MP197HB containment boundary shall be 1.0 x 10^{-7} ref cm^3/s. The test must have a sensitivity of at least one half the acceptance criterion, or 5 x 10^{-8} ref cm^3/s. *The MP197HB used for shipping RWC contents does not require leak tight criteria for containment. A reference air leak rate less than leak tight criteria is allowed for shipment of the RWC contents. Leak rate criteria for RWC contents are established in Appendix A.4.6.*

A.4.3 Containment under Hypothetical Accident Conditions (Type B Packages)

A.4.3.1 Fission Gas Products

There is no need to explicitly determine the source term available for release. As described earlier, the NUHOMS®-MP197HB is designed and tested for a leak rate of $1x10^{-7}$ ref cm^3/s, defined as "leak tight" per ANSI N14.5 *[4]*. Additionally, the structural and thermal analyses presented in Chapters A.2 and A.3, respectively, verify that there is no release of radioactive materials under any of the normal and accident conditions of transport.

A.4.3.2 Containment of Radioactive Material

The NUHOMS®-MP197HB is designed and tested to be "leak tight." When transporting irradiated fuel, the NUHOMS®-MP197HB contains a sealed (welded) canister (DSC) which is also tested to a "leak tight" criteria. When transporting irradiated/contaminated hardware, the NUHOMS®-MP197HB provides two "leak tight" containment boundaries for the contents. The results of the structural and thermal analyses presented in Chapters A.2 and A.3, respectively, verify the package will meet the leakage criteria of 10CFR71.51 for the hypothetical accident scenario.

A.4.3.3 Containment Criterion

This package has been designed and is verified by leak testing, to meet the "leak tight" criteria of ANSI N14.5 *[4]*. The results of the structural and thermal analyses presented in Chapters A.2 and A.3, respectively, verify the package will meet the leakage criteria of 10CFR71.51 for all the

hypothetical accident conditions. *The MP197HB used for shipping RWC contents does not require leak tight criteria for containment. A reference air leak rate less than leak tight criteria is allowed for shipment of the RWC contents. Leak rate criteria for RWC contents are established in Appendix A.4.6.*

A.4.4 Special Requirements

Used nuclear fuel meets the solid plutonium requirements of 10 CFR 71.63. Solid plutonium is not an authorized content for the secondary containers containing dry irradiated and/or contaminated non-fuel bearing solid materials.

A.4.5 References

1. American Society of Mechanical Engineers, ASME Boiler And Pressure Vessel Code, Section III, Division 1 – Subsection NB, 2004 edition including 2006 Addenda.

2. USNRC Regulatory Guide 7.6, "Design Criteria for the Structural Analysis of Shipping Cask Containment Vessel," Rev. 1, March 1978.

3. USNRC Regulatory Guide 7.8, "Load Combinations for the Structural Analysis of Shipping Cask," Rev. 1, March 1989.

4. ANSI N14.5-*2014*, "American National Standard for Radioactive Material – Leakage Tests on Packages for Shipment," *June 2014*.

5. "Parker O-Ring Handbook," Publication No. ORD-5700, 2007 Edition, Parker Seals www.parkerorings.com.

6. Garlock Sealing Technologies, Inc., LLC; Catalogue: HELICOFLEX® Spring Energized Seals. http://pdf.directindustry.com/pdf/garlock-sealing-technologies-inc-llc/helicoflex-spring-energized-seals/5615-10918.html

7. Parker Hannifen Corporation, Composite Sealing Systems Division, "Metal Seal Design Guide, High Performance Engineered Seals and Sealing Systems. www.parker.com/literature/Seal%20Group/CSS%205129.pdf

A.4.6 Appendices

A.4.6.1 Containment Reference Leak Rate for RWC Contents

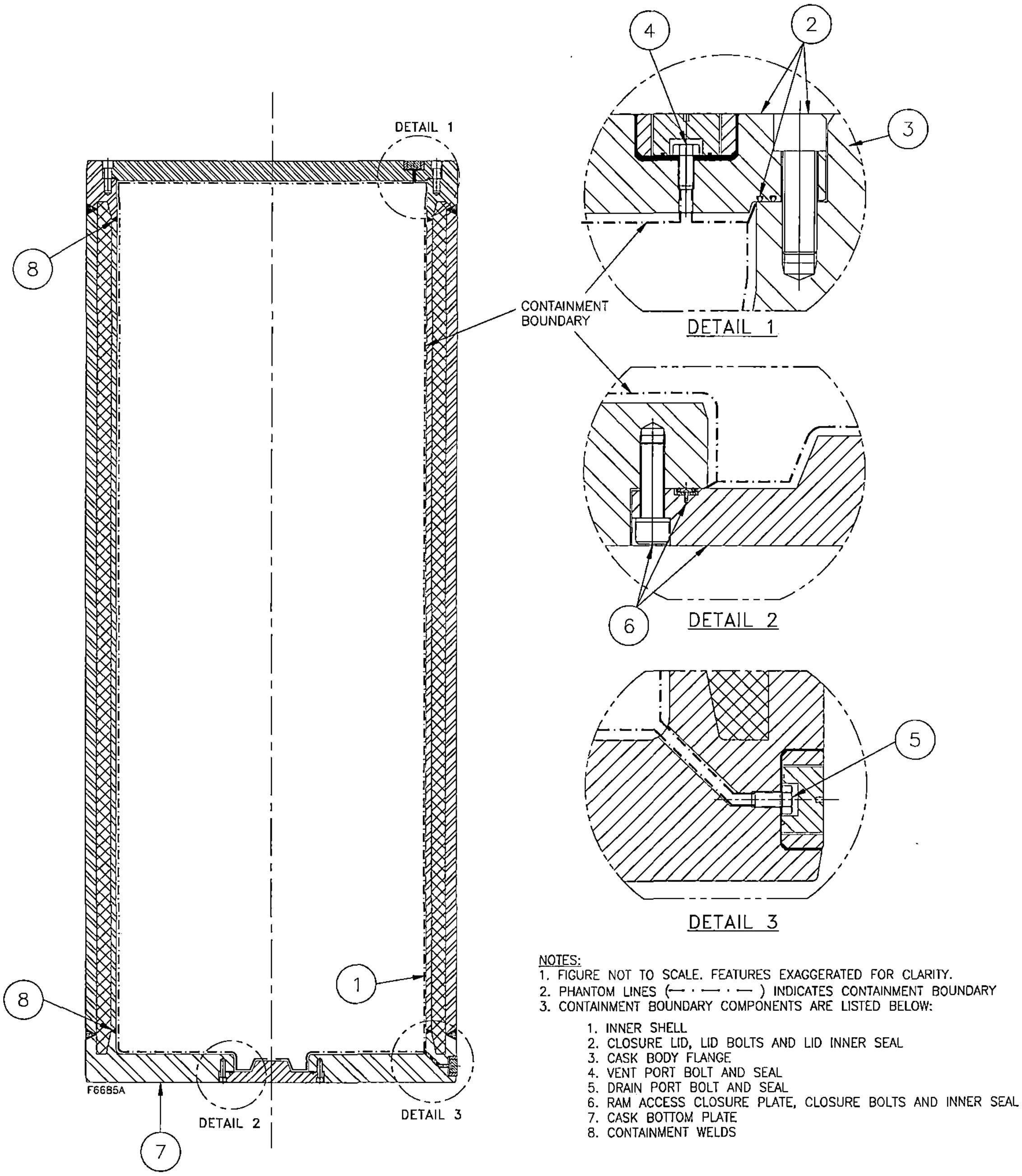

Figure A.4-1
NUHOMS®-MP197HB Containment Boundary Components

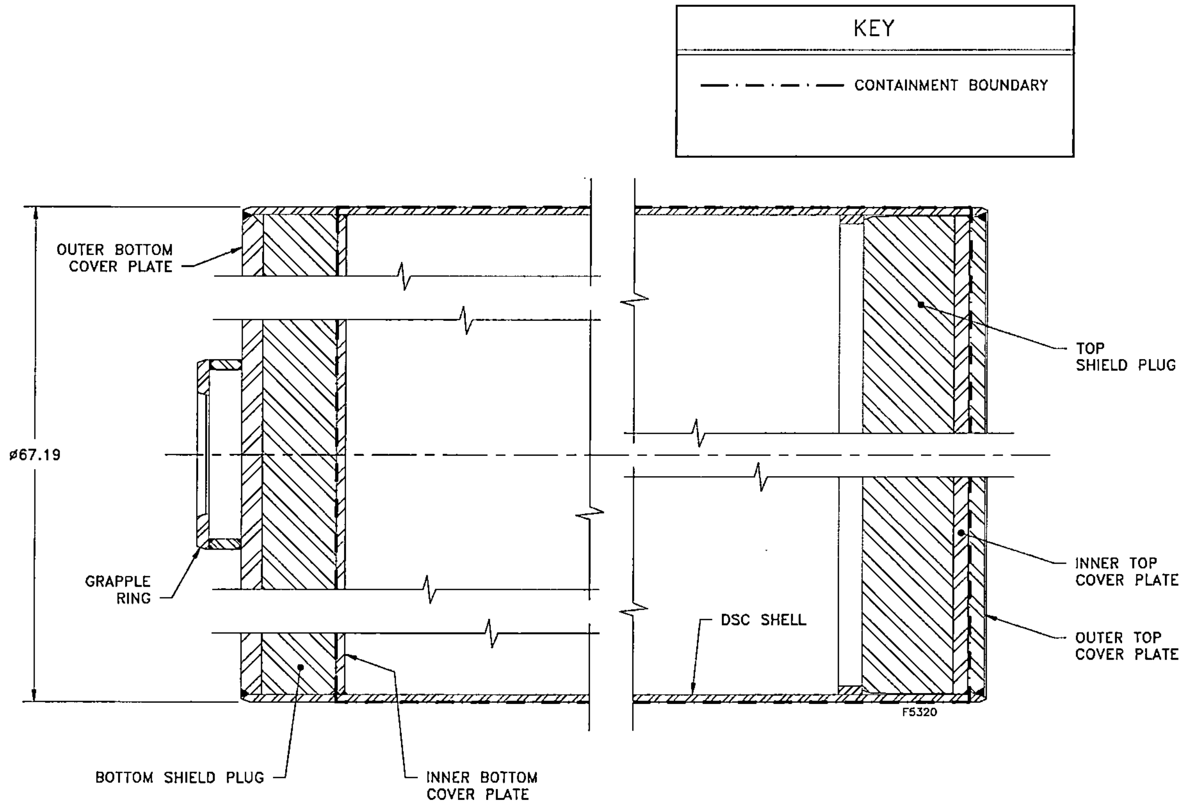

Figure A.4-2
Typical DSC Containment Boundary

(Part 1 of 2)

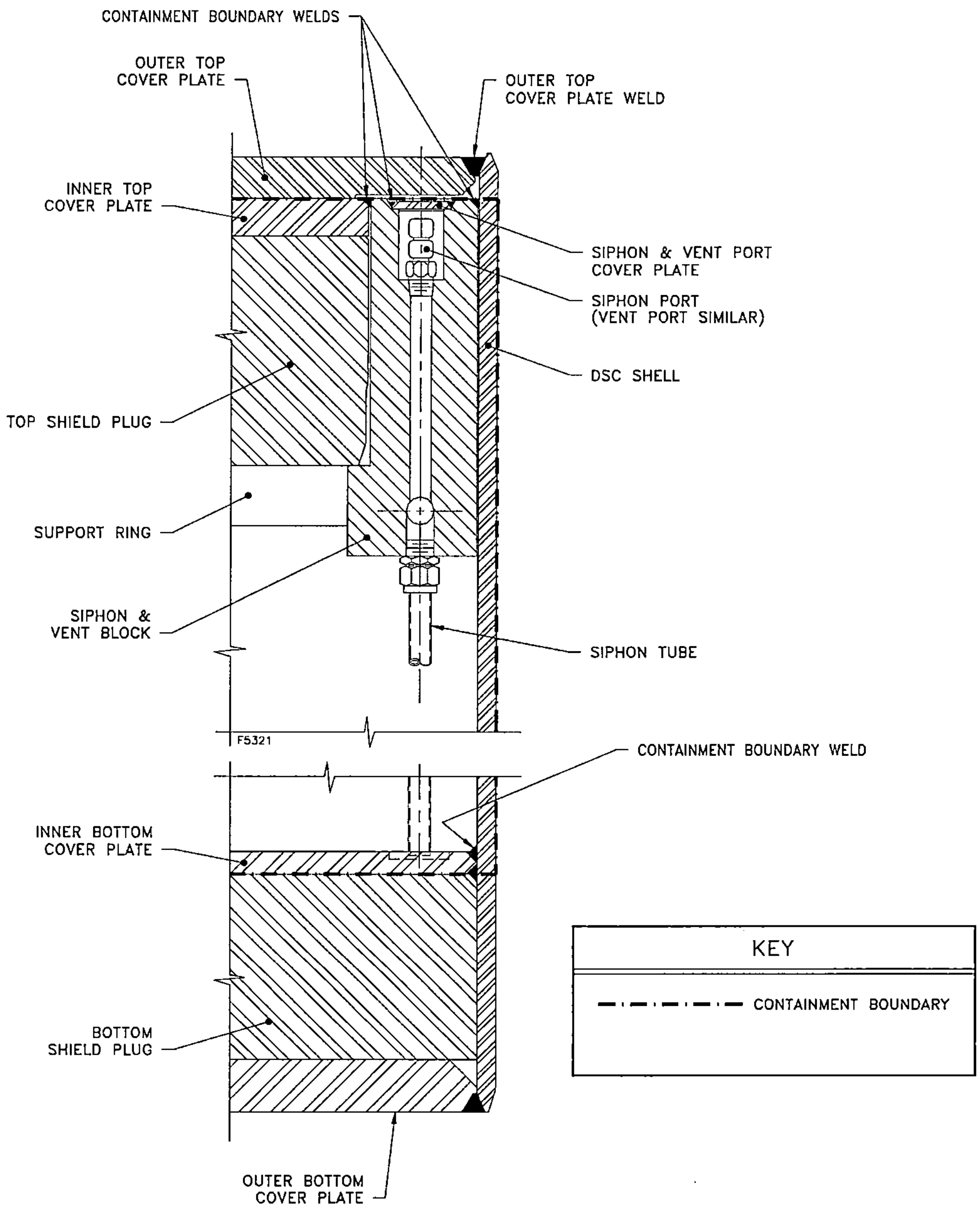

Figure A.4-2
Typical DSC Containment Boundary
(Part 2 of 2)

Appendix A.4.6.1
Containment Reference Leak Rate for RWC Contents

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LIST OF TABLES

Appendix A.4.6.1 is newly added for Revision 18A.

Appendix A.4.6.1
Containment Reference Leak Rate for RWC Contents

NOTE: References in this appendix are shown as [1], [2], etc., and refer to the reference list in Section A.4.6.1.4.

A.4.6.1.1 Criterion, Parameters, and Assumptions

There are two release rates calculated corresponding to the requirements for NCT and HAC in 10 CFR 71.51. The smallest value of these is determined to be the bounding release rate, although NCT and HAC values are both reported. Table A.4.6.1-1 provides the containment criteria for the MP197HB transportation cask.

Table A.4.6.1-1
10CFR71 Containment Criterion for Type B Transportation Packages

Radioactive Release Rate	
Transport Condition	**Value**
Normal Condition of Transport (NCT)	Less than $A_2 \times 10^{-6}$ per hour
Hypothetical Accident Condition (HAC)	Less than A_2 per week (excluding Krypton-85)

A.4.6.1.1.1 Crud Related Data

The MP197HB used with the RWC is designed to carry dry irradiated solid materials, and therefore, there are no radioactive liquids or gases to be contained. However, reactor hardware can include surface contamination ("crud"). The crud can spall and possibly form an aerosol in the cavity atmosphere which could present a potential dispersion situation. Studies [2] show the crud to be very stable and adherent. The typical chemical composition of materials in this aerosol would be primarily oxides of the constituents of reactor hardware metals including radionuclides such as Co-60, Mn-54, Fe-55, and Ni-63. If there was any failed fuel in the reactor or storage pool along with the hardware, there might also be minute traces of fission products.

The major radionuclide of concern in crud is Co-60. Reference [2] reports maximum measured spot crud levels on spent fuel rods for various GE BWR plants between 110 and 180 $\mu Ci/cm^2$ at discharge. Assuming that crud levels on irradiated hardware are no greater than on fuel rods, an overall average value 25% higher than the smallest maximum spot activity of 110 $\mu Ci/cm^2$ can be used for irradiated hardware.

A.4.6.1.1.2 Fluid Parameters

Fluid parameters for calculating volumetric leak rates are shown below in Table A.4.6.1-2.

Appendix A.4.6.1 is newly added for Revision 18A.

