APPENDIX A.1
INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION
NUHOMS®-MP187 Cask System

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A.1. INTRODUCTION AND GENERAL DESCRIPTION OF INSTALLATION

No change or additional information required for the NUHOMS®-MP187 Cask System for Chapter 1.

APPENDIX A.2
SITE CHARACTERISTICS
NUHOMS®-MP187 Cask System

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A.2. SITE CHARACTERISTICS

No change or additional information required for the NUHOMS®-MP187 Cask System for Chapter 2.

APPENDIX A.3
PRINCIPAL DESIGN CRITERIA
NUHOMS®-MP187 Cask System

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A.3. PRINCIPAL DESIGN CRITERIA

The NUHOMS®-MP187 Cask System principal design criteria is documented in Section 3 of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.3-1]. Table A.3-1 provides a comparison of the NUHOMS®-MP187 Cask System principal design criteria and the WCS Consolidated Interim Storage Facility (*WCS* CISF) design criteria provided in Table 1-2 which demonstrates that the NUHOMS®-MP187 Cask System bounds the WCS CISF criteria.

A.3.1 SSCs Important to Safety

The classifications of the NUHOMS®-MP187 Cask System systems, structures and components are discussed in Section 3.4 of Volume 1 and Section 3.2 of Appendix C of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.3-1]. These classifications are summarized in Table A.3-2 for convenience.

A.3.1.1 FO-, FC-, FF- DSCs and GTCC Canister

The FO-, FC- and FF-dry shielded canisters (DSC) provide the fuel assembly (FA) support required to maintain the fuel geometry for criticality control. Accidental criticality inside a DSC could lead to off-site doses exceeding regulatory limits, which must be prevented. The DSCs, including the GTCC canister, also provide the confinement boundary for radioactive materials. Therefore, the DSCs, including the GTCC canister, are designed to maintain structural integrity under all accident conditions identified in Chapter 12 without losing their function to provide confinement of the spent fuel assemblies. The DSCs, including the GTCC canister, are important-to-safety (ITS).

A.3.1.2 Horizontal Storage Module

For the NUHOMS®-MP187 Cask System, the horizontal storage modules (HSM) used is the HSM Model 80, 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 [A.3-4] and constructed to the requirements of ACI-318 [A.3-5]. The level of testing, inspection, and documentation provided during construction and maintenance is in accordance with the quality assurance requirements defined in 10 CFR Part 72, Subpart G. Thermal instrumentation for monitoring HSM concrete temperatures is considered "not-important-to-safety" (NITS).

A.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 to ACI-318 [A.3-5] as commercial-grade items.

A.3.1.4 NUHOMS® Transfer Equipment

For the NUHOMS®-MP187 Cask System, the MP187 transportation cask is qualified for transfer operations and herein referred to as a transfer cask. The MP187 transfer 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. The MP187 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.

A.3.2 Spent Fuel to Be Stored

The authorized content for the FO-, FC- and FF-DSCs are described in site-specific license SNM-2510 [A.3-6] and the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.3-1].

A.3.2.1 FO-, FC-DSC

SNM-2510 Technical Specifications Section 2.1.1 [A.3-6] provides a description of the fuels stored in the FO- and FC-DSCs as referenced in Section 10.3.1.1 "FO and FC-DSC Fuel Specifications" of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.3-1].

A.3.2.2 FF-DSC

SNM-2510 Technical Specifications Section 2.1.1 [A.3-6] provides a description of the fuels stored in the FF-DSC as referenced in Section 10.3.1.2 "FF-DSC Fuel Specifications" of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.3-1].

A.3.3 Design Criteria for Environmental Conditions and Natural Phenomena

A.3.3.1 Tornado Wind and Tornado Missiles

The design basis tornado wind and tornado missiles for the NUHOMS®-MP187 Cask System are provided in Section 3.2.1 of Volume 1 of reference [A.3-1]. The NUHOMS®-MP187 Cask System 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 [A.3-8]) while the WCS CISF is in Region II, a less severe location with respect to tornado and tornado missiles.

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 MP187 cask protects the DSC during transit to the Storage Pad from adverse environmental effects such as tornado winds and missiles.

A.3.3.2 Water Level (Flood) Design

Although the Rancho Seco site is a dry site not subject to flooding, 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 postulated flood height of 50 feet with a water velocity of 15 fps.

The DSCs are evaluated for 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.

A.3.3.3 Seismic Design

The seismic criteria for the NUHOMS®-MP187 Cask System are provided by the enveloping acceleration response spectra at the concrete pad base and HSM center of gravity obtained by the WCS CISF soil-structure interaction (SSI) analysis. The SSI analysis is based on the WCS CISF site-specific ground motion in the form of the 10,000-year return period uniform hazard spectra as described in Section 7.6.4.

A.3.3.4 Snow and Ice Loading

The design basis snow and ice loading for the NUHOMS®-MP187 Cask System are provided in Section 3.2.4 of Volume 1 of reference [A.3-1]. Snow and ice loads for the HSM are conservatively derived from ANSI A58.1 1982 [A.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 NUHOMS®-MP187 Cask System components envelopes the maximum WCS CISF snow and ice loads of 10 psf.

A.3.3.5 Lightning

The likelihood of lightning striking the HSM Model 80 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.

A.3.4 Safety Protection Systems

The safety protection systems of the NUHOMS®-MP187 Cask System are discussed in Section 3.3 of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.3-1].

A.3.4.1 General

The NUHOMS®-MP187 Cask 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 A.3-2. The key elements of the NUHOMS®-MP187 Cask 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.

A.3.4.2 Structural

The principal design criteria for the DSCs are presented in Section 3.2.5.2 of Volume I of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.3-1]. The DSCs are designed to store intact, damaged and failed PWR FAs with or without Control Components. 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 MP187 cask when used as a transfer cask are presented in Section 3.2.5.3 of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.3-1]. In this mode the MP187 cask is designed for the on-site transfer of a loaded DSC from the Cask Handling Building to the HSM. The principal design criteria for the HSMs are provided in Section 3.2.5.1, Volume I of reference [A.3-1].

A.3.4.3 Thermal

The thermal performance requirements for the NUHOMS®-MP187 Cask System are described in Section 3.1.1.2 of Volume I of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.3-1]. 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.

A.3.4.4 Shielding/Confinement/Radiation Protection

The shielding performance and radiation protection requirements for the NUHOMS®-MP187 Cask System are described in Section 3.3.5 of Volume I of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.3-1]. The confinement performance requirements for the NUHOMS®-MP187 Cask System are described in Section 3.3.2 of Volume I of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.3-1] for storage conditions. In addition, bounding evaluations in WCS CISF SAR Section A.7.7 are performed to demonstrate that the confinement boundaries for the FO-, FC-, FF-DSCs do 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 each end of an HSM array to minimize radiation dose rates both on-site and off-site. The HSMs provide sufficient biological shielding to protect workers and the public.

