APPENDIX D.1
INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION
Standardized NUHOMS®-61BTH Type 1 System

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D.1. INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION

No change or additional information required for the Standardized NUHOMS® System containing the NUHOMS® 61BTH DSCs for Chapter 1.

APPENDIX D.2
SITE CHARACTERISTICS
Standardized NUHOMS®-61BTH Type 1 System

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D.2. SITE CHARACTERISTICS

No change or additional information required for the Standardized NUHOMS® System containing the NUHOMS® 61BTH DSCs for Chapter 2.

APPENDIX D.3
PRINCIPAL DESIGN CRITERIA
Standardized NUHOMS®-61BTH Type 1 System

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D.3. PRINCIPAL DESIGN CRITERIA

The Standardized NUHOMS®-61BTH Type 1 System (referred to as 61BTH in this appendix) principal design criteria is documented in Chapter T.2 of the "Standardized NUHOMS® Horizontal Modular Storage System Safety Analysis Report" [D.3-1]. Table D.3-1 provides a comparison of the Standardized NUHOMS®-61BTH Type 1 System principal design criteria and the WCS Consolidated Interim Storage Facility (*WCS* CISF) design criteria provided in Table 1-2 which demonstrates that the Standardized NUHOMS®-61BTH Type 1 System bounds the WCS CISF criteria.

D.3.1 SSCs Important to Safety

The classifications of the NUHOMS®-61BTH Type 1 System systems, structures and components, are discussed in Section T.2.3 of the "Standardized NUHOMS® Horizontal Modular Storage System Safety Analysis Report" [D.3-1]. These classifications are summarized in Table D.3-2 for convenience.

D.3.1.1 61BTH-DSCs (Type 1)

The 61BTH-DSC provides fuel assembly support required to maintain the fuel geometry for criticality control. Accidental criticality inside a 61BTH-DSC could lead to off-site doses comparable with the limits in 10 CFR Part 100 which must be prevented. The 61BTH-DSC also provides the confinement boundary for radioactive materials.

The DSCs are designed to maintain structural integrity under all accident conditions identified in Chapter 12 without losing its function to provide confinement of the spent fuel assemblies. The DSCs are important-to-safety (ITS).

D.3.1.2 Horizontal Storage Module

For the Standardized NUHOMS®-61BTH Type 1 System the horizontal storage modules (HSM) used is the HSM Model 102, herein referred to as HSM. The HSMs are considered ITS since these provide physical protection and shielding for the DSC during storage. The reinforced concrete HSM is designed in accordance with American Concrete Institute (ACI) 349 [D.3-4] and constructed to ACI-318 [D.3-5]. The level of testing, inspection, and documentation provided during construction and maintenance is in accordance with the quality assurance requirements as defined in 10 CFR Part 72, Subpart G. Thermal instrumentation for monitoring HSM concrete temperatures is considered "not important-to-safety" (NITS).

D.3.1.3 NUHOMS® Basemat and Approach Slab

The basemat and approach slabs for the HSMs are considered NITS and are designed, constructed, maintained, and tested as commercial-grade items.

D.3.1.4 NUHOMS® Transfer Equipment

The MP197HB transportation cask is qualified for transfer operations for Standardized NUHOMS®-61BTH Type 1 System in this application and herein is referred to as a transfer cask. The MP197HB cask is ITS since it protects the DSC during handling and is part of the primary load path used while handling the DSCs in the Cask Handling Building. An accidental drop of a loaded transfer cask has the potential for creating conditions adverse to the public health and safety. These possible drop conditions are evaluated with respect to the impact on the DSC in Chapter 12. Therefore, the MP197HB is designed, constructed, and tested in accordance with a QA program incorporating a graded quality approach for ITS requirements as defined by 10 CFR Part 72, Subpart G, paragraph 72.140(b).

The remaining transfer equipment (i.e., ram, skid, transfer vehicle) is necessary for the successful loading of the DSCs into the HSM. However, these items are not required to provide reasonable assurance that the canister can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public. Therefore, these components are considered NITS and need not comply with the requirements of 10 CFR Part 72. These components are designed, constructed, and tested in accordance with good industry practices.

D.3.2 Spent Fuel to Be Stored

The authorized content for the 61BTH Type 1 DSCs are described in Certificate of Compliance 72-1004 [D.3-6] and the "Standardized NUHOMS® Horizontal Modular Storage System Safety Analysis Report" [D.3-1]; except fuel assemblies with burnups greater than 45 GWd/MTU will not be stored at the WCS CISF in a 61BTH Type 1 canister.

Certificate of Compliance 72-1004 Technical Specifications Table 1-1t [D.3-6] provides a description of the fuels stored in the 61BTH Type 1 DSCs as referenced in Section T.2.1 "Spent Fuel to be Stored" of the "Standardized NUHOMS® Horizontal Modular Storage System Safety Analysis Report" [D.3-1]; except fuel assemblies with burnups greater than 45 GWd/MTU will not be stored at the WCS CISF in a 61BTH Type 1 canister.

D.3.3 Design Criteria for Environmental Conditions and Natural Phenomena

D.3.3.1 Tornado Wind and Tornado Missiles

The design basis tornado wind and tornado missiles for the Standardized NUHOMS® Horizontal Modular Storage System HSM Model 102 are provided in Section T.2.2.1 and Section 3.2.5 of reference [D.3-1] and in Table D.3-1 for the NUHOMS®-MP197HB cask. The 61BTH-DSC and HSM Model 102 components are designed and conservatively evaluated for the most severe tornado and missiles anywhere within the United States (Region I as defined in NRC Regulatory Guide 1.76 [D.3-8]) while the WCS CISF is in Region II, a less severe location with respect to tornado and tornado missiles. The MP197HB cask is evaluated against the Region II tornado and tornado missiles as described in Appendix C.7.

The HSM protects the DSC from adverse environmental effects and is the principal structure exposed to tornado wind and missile loads. Furthermore, all components of the HSM (regardless of their safety classification) are designed to withstand tornadoes and tornado-based missiles. The MP197HB cask protects the DSC during transit to the Storage Pad from adverse environmental effects such as tornado winds and missiles.

D.3.3.2 Water Level (Flood) Design

The DSCs and HSM are designed for an enveloping design basis flood, postulated to result from natural phenomena as specified by 10 CFR 72.122(b). The system is evaluated for a flood height of 50 feet with a water velocity of 15 fps.

The DSCs are subjected to an external hydrostatic pressure equivalent to the 50 feet head of water. The HSM is evaluated for the effects of a water current of 15 fps impinging on the sides of a submerged HSM. For the flood case that submerges the HSM, the inside of the HSM will rapidly fill with water through the HSM vents.

As documented in Sections 2.4.2.2 and 3.2.2, the WCS CISF is not in a floodplain and is above the Probable Maximum Flood elevation and, therefore, will remain dry in the event of a flood.

D.3.3.3 Seismic Design

The seismic criteria for the Standardized NUHOMS® System HSM Model 102 are provided in Section T.2.2.3 and Section 8.2 of reference [D.3-1]. The site-specific seismic ground motion developed for the WCS CISF in the form of the 10,000-year return period uniform hazard response spectrum for the horizontal and vertical directions are described in Chapter 2. Those spectra are used to derive the enveloped acceleration spectra at the concrete pad base and HSM center of gravity. These enveloped spectra are the design seismic basis for the NUHOMS®-61BTH Type 1 System components.

D.3.3.4 Snow and Ice Loading

The design basis snow and ice loading for the Standardized NUHOMS® -61BTH Type 1 System are provided in Section T.2.2.4 and Section 3.2.4 of reference [D.3-1]. Snow and ice loads for the HSM are conservatively derived from ANSI A58.1 1982 [D.3-9]. The maximum 100 year roof snow load, specified for most areas of the continental United States for an unheated structure, of 110 psf is assumed. For the purpose of this conservative generic evaluation, a total live load of 200 psf is used in the HSM analysis to envelope all postulated live loadings, including snow and ice. Snow and ice loads for the on-site transfer cask with a loaded DSC are negligible due to the smooth curved surface of the cask, the heat rejection of the SFAs, and the infrequent short term use of the cask.

The snow and ice loads used in the evaluation of the Standardized NUHOMS®-61BTH Type 1 System components envelopes the maximum WCS CISF snow and ice loads of 10 psf.

D.3.3.5 Lightning

The likelihood of lightning striking the HSM Model 102 and causing an off-normal or accident condition is not considered a credible event. Simple lightning protection equipment and grounding for the HSM structures is considered a miscellaneous attachment acceptable per the HSM design.

D.3.4 Safety Protection Systems

The safety protection systems of the NUHOMS®-61BTH Type 1 System are discussed in Section T.2.3 of the “Standardized NUHOMS® Horizontal Modular Storage System Safety Analysis Report” [D.3-1].

D.3.4.1 General

The NUHOMS®-61BTH Type 1 System is designed for safe confinement during dry storage of SFAs. The components, structures, and equipment that are designed to assure that this safety objective is met are summarized in Table D.3-2. The key elements of the NUHOMS®-61BTH Type 1 System and its operation at the WCS CISF that require special design consideration are:

1. Minimizing the contamination of the DSC exterior.
2. The double closure seal welds on the DSC shell to form a pressure retaining confinement boundary and to maintain a helium atmosphere.
3. Minimizing personnel radiation exposure during DSC transfer operations.
4. Design of the cask and DSC for postulated accidents.
5. Design of the HSM passive ventilation system for effective decay heat removal to ensure the integrity of the fuel cladding.
6. Design of the DSC basket assembly to ensure subcriticality.

D.3.4.2 Structural

The principal design criteria for the DSCs are presented in Section T.2.5 of the “Standardized NUHOMS® Horizontal Modular Storage System Safety Analysis Report” [D.3-1]. The DSCs are designed to store intact and failed PWR FAs with or without channels. The fuel cladding integrity is assured by limiting fuel cladding temperature and maintaining a nonoxidizing environment in the DSC cavity.

The principal design criteria for the MP197HB cask are presented in Section 3.2.5.3 of the “NUHOMS® -MP197 Transportation Package Safety Analysis Report” [D.3-10]. The cask is designed to transfer the loaded DSCs to the HSM.

D.3.4.3 Thermal

The HSM relies on natural convection through the air space in the HSM to cool the DSC. This passive convective ventilation system is driven by the pressure difference due to the stack effect (ΔP_s) provided by the height difference between the bottom of the DSC and the HSM air outlet. This pressure difference is greater than the flow pressure drop (ΔP_f) at the design air inlet and outlet temperatures.

D.3.4.4 Shielding/Confinement/Radiation Protection

The shielding performance and radiation protection requirements for the Standardized NUHOMS(R)-61BT System are described in Sections T.2.3.5 and 3.3.5 of Reference [D.3-1]. The confinement performance requirements for the Standardized NUHOMS®-61BT System are described in Section T.2.3.2 of Reference [D.3-1] for storage conditions. In addition, a bounding evaluation in WCS CISF SAR Section D.7.8 is presented to demonstrate that the confinement boundary for the 61BTH Type 1 DSC does not exceed ASME B&PV Subsection NB Article NB-3200 (Level A allowables) during normal conditions of transport to provide reasonable assurance that the confinement boundary is not adversely impacted by transport to the WCS CISF.

The HSM provides the bulk of the radiation shielding for the DSCs. The HSM design is arranged in a back-to-back arrangement. Thick concrete supplemental shield walls are used at either end of an HSM array to minimize radiation dose rates both on-site and off-site. The HSM provide sufficient biological shielding to protect workers and the public.

The MP197HB cask is designed to provide sufficient shielding to ensure dose rates are ALARA during transfer operations and off-normal and accident conditions.

There are no radioactive releases of effluents during normal and off-normal storage operations. In addition, there are no credible accidents that cause significant releases of radioactive effluents from the DSC. Therefore, there are no off-gas or monitoring systems required for the system at the WCS CISF.

D.3.4.5 Criticality

For the DSCs, a combination of fixed poison in the basket and geometry are relied on to maintain criticality control. The structural analysis shows that there is no deformation of the basket under accident conditions that would increase reactivity.

D.3.4.6 Material Selection

Materials are selected based on their corrosion resistance, susceptibility to stress corrosion cracking, embrittlement properties, and the environment in which they operate during normal, off normal and accident conditions. The confinement boundary for the DSC materials meet the requirements of ASME Boiler and Pressure Vessel Code, Section III, Article NB-2000 and the specification requirements of Section II, Part D [D.3-7], with the listing of ASME Code alternatives for the DSCs provided in Tables T.3.1-2 and T.3.1-3 of the "Standardized NUHOMS® Horizontal Modular Storage System Safety Analysis Report" [D.3-1]. The code alternatives applicable to the MP197HB Cask are provided in Appendix A.2.13.13 of reference [D.3-10]. The DSC and cask materials are resistant to corrosion and are not susceptible to other galvanic reactions. Studies under severe marine environments have demonstrated that the shell materials used in the DSC shells are expected to demonstrate minimal corrosion during an 80-year exposure. The DSC internals are enveloped in a dry, helium-inerted environment and are designed for all postulated environmental conditions. The HSM is a reinforced concrete component with an internal DSC support structure that is fabricated to ACI and AISC Code requirements. Both have durability well beyond a design life of 80 years.

D.3.4.7 Operating Procedures

The sequence of operations are outlined for the NUHOMS®-61BTH Type 1 System in Chapter 5 and C.5 for receipt and transfer of the DSCs to the storage pad, insertion into the HSM, monitoring operations, and retrieval and shipping. Throughout Chapter 5, CAUTION statements are provided at the steps where special notice is needed to maintain ALARA, protect the contents of the DSC, or protect the public and/or ITS components of the NUHOMS®-61BTH Type 1 System.

D.3.5 References

D.3-1 TN Americas, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," NRC Docket No. 72-1004, TN Americas Document No. NUH-003, Revision 14.

D.3-2 U.S. Nuclear Regulatory Commission, "Certificate of Compliance No. 9302, Revision 7 for the Model No. NUHOMS®-MP197 and NUHOMS®-MP197HB Packages (Docket 71-9302).

D.3-3 Proposed SNM-1050, WCS Consolidated Interim Storage Facility Technical Specifications, Amendment 0.

D.3-4 American Concrete Institute, "Code Requirements for Nuclear Safety Related Concrete Structures" and Commentary, ACI 349-85 and ACI 349R-85, American Concrete Institute, Detroit Michigan (1985).

D.3-5 American Concrete Institute, "Building Code Requirement for Reinforced Concrete," ACI-318, American Concrete Institute, Detroit Michigan (1983).

D.3-6 Certificate of Compliance 72-1004, Amendment all.

D.3-7 American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Section III, Division 1, Subsection NB, 1998 Edition including 2000 Addenda.

D.3-8 Reg Guide 1.76, "Design-Basis Tornado And Tornado Missiles For Nuclear Power Plants," Revision 1, March 2007.

D.3-9 ANSI A58.1-1982, "Building Code Requirements for Minimum Design Loads in Buildings and Other Structures."

D.3-10 TN Document, NUH09.101 Rev. 17, "NUHOMS® -MP197 Transportation Package Safety Analysis Report." (Basis for NRC CoC 71-9302).

Table D.3-1
Summary of WCS CISF Principal Design Criteria
(5 pages)

Design Parameter	WCS CISF Design Criteria	Condition	NUHOMS®-61BTH Type 1 Design Criteria
Type of fuel	Commercial, light water reactor spent fuel	Normal (Bounded)	Standardized NUHOMS® FSAR Section T.2.1
Storage Systems	Transportable canisters and storage overpacks docketed by the NRC	Normal (Bounded)	71-9302 72-1004
Fuel Characteristics	Criteria as specified in previously approved licenses for included systems	Normal (Bounded)	Standardized NUHOMS® FSAR Section, T.2.1
Tornado (Wind Load) (HSM Model 102)	Max translational speed: 40 mph Max rotational speed: 160 mph Max tornado wind speed: 200 mph Radius of max rotational speed: 150 ft Tornado pressure drop: 0.9 psi Rate of pressure drop: 0.4 psi/sec	Accident (Bounded)	Standardized NUHOMS® FSAR Sections 3.2.1 and T.2.2.1 Max translational speed: 70 mph Max rotational speed: 290 mph Max tornado wind speed: 360 mph Radius of max rotational speed: 150 ft Tornado pressure drop: 3.0 psi Rate of pressure drop: 2.0 psi/sec
Tornado (Wind Load) (MP197HB TC)	Max translational speed: 40 mph Max rotational speed: 160 mph Max tornado wind speed: 200 mph Radius of max rotational speed: 150 ft Tornado pressure drop: 0.9 psi Rate of pressure drop: 0.4 psi/sec	Accident (Bounded)	Sections D.7.7 and C.7.7.4 (New Evaluation) Max translational speed: N/A Max rotational speed: N/A Max tornado wind speed: 360 mph Radius of max rotational speed: N/A Tornado pressure drop: N/A Rate of pressure drop: N/A

Table D.3-1
Summary of WCS CISF Principal Design Criteria
(5 pages)

Design Parameter	WCS CISF Design Criteria	Condition	NUHOMS®-61BTH Type 1 Design Criteria
Tornado (HSM Missile)	Automobile 4000 lb, 112 ft/s Schedule 40 Pipe 287 lb, 112 ft/s Solid Steel Sphere 0.147 lb, 23 ft/s	Accident (Bounded)	Standardized NUHOMS® FSAR Sections 3.2.1 and T.2.2.1 Automobile 4000 lb, 195 ft/s 8" diameter shell 276 lb, 185 ft/s Solid Steel Sphere 0.147 lb, 23 ft/s Wood plank missile 200 lb, 440 ft/s
Tornado (MP197HB Missile)	Automobile 4000 lb, 112 ft/s Schedule 40 Pipe 287 lb, 112 ft/s Solid Steel Sphere 0.147 lb, 23 ft/s	Accident (Same)	Sections D.7.7 and C.7.7.1 (New Evaluation) Automobile 4000 lb, 112 ft/s Schedule 40 Pipe 287 lb, 112 ft/s Solid Steel Sphere 0.147 lb, 23 ft/s
Floods	The WCS CISF is not in a floodplain and is above the Probable Maximum Flood elevation and will remain dry in the event of a flood.s	Accident (Bounded)	Standardized NUHOMS® FSAR Sections 3.2.2 and T.2.2.2 Flood height 50 ft Water velocity 15 ft/s
Seismic (Ground Motion)	Site-specific ground-surface uniform hazard response spectra (UHRS) with 1E-4 annual frequency of exceedance (AFE) having peak ground acceleration (PGA) of 0.250 g horizontal and 0.175 g vertical. (Table 1-5 and Figure 1-5)	Accident (Evaluated)	See Evaluations in Sections 7.6.4, 7.6.5, D.7.5.3, and D.7.6
Vent Blockage	For NUHOMS® Systems: Inlet and outlet vents blocked 40 hrs	Accident (Same)	Standardized NUHOMS® FSAR Section T.4.4.5 Inlet and outlet vents blocked 40 hrs
Fire/Explosion	For NUHOMS® Systems: Equivalent fire 300 gallons of diesel fuel	Accident (Same)	Standardized NUHOMS® FSAR Sections 3.3.6 and T.2.3.6 Equivalent fire 300 gallons of diesel fuel