Table A.4.6.1-2
Fluid Parameters

Parameter	NCT Leak to Atmosphere	HAC Leak to Atmosphere	Reference Air In-Leakage	Units
Fluid Type	Air	Air	Air at STP	n/a
Fluid Molecular Weight, M	29.00	29.00	29.00	g/mol
Fluid Upstream Pressure, P_u	1.87(1)	1.98(1)	1.00	atm abs
Fluid Downstream Pressure, P_d	0.25(1)	0.25(1)	0.01	atm abs
Leakage Hole Length, a	0.7(1)	0.7(1)	0.7(1)	cm
Fluid Viscosity, μ [4]	0.02462	0.02596	0.0185	cP
Fluid Temperature, T	443.7(1)	471.5(1)	298	K
Average Stream Pressure, P_a	1.06	1.12	0.51	atm abs

1. These values are assumed parameters and are shown here for completeness. The actual assumption and justification are set forth in Section A.4.6.1.1.3.

A.4.6.1.1.3 Assumptions

a) Residual contamination on the interior surface of the cask is neglected. The MP197HB cask interior is kept clean during loading operations by design. The space between the RWC and cask cavity is filled with clean water and a seal is placed between the RWC and cask during loading operations. This assures that the cask cavity remains clean.

b) The only nuclide considered is the activity from Co-60 in the crud.

c) Releases due to crud spallation are conservatively assumed to occur instantaneously at the moment of containment closure. This assumption ensures the maximum amount of radioactive inventory is available should a leak occur just after closure. This assumption is taken for simplicity and ease of calculation.

d) The length of the leakage hole for calculation of the permissible leak rates is assumed to be 0.7 cm (0.275 in). This assumes the leak path length is on the order of the lid seal width.

e) Cavity pressures and gas temperatures relevant to MP197HB transport as shown in Table A.4.6.1-3 are summarized from the thermal evaluation, Sections A.3.3.3, A.3.4.3, and A.3.6.8. The temperatures used are the average cavity gas temperatures for the bounding DSCs with spent fuel contents. The pressures used are obtained from the average cavity gas temperatures.

Table A.4.6.1-3
MP197HB Cavity Gas Temperatures and Pressures

Parameter	Normal	Accident
Pressure	1.87 atm abs (12.7 psig)	1.98 atm abs (14.4 psig)
Temperature	443.7 K (339 °F)	471.5 K (389 °F)

f) It is assumed that the crud surface density provided in [2] of 110 to 180 μCi/cm^2 is reasonably bounding for the purposes of this calculation. The crud is also assumed to be comprised of 100% Co-60. No crud decay is assumed.

g) There are no fission gas products in the MP197HB contents.

h) The free containment volume used to calculate the average activity concentration available for release assume a maximum payload of steel of 112,000 lbs., Section A.2.13.1.2, including the RWC,at a density equal to 7.9 g/cm^3, which bounds the average concentration activity used to determine the releasable activity.

i) The downstream pressure is conservatively taken as 0.25 atm abs for both the NCTand the HAC analyses [1, 3].

j) Solid activated and contaminated waste is confined to the RWC which is a closed container. The RWC is not part of the containment boundary, but will limit any release of any surface contamination that spalls from the waste.

A.4.6.1.2 Determine Allowable Release Rates

The methodology employed in this calculation is based on NUREG/CR-6487 [5]. ANSI N14.5 [3] provides the basis and methods for determining the maximum allowable reference leak rate for leak testing purposes. The allowable reference leak rate is compared to the design criteria for the MP197HB cask.

The calculation is performed in several steps that are described below.

Step 1 – Determine the source term for containment evaluation. Source terms are derived for normal conditions of transport (NCT) and hypothetical accident conditions (HAC).

Step 2 –Calculate effective A_2 values for each transportation condition (NCT and HAC).

Step 3 – Using the effective A_2 values and the source concentrations (source activity available for release in the cask), calculate the permissible leakage rate to satisfy 10 CFR 71.

Step 4 – Using ANSI N14.5 [3], calculate the reference air leakage rates.

A.4.6.1.2.1 Determine the source term

a) Identify the radioactive contents

Although the possibility of forming and releasing a crud-aerosol is minimal, a leakage rate can be calculated for this phenomenon. It is most probable that the crud particles will plug the small holes through which gas leakage usually occurs. However, it is assumed that the particulate leakage rate is the same as the gas leakage rate. The major radionuclide of concern in crud is Co-60.

b) Determine the total releasable activity

Reference [2] reports maximum measured spot crud levels on spent fuel rods for various GE BWR plants between 110 and 180 μCi/cm^2 at discharge. Assuming that crud levels on irradiated

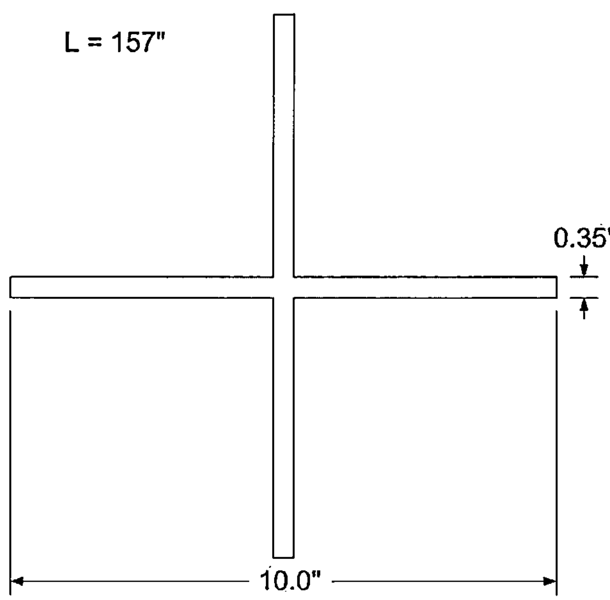
hardware are no greater than on fuel rods, an overall average value 25% higher than the smallest maximum spot activity of 110 μCi/cm^2 can be used for irradiated hardware. The irradiated hardware is typically utilized in the reactor for several years and then may be stored in the fuel pool for several more years. To allow immediate shipment, without requiring an "effective" decay time", the activity is not corrected for decay of Co-60:

$$110\,\mu Ci/cm^2 \times 1.25 = 137.5\ \mu Ci/cm^2$$

Typical contents for the MP197HB used with RWC packaging include irradiated hardware. One type, control rod blades (CRB), is assumed to have the greatest surface area.

The CRB is essentially a cruciform shape with an overall width of approximately 10 in. as shown in the sketch below. It is approximately 157 in. long with 0.35 in. thick plates and weighs approximately 130 kg. The approximate surface area for a CRB can be calculated as:

$$A = (8(10 - 0.35)/2 + 4 \times 0.35) \times 157 = 6280\ in^2 = 40{,}516\ cm^2/CRB$$



Assuming a shipment of no more than 100 CRBs, the activity of Co-60 (crud) on the CRBs in the containment is then:

$$\mathcal{A}_A = 40{,}516\frac{cm^2}{CRB} \times 100\ CRB \times 137.5\ \mu Ci/cm^2 = 557\ Ci$$

Spallation of the crud from the irradiated hardware must occur if an aerosol is to form for possible release. Test data have been reported [6] estimating spallation fractions of 0.05 for BWR fuel rods under "normal" conditions. For conservatism, a spallation factor of 0.15 is assumed for NCT. Of the fraction that spalls from the rods, only a certain fraction of that becomes an aerosol due to agglomeration, plating-out, etc. Because the irradiated hardware is

"handled" quite extensively in the fuel pool, a majority of the easily removable crud will be removed in the fuel pool. Thus it is reasonable to assume that 15% of the crud will spall from the irradiated hardware and all of the spalled crud will become an aerosol capable of leaking from the containment. Therefore, the activity available for release as an aerosol for NCT is:

$$\mathcal{A}_N = 557\ Ci \times 0.15 = 84\ Ci$$

All of the 557 Ci of Co-60 activity on the irradiated hardware is assumed to be available for release for HAC.

A.4.6.1.2.2 Determine an A2 value for the releasable activity

All releasable activity is assumed to be Co-60. The A_2 value for Co-60 is 11 Ci [1].

A.4.6.1.2.3 Determination of allowable leakage rates

a) Determine the release rate for NCT and HAC

The allowable release rate for NCT, R_N is calculated as:

$$\begin{aligned} R_N = 10^{-6} A_2\ per\ hour &= 2.78 \times 10^{-10} A_2\ per\ sec \\ &= 2.78 \times 10^{-10} A_2\ per\ sec \times 11\ Ci/A_2 \\ &= 3.06 \times 10^{-9}\ Ci/sec \end{aligned}$$

The allowable release rate for HAC, R_A is calculated as:

$$\begin{aligned} R_A = A_2\ per\ week &= 1.65 \times 10^{-6} A_2\ per\ sec \\ &= 1.65 \times 10^{-6} A_2\ per\ sec \times 11\ Ci/A_2 \\ &= 1.82 \times 10^{-5}\ Ci/sec \end{aligned}$$

b) NCT Allowable Leak Rate, L_N

The following equation, from ANSI N14.5 [3], is used to calculate the permissible volumetric gas release rate at cask conditions,

$$L_N = \frac{R_N}{C_N}$$

where C_N is the average activity concentration of the gas available for release inside the cask in Ci/cm^3 and R_N is the allowable release rate.

The average activity concentration, C_N, is calculated as:

$$C_N = \frac{\mathcal{A}_N}{V_N}\ Ci/cm^3$$

where V_N = the free volume of the containment system and $\mathcal{A}_N$ is the releasable activity.

Appendix A.4.6.1 is newly added for Revision 18A.

The free volume in the containment is the MP197HB cavity volume less the waste volume and the liner volume. The MP197HB cavity volume, based on dimensions given on drawing MP197HB-71-1014 and the required shielding thicknesses for the RWC at the top and bottom ends, is:

$$V_C = \pi/4 \times 68^2\ in^2 \times 196.81\ in \times 2.54^3\ cm^3/in^3 = 1.17 \times 10^7 cm^3$$

Assuming the packaging has its maximum payload, 112,000 lbs including a liner, the payload volume, assuming a metal density of 7.9 g/ cm^3, is:

$$V_P = \frac{112{,}000\ lbs}{2.205 \times 10^{-3} \frac{lbs}{g} \times 7.9\ g/cm^3} = 6.43 \times 10^6 cm^3$$

The minimum free containment volume is:

$$V_N = V_C - V_P = 1.17 \times 10^7 cm^3 - 6.43 \times 10^6 cm^3 = 5.27 \times 10^6 cm^3$$

The average activity concentration is:

$$C_N = \frac{\mathcal{A}_N}{V_N} Ci/cm^3 = \frac{84\ Ci}{5.27 \times 10^6 cm^3} = 1.59 \times 10^{-5} Ci/cm^3$$

The maximum allowable leakage rate during normal condition of transport is:

$$L_N = \frac{R_N}{C_N} = \frac{3.06 \times 10^{-9}\ Ci/sec}{1.59 \times 10^{-5} Ci/cm^3} = 1.92 \times 10^{-4} cm^3/sec$$

c) HAC Allowable Leak Rate, L_N

Using the free containment volume calculated for NCT, $V_A = V_N$, and assuming that all of the Co-60 crud activity on the irradiated hardware becomes an aerosol, the average activity is:

$$C_A = \frac{\mathcal{A}_A}{V_A} Ci/cm^3 = \frac{557\ Ci}{5.27 \times 10^6 cm^3} = 1.06 \times 10^{-4} Ci/cm^3$$

The maximum allowable leakage rate during HAC is:

$$L_A = \frac{R_A}{C_A} = \frac{1.82 \times 10^{-5}\ Ci/sec}{1.06 \times 10^{-4} Ci/cm^3} = 1.72 \times 10^{-1} cm^3/sec$$

A.4.6.1.2.4 Determine the reference air leakage rates

a) NCT reference air leakage rate, L_{RN}

The air leakage rate at standard conditions that is equivalent to L_N is determined following the example 19 in ANSI N14.5, Annex B, [3]. The following formula is used for calculating the reference air leakage rate,

$$L_u = (F_c + F_m)(P_u - P_d) \cdot \left(\frac{P_a}{P_u}\right) cm^3/sec \qquad \text{(Eq. 1)}$$

where,

L_u is the upstream volumetric leakage rate (cm^3/sec),

F_c is the coefficient of continuum flow conductance per unit pressure (cm^3/atm-sec),

$$F_c = \frac{(2.49 \times 10^6 \cdot D^4)}{(a\mu)} \qquad \text{(Eq. 2)}$$

F_m is the coefficient of free molecular flow conductance per unit pressure (cm^3/atm-sec),

$$F_m = \frac{\left(3.81 \times 10^3 \cdot D^3 \cdot \left(\frac{T}{M}\right)^{0.5}\right)}{(aP_a)} \qquad \text{(Eq. 3)}$$

where, D is the leakage hole diameter (cm), a is the leakage hole length (cm), μ is the fluid viscosity (cP), T is the fluid absolute temperature and M is the molecular weight (g/mol).

P_u is the upstream fluid pressure (atm abs),

P_d is the downstream fluid pressure (atm abs) and

P_a is the average stream pressure (atm abs). The average stream pressure is calculated as a linear average,

$$P_a = \frac{1}{2}(P_u + P_d) \qquad \text{(Eq. 4)}$$

a is the assumed length of the leakage path, 0.7 cm (0.275 in) (See Assumption A.4.6.1.1.3.d).

The value for L_N calculated in A.4.6.1.2.3.b is the maximum leakage rate, L_U is equation 1. All the parameters are known except the leakage hole diameter. The diameter is found by iteratively solving the equation 1. For NCT, $L_U = L_N = 1.92 \times 10^{-4}$ cm^3/sec.

Using the values given for NCT in Table A.4.6.1-2, the resulting leakage hole diameter, D is found as,

$$D = 1.064 \times 10^{-3}\ cm$$

The F_c and F_m values using this diameter are calculated using equations 2 and 3 as,

$$F_c = \frac{(2.49 \times 10^6 \cdot (1.064 \times 10^{-3}\ cm)^4)}{(0.7 \times 0.02462)} = 1.85 \times 10^{-4}$$

$$F_m = \frac{\left(3.81 \times 10^3 \cdot (1.064 \times 10^{-3}\ cm)^3 \cdot \left(\frac{443.7}{29}\right)^{0.5}\right)}{(0.7 \times 1.06)} = 2.42 \times 10^{-5}$$

and L_N is verified using the value for D in equation 1 as:

$$L_N = (1.85 \times 10^{-4} + 2.42 \times 10^{-5})(1.87 - 0.25) \cdot \left(\frac{1.06}{1.87}\right)$$
$$= 1.92 \times 10^{-4}\ cm^3/sec$$

Using this value of D, the resulting standard leakage rate is calculated using the same equation 1, but with parameters corresponding to standard conditions. The resulting NCT reference air leakage rate L_{RN} is calculated as:

$$F_c = \frac{(2.49 \times 10^6 \cdot (1.064 \times 10^{-3})^4)}{(0.7 \times 0.0185)} = 2.46 \times 10^{-4}$$

$$F_m = \frac{\left(3.81 \times 10^3 \cdot (1.064 \times 10^{-3})^3 \cdot \left(\frac{298}{29}\right)^{0.5}\right)}{(0.7 \times .505)} = 4.16 \times 10^{-5}$$

$$L_{RN} = (2.46 \times 10^{-4} + 4.16 \times 10^{-5})(1.00 - 0.01) \cdot \left(\frac{0.505}{1.00}\right)$$
$$= 1.44 \times 10^{-4}\ cm^3/sec$$

b) HAC Reference Air Leakage Rate, L_{RA}

The value for L_A calculated in A.4.6.1.2.3.c is the maximum leakage rate, L_U is equation 1. All the parameters are known except the leakage hole diameter. The diameter is found by iteratively solving the equation 1. For HAC, $L_U = L_A = 1.72 \times 10^{-1}$ cm^3/sec.

Using the iterative calculation method described in A.4.6.1.2.1.4.a and parameter values given in Table A.4.6.1-2 for HAC, the resulting leakage hole diameter, D, is found as:

$$D = 5.953 \times 10^{-3}\ cm$$

The F_c and F_m values using this diameter are,

$$F_c = \frac{(2.49 \times 10^6 \cdot (5.953 \times 10^{-3})^4)}{(0.7 \times 0.02596)} = 1.72 \times 10^{-1}$$

$$F_m = \frac{\left(3.81 \times 10^3 \cdot (5.953 \times 10^{-3})^3 \cdot \left(\frac{471.5}{29}\right)^{0.5}\right)}{(0.7 \times 1.12)} = 4.15 \times 10^{-3}$$

and L_A is verified using the value for D in equation 1 as:

$$L_A = (1.72 \times 10^{-1} + 4.15 \times 10^{-3})(1.98 - 0.25) \cdot \left(\frac{1.12}{1.98}\right)$$
$$= 1.72 \times 10^{-1}\ cm^3/sec$$

Using this value of D, the resulting standard leakage rate is calculated using the same equation 1, but with parameters corresponding to standard conditions. The resulting HAC reference leakage rate L_{RA} is calculated as:

$$F_c = \frac{(2.49 \times 10^6 \cdot (5.953 \times 10^{-3})^4)}{(0.7 \times 0.0185)} = 2.42 \times 10^{-1}$$

$$F_m = \frac{\left(3.81 \times 10^3 \cdot (5.953 \times 10^{-3})^3 \cdot \left(\frac{298}{29}\right)^{0.5}\right)}{(0.7 \times 0.505)} = 7.29 \times 10^{-3}$$

$$L_{RA} = (2.42 \times 10^{-1} + 7.29 \times 10^{-3})(1.00 - 0.01) \cdot \left(\frac{0.505}{1.00}\right)$$
$$= 1.24 \times 10^{-1}\ cm^3/sec$$

c) Reference Air Leak Rate, L_R

The NCT reference air leak rate is the more restrictive of the values determined for the NCT and HAC, therefore, $L_R = L_{NR} = 1.44 \times 10^{-4}$ ref cm^3/sec.