The MP187 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.

A.3.4.5 Criticality

The criticality performance requirements for the NUHOMS®-MP187 Cask System are described in Section 3.3.4 of Volume I of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.3-1].

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.

A.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 [A.3-7], with the listing of ASME Code exceptions for the DSCs and the cask provided in Appendix A “ASME Code Exceptions for the MP187 cask and FO, FC, and FF DSC's” of the “Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report” [A.3-1]. 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.

A.3.4.7 Operating Procedures

The sequence of operations are outlined for the NUHOMS®-MP187 Cask System in Chapter 5 and A.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®-MP187 Cask System.

A.3.5 References

A.3-1 "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report," NRC Docket No. 72-11, Revision 4.

A.3-2 TN Document NUH-05-151 Rev. 17, "NUHOMS®-MP187 Multi-Purpose Transportation Package Safety Analysis Report." (Basis for NRC CoC 71-9255).

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

A.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).

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

A.3-6 U.S. Nuclear Regulatory Commission, "License for Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste," License Number SNM-2510, Docket Number 72-11, Amendment all.

A.3-7 American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Section III, Division 1, 1983 Edition with Winter 1985 Addenda.

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

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

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

Design Parameter	WCS CISF Design Criteria	Condition	NUHOMS®-MP187 Design Criteria
Type of fuel	Commercial, light water reactor spent fuel	Normal (Bounded)	Rancho Seco FSAR Section 10.3.1.1 and 10.3.1.2 of Volume 1
Storage Systems	Transportable canisters and storage overpacks docketed by the NRC	Normal (Bounded)	71-9255 72-11 (SNM-2510)
Fuel Characteristics	Criteria as specified in previously approved licenses for included systems	Normal (Bounded)	Rancho Seco FSAR Section 10.3.1.1 and 10.3.1.2 of Volume 1
Tornado (Wind Load) (HSM Model 80)	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)	Rancho Seco FSAR Section 3.2.1 of Volume 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) (MP187 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)	Rancho Seco FSAR Section 3.2.1 of Volume 1 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
Tornado (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)	Rancho Seco FSAR Table 3-1 of Volume 2 Automobile 4000 lb, 185 ft/s 8" diameter shell 276 lb, 185 ft/s Solid Steel Sphere 0.147 lb, 23 ft/s

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

Design Parameter	WCS CISF Design Criteria	Condition	NUHOMS®-MP187 Design Criteria
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.	Accident (Bounded)	Rancho Seco FSAR Table 3-1 of Volume 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 and A.7.5
Vent Blockage	For NUHOMS® Systems: Inlet and outlet vents blocked 40 hrs	Accident (Same)	Rancho Seco FSAR Section 8.3.5 of Volume 2 Inlet and outlet vents blocked 40 hrs
Fire/Explosion	For NUHOMS® Systems: Equivalent fire 300 gallons of diesel fuel	Accident (Same)	Rancho Seco FSAR Section 8.2.1 of Volume 1 and Appendix B Equivalent fire 300 gallons of diesel fuel
Cask Drop	For NUHOMS® Systems: Transfer Cask Horizontal side drop or slap down 80 inches(3)	Accident (Same)	Rancho Seco FSAR Section 8.2.1 of Volume 1 and Appendix B Transfer Cask Horizontal side drop or slap down 80 inches(3)
Transfer Load	For NUHOMS® Systems only: Normal insertion load 60 kips Normal extraction load 60 kips	Normal (Same)	Rancho Seco FSAR Appendix B page 8.1-26 Normal insertion load 60 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)	Rancho Seco FSAR Appendix B page 8.1-29 Maximum insertion load 80 kips Maximum extraction load 80 kips

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

Design Parameter	WCS CISF Design Criteria	Condition	NUHOMS®-MP187 Design Criteria
Ambient Temperatures	Normal temperature 44.1 – 81.5°F	Normal (Bounded)	Rancho Seco FSAR Section 8.1.1.3 of Volume 1 Normal temperature 0 - 101°F(1)
Off-Normal Temperature	Minimum temperature 30.1°F Maximum temperature 113°F	Off-Normal (Bounded)	Rancho Seco FSAR Section 8.1.1.3 of Volume 1 Minimum temperature -20.0°F Maximum temperature 120°F(2)
Extreme Temperature	Maximum temperature 113°F	Accident (Bounded)	Rancho Seco FSAR Section 8.1.1.3 of Volume 1 Maximum temperature 120°F(2)
Solar Load (Insolation)	Horizontal flat surface insolation 2949.4 BTU/day-ft^2 Curved surface solar insolation 1474.7 BTU/day-ft^2	Normal (No Impact)	Rancho Seco FSAR Table 8-1 of Volume 2 Horizontal flat surface insolation(5) 2112 BTU/day-ft^2 Curved surface solar insolation Not Specified
Snow and Ice	Snow Load 10 psf	Normal (Bounded)	Rancho Seco FSAR Section 3.2.4 of Volume 1 Snow Load 110 psf
Dead Weight	Per design basis for systems listed in Table 1-1	Normal (Same)	Rancho Seco FSAR Section 8.1.1.1 of Volume 1 [A.3-1]
Internal and External Pressure Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	Rancho Seco FSAR Sections 3.2.2 and 8.1.1.2 of Volume 1 [A.3-1]
Design Basis Thermal Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	Rancho Seco FSAR Sections 8.1.1.3 and 8.1.1.9 of Volume 1

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

Design Parameter	WCS CISF Design Criteria	Condition	NUHOMS®-MP187 Design Criteria
Operating Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	Rancho Seco FSAR Table 3-3 and Table 3-4 of Volume 1 and Table 3-1 of Volume 2 provide the Operating Loads applicable to the Canisters, Transfer Cask and HSM. [A.3-1]
Live Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	Rancho Seco FSAR Section 3.2.4 of Volume 1 Design Load (including snow and ice) 200psf
Radiological Protection	Public wholebody ≤ 5 Rem Public deep dose plus individual organ or tissue ≤ 50 Rem Public shallow dose to skin or extremities ≤ 50 mrem Public lens of eye ≤ 15 mrem	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(4) Public thyroid ≤ 75 mrem/yr(4) Public critical organ ≤ 25 mrem/yr(4)	Normal (Same)	Chapter 9 demonstrates these limits are met Public wholebody ≤ 25 mrem/yr(4) Public thyroid ≤ 75 mrem/yr(4) Public critical organ ≤ 25 mrem/yr(4)
Confinement	Per design basis for systems listed in Table 1-1	N/A	Rancho Seco FSAR Section 3.3.2.1 of Volume 1 and Appendix B pages 3.3-1 to 3.3-2 of Reference [A.3-1]
Nuclear Criticality	Per design basis for systems listed in Table 1-1	N/A	Rancho Seco FSAR Section 3.3.4 of Volume 1 of Reference [A.3-1]
Decommissioning	Minimize potential contamination	Normal (Same)	Rancho Seco FSAR Section 3.5 and 9.6 of Volume 1 Minimize potential contamination