Table D.3-1
Summary of WCS CISF Principal Design Criteria
(5 pages)

Design Parameter	WCS CISF Design Criteria	Condition	NUHOMS®-61BTH Type 1 Design Criteria
Cask Drop	For NUHOMS® Systems: Transfer Cask Horizontal side drop or slap down 80 inches(2)	Accident (Same)	Sections D.7.7 and C.7.7 (New Evaluation) Transfer Cask Horizontal side drop or slap down 80 inches(2)
Transfer Load	For NUHOMS® Systems only: Normal insertion load 60 kips Normal extraction load 60 kips	Normal (Bounded)	Sections D.7.7 and C.7.7 (New Evaluation) and Standardized NUHOMS® SAR Section, T.3.6.1.1 Normal insertion load 80 kips Normal extraction load 60 kips
Transfer Load	For NUHOMS® Systems only: Maximum insertion load 80 kips Maximum extraction load 80 kips	Off-Normal/ Accident (Same)	Sections D.7.7 and C.7.7 (New Evaluation) and Standardized NUHOMS® FSAR Section, T.3.6.2.1 Maximum insertion load 80 kips Maximum extraction load 80 kips
Ambient Temperatures	Normal temperature 44.1 – 81.5°F	Normal (Bounded)	Section D.8.5 (New Evaluation) and Standardized NUHOMS® FSAR Section, T.4.4.3 Normal temperature 0 - 100°F(1)
Off-Normal Temperature	Minimum temperature 30.1°F Maximum temperature 113°F	Off-Normal (Bounded)	Section D.8.5 (New Evaluation) and Standardized NUHOMS® FSAR Section, T.4.4.3 Minimum temperature -40.0°F Maximum temperature 125°F
Extreme Temperature	Maximum temperature 113°F	Accident (Bounded)	Sections D.8.5 (New Evaluation) and Standardized NUHOMS® FSAR Section, T.4.4.3 Maximum temperature 125°F

Table D.3-1
Summary of WCS CISF Principal Design Criteria
(5 pages)

Design Parameter	WCS CISF Design Criteria	Condition	NUHOMS®-61BTH Type 1 Design Criteria
Solar Load (Insolation)	Horizontal flat surface insolation 2949.4 BTU/day-ft^2 Curved surface solar insolation 1474.7 BTU/day-ft^2	Normal (Same)	Section D.8.5 (New Evaluation) and Standardized NUHOMS® FSAR Table 8.1-17 Horizontal flat surface insolation 2949.4 BTU/day-ft^2 Curved surface solar insolation 1474.7 BTU/day-ft^2
Snow and Ice	Snow Load 10 psf	Normal (Bounded)	Standardized NUHOMS® FSAR Sections 3.2.4 and T.2.2.4 Snow Load 110 psf
Dead Weight	Per design basis for systems listed in Table 1-1	Normal (Same)	Standardized NUHOMS® FSAR Sections T.3.2, T.3.6.1.1, T.3.6.1.2, T.3.6.1.3 and Tables T.2-14, T.3.2-1 and T.3.2-2 [D.3-1]
Internal and External Pressure Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	Standardized NUHOMS® FSAR Sections T.3.6.1, T.3.6.2, and Table T.2-14 [D.3-1]
Design Basis Thermal Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	Standardized NUHOMS® FSAR Sections T.3.6.1.1, T.3.6.1.2, T.3.6.1.3, T.3.6.2 and Table T.2-14 [D.3-1]
Operating Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	Standardized NUHOMS® FSAR Sections T.3.6.1.1, T.3.6.1.2, T.3.6.1.3 and Table T.2-14 [D.3-1]
Live Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	Standardized NUHOMS® FSAR Section T.3.6.1.1 Design Load (including snow and ice) 200psf

Table D.3-1
Summary of WCS CISF Principal Design Criteria
(5 pages)

Design Parameter	WCS CISF Design Criteria	Condition	NUHOMS®-61BTH Type 1 Design Criteria
Radiological Protection	Public wholebody ≤ 5 Rem Public deep dose plus individual organ or tissue ≤ 50 Rem Public shallow dose to skin or extremities ≤ 50 Rem Public lens of eye ≤ 15 Rem	Accident (Same)	Chapter 9 demonstrates these limits are met Public wholebody ≤ 5 Rem Public deep dose plus individual organ or tissue ≤ 50 Rem Public shallow dose to skin or extremities ≤ 50 Rem Public lens of eye ≤ 15 Rem
Radiological Protection	Public wholebody ≤ 25 mrem/yr(3) Public thyroid ≤ 75 mrem/yr(3) Public critical organ ≤ 25 mrem/yr(3)	Normal (Same)	Chapter 9 demonstrates these limits are met Public wholebody ≤ 25 mrem/yr(3) Public thyroid ≤ 75 mrem/yr(3) Public critical organ ≤ 25 mrem/yr(3)
Confinement	Per design basis for systems listed in Table 1-1	N/A	Standardized NUHOMS® FSAR Section T.7
Nuclear Criticality	Per design basis for systems listed in Table 1-1	N/A	Standardized NUHOMS® FSAR Section T.6
Decommissioning	Minimize potential contamination	Normal (Same)	Standardized NUHOMS® FSAR Sections 9.6 and T.1.4 Minimize potential contamination
Materials Handling and Retrieval Capability	Cask/canister handling system prevent breach of confinement boundary under all conditions Storage system allows ready retrieval of canister for shipment off-site	Normal (Same)	Standardized NUHOMS® FSAR Sections T.2.3.2 and T.7 Cask/canister handling system prevent breach of confinement boundary under all conditions Storage system allows ready retrieval of canister for shipment off-site

Notes

1. Not Used.

2. 75g Vertical, 75g Horizontal and 25g corner is equivalent to 80 inch drop.
3. In accordance with 10 CFR 72.104(a)(3) limits include any other radiation from uranium fuel cycle operations within the region.

Table D.3-2
NUHOMS®-61BTH Type 1 System Major Components and Safety Classifications

Component	10CFR72 Classification
Dry Shielded Canister (DSC)	Important to Safety(1)
Horizontal Storage Module (HSM)	Important to Safety(1)
Basemat and Approach Slabs	Not Important to Safety
Transfer Equipment	
Cask	Important to Safety
Transport Trailer/Skid	Not Important to Safety
Ram Assembly	Not Important to Safety
Lubricant	Not Important to Safety
Auxiliary Equipment	
HSM Temperature Monitoring	Not Important to Safety

Notes

1. Graded Quality

APPENDIX D.4
OPERATING SYSTEMS
Standardized NUHOMS®-61BTH Type 1 System

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D.4. OPERATING SYSTEMS

This Appendix provides information on the operating systems applicable to the Standardized NUHOMS® System with the NUHOMS® 61BTH Type 1 DSC identified in Chapter 4 of the SAR. Those systems include the concrete pad structures, cask storage system, cask transporter system and the optional HSM thermal monitoring system.

D.4.1 Concrete Pad Structures

This section is applicable to the basemat and approach slabs for the NUHOMS® HSM Model 102. The following discussion provides guidance for these structures; but as noted in Section D.4.1.3, the basemat and approach slabs are not-important-to-safety (NITS).

D.4.1.1 Operating Functions

The NUHOMS® System basemat and approach slabs are cast-in-place reinforced concrete foundation structures that support the HSMs (the basemat) and provide for access and support of the transfer system (the approach slabs). The thickness of the basemat and the approach slab will be determined by Storage Area foundation analysis.

D.4.1.2 Design Description

The following provides a description of the design considerations that will be taken into account when designing the basemat and approach slabs.

The basemat and approach slab loads consist of both dead and live loads, seismic loads, and tornado wind loads imposed on the HSM array and transferred to the basemat.

The dead load consists of the weight of the basemat or approach slab.

Live loads for the basemat include the weight of the loaded DSC, the weight of the modules and shield walls plus an additional 200 psf applied over the surface area of the HSM base to account for snow and ice loads, safety railings on the roofs of the HSM, etc. These loads are provided in Table D.4-1. The values shown in Table D.4-1 are based on nominal material density; however, the as-built weight can vary ±5%, therefore; the storage pad is designed to accommodate 105% of the nominal weight shown in the table.

Live loads for the approach slab include the MP197HB cask and transfer vehicle design payload which is 300,000 lb. Additional live loads of 200 psf are applied over the surface area of the approach slabs.

Localized front (furthest from HSM) jack loads of 85,000 lb and rear jack loads of 109,000 lb are considered in designing the approach slab (this conservatively assumes the load of the DSC is carried only by the two rear jacks as the DSC is inserted into the HSM). These loads are spread as necessary by use of spreading plates or other suitable means.

The site-specific soil conditions at the WCS Consolidated Interim Storage Facility (*WCS* CISF) are considered in the basemat design based on basemat and HSM acceleration resulting from seismic activity.

Tornado wind loads acting on the HSM array are transferred to the basemat as friction and pressure loads. Generic design pressure loads acting on the NUHOMS® system due to tornado wind loading are described in the Standardized NUHOMS® UFSAR, Section 3.2.1 [D.4-1]. These may be replaced by the site-specific tornado loads which are significantly lower.

The basemat for the NUHOMS® HSMs will be level and constructed with a "Class B" surface flatness finish as specified in ACI 301-89 [D.4-2], or FF 25 per ASTM E 1155. Specifically, finishes with Class B tolerances shall be true planes within 1/4" in 10 feet, as determined by a ten foot straightedge placed anywhere on the slab in any direction. Although Class B surface finish is required, for modules with mating surfaces Class A surface flatness or FF 50 per ASTM E 1155 is recommended in order to provide better fit up and minimize gaps.

The surface finish for the basemat may be broomed, troweled or ground surface. Laser guided finishers and certified personnel may be utilized for construction of the basemat to assure proper finish, levelness and flatness. Alternatively, when grouted installation of HSMs is used, a reduced flatness may be targeted. The grouted installation consists of setting the modules on approximately one-inch thick stainless steel shims and grouting between the module and the pad using cement-based grouts.

The slope of the approach slabs shall not exceed 7% which is the adjustable limit of brake of the transfer vehicle.

The overall dimensions of the HSM modules are listed in Table D.4-2. When determining the length of the basemat, 1/2" should be added to the width of each module to account for as-built conditions in the modules and basemat. The basemat typically extends one foot beyond the front face of the module and matches the elevation of the approach slab. Thus, the width of a basemat for the double array is typically two feet wider than the modules. Similarly, the basemat typically extends one foot beyond the end walls.

To maintain levelness and stability of the module array, the joints intersecting the basemat should be minimized. Joints with expansion and sealant material must be compatible with expected basemat temperatures.

Two methods of HSM array expansion are permitted. One involves the temporary removal of end walls, installation of new modules, and then re-installation of the end walls. This method requires that the existing modules adjacent to the end walls be empty (unloaded) during array expansion. The other method of array expansion effectively buries the existing end walls by placing new modules directly adjacent to the end walls with new end walls placed at the end of the expanded array. The length of the basemat should be designed to accommodate the planned method of array expansion, as applicable. The basemat shall be designed to a maximum differential settlement of 1/4 inch, front to back and side-to-side (HSM array).

Finally, approach roads and aprons should be designed or repaired to eliminate features such as speed bumps, drains or potholes that would result in a difference of more than 5 inches in surface flatness over any 10-foot wide by 20-foot long area.

D.4.1.3 Safety Considerations

The foundation is not relied upon to provide safety functions. There are no structural connections or means to transfer shear between the HSM base unit module and the foundation slab. Therefore, the basemat and approach slabs for the HSMs are considered NITS and are designed, constructed, maintained, and tested as commercial-grade items.

D.4.2 Cask Storage System

This section is applicable to the NUHOMS® 61BTH Type 1 DSC; NUHOMS® HSM Model 102 and MP197HB cask configured for transfer operations.

D.4.2.1 Operating Function

The overall function of the HSM Model 102 used at the WCS CISF is to safely provide interim storage of spent nuclear fuel (SNF) NUHOMS® 61BTH Type 1 DSCs (canisters). These canisters provide a convenient means to place quantities of SNF into dry storage in a way that allows easy retrieval of the canisters for off-site shipment.

The NUHOMS® 61BTH Type 1 DSCs containing SNF assemblies are designed for storage in accordance with 10 CFR 72, and for transportation in accordance with 10 CFR 71. The main function of sealed canisters is to accommodate SNF assemblies, and provide confinement and criticality control during normal operation and postulated design-basis accident conditions for on-site storage. The NUHOMS® 61BTH Type 1 DSCs are shown in drawing NUH61BH-1000-SAR Revision 3 included in Section D.4.6.

The HSM Model 102 is designed in accordance with 10 CFR 72, and provides horizontal on-site storage of the sealed SNF. The main function of the HSM Model 102 is to provide safe, long-term storage of NUHOMS® 61BTH Type 1 DSCs containing SNF assemblies.

The HSM Model 102 design function is to passively cool the canisters by air convection. The HSM Model 102 also provides the capability for canister transfer from their associated transportation/transfer casks. The drawings for the HSM Model 102 are NUH-03-6008-SAR Revision 10, NUH-03-6009-SAR Revision 9, NUH-03-6010-SAR Revision 5, NUH-03-6014-SAR Revision 9, NUH-03-6015-SAR Revision 8, NUH-03-6016-SAR Revision 10, NUH-03-6017-01-SAR Revision 7, NUH-03-6018-SAR Revision 7 and NUH-03-6024-SAR Revision 5 included in Section A.4.6.

The MP197HB cask, in the transfer configuration, design function is to protect the canisters and provide shielding from the radiation sources inside the canisters during transfer operations. The MP197HB cask in the transfer configuration is shown in drawings MP197HB-71-1005 Revision 4, MP197HB-71-1014 Revision 1, MP197HB-71-1006 Revision 2, MP197HB-71-1002 Revision 6 and MP197HB-71-1004 Revision 4, included in Section C.4.6.

D.4.2.2 Design Description

The NUHOMS® 61BTH Type 1 DSCs are stainless steel flat head pressure vessels that provide confinement that is designed to withstand all normal condition loads as well as off-normal and accident condition loads created by earthquakes, tornadoes, flooding, and other natural phenomena.

The HSM Model 102 is a low profile, reinforced concrete structure designed to withstand all normal condition loads as well as the off-normal and accident condition loads created by earthquakes, tornadoes, flooding, and other natural phenomena. The HSM is also designed to withstand off-normal and accident condition loadings postulated to occur during design basis accident conditions such as a complete loss of ventilation.

The MP197HB cask, in the transfer configuration, is used to transfer the canisters from the Cask Handling Building to the storage pad where the cask is mated to the HSM Model 102. The cask is designed to withstand all normal condition loads as well as the off-normal and accident condition loads created by earthquakes, tornadoes, flooding, and other natural phenomena.

D.4.2.3 Safety Considerations

The NUHOMS® 61BTH Type 1 DSCs are important-to-safety (ITS), Quality Category A components.

The HSM Model 102 is an ITS, Quality Category B component. The MP-197HB Cask is an ITS, Quality Category A component.

D.4.3 Cask Transporter System

This section is applicable to the cask transporter system for the Standardized NUHOMS® System. This following provides a general description of the cask transporter system, however as noted Section D.4.3.3, this equipment is NITS.

D.4.3.1 Operating Function

The cask transporter system for the MP197HB cask is designed to move the loaded MP197HB cask in the on-site transfer configuration between the Cask Handling Building and the Storage Area and transfer the canister from the MP197HB cask to the HSM Model 102.

D.4.3.2 Design Description

This transfer vehicle includes a transfer skid which cradles the top and bottom lifting trunnions of the cask, and is designed to be moved with the skid and cask. The transfer vehicle is also used in the Storage Area to transfer the canister from an MP197HB cask to an HSM. It features a transfer skid, a skid positioner, a hydraulic ram system and hydraulic jacks for stabilization. The system utilizes a self-contained hydraulic ram to hydraulically push the canister out of the MP197HB cask and into the HSM. The alignment of the MP197HB and the HSM is verified by an alignment system.

D.4.3.3 Safety Considerations

All transfer equipment is designed to limit the height of the MP197HB cask to less than 80” above the surrounding area; therefore, it is NITS and is designed, constructed, maintained, and tested as commercial-grade items.

D.4.4 Storage Module Thermal Monitoring System

Instrumentation is provided for monitoring HSM temperatures as described in Section 5.1.3 HSM Thermal Monitoring Program of the Technical Specifications [D.4-3] that may be used as one of two options provided to prevent conditions that could lead to exceeding the concrete and fuel clad temperature criteria.

D.4.5 References

D.4-1 TN Document NUH-003, Revision 14, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel." (Basis for NRC CoC 72-1004).

D.4-2 American Concrete Institute, "Specifications for Structural Concrete for Buildings," ACI 301, 1989.

D.4-3 Proposed SNM-1050, WCS Consolidated Interim Storage Facility Technical Specifications, Amendment 0.

D.4.6 Supplemental Data Drawings

The following drawing is located as noted below:

1. "NUHOMS® 61BTH DSC Type 1 Main Assembly (five sheets)," NUH61BH-1000-SAR, Revision 3 (See Section T.1.5 of Appendix T of the "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel" [D.4-1]).

Table D.4-1
Weight of HSM Model 102

Component	Nominal Weight kips(1)	105% weight kips
HSM Model 102	258.3	271.2
End Walls	48	50.4

Notes

1. Values reported in this table are for the purposes of designing the basemat and may differ from other SAR values.

Table D.4-2
HSM Model 102 Overall Dimensions

Width	Depth	Height
122”	228”	180”

APPENDIX D.5
OPERATING PROCEDURES
Standardized NUHOMS®-61BTH Type 1 System

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D.5. OPERATING PROCEDURES

This chapter presents the operating procedures for the Standardized NUHOMS® System containing the NUHOMS® 61BTH Type 1 DSCs originally loaded and stored under Certificate of Compliance (CoC) 1004 with the addition of the NUHOMS®-MP197HB transport/transfer cask (TC) qualified for transfer operations with the 61BTH Type 1 DSC. The procedures include receipt of the TC; placing the TC onto the transfer skid on the transfer vehicle, transfer to the Storage Area, DSC transfer into the Horizontal Storage Module (HSM), monitoring operations, and DSC retrieval from the HSM. The NUHOMS®-MP197HB transfer equipment, and the Cask Handling Building systems and equipment are used to accomplish these operations. Procedures are delineated here to describe how these operations may be performed and are not intended to be limiting. Temporary shielding may be used throughout as appropriate to maintain doses as low as reasonably achievable (ALARA).