A.4.6.1.3 Leak Rate Criteria

The releasable activity values for the cask are calculated as 84 Ci for NCT and 557 Ci for HAC. Table A.4.6-4 summarizes the allowable radionuclide release rates to satisfy 10 CFR 71 containment requirements. The release rates to satisfy 10 CFR 71 for NCT and HAC are shown in Table A.4.6-5 and A.4.6-6.

The following leak rates are specified for tests in accordance with ANSI N14.5, Section 7 [3]:

Fabrication, maintenance and periodic verification tests shall determine that the leak rate for the cask is no greater than $L_R = 1.44 \times 10^{-4}$ ref cm^3/sec with a test sensitivity better than 7.20×10^{-5} cm^3/sec.

Pre-shipment tests shall use the reference air leak rate or demonstrate no detectable leakage when tested to a sensitivity of at least 10^{-3} ref cm^3/sec.

A.4.6.1.4 References

1. "Packaging and Transportation of Radioactive Material," 10 CFR Part 71.

2. Hazelton, R.F., "Characteristics of Fuel Crud and its Impact on Storage, Handling and Shipment of Spent Fuel", PNL-6273 Pacific Northwest Laboratories, September 1987.

3. ANSI N14.5-2014, "American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment," June 2014.

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5. NUREG/CR-6487, "Containment Analysis for Type B Packages Used to Transport Various Contents," LLNL, November 1996.

6. Einziger, R.E., and J. Cook "LWR Spent Fuel Dry Storage Behavior at 229°C", NUREG/CR-3708, HEDL-TME-84-17, Hanford Engineering Development Laboratory, Richland Washington, August 1984.

Table A.4.6.1-4
10 CFR 71 Allowable Release Rates for the MP197HB Transport Cask

Case	Effective A_2 (Ci)	Allowable Release Rate	Allowable Release Rate, R (Ci/sec)	Average Activity Concentration C (Ci/cm^3)	Allowable Leakage Rate L (cm^3/sec)
NTC	11	A_2 x 10^{-6} per hour (2.78 x 10^{-10} A_2 per second)	3.06E-09	1.59E-05	1.92E-04
HAC	11	A_2 per week (1.65 x 10^{-6} A_2 per second)	1.82E-05	1.06E-04	1.72E-01

Table A.4.6.1-5
Leak Rates for the MP197HB Transport Cask – Normal Conditions of Transport

Allowable Leakage Rate							
D (cm)	F_c (cc/atm-sec)	F_m (cc/atm-sec)	P_u (atm abs)	P_d (atm abs)	P_a (atm abs)	T (K)	L_N (cc/sec)
1.064E-03	1.85E-04	2.42E-05	1.87	0.25	1.06	443.7	1.92E-04
Reference Leakage Rate							
D (cm)	F_c (cc/atm-sec)	F_m (cc/atm-sec)	P_u (atm abs)	P_d (atm abs)	P_a (atm abs)	T (K)	L_{RN} (ref cc/sec)
1.064E-03	2.46E-04	4.16E-05	1.00	0.01	0.51	298	1.44E-04

Table A.4.6.1-6
Leak Rates for the MP197HB Transport Cask – Hypothetical Accident Condition

Allowable Leakage Rate							
D (cm)	F_c (cc/atm-sec)	F_m (cc/atm-sec)	P_u (atm abs)	P_d (atm abs)	P_a (atm abs)	T (K)	L_A (cc/sec)
5.953E-03	1.72E-01	4.15E-03	1.98	0.25	1.12	471.5	1.72E-01
Reference Leakage Rate							
D (cm)	F_c (cc/atm-sec)	F_m (cc/atm-sec)	P_u (atm abs)	P_d (atm abs)	P_a (atm abs)	T (K)	L_{RA} (ref cc/sec)
5.953E-03	2.42E-01	7.29E-03	1.00	0.01	0.51	298	1.24E-01

Appendix A.4.6.1 is newly added for Revision 18A.

Chapter A.7
Package Operations

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Chapter A.7
Package Operations

NOTE: References in this chapter are shown as [1], [2], etc., and refer to the reference list in Section A.7.5. A glossary of terms used in this chapter is provided in Section A.7.6.

This chapter contains NUHOMS®-MP197HB cask loading and unloading procedures that are intended to show the general approach to cask operational activities. The procedures in this chapter are intended to show the types of operations that will be performed and are not intended to be limiting. Site specific conditions and requirements may require the use of different equipment and ordering of steps to accomplish the same objectives or acceptance criteria which must be met to ensure the integrity of the package.

A separate operations manual (OM) will be prepared for the NUHOMS®-MP197HB cask to describe the operational steps in greater detail. The OM, along with the information in this chapter, will be used to prepare the site-specific procedures that will address the particular operational considerations related to the cask.

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A.7.1 NUHOMS®-MP197HB Package Loading

The use of the NUHOMS®-MP197HB cask to transport fuel offsite involves (1) preparation of the cask for use, (2) verification that the fuel assemblies loaded in the dry shielded canister (DSC) meet the criteria set forth in this document, and (3) installation of a DSC into the cask. Also included herein are procedures to prepare and load fuel in an empty DSC contained in a NUHOMS®-MP197HB cask and to close the DSC.

The use of the NUHOMS®-MP197HB cask to transport dry irradiated and/or contaminated non-fuel bearing solid materials in radioactive waste canisters (RWCs) involves (1) preparation of the cask for use, (2) verification that the waste to be loaded meet the criteria set forth in this document, and (3) loading of the RWC and waste into the cask.

Offsite transport involves (1) preparation of the cask for transport, (2) assembly verification leakage-rate testing of the packaging containment boundary, (3) placement of the cask onto a transportation vehicle, and (4) installation of the impact limiters.

During shipment, the packaging contains any one of the DSCs as described in Chapter A.1, Appendices A.1.4.1 through A.1.4.9 or an RWC as described in Appendix A.1.4.9A. Type and

form of the content and their maximum quantity to be loaded in any of the nine DSCs are specified in Table A.7-2a. Type and form of the content and their maximum quantity to be loaded in an RWC are specified in Table A.7-2b. Procedures are provided in this section for (1) transport of the cask/DSC/RWC directly from the plant spent fuel pool and (2) transport of a DSC/RWC which was previously stored in a NUHOMS® horizontal storage module (HSM). Section A.7.7 contains an appendix for each DSC model detailing its loading procedures. Table A.7-3 lists these appendices.

A.7.1.1 NUHOMS®-MP197HB Cask Preparation for Loading

Procedures for preparing the cask for use after receipt at the loading site are provided in this section and are applicable for shipment of DSCs loaded with fuel or of RWCs loaded with dry irradiated and/or contaminated non-fuel bearing solid materials.

1. Remove the impact limiters from the cask.
2. *NOT USED.*
3. Remove the transportation skid personnel barrier and tie down assembly.
4. Take contamination smears on the outside surfaces of the cask. If necessary, decontaminate the cask.
5. *Elastomer* O-ring seals *may be reused. Metallic seals* shall be discarded after each use.
6. Install the front and rear trunnions, if required*, and torque the bolts as specified in Drawing MP197HB-71-1002, Chapter A.1, Appendix A.1.4.10.1 following the torquing sequence shown in Figure A.7-1.*
7. Lift the cask and place it on the onsite transfer trailer or upending frame, or lift the cask/transport skid and place them in the appropriate location.
8. NOT USED.
9. NOT USED.
10. If transporting any of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) or an RWC, verify that the MP197HB cask has been fitted with an internal sleeve. This step, if required, can be performed at any time prior to placing the DSC or RWC in the cask.
11. If transporting a NUHOMS®-69BTH DSC with heat load greater than 26 kW, verify that the removable external aluminum fins are available to be fitted to the cask after the cask is closed (Refer to Drawing MP197HB-71-1011 provided in Appendix A.1.4.10.1). Note that fins are not required to meet the 10 CFR 71 requirements and are optional.
12. For a specific DSC model to be loaded inside the MP197HB cask, verify the canister/basket type (A, B, C, D, E, or F as applicable) is appropriate for the fuel to be transported.
13. The candidate intact, damaged and failed fuel assemblies to be transported in a specific DSC model must be evaluated (by plant records or other means) to verify that they meet the criteria of the applicable fuel specification as listed in Table A.7-2a.
14. For the transportation of fuel within the NUHOMS®-32PT, 24PTH, 32PTH, 32PTH1, or 37PTH DSCs where burnup credit is employed for criticality safety, additional administrative controls to prevent misloading are also outlined in the applicable appendices of this chapter.

A.7.1.2 NUHOMS®-MP197HB Cask Wet Loading

NOTE: The wet loading procedure described in this section is applicable only when using the MP197HB cask for loading fuel from a spent fuel pool into any one of the DSCs listed in Chapter A.1 or for loading irradiated waste into a RWC. This section also provides steps for closure of the DSC/RWC.

Site specific conditions and requirements may require the use of different equipment and ordering of steps than those described below to accomplish the same objectives or acceptance criteria which must be met to ensure the integrity of the package.

1. Prior to being placed in service, the cask is to be cleaned or decontaminated as necessary.
2. *Verify proper ram access closure plate, drain port bolt, and ram access test port bolt are installed based on the following requirements. If necessary, replace components and tighten bolts as specified on Drawing MP197HB-71-1002, Chapter A.1 Appendix A.1.4.10.1 following the torquing sequence shown in Figure A.7-1.*
3. *For DSC shipments, the specific ram access closure plate, drain port bolt, and ram access test port bolt incorporate metal seals. Prior to installation, the sealing surfaces shall be inspected and new seals installed.*
4. *For RWC shipments, the specific ram access closure plate, drain port bolt, and ram access test port bolt incorporate elastomer O-ring seals. Prior to installation, the seals and sealing surfaces shall be inspected. Verify that the seals have been replaced within the last 12 months.*
5. Engage the cask front trunnions with the lifting yoke using the plant crane, rotate the cask to a vertical orientation, lift the cask from the onsite transfer skid *or upending frame*, and place the cask in the plant designated preparation area.
6. Install the shear key plug assembly.
7. If the cask lid has not already been removed, remove the bolts from the cask lid and lift the lid from the cask.
8. *Inspect the lid O-rings and sealing surfaces. Verify that the O-rings have been replaced within the last 12 months.*
9. *Inspect the vent and lid test port O-rings and associated sealing surfaces. Verify that the O-rings have been replaced within the last 12 months.*
10. If loading any one of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) or RWCs from the MP197HB cask, install an unloading flange. Depending on the DSC *or RWC* model being loaded, verify that a DSC *or RWC* bottom spacer of appropriate height is placed at the bottom of the cask. The height of the DSC *or RWC* bottom spacer required for each type of DSC *or RWC* is listed in Table A.7-1.
11. *If not already installed, place an empty DSC or RWC in the cask.*
12. If damaged fuel is to be loaded in the DSC, place bottom end caps into the cell locations that are to receive damaged fuel. For the NUHOMS®-24PT4 DSC only, verify that the failed fuel cans, required for loading damaged fuel assemblies if used, have replaced the guide sleeves at the locations specified for the specific configurations of the 24PT4 DSC.
13. If failed fuel is to be loaded in the DSC (24PTH or 61BTH DSCs only), put the appropriate empty failed fuel cans in the appropriate locations.

13a. If fuel and basket spacers are required, the height of the fuel and basket spacers required for each type of DSC is listed in Table A.7-1.

14. Fill the cask/DSC *or RWC* annulus with water. Install the annulus seal.
15. Fill the DSC *or RWC* cavity with water. For the NUHOMS®-32PT, 24PTH, 32PTH, 32PTH1, and 37PTH DSCs, a minimum soluble boron concentration is required during loading and unloading operations.

A.7.1.2.1 DSC/RWC Wet Loading

The procedures for loading, vacuum drying, and sealing the DSC/RWC are described in detail in Appendices A.7.7.1 through A.7.7.10 as listed in Table A.7-3.

Following the completion of the wet loading activities described in a specific appendix listed in Table A.7-3, the MP197HB cask is prepared for downending as described in the next section.

A.7.1.2.2 Preparing the NUHOMS®-MP197HB Cask for Downending

1. *NOT USED.*
2. If transporting any one of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) or RWC, *remove the unloading flange.*
3. *NOT USED.*
4. NOT USED.
5. Install shims, if required.

5a. Install the DSC top spacer if required. The appropriate height of the DSC top spacer required for each type of DSC is listed in Table A.7-1.

6. Install the cask lid *and torque the bolts as specified on Drawing MP197HB-71-1002, Chapter A.1 Appendix A.1.4.10.1 following the torquing sequence shown in Figure A.7-1.*
7. *NOT USED.*
8. *NOT USED.*
9. *If the cask was wet loaded, perform the dryness verification test following the procedure given in Section A.7.4.1.*
10. Perform the assembly verification leakage test following the procedure given in Section A.7.4.*2*.

A.7.1.2.3 NUHOMS®-MP197HB Cask Downending

NOTE: Alternate procedures may be developed for plants with unique requirements.

1. Remove the shear key plug assembly from the cask.
2. Lift the cask over the onsite transfer skid *or upending frame*.
3. NOT USED.
4. Position the cask rear trunnions onto the onsite transfer skid *or upending frame*.
5. Downend the cask and secure it to the skid *or frame*.
6. NOT USED.
7. NOT USED.
8. NOT USED.
9. Prepare the cask for transportation in accordance with the procedure described in Section A.7.1.4.

A.7.1.3 NUHOMS®-MP197HB Cask Dry Loading (Transferring a Loaded DSC or RWC from an Overpack into an MP197HB Cask)

A number of NUHOMS® DSCs are currently being used for onsite storage of spent fuel inside the NUHOMS® horizontal storage modules (HSMs) or the advanced horizontal storage modules (AHSMs) under the provisions of 10 CFR 72.

This section summarizes the steps for transferring a previously loaded DSC under a 10 CFR *Part* 72 license from the HSM or AHSM (generally referred here as HSM) to the MP197HB cask for transportation. Depending on the most recent use of the cask, several of the initial steps listed below may not be necessary.

An RWC may be stored in an HSM, AHSM or other allowed overpack on the plant site. When the MP197HB cask is dry loaded with an RWC, operational steps similar to dry loading a DSC from an HSM into the MP197HB cask should be used depending on the storage overpack.

CAUTION:

Before initiating any steps described in this section:

- The licensee shall perform an audit of spent fuel pool records from the time of canister loading for the identification of the loaded fuel assemblies, and
- The licensee shall compare the irradiation parameters of the loaded contents against those shown in Table A.6-17 to ensure compliance with the isotopic depletion analysis.

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3. Remove the ram access closure plate, *the port bolts for the drain and ram access test ports,* and the lid.
4. If loading any one of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) *or RWCs* in the NUHOMS®-MP197HB cask, install an unloading flange. Verify that a DSC *or RWC* bottom spacer of appropriate height is placed at the bottom of the cask. The height of the DSC *or RWC* bottom spacer required for each type of DSC *or RWC* is listed in Table A.7-1.
5. For DSC shipments, obtain the specific ram access closure plate, drain port bolt, and ram access test port bolt that incorporate metal seals. Prior to installation, the sealing surfaces shall be inspected and new seals installed.
5a. For RWC shipments, obtain the specific ram access closure plate, drain port bolt, and ram access test port bolt that incorporate elastomer O-ring seals. Prior to installation, the seals and sealing surfaces shall be inspected. Verify that the seals have been replaced within the last 12 months.
5b. Inspect the lid, vent, and lid test port O-rings and associated sealing surfaces. Verify that the O-rings have been replaced within the last 12 months.
6. Bring the onsite transfer trailer and the NUHOMS®-MP197HB cask to the ISFSI site.
7. Remove the HSM door and the DSC seismic restraint assembly from the HSM.
8. NOT USED.
9. Align and dock the cask with the HSM.
10. Install the cask/HSM restraints.
11. Align the hydraulic ram cylinder in the ram trunnion support assembly.
12. Extend the ram hydraulic cylinder and engage the grapple ring.
13. NOT USED.
14. Retract the ram hydraulic cylinder until the DSC is fully retracted into the cask.
15. NOT USED.
16. Disengage the hydraulic ram from the grapple ring and remove from the cask ram access area.
17. Install the cask ram access closure plate (with new seals *for DSC shipments)*, following the torquing sequence shown in Figure A.7-1, and torque as specified in Drawing MP197HB-71-1002, Chapter A.1, Appendix A.1.4.10.1.
18. Remove the cask/HSM restraints.
19. Move the cask to the transfer position.
20. NOT USED.
21. NOT USED.
22. If transporting any one of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) *or RWC, remove the unloading flange..*
23. Install shims, if required.
23a. Install the DSC top spacer as specified in Table A.7-1.