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

Design Parameter	WCS CISF Design Criteria	Condition	NUHOMS®-MP187 Design Criteria
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)	Rancho Seco FSAR Section 3.2.5.2 of Volume 1 Cask/canister handling system prevent breach of confinement boundary under all conditions Rancho Seco FSAR Section 5.1 of Volume 2 Storage system allows ready retrieval of canister for shipment off-site

Notes

1. Not used
2. Not used
3. 75g Vertical 75g Horizontal and 25g corner is equivalent to 80 inch drop.
4. In accordance with 10 CFR 72.104(a)(3) limits include any other radiation from uranium fuel cycle operations within the region.
5. Rancho Seco FSAR Section 8.1.1.1, Item 6 of Volume 2 demonstrates that variations in isolation have little impact on system temperatures, therefore use of the lower values in the evaluations is acceptable.

Table A.3-2
NUHOMS®-MP187 Cask 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 A.4
OPERATING SYSTEMS
NUHOMS®-MP187 Cask System

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A.4. OPERATING SYSTEMS

This Appendix provides information on the operating systems applicable to the NUHOMS®-MP187 Cask System 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.

A.4.1 Concrete Pad Structures

This section is applicable to the basemat and approach slabs for the NUHOMS® HSM Model 80. The following discussion provides guidance for these structures; but as noted in Section A.4.1.3, the basemat and approach slabs are not-important-to-safety (NITS).

A.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.

A.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 A.4-1. The values shown in Table A.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 MP187 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 [A.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 [A.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 for the transfer vehicle.

The overall dimensions of the HSM modules are listed in Table A.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.

A.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.

A.4.2 Cask Storage System

This section is applicable to the FO-, FC-and FF-DSC and Greater than Class C (GTCC) waste canisters; NUHOMS® HSM Model 80; and MP187 cask configured for transfer operations.

A.4.2.1 Operating Function

The overall function of the HSM Model 80 used at the WCS CISF is to safely provide interim storage of spent nuclear fuel (SNF) and GTCC waste canisters. These canisters provide a convenient means to place set quantities of spent nuclear fuel (SNF) and GTCC into dry storage in a way that allows easy retrieval of the canisters for off-site shipment.

The FO-, FC- and FF-DSC canisters containing SNF assemblies and GTCC waste canisters 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 GTCC waste, and provide confinement and criticality control during normal operation and postulated design-basis accident conditions for on-site storage. The FC-and FO-DSCs are shown in drawing NUH-05-4004 Revision 16 and the FF-DSC is shown in drawing NUH-05-4005 Revision 14, included in Section A.4.6. The GTCC canister is shown in drawings 13302-1005 Revision 0 and 13302-10007 Revision 0 included in Section A.4.6.

The HSM Model 80 is designed in accordance with 10 CFR 72, and provides horizontal on-site storage of the sealed SNF and GTCC waste canisters. The main function of the HSM Model 80 is to provide safe, long-term storage of FO-, FC- and FF-DSCs containing SNF assemblies and GTCC waste canisters containing solid reactor waste.

The HSM Model 80 design function is to passively cool the canisters by air convection. The HSM Model 80 also provides the capability for canister transfer from their associated transportation/transfer casks. The drawings for the HSM Model 80 are not included in Reference [A.4-4] as the HSM was incorporated by reference into the the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report." The applicable drawings for the HSM Model 80 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 MP187 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 MP187 cask in the transfer configuration is shown in drawings NUH-05-4001 Revision 15 and NUH-05-4003 Revision 10, included in Section A.4.6.

A.4.2.2 Design Description

The FO-, FC- and FF-DSCs and GTCC waste canister are stainless steel flat head pressure vessels that provides confinement that 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.

The HSM Model 80 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 MP187 cask, in the transfer configuration, is used to transfer the canisters from the CHB to the storage pad where the cask is mated to the HSM Model 80. 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.

A.4.2.3 Safety Considerations

The FO-, FC- and FF- DSCs are important-to-safety (ITS), Quality Category A components. The GTCC waste canister is an ITS, Quality Category B component. The HSM Model 80 is an ITS, Quality Category B component. The MP-187 Cask is an ITS, Quality Category B component.

A.4.3 Cask Transporter System

This section is applicable to the cask transporter system for the MP187 cask. This following provides a general description of the cask transporter system, however as noted Section A.4.3.3, this equipment is NITS.

A.4.3.1 Operating Function

The cask transporter system for the MP187 cask is designed to move the loaded MP187 cask in the on-site transfer configuration between the Cask Handling Building and the Storage Area and transfer the canister from the MP187 cask to the HSM Model 80.

A.4.3.2 Design Description

The 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 MP187 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 MP187 cask and into the HSM. The alignment of the MP187 cask and the HSM is verified by an alignment system.

A.4.3.3 Safety Considerations

All transfer equipment is designed to limit the height of the MP187 cask to less than 80” above the surrounding surface; therefore, it is NITS and is designed, constructed, maintained, and tested as commercial-grade items.

A.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 [A.4-3] that may be used as one of two options provided to prevent conditions that could lead to exceeding the concrete and SNF clad temperature criteria.

A.4.5 References

A.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).

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

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

A.4-4 "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report," NRC Docket No. 72-11, Revision 4.

A.4.6 Supplemental Data Drawings

The following drawings are incorporated by reference or enclosed as noted below:

1. “NUHOMS FO-DSC and FC-DSC for PWR Fuel Main Assembly (four sheets),” NUH-05-4004, Revision 16 (See Volume 4 of the “Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report” [A.4-4]).

2. “NUHOMS FF-DSC for PWR Fuel Main Assembly (four sheets),” NUH-05-4005, Revision 14 (See Volume 4 of the “Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report” [A.4-4]).

3. Not Used.

4. Not Used.

5. “Standardized NUHOMS® ISFSI Horizontal Storage Module ISFSI General Arrangement (three sheets),” NUH-03-6008-SAR, Revision 10 (See Section E.2 of Appendix E of the “Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel” [A.4-1]).

6. “Standardized NUHOMS® ISFSI Horizontal Storage Module Main Assembly (two sheets),” NUH-03-6009-SAR, Revision 9 (See Section E.2 of Appendix E of the “Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel” [A.4-1]).

7. “Standardized NUHOMS® ISFSI Horizontal Storage Module Base Unit Assembly (two sheets),” NUH-03-6010-SAR, Revision 5 (See Section E.2 of Appendix E of the “Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel” [A.4-1]).