The following sections outline the typical operating procedures for the Standardized NUHOMS®-61BTH Type 1 System. These procedures have been developed to minimize the amount of time required to complete the subject operations, to minimize personnel exposure, and to assure that all operations required for transfer, and storage are performed safely. Operations may be performed in a different order if desired to better utilize personnel and minimize dose as conditions dictate.

Pictograms of the Standardized NUHOMS®-61BTH Type 1 System operations are presented in Figure D.5-1.

The generic terms used throughout this section are as follows.

- TC, or transfer cask is used for the NUHOMS®-MP197HB transport/transfer cask.
- DSC is used for the NUHOMS®-61BTH Type 1 DSC.
- HSM is used for the HSM Model 102.

D.5.1 Procedures for Loading the DSC and Transfer to the HSM

A pictorial representation of key phases of this process is provided in Figure D.5-1.

D.5.1.1 Receipt of the Loaded NUHOMS®-MP197HB Cask

Procedures for receiving the loaded TC after shipment are described in this section. These procedures are taken from reference [D.5-1], and must remain consistent with [D.5-1].

1. Verify that the tamperproof seals are intact.

2. Remove the tamperproof seals.

3. Remove the holddown bolts from the impact limiters and install the impact limiter hoist rings provided.

4. Remove the impact limiters from the TC.

5. Remove the transportation skid personnel barrier and tie-down straps.

6. Take contamination smears on the outside surfaces of the TC. If necessary, decontaminate the TC until smearable contamination is at an acceptable level.

7. Install the front and rear trunnions and torque the bolts to 1000-1100 ft-lbs for double shoulder trunnions and 800-900 ft-lbs for single shoulder trunnions following the torqueing sequence in accordance with the transport license requirements [D.5-1].

   Note: The WCS CISF is not authorized to accept high burnup fuel assemblies in the 61BTH Type 1 DSC at this time.

8. Attach the WCS Lift Beam Assembly to TC top and bottom ends.

9. Using the overhead crane, lift the TC from the conveyance. Place the TC onto the transfer cask skid trunnion towers.

CAUTION: Verify that the TC is not lifted more than 80” above the adjacent surface in accordance with the limits specified in Section 5.2.1 of the Technical Specifications [D.5-2].

10. Inspect the trunnions to ensure that they are properly seated onto the skid.

11. Remove the WCS Lift Beam Assembly.

12. Install the cask shear key plug assembly.

13. Install the on-site support skid pillow block covers.

14. Any time prior to removing the TC top cover plate or the bottom ram access cover plate, sample the TC cavity atmosphere through the vent port. Flush the TC interior gases to the radwaste system if necessary.

15. Draw a vacuum on the TC cavity and helium leak test the DSC in accordance with reference [D.5-3] requirements.

D.5.1.2 Transfer to the HSM

1. Prior to the TC arrival at the HSM or prior to positioning the TC at the HSM, remove the HSM door, inspect the cavity of the HSM, removing any debris and ready the HSM to receive a DSC. The doors on adjacent HSMs should remain in place.

CAUTION: The inside of empty modules have the potential for high dose rates due to adjacent loaded modules. Proper ALARA practices should be followed for operations inside these modules and in the areas outside these modules whenever the door from an empty HSM has been removed.

2. Inspect the HSM air inlets and outlets to ensure that they are clear of debris. Inspect the screens on the air inlets and outlets for damage.

3. Verify specified lubrication of the DSC support structure rails.

4. Move the TC from Cask Handling Building to the storage pad along the designated transfer route.

5. Once at the storage pad, position the transfer vehicle to within a few feet of the HSM.

   Note: If performing inspection of the DSC surface per reference [D.5-3] requirement, install inspection apparatus between the TC and the HSM..

6. Check the position of the transfer vehicle to ensure the centerline of the HSM and TC approximately coincide. If the transfer vehicle is not properly oriented, reposition the transfer vehicle, as necessary.

7. Unbolt and remove the TC top cover plate.

8. Verify the DSC serial number against appropriate records.

CAUTION: High dose rates are expected after removal of the TC top cover. Proper ALARA practices should be followed.

9. Remove the cask spacer ring and install the unloading flange.

10. Back the transfer vehicle to within a few inches of the HSM/inspection apparatus, set the transfer vehicle brakes and disengage the tractor, if applicable. Extend the transfer vehicle vertical jacks.

11. Use the skid positioning system to bring the TC into approximate vertical and horizontal alignment with the HSM. Using alignment equipment and the alignment marks on the TC and the HSM, adjust the position of the TC until it is properly aligned with the HSM.

12. Using the skid positioning system, fully insert the TC into the HSM/inspection apparatus access opening docking collar.

13. Secure the TC to the front wall embedments of the HSM using the cask restraints.

14. After the TC is docked with the HSM/inspection apparatus, verify the alignment of the TC using the alignment equipment.

15. Remove the bottom ram access cover plate. Position the ram behind the TC in approximate horizontal alignment with the TC and level the ram. Extend the ram through the bottom TC opening into the DSC grapple ring.

16. Operate the ram grapple and engage the grapple arms with the DSC grapple ring.

17. Recheck all alignment marks and ready all systems for DSC transfer.

18. Activate the ram to initiate insertion of the DSC into the HSM. Stop the ram when the DSC reaches the support rail stops at the back of the module.

    Note: Performing inspection of the DSC surface, as required, by the aging management program while the DSC is being transferred from the TC to the HSM.

19. Disengage the ram grapple mechanism so that the grapple is retracted away from the DSC grapple ring.

20. Retract and disengage the ram system from the TC and move it clear of the TC. Remove the cask restraints from the HSM.

21. Using the skid positioning system, disengage the TC from the HSM/inspection apparatus access opening.

22. Remove the inspection apparatus, if used.

23. Install the DSC axial restraint through the HSM door opening.

CAUTION: High dose rates are expected in the HSM cavity after removal of the HSM door. Proper ALARA practices should be followed.

24. The transfer vehicle can be moved, as necessary, to install the HSM door. Install the HSM door and secure it in place. The door may be welded for security.

25. Remove the unloading flange and replace the cask spacer ring.

26. Replace the TC top cover plate and ram access cover plate. Secure the skid to the transfer vehicle.

27. Move the transfer vehicle and TC to the designated area. Return the remaining transfer equipment to the Storage Area.

D.5.1.3 Monitoring Operations

1. Perform routine security surveillance in accordance with the security plan.

2. Perform a daily visual surveillance of the HSM air inlets and outlets (bird screens) to verify that no debris is obstructing the HSM vents in accordance with Section 5.1.3(a) of the Technical Specification [D.5-2] requirements, or, perform a temperature measurement for each EOS-HSM in accordance with Section 5.1.3(b) of the Technical Specifications [D.5-2] requirements.

D.5.2 Procedures for Unloading the DSC

The following section outlines the procedures for retrieving the DSC from the HSM for shipment off-site.

D.5.2.1 DSC Retrieval from the HSM

1. Ready the TC, transfer vehicle, and support skid for service. Remove the top cover and ram access plates from the TC. Move the transfer vehicle to the HSM.

2. Remove the HSM door and the DSC axial restraint. Position the transfer vehicle to within a few feet of the HSM.

3. Check the position of the transfer vehicle to ensure the centerline of the HSM and TC approximately coincide. If the transfer vehicle is not properly oriented, reposition the transfer vehicle as necessary.

CAUTION: High dose rates are expected in the HSM cavity after removal of the HSM door. Proper ALARA practices should be followed.

4. Back the TC to within a few inches of the HSM, set the transfer vehicle brakes and disengage the tractor, if applicable. Extend the transfer vehicle vertical jacks.

5. Use the skid positioning system to bring the TC into approximate vertical and horizontal alignment with the HSM. Using alignment equipment and the alignment marks on the TC and the HSM, adjust the position of the TC until it is properly aligned with the HSM.

6. Using the skid positioning system, fully insert the TC into the HSM access opening docking collar.

7. Secure the TC to the front wall embedments of the HSM using the cask restraints.

8. After the TC is docked with the HSM, verify the alignment of the TC using the alignment equipment.

9. Position the ram behind the TC in approximate horizontal alignment with the TC and level the ram. Extend the ram through the TC into the HSM until it is inserted in the DSC grapple ring.

10. Operate the ram grapple and engage the grapple arms with the DSC grapple ring.

11. Recheck all alignment marks and ready all systems for DSC transfer.

12. Activate the ram to pull the DSC into the TC.

13. Once the DSC is seated in the TC, disengage the ram grapple mechanism so that the grapple is retracted away from the DSC grapple ring.

14. Retract and disengage the ram system from the TC and move it clear of the TC. Remove the cask restraints from the HSM.

15. Using the skid positioning system, disengage the TC from the HSM access opening.

CAUTION: The inside of empty modules have the potential for high dose rates due to adjacent loaded modules. Proper ALARA practices should be followed for operations inside these modules and in the areas outside these modules whenever the door from the empty HSM has been removed.

16. Bolt the TC top cover plate and the ram access cover into place, tightening the bolts to the required torque in a star pattern.

17. Retract the vertical jacks and disconnect the skid positioning system.

18. Ready the transfer vehicle for transfer.

19. Replace the HSM door and DSC axial restraint on the HSM.

20. Move the TC from the storage pad to the Cask Handling Building along the designated transfer route.

21. Prepare the transportation cask for transport in accordance with Certificate of Compliance No. 9302.

D.5.3 References

D.5-1 U.S. Nuclear Regulatory Commission, "Certificate of Compliance No. 9302, Revision 7 for the Model No. NUHOMS®-MP197 and NUHOMS®-MP197HB Packages (Docket 71-9302).

D.5-2 Proposed SNM-1050, WCS Consolidated Interim Storage Facility Technical Specifications, Amendment 0.

D.5-3 "Post Transport Package Evaluation," QP-10.02, Revision 1.

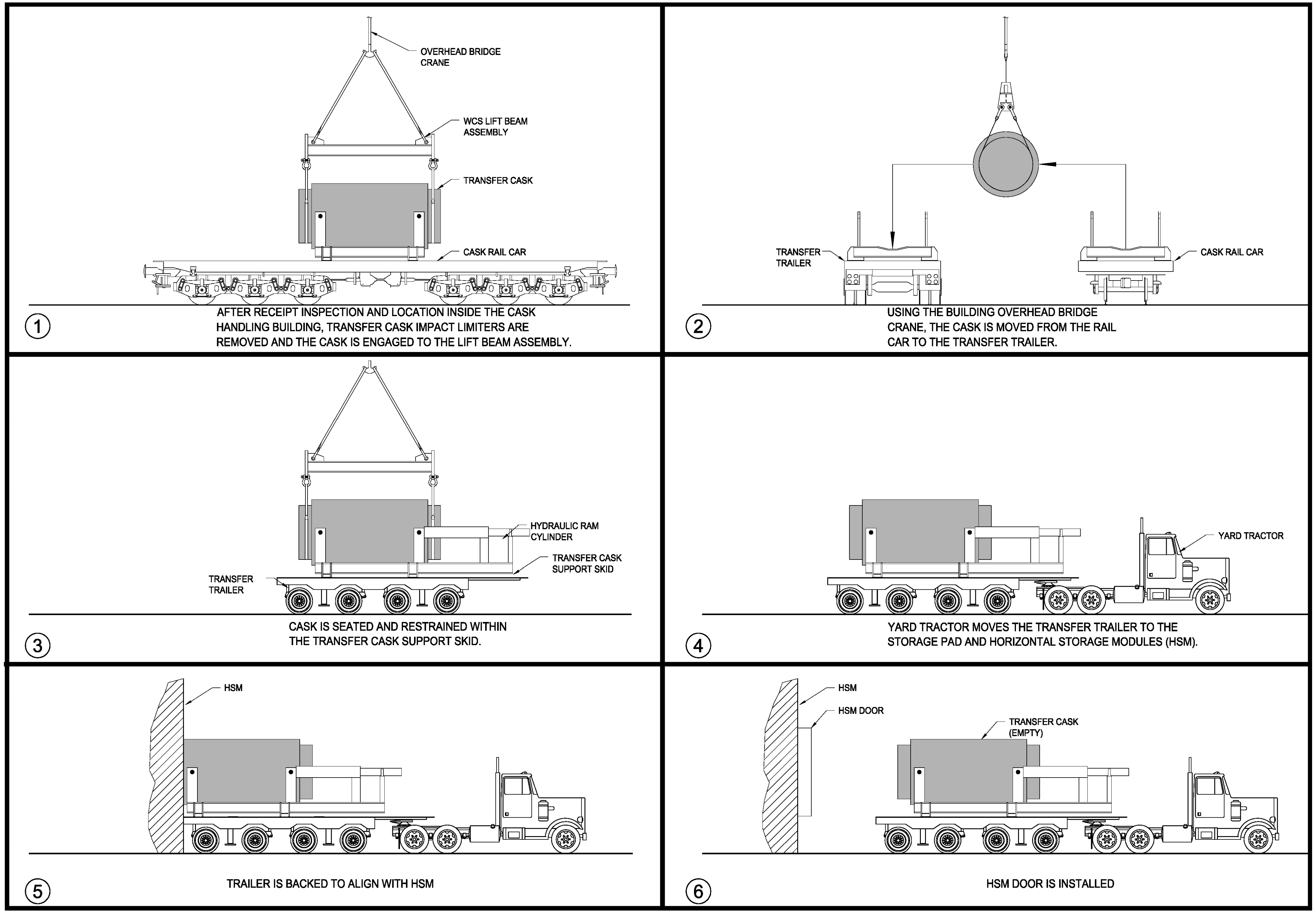

Figure D.5-1
Standardized NUHOMS®-61BTH Type 1 System Loading Operations

APPENDIX D.6
WASTE CONFINEMENT AND MANAGEMENT
Standardized NUHOMS®-61BTH Type 1 System

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D.6. WASTE CONFINEMENT AND MANAGEMENT

No change or additional information required for the Standardized NUHOMS® System containing the NUHOMS® 61BTH DSCs for Chapter 6.

APPENDIX D.7
STRUCTURAL EVALUATION
Standardized NUHOMS®-61BTH Type 1 System

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D.7. STRUCTURAL EVALUATION

This Appendix describes the structural evaluation of the Standardized NUHOMS®-61BTH Type 1 System components utilized for transfer and storage of the 61BTH Type 1 canister at the WCS Consolidated Interim Storage Facility (*WCS* CISF). As presented in Chapter 1, Table 1-1, the Standardized NUHOMS® System storage components include the 61BTH Type 1 Dry Shielded Canister (DSC or canister) and the HSM Model 102 storage overpack. At the WCS CISF, the MP197HB transportation cask will be used for on-site transfer activities.

The HSM Model 102 is described in detail in Section 4.2.3.2 of the Standardized NUHOMS® Updated Final Safety Analysis Report (UFSAR) [D.7-2]. The 61BTH Type 1 DSC is described in detail in Section T.1.2 of [D.7-2]. Both of these components are approved by the NRC in Certificate of compliance (CoC) No. 1004 for transfer and storage of spent nuclear fuel (SNF) under the requirements of 10 CFR Part 72.

The MP197HB cask is described in Section A.1.2 of the NUHOMS®-MP197 Transportation Package Safety Analysis Report (SAR) [D.7-1]. The MP197HB cask is approved by the NRC in CoC No. 9302 for off-site transportation of SNF under the requirements of 10 CFR Part 71. The evaluation of the MP197HB cask for on-site transfer operations under 10 CFR Part 72 is contained in Appendix C.7.

The evaluation of the 61BTH Type 1 DSC for transfer and storage of SNF is contained in Appendix T of [D.7-2]. The evaluation of the HSM Model 102 is contained in Chapter 8 of the Standardized NUHOMS® Updated Final Safety Analysis Report [D.7-2].

Section D.7.3 presents a seismic reconciliation evaluation for the HSM Model 80/102 and for the 61BTH Type 1 DSC. This reconciliation, in combination with evaluations in the Standardized NUHOMS® Updated Final Safety Analysis Report [D.7-2] and evaluations of the MP197HB cask in Appendix C.7 demonstrate that the MP197HB cask / 61BTH Type 1 / HSM Model 102 transfer and storage system components satisfy all of the 10 CFR Part 72 requirements for storage at the WCS CISF.

Qualification of the 61BTH Type 1 DSC confinement boundary during Normal Conditions of Transport is addressed in Section D.7.8

Transfer Cask

The principal design criteria for the MP197HB cask for service at the WCS CISF are described in Table D.3-1 of Appendix D.3 and in Section C.7.7.1. The design approach, design criteria and loading combinations for the MP197HB cask are also described in Section C.7.7.1.

Horizontal Storage Module

The design approach, design criteria and loading combinations for the reinforced concrete HSM and its DSC steel support structure are discussed in Section 3.2.5.1 of the Standardized NUHOMS® Updated Final Safety Analysis Report [D.7-2].

Dry Shielded Canister

The 61BTH Type 1 DSC design approach, design criteria and load combinations for transfer and storage are summarized in Appendix T, Sections T.2 and T.3 of the Standardized NUHOMS® Updated Final Safety Analysis Report [D.7-2].

D.7.1 Discussion

As discussed in Chapter 1, the 61BTH Type 1 DSCs from an Interim Spent Fuel Storage Installation (ISFSI) site will be transported to the WCS CISF in the NUHOMS® MP197HB transportation cask under NRC Certificate of Compliance 9302 [D.7-1]. At the WCS CISF, the 61BTH Type 1 DSCs, described in Appendix T of [D.7-2], are to be stored inside the HSM Model 102 described in Chapter 4 of [D.7-2].

The 61BTH Type 1 DSC is licensed under NRC Certificate of Compliance (CoC) 1004 [D.7-2] for storage in the HSM Model 102 and for transfer operations in the OS197 transfer cask. This appendix reconciles the analyses of the 61BTH Type 1 DSC for transfer operations in the OS197 transfer cask with the transfer operations in the MP197HB cask at the WCS CISF.

As described in Chapter 3, with the exception of seismic loading, the design criteria for the Standardized NUHOMS® components 61BTH Type 1 and HSM Model 102 as described in [D.7-2] envelop the design criteria for the WCS CISF.