24. Install the cask lid *and torque the bolts as specified on Drawing MP197HB-71-1002, Chapter A.1 Appendix A.1.4.10.1 following the torquing sequence shown in Figure A.7-1.*
25. NOT USED.
26. *NOT USED.*
27. When required, perform helium leak detection testing of the cask cavity to verify the integrity of a loaded DSC in accordance with the procedure given in Part 3 of [16] TN E-33299, "Evaluation Procedure to Verify DSC Acceptance for Transport."

28. *If currently installed,* remove the shear key plug assembly from the cask.
29. Perform the assembly verification leakage test following the procedure given in Section A.7.4.*2*.
30. Prepare the cask for transportation in accordance with the procedure described in Section A.7.1.4.

A.7.1.4 NUHOMS®-MP197HB Cask Preparation for Transport

Once the NUHOMS®-MP197HB cask has been loaded using either the wet loading procedure described in Section A.7.1.2 or the dry loading procedure described in Section A.7.1.3 above, the following tasks are performed to prepare the cask for transportation. The cask is assumed to be seated horizontally in the onsite transfer skid. Alternate procedures may be developed for plants with unique requirements.

1. Verify that the cask surface removable contamination levels meet the requirements of 49 CFR 173.443 [2] and 10 CFR 71.87 [3].
2. Verify that the assembly verification leakage rate testing *has been performed as* specified in Section A.7.4.*2*. This test must be performed within 12 months prior to the shipment.
3. If the packaging contains high burnup fuel assemblies, perform a Radiation Survey (both neutron and gamma) and a Thermal Survey of the cask loaded with the contents to evaluate the axial radiation and thermal source distributions prior to transportation.

   These surveys shall be performed using the same quality assurance requirements to comply with 10 CFR 71.43 and 10 CFR 71.47 [3] in accordance with Regulatory Guide 1.21 [19]. A record of the survey results showing the location of the survey points, type and model of the instruments shall be prepared for delivery to the packaging recipient. The location of the survey points should be labeled legibly on the cask outer surface for recipient use. An example showing survey points on a Type B cask for transportation of non-fuel bearing solid material is provided in *Figure A.7-4*.

A.7.1.4.1 Placing the NUHOMS®-MP197HB Cask onto the Conveyance

The procedure for placement of the cask on the conveyance is given in this section. If the cask is already on the transportation skid, rig the cask/skid, lift and place on the conveyance, then skip to Step 8.

1. Bring the cask to the conveyance.
2. NOT USED.
3. NOT USED.
4. NOT USED.
5. Place the cask onto the transportation skid.
6. Remove the cask upper and lower trunnions and install the trunnion plugs.
7. NOT USED.
8. If necessary, install the optional external aluminum fins.

9. Install the transportation skid tie-down straps.
10. Install the impact limiters on the cask and torque the attachment bolts in accordance with the drawings in Chapter A.1, Appendix A.1.4.10.1.
11. Remove the impact limiter hoist rings and replace them with hex bolts.
12. Install the cask tamperproof seals.
13. Install the transportation skid personnel barrier.
14. Perform a final radiation survey to assure the cask radiation levels do not exceed 49 CFR 173.441 [2] and 10 CFR 71.47 [3] requirements.
15. Verify that the temperature on all accessible surfaces is < 185°F.
16. Prepare the final shipping documentation and release the loaded cask for shipment.

A.7.2 NUHOMS®-MP197HB Package Unloading

Unloading the NUHOMS®-MP197HB cask after transport involves removing the cask from the conveyance and removing the DSC from the cask. The cask is designed to allow the DSC to be unloaded from the cask into a NUHOMS® staging module, hot cell or other suitable overpack, and provisions exist to allow wet unloading into a fuel pool. *RWCs can either be unloaded similarly to the DSCs, or the contents can be vertically unloaded with the RWC remaining in the cask.* The necessary procedures for these tasks are essentially the reverse of those described in Section A.7.1.

A.7.2.1 Receipt of Loaded NUHOMS®-MP197HB Package from Carrier

Procedures for receiving the loaded cask after shipment are described in this section. Procedures for receiving an empty cask are provided in Section A.7.1.1.

1. Verify that the tamperproof seals are intact.
2. Remove the tamperproof seals.
3. Remove the hex bolts from the impact limiters and replace them with the impact limiter hoist rings provided.
4. Remove the impact limiters from the cask.
5. Remove the transportation skid personnel barrier and tie-down straps.
6. Remove the external aluminum fins, if present.
7. Take contamination smears on the outside surfaces of the cask. If necessary, decontaminate the cask.
8. *If required for unloading, i*nstall the front and rear trunnions and torque the bolts *as specified in Drawing MP197HB-71-1002, Chapter A.1, Appendix A.1.4.10.1* following the torquing sequence shown in Figure A.7-1.
9. If the packaging contains high burnup fuel assemblies, perform a Radiation Survey (both neutron and gamma) and a Thermal Survey of the cask loaded with the contents to evaluate the axial radiation and thermal source distributions. These surveys shall be performed on the survey locations identified in Section A.7.1.4, Step 3 using the same quality assurance requirements. It is recommended to use the same type and model of the

instruments that were used in the surveys prior to transportation. Compare the results of the above surveys to the results of the surveys performed prior to transportation required in Section A.7.1.4.

The shifts of the peak temperature or peak dose rates, particularly the neutron dose rate, toward the cask ends are the criteria to indicate that potentially a fuel reconfiguration occurred during transport.

The information obtained from these inspections can be employed as indicators to determine the ALARA requirements of the unloading operations.

10. Lift the cask from the conveyance. Place cask onto the onsite transfer trailer or other location.
11. Prior to unloading of high burnup fuel assemblies, perform the operations outlined in Table A.7-5.
12. Transfer the cask to a staging module, fuel pool, dry cell, storage overpack, *or other allowed unloading location* and unload using the procedures described in the following sections.

A.7.2.2 Removal of Contents from NUHOMS®-MP197HB Cask

For unloading of high burnup fuel assemblies, proceed with the following operations only after performing the operations outlined in Table A.7-5.

A.7.2.2.1 Unloading the NUHOMS®-MP197HB Cask to a Suitable Overpack

The procedure for unloading a DSC/RWC from the cask into an HSM or other authorized overpack is summarized in this section. This procedure is typical of NUHOMS® ISFSIs. Alternate procedures may be developed for plants with unique requirements.

1. Verify that the MP197HB cask has been prepared as described in Section A.7.1.1.
2. If the shear key plug assembly is not in place, install the shear key plug assembly *if needed.*
3. Position the onsite transfer trailer in front of the module face.
4. *For DSC shipments, s*ample the cask cavity atmosphere through the vent port. Flush the cask interior gases if necessary.
5. Remove the cask ram access closure plate.
6. NOT USED.
7. Remove the HSM/overpack door.
8. Align the cask with the HSM/overpack.
9. Remove the cask lid.
10. If unloading any one of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) or the RWC from the MP197HB cask *and* install an unloading flange.
11. Dock the cask with the HSM/overpack and install the cask/HSM restraints.
12. NOT USED.
13. Extend the ram hydraulic cylinder and engage the grapple ring.
14. NOT USED.
15. Using the ram hydraulic cylinder move the DSC/RWC into the HSM/overpack.
16. NOT USED.
17. NOT USED.
18. Remove the cask/HSM restraints and move the cask away from the HSM/overpack.
19. Install the cask lid and cask ram access closure plate, if required.
20. Install the HSM/overpack door and seismic restraint, as applicable.
21. NOT USED.
22. NOT USED.

A.7.2.2.2 Unloading the NUHOMS®-MP197HB Cask to a Fuel Pool

The procedure for unloading the cask and DSC/RWC to a fuel pool is summarized in this section. Site specific conditions and requirements may require the use of different equipment and ordering of steps than those descried below to accomplish the same objectives or acceptance criteria which must be met to ensure the integrity of the package. Note that the NUHOMS®-MP197HB cask or an alternate suitable cask may be used for onsite movements of the DSC/RWC.

1. Verify that the NUHOMS®-MP197HB cask has been prepared as described in Section A.7.1.1.
2. Place the cask in the fuel receiving area.

3. NOT USED.
4. Rotate the cask to a vertical orientation and place the cask in the decon pit.
5. If the shear key plug assembly is not already in place, install the shear key plug assembly.
6. Sample the cask cavity atmosphere. Flush the cask interior gases if necessary.
7. Remove the lid from the cask.
8. NOT USED.
9. If the cask contains any one of the smaller diameter DSC models (NUHOMS®-24PT4, 32PT, 24PTH, 61BT, or 61BTH) or an RWC, remove the cask spacer ring at the top of the aluminum sleeve as shown in Drawing MP197HB-71-1014, Appendix A.1.4.10.1.
10. Fill the cask/DSC or cask/RWC annulus with water and install the cask/DSC or cask/RWC annulus seal.

After completion of the preparatory steps described above, follow the specific DSC unloading procedure as described in one of Appendices A.7.7.1 through A.7.7.9 as listed in Table A.7-4.

A.7.2.2.3 Unloading the NUHOMS®-MP197HB Cask to a Dry Cell

The procedure for handling a DSC in a dry cell is highly dependent on the design of the dry cell and on the intended future use of the DSC. The procedure described below is intended to show the type of operations that will be performed and is not intended to be limiting.

1. Tow the onsite transfer trailer to the hot cell area.
2. NOT USED.
3. Using the cask lifting yoke, place the cask in the appropriate handling area.
4. Sample the cask cavity atmosphere. Flush the cask interior gases if necessary.
5. Install the shear key plug assembly, if required.
6. Remove the lid from the cask.
7. NOT USED.
8. Transfer the cask to the unloading area.
9. Remove the contents from the cask.
10. Decontaminate the cask as necessary.
11. NOT USED.

A.7.2.2.4 *Vertical* Unloading of RWC-*DD contents* from the NUHOMS®-MP197HB Cask

This procedure is for *removal of contents from within a RWC-DD* at a disposal site. *The RWC-DD will remain within the NUHOMS®-MP197HB cask at all times and may be reused after unloading.* The procedure described below is intended to show the type of operations that will be performed and is not intended to be limiting.

1. *Lift the cask and transfer it onto an upending device.*
2. *Upend the cask and place it on a solid surface.*
3. *Remove the cask lid.*
4. *Remove the RWC-DD lid.*
5. *Install sealing surface protection, as appropriate.*
6. *Lift the contents out of the RWC-DD and transfer to disposal area.*
7. *Remove the sealing surface protection, if used.*
8. *Install the RWC-DD lid.*
9. *Install the cask lid.*
10. *Downend the cask.*

A.7.3 Preparation of Empty Package for Transport

Previously used and empty NUHOMS®-MP197HB casks shall be prepared for transport per the requirements of 49 CFR 173.427 [2].

A.7.4 Other Operations

A.7.4.1 Cask Cavity Vacuum Drying and Dryness Verification Test

The procedure for drying the cask cavity of moisture and performing a dryness verification test is given in this section. These steps are only required if the cask was wet loaded.

1. *Connect a vacuum system to the cask vent port.*
2. *Connect a drain bottle, or similar, to the cask drain port.*
3. *Evacuate the cask cavity until the vacuum level is 40 mbar, or less.*
4. *Isolate the vacuum system and vent the cask cavity to allow residual moisture to condense and flow through the drain port.*
5. *Repeat steps 3 and 4 several times until no more water escapes the drain port.*
6. *Close the cask drain port.*
7. *Evacuate the cask cavity until the vacuum level is 10 mbar, or less.*
8. *Isolate the vacuum system and measure the cask cavity pressure rise over a period of 10 minutes. The acceptance criterion for this dryness test is a pressure rise no greater than 6 mbar.*
9. *Repeat steps 7 and 8 as necessary to achieve an acceptable result.*

A.7.4.2 *Pre-shipment* Verification Leakage Testing of the NUHOMS®-MP197HB Cask Containment Boundary

The procedure for assembly verification leakage testing of the cask containment boundary prior to shipment is given in this section. Assembly verification leakage testing shall conform to the requirements of ANSI N14.5 [1] or ISO -12807 [11]. A flow chart of the assembly verification leakage test *for DSC shipments* is provided in Figure A.7-2. The order in which the leakage tests of the various seals are performed may vary. If more than one leakage detector is available then more than one seal may be tested at a time. Personnel performing the leakage test shall be specifically trained in leakage testing in accordance with SNT-TC-1A [7]. *The acceptance criterion for pre-shipment leakage rate testing shall be either (a) a leakage rate of not more than the reference air leakage rate, or (2) no detected leakage when tested to a sensitivity of at least* 10^{-3} *ref-cm*^{3}*/s.*

The following steps present one method of performing the pre-shipment verification leakage testing. Alternate methods and order of testing are acceptable as long as the above criteria is satisfied for the MP197HB containment boundary seals.

1. *Remove the port plugs from the lid test port, vent port, drain port, and the bottom test port.*
2. *Attach a suitable vacuum pump to the cask lid test port.*
3. *Evacuate the volume between the lid O-rings and perform the pre-shipment leak test in accordance with Section A.8.2.2. If either O-ring was replaced, the maintenance leak test in Section A.8.2.2 shall be performed.*
4. *After meeting the leak test criteria, disconnect the vacuum pump and either tighten the port bolt, or verify it has been tightened, in accordance with Drawing MP197HB-71-1002 in Chapter A.1.*
5. *Install the port plug.*
6. *Repeat steps 2-5 for the bottom test port.*
7. *Attach a suitable vacuum pump to the vent port.*
8. *Either tighten the port bolt, of verify it has been tightened, in accordance with Drawing MP197HB-71-1002 in Chapter A.1.*
9. *Evacuate the volume outside of the closed port bolt seal and perform the pre-shipment leak test in accordance with Section A.8.2.2. If the O-ring was replaced, the maintenance leak test in Section A.2.2 shall be performed.*
10. *After meeting the leak test criteria, disconnect the vacuum pump and install the port plug.*
11. *Repeat steps 7-10 for the drain port.*

This concludes the assembly verification leakage test procedure.

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A.7.5 References

1. ANSI N14.5-*2014*, "American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment," American National Standards Institute, Inc., New York, *2014*.
2. Title 49, Code of Federal Regulations, Part 173 (49 CFR 173), "Shippers - General Requirements for Shipments and Packaging."
3. Title 10, Code of Federal Regulations, Part 71 (10 CFR 71), "Packaging and Transportation of Radioactive Material."
4. U.S. Nuclear Regulatory Commission, Office of the Nuclear Material Safety and Safeguards, "Safety Evaluation of VECTRA Technologies' Response to Nuclear Regulatory Commission Bulletin 96-04 for the NUHOMS®-24P and NUHOMS®-7P."
5. U.S. Nuclear Regulatory Commission Bulletin 96-04, "Chemical, Galvanic or Other Reactions in Spent Fuel Storage and Transportation Casks," July 5, 1996.
6. Not Used.
7. SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing."
8. Updated Final Safety Analysis Report for The Standardized Advanced NUHOMS® Horizontal Modular Storage System For Irradiated Nuclear Fuel (CoC 1029) Revision 3.
9. Not used.
10. Not used.
11. ISO-12807, "Safety Transport of Radioactive Materials – Leakage Testing on Packages," First Edition, 1996.
12. NUREG-1927, March 2011, "Standard Review Plan for Renewal of Spent Fuel Dry Cask Storage System Licenses and Certificates of Compliance," United States Nuclear Regulatory Commission.
13. EPRI Report No. 1013524, "Climatic Corrosion Considerations for Independent Spent Fuel Storage Installations in Marine Environments," Electric Power Research Institute, June 2006.
14. "Repairing SCC of type 316 SS vessels" Materials Performance, September 2007, NACE International (p. 80).
15. NUREG/CR-7030, "Atmospheric Stress Corrosion Cracking Susceptibility of Welded and Unwelded 304, 304L, and 316L Austenitic Stainless Steels Commonly Used for Dry Cask Storage Containers Exposed to Marine Environments," Page 47, Nuclear Regulatory Commission, October 2010.
16. E-33299, "Evaluation Procedure to Verify DSC Acceptance for Transport," Transnuclear, August 2012, Revision 1.
17. Catherine Houska "Deicing Salt – Recognizing The Corrosion Threat" TMR Consulting, Pittsburg, PA http://www.imoa.info/_files/pdf/DeicingSalt.pdf
18. Greg Oberson, Darrel Dunn, Todd Mintz, Xihua He, Roberto Pabalan and Larry miller, "US NRC-Sponsored Research on Stress Corrosion Cracking Susceptibility of Dry Storage Canister Materials in Marine Environments – 13344" WM2013 Conference, February 24-28, 2013, Phoenix, Arizona USA, US NRC ADAMS, ML13029A490

19. *Regulatory Guide, 1.21, Revision 2, June 2009, "Measuring, Evaluation, and Reporting Radioactive Material in Liquid Gaseous Effluents and Solid Waste," United States Nuclear Regulatory Commission.*

20. *NUREG-1617, "Standard Review Plan for Transportation Packages for Spent Nuclear Fuel Final Report," March 2000.*

A.7.6 Glossary

The terms used in the above procedures are defined below.

annulus seal: Seal placed between the cask and DSC/RWC during operations in the fuel pool.

cask lifting yoke: Passive, open hook lifting yoke used for vertical lifts of the cask.

cask/HSM restraints: Provides the load path between the cask and HSM during DSC transfer operation.

conveyance: Any suitable conveyance such as a railcar, heavy haul trailer, barge, ship, etc.

horizontal storage module (HSM): Concrete shielded structure used for onsite storage of DSCs. HSM references herein refer to all models of HSM (e.g., HSM Model 80, Model 102, Model 152, Model 202, HSM-H, HSM-HS, AHSM, etc.) HSM also includes any other overpack authorized to accept a DSC or RWC via a horizontal transfer.

hydraulic ram: Hydraulic cylinder used to insert/withdraw DSCs to/from HSMs.

onsite transfer skid: Skid present on the onsite transfer trailer used to support the cask during onsite movements. Note in some cases the transportation skid may function as the onsite transfer skid.

onsite transfer trailer: A trailer used for onsite movements of the cask.

ram trunnion support assembly: Frame attached to the skid which provides an anchor for the hydraulic ram during DSC insertion and retrieval.

skid positioning system: Hydraulically operated alignment system that provides the interface between the onsite transfer trailer and the onsite transfer skid. It is used to align the skid (and cask) with the HSM prior to transfer.