8. “Standardized NUHOMS® ISFSI Horizontal Storage Module Base Unit (three sheets),” NUH-03-6014-SAR, Revision 9 (See Section E.2 of Appendix E of the “Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel” [A.4-1]).

9. “Standardized NUHOMS® ISFSI Horizontal Storage Module Roof Slab Assembly (two sheets),” NUH-03-6015-SAR, Revision 8 (See Section E.2 of Appendix E of the “Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel” [A.4-1]).

10. "Standardized NUHOMS® ISFSI Horizontal Storage Module DSC Support Structure (two sheets)," NUH-03-6016-SAR, Revision 10 (See Section E.2 of Appendix E of the "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel" [A.4-1]).

11. "Standardized NUHOMS® ISFSI Horizontal Storage Module, Module Accessories (five sheets)," NUH-03-6017-01-SAR, Revision 7 (See Section E.2 of Appendix E of the "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel" [A.4-1]).

12. "Standardized NUHOMS® ISFSI Horizontal Storage Module Shield Wall Plans and Details (two sheets)," NUH-03-6018-SAR, Revision 7 (See Section E.2 of Appendix E of the "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel" [A.4-1]).

13. "Standardized NUHOMS® ISFSI Horizontal Storage Module, Module Erection Hardware (two sheets)," NUH-03-6024-SAR, Revision 5 (See Section E.2 of Appendix E of the "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel" [A.4-1]).

14. "NUHOMS MP-187 Multi-purpose Cask Main Assembly (six sheets)," NUH-05-4001 Revision 15 (See Volume 4 of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.4-4]).

15. "NUHOMS MP-187 Multi-purpose Cask Onsite Transfer Arrangement (two sheets)," NUH-05-4003 Revision 10 (See Volume 4 of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.4-4]).

Table A.4-1
Weight of HSM Model 80

Component	Nominal Weight kips[1]	105% weight kips
HSM Model 80	239.4	251.4
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 A.4-2
HSM Model 80 Overall Dimensions

Width	Depth	Height
122”	228”	180”

APPENDIX A.5
OPERATING PROCEDURES
NUHOMS®-MP187 Cask System

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A.5. OPERATING PROCEDURES

This chapter presents the operating procedures for the NUHOMS®-MP187 System containing FO-, FC-, FF-DSCs and GTCC waste canisters originally loaded and stored under Materials License SNM-2510. The procedures include receipt of the NUHOMS®-MP187 Cask (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®-MP187 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 NUHOMS®-MP187 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 NUHOMS®-MP187 System operations are presented in Figure A.5-1.

The generic terms used throughout this section are as follows.

- TC, or transfer cask is used for the NUHOMS®-MP187 transport/transfer cask.
- DSC is used for the FO-DSC, FC-DSC, FF-DSC and GTCC waste canisters.
- HSM is used for the HSM Model 80.

A.5.1 Procedures for Receiving the Transport Cask and Transfer to the HSM

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

A.5.1.1 Receipt of the Loaded NUHOMS®-MP187 Cask

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

1. Verify that the tamperproof seals are intact.

2. Remove the tamperproof seals.

3. Remove the impact limiter attachment bolts from each impact limiter and remove the impact limiters from the TC.

4. Remove the transportation skid personnel barrier and skid support structure (closure assembly).

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

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

7. Using the overhead crane, lift the TC from the railcar.

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 [A.5-2].

   a. Remove upper and lower trunnion plugs.

   b. Inspect the trunnion sockets for excessive wear, galling, or distortion in accordance with the transport license requirements [A.5-1].

   c. Install the upper and lower trunnions. Torque trunnion attachment bolts to at least 200 ft-lbs in accordance with the transport license requirements [A.5-1].

8. Place the TC onto the transfer cask skid trunnion towers.

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

10. Remove the WCS Lift Beam Assembly.

11. Install the cask shear key plug assembly.

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

13. 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.

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

A.5.1.2 Transfer to the HSM

1. Prior to the TC arrival 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 must 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 the 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 [A.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 plate. Proper ALARA practices should be followed.

9. 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.

10. 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.

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

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

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

14. 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.

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

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

17. 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.

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

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

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

21. Remove the inspection apparatus if used.

22. 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.

23. 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.

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

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

A.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 [A.5-2] requirements, or, perform a temperature measurement for each HSM in accordance with Section 5.1.3(b) of the Technical Specifications [A.5-2] requirements.

A.5.2 Procedures for Retrieval and Off-Site Shipment

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

A.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 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 plate 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. 9255.

A.5.3 References

A.5-1 Certificate of Compliance for Radioactive Material Packages, No. 9255, current Revision , including the TN drawings incorporated by Condition 5.(a)(3) of the CoC and SAR Chapters 7 and 8 incorporated by Condition 7 of the CoC.