Finally, bounding evaluations in Section D.7.8 are referenced to demonstrate that the confinement boundaries for the 61BTH Type 1 DSC does not exceed ASME B&PV Subsection NB Article NB-3200 (Level A allowables) during normal conditions of transport to provide reasonable assurance that the confinement boundary is not adversely impacted by transport to the WCS CISF.

D.7.2 Summary of Mechanical Properties of Materials

The material properties for the 61BTH Type 1 DSC are given in Appendix T Section T.3.3 of [D.7-2].

The material properties for the HSM Model 102 are given in Table 8.1-3 of [D.7-2].

The material properties for the MP197HB cask are given in Chapter A.2.2 of [D.7-1].

D.7.3 Seismic Reconciliation of the Canister, HSM Model 102, and MP197HB Cask

The WCS CISF site-specific seismic ground motion developed for the WCS CISF in the form of the 10,000-year return period uniform hazard response spectra for the horizontal and vertical directions is described in Chapter 2. A comparison of the WCS CISF site-specific response spectra and the Regulatory Guide 1.60 response spectra is shown in Figure D.7-1 for 3%, 5%, and 7% damping values. This comparison indicates that for system frequencies above about 10 Hz (horizontal direction) and 9 Hz (vertical direction), the WCS CISF spectral accelerations are higher than the design basis spectral accelerations. The ZPA values of 0.25g (horizontal) and 0.175g (vertical) for the WCS CISF ground motion are essentially the same as those for the Standardized NUHOMS® System as documented in Section 3.2.3 of [D.7-2].

This section describes the reconciliation evaluations of the 61BTH Type 1 DSC and the HSM Model 102 using the enveloping response spectra at the HSM CG and base, which are obtained from the soil-structure interaction (SSI) analysis of the WCS CISF. Comparisons of the 7%-damped WCS CISF 10,000-year return period uniform hazard response spectra and +/-15% peak-broadened HSM center of gravity (CG) response spectra from the WCS CISF SSI analysis in the HSM’s transverse, longitudinal, and vertical directions are shown in Figure D.7-4, Figure D.7-5, and Figure D.7-6, respectively. The +/-15% peak-broadened HSM CG response spectra for damping values of 7%, 3%, and 2% are shown in Figure D.7-7 through Figure D.7-9. Section C.7.3.2 presents the reconciliation evaluation of the MP197HB cask as a transfer cask.

D.7.3.1 HSM Model 80 and Model 102

The seismic analysis of the HSM (Model 80 and Model 102, herein referred to as “HSM”) is described in Section 8.2.3 of [D.7-2]. This analysis is reconciled in consideration of the enveloping response spectra at the HSM CG obtained from the WCS CISF SSI analysis, which are shown in Figure D.7-7 through Figure D.7-9. The same analysis methodology as used for the seismic evaluation of the HSM in Section 8.2.3.2.B in [D.7-2] is used for this reconciliation evaluation.

A dynamic response spectrum analysis is performed using the HSM ANSYS model shown in Figure 8.1-22 of [D.7-2] and the 7% damped response spectra at the HSM CG obtained from the WCS CISF SSI analysis. The ANSYS code Release 10.0 [D.7-4] is used for the analysis. The model includes an 88.7 kips canister, which is the weight of the 61BTH Type 1 DSC and also the bounding weight of the canister types considered in this application. The forces and moments in the various HSM concrete and steel components of the HSM are evaluated and compared to previous results as applicable.

D.7.3.1.1 HSM Modal Frequency Analysis

A modal frequency analysis is performed to extract the frequencies and associated mode shapes of the HSM model shown in Figure 8.1-22 of [D.7-2]. The modal analysis results indicate that the lowest frequency of 20.76 Hz corresponds to the DSC steel support structure in the transverse horizontal direction. The corresponding mode shapes are shown in Figure D.7-2 and Figure D.7-3. The other predominant frequencies corresponding to the HSM concrete/steel support structure are 28.90Hz, 34.41 Hz, and 44.58 Hz in the axial, transverse, and vertical directions, respectively.

D.7.3.1.2 HSM Response Spectrum Analysis

The 7%-damped response spectra at the HSM CG obtained from the WCS CISF SSI analysis are applied to the ANSYS HSM model to perform a response spectrum analysis. Forces and moments resulting from the analysis are used in the seismic load combination (deadweight + live load + normal thermal + seismic loading).

The effect of the increase in canister weight on the non-seismic load combinations has been evaluated in [D.7-2] for a bounding canister weight of up to 102 kips for the 32PT DSC. Therefore, only the seismic load combination is addressed in this reconciliation evaluation.

The results of the seismic reconciliation analyses are discussed in the following sections.

D.7.3.1.3 Evaluation of the HSM Concrete Components

The forces and moments for each HSM subcomponent (roof slab, walls, floor slab) are determined for the WCS CISF spectra obtained from the SSI analysis, and then compared to their respective capacities, calculated as described in Section 8.1.1.5.E of [D.7-2]. The comparison is shown in Table D.7-1. As seen in this table, the demand-to-capacity ratios for all the HSM concrete subcomponents are less than 1.0. Therefore, the HSM concrete components are acceptable for the WCS CISF site-specific seismic loading.

D.7.3.1.4 Evaluation of the DSC Steel Support Structure

The forces and moments and resulting stresses for each DSC steel support structure component are determined for the WCS CISF spectra obtained from the SSI analysis, and then compared to AISC code allowables as described in Section 8.2.10.6 of [D.7-2]. As seen in the comparison shown in Table D.7-2, the maximum stresses or stress interaction ratios are less than the allowables. Therefore, the DSC steel support structure components are qualified and are acceptable for the WCS CISF site-specific seismic loading.

D.7.3.1.5 Evaluation of Miscellaneous Components

D.7.3.1.5.1 Evaluation of the DSC Axial Retainer

The evaluation of the DSC axial retainer is described in Section 8.2.3.2(C)(iii) of [D.7-2]. The seismic load on the retainer is calculated below for the WCS CISF site-specific seismic loading.

The maximum shear and bending stresses in the DSC axial retainer are 19.8 ksi and 25.8 ksi, respectively. The allowable shear and bending stresses are 23.5 ksi and 44.3 ksi, respectively. Therefore, the DSC axial retainer stresses are within allowable values.

D.7.3.1.5.2 Evaluation of the Heat Shields

The heat shield studs are evaluated for the axial, shear and bending forces due to the WCS CISF site-specific loading. The stiffness of the 3/8” diameter studs is calculated and used to determine the natural frequency of the heat shield panels in the in-plane directions. The corresponding seismic accelerations are combined with deadweight loading to determine the maximum loads on the studs. The maximum axial, bending, and shear stresses in the studs are found to be 1.59 ksi, 14.05 ksi, and 0.40 ksi, respectively. The maximum stress ratio is found to be 0.43 for combined axial plus bending stress.

Therefore, the heat shield plates and studs are acceptable for the WCS CISF seismic loading.

D.7.3.1.6 Evaluation of HSM Seismic Stability and Sliding

The HSM is evaluated for seismic sliding and overturning stability due to the WCS CISF site-specific loading. The maximum sliding distance, rocking angle, and uplift height from the WCS CISF SSI analysis are 0.19", 0.05°, and 0.08", respectively. Therefore, the sliding and overturning stability characteristics of the HSM are acceptable for the WCS CISF seismic loading.

D.7.3.2 MP197HB Cask as On-Site Transfer Cask

The seismic reconciliation is contained in Section C.7.3.2.

D.7.3.3 61BTH Type 1 DSC

Per Section T.3.7.2.1 of Reference [D.7-2], the canister shell components are evaluated for seismic loading of 3.0g and 1.0g for the horizontal and vertical directions, respectively. The basket components are evaluated for a bounding acceleration of 2g in each of the axial, transverse, and vertical direction [Section T.3.6.1.3.4 of D.7-2].

[ ]

D.7.4 Reconciliation of Thermal Loads for the Canister in the HSM Model 102 and in the MP197HB Cask

As noted in Appendix D.8, the thermal performance of the HSM Model 102 with the 61BTH Type 1 DSC at the WCS CISF for normal, off-normal, and accident conditions is bounded by the design basis evaluations as described in Appendix T.4 of [D.7-2]. Since the temperatures of the canister components during storage at the WCS CISF are bounded by the analyses in [D.7-2], the analyses for design basis internal pressure and normal thermal loads, as well as the allowable stress criteria, are also bounded.

The thermal analyses of the 61BTH Type 1 DSC for transfer conditions at the WCS CISF for normal, off-normal, and accident conditions in the MP197HB cask are detailed in Appendix D.8. Comparison of the maximum canister component temperatures shown in Table D.8-2 (for transfer conditions at the WCS CISF) and Table T.4-18 of [D.7-2] indicates the following:

- The canister shell temperature for the off-normal condition increases by 8ºF (2%) for transfer in the MP197HB cask at the WCS CISF.
- The canister internal basket component temperatures are lower or essentially equal (1ºF increase for fuel compartment temperature) for transfer in the MP197HB cask at the WCS CISF.

The very small increase in temperature is inconsequential for the thermal stress evaluations as the temperatures used to determine the component material properties and allowable stresses in Table T.3.7-12, Table T.3.7.14, and Table T.3.7.16 of [D.7-2] bound the maximum temperatures during transfer in the MP197HB cask.

Therefore, it is concluded that the temperature distributions and thermal stresses for normal, off-normal, and accident conditions in [D.7-2] are applicable for transfer of the 61BTH Type 1 DSC in the MP197HB cask.

D.7.5 Structural Analysis of Canister (Storage and Transfer)

The structural analysis of the 61BTH Type 1 DSC for normal, off-normal, and accident loads is presented in Sections T.3.6.1, T.3.6.2, and T.3.7 respectively, of [D.7-2]. Loading types applicable to each affected component are summarized in Table T.3.6-1, Table T.3.6-2, and Table T.3.7-1 for normal, off-normal, and accident conditions, respectively, of [D.7-2]. Results for normal and off-normal loads are summarized in Table T.3.7-12 of [D.7-2]. Results for accident loads are presented in Table K.3.7-14 of [D.7-2].

The evaluations of the 61BTH Type 1 DSC for transfer loads performed in [D.7-2] Appendix T and summarized below in Sections D.7.5.1 through D.7.5.3 were performed for transfer in the OS197 transfer cask. The geometric parameters of the transfer cask that may affect the structural analyses are the cask cavity inner diameter, cask rail locations, cask rail width, and cask rail thickness. Transportation (and transfer) of the 61BTH Type 1 DSC in the MP197HB cask requires the use of a sleeve installed inside the cask. The dimensions of the above-mentioned geometric parameters for the MP197HB cask with the internal spacer sleeve are compared to the same geometric parameters dimensions for the OS197 transfer cask, as follows:

• Cavity Diameter:	OS197 transfer cask	68.00”
	MP197HB cask with sleeve:	68.00”
• Rail Locations:	OS197 transfer cask:	±18.5°
	MP197HB cask with sleeve:	±18.5° and ±38°
• Rail Width:	OS197 transfer cask:	3.00”
	MP197HB cask with sleeve: 3.00”	
• Rail Thickness:	OS197 transfer cask:	0.12”
	MP197HB cask with sleeve:	(0.62”-0.50” inset =) 0.12”

As shown above, all of the critical dimensions are identical. The MP197HB cask has an additional set of rails (at ± 38º) which will have a beneficial effect due to the additional support offered to the canister shell and basket assembly. The transfer cask shell is conservatively assumed to be rigid for analyses of the canister shell and basket. Therefore any difference in stiffness of the OS197 transfer cask and MP197HB cask has no impact on the canister analyses as only the interface dimensions would have an effect on the canister analyses. Since the interface dimensions are the same, the analyses of the 61BTH Type 1 DSC shell and basket assemblies for on-site transfer in the OS197 transfer cask are applicable and equivalent for on-site transfer in the MP197HB cask.

The MP197HB cask, including the internal spacer sleeve, contains the same features as the OS197 transfer cask designed to minimize the possibility of a jammed or binding canister during loading and unloading operations. The calculations performed for the postulated off-normal condition of a jammed or binding casnister are based only on the maximum hydraulic ram force and the diameter of the casnister.

Based on the reconciliations presented above, the 61BTH Type 1 DSC calculations performed in [D.7-2] and discussed below in Section D.7.5.1, Section D.7.5.2, and Section D.7.5.3 involving use of the OS197 transfer cask are applicable for loading and unloading of the 61BTH Type 1 DSC with the MP197HB cask.

The following is a summary of the structural analyses of the 61BTH Type 1 DSC shell and basket assemblies.

D.7.5.1 Normal Loads (Storage in HSM Model 102 and Transfer in MP197HB Cask)

The structural analysis of the 61BTH Type 1 DSC for normal loads is presented in Section T.3.6.1 of [D.7-2].

Canister Shell Assembly

Section T.3.6.1.2 of [D.7-2] describes the 61BTH Type 1 DSC shell analyses for Normal Operating Loads. The analyses are performed using 3-dimensional ANSYS finite element models. The load cases considered include deadweight, design basis normal operating internal and external pressure, normal operating thermal loads, and normal operation handling loads.

The maximum calculated stress results for the individual load cases are shown in Table T.3.6-4 of [D.7-2]. The calculated stresses for each load case are combined in accordance with the load combinations presented in Table T.2-11 of [D.7-2]. The resulting stresses for the controlling load combinations are reported in Section T.3.7.12 of [D.7-2]. All stresses are within the ASME Code allowable stresses.

Basket Assembly

Section T.3.6.1.3 of [D.7-2] describes the 61BTH Type 1 basket analyses for Normal Operating Loads. The analyses are performed using a 3-dimensional ANSYS finite element model. The basket is evaluated separately for Handling/Transfer Loads and for Operation/Storage loads in Sections T.3.6.1.3.3 and T.3.6.1.3.4 of [D.7-2], respectively. The basket thermal stress analysis is contained in Section T.3.4.4.3 of [D.7-2]. The load cases considered include thermal stress, deadweight, handling/transfer loads, and seismic loads. (The seismic loading is considered a Service Level C event; however, it has been used to bound the Horizontal Dead Weight case and is, therefore, presented in the section for Normal Operation/Storage Loads.)

Section T.3.6.1.3.3-C of [D.7-2] presents a table of results for the Handling/Transfer Loads analyses of the 61BTH Type 1 basket. All stresses are within the allowable limits.

Section T.3.6.1.3.4-E of [D.7-2] presents a table of results for the Operation/Storage Loads analyses of the 61BTH Type 1 basket. All stresses are within the allowable limits.

D.7.5.2 Off-Normal Loads

The structural analyses for off-normal loads is contained in Section T.3.6.2 of [D.7-2]. Two limiting off-normal events are defined which envelope the range of expected off-normal structural loads:

- Jammed Canister During Transfer

  Section T.3.6.2.1 of [D.7-2] presents a series of hand calculations to determine the stresses on the canister shell due to various postulated loading conditions (axial sticking of the canister, Binding of the canister). All stresses are within the ASME code limits.

- Off-Normal Thermal Loads

  Off-normal ambient temperatures are defined as -40 °F and 117 °F for the 61BTH Type 1 DSC in [D.7-2] Appendix T.3.6.2.2. The stress results presented in Table T.3.6-4 of [D.7-2] show that the canister stress limits are satisfied for the off-normal thermal loads. The thermal stress analyses in Section T.3.4.4.3 of [D.7-2] show that the stress limits for the basket are satisfied for the off-normal thermal loads. As discussed in Section D.7.4, the thermal stress analyses of the 61BTH Type 1 DSC for transfer in the OS197 transfer cask are applicable for transfer in the MP197HB cask.

D.7.5.3 Accident Loads

The structural analysis of the 61BTH Type 1 DSC for accident loads is presented in Section T.3.7 of [D.7-2]. The following accident conditions affect the canister and are evaluated:

- Earthquake

  The seismic load is reconciled in Section D.7.3.3. As concluded in Section C.7.3.3, the 61BTH Type 1 DSC is acceptable for storage at the WCS CISF.

- Flood

  Evaluation of the canister for flood loads is contained in Section T.3.7.3.2 of [D.7-2]. The ASME Code methodology in NB-3133.3 is used to show that there is a safety margin of at least 1.57 against buckling of the canister shell. The shell stresses are calculated using an ANSYS finite element model and are shown to be much less than the ASME Service Level C allowable values.

- Accidental Cask Drop

  The 61BTH Type 1 DSC evaluation of the accidental drop is documented in Section T.3.7.4 of [D.7-2]. Equivalent static loading of 75g is used to evaluate the effects of the drops.

The canister shell assembly results are summarized in Table T.3.7-2 of [D.7-2] and show that all applicable ASME stress criteria are satisfied. Stability of the canister shell against buckling is also evaluated in Section T.3.7.4.2.4 of [D.7-2] and shown to satisfy the acceptance criteria of ASME Appendix F.

The 61BTH Type 1 basket assembly drop evaluation is described in Section T.3.7.4.3 of [D.7-2]. Basket assembly results for the side drop and end drop are summarized in Table T.3.7-5 and Table T.3.7-7 of [D.7-2]. All applicable stress limits were met. Stability analyses are performed in Section T.3.7.4.3.3 of [D.7-2] using both finite element analyses and hand calculations to evaluate the basket and transition rail plates for stability. The results indicated that the fuel compartment plates and transition rails have sufficient margin against failure.

D.7.6 Structural Analysis of HSM Model 102 with Canister (Storage Configuration)

The structural analysis of the HSM Model 102 reinforced concrete and DSC steel support structure for normal, off-normal, and accident conditions is presented in Sections 8.1.1, 8.1.2 and 8.2, respectively, of [D.7-2]. Loading types applicable to each affected component are summarized in Table 8.1-1, Table 8.1-2, and Table 8.2-1 for normal, off-normal, and accident conditions, respectively, of [D.7-2]. Results for normal and off-normal loads are summarized in Table 8.1-14 and Table 8.1-19 of [D.7-2]. Results for accident loads are presented in Table 8.2-3, Table 8.2-18, Table 8.2-19, and Table 8.2-20 of [D.7-2].

The analyses and results listed above were originally performed for a bounding canister weight of 80.0 kips. The maximum weight of the 61BTH Type 1 DSC is 88.7 kips [D.7-2 Table T.3.2-1]. As described in Paragraph T.3.6.1.4 of [D.7-2], the DSC steel support structure is evaluated in Appendix M of [D.7-2] for a bounding weight of 102 kips which bounds the maximum weight of the 61BTH Type 1 DSC.

As described in Paragraph T.3.6.1.5, the HSM is qualified in Appendix M of [D.7-2] for a bounding weight of 102 kips which bounds the maximum weight of the 61BTH Type 1 DSC.