A.7.7 Appendices

A.7.7.1 NUHOMS®-24PT4 DSC Wet Loading and Unloading

A.7.7.2 NUHOMS®-32PT DSC Wet Loading and Unloading

A.7.7.3 NUHOMS®-24PTH DSC Wet Loading and Unloading

A.7.7.4 NUHOMS®-32PTH DSC Wet Loading and Unloading

A.7.7.5 NUHOMS®-32PTH1 DSC Wet Loading and Unloading

A.7.7.6 NUHOMS®-37PTH DSC Wet Loading and Unloading

A.7.7.7 NUHOMS®-61BT DSC Wet Loading and Unloading

A.7.7.8 NUHOMS®-61BTH DSC Wet Loading and Unloading

A.7.7.9 NUHOMS®-69BTH DSC Wet Loading and Unloading

A.7.7.10 RWC Wet Loading

Table A.7-1
DSC/*RWC*, Fuel, and Basket Spacer Nominal Heights for Each Type of DSC/*RWC*
(All dimensions are in inches)

Canister Type	61BT	61BTH		69BTH	24PTH			24PT4	32PT				32PTH	32PTH Type 1	32PTH1			37PTH		RWC
		Type 1	Type 2		S	L	S-LC		S-100	S-125	L-100	L-125			S	M	L	S	M	
DSC bottom spacer height(1)	2.20	2.20	2.20	1.24	11.7	5.7	11.7	2.2	11.7	11.7	5.7	5.7	12.5	5.25	12.5	5.25	N/A	16.25	9.0	*(5)*
DSC top spacer height	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Fuel spacer height	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	(2)(4)	N/A
Basket spacer height	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	(3)(4)	N/A

(1) DSC/*RWC* top and bottom spacers can be combined to one spacer. If one spacer is used, it can be installed either on top or bottom of the DSC/*RWC*. The height of the spacer is to be determined such that the gap between the cask and DSC/*RWC* is below 0.5" for normal transport conditions. *The specified spacer height includes any axial spacing provided by the internal canister sleeve components.*

(2) Fuel spacer can be installed either on top or bottom of the fuel assembly. The height of the fuel spacer to be determined using the formula specified in Appendix A.2.13.14, Table A.2.13.14-2 such that the gap between the fuel assemblies and the DSC is below 1.5" for normal transport conditions.

(3) Basket spacer can be installed either on top or bottom of the basket. The height of the basket spacer is to be determined such that the gap between the basket and the DSC is below 0.815" for normal transport conditions.

(4) Fuel and basket spacers can be combined in one spacer.

(5) Height of spacer for RWC-W and RWC-B is 11.75" and height of spacer for RWC-DD is 2.20".

Table A.7-2*a*
Applicable Fuel Specification for Various DSCs

DSC MODEL	Applicable Fuel Specification from Chapter A.1
NUHOMS®-24PT4	Tables A.1.4.1-1 and A.1.4.1-2
NUHOMS®-32PT	Table A.1.4.2-2
NUHOMS®-24PTH	Table A.1.4.3-2
NUHOMS®-32PTH	Table A.1.4.4-2
NUHOMS®-32PTH1	Table A.1.4.5-2
NUHOMS®-37PTH	Table A.1.4.6-2
NUHOMS®-61BT	Table A.1.4.7-2
NUHOMS®-61BTH	Table A.1.4.8-2
NUHOMS®-69BTH	Table A.1.4.9-1

Table A.7-2*b*
Applicable Content Specification for RWC

Type and Form of Material	*The NUHOMS®-MP197HB packaging is designed for shipment of various types of irradiated and contaminated reactor hardware. The payload will vary from shipment to shipment. Typical composition of the payload consists of the following components either individually or in combinations:* *1. BWR Control Rod Blades* *2. BWR Local Power Range Monitors (LPRMs)* *3. BWR Fuel Channels* *4. BWR Poison Curtains* *5. PWR Burnable Poison Rod Assemblies (BPRAs)* *6. PWR and BWR Reactor Vessel and Internals*
Decay Heat load	*≤ 5 kW*
Loading	*Components with high specific activity are generally placed near the center of the RWC. For each shipment, the RWC is normally filled to capacity, which prevents shifting of the contents during transport. If the RWC is not full, appropriate component spacers or shoring is used to prevent significant movement of the contents.*
Maximum Quantity of Material per Package	*(a) The quantity of radioactive material is limited to a maximum of 8,182* A_2*. The radioactive material is primarily in the form of neutron activated metals, or metal oxides in solid form. Surface contamination may also be present on the irradiated components. When a wet load procedure (i.e., in-pool) is followed for cask loading, the cask cavity and RWC are drained and dried to ensure that there are no free liquids in the package during transport.* *(b) The NUHOMS®-MP197HB packaging is designed to transport a payload of up to 56.0 tons of dry irradiated and/or contaminated non-fuel bearing solid materials in the RWC.* *(c) The maximum quantity of non-fuel bearing radioactive material loaded into a package shall not exceed 8,182* A_2 *(90,000 Ci of Co-60).*

Table A.7-3
Appendices Containing Loading Procedures for Various DSCs

DSC Model	Appendix
NUHOMS®-24PT4	A.7.7.1
NUHOMS®-32PT	A.7.7.2
NUHOMS®-24PTH	A.7.7.3
NUHOMS®-32PTH	A.7.7.4
NUHOMS®-32PTH1	A.7.7.5
NUHOMS®-37PTH	A.7.7.6
NUHOMS®-61BT	A.7.7.7
NUHOMS®-61BTH	A.7.7.8
NUHOMS®-69BTH	A.7.7.9
RWC	A.7.7.10

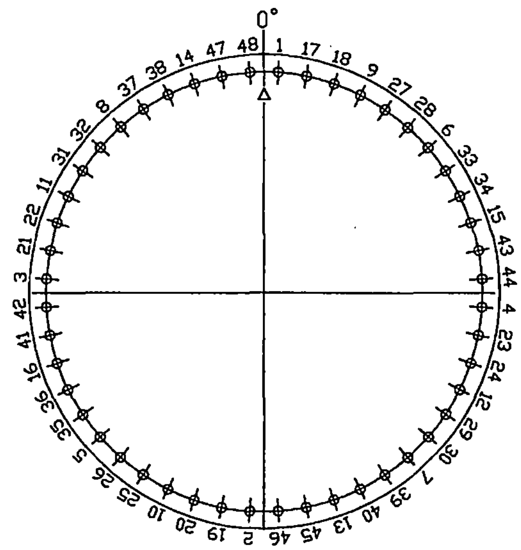
Table A.7-4
Appendices Containing Unloading Procedures for Various DSCs

DSC Model	Appendix
NUHOMS®-24PT4	A.7.7.1, Section A.7.7.1.4
NUHOMS®-32PT	A.7.7.2, Section A.7.7.2.4
NUHOMS®-24PTH	A.7.7.3, Section A.7.7.3.4
NUHOMS®-32PTH	A.7.7.4, Section A.7.7.4.4
NUHOMS®-32PTH1	A.7.7.5, Section A.7.7.5.4
NUHOMS®-37PTH	A.7.7.6, Section A.7.7.6.4
NUHOMS®-61BT	A.7.7.7, Section A.7.7.7.4
NUHOMS®-61BTH	A.7.7.8, Section A.7.7.8.4
NUHOMS®-69BTH	A.7.7.9, Section A.7.7.9.4

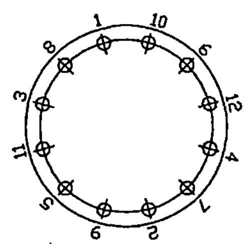
Table A.7-5
The Unloading Procedure which Shall Be Part of the User's Operating Procedures

NOTE: In the event that breach and/or reconfiguration of fuel are confirmed during unloading of high burnup fuel assemblies, a written report should be generated in accordance with 10 CFR 71.95. *The report shall include the required corrective action(s). The corrective action(s) shall be implemented prior to resumption of transports.*

Proprietary Information on This Page
Withheld Pursuant to 10 CFR 2.390



MP197HB Cask Lid



Trunnion and Ram *Access* Closure Plate

Figure A.7-1
Torquing Patterns

Figure A.7-2
NOT USED

Figure A.7-3
DSC Evaluation for Transport Flowchart

Figure A.7-4
Example of Survey Point Locations on a Transport Cask

Appendix A.7.7.10
Radioactive Waste Canister (RWC) Wet Loading Procedures

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Appendix A.7.7.10
Radioactive Waste Canister (RWC) Wet Loading Procedures

Note: The steps below apply to all versions of the RWC unless noted otherwise. The term cask, used in these steps refers to either the NUHOMS®-MP197HB cask or an acceptable NUHOMS® transfer cask.

A.7.7.10.1 Wet Loading of the RWC

The starting condition for the following steps assumes completion of the cask preparation steps in Section A.7.1.2.

1. Lift the cask and position it over the cask loading area of the spent fuel pool.
2. Lower the cask into the fuel pool.
3. Place the cask in the location of the fuel pool used for the cask loading area.
4. Disengage the lifting yoke from the cask lifting trunnions and move the yoke clear of the cask.
5. Load the RWC cavity. Record contents and location on the cask loading report to the extent practical.
6. Install the liner shield plug (RWC-W).
7. *Install the top shield plug (RWC-W & RWC-B).*
8. *Install the shield lid (RWC-DD).*
9. Inspect the shield plug/lid to verify that it is properly seated within the RWC. Repeat steps 6 through 8 as necessary.
10. NOT USED.
11. *NOT USED.*
12. Check the radiation levels at the center of the top shield plug *or lid* and around the perimeter of the cask.
13. NOT USED.
14. Lift the cask from the fuel pool.
15. Move the cask to the plant designated preparation area.

A.7.7.10.2 RWC-*W/RWC-B* Drying and Backfilling

1. Check the radiation levels along the perimeter of the cask. The cask exterior surface should be decontaminated as necessary. Temporary shielding may be installed as necessary to minimize personnel exposure.
2. NOT USED.
3. Disengage top shield plug from the lifting yoke and position the yoke clear of the cask.

4. Decontaminate the exposed surfaces of the RWC cylindrical shell perimeter and remove the annulus seal.

5. Allow water from the annulus to drain out until the water level is approximately twelve inches below the top edge of the RWC shell. Take swipes around the outer exposed surface of the RWC shell and check for smearable contamination as required.

   CAUTION: Radiation dose rates are expected to be high at the RWC vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

6. Prior to the start of welding operations drain approximately 100 gallons of water from the RWC.

7. NOT USED.

8. Install the automated welding machine onto the top shield plug.

9. Check radiation levels along the surface of the top shield plug. Temporary shielding may be installed as necessary.

10. Take precautions to prevent debris and weld splatter from entering the annulus.

11. Weld the top shield to the RWC shell.

12. Perform required dye penetrant examination of the weld surface(s).

13. NOT USED.

14. Remove remaining bulk water from the RWC cavity.

15. Once the water stops flowing from the RWC, close the RWC siphon port and disengage the gas source.

16. Connect the VDS to the cask.

17. Start the VDS and draw a vacuum on the RWC cavity until dry. That is, until a vacuum of approximately 10 mbar can be maintained for 10 minutes.

18. Use air or helium to pressurize the RWC to 2.5 ± 1.0 psig backfill pressure (stable for 30 minutes).

    CAUTION: Radiation dose rates are expected to be high at the vent and siphon port locations. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.

19. Close the line connected to the vent port.

A.7.7.10.3 RWC-*W/RWC-B* Sealing Operations

1. Disconnect the VDS from the RWC. Seal weld the prefabricated covers over the vent and siphon ports and perform the required dye penetrant weld examination(s).

2. Install the outer top cover plate and the automated welding system onto the RWC.

3. Tack weld the outer top cover plate to the RWC shell. Place the outer top cover plate weld root pass.
4. Perform dye penetrant examination of the root pass weld. Weld out the outer top cover plate to the RWC shell and perform the required dye penetrant examination on the weld surface(s).
5. Remove the automated welding machine from the RWC.
6. Drain the water from the cask/RWC annulus.

The cask/RWC is now ready to be prepared for downending as described in Chapter A.7, Section A.7.1.2.2.

A.7.7.10.4 RWC-DD Drying and Sealing Operations

1. *Check the radiation levels along the perimeter of the cask. The cask exterior surface should be decontaminated as necessary. Temporary shielding may be installed as necessary to minimize personnel exposure.*
2. *Disengage lid from the lifting yoke and position the yoke clear of the cask.*
3. *Install lid bolts.*

   CAUTION: *Radiation dose rates are expected to be high at the RWC-DD drain port location. Use proper ALARA practices (e.g., use of temporary shielding, appropriate positioning of personnel, etc.) to minimize personnel exposure.*

4. *Decontaminate the exposed surfaces of the RWC-DD cylindrical shell perimeter and remove the annulus seal.*
5. *Take swipes around the outer exposed surface of the RWC-DD shell and check for smearable contamination as required. The annulus water level may be lowered as necessary to perform this step.*
6. *Remove bulk water from the RWC-DD cavity.*
7. *Connect a vacuum system to the RWC-DD.*
8. *Evacuate the RWC-DD cavity until dry. That is, until a vacuum of approximately 10 mbar can be maintained for 10 minutes with the vacuum system connected.*
9. *Disconnect the vacuum system and close the RWC-DD port.*
10. *Drain the water from the cask/RWC-DD annulus.*

The cask/RWC is now ready to be prepared for downending as described in Chapter A.7, Section A.7.1.2.2.

Chapter A.8
Acceptance Tests and Maintenance Program

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Chapter A.8
Acceptance Tests and Maintenance Program

NOTE: References in this Chapter are shown as [1], [2], etc. and refer to the reference list in Section A.8.3.

A.8.1 Acceptance Tests

The following reviews, inspections, and tests shall be performed on the NUHOMS®-MP197HB packaging prior to initial transport. Many of these tests will be performed at the fabricator's facility prior to delivery of the cask or dry shielded canister (DSC) to the utility for use. Tests will be performed in accordance with written procedures.

A.8.1.1 Visual Inspection and Measurements

Visual inspections are performed at the fabricator's facility to ensure that the packaging conforms to the drawings and specifications. The visual inspections include:

- cleanliness inspections,
- visual weld inspections as required by ASME Code [1],
- inspection of sealing surface finish, and
- dimensional inspections for conformance with the drawings included in Chapter A.1, Appendix A.1.4.10.

A.8.1.2 Weld Examinations

The structural materials are chemically and physically tested to confirm that the required properties are met.

To the maximum extent practical, all welding is performed using qualified processes and qualified personnel, according to the ASME Boiler and the Pressure Vessel Code [1]. Base materials and welds are examined in accordance with the ASME Boiler and Pressure Vessel Code requirements. NDE requirements for welds are specified on the drawings provided in Appendix A.1.4.10. All NDE is performed in accordance with written procedures. The inspection personnel are qualified in accordance with SNT-TC-1A [2].

The containment welds of the NUHOMS®-MP197HB cask, and the NUHOMS®-DSCs are designed, fabricated, tested and inspected in accordance with ASME B&PV Code Subsection NB. Welds of the noncontainment structure are inspected as per the NDE acceptance criteria of ASME B&PV Code, Subsection NF.

The NUHOMS®-DSC fuel baskets are designed, fabricated, and inspected in accordance with the ASME B&PV Code Subsection NG. Fusion weld tests as required are shown on drawings provided in Appendix A.1.4.10.

Alternatives to the code are described in Chapter A.2, Section A.2.1.4 and Appendix A.2.13.13.

A.8.1.3 Structural and Pressure Tests

A.8.1.3.1 Load Tests

Two sets of trunnions are provided for the NUHOMS®-MP197HB transport package lifting. One set of trunnions has double shoulders (non-single failure proof). The other set of trunnions has a single shoulder (single failure proof). Only one set of trunnions is used depending on site and transfer operation requirements. The trunnions are fabricated and tested in accordance with ANSI N14.6 [3]. A load test of 3.0 times the design lift load (for single failure proof trunnions) or 1.5 times the design lift load (for non-single failure proof trunnions) is applied to the trunnions for a period of ten minutes, to ensure that the trunnions can perform satisfactorily.