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

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

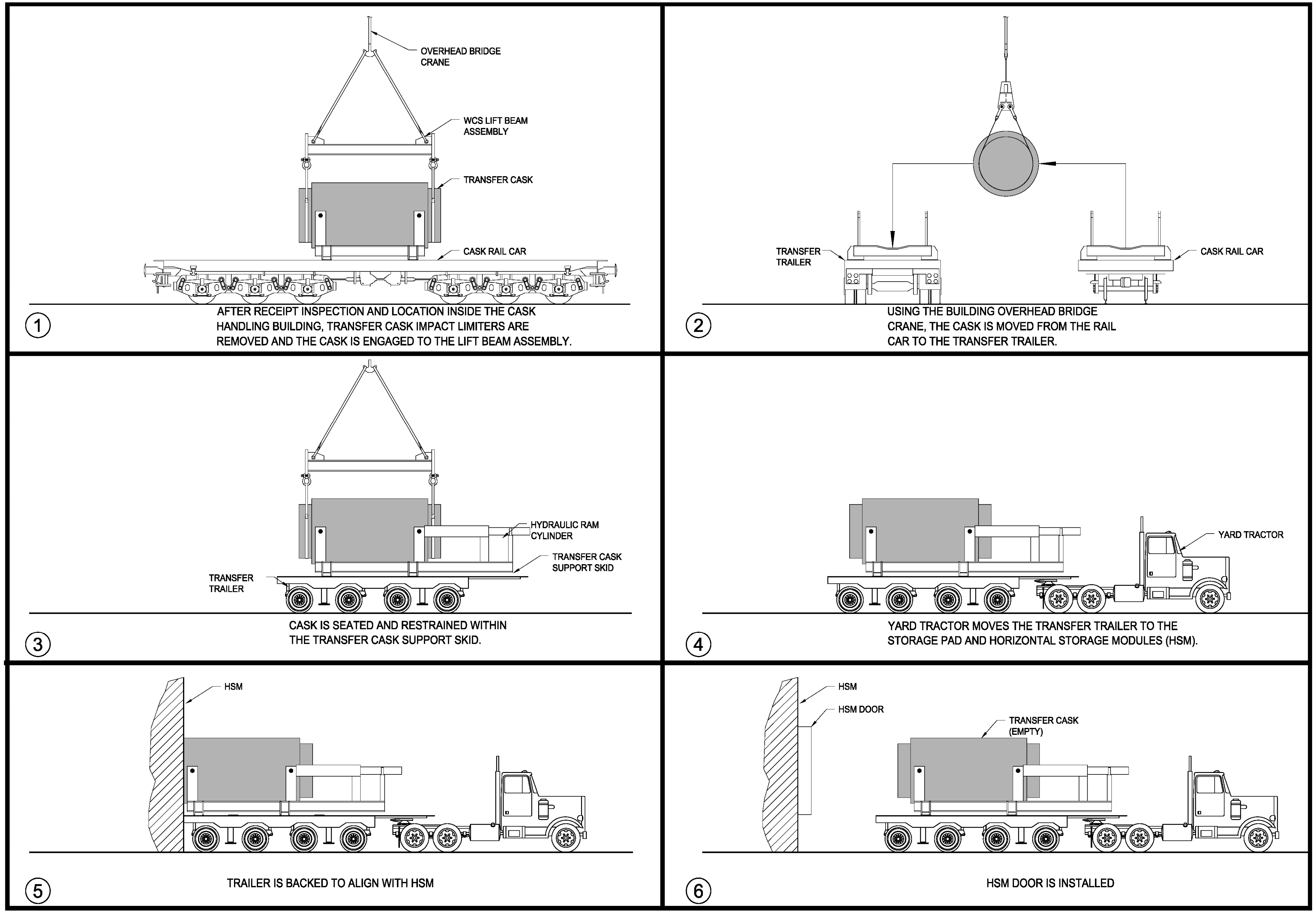

Figure A.5-1
NUHOMS®-MP187 System Operations

APPENDIX A.6
WASTE CONFINEMENT AND MANAGEMENT
NUHOMS®-MP187 Cask System

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A.6. WASTE CONFINEMENT AND MANAGEMENT

No change or additional information required for the NUHOMS®-MP187 Cask System for Chapter 6.

APPENDIX A.7
STRUCTURAL EVALUATION
NUHOMS®-MP187 Cask System

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A.7. STRUCTURAL EVALUATION

This Appendix describes the structural evaluation of the NUHOMS®-MP187 Cask System components utilized for transfer and storage of canisterized spent nuclear fuel (SNF) and Greater Than Class C (GTCC) waste at the WCS Consolidated Interim Storage Facility (*WCS* CISF). As presented in Chapter 1, Table 1-1, the NUHOMS®-MP187 Cask System includes the FO-, FC-, FF- Dry Shielded Canisters (DSCs or canisters); GTCC waste canisters; and the HSM Model 80 storage overpack as the storage components, and the MP187 cask as the on-site cask for handling and transfer operations. The canisters and the MP187 cask are described in detail in Section 4.2, Volume I of the Rancho Seco Independent Spent Fuel Storage Installation Final Safety Analysis Report (ISFSI FSAR) [A.7-4]. The HSM Model 80 is described in detail in Section 4.2.3.2 of the Standardized NUHOMS® Updated Final Safety Analysis Report (UFSAR) [A.7-3]. All three components are NRC-approved [A.7-1] [A.7-6] for SNF and GTCC waste canister transfer and storage under the requirements of 10 CFR Part 72. This appendix is prepared to demonstrate that these licensed NUHOMS®-MP187 Cask System components are also qualified to safely transfer and store canisterized SNF and GTCC waste that is currently in storage at the Rancho Seco ISFSI at the WCS CISF in accordance with the requirements of 10 CFR Part 72.

The evaluation of the MP187 cask as the on-site transfer cask is contained in Volume I and Volume III of [A.7-4]. The evaluation of the canisters is contained in Volume I and Volume II of [A.7-4]. The evaluation of the HSM Model 80 is contained in Chapter 8 of [A.7-3].

Except for the seismic reconciliation evaluation presented in Section A.7.5, and the qualification of the canister confinement boundaries during Normal Conditions of Transport in Section A.7.7, no new structural analyses are presented in this appendix. This appendix demonstrates that (with the exception of the seismic reconciliation evaluation) the structural evaluations contained in [A.7-4] and, as applicable, in [A.7-3] are bounding for the WCS CISF.

A.7.1 Discussion

As discussed in Chapter 1.0, the canisters from the Rancho Seco ISFSI will be transported to the WCS CISF in the NUHOMS®-MP187 Multi-Purpose Cask, licensed under NRC Certificate of Compliance 9255 [A.7-2]. At the WCS CISF, the canisters are to be stored inside the Standardized NUHOMS® HSM Model 80. The canisters, licensed for storage at the Rancho Seco ISFSI under NRC SNM-2510 [A.7-1], are described in Section 4.2.5.2 of Volume I of [A.7-4]. The HSM Model 80, licensed under NRC Certificate of Compliance 1004 [A.7-6], is described in Section 4.2.3.2 of [A.7-3]. The MP187 cask is to be used for on-site transfer and handling operations at the WCS CISF. The MP187 cask, licensed for on-site transfer at the Rancho Seco ISFSI under NRC SNM-2510 [A.7-1], is described in Section 4.2.5.3 of Volume I of [A.7-4].

As stated in Section 1.2 of Volume I of [A.7-4], the canisters are stored within the HSMs installed at the Rancho Seco ISFSI. The HSM design for the Rancho Seco ISFSI is based on the HSM design as described in the Standardized NUHOMS® UFSAR, Revision 4A. Appendix B of [A.7-4] contains the applicable page from the Standardized NUHOMS® UFSAR Revision 4A, as listed on the Appendix B list of pages. Appendix B of [A.7-4] is henceforth cited as [A.7-5]. A subsequent revision of the Standardized NUHOMS® UFSAR implemented certain design modifications to the HSM; and the revised HSM configuration was eventually designated as the HSM Model 80. See Section 1.3.1.2 of [A.7-3]. The main design modifications implemented in included:

1) the steel cask docking ring flange is eliminated so that the cask docking flange is formed in concrete during casting of the base unit,
2) the support rail extension plate anchorage is modified to eliminate field welding, and,
3) a drop-in tube steel is used as the axial retainer, so that the door is no longer in the load path for axial restraint of the canister.

These modifications were shown not to have an adverse effect on the intended safety functions of the HSM. Therefore, the Rancho Seco ISFSI HSMs and the HSM Model 80 are equivalent and can be substituted at the WCS CISF without affecting the licensing basis of the canisters as contained in [A.7-4].