The HSM door and heat shields are not affected by the weight of the canister, and therefore is qualified by the design basis calculations described in Section 8.1 and 8.2 of [D.7-2].

The reconciliation for the seismic loading on the HSM Model 102 is contained in Section D.7.3.1.

Summaries of the HSM Model 102 analyses for normal, off-normal, and accident conditions can be found in Sections C.7.6.1, C.7.6.2, and C.7.6.3, respectively. The load combinations and analysis results are summarized in Section C.7.6.4.

Based on these discussions, the stress ratios for the HSM Model 102 loaded with the 61BTH Type 1 canister at the WCS CISF are acceptable.

D.7.7 Structural Analysis of MP197HB Cask as On-Site Transfer Cask

The evaluation of the MP197HB cask as the on-site transfer cask for the 61BT and 61BTH Type 1 DSCs is contained in Appendix C.7.

General information regarding the structural analyses of the MP197HB cask for on-site transfer operations at the WCS CISF is contained in Section C.7.7.1. Evaluations for normal and off-normal conditions are contained in Section C.7.7.2. Evaluations for accident conditions are contained in Section C.7.7.3. Evaluations of cask stability due to design basis tornado and seismic loads and cask resistance to puncture due to tornado-generated missiles are contained in Section C.7.7.4.

Based on the evaluation presented in Section C.7.7 the MP197HB cask is qualified for use as a transfer cask at the WCS CISF.

D.7.8 Structural Evaluation of 61BTH Type 1 DSC Confinement Boundary under Normal Conditions of Transport

The 61BTH Type 1 DSC shell assembly consists of a cylindrical shell, top outer/inner cover plates, bottom inner/outer cover plates and bottom and top shield plugs. The 61BTH Type 1 DSC consists of a shell which is a welded, stainless steel cylinder with a stainless steel bottom closure assembly, and a stainless steel top closure assembly. Additional details, geometry and shell and plate thicknesses are provided on the drawings in Section D.4.6. The confinement boundary is addressed in Section D.11.1. The 61BTH Type 1 DSC shell is evaluated for Normal Conditions of Transport in the MP197HB Transport cask in Sections A.2.6.15.2 and A.2.13.7 of [D.7-1]. As described in Section A.2.13.7.1 of [D.7-1], the 61TH DSC is categorized as a Group 2 DSC. The analysis of the Group 2 DSCs (which include the 61BTH Type 1 DSC) are documented Sections A.2.13.7.2 and A.2.13.7.3 of [D.7-1] and the results are reported in Sections A.2.13.7.4.2 A.1 – A.3 of [D.7-1] for Normal Conditions of Transport.

The result of the 61BTH Type 1 DSCs structural analysis is acceptable for the loads and combinations described in Section A.2.13.7.3 of D.7-1] and hence structurally adequate for normal conditions of transport loading conditions.

D.7.9 References

D.7-1 TN Document, NUH09.101 Rev. 17, "NUHOMS® -MP197 Transportation Package Safety Analysis Report." (Basis for NRC CoC 71-9302).

D.7-2 TN Document NUH-003, Revision 14, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel." (Basis for NRC CoC 72-1004).

D.7-3 Blevins, Robert D. Formulas for Natural Frequency and Mode Shape. 2001.

D.7-4 ANSYS Computer Code and User's Manual, Version 10.0 A1.

Table D.7-1
Comparison of Seismic Load Combination Forces and Moments on HSM Concrete Components with Capacities (kip/ft, kip-in/ft)

Component	Quantity	Shear, V_{o1} (Note 1)	Shear, V_{o2} (Note 1)	Moment, M_1 (Note 2)	Moment, M_2 (Note 2)
Floor Slab	Demand(3)	3.37	4.01	23.95	20.05
	Capacity(4)	13.50	14.60	206.00	223.00
	Ratio	0.25	0.27	0.12	0.09
Roof Slab	Demand(3)	4.78	5.79	112.67	113.71
	Capacity(4)	42.50	44.00	1753.00	1813.00
	Ratio	0.11	0.13	0.06	0.06
Side Walls	Demand(3)	14.02	5.59	116.52	133.90
	Capacity(4)	22.90	24.00	728.00	694.00
	Ratio	0.61	0.23	0.16	0.19
Front Wall	Demand(3)	22.84	36.74	260.26	242.27
	Capacity(4)	40.50	41.40	881.00	901.00
	Ratio	0.56	0.89	0.30	0.27
Rear Wall	Demand(3)	5.51	4.22	69.53	74.67
	Capacity(4)	14.30	15.30	305.00	457.00
	Ratio	0.39	0.28	0.23	0.16

Notes:

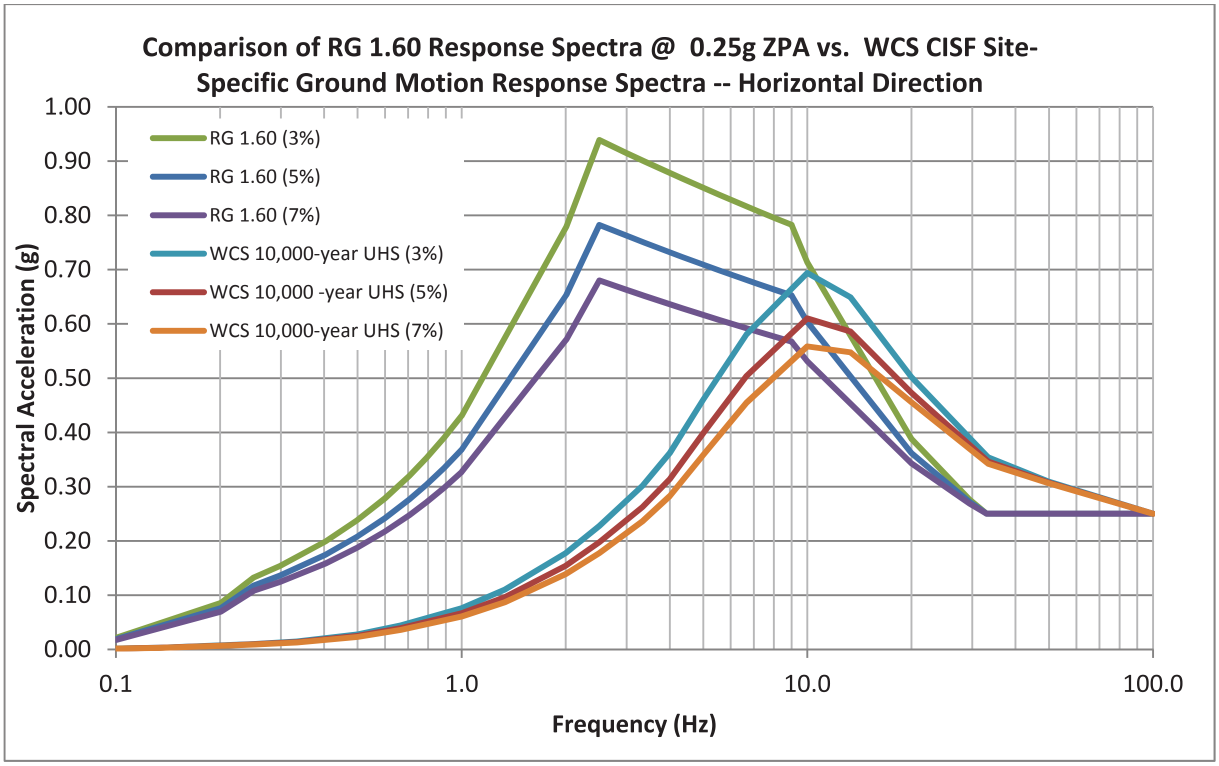
1) V_{o1}, $V_{o2,}$ out of plane shear (beam shear)
2) M_1, M_2, out of plane moments (beam bending moments)
3) Maximum (absolute) values for Seismic Load combination for spectra from WCS CISF SSI analysis.
4) Concrete subcomponent capacities are calculated in accordance with ACI 349-85 and documented in Section 8.1.1.5.E of [D.7-2]

Table D.7-2
Comparison of Seismic Load Combination Stresses in DSC Support Structure Components with Capacities

Component	Calculated Stress						
	Axial (ksi)	Strong Axis Bending (ksi)	Weak Axis Bending (ksi)	Shear (ksi)	Interaction Ratio (Demand /Capacity)	Allowable Tensile Stress (ksi)	Allowable Shear Stress (ksi)
Rail	1.96	3.03	12.49	4.97	0.48	-	18.1
Cross Beam	1.43	5.52	7.34	12.90	0.40	-	18.1
Column	6.84	4.41	4.44	0.25	0.56	-	18.1
Wall Attachment Channel	15.52	-	-	-	-	23.2	-
Mounting Plate Bolt	21.82	-	-	-	-	29.1	-

Notes:
Allowable stresses taken at 270°F and increased by 60% in accordance with ANSI/ANS 57.9.

Table D.7-3
Deleted



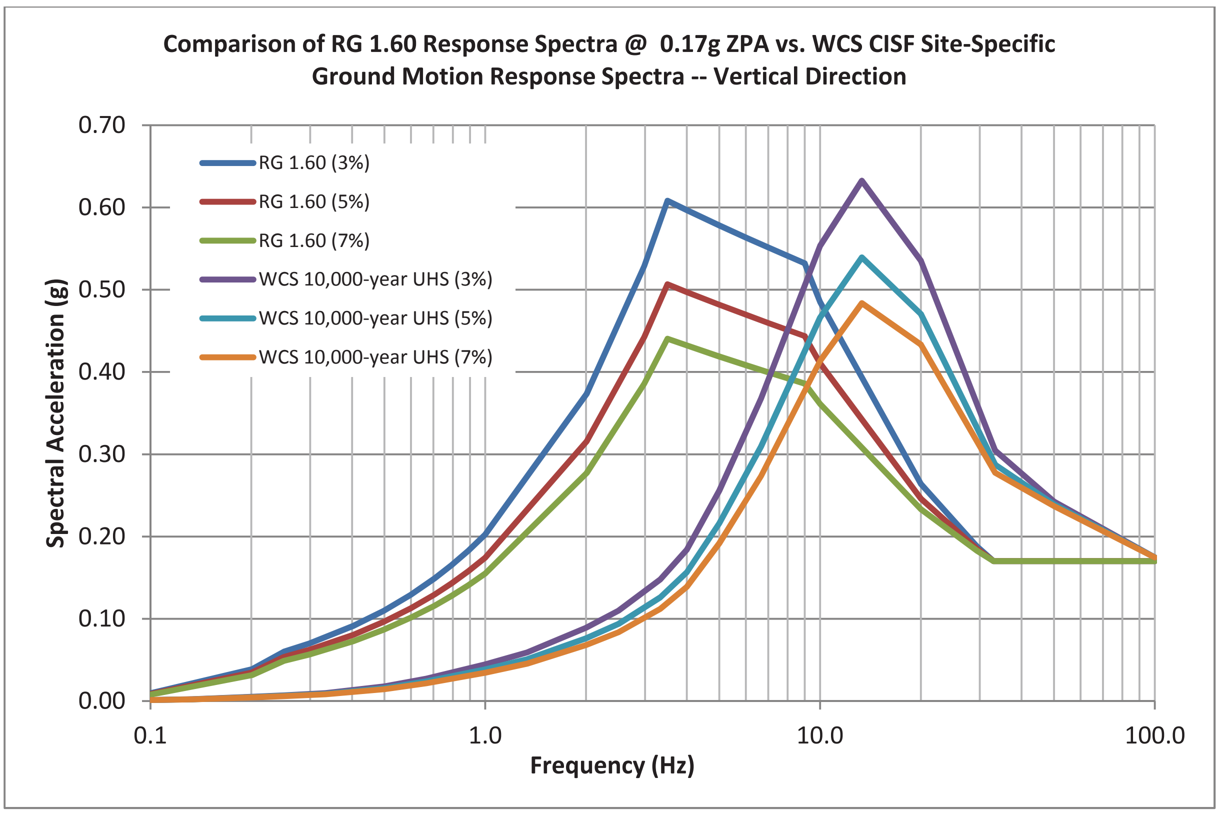


Figure D.7-1
Design Basis Response Spectra for the 61BTH Type 1 DSC, HSM Model 102 and MP197HB Cask compared to the WCS CISF 10,000-year UHS

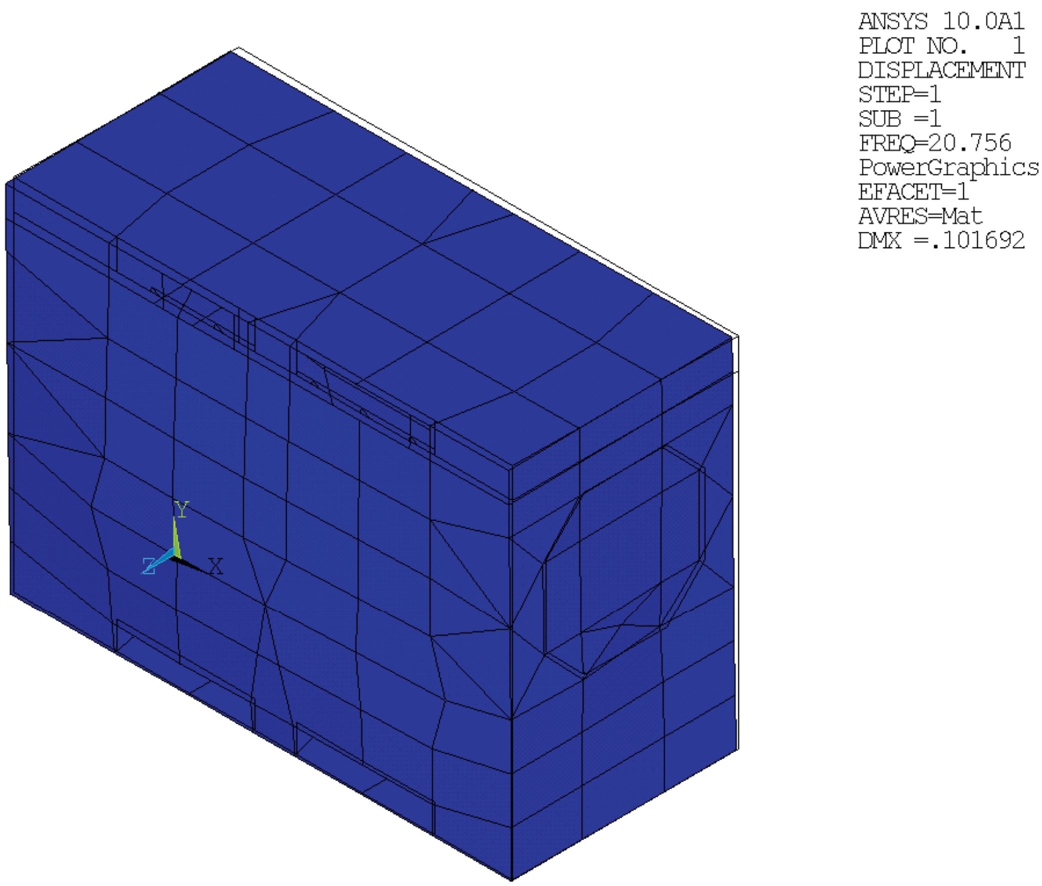


Figure D.7-2
HSM Mode Shape for Mode 1

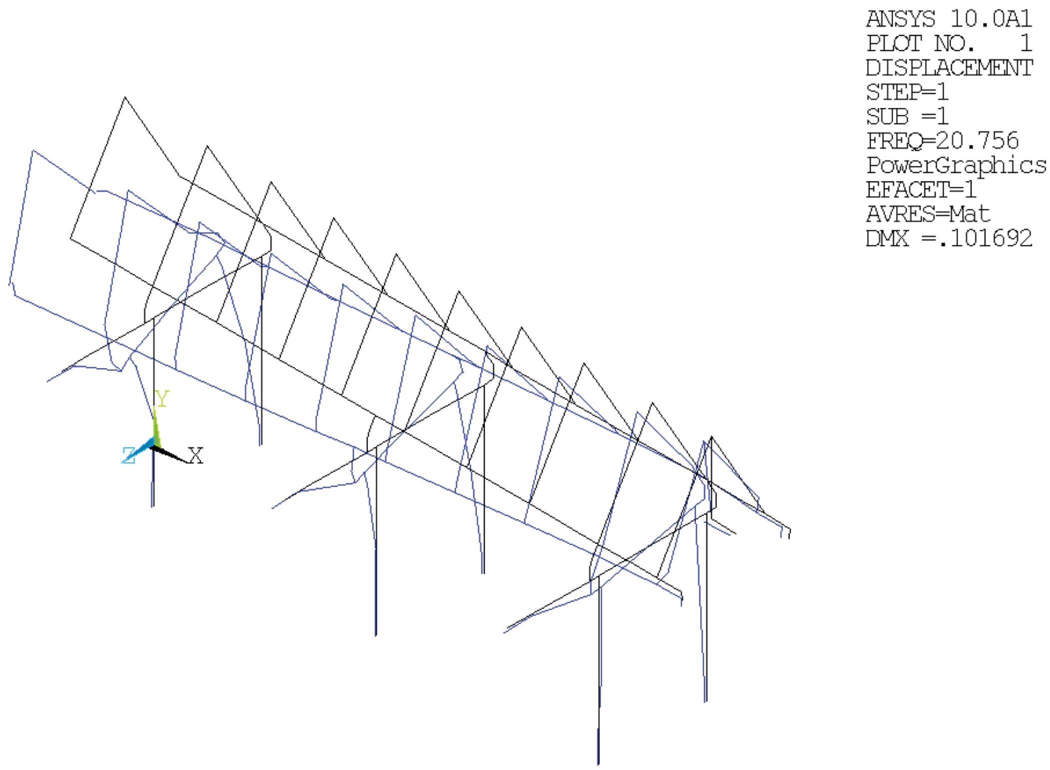


Figure D.7-3
Support Structure Mode Shape for Mode 1

Proprietary Information on Pages D.7-24 through D.7-29
Withheld Pursuant to 10 CFR 2.390

APPENDIX D.8
THERMAL EVALUATION
Standardized NUHOMS®-61BTH Type 1 System

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D.8. THERMAL EVALUATION

This chapter presents the thermal evaluations which demonstrate that the NUHOMS®-61BTH Type 1 Dry Shielded Canister (DSC), stored in the NUHOMS® HSM Model 102 storage module and transferred in the NUHOMS® MP197HB transportation/transfer cask (MP197HB cask), meet the thermal requirements of 10 CFR 72 for the dry storage of spent nuclear fuel (SNF). The NUHOMS®-61BTH System is designed to passively reject decay heat during storage and transfer of SNF for normal, off-normal and accident conditions while maintaining temperatures and pressures within specified regulatory limits.