A force equal to 1.5 times the impact limiter weight will be applied to the hoist rings of each impact limiter for a period of ten (10) minutes. At the conclusion of the test, the impact limiter hoist rings will be visually examined for defects and permanent deformation.

A.8.1.3.2 Pressure Tests

A pressure test is performed on the NUHOMS®-MP197HB packaging assembly at a pressure between 40.0 and 45.0 psig. This is well above 1.5 times the maximum normal operating pressure of 12.7 psig (Chapter A.3, Table A.3-20). The test pressure is held for a minimum of 10 minutes. The test is performed in accordance with ASME B&PV Code, Section III, Subsection NB, Paragraph NB-6200 or NB-6300. All visible joints/surfaces are visually examined for possible leakage after application of the pressure.

In addition, a bubble leakage test is performed on the resin enclosure. The purpose of this test is to identify any potential leakage passages in the enclosure welds.

A.8.1.4 Containment Boundary Leakage Tests

A.8.1.4.1 MP197HB Cask Leakage Tests

Leakage tests are performed on the MP197HB cask containment boundary prior to first use, typically at the fabricator's facility. The fabrication verification leakage test can be separated into the following five tests: 1) cask leakage integrity, 2) cask vent port closure bolt seal integrity, 3) cask drain port closure bolt seal integrity, 4) cask lid seal integrity, and 5) ram access closure plate seal integrity. These tests are usually performed using the helium mass spectrometer method. Alternative methods are acceptable, provided that the required sensitivity is achieved. The leakage test is performed in accordance with ANSI N14.5 [4] or ISO-12807 [11]. The personnel performing the leakage test are qualified in accordance with SNT-TC-1A [2].

Cask Leakage Integrity Test

Prior to lead pour and final machining of the inner shell, the cylindrical portion of the containment boundary, including the bottom end closure, will be leakage tested in accordance with the requirements of ANSI N14.5 [4] or ISO-12807 [11], using temporary closures and seals for the ram access cover plate and lid. Because the inner shell will not be accessible for leakage

testing after lead is poured, leakage testing will be performed during the fabrication process, as permitted by ANSI N14.5 Table 1 [4].

If a leakage is discovered, the source will be determined, repaired, and the shells retested to ensure that the measured leakage rate is less than $1x10^{-7}$ ref cm^3/s.

The test will be performed in conjunction with the non-destructive examination of the inner shell welds in accordance with ASME B&PVC Code, Section III, Subsection NB. An MT or PT examination of every weld layer in the shell-to-top-forging closure weld and an MT or PT examination of all final machined weld surfaces of the inner shell will be performed per the Code.

Fabrication Verification Leakage Tests

The fabrication verification leakage tests include the following:

- Cask vent port closure bolt seal integrity
- Cask drain port closure bolt seal integrity
- Cask lid seal integrity
- Cask ram access closure plate seal integrity

The tests will be performed in accordance with the ANSI N 14.5 [4] or ISO-12807 [11]. The acceptance criterion requires each component to be individually leaktight, that is, the leakage rate must be less than $1x10^{-7}$ ref cm^3/s.

A.8.1.4.2 NUHOMS® DSCs Leakage Test

The containment boundary of a NUHOMS® DSC is leakage tested to verify it is leaktight *in accordance with 10 CFR Part 72 CoC and associated Technical Specification requirements for a given DSC at the time of leakage testing.* The leakage tests are typically performed using the helium mass spectrometer method. Alternative methods are acceptable, provided that the required sensitivity is achieved. Following completion of the welding of the DSC inner top cover plate and siphon and vent cover plates, these welds are leakage tested to $\leq 1.0 \times 10^{-7}$ ref cm^3/s.

If the leakage rate exceeds this criteria, the inner top cover plate seal weld and siphon and vent cover plate welds will be inspected and repaired where necessary.

For the 24PT4 DSC, the leakage test requirements outlined in CoC 1029 are used to demonstrate leaktightness in lieu of the above criteria.

A.8.1.5 MP197HB Cask Component and Material Tests

A.8.1.5.1 Valves, Rupture Discs, and Fluid Transport Devices

There are no valves, rupture discs, or couplings in the containment of the NUHOMS®-MP197HB packaging.

A.8.1.5.2 Gaskets

The lid and all the other containment penetrations are sealed using O-ring seals. Leakage testing of the seals is described in Section A.8.1.4.1.

A.8.1.5.3 Impact Limiter Leakage Test

Prior to initial use, the following test will be performed, after all the seal welds have been completed on the impact limiter to verify that the impact limiter wood is completely enclosed, thereby preventing any moisture exchange with the ambient environment.

Each impact limiter container is pressurized to a pressure between 2.0 and 3.0 psig. Test all the weld seams and penetrations for leakage using a soap bubble test.

A.8.1.5.4 Functional Tests

The following functional tests will be performed prior to the first use of the cask. Generally these tests will be performed at the fabrication facility.

a. Installation and removal of the lid, ram access cover plates, port plugs, and other fittings will be observed. Each component will be checked for difficulties in installation and removal. After removal, each component will be visually examined for damage. Any defects will be corrected prior to the acceptance of the cask.
b. After installation of the fuel basket into the DSC, each basket compartment will be checked by gauge to demonstrate that the fuel assemblies will fit in the basket.

A.8.1.6 Shielding Tests

Chapter A.5 presents the analyses performed to ensure that the NUHOMS®-MP197HB package shielding integrity is adequate.

A.8.1.6.1 Gamma Shield Test

The integrity of the NUHOMS®-MP197HB cask poured lead shielding will be confirmed via gamma scanning prior to installation of the neutron shield.

The outer cask surface is gridded and a gamma scan chart is made to reflect the gridded surface. The gamma scan is performed using a detector with a detection area enveloping the grid minimum area (e.g., for a 6" × 6" grid, the detector will encompass a 6" × 6" square).

The acceptance criterion for the gamma scan is based on the results of dose rate measurements of mockup test block constructed to replicate the MP197HB cask through-wall configuration. The test block consists of the inner wall, layer of lead, and the outer wall. The test uses nominal thicknesses of steel walls (provided in SAR drawings given in Chapter A.1, Appendix A.1.4.10) and nominal less 5% thickness of lead layer. The dose rate measured using the test block configuration is used as the maximum acceptable reading for the inspected cask.

The source/detector distance used in the cask inspection shall be the same as that used in establishing the maximum dose rate limit.

A.8.1.6.2 Neutron Shield

The radial neutron shield is protected from damage or loss by the aluminum and steel enclosure. The neutron shield material, VYAL B, is a proprietary vinyl ester resin mixed with alumina hydrate and zinc borate which are added for their fire retardant properties.

The primary function of the resin is to shield against neutrons, which is performed primarily by the hydrogen content in the resin. The sole function of the boron is to suppress n-γ reactions with hydrogen. The resin also provides some gamma shielding, which is a function of the overall resin density, and is not sensitive to composition.

The proprietary process for the VYAL-B mixing and installation is described in SAR Section *A.5.5.*

The following are acceptance values for density and chemical composition for the resin. The values used in the shielding calculations of Chapter A.5 are included for comparison.

Chapter A.5 values		Acceptance Testing Values		
Element	Nominal wt %	Element	Wt %	Acceptance range (wt %)
H	4.54	H	5.0	± 8
B	0.82	B	0.9	± 10

The minimum resin density in acceptance testing is 1.75 g/cm^3. Resin composition or density test results which fall outside of this range will be evaluated to ensure that the shielding regulatory dose limits are not exceeded.

Tests are performed at loading to ensure that the radiation dose limits are not exceeded for each cask.

A.8.1.7 Neutron Absorber Tests

The neutron absorber used for criticality control in the DSC baskets may consist of any of the following types of material. Depending on the DSC model, these neutron absorber materials may be used alone or be paired with aluminum:

(a) Boron-aluminum alloy (borated aluminum)

(b) Boron carbide/Aluminum metal matrix composite (MMC)

(c) Boral®

These materials only serve as neutron absorber for criticality control and as heat conduction paths. The MP197HB packaging safety analyses do not rely upon their mechanical strength. The radiation and temperature environment in the cask is not sufficiently severe to damage these metallic/ceramic materials. To assure performance of the neutron absorber's design function only

the presence of B10 and the uniformity of its distribution need to be verified, with testing requirements specific to each material. The boron content of these materials is given in the Appendices A.1.4 for each DSC type.

References to metal matrix composites throughout this chapter are not intended to refer to Boral®, which is described later in this section.

A.8.1.7.1 Boron Aluminum Alloy (Borated Aluminum)

The material is produced by direct chill (DC) or permanent mold casting with boron precipitating primarily as a uniform fine dispersion of discrete AlB_2 or TiB_2 particles in the matrix of aluminum or aluminum alloy (other boron compounds, such as AlB_{12}, can also occur). For extruded products, the TiB_2 form of the alloy shall be used. For rolled products, either the AlB_2, the TiB_2, or a hybrid may be used.

Boron is added to the aluminum in the quantity necessary to provide the specified minimum B10 areal density in the final product. The amount required to achieve the specified minimum B10 areal density will depend on whether boron with the natural isotopic distribution of the isotopes B10 and B11, or boron enriched in B10 is used. In no case shall the boron content in the aluminum or aluminum alloy exceed 5% by weight.

The criticality calculations take credit for 90% of the minimum specified B10 areal density of borated aluminum. The basis for this credit is the B10 areal density acceptance testing, which shall be as specified in Section A.8.1.7.6. The specified acceptance testing assures that at any location in the material, the minimum specified areal density of B10 will be found with 95% probability and 95% confidence.

A.8.1.7.2 Boron Carbide/Aluminum Metal Matrix Composites (MMC)

The material is a composite of fine boron carbide particles in an aluminum or aluminum alloy matrix. The material shall be produced by either direct chill casting, permanent mold casting, powder metallurgy, or thermal spray techniques. The boron carbide content shall not exceed 40% by volume. The boron carbide content for MMCs with an integral aluminum cladding shall not exceed 50% by volume.

The final MMC product shall have density greater than 98% of theoretical density demonstrated by qualification testing, with no more than 0.5 volume % interconnected porosity. For MMC with an integral cladding, the final density of the core shall be greater than 97% of theoretical density demonstrated by qualification testing, with no more than 0.5 volume % interconnected porosity of the core and cladding as a unit of the final product.

Boron carbide particles for the products considered here shall be smaller than 40 microns or less. No more than 10% of the particles shall be over 60 microns.

Prior to use in the DSC, MMCs shall pass the qualification testing specified in Section A.8.1.7.7, and shall subsequently be subject to the process controls specified in Section A.8.1.7.8.

The criticality calculations take credit for 90% of the minimum specified B10 areal density of MMCs. The basis for this credit is the B10 areal density acceptance testing, which is specified in Section A.8.1.7.6. The specified acceptance testing assures that at any location in the final product, the minimum specified areal density of B10 will be found with 95% probability and 95% confidence.

A.8.1.7.3 Boral®

This material consists of a core of aluminum and boron carbide powders between two outer layers of aluminum, mechanically bonded by hot-rolling an "ingot" consisting of an aluminum box filled with blended boron carbide and aluminum powders. The core, which is exposed at the edges of the sheet, is slightly porous. Before rolling, at least 80% by weight of the B_4C particals in BORAL® shall be smaller than 200 microns. The nominal boron carbide content shall be limited to 65% (+ 2% tolerance limit) of the core by weight.

The criticality calculations take credit for 75% of the minimum specified B10 areal density of Boral®. B10 areal density will be verified by chemical analysis and by certification of the B10 isotopic fraction for the boron carbide powder, or by neutron transmission testing. Areal density testing is performed on a coupon taken from the sheet produced from each ingot. If the measured areal density is below that specified, all the material produced from that ingot will be either rejected, or accepted only on the basis of alternate verification of B10 areal density for each of the final pieces produced from that ingot.

A.8.1.7.4 Visual Inspections of Neutron Absorbers

Neutron absorbers shall be 100% visually inspected in accordance with the Certificate Holder's QA procedures. Material that does not meet the following acceptance criteria shall be reworked, repaired, or scrapped. Blisters shall be treated as non-conforming. Inspection of MMCs with an integral aluminum cladding shall also include verification that the matrix is not exposed through the faces of the aluminum cladding and that solid aluminum is not present at the edges. For Boral, visual inspection shall verify that there are no cracks through the cladding, exposed core on the face of the sheet, or solid aluminum at the edge of the sheet.

A.8.1.7.5 Other Visual Inspections Criteria (non-CoC Conditions)

For borated aluminum and MMCs, visual inspections shall follow the recommendations in Aluminum Standards and Data, Chapter 4 "Quality Control, Visual Inspection of Aluminum Mill Products and Castings"[12]. Local or cosmetic conditions such as scratches, nicks, die lines, inclusions, abrasion, isolated pores, or discoloration are acceptable.

A.8.1.7.6 Specification for Acceptance Testing of Neutron Absorbers by Neutron Transmission

A.8.1.7.6a Neutron Transmission acceptance testing procedures shall be subject to approval by the Certificate Holder. Test coupons shall be removed from the rolled or extruded production material at locations that are systematically or probabilistically distributed throughout the lot.

Test coupons shall not exhibit physical defects that would not be acceptable in the finished product, or that would preclude an accurate measurement of the coupon's physical thickness.

A lot is defined as all the pieces produced from a single ingot or heat or from a group of billets from the same heat. If this definition results in lot size too small to provide a meaningful statistical analysis of results, an alternate larger lot definition may be used, so long as it results in accumulating material that is uniform for sampling purposes.

The sampling rate for neutron transmission measurements shall be such that there is at least one neutron transmission measurement for each 2000 square inches of final product in each lot.

The B10 areal density is measured using a collimated thermal neutron beam of no more than 1 inch diameter.

The neutron transmission through the test coupons is converted to B10 areal density by comparison with transmission through calibrated standards. These standards are composed of a homogeneous boron compound without other significant neutron absorbers. For example, boron carbide, zirconium diboride or titanium diboride sheets are acceptable standards. These standards are paired with aluminum shims sized to match the effect of neutron scattering by aluminum in the test coupons. Uniform but non-homogeneous materials such as metal matrix composites may be used for standards, provided that testing shows them to provide neutron attenuation equivalent to a homogeneous standard. Standards will be calibrated, traceable to nationally recognized standards, or by attenuation of a monoenergetic neutron beam correlated to the known cross section of boron 10 at that energy.

Alternatively, digital image analysis may be used to compare neutron radioscopic images of the test coupon to images of the standards. The area of image analysis shall be no more than 0.75 sq. inch.

The minimum areal density specified shall be verified for each lot at the 95% probability, 95% confidence level or better. If a goodness-of-fit test demonstrates that the sample comes from a normal population, the one-sided tolerance limit for a normal distribution may be used for this purpose. Otherwise, a non-parametric (distribution-free) method of determining the one-sided tolerance limit may be used. Demonstration of the one-sided tolerance limit shall be evaluated for acceptance in accordance with the Certificate Holder's QA procedures.

A.8.1.7.6b The following illustrates one acceptable method and is intended to be utilized as an example. Therefore, the following text is not part of the CoC 9302 Conditions.

The acceptance criterion for individual plates is determined from a statistical analysis of the test results for their lot. The B10 areal densities determined by neutron transmission are converted to volume density, i.e., the B10 areal density is divided by the thickness at the location of the neutron transmission measurement or the maximum thickness of the coupon. The lower tolerance limit of B10 volume density is then determined, defined as the mean value of B10

volume density for the sample, less K times the standard deviation, where K is the one-sided tolerance limit factor with 95% probability and 95% confidence [13].

Finally, the minimum specified value of B10 areal density is divided by the lower tolerance limit of B10 volume density to arrive at the minimum plate thickness which provides the specified B10 areal density.

Any plate which is thinner than the statistically derived minimum thickness from Section A.8.1.7.6a or the minimum design thickness, whichever is greater, shall be treated as non-conforming, with the following exception. Local depressions are acceptable, so long as they total no more than 0.5% of the area on any given plate, and the thickness at their location is not less than 90% of the minimum design thickness. Edge effects due to manufacturing operations such as shearing, deburring, and chamfering need not be included in this determination.

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

A.8.1.7.7 Specification for Qualification Testing of Metal Matrix Composites

A.8.1.7.7.1 Applicability and Scope

Metal matrix composites (MMCs) acceptable for use in the DSCs are described in Section A.8.1.7.2.

Prior to initial use in a spent fuel transport system, such MMCs shall be subjected to qualification testing that will verify that the product satisfies the design function. Key process controls shall be identified per Section A.8.1.7.8 so that the production material is equivalent to or better than the qualification test material. Changes to key processes shall be subject to qualification before use of such material in a spent fuel dry storage or transport system.

ASTM test methods and practices are referenced below for guidance. Alternative methods may be used with the approval of the certificate holder.

A.8.1.7.7.2 Design Requirements

In order to perform its design functions the product must have at a minimum sufficient strength and ductility for manufacturing and for the normal and accident conditions of the transport system. This is demonstrated by the tests in Section A.8.1.7.7.4. It must have a uniform distribution of boron carbide. This is demonstrated by the tests in Section A.8.1.7.7.5.