The MP187 cask is a multi-purpose cask designed and evaluated as a transfer cask for use in loading HSMs under 10 CFR Part 72 [A.7-1] [A.7-4] and as a transportation cask for off-site shipments under the provisions of 10 CFR Part 71 [A.7-2] [A.7-7]. The evaluation of the MP187 cask as a transfer cask is based on Revision 13 of drawing NUH-05-4001 (Cask Main Assembly) and Revision 8 of NUH-05-4003 (Cask On-Site Transfer Arrangement), as shown in Volume IV of [A.7-4]. The current revision of NUH-05-4001 is Revision 15 as shown in Section 1.3.2 of [A.7-7]. There are no significant design differences in the cask main assembly configuration between these two revisions.

Furthermore, as described in Chapter 3 the design criteria for the Rancho Seco ISFSI envelops the design criteria for the WCS CISF, except for the site-specific seismic criteria, which are reconciled in Section A.7.5. Therefore, the 10CFR Part 72 evaluations of the MP187 cask performed in [A.7-4] are applicable and the current configuration of the MP187 cask is acceptable for use as a transfer cask at the WCS CISF.

Finally, bounding evaluations in Section A.7.7 are performed to demonstrate that the confinement boundaries for the FO-, FC-, FF-DSCs do 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.

A.7.2 Summary of Mechanical Properties of Materials

As described in Sections 1.2.1 and 1.2.2 of Volume I of [A.7-4], the Rancho Seco canisters and HSM designs are based on the Standardized NUHOMS® design for the 24P DSC, which is discussed in Appendix B of the Rancho Seco FSAR [A.7-5], with modifications made to the basket design to qualify the Rancho Seco canisters for off-site transport. Per Section 8.1.1.3 of Volume I of [A.7-4], the mechanical properties of materials of construction for the canisters and the HSMs at the Rancho Seco ISFSI are the same as those presented in Table 8.1-3 of Appendix B of the Rancho Seco FSAR [A.7-5]. Mechanical properties for the MP187 cask are provided in Section 2.3 of [A.7-7].

The material specifications for the canisters and the MP187 cask are provided in the drawings contained in Volume IV of [A.7-4]. Material properties of the Standardized NUHOMS® HSM Model 80 are presented in Table 8.1-3 of [A.7-3]. Material specifications for the HSM Model 80 are provided in the HSM drawings contained in Appendix E.2 of [A.7-3].

A.7.3 Structural Analysis of MP187 Cask with a Canister (Transfer Configuration)

Section 3.2 of Volume I of [A.7-4] presents the structural design criteria for the canisters and the MP187 cask. Table 3-3 and Table 3-4 of Volume I of [A.7-4] summarize the design loading criteria for the canisters and the MP187 cask, respectively. As described in Section 3.2.5.2 of Volume I of [A.7-4], the canisters are designed to meet the stress intensity allowables of the ASME Boiler and Pressure Vessel Code (1992 Code, 1993 Addendum) Section III, Division I, Subsections NB, NF, and NG for Class I components and supports. As described in Section 3.2.5.3 of Volume I, the MP187 cask is designed to meet the stress intensity allowables of the ASME Code, Subsection NB for structural or shell components and Subsection NF for the neutron shield jacket assembly.

Table 3-6 of Volume I of [A.7-4] presents the load combinations for the canisters according to the ASME B&PV Code Service Levels A, B, C, and D, while Table 3-7 of Volume I of [A.7-4] presents pertinent ASME Code stress allowables criteria.

Table 3-8 of Volume I of [A.7-4] presents the load combinations for the MP187 cask according to the ASME B&PV Code Service Levels A, B, C, and D, while Table 3-9 of Volume I of [A.7-4] presents pertinent ASME Code stress allowables criteria.

The following sections are a summary of the structural analyses.

A.7.3.1 Normal and Off-Normal Conditions

The structural analysis of the MP187 cask and the canisters for normal and off-normal operating conditions during transfer operations are discussed in Section 8.1 of Volume I of [A.7-4]. Table 8-1 of Volume I of [A.7-4] presents a summary of the normal and off-normal load types applicable to each component.

Normal loads include: (1) dead weight loads (Section 8.1.1.1), (2) design basis internal pressure loads (Section 8.1.1.2), (3) design basis thermal loads (Section 8.1.1.3), (4) normal operational handling loads (Section 8.1.1.4) and (5) design basis live loads (Section 8.1.1.6). Off-normal loads include off-normal handling (Section 8.1.1.5), and off-normal temperature and pressure loads. Normal and off-normal loads that are unique to the HSM storage mode of operations are addressed in Volume II, Chapter 8. (All section references in this paragraph are to [A.7-4]).

Linear elastic static analysis of the MP187 cask and the canisters are performed using finite element models using the ANSYS program. Stresses for the critical lift loads of the MP187 cask trunnions, trunnion sleeves, trunnion attachment bolts and trunnion sleeve/cask outer shell welds are determined using hand calculations. Stress results for normal and off-normal conditions are summarized in Volume I of [A.7-4], Table 8-3 for the MP187 cask and in Table 8-4, Table 8-5, and Table 8-6 for the canisters, respectively. The stresses in the MP187 cask and the canister components are shown to meet the stress allowables criteria of the ASME Code.

A.7.3.2 Accident Conditions

The structural analysis of the MP187 cask and the canisters for postulated accidents during transfer operations are discussed in Section 8.2 of Volume I of [A.7-4]. Table 8-7 of Volume I of [A.7-4] presents a summary of the accident load types applicable to each component.

Postulated accident loads include: (1) accidental cask drop, (2) canister leakage, (3) accident pressurization, (4) earthquake, and (5) fire. In addition, Section 3.2 of Volume I of [A.7-4] discusses natural phenomena type loads, e.g. tornado wind loads and tornado-generated missiles, and flood loading.

Linear elastic or elastic-plastic equivalent static analyses are performed using finite element models using the ANSYS program. Accident condition stresses for the MP187 cask are summarized in Table 8-8 and for the canisters in Table 8-9, Table 8-10, and Table 8-11, respectively, of Volume I of [A.7-4].

Section 8.3 of Volume III of [A.7-4] presents results for the MP187 cask stability and stress analysis for tornado wind and tornado generated missiles. The stability analyses correspond to a hypothetical storage configuration of the cask (cask in vertical configuration). Section 8.2.4.3 of Volume I of [A.7-4] addresses the seismic stability of the MP187 cask during on-site transfer operations (the loaded cask is secured to the on-site transfer skid and trailer in the horizontal configuration) and determines that the results for the cask in the hypothetical storage mode (vertical configuration), as documented in Volume III, are bounding. Section B.7.8 presents an alternate evaluation of the MP187 cask in the transfer configuration at the WCS CISF.

A.7.3.3 Load Combinations (Volume I of [A.7-4])

MP187 Cask enveloping load combination results are summarized in Table 8-12, Table 8-13, and Table 8-14 for Service Level A and B (normal/off-normal conditions), Service Level C (accident conditions), and Service Level D (accident conditions), respectively.