D.8.1 Discussion

As discussed in Chapter 1.0, the 61BTH Type 1 DSCs from an ISFSI site will be transported to the WCS Consolidated Interim Storage Facility (*WCS* CISF) in the MP197HB cask under NRC Certificate of Compliance No. 9302 [D.8-2]. At the WCS CISF, the 61BTH Type 1 DSCs, described in Section T.1, Appendix T of the Standardized NUHOMS® UFSAR [D.8-3], are to be stored inside the NUHOMS® HSM Model 102 described in Chapter 4 of [D.8-3]. For on-site transfer of the 61BTH Type 1 DSCs, the MP197HB TC, described in Appendix A.1.2 of the MP197 SAR [D.8-4], is to be used.

The 61BTH Type 1 DSC is certified for storage in the HSM Model 102 and on-site transfer in the OS197 Transfer Cask with a design basis heat load of 22.0 kW [D.8-3]. The thermal analysis for storage and transfer of the 61BTH Type 1 DSC is presented in Appendix T.4 of [D.8-3].

This Appendix qualifies the 61BTH Type 1 DSC for storage in the HSM Model 102 at the WCS CISF with the same heat load of 22.0 kW under the WCS *CISF* environmental conditions. No new thermal analysis is performed for storage of the 61BTH Type 1 DSC in this Appendix. Although no new thermal evaluations are performed for the storage conditions, the material properties, thermal models and results from Appendix T.4 of [D.8-3] are referenced in this Appendix for completeness.

The MP197HB TC has previously been certified for transportation of the 61BTH Type 1 DSC [D.8-2]. Upon arrival of the MP197HB cask, it is reconfigured from its transportation arrangement to its transfer arrangement. A new thermal analysis for transfer of the 61BTH Type 1 DSC in the MP197HB cask with a heat load of 22.0 kW is also performed. During transfer operations, the MP197HB cask does not provide any confinement function. Therefore, the thermal performance of the various seals within the MP197HB cask are not evaluated in this application.

The thermal design criteria for storage and transfer of 61BTH Type 1 DSC are listed in Section T.4.1, Appendix T of [D.8-3].

This Appendix demonstrates that all the 10 CFR Part 72 thermal requirements for storage and transfer of the 61BTH Type 1 DSC at the WCS CISF are met.

D.8.2 Summary of Thermal Properties of Materials

The material properties of the HSM Model 80/Model 102 storage module are listed in Table 8.1-8 and Table 8.1-9 of [D.8-3] and the material properties of the NUHOMS® 61BTH Type 1 DSC are listed in Section T.4.2 of [D.8-3]. The material properties of the MP197HB TC are listed in Section A.3.2.1 of [D.8-4].

Helium gas within the Cask/Canister annulus is replaced with air during transfer operations. Due to this change, the effective properties for the internal sleeve are re-calculated using the same methodology as used in [D.8-4]. The effective thermal conductivity of inner sleeve component with air gap for transfer in the MP197HB cask at the WCS CISF is calculated in Section D.8.5.1.

An emissivity value of 0.9 is used for the white paint on the MP197HB cask neutron shield shell exterior surface as noted in Section A.3.2.1, item 31, Appendix A.3 of [D.8-4]. In addition, for the transfer configuration, the inside surface of the MP197HB cask inner sleeve (see Note 5 of drawing MP197HB-71-1014 of [D.8-4]) is to be painted white. Accordingly, an emissivity value of 0.9 is used for the inner surface of the TC inner sleeve.

D.8.3 Specification for Components

The thermal conductivity of the neutron absorber materials made from a single piece or paired with an aluminum sheet for the NUHOMS® 61BTH Type 1 DSC are provided in Section T.4.3, Appendix T of [D.8-3].

D.8.4 Thermal Analysis of HSM Model 102 with Canister for Storage Conditions

As discussed in Section D.8.1, NUHOMS® 61BTH Type 1 DSC will be stored inside the HSM Model 102 at the WCS CISF. This configuration for storage operations is approved under CoC 1004 and a discussion on the thermal evaluation for this configuration is presented in Chapter T.4 of [D.8-3]. Because this configuration is previously approved, this section only presents a reconciliation of the ambient temperatures between [D.8-3] and the WCS CISF.

D.8.4.1 Ambient Temperature Specification at WCS CISF

As specified in Table 1-2, normal ambient temperature is considered in the range of 44.1°F to 81.5°F. Off-normal ambient temperature is considered in the range of 30.1°F to 113°F. Accident ambient temperature is considered as 113°F.

D.8.4.1.1 Comparison of WCS CISF Ambient Conditions with Ambient Conditions Used in the Standardized NUHOMS® UFSAR

As described in Chapter T.4, Section T.4.4 of [D.8-3], the thermal evaluation for HSM is presented in Section 8.1.3 of [D.8-3]. A review of the thermal evaluation presented in Section 8.1.3 of [D.8-3] shows that average daily ambient temperatures of 100°F and 125°F are used for normal and off-normal hot storage conditions, respectively. These temperatures bound the ambient temperatures for normal, off-normal, and accident conditions at the WCS CISF. The lowest off-normal ambient temperature evaluated is the -40°F used in [D.8-3].

Based on this discussion, the thermal evaluation for storage conditions presented in Chapter T.4 of [D.8-3] is bounding for the WCS CISF and no additional evaluations are performed. Sections D.8.4.2 through D.8.4.5 present the references to the appropriate section within [D.8-3] as it relates to the thermal evaluations performed for NUHOMS® 61BTH Type 1 DSC and HSM Model 102 for storage conditions.

D.8.4.2 Thermal Model of HSM Model 102 with 61BTH Type 1 DSC

The HEATING7 thermal model of the HSM Model 102 is described in Section 8.1.3 of [D.8-3].

The three-dimensional ANSYS model of the 61BTH Type 1 DSC with a heat load of 22.0 kW is described in Section T.4.6.2, Appendix T of [D.8-3]. Section T.4.6 of [D.8-3] presents a thermal analysis for the 61BTH Type 1 DSC.

The 61BTH Type 1 DSC model for accident analysis is based on the HSM model described in Section 8.1.3.1 of [D.8-3]. The accident analysis is performed with HSM vents totally blocked for 40 hours, decay heat of 24 kW and with a maximum ambient steady state temperature of 125°F.

D.8.4.3 HSM Model 102 Thermal Model Results

The thermal evaluation for the 61BTH Type 1 DSC in the HSM Model 102 with a maximum heat load of 22 kW is based on the thermal evaluation of a NUHOMS® 24P DSC in an HSM with a maximum heat load of 24 kW as described in Section T.4.4, Chapter T.4 of [D.8-3]. The thermal evaluation for the 24P DSC in an HSM is described in Section 8.1.3 of [D.8-3].

The results of the HSM Model 102 thermal analysis for normal, off-normal and accident conditions are presented in Table 8.1-24 of [D.8-3].

D.8.4.4 61BTH Type 1 DSC Thermal Model Results

As described in Section T.4.6.6.1, Chapter T.4 of [D.8-3], the shell temperatures calculated in Section 8.1.3.1 and listed in Table 8.1-24 of [D.8-3] for the 24P DSC in the HSM Model 102 with a 24 kW heat load are conservatively applied to the ANSYS model of the 61BTH Type 1 DSC with a 22 kW heat load.

The maximum fuel cladding temperatures for storage of the 61BTH Type 1 DSC in the HSM Model 102, under normal, off-normal and accident conditions are listed in Table T.4-12, Table T.4-17 and Table T.4-21 of [D.8-3], respectively. The maximum component temperatures of the 61BTH Type 1 DSC are presented in Table T.4-13, Table T.4-18 and Table T.4-22 of [D.8-3], respectively.

A review of Table T.4-13 and T.4-18, Chapter T.4 of [D.8-3], shows, that for normal and off-normal conditions, the 61BTH Type 1 DSC component temperatures for the transfer case are much higher than the storage case. Hence, the canister cavity pressures during storage of the 61BTH Type 1 DSC in the HSM Model 102 are bounded by the canister cavity pressures for the transfer of the 61BTH Type 1 DSC in the MP197HB cask. Sections D.8.5.2 and D.8.5.3 present a reconciliation of the 61BTH Type 1 DSC internal pressures for the transfer case.

D.8.4.5 Evaluation of the 61BTH Type 1 DSC Storage in HSM Model 102

The thermal performance of the HSM Model 102 module with the 61BTH Type 1 DSC at the WCS CISF under normal, off-normal and accident conditions is bounded by the thermal analysis presented in Section 8.1.3 and Chapter T.4 of [D.8-3]. The bounding evaluation demonstrates that all the 10 CFR Part 72 thermal limits and criteria are met.

D.8.5 Thermal Analysis of MP197HB Cask with Canister for Transfer Operations

As discussed in Section D.8.1, the 61BTH Type 1 DSC will be transported to the WCS CISF under the NRC Certificate of Compliance No. 9302 [D.8-2]. Within the WCS CISF, the transfer operations i.e. movement of the canister from the transfer cask into the storage module will be performed under 10 CFR Part 72. This section presents the thermal evaluation for this on-site transfer operation.

D.8.5.1 Thermal Model of MP197HB TC with 61BTH Type 1 DSC

The MP197HB Transportation Cask configuration is shown in the design drawings included in Section A.1.4.10.1, Chapter A.1 of [D.8-4]. The ANSYS model of the MP197HB TC is presented in Section A.3.3.1.1, Appendix A.3 of [D.8-4]. ANSYS 10.0 [D.8-3] is used for the MP197HB TC modeling and thermal analysis. This transportation model of the MP197HB cask is modified to replicate the transfer configuration of the TC as follows:

- The impact limiters are removed
- Convection, insolation and radiation are applied on additional surfaces exposed to ambient as a result of removing the impact limiters
- Helium gas within the cask/canister annulus is replaced with air during transfer operations. In addition, the internal sleeve of the MP197HB cask is considered to be painted white (see Note 5 of drawing MP197HB-71-1014 of [D.8-4])

The thermal properties of the materials used in the analysis of the MP197HB cask with the 61BTH Type 1 DSC in transfer mode are the same as those presented in Section A.3.2.1, Appendix A.3 of [D.8-4] except for the effective conductivity of the internal sleeve.

The effective thermal conductivity for the TC inner sleeve with air gap in axial ($k_{eff,axl}$) and radial ($k_{eff,rad}$) directions is recalculated using the methodology described in Item 5, Section A.3.3.1.3 of [D.8-4]. Table below lists the effective thermal conductivity of inner sleeve of the MP197HB cask for transfer.

Effective Thermal Conductivity of MP197HB Cask Inner Sleeve with Air Gap

Temperature (°F)	$k_{eff,axl}$ (Btu/hr-in-°F)	$k_{eff,rad}$ (Btu/hr-in-°F)
70	0.403	7.646
100	0.420	7.710
150	0.445	7.798
200	0.469	7.878
250	0.494	7.941
300	0.519	8.005
350	0.543	8.061
400	0.567	8.109

D.8.5.2 MP197HB TC Thermal Model Results (Normal and Off-Normal Conditions):

As noted in Table 1-2, the maximum ambient temperature for normal and off-normal conditions are 81.5°F and 113°F, respectively. However, an ambient temperature of 105°F is conservatively used in the thermal evaluation for transfer operations at the WCS CISF.

The maximum temperatures of the components of the MP197HB cask loaded with the 61BTH Type 1 DSC for transfer at the WCS CISF at an ambient temperature of 105°F daily average temperature are presented in the table below. Also listed for comparison are the maximum component temperatures of the MP197HB cask loaded with the 61BTH Type 1 DSC for normal transportation condition [D.8-4].

Comparison of MP197HB TC Component Maximum Temperatures for Transportation v/s Transfer of 61BTH Type 1 DSC

Transfer/Transportation Operation	**Transportation MP197HB TC with 61BTH Type 1 DSC**(2) Normal T_{amb}=100°F	**Transfer MP197HB TC with 61BTH Type 1 DSC** (1)
Heat load	22 kW	22 kW
Component	T_{max}, °F	T_{max}, °F
Canister shell	406	423
Inner sleeve	317	286
Cask inner shell	315	272
Gamma shield	314	271
Outer shell	306	242
Shield shell	272	221
Cask lid	248	146
Cask bottom plate	307	175

1 – Daily ambient average temperature of 105°F is used for analysis.

2 – From Table A.3-8 of [D.8-4].

As seen from the table above, the maximum MP197HB cask component temperatures for transfer at the WCS CISF are below the maximum component temperatures for transportation at 100°F. The maximum temperature of the MP197HB cask components for the transfer case decrease compared to the transportation case due to the increased heat rejection from the TC external surface to the ambient. This is due to the removal of impact limiters (which cover parts of MP197HB cask outside surface) and higher emissivity of white paint used on the internal surface of the MP197HB cask inner sleeve.

The maximum 61BTH Type 1 DSC shell temperature increases by 17°F. This increase is due to the use of air in the cask/canister annulus versus the use of helium in the transportation case.

The maximum temperatures of the MP197HB cask with the 61BTH Type 1 DSC at the WCS CISF for normal and off-normal transfer conditions are listed in Table D.8-1.

Since the maximum 61BTH Type 1 DSC surface temperature for transfer is higher than the maximum 61BTH Type 1 DSC surface temperature for transportation, the 61BTH Type 1 DSC shell temperature profile from the transfer evaluation is mapped to the 61BTH Type 1 DSC basket model described in Section T.4.6.2, Appendix T.4 of [D.8-3]. The results of this evaluation provide the maximum 61BTH Type 1 DSC basket component temperatures and the maximum fuel cladding temperature for off-normal conditions.

The maximum temperatures of the components of the 61BTH Type 1 DSC and the maximum fuel cladding temperature at the WCS CISF for normal and off-normal transfer conditions are presented in Table D.8-2.

<u>61BTH Type 1 DSC Cavity Pressure (Normal and Off-Normal Conditions)</u>

The average helium temperature for the 61BTH Type 1 DSC during off-normal transfer operations in MP197HB cask is 489°F. This is lower than the average helium temperature of 504°F (See Section T.4.6.7.6, Chapter T.4 of [D.8-3] used to determine the maximum internal pressure during off-normal transfer operations in OS197 transfer cask. A similar behavior will be observed for normal transfer operations wherein the average helium temperature of helium within the 61BTH Type 1 DSC during transfer in MP197HB cask will lower compared to the transfer in OS197 transfer cask. Since the average helium temperatures are lower, the maximum internal pressures listed in Table T.4-16 and Table T.4-20, Appendix T of [D.8-3] remains bounding.

D.8.5.3 MP197HB Cask and 61BTH Type 1 DSC Thermal Analysis (Accident Conditions)

Fire accident is the only postulated hypothetical accident condition (HAC) considered in the thermal evaluation during transfer of 61BTH Type 1 DSC in MP197HB cask. Based on the discussion in Section T.4.6.8.3 of [D.8-3], a 300 gallon diesel fire with duration of 15 minutes is considered during transfer operations. The same accident is also considered during transfer operations at the WCS CISF.

However, the fire duration of 15 minutes considered in transfer operations is half of the 30 minute fire duration considered for transportation in Section A.3.4, Appendix A.3 of [D.8-4]. This ensures that the heat input from the fire to the cask/canister is lower during transfer operations compared to the transportation operations. In addition, the bounding HAC evaluations performed in Section A.3.4, Appendix A.3 of [D.8-4] considers a minimum heat load of 26 kW compared to the maximum heat load of 22 kW for NUHOMS® 61BTH Type 1 DSC.

One change to the MP197HB cask is that the impact limiters are not present during the transfer fire accident unlike the transportation fire evaluation presented in Section A.3.4, Appendix A.3 of [D.8-4]. The ends of the cask might experience slightly higher heat input into the cask compared to the fire accident evaluation performed for transportation and might impact the components exposed to fire. The only components at the ends of the cask that have a temperature limit are the cask seals. However, since there is no confinement function provided by the MP197HB cask under transfer operations, the cask seals are not required under transfer operations. Therefore, there is no adverse impact on the cask performance because of the increased heat input towards the ends.

Based on the above discussion, the maximum temperatures of the MP197HB cask components presented in Table A.3-19 (for load case with internal sleeve) of [D.8-4] for the transportation configuration bound the values for the transfer case. Table D.8-1 presents these bounding maximum temperatures for the MP197HB cask components for the HAC conditions during transfer operations at WCS CISF.

Based on the discussion in Section A.3.4.3 of [D.8-4], the maximum the canister shell temperature occurs during post-fire steady state conditions due to the large thermal mass of the basket and the relative large gap between the canister shell and the sleeve. A similar behavior would be expected for the hypothetical fire accident condition at the WCS CISF.

The maximum canister shell temperature during post fire steady-conditions for 61BTH Type 1 DSC is 441°F (See Table A.3-17 of [D.8-4]). Based on the evaluation performed for off-normal steady-state condition in Section D.8.5.2, a maximum temperature increase of 17°F is observed for the 61BTH Type 1 DSC shell temperature during transfer operations in MP197HB cask at the WCS CISF. Considering a similar increase, the maximum canister shell temperature due to fire accident at WCS CISF would be about 458 °F (441 °F +17 °F=458 °F). This canister Shell temperature is lower than the maximum canister shell temperature of 467 °F considered for the accident transfer conditions during transfer in OS197 transfer cask (See Table T.4-22 of [D.8-3]).

Therefore, the maximum 61BTH Type 1 DSC temperatures and maximum fuel cladding temperature under accident conditions for the MP197HB cask are bounded by the accident maximum temperatures for the OS197 transfer cask listed in Tables T.4-21 and T.4-22 of [D.8-3]. These bounding temperature values for the 61BTH Type 1 DSC under OS197 transfer cask accident conditions are presented in Table D.8-2.

61BTH Type 1 DSC Cavity Pressure (Accident Conditions)

Section T.4.6.8.5, Chapter T.4 of [D.8-3] evaluates the maximum accident pressure for the 61BTH DSC. The maximum internal pressure for 61BTH Type 1 DSC occurs during transfer accident conditions in the OS197 transfer cask and are summarized in Table T.4-24, Chapter T.4 of [D.8-3].

As discussed above, the 61BTH Type 1 DSC basket temperatures during accident transfer in the MP197HB TC are bounded by the 61BTH Type 1 DSC basket temperatures during accident transfer in the OS197 transfer cask. Therefore, the maximum 61BTH Type 1 DSC cavity pressure under accident conditions at the WCS CISF is bounded by the maximum accident condition canister cavity pressure of 56.1 psig presented in Table T.4-24, Appendix T.4 of [D.8-3].