A.8.1.7.7.3 Durability

There is no need to include accelerated radiation damage testing in the qualification. Such testing has already been performed on MMCs, and the results confirm what would be expected of materials that fall within the limits of applicability cited above. Metals and ceramics do not experience measurable changes in mechanical properties due to fast neutron fluences typical over the lifetime of spent fuel transport, about 10^{15} neutrons/cm^2.

The need for thermal damage and corrosion (hydrogen generation) testing shall be evaluated case-by-case based on comparison of the material composition and environmental conditions with previous thermal or corrosion testing of MMCs.

Thermal damage testing is not required for unclad MMCs consisting only of boron carbide in an aluminum 1100 matrix, because there is no reaction between aluminum and boron carbide below 842°F, well above the basket temperature under normal conditions of transport[1].

Thermal damage testing is not required for unclad MMCs consisting only of boron carbide in an aluminum 1100 matrix, because there is no reaction between aluminum and boron carbide below 842°F, well above the basket temperature under normal conditions of transport[2].

Corrosion testing is not required for MMCs (clad or unclad) consisting only of boron carbide in an aluminum 1100 matrix, because testing on one such material has already been performed by Transnuclear[3].

A.8.1.7.7.3.1 Delamination Testing of Clad MMC

Clad MMCs shall be subjected to thermal damage testing following water immersion to ensure that delamination does not occur under normal conditions of storage. This testing shall include conditions to simulate water conditions of the pool and heating temperatures for storage. An example of such a test would be: (1) immerse a specimen at least 6 x 6 inches in water under pressure ≥30 psig for at least 24 hours, (2) place the specimen in a vacuum furnace preheated to at least 300°F and evacuate the furnace. Acceptance criterion for the test shall be no blistering or delamination of the cladding.

A.8.1.7.7.4 Required Qualification Tests and Examinations to Demonstrate Mechanical Integrity

At least three samples, one each from approximately the two ends and middle of the qualification material run shall be subject to:

a) room temperature tensile testing (ASTM- B557[4]) demonstrating that the material has the following tensile properties:

- Minimum yield strength, 0.2% offset: 1.5 ksi
- Minimum ultimate strength: 5 ksi
- Minimum elongation in 2 inches: 0.5%

1 Sung, C., "Microstructural Observation of Thermally Aged and Irradiated Aluminum/Boron Carbide (B_4C) Metal Matrix Composite by Transmission and Scanning Electron Microscope," 1998.

2 Sung, C., "Microstructural Observation of Thermally Aged and Irradiated Aluminum/Boron Carbide (B_4C) Metal Matrix Composite by Transmission and Scanning Electron Microscope," 1998.

3 Boralyn testing submitted to the NRC under docket 71-1027, 1998.

4 ASTM B557 Standard Test Methods of Tension Testing Wrought and Cast Aluminum and Magnesium-Alloy Products

As an alternative to the elongation requirement, ductility may be demonstrated by bend testing per ASTM E290[5]. The radius of the pin or mandrel shall be no greater than three times the material thickness, and the material shall be bent at least 90 degrees without complete fracture,

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

c) For MMCs with an integral aluminum cladding, thermal durability testing demonstrating that after a minimum 24 hour soak in either pure or borated water, then insertion into a preheated oven at approximately 825°F for a minimum of 24 hours, the specimens are free of blisters and delamination and pass the mechanical testing requirements described in test 'a' of this section.

A.8.1.7.7.5 Required Tests and Examinations to Demonstrate B10 Uniformity

Uniformity of the boron distribution shall be verified either by:

a) Neutron radioscopy of material from the ends and middle of the test material production run, verifying no more than 10% difference between the minimum and maximum B10 areal density, or
b) Quantitative testing for the B10 areal density, B10 density, or the boron carbide weight fraction, on locations distributed over the test material production run, verifying that one standard deviation in the sample is less than 10% of the sample mean. Testing may be performed by a neutron transmission method similar to that specified in Section A.8.1.7.6, or by chemical analysis for boron carbide content in the composite.

A.8.1.7.7.6 Approval of Procedures

Qualification procedures shall be subject to approval by the Certificate Holder.

A.8.1.7.8 Specification for Process Controls for Metal Matrix Composites

This section provides process controls to ensure that the material delivered for use is equivalent to the qualificaion test material.

A.8.1.7.8.1 Applicability and Scope

Key processing changes shall be subject to qualification prior to use of the material produced by the revised process. The Certificate Holder shall determine whether a complete or partial re-qualification program per Section A.8.1.7.7 is required, depending on the characteristics of the material that could be affected by the process change.

[5] ASTM E290, Standard Methods for Bend Testing of Materials for Ductility.

A.8.1.7.8.2 Definition of Key Process Changes

Key process changes are those which could adversely affect the uniform distribution of the boron carbide in the aluminum, reduce density, reduce corrosion resistance, or reduce the mechanical strength or ductility of the MMC.

A.8.1.7.8.3 Identification and Control of Key Process Changes

The manufacturer shall provide the Certificate Holder with a description of materials and process controls used in producing the MMC. The Certificate Holder and manufacturer shall identify key process changes as defined in Section A.8.1.7.8.2.

An increase in nominal boron carbide content over that previously qualified shall always be regarded as a key process change. The following are examples of other changes that are established as key process changes, as determined by the Certificate Holder's review of the specific applications and production processes:

a) Changes in the boron carbide particle size specification that increase the average particle size by more than 5 microns or that increase the amount of particles larger than 60 microns from the previously qualified material by more than 5% of the total distribution but less than the 10% limit,

b) Change of the billet production process, e.g., from vacuum hot pressing to cold isostatic pressing followed by vacuum sintering,

c) Change in the nominal matrix alloy,

d) Changes in mechanical processing that could result in reduced density of the final product, e.g., for PM or thermal spray MMCs that were qualified with extruded material, a change to direct rolling from the billet,

e) For MMCs using a magnesium-alloyed aluminum matrix, changes in the billet formation process that could increase the likelihood of magnesium reaction with the boron carbide, such as an increase in the maximum temperature or time at maximum temperature,

f) Changes in powder blending or melt stirring processes that could result in less uniform distribution of boron carbide, e.g., change in duration of powder blending, and

g) For MMCs with an integral aluminum cladding, a change greater than 25% in the ratio of the nominal aluminum cladding thickness (sum of two sides of cladding) and the nominal matrix thickness could result in changes in the mechanical properties of the final product.

In no case shall process changes be accepted if they result in a product outside the limits in Sections A.8.1.7.7.1 and A.8.1.7.7.4.

A.8.1.7.9 Neutron Absorber for DSCs Already Loaded and DSCs Under Fabrication

The neutron absorber tests and acceptance criteria as described in Section A.8.1.7.1 through Section A.8.1.7.8 are only applicable to all the canister types that will be loaded in the spent fuel pool using the MP197HB cask. However, for canister types which are already in service under 10CFR Part72, the neutron absorber material acceptance requirements for each specific canister

type as described in the applicable 10CFR Part72 approved certificate of compliance are applicable.

A.8.1.8 Cask Thermal Tests

The thermal evaluation of the MP197HB cask described in Chapter A.3 is performed using very conservative and bounding assumptions. Gaps between the components are modeled in the thermal analysis to account for possible gaps expected during fabrication. Gaps are assumed to be present during NCT and HAC post fire cases when calculating heat flow out of the cask and gaps are assumed closed when calculating heat flow into the cask (i.e., during the HAC fire). The calculated cladding temperatures are much lower than the cladding temperature limit, assuring large margins to the limits. The cladding temperatures reported for the DSCs are very conservative because the allowed heat loads for a given DSC are reduced until the calculated DSC shell temperature in the MP197HB cask is below that calculated for storage conditions in the applicable 10 CFR Part 72 license. The reported cladding temperature is that of the higher heat load allowed under storage conditions with the same or higher DSC shell temperature.

However, to provide additional assurance that the thermal performance of the fabricated cask is equal to or exceeds the theoretical performance reported in the SAR, a thermal test is performed after fabrication of MP197HB cask.

Heat dissipation for the MP197HB cask to the ambient occurs three-dimensionally with a significant portion of the design heat load being radially dissipated through the neutron shield region of the cask body. The cask top and bottom ends beyond the neutron shield region are covered by the impact limiters. Due to limited contact between the thermal shields and the cask end plates (cask bottom plate and cask lid) and the insulating properties of wood within the impact limiters, the heat dissipation in the axial direction is largely restricted and is insignificant in comparison to the radial heat dissipation.

The thermal test measures the effective thermal conductivity of a cask in the radial direction over an approximately 10-ft exposed length within the neutron shield region. These measured thermal conductivities will be used as thermal input into the ANSYS model described in the SAR, Chapter A.3, Section A.3.3.1.1 for the NCT thermal analysis. The temperature distribution computed with the measured conductivity of the cask is then compared against the corresponding values in the SAR, Chapter A.3, Table A.3-8, and A.3-10 to demonstrate the thermal performance of the fabricated cask is equal to or exceeds the theoretical performance reported in the SAR.

A.8.1.9 Neutron Absorber Thermal Conductivity Testing

Acceptance testing shall conform to ASTM E1225, ASTM E1461, or equivalent method, performed at room temperature on coupons taken from the rolled or extruded production material. Initial sampling shall be one test per lot, and may be reduced if the first five tests meet the specified minimum thermal conductivity. For cast products, the lot shall be defined by the heat or ingot. For other products, the lot shall be defined as material produced in a single production campaign using the same heat or lots of aluminum and boron carbide feed materials.

If a thermal conductivity test result is below the specified minimum, at least four additional tests shall be performed on the material from that lot. If the mean value of those tests, including the original test, falls below the specified minimum, the associated lot shall be rejected.

After twenty five tests of a single type of material, with the same aluminum alloy matrix, the same boron content, and the same primary boron phase, e.g., B_4C, TiB_2, or AlB_2, if the mean value of all the test results less two standard deviations meets the specified thermal conductivity, no further testing of that material is required. This exemption may also be applied to the same type of material if the matrix of the material changes to a more thermally conductive alloy (e.g., from 6000 to 1000 series aluminum), or if the boron content is reduced without changing the boron phase.

The measured thermal conductivity values shall satisfy the minimum required conductivities as shown in Section A.3.2.1, Table 17 for HLZC #1, #2 and #3, and in Section A.3.2.1, Table 19 for HLZC #4.

In cases where the specified thickness of the neutron absorber may vary, the equations introduced in Section A.3.3.1.5 shall be used to determine the minimum required effective thermal conductivity.

The thermal conductivity test requirement does not apply to aluminum that is paired with the neutron absorber.

A.8.2 Maintenance Program

A.8.2.1 Structural and Pressure Tests

Within 14 months prior to any lift of a NUHOMS®-MP197HB transport package, the front trunnions shall be subject to either of the following:

- A test load equal to 300% of the maximum service load per ANSI N14.6 [3], paragraph 7.3.1(a) for single failure proof trunnions or a test load equal to 150% of the maximum service load per ANSI N14.6 [3], paragraph 7.3.1(b) for non-single failure proof trunnions. After sustaining the test load for a period of not less than 10 minutes, accessible critical areas shall be subjected to visual inspection for defects, and all components shall be inspected for permanent deformation.
- Dimensional testing, visual inspection and nondestructive examination of accessible critical areas of the trunnions including the bearing surfaces in accordance with Paragraph 6.3.1 of ANSI N14.6 [3].

A.8.2.2 Leakage Tests

The following containment boundary components shall be subject to periodic maintenance, and preshipment leakage testing in accordance with ANSI N14.5 [4] or ISO-12807 [11]:

- Lid
- Ram Access Closure Plate
- Vent Port
- Drain Port

Leakage Tests for DSC Shipments

Test	**Frequency**	**Acceptance Criteria**	**Typical Method (ANSI N14.5 TABLE A-1, [4])**
Periodic	Within 12 months prior to shipment	Each component individually ≤ 1×10^{-7} ref cm^3/s	(He) A.5.3 A.5.4
Pre-shipment	Before each shipment, after the contents are loaded and the package is closed	No detected leakage, sensitivity of 10^{-3} ref cm^3/s or better, unless seal is replaced.	A.5.1 A.5.2 A.5.8 A.5.9
Maintenance	After maintenance, repair, or replacement of containment components, including inner seals	Each component individually ≤ 1×10^{-7} ref cm^3/s	(He) A.5.3 A.5.4

Leakage Tests for RWC Shipments

Test	***Frequency***	***Acceptance Criteria***	***Typical Method (ANSI N14.5 TABLE A-1, [4])***
Periodic	*Within 12 months prior to shipment*	*Each component individually ≤ 1.44×10^{-4} ref cm^3/s with a test sensitivity of 7.20×10^{-5} ref cm^3/s*	*A.5.1 A.5.2 A.5.8 A.5.9*
Pre-shipment	*Before each shipment, after the contents are loaded and the package is closed*	*No detected leakage, sensitivity of 10^{-3} ref cm^3/s or better, unless seal is replaced.*	*A.5.1 A.5.2 A.5.8 A.5.9*
Maintenance	*After maintenance, repair, or replacement of containment components, including inner seals*	*Each component individually ≤ 1.44×10^{-4} ref cm^3/s with a test sensitivity of 7.20×10^{-5} ref cm^3/s*	*A.5.1 A.5.2 A.5.8 A.5.9*

No leakage tests are required prior to shipment of an empty NUHOMS®-MP197HB packaging.

A.8.2.3 Component and Material Tests

A.8.2.3.1 Fasteners

All threaded fasteners and port plugs shall be inspected whenever removed, and annually, for deformed or stripped threads. Damaged parts shall be evaluated for continued use and replaced as required.

At a minimum, the MP197HB cask lid bolts shall be replaced at least every 250 shipments (round trip) to ensure adequate fatigue strength is maintained.

A.8.2.3.2 Impact Limiters

A visual examination of the impact limiters before each shipment will be performed to ensure that the impact limiters have not been degraded between leakage test intervals. If there is no evidence of weld cracking or other damage which could result in water in-leakage, the wood will not be degraded. If there is visual damage, the impact limiter will be removed from service, repaired, if possible, and inspected for degradation of the wood. Impact limiters will be leakage tested once every five years to ensure that water has not entered the impact limiters. If the leakage test indicates that the impact limiters have a leak, a humidity test will be performed to verify that there is no free water in the impact limiters.

A.8.2.3.3 Valves, Rupture Discs, and Gaskets on Containment Vessel

Metallic seals are to be replaced prior to transport of a loaded NUHOMS®-MP197HB packaging.

Elastomer O-ring seals may be reused for transport of a loaded NUHOMS®-MP197HB packaging, provided they have been replaced within 12 months of the shipment.

Metallic and elastomer O-ring seals may be reused for transport of an empty NUHOMS®-MP197HB packaging.

There are no valves, rupture discs, or couplings on the containment of the NUHOMS®-MP197HB packaging.

A.8.2.3.4 Shielding

There are no periodic tests or inspections required for the NUHOMS®-MP197HB shielding. As described in Chapter A.7, radiation surveys will be performed on the package exterior to ensure that the limits specified in 10 CFR 71.47 are met prior to each shipment.

The material composition of the VYAL-B neutron shielding resin employed in the shielding calculations are based on minimum guaranteed values that are determined as a result of extensive tests under various (including extreme) environmental conditions. These tests indicate that the neutron shielding resin does not degrade under normal conditions and is durable over extended periods of time. The shielding calculations employed are based on conservative models and design basis source terms and demonstrate that the dose rate criteria are satisfied with sufficient margin. The comparisons of calculated and measured dose rate have indicated that the calculated dose rates are highly conservative. The 10CFR 71 dose rate compliance measurements serve to indicate the shielding effectiveness of the package. Therefore, periodic tests for the neutron shielding resin are not necessary.

A.8.2.4 Periodic Thermal Tests

There are no periodic tests or inspections required for the NUHOMS®-MP197HB package heat transfer components for the reasons explained in Section A.8.1.8.

A.8.2.5 Miscellaneous Tests

There are no additional maintenance tests required for the MP197HB package.

A.8.3 References

1. ASME Boiler and Pressure Vessel Code, Section III, 2004 Edition including 2006 addenda. (For the MP197HB; various editions apply to specific DSCs. See Chapter A.2 for specific applications).
2. SNT-TC-1A, "American Society for Nondestructive Testing, Personnel Qualification and Certification in Nondestructive Testing."
3. ANSI N14.6-1993, "American National Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds or More for Nuclear Materials," New York.
4. ANSI N14.5-*2014*, "American National Standard for Leakage Tests on Packages for Shipment of Radioactive Materials."
5. Not Used.
6. Not Used.
7. Not Used.
8. Not Used.
9. Not Used.
10. Not Used.
11. ISO-12807, "Safe transport of radioactive material - Leakage testing on packages," First Edition, 1996.
12. "Aluminum Standards and Data, 2003," The Aluminum Association.
13. Natrella, "Experimental Statistics," Dover, 2005.
14. ASTM E1225, "Thermal Conductivity of Solids by Means of the Guarded-Comparative-Longitudinal Heat Flow Technique."
15. ASTM E1461, "Thermal Diffusivity of Solids by the Flash Method."