FO- DSC enveloping load combination results are summarized in Table 8-15, Table 8-16, and Table 8-17 for Service Level A and B (normal/off-normal conditions), Service Level C (accident conditions), and Service Level D (accident conditions) of [A.7-4], respectively.

FC- DSC enveloping load combination results are summarized in Table 8-18, Table 8-19, and Table 8-20 for Service Level A and B (normal/off-normal conditions), Service Level C (accident conditions), and Service Level D (accident conditions) of [A.7-4], respectively.

FF- DSC enveloping load combination results are summarized in Table 8-21, Table 8-22, and Table 8-23 for Service Level A and B (normal/off-normal conditions), Service Level C (accident conditions), and Service Level D (accident conditions) of [A.7-4], respectively.

The GTCC waste canisters are bounded by the FO-DSC.

The results of the analyses show that adequate safety margins exist for all postulated accidents and natural phenomena events and that the stress criteria of the ASME Code are satisfied.

A.7.4 Structural Analysis of HSM Model 80 with a Canister (Storage Configuration)

As described in Section 3.2 of Volume I of [A.7-4], the canisters are designed by analysis to meet the stress intensity allowables of the ASME Boiler and Pressure Vessel Code (1992 Code, 1993 Addendum) Section III, Division I, Subsection NB, NF, and NG for Class I components and supports.

The canisters' design approach, design criteria and load combinations for storage in the HSM are discussed in Section 3.2.5.2 of Volume II of [A.7-4]. Table 3-5 of [A.7-4] summarizes the storage load combinations and ASME Code Service Levels for the canisters.

As stated in Volume II of [A.7-4], the Rancho Seco HSM design is similar to the Standardized NUHOMS® HSM design. As discussed in Section A.7.1 the Standardized NUHOMS® HSM design that formed the basis for the licensing of the Rancho Seco HSM, which is discussed in Appendix B of the Rancho Seco FSAR [A.7-5] was subsequently designated as the HSM Model 80 in [A.7-3]. The loads for the HSM concrete and DSC steel support structure shown in Table 3.2-1 of [A.7-3] are the same or bound the loads in Table 3-1 and Table 3-2 of Volume II of [A.7-4]. The HSM Model 80 is evaluated in [A.7-3] for canister weights that bound the bounding weight of 81.2 kips for the canisters. (e.g. the evaluation of the HSM Model 80 loaded with a 61BT DSC (weight of 88.39 kips, per Table K.3.2-1 of [A.7-3]) is presented in Sections K.3.7.3.4 and K.3.7.3.5 of [A.7-3]).

The design approach, design criteria, and loading combinations for the reinforced concrete HSM Model 80 and its DSC steel support structure are discussed in Section 3.2.5 of [A.7-3]. Table 3.2-5 and Table 3.2-8 of [A.7-3] provide the loads and load combinations for the HSM concrete and DSC steel support structure, respectively. These are the same as those shown in Volume II of [A.7-4], Table 3-4 and Table 3-6 and discussed in Section 3.2.5.1. Both the Rancho Seco HSM and the HSM Model 80 are designed in accordance with the requirements of the ACI "Code Requirements for Nuclear Safety Related Concrete Structures" ACI 349-85 (concrete) and the AISC "Specification for Structural Steel Buildings", Ninth Edition, 1989 (DSC steel support structure). Table 3.2-10 of [A.7-3] summarizes the design criteria for the DSC steel support steel structure. This is the same as presented in Table 3-8 of Volume II of [A.7-4].

The discussion above establishes that the HSM as described in Volume II of [A.7-4] and the HSM Model 80 as described in [A.7-3] have the same geometry and are based on the same design criteria. Furthermore, as discussed in Chapter 3, (with the exception of seismic loading criteria), the loading and structural design criteria for the Rancho Seco ISFSI and the Standardized NUHOMS® components bound the WCS CISF design requirements. The seismic load is reconciled in Section A.7.5.2 and Section A.7.5.3 for the canisters and the HSM Model 80, respectively. Therefore, the HSM Model 80 as described in [A.7-3] is acceptable for storage of the canisters at the WCS CISF.

The structural analyses of the canisters for normal, off-normal, and accident conditions during storage are presented in Sections 8.1.4, 8.2 and 8.3 of Volume II of [A.7-4], respectively. The structural analyses of the HSM Model 80 for normal and off-normal conditions are presented in Section 8.1, and for accident conditions in Section 8.2, of [A.7-3].

The following Sections are a summary of the structural analyses.

A.7.4.1 Normal and Off-Normal Conditions

Normal and off-normal loads that are unique to the HSM storage mode of operations are addressed in Volume II, Chapter 8 of [A.7-4]. Table 8-6 and Table 8-7 of Volume II of [A.7-4] present the normal and off-normal loads applicable to each component. For the HSM Model 80, similar tables are presented (Table 8.1-1 and Table 8.1-2) in [A.7-3].

Normal loads analyzed for the storage mode of operation include: (1) dead weight loads (Section 8.1.4.1), (2) design basis internal pressure loads (Section 8.1.4.2), (3) design basis thermal loads (Section 8.1.4.3), (4) operational handling loads (Section 8.1.4.4), and (5) design basis live loads (Section 8.1.4.5). Off-normal loads include off-normal handling, and off-normal temperature and pressure loads. (All section references in this paragraph are to [A.7-4]).

The structural analyses of the canisters for normal and off-normal operating conditions during storage operations are discussed in Sections 8.1.4 and 8.2 of Volume II of [A.7-4]. Results for normal and off-normal HSM storage conditions loads applicable to the canisters are summarized in Table 8-9, Table 8-10, and Table 8-11, respectively in Volume II of [A.7-4].

The structural analyses of the HSM Model 80 for normal and off-normal operating conditions are presented in Sections 8.1.1.4 through 8.1.1.7 and 8.1.2 (as applicable to the HSM Model 80) of [A.7-3]. Table 8.1-14 thru Table 8.1-19 of [A.7-3] present the structural analyses results for the HSM Model 80 for normal and off-normal conditions.

A.7.4.2 Accident Conditions

The structural analyses of the canisters for postulated accidents during storage operations are discussed in Section 8.3 of Volume II of [A.7-4]. Table 8-8 of Volume II of [A.7-4] presents the accident load types during storage applicable to each storage system component. The loads identification Table 8.2-1 in [A.7-3] identifies storage condition loadings applicable for the HSM Model 80.

Postulated accident loads include: (1) tornado winds and tornado generated missiles, (2) design basis earthquake, (3) design basis flood, (4) lightning effects, (5) debris blockage of HSM air inlet and outlet openings, (6) reduced HSM air inlet and outlet shielding, (7) snow and ice loads, and (8) fire and explosion.