D.8.5.4 Evaluation of MP197HB TC Performance

The thermal performance of the MP197HB cask with the 61BTH Type 1 DSC is evaluated under normal, off-normal and accident conditions of operation as described above and is shown to satisfy all the 10 CFR Part 72 thermal limits and criteria.

D.8.6 References

D.8-1 Not Used.

D.8-2 U.S. Nuclear Regulatory Commission, “Certificate of Compliance No. 9302, Revision 7 for the Model No. NUHOMS®-MP197 and NUHOMS®-MP197HB Packages (Docket 71-9302).

D.8-3 TN Document NUH-003, Revision 14, “Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel.” (Basis for NRC CoC 72-1004).

D.8-4 TN Document, NUH09.101 Rev. 17, “NUHOMS® -MP197 Transportation Package Safety Analysis Report.” (Basis for NRC CoC 71-9302).

D.8-5 ANSYS Mechanical APDL, Release 10.0.

D.8-6 U.S. Nuclear Regulatory Commission, Spent Fuel Project Office, Interim Staff Guidance -11 (ISG-11), Revision 3, “Cladding Considerations for the Transportation and Storage of Spent Fuel,” November 17, 2003.

Table D.8-1
Maximum Temperatures of MP197HB TC Components for 61BTH Type 1 DSC Transfer at the WCS CISF

	DSC Heat Load 22 kW				
	Normal T_{amb}=44.1°F	**Normal T_{amb}=81.5°F**	**Off-normal T_{amb}=-30.1°F**	**Off-normal T_{amb}=94.6°F**	**Accident(1) T_{amb}=113°F**
Component	T_{max}, °F				
Inner sleeve	<286			286	409
Cask inner shell	<272			272	413
Gamma shield	<271			271	508
Outer shell	<242			242	645
Shield shell	<221			221	1071
Cask lid	<146			146	367
Cask bottom plate	<175			175	309

1 – Bounded by values from Table A.3-19 of [D.8-4].

Table D.8-2
NUHOMS® 61BTH Type 1 DSC Fuel Cladding and DSC Component Temperatures for Transfer in MP197HB TC at the WCS CISF

	Normal Conditions			Off-Normal Conditions		Accident Conditions	
Component	**Maximum Temperature[1] (°F)**	**Minimum Temperature[5] (°F)**	**Allowable Range (°F)**	**Maximum Temperature (°F)**	**Allowable Range (°F)**	**Maximum Temperature[4] (°F)**	**Allowable Range (°F)**
Canister Shell	<424	-20	[2]	424	[2]	<467	[2]
Top Grid	<426	-20	[2]	426	[2]	<531	
Basket Rails	<562	-20	[2]	562	[2]	<609	[2]
Neutron Absorber	<682	-20	[2]	682	[2]	<727	
Fuel Compartment	<683	-20	[2]	683	[2]	<727	[2]
Fuel Cladding	<706	-20	752[3]	706	752[3]	<749	1058[3]
Average Cavity Gas Temperature	<489	NA	NA	489	NA	<550[6]	NA

1 – Bounded by off-normal condition.

2 – The components perform their intended safety function within the operating range.

3 – From ISG-11, Revision 3 [D.8-6].

4 – Bounded by accident transfer condition in OS197 TC. See Table 4-21 and Table 4-22 of [D.8-3].

5 – Assuming no credit for decay heat and a daily average ambient temperature of -20°F. The -20°F off-normal temperature is used to bound the minimum normal ambient temperature of 44.1°F listed in Table 1.2.

6 – Design basis average He temperature used in Table T.4-24 of [D.8-3].

APPENDIX D.9
RADIATION PROTECTION
Standardized NUHOMS®-61BTH Type 1 System

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D.9. RADIATION PROTECTION

The Standardized NUHOMS® System Cask System with the NUHOMS® 61BTH Type 1 DSC radiation protection evaluations are documented in Section T.5 of the "Standardized NUHOMS® Horizontal Modular Storage System Safety Analysis Report" [D.9-1]. Details of the shielding design features for the MP-197HB cask are provided in Section A.5.1.1 of reference [D.9-2]. Drawings showing the shield thicknesses for the NUHOMS®-61 BTH Type 1 DSC are listed in Section D.4.6. Drawings showing the shielding thicknesses for the HSM Model 102 are listed in Section A.4.6 and for the MP197HB cask in Section C.4.6.

D.9.1 Radiation Protection Design Features

Details of the Storage Area shielding design features for the Standardized NUHOMS® System Cask System which includes the 61BTH Type 1 DSC stored in an HSM Model 102 are documented in Section 7.3.2.1 and T.5 of reference [D.9-1]. Details of the sheilding design features for the MP-197HB cask are provided in Section A.5.1.1 of reference [D.9-2]. Drawing showing the shield thicknesses for the NUHOMS®-61BTH Type 1 DSC are listed in Section D.4.6. Drawings showing the shielding thicknesses for the HSM Model 102 are listed in Section A.4.6 and for the MP197HB cask in Section C.4.6.

D.9.2 Occupational Exposure Evaluation

D.9.2.1 Analysis Methodology

Dose rates are known in the vicinity of the HSM Model 102 and MP197HB casks based upon the existing FSAR [D.9-1] and SAR [D.9-2]. The operational sequence is determined for each system, as well as the associated number of workers, their location, and duration per operation. The collective dose per step is then computed as:

$$C = D*N*T,$$

where

C is the collective dose (person-mrem),

D is the dose rate for each operation (mrem/hr),

N is the number of workers for that operation, and

T is the duration of the operation (hr)

Once the collective dose is determined for each step, the collective doses are summed to create the total collective dose. The total collective dose is determined for a single receipt/transfer operation.

D.9.2.2 Dose Assessment

A dose assessment is performed for receipt and transfer of a 61BTH Type 1 DSC to HSM Model 102 using the MP197HB cask.

Seven general locations around the cask are defined, as shown in the top half of Figure D.9-1: top, top edge, top corner, side, bottom corner, bottom edge, and bottom. These seven general locations are reduced to only three locations for which dose rate information is available, as shown in the bottom half of Figure D.9-1: top, side, and bottom.

A loading operation is divided into receipt and transfer operations. Dose rates for receipt operations are obtained from the transportation SAR for the MP197HB cask, as discussed below. Dose rates for the transfer operations are obtained from Table T.5-2 of the storage FSAR [D.9-1] for the HSM Model 102.

For some configurations, dose rates are not available in the reference transportation SAR or storage FSAR. In these instances, bounding dose rates are obtained for similar systems:

- For receipt of the 61BTH Type 1 DSC inside the MP197HB cask, bounding dose rates for receipt of the 69BTH DSC inside the MP197HB cask from Table A.5-1 of reference [D.9-2] are utilized. This approach is conservative because the 69BTH DSC contains a larger source than the 61BTH Type 1 DSC.

- For transfer of the 61BTH Type 1 DSC inside the MP197HB cask, bounding dose rates for transfer of the 69BTH DSC inside the OS200 transfer cask from Table Y.5-3 of reference [D.9-1] are utilized. This approach is conservative because the OS200 transfer cask contains less shielding than the MP197HB cask, and the 69BTH DSC contains a larger source than the 61BTH Type 1 DSC.

The configurations used in the dose rate analysis are summarized in Table D.9-1. Results for the various loading scenarios are provided in Table D.9-2 and Table D.9-3. Separate tables are developed for receipt and transfer operations. These tables provide the process steps, number of workers, occupancy time, distance, dose rate, and collective dose for all operations.

The total collective dose for an operation is the sum of the receipt and transfer collective doses. The total collective dose for receipt and transfer of 61BTH Type 1 DSC to an HSM Model 102 using the MP197HB cask: 1016 person-mrem.

The total collective dose for unloading a 61BTH Type 1 DSC from an HSM Model 102 and preparing it for transport off-site is bounded by the loading operations (1016 person-mrem). Operations for removing the 61BTH Type 1 DSC from the HSM Model 102 and off-site shipment are identical to loading operations, except in reverse order. The collective dose for unloading is bounded because during storage at the WCS CISF the source terms will have decayed reducing surface dose rates. The total collective dose is the sum of receipt, transfer, retrieval, and shipment is 2032 person-mrem.

D.9.3 References

D.9-1 TN Document NUH-003, Revision 14, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel." (Basis for NRC CoC 72-1004).

D.9-2 TN Document, NUH09.101 Rev. 17, "NUHOMS® -MP197 Transportation Package Safety Analysis Report." (Basis for NRC CoC 71-9302).

Table D.9-1
Analyses Used for Receipt and Transfer Configurations

Actual Configuration	Receipt Analysis Configuration	Transfer Analysis Configuration
61BTH Type 1 DSC transferred from the MP197HB cask into an HSM Model 102	69BTH DSC (bounds 61BTH Type 1 DSC) inside MP197HB cask [D.9-2]	69BTH DSC (bounds 61BTH Type 1 DSC) inside OS200 transfer cask (bounds MP197HB cask) [D.9-1]

Table D.9-2
Occupational Collective Dose for Receipt of MP197HB Cask Loaded with 61BTH Type 1 DSC

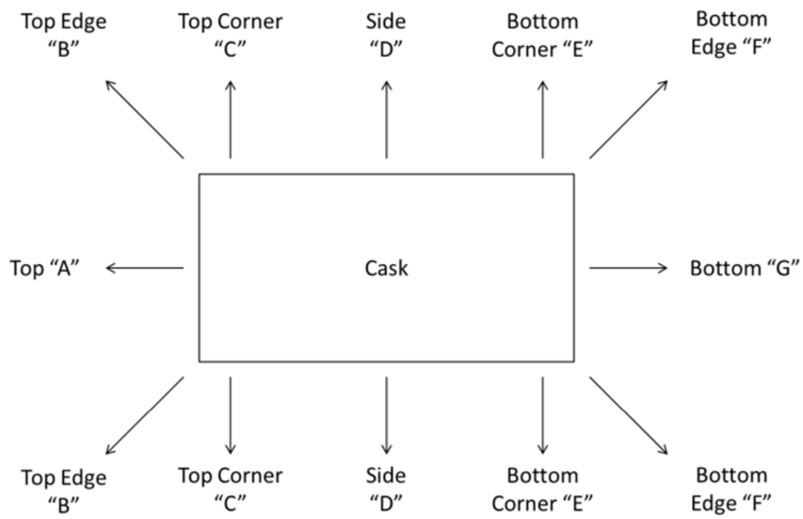
Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)*
Verify that the tamperproof seals are intact.	1	0.07	Top	1	3.62	2
	1	0.07	Bottom	1	22.2	
Remove the tamperproof seals.	1	0.07	Top	1	3.62	2
	1	0.07	Bottom	1	22.2	
Remove the hex bolts from the impact limiters and replace them with the impact limiter hoist rings provided. Remove the impact limiters from the cask.	2	0.5	Top Edge	1	3.62	26
	2	0.5	Bottom Edge	1	22.2	
Remove the transportation skid personnel barrier and tie-down straps	3	0.5	Side	1	129	194
Remove the external aluminum fins, if present	---	---	---	---	---	0
Take contamination smears on the outside surfaces of the cask. If necessary, decontaminate the cask.	2	0.17	Top	1	62.24	181
	2	0.17	Side	1	129	
	2	0.17	Bottom	1	338.56	
Install the front and rear trunnions and torque the bolts.	2	0.5	Top Corner	1	3.62	26
	2	0.5	Bottom Corner	1	22.2	
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.	2	0.17	Top	1	62.24	181
	2	0.17	Side	1	129	
	2	0.17	Bottom	1	338.56	
Lift the cask from the conveyance. Place cask onto the on-site transfer vehicle or other location.	2	0.5	Side	1	129	129
Transfer the cask to a staging module.	1	0.2	Side	1	129	26
					Total (person-mrem)	767

*Rounded up to nearest whole number

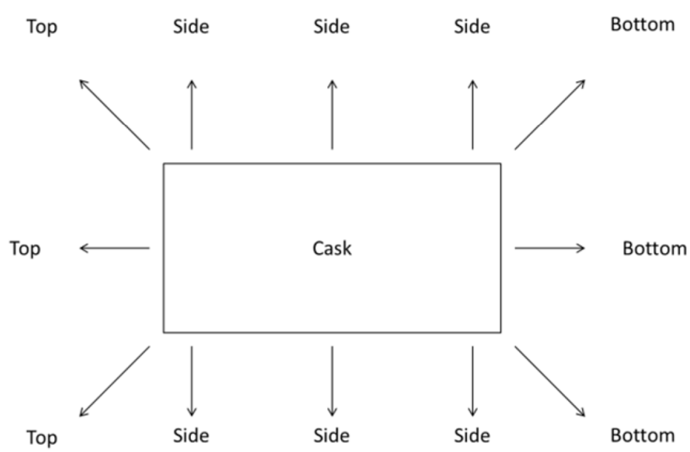
Table D.9-3
Occupational Collective Dose for Transfer of 61BTH Type 1 DSC from MP197HB Cask to HSM Model 102

Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)*
Position the Cask Close to the HSM	---	---	---	Far	Background	0
Remove the Cask Lid	2	0.67	Top/Avg. Front HSM	1	41	55
Align and Dock the Cask with the HSM	2	0.25	Top Corner/Avg. Front HSM	1	99	50
Position and Align Ram with Cask	2	0.5	Top Corner/Avg. Front HSM	1	99	99
Remove Ram Access Cover Plate	1	0.083	Bottom	1	258	22
Transfer the DSC to the HSM	---	---	---	Far	Background	0
Un-Dock the Cask	2	0.083	Side/Avg. Front HSM	1	43	8
Install the HSM Access Door	2	0.5	Avg. Front HSM	1	15	15
Total (person-mrem)						249

*Rounded up to nearest whole number



Detailed Cask Locations



Simplified Cask Locations

Figure D.9-1
Worker Locations Around Cask

APPENDIX D.10
CRITICALITY EVALUATION
Standardized NUHOMS®-61BTH Type 1 System

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D.10. CRITICALITY EVALUATION

The design criteria for the Standardized NUHOMS® 61BTH Type 1 System require that the canister is designed to remain subcritical under normal, off-normal, and accident conditions associated with spent nuclear fuel (SNF) handling, storage and off-site transportation. The design of the canister is such that, under all credible conditions, the highest effective neutron multiplication factor (k_{eff}) remains less than the upper safety limit (USL) of 0.9415 which includes an administrative margin of 0.05, code bias and bias uncertainties.

D.10.1 Discussion and Results

The 61BTH Type 1 DSC criticality analysis is documented in Chapter T.6 of the "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel" [D.10-1]. This criticality analysis bounds the conditions for transfer and on-site storage at the WCS Consolidated Interim Storage Facility (*WCS* CISF) because there is no credible event which would result in the flooding of a canister in HSM storage which would result in k_{eff} exceeding the worst case 10 CFR 72 storage conditions evaluated in [D.10-1]. Specific information on the criticality safety analysis which bounds the WCS CISF is discussed in this section.

The 61BTH Type 1 DSC consists of a SNF assembly (cylindrical shell, canister top and bottom cover plates and shield plugs or shield plug assemblies) and a basket assembly. The basket structure consists of 2x2 and 3x3 stainless steel SNF compartment assemblies held in place by basket rails in combination with either a holddown ring or an optional top grid assembly provided at the top of the basket. The four 2x2 and five 3x3 compartment assemblies are held together by welded stainless steel boxes wrapped around the SNF compartments, which also retain the neutron poison plates placed between the compartment assemblies. The poison plates provide the necessary criticality control and provide a heat conduction path from the SNF assemblies to the canister shell. The authorized poison plates are borated aluminum, boron carbide/metal matrix composite (MMC) or Boral ®. The canister is authorized to store 61 intact SNF assemblies. It is also authorized to store SNF assemblies containing Blended Low Enriched Uranium (BLEU) fuel material. Reconstituted SNF assemblies containing up to 10 replacement irradiated stainless steel rods per assembly or 61 lower enriched UO_2 rods instead of zircaloy clad enriched UO_2 rods are acceptable for storage. It can also accommodate up to a maximum of 16 damaged SNF assemblies in the 2x2 compartments located at the outer edge of the canister.

The continued efficacy of the neutron absorbers is assured when the canister arrives as the WCS CISF because the basket, including poison material, is designed and analyzed to maintain its configuration for all normal, off-normal and accident conditions of storage and for normal and hypothetical accidents during transport in the MP197HB cask as documented in Section A.6.5.1.4.1 of the "NUHOMS®-MP197 Transport Packaging Safety Analysis Report" [D.10-4].

The design basis criticality analysis performed for the 61BTH Type 1 DSC assumes the most reactive configuration of the canister and contents in an infinite array of casks bounding all conditions of receipt, transfer and storage at the WCS CISF where the canisters will remain dry under all conditions of transfer and storage including normal, off-normal and accident conditions as demonstrated in Chapter 12.

The results of the evaluations demonstrate that the maximum calculated k_{eff}, including statistical uncertainty and bias, are less than 0.9415.

D.10.2 Package Fuel Loading

Section 2.1 of the Technical Specifications [D.10-3] lists the SNF assemblies authorized for storage at the WCS CISF. Section 6.2 Spent Fuel Loading of [D.10-1] provides the Package Fuel Loading.

D.10.3 Model Specification

Section 6.3 Model Specification of [D.10-1] provides a discussion of the criticality model canister regional densities used to calculate the bounding k_{eff} for the 61BTH Type 1 DSC.

D.10.4 Criticality Calculation

Section 6.4 Criticality Calculation of [D.10-1] provides a discussion of the criticality calculations that demonstrate that the maximum calculated k_{eff} for the 61BTH Type 1 DSC is less than 0.9415.

D.10.5 Critical Benchmark Experiments

Section 6.5 Critical Benchmark Experiments of [D.10-1] provides a discussion of the benchmark experiments and applicability, details of benchmark calculations, and the results of benchmark calculations, including calculation of the USL.

D.10.6 References

D.10-1 TN Document NUH-003, Revision 14, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel." (Basis for NRC CoC 72-1004).

D.10-2 TN, "Technical Specifications for the Standardized NUHOMS® Horizontal Modular Storage System," USNRC Docket Number 72-1004.

D.10-3 Proposed SNM-1050, WCS Consolidated Interim Storage Facility Technical Specifications, Amendment 0.

D.10-4 TN Document, NUH09.101 Rev. 17, "NUHOMS® -MP197 Transportation Package Safety Analysis Report." (Basis for NRC CoC 71-9302).

APPENDIX D.11
CONFINEMENT EVALUATION
Standardized NUHOMS®-61BTH Type 1 System

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D.11 CONFINEMENT EVALUATION

The design criteria for the NUHOMS® 61BTH Type 1 DSC is designed to maintain confinement of radioactive material under normal, off-normal, and accident conditions associated with fuel handling, storage and off-site transportation.