Enclosure 4 to E-50408

Proposed Changes to CoC 9302 Revision 8

NRC FORM 618 (8-2000) 10 CFR 71			U.S. NUCLEAR REGULATORY COMMISSION	
CERTIFICATE OF COMPLIANCE FOR RADIOACTIVE MATERIAL PACKAGES				
1. a. CERTIFICATION NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE / PAGES
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2. PREAMBLE

a. This certificate is issued to certify that the package (packaging and contents) described in Item 5 below meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION.

c. ISSUED TO (Name and Address)

TN Americas, LLC.
7135 Minstrel Way, Suite 300
Columbia, MD 21045

d. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION

NUHOMS®-MP197 Transportation Package Safety Analysis Report, Revision No. ~~18, dated April 2017~~ TBD. TBD

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model Nos: NUHOMS®-MP197, NUHOMS®-MP197HB

(2) Description: NUHOMS®-MP197

The NUHOMS®-MP197 package consists of an outer packaging, used for the transport of the NUHOMS®-61BT dry shielded canister (DSC). Weights and dimension noted below are approximate values.

Packaging

The NUHOMS®-MP197 packaging is fabricated primarily of stainless steel. Non-stainless steel items include the lead shielding between the containment boundary inner shell and the structural shell, the O-ring seals, the neutron shield, and carbon steel closure bolts. The body of the packaging consists of a 1.25 inch thick, 68 inch inside diameter, stainless steel inner (containment) shell and a 2.5 inch thick, 82 inch outside diameter stainless steel structural shell, without impact limiters, which sandwich the 3.25 inch thick cast lead shielding. The packaging is 208 inches long and has an outer diameter of 91.5 inches. The weight of the packaging body is 148,840 pounds including about 10,000 pounds of neutron shield and 60,000 pounds of cast lead.

5.(a)(3) Description, NUHOMS®-MP197HB

The NUHOMS®-MP197HB package consists of an outer packaging, which is used for the off-site transport of any one of the nine NUHOMS® DSCs (24PT4, 24PTH, 32PT, 32PTH, 32PTH1, 37PTH, 61BT, 61BTH, and 69BTH). It is also used to transport a secondary container (Radioactive Waste Container (RWC)) with dry irradiated and/or contaminated non-fuel bearing solid materials. Weights and dimensions are approximate values, unless otherwise noted.

Packaging

The MP197HB packaging is a modified version of the MP197 packaging described in 5(a)(2).

The packaging is fabricated primarily of nickel-alloy steel (NAS). Other materials include the cast lead shielding between the containment boundary inner shell and the structural shell, the O-ring seals, the resin neutron shield, and the carbon steel closure bolts. Socket headed cap screws (bolts) are used to secure the lid to the package body and the RAM access closure plate to the bottom of the package. The body of the packaging consists of a NAS inner shell, 1.25 inch thick with a 70.5 inch inside diameter, and a NAS outer shell, 2.75 inch thick with a 84.5 inch outside diameter, which sandwich the 3 inch thick cast lead shielding material.

The packaging is 271.25 inch long with a diameter of 126 inches, when both impact limiters are installed. The packaging diameter, including the radial neutron shield, is 97.75 inches without the fins or 104.25 inches with the fins. The fins are an optional feature for heat loads less than or equal to 26 kW. The packaging cavity is 199.25 inches long and 70.5 inches in diameter without the internal sleeve (discussed below) or 68 inches in diameter with the sleeve.

The MP197HB uses an internal ~~aluminum~~ sleeve for smaller diameter DSCs and secondary containers. The inner sleeve is designed with slots to accommodate the existing rails inside the packaging and to provide rails inside the sleeve on which the smaller diameter DSCs or secondary containers slide during horizontal loading or unloading of the package.

The gross weight of the loaded package is 152 tons including a maximum payload of 56 tons. Four removable trunnions, attached to the package body, are provided for lifting and handling operations, including rotation of the packaging between the horizontal and vertical orientations.

The package containment boundary consists of the inner shell, a 6.5 inch thick bottom plate with a 28.88 inch diameter, a 2.5 inch thick RAM access closure plate with seal and bolts, a package body flange, a 4.5 inch thick lid with seal and bolts, vent and drain ports with closures bolts and seals, and all containment welds.

5.(a)(3) Description, NUHOMS®-MP197HB (continued)

Add: "For contents loaded in a Dry Shielded Canister (DSC), an"

~~An~~ ~~inert~~ atmosphere (helium) is maintained in the package cavity. Helium assists in heat removal and provides a non-reactive environment to protect the fuel assemblies against fuel cladding degradation. Shielding is provided by approximately 4 inches of steel, 3 inches of lead and 6.25 inches of neutron shielding assembly.

To accommodate the NUHOMS®-69BTH DSC with heat loads greater than 26 kW, removable external fins are provided for the packaging.

Dry Shielded Canister (DSC)

The function of the DSC, which is placed within the transport package, is identical to that described for the MP197 cask in 5(a)(2) above. The DSC consists of a stainless steel shell and a basket assembly. The DSC basket assembly provides criticality control and contains a storage position for each fuel assembly. No credit is taken for the DSC as a containment boundary.

There are nine DSC designs and a radioactive waste canister authorized for transport in the NUHOMS®-MP197HB packaging. The packaging cavity is designed to accommodate the larger 69.8 inch diameter DSCs (32PTH, 32PTH1, 37PTH, and 69BTH DSC). To accommodate the smaller 67.3 inch diameter DSCs (24PT4, 24PTH, 32PT, 61BT, and 61BTH DSC) or secondary container (RWC), an ~~aluminum~~ inner sleeve is provided. To accommodate the varying lengths of the DSCs and secondary containers, stainless steel or aluminum spacers are provided to limit axial movement of the payload. Spacers are to be installed in the MP197HB overpack or DSC cavity, if necessary, to limit the axial gaps between the components, as specified n Chapter A.7, Table A.7-1 of the application.

The maximum weight of the payload (DSC including the fuel) is limited to 56 tons.

The DSC basket poison plates are constructed from Boral®, borated aluminum or aluminum/B_4C metal matrix composite (MMC) and provide a heat conduction path from the fuel assemblies to the canister wall, as well as the necessary criticality control.

Radioactive Waste Container (RWC)

The RWC consists of a payload of dry irradiated and/or contaminated non-fuel bearing solid materials. No credit is taken for the containment provided by the RWC.

The RWC assembly together with any appropriate cask cavity spacers shall provide an equivalent of 1.75 inches minimum steel shielding in the radial direction. A minimum of 5.75 inches equivalent steel shielding shall be provided at the bottom of the canister and a minimum of 7.00 inches equivalent steel shielding at the top of the canister. The maximum weight of the payload (RWC, including waste) is limited to 56 tons.

5.(a)(4) Drawings, NUHOMS®-MP197 (continued)

1093-71-14, Revision 1,
NUHOMS®-61BT Transportable Canister for BWR Fuel General Assembly

1093-71-15, Revision 2,
NUHOMS®-61BT Transportable Canister for BWR Fuel Shell Assembly

1093-71-16, Revision 0,
NUHOMS®-61BT Transportable Canister for BWR Fuel Shell Assembly

1093-71-17, Revision 2,
NUHOMS®-61BT Transportable Canister for BWR Fuel Canister Details

1093-71-18, Revision 1,
NUHOMS®-61BT Transportable Canister for BWR Fuel Canister Details

1093-71-20, Revision 0,
NUHOMS®-MP197 Packaging Regulatory Plate

1093-71-21, Revision 0,
NUHOMS®-MP197 Packaging on Transport Skids

5.(a)(5) Drawings, NUHOMS®-MP197HB

The NUHOMS®-MP197HB package shall be constructed and assembled in accordance with the following Transnuclear, Inc. drawings:

MP197HB-71-1001 Rev 4 NUHOMS®-MP197HB Packaging Transport Configuration (2 sheets)

MP197HB-71-1002 Rev 7 NUHOMS®-MP197HB Packaging Parts List (2 sheets)

MP197HB-71-1003 Rev 3 NUHOMS®-MP197HB Packaging General Arrangement (1 sheet)

MP197HB-71-1004 Rev 5 NUHOMS®-MP197HB Packaging Cask Body Assembly (1 sheet)

MP197HB-71-1005 Rev 6 NUHOMS®-MP197HB Packaging Cask Body Details (3 sheets)

MP197HB-71-1006 Rev 3 NUHOMS®-MP197HB Packaging Lid Assembly And Details (1 sheet)

MP197HB-71-1007 Rev 1 NUHOMS®-MP197HB Packaging Regulatory Plate (1 sheet)

MP197HB-71-1008 Rev 2 NUHOMS®-MP197HB Packaging Impact Limiter Assembly (1 sheet)

MP197HB-71-1009 Rev 2 NUHOMS®-MP197HB Packaging Impact Limiter Details (1 sheet)

MP197HB-71-1011 Rev 1	NUHOMS®-MP197HB Packaging Transport Configuration Outer Sleeve With Fins Option (1 sheet)
MP197HB-71-1014 Rev 2	NUHOMS®-MP197HB Packaging Internal Sleeve Design (~~2~~ 1 sheets)
NUH24PT4-71-1001 Rev 0	NUHOMS® 24PT4 Transportable Canister For PWR Fuel Basket Assembly (5 sheets)
NUH24PT4-71-1002 Rev 0	NUHOMS® 24PT4 Transportable Canister For PWR Fuel Main Assembly (8 sheets)
NUH24PT4-71-1003 Rev 0	NUHOMS® 24PT4 Transportable Canister For PWR Fuel Failed Fuel Can (4 sheets)
NUH32PT-71-1000 Rev 0	NUHOMS® 32PT Transportable Canister For PWR Fuel Summary Dimensions (1 sheet)
NUH32PT-71-1001 Rev 1	NUHOMS® 32PT Transportable Canister For PWR Fuel Main Assembly (5 sheets)
NUH32PT-71-1002 Rev 1	NUHOMS® 32PT Transportable Canister For PWR Fuel Shell Assembly (3 sheets)
NUH32PT-71-1003 Rev 1	NUHOMS® 32PT Transportable Canister For PWR Fuel “A” Basket Assembly (16 Poison/16 Compartment Plates)(8 sheets)
NUH32PT-71-1004 Rev 1	NUHOMS® 32PT Transportable Canister For PWR Fuel Aluminum Transition Rail – R90 (2 sheets)
NUH32PT-71-1005 Rev 1	NUHOMS® 32PT Transportable Canister For PWR Fuel Aluminum Transition Rail –R45 (1 sheet)
NUH32PT-71-1006 Rev 1	NUHOMS® 32PT Transportable Canister For PWR Fuel “A/B/C/D” Basket Assembly (20 Poison/12 Compartment Plates)(6 sheets)
NUH32PT-71-1007 Rev 1	NUHOMS® 32PT Transportable Canister For PWR Fuel “A/B/C/D” Basket Assembly (24 Poison/8 Compartment Plates)(8 sheets)
NUH24PTH-71-1000 Rev 1	NUHOMS® 24PTH Transportable Canister For PWR Fuel Main Assembly (5 sheets)
NUH24PTH-71-1001 Rev 1	NUHOMS® 24PTH Transportable Canister For PWR Fuel Basket Shell Assembly (4 sheets)
NUH24PTH-71-1002 Rev 1	NUHOMS® 24PTH Transportable Canister For PWR Fuel Shell Assembly (4 sheets)
NUH24PTH-71-1003 Rev 2	NUHOMS® 24PTH Transportable Canister For PWR Fuel Basket Assembly (8 sheets)

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NUH61BTH-71-1103 Rev 1	NUHOMS® 61BTH Type 2 Transportable Canister For BWR Fuel Transition Rails (2 sheets)
NUH61BTH-71-1104 Rev 1	NUHOMS® 61BTH Type 2 Transportable Canister For BWR Fuel Damaged Fuel End Caps (1 sheet)
NUH61BTH-71-1105 Rev 1	NUHOMS® 61BTHF Type 2 Transportable Canister For BWR Fuel Failed Fuel Can (2 sheets)
NUH61BTH-71-1106 Rev 2	NUHOMS® 61BTH Type 2 Transportable Canister For BWR Fuel Top Grid Assembly Alternate 3 (2 sheets)
NUH69BTH-71-1001 Rev 3	NUHOMS® 69BTH Transportable Canister For BWR Fuel Main Assembly (4 sheets)
NUH69BTH-71-1002 Rev 3	NUHOMS® 69BTH Transportable Canister For BWR Fuel Basket – Shell Assembly (4 sheets)
NUH69BTH-71-1003 Rev 3	NUHOMS® 69BTH Transportable Canister For BWR Fuel Shell Assembly (4 sheets)
NUH69BTH-71-1004 Rev 6	NUHOMS® 69BTH Transportable Canister For BWR Fuel Alternate Top Closure (7 sheets)
NUH69BTH-71-1011 Rev 3	NUHOMS® 69BTH Transportable Canister For BWR Fuel Basket Assembly (5 sheets)
NUH69BTH-71-1012 Rev 4	NUHOMS® 69BTH Transportable Canister For BWR Fuel Transition Rail Assembly And Details (6 sheets)
NUH69BTH-71-1013 Rev 4	NUHOMS® 69BTH Transportable Canister For BWR Fuel Holddown Ring Assembly (2 sheets)
NUH69BTH-71-1014 Rev 2	NUHOMS® 69BTH Transportable Canister For BWR Fuel Damaged Fuel Modification (1 sheet)
NUH69BTH-71-1015 Rev 2	NUHOMS® 69BTH Transportable Canister For BWR Fuel Damaged Fuel End Caps (1 sheet)
NUHRWC-71-1001 Rev 2	NUHOMS® System ~~RWC Canister - Welded Top Shield Plug Design Main Assembly~~ Radioactive Waste Canister (~~5~~ 2 sheets)
~~NUHRWC-71-1002 Rev 1~~	~~NUHOMS® System RWC Canister - Welded Top Shield Plug Design Inner Liner (3 sheets)~~
~~NUHRWC-71-1003 Rev 0~~	~~NUHOMS® System RWC Canister - Bolted Top Shield Plug Design Main Assembly (4 sheets)~~

7. In addition to the requirements of Subpart G of 10 CFR Part 71, the NUHOMS®-MP197 and NUHOMS®-MP197HB packages shall:

   (a) Be prepared for shipment and operated in accordance with the Operating Procedures in Chapters 7.0 and A.7 of the application, respectively; and

   (b) Meet the Acceptance Tests and Maintenance Program of Chapters 8.0 and A.8 of the application, respectively.

8. Additional operating requirements of the NUHOMS®-MP197 package include:

   (a) Verification of the basket type A, B, or C, by inspection of the last digit of the serial number on the grapple ring at the bottom of the DSC.

   (b) Verification that the fuel assemblies to be placed in the DSC meet the maximum burnup, maximum initial enrichment, minimum cooling time, and maximum decay heat limits for fuel assemblies as specified in Tables 2 and 3. The enrichment limit must correspond to the basket type determined in 8(a) above.

   Add "of DSCs"

   (c) Replacement of the package lid bolts after 85, or fewer, roundtrip shipments to ensure that the allowable fatigue damage factor will not be exceeded during normal conditions of transport.

9. Additional operating requirements of the NUHOMS®-MP197HB package include:

   (a) Transportation is limited to facilities that have the capability to handle uncanned damaged fuel assemblies.

   (b) Detailed site-specific procedures shall be developed to address site specific conditions and requirements that may require the use of different equipment and ordering of steps to accomplish the same objectives or acceptance criteria which must be met to ensure the integrity of the package.

   Add "DSC"

   (c) Prior to transportation, the condition of the canister must be evaluated to verify that (i) the containment function of the canister is maintained and (ii) the degradation of neutron absorbers and basket materials has not occurred to the extent they would no longer comply with applicable materials and dimensions, as specified in condition 5(a)(5). The verification of the containment function shall follow the instructions outlined in Chapter A.7, Section A.7.1.3, Step 5 of the application. The effectiveness of the inspection and verification techniques, outlined in Chapter A.7, Section A.7.1.3, Step 5, shall be demonstrated on mockups or working systems, prior to transportation.

   Add ",titled "Evaluation," "

   Add "DSC"

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(d) The aging management plan and evaluation for each ~~canister~~, or set of ~~canisters,~~ shall be submitted to the NRC prior to shipment. Add "DSC" Add "DSCs"

(e) Replacement of the package lid bolts after 250, or fewer, round trip shipments to ensure that the allowable fatigue damage factor will not be exceeded during normal conditions of transport.

10. The NUHOMS®-MP197 and NUHOMS®-MP197HB packages are approved for exclusive use by rail, truck, or marine transport. Transport by air is not authorized.

11. The NUHOMS®-MP197 and NUHOMS®-MP197HB packages authorized by this certificate are hereby approved for use under the general license provisions of 10 CFR 71.17.

12. Revision No. ~~7~~ of this certificate may be used until ~~May 31, 2018.~~ TBD

13. Expiration Date: August 31, 2022.

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REFERENCES

NUHOMS®-MP197 Transportation Package Safety Analysis Report, Revision No. ~~18, dated April 2017~~. TBD

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

John McKirgan, Chief
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Date: ~~May 23, 2017~~ TBD