D.11.1 Confinement Boundary

The 61BTH Type 1 DSC confinement is documented in Appendix T Chapter 7 of the "Standardized NUHOMS® System Updated Final Safety Analysis Report" [D.11-1]. Section T.7.1 of [D.11-1] details the requirements of the confinement boundary. Figure T.3.1-1 of reference [D.11-1] provides a figure that shows the components and welds that make up the confinement boundary for the 61BTH Type 1 DSC. Drawings for the canisters, including the confinement boundary are referenced in Section D.4.6. In addition, a bounding evaluation in Section D.7.8 is presented to demonstrate that the confinement boundary for the 61BTH Type 1 DSC does not exceed ASME B&PV Subsection NB Article NB-3200 (Level A allowables) during normal conditions of transport to provide reasonable assurance that the confinement boundary is not adversely impacted by transport to the WCS CISF.

The Technical Specifications for Standardized NUHOMS® [D.11-2] outline the requirements for preventing the leakage of radioactive materials in the 61BTH Type 1 DSC. Section 4.2, "Codes and Standards," lists the codes and standards for design, fabrication, and inspection of the 61BTH (Type 1 and Type 2) DSC, including alternatives to the ASME Code for the 61BTH (Type1 and Type 2) DSC confinement boundary and basket.

Section 3.1, "Fuel Integrity," of the Technical Specifications for the Standardized NUHOMS® [D.11-2] includes limiting condition for operations (LCO) 3.1.1 for DSC bulkwater removal medium and vacuum drying pressure and LCO 3.1.2 for DSC helium backfill pressure. These LCOs create a dry, inert atmosphere, which contributes to preventing the leakage of radioactive material.

D.11.2 Requirements for Normal Conditions of Storage

Section T.7.2 of [D.11-1] describes how the 61BTH Type 1 DSC is designed, fabricated and tested to be “leaktight” to prevent the leakage of radioactive materials. The Technical Specifications for Standardized NUHOMS® [D.11-2] outlines the requirements for preventing the leakage of radioactive materials in the 61BTH Type 1 DSC. Section 4.2, “Codes and Standards,” lists the codes and standards for design, fabrication, and inspection of the 61BTH (Type 1 and Type 2) DSC, including alternatives to the ASME Code for the 61BTH (Type 1 and Type 2) DSC confinement boundary and basket.

Section 3.1, “Fuel Integrity,” of the Technical Specifications for the Standardized NUHOMS® [D.11-2] includes limiting condition for operation (LCO) 3.1.1 for DSC bulkwater removal medium and vacuum drying and LCO 3.1.2 for DSC helium backfill pressure. These LCOs create a dry, inert atmosphere, which contributes to preventing the leakage of radioactive material.

D.11.3 Confinement Requirements for Hypothetical Accident Conditions

Section T.7.3 of [D.11-1] provides a discussion on how the 61BTH Type 1 DSC is designed, fabricated and tested to be "leaktight" to prevent the leakage of radioactive materials following hypothetical accident conditions. The Technical Specification for Standardized NUHOMS® [D.11-2] outlines the requirements for preventing the leakage of radioactive materials following hypothetical accident conditions in the 61BTH Type 1 DSC. Section 4.2, "Codes and Standards," lists the codes and standards for design, fabrication, and inspection of the 61BTH (Type 1 and Type 2) DSC, including alternatives to the ASME Code for the 61BTH (Type 1 and Type 2) DSC confinement boundary and basket.

Section 3.1, "Fuel Integrity," of the Technical Specifications for the Standardized NUHOMS® [D.11-2] includes limiting condition for operation (LCO) 3.1.1 for DSC bulkwater removal medium and vacuum drying pressure and LCO 3.1.2 for DSC helium backfill pressure. These LCOs create a dry, inert atmosphere, which contributes to preventing the leakage of radioactive material.

D.11.4 References

D.11-1 TN Document NUH-003, Revision 14, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel." (Basis for NRC CoC 72-1004).

D.11-2 TN Americas, "Technical Specifications for the Standardized NUHOMS® Horizontal Modular Storage System", Amendment 13, USNRC Docket Number 72-1004.

APPENDIX D.12
ACCIDENT ANALYSIS
Standardized NUHOMS®-61BTH Type 1 System

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D.12. ACCIDENT ANALYSIS

This section describes the postulated off-normal and accident events that could occur during transfer and storage for the Standardized NUHOMS® -61BTH Type 1 System canister in a HSM Model 102 storage overpack and use of the MP197HB cask for transfer operations. Detailed analyses are provided in the "Standardized NUHOMS® Horizontal Modular Storage System Safety Analysis Report" [D.12-1] for the canister and HSM Model 102 are referenced herein. Qualification for use of the MP197HB cask as a transfer cask for off-normal and accident conditions is also addressed.

D.12.1 Off-Normal Operations

The off-normal conditions considered for the Standardized NUHOMS® System are off-normal transfer loads, extreme temperatures and a postulated release of radionuclides.

D.12.1.1 Off-Normal Transfer Loads

Off-Normal transfer loads are addressed in Section T.11.1.1 of [D.12-1] which is a "jammed" canister during loading or unloading from the HSM Model 102.

Postulated Cause of the Event

The postulated cause of the event is described in Sections T.11.1.1.1 and 8.1.2 of [D.12-1].

Detection of the Event

Detection of the event is described in Sections T.11.1.1.2 and 8.1.2.1 of [D.12-1].

Analysis of Effects and Consequences

Sections T.11.1.1.3, T.3.6.2 and T.3.6.1.3.3 of [D.12-1] provides a discussion of the analysis performed and effects and consequences of the event. There is no breach of the confinement pressure boundary and, therefore, no potential for release of radioactive materials.

Corrective Actions

Consistent with Sections T.11.1.1.4 and 8.1.2.1 of [D.12-1], the required corrective action is to reverse the direction of the force being applied to the canister by the ram, and return the canister to its previous position. Since no permanent deformation of the canister occurs, the sliding transfer of the canister to its previous position is unimpeded. The transfer cask alignment is then rechecked, and the transfer cask repositioned as necessary before attempts at transfer are renewed.

D.12.1.2 Extreme Ambient Temperatures

The design of the Standardized NUHOMS® System envelopes the extreme temperatures at the WCS Consolidated Interim Storage Facility (*WCS* CISF) as demonstrated in Section D.8.4.

Postulated Cause of the Event

The postulated cause of the event is described in Sections T.11.1.2.1 and 8.1.2.2 of [D.12-1]

Detection of the Event

Detection of the event is described in Sections T.11.1.2.2 and 8.1.2.2 of [D.12-1].

Analysis of Effects and Consequences

Section T.11.1.2.3 of [D.12-1] and Appendix D.8 provides a discussion of the analysis performed and effects and consequences of the event. There is no breach of the confinement pressure boundary and, therefore, no potential for release of radioactive materials.

Corrective Actions

Consistent with Section T.11.1.2.4 of [D.12-1], restrictions for on-site handling of the transfer cask with a loaded canister under extreme temperature conditions are presented in the Technical Specifications [D.12-2].

D.12.1.3 Off-Normal Release of Radionuclides

As described in Section T.11.1.3 of [D.12-1], the canister is designed, fabricated and tested to be leak-tight, therefore, there is no possibility for release of radionuclides from the canister under normal, off-normal and accident conditions.

D.12.2 Postulated Accident

The postulated accident conditions for the Standardized NUHOMS®-61BTH Type 1 System with the MP197HB cask in the transfer configuration addressed in this SAR section are:

- Blockage of Air Inlets/Outlets
- Drop Accidents
- Earthquakes
- Lightning
- Fire/Explosion
- Flood
- Tornado Wind and Missiles
- Reduced HSM Air Inlet and Outlet Shielding

D.12.2.1 Blockage of Air Inlets/Outlets

Cause of Accident

Sections T.11.2.7.1 and 8.2.7.1 of [D.12-1] provides the potential for blocked air vents for the HSM Model 102.

Accident Analysis

The structural and thermal consequences of blocking the air inlets and outlets are addressed in Sections T.11.2.7.2, 8.2.7.2, T.3.7.7, T.3.4.4.3 and T.4 of [D.12-1]. In addition, Chapter D.8 demonstrates that the thermal analysis performed for the Standardized NUHOMS® System with the canister and HSM Model 102 in [D.12-1] is bounding for WCS CISF conditions.

Accident Dose Calculations

Sections T.11.2.7.3 and T.5 of [D.12-1] demonstrates that there are no off-site radiological consequences for this accident condition and minimum occupational exposures to clear the vents.

Corrective Actions

Consistent with Sections T.11.2.7.4 and 8.2.7.4 of [D.12-1], blockage of the HSM Model 102 vents is to be cleared within the 40-hour time frame analyzed to restore HSM ventilation.

D.12.2.2 Drop Accidents

Cause of Accident

Sections T.11.2.5.1 and T.3.7.4.1 of [D.12-1] discusses the cask drop for the MP197HB cask in the transfer configuration when it contains the canister.

Accident Analysis

The structural thermal consequences for the effects of a drop accident are addressed in Section T.11.2.5.2 of [D.12-1] for the canister and in Appendix D.8 for the MP197HB cask in the transfer configuration. This analysis demonstrates that the canister remains leak tight and the basket maintains its configuration following the drop event. In addition, Chapter D.8 presents the thermal analysis performed for the MP197HB cask for WCS CISF conditions.

Accident Dose Calculations

The accident dose calculations presented in Section T.11.2.5.3 of [D.12-1], are very conservative because the MP197HB cask consists of a solid neutron shield, the source terms for the contents of the canister have significantly decayed prior to transportation to the WCS *CISF* and the boundary is approximately 0.75 miles from the WCS CISF.

Corrective Action

Consistent with Sections T.11.2.5.4 and 8.2.5.4 of [D.12-1], the canister will be inspected for damage, as necessary. Removal of the transfer cask top cover plate may require cutting of the bolts in the event of a corner drop onto the top end. These operations will take place in the Cask Handling Building.

Following recovery of the transfer cask and transfer of the canister in the HSM, the transfer cask will be inspected, repaired and tested as appropriate prior to reuse.

For recovery of the cask and contents, it may be necessary to develop a special sling/lifting apparatus to move the transfer cask from the drop site to the cask handling building. This may require several weeks of planning to ensure all steps are correctly organized. During this time, temporary shielding may be added to the transfer cask to minimize on-site exposure to WCS CISF operations personnel. The transfer cask would be roped off to ensure the safety of personnel.

D.12.2.3 Earthquakes

Cause of Accident

Site-specific ground-surface uniform hazard response spectra (UHRS) with 1E-4 annual frequency of exceedance (AFE) having peak ground acceleration (PGA) of 0.250 g horizontal and 0.175 g vertical are shown in Table 1-2, Table 1-5 and Figure 1-5. The site-specific response spectra are used in the WCS CISF SSI analysis to obtain the enveloped acceleration spectra at the HSM CG and base. Section D.7.3 demonstrates that the MP197HB cask and Standardized NUHOMS® System components are structurally adequate for the WCS CISF site-specific seismic loading.

Accident Analysis

The structural and thermal consequences of an earthquake are addressed in Sections T.11.2.2.2, 8.2.3.2 and T.3.7.2 of [D.12-1]. The MP197HB cask, when mounted on the transfer vehicle during an earthquake is evaluated in Appendix D.7. In addition, Chapter D.8 demonstrates that the thermal analysis performed for the Standardized NUHOMS® System in [D.12-1] is bounding for WCS CISF conditions.

Accident Dose Calculations

As documented in Section T.11.2.2.3 of [D.12-1], there are no radiological consequences as a result of a seismic event.

Corrective Actions

Consistent with Section T.11.2.2.4 of [D.12-1], inspection of HSM Model 102s subsequent to a significant earthquake is required to identify potential damage or change in HSM configuration. Repair of damage to HSM concrete components, including shield walls may be necessary. Movement of HSMs as a result of the seismic event will require evaluation and possible repositioning of HSMs and shielding to preseismic event configuration.

D.12.2.4 Lightning

Cause of Accident

As stated in Sections T.11.2.6.1 and 8.2.6 of [D.12-1], the likelihood of lightning striking the HSM and causing an off-normal or accident condition is not considered a credible event. Simple lightning protection equipment for the HSM structures is considered a miscellaneous attachment acceptable per the HSM design.

Accident Analysis

Should lightning strike in the vicinity of the HSM the normal storage operations of the HSM will not be affected. The current discharged by the lightning will follow the low impedance path offered by the surrounding structures or the grounding system installed around each block of HSMs. The heat or mechanical forces generated by current passing through the higher impedance concrete will not damage the HSM. Since the HSM requires no equipment for its continued operation, the resulting current surge from the lightning will not affect the normal operation of the HSM.

Since no accident conditions will develop as the result of a lightning strike near the HSM, no corrective action would be necessary. In addition, there would be no radiological consequences

D.12.2.5 Fire and Explosion

Cause of Accident

As described in Section T.11.2.10.1 of [D.12-1] combustible materials will not normally be stored at the storage pad. Therefore, a credible fire would be very small and of short duration such as that due to a fire or explosion from a vehicle or portable crane.

However, a hypothetical fire accident is evaluated for the NUHOMS®-61BTH Type 1 System based on a diesel fuel fire. The source of fuel is postulated to be from a ruptured fuel tank of the transfer cask transporter vehicle or portable crane. The bounding capacity of the fuel tank is 300 gallons of diesel and the bounding hypothetical fire is an engulfing fire around the transfer cask. Direct engulfment of the HSM is highly unlikely. Any fire within the WCS CISF boundary while the canister is in the HSM would be bounded by the fire during transfer cask movement. The HSM concrete acts as a significant insulating firewall to protect the canister from the high temperatures of the fire.

Accident Analysis

The structural and thermal consequences of a fire accident are addressed in Sections T.12.2.10.2 and T.4.6.8.3 of [D.12-1]. Appendix D.8 demonstrates that the MP197HB cask performs its safety functions during and after the postulated fire/explosion accident. As stated above, the maximum flammable fuel either during the transfer operation or inside the WCS CISF is 300 gallons of diesel fuel.

Accident Dose Calculations

As documented in Section T.11.2.10.3 of [D.12-1], there are minimal radiological consequences for this accident condition.

Corrective Actions

Consistent with Section T.11.2.10.4 of [D.12-1], evaluation of HSM or cask neutron shield damage as a result of a fire is to be performed to assess the need for temporary shielding (for HSM or cask, if fire occurs during transfer operations) and repairs to restore the transfer cask and HSM to pre-fire design conditions.

D.12.2.6 Flood

Cause of Accident

The Probable Maximum flood is considered to occur as a severe natural phenomenon.

Accident Analysis

As documented in Sections 2.4.2.2 and 3.2.2, the WCS CISF is not in a floodplain and is above the Probable Maximum Flood elevation and, therefore, will remain dry in the event of a flood.

D.12.2.7 Tornado Wind and Missiles

Cause of Accident

In accordance with ANSI-57.9 [D.12-4] and 10 CFR 72.122, the Standardized NUHOMS® System components are designed for tornado effects including tornado wind effects. In addition, the HSM and MP197HB cask in the transfer configuration are also design for tornado missile effects. The Standardized NUHOMS® System components (HSM and canister) are designed and conservatively evaluated for the most severe tornado and missiles anywhere within the United States (Region I as defined in NRC Regulatory Guide 1.76 [D.12-5]) while the WCS CISF is in Region II, a less severe location with respect to tornado and tornado missiles. The MP197HB cask in the transfer configuration is evaluated for Region II tornado and tornado missiles.

Accident Analysis

The structural and thermal consequences of the effects of tornado wind and missile loads on the HSM and canister are addressed in Sections T.11.2.3.2, 8.2.2 and T.3.7.1 of [D.12-1]. Similarly, the structural and thermal consequences of tornado wind and missile loads for the MP197HB cask are addressed in Appendices D.7 and D.8.

Accident Dose Calculations

As documented in Section T.11.2.3.3 of [D.12-1], there are no radiological consequences for this accident condition.

Corrective Actions

Consistent with Sections T.11.2.3.4 of [D.12-1], evaluation of HSM damage as a result of a Tornado is to be performed to assess the need for temporary shielding and HSM repairs to return the HSMs to pre-tornado design conditions.

D.12.2.8 Reduced HSM Air Inlet and Outlet Shielding

This event is described in Section 8.2.1 of [D.12-1] for the Standardized NUHOMS® System. This event is a postulated accident of partial loss of shielding for the HSM air inlet and outlet vents provided by the adjacent HSM Model 102. All other components of the NUHOMS® System are assumed to be functioning normally.

Cause of Accident

Sections T.11.2.1.1 and 8.2.1.1 of [D.12-1] provides the causes for the accident.

Accident Analysis

The structural and thermal consequences for the accident are addressed in Section T.11.2.1.2 of [D.12-1].

Accident Dose Calculations

Section T.11.2.1.3 of [D.12-1] provides a bounding evaluation which demonstrates that the 10 CFR Part 72 requirements for this postulated event are met. The analysis is bounding because the source terms assumed for the canister at the WCS CISF have experienced significant decay in order to meet shipping requirements and the boundary is approximately 0.75 miles from the WCS CISF which is significantly farther than the 100 meters assumed in the evaluation.

Corrective Actions

Consistent with Sections T.11.2.1.4 and 8.2.1.4 of [D.12-1], to recover from an accident resulting in a partial loss of adjacent HSM shielding effects, repositioning of the adjacent HSM is required. This can be done using hydraulic jacks or a suitable crane to reposition the affected HSMs. It is estimated that the entire operation could be completed in less than eight hours, of which a mechanic would be on the HSM roof for approximately two hours. During this time he receives a dose of less than 2270 mrem. An additional dose to the mechanic and to the crane operator on the ground during this operation will be less than 597 mrem each (assuming an average distance of ten feet from the center of the HSM front wall). Severe foundation settlement would require that the affected HSMs be taken out of service and that repairs to the foundation be made.

D.12.3 References

D.12-1 TN Document NUH-003, Revision 14, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel." (Basis for NRC CoC 72-1004).

D.12-2 Proposed SNM-1050, WCS Consolidated Interim Storage Facility Technical Specifications, Amendment 0.

D.12-3 NRC Regulatory Guide 1.60, Rev. 1, "Design Response Spectra for Seismic Design of Nuclear Power Plants," Dec 1973.

D.12-4 American National Standards Institute, American Nuclear Society, ANSI/ANS 57.9 1984, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type).

D.12-5 NRC Regulatory Guide 1.76, "Design Basis Tornado and Tornado Missiles for Nuclear Power Plants," 1974.