Volume II, Section 8.3 of [A.7-4] states that the accident condition loadings for the canisters loaded in the Rancho Seco HSM are the same or bounded by the 24P DSC in the HSM, as discussed in Appendix B of the Rancho Seco FSAR [A.7-5].

The structural analyses of the HSM Model 80 for accident conditions are presented in Section 8.2 of [A.7-3]. Table 8.2-3 presents the structural analyses results for the HSM Model 80 for accident conditions.

The original HSM in Appendix B of the Rancho Seco FSAR [A.7-5] was subsequently designated as the HSM Model 80 in [A.7-3]. Thus, the results for the canisters in [A.7-4] and the HSM Model 80 in [A.7-3] are applicable, except for the seismic load evaluations. Seismic reconciliation evaluations as described in Section A.7.5 address the site-specific ground motion at WCS CISF.

A.7.4.3 Load Combinations

HSM Model 80 enveloping load combination results are summarized in Table 8.2-18, Table 8.2-19, and Table 8.2-20 of [A.7-3]. The stress results for the HSM Model 80 presented in Table 8.2-18, Table 8.2-19, and Table 8.2-20 are bounding when the HSM Model 80 is loaded with a canister.

The enveloping load combination results summarized in Table 8-15, Table 8-16, and Table 8-17 of Volume I of [A.7-4] bound the storage specific loads for the FO DSC and GTCC waste canister.

The enveloping load combination results summarized in Table 8-18, Table 8-19, and Table 8-20 of Volume I of [A.7-4] bound the storage specific loads for the FC DSC.

The enveloping load combination results summarized in Table 8-21, Table 8-22, and Table 8-23 of Volume I of [A.7-4] bound the storage specific loads for the FF DSC.

A.7.5 Seismic Reconciliation of the MP187 Cask, Canisters, and HSM Model 80

The 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 are described in Chapter 2. A comparison of the site-specific response spectra for the WCS CISF ground motion and the Regulatory Guide 1.60 design-basis ground motions' response spectra are shown in Figure A.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 Rancho Seco IFSFI and the Standardized NUHOMS® System.

This section summarizes the stress reconciliation of the MP187 cask, the canisters, and the HSM Model 80 using the enveloped acceleration spectra at the HSMs center of gravity (CG) and base derived from the concrete pad soil-structure interaction (SSI) analysis.

A.7.5.1 MP187 Cask

The MP187 cask is a multi-purpose cask, designed as a transfer cask for use in loading HSMs under the provisions of 10 CFR 72, and as a transportation cask for off-site shipment under the provisions of 10 CFR 71. Due to the cask's design to meet off-site shipping requirements, large factors of safety are afforded for on-site transfer operations.

As noted in Volume I, Section 1.2 and Volume III, Section 8 of [A.7-4], the MP187 cask was intended to be licensed under 10 CFR 72 for storage of a canister if required to recover from an off-normal event at the ISFSI. Although ultimately not licensed as a storage component, the fact that it was designed to meet the storage requirements under 10 CFR Part 72 provides the MP187 cask with additional uncredited safety margins.

As noted in Section 3.2.3 of Volume I of [A.7-4], based on the calculated cask structural frequencies of 17.9 (ovalling mode) and 83 Hz (beam mode), an amplification factor of 2.5 and a multimode factor of 1.5 are applied to the R.G. 1.60 ZPA acceleration of 0.25g (horizontal) and 0.17g (vertical). This resulted in equivalent static accelerations for the horizontal and vertical directions of 0.95g and 0.65g. The R.G. 1.60 response spectrum amplification for 2% damping at 17.9 Hz is 1.8 (a higher amplification factor of 2.5 was conservatively used in the design basis evaluation). Thus, the 0.95g used for the MP187 cask design basis seismic evaluation has margin to accommodate the increased spectral amplifications for the WCS CISF.

[ ]

This factor is applied to the governing seismic stress in Table 8-8 of Volume I of [A.7-4]. As reported in Table 8-8 of Volume I of [A.7-4] the maximum seismic stress is 3.4 ksi. The load combination results are shown in Table 8-13 of Volume I. Per Note 2 of Table 8-13 the seismic load combinations C1 and C2 are enveloped into a bounding load combination C1/C2. The enveloping bounding load combination C1/C2 consists of deadweight stress (2.4 ksi from Table 8-3), normal handling (3.7 ksi from Table 8-3), accident pressure (0.5 ksi from Table 8-8), and seismic (3.4 ksi from Table 8-8). Table 8-13 shows that the controlling stress ratio is 0.42 and corresponds to the cask outer shell primary stress of 10 ksi. Using the above-calculated factor the seismic stress of 3.4 ksi is increased to 3.4x2.17 = 7.38 ksi. Moreover, per Volume I, Section 8.2.3, accident pressure loads apply only for a hypothetical storage condition. When used as a transfer cask the MP187 cask is not required to hold pressure. Therefore, in this evaluation the 0.5 ksi accident pressure is removed from the load combination. The updated C1/C2 load combination now renders a total stress of 13.5 ksi, or a stress ratio of 0.56.

Furthermore, the maximum stress ratio in Table 8-13 is 0.81 and corresponds to a non-seismic load combination (C4). It is concluded that seismic load is not the controlling load at the WCS CISF and the bounding load stress margins for the MP187 cask, as documented in [A.7-4], remain unchanged.

A.7.5.2 Canisters

SSI analyses were performed for the pad with high level waste storage units at the Andrews, TX waste storage facility site. These analyses are presented in Section 7.6.4. One of the purposes of the analyses was to determine the envelope of the acceleration response spectra at the HSM center of gravity. The +/-15% peak-broadened HSM CG response spectra for damping values of 7%, 3%, and 2% are shown in Figures D.7-7 through D.7-9.

Based on NRC Reg. Guide 1.61 [A.7-8], a damping value of three percent is used for the DSC seismic analysis. The resulting stresses in the DSC shell due to the vertical and horizontal seismic loads are determined and reconciled with the original seismic analysis for the individual DSCs.

DSC Natural Frequency Calculation

ANSYS [A.7-9] finite element analyses are used to determine the natural frequencies of the DSCs. Since the FC and FF DSCs have ASTM B29 Lead in the shield plug assemblies a bounding model is developed to envelop the critical dimensions of the DSCs. Similarly FO, 61BT, and 61BTH Type 1 DSCs have steel shield plugs a bounding model is developed to envelop the critical dimensions of the DSCs. These critical dimensions and the dimensions used in the bounding model are summarized in Table A.7-1 and Table A.7-2.

Since a half symmetry model is used, symmetry boundary conditions were applied on the symmetry surface. Furthermore, the DSC was restrained radially along two lines of nodes at the outer diameter; at plane of symmetry and at 0.61 inch, which is less than the half-rail width. All nodes on the outer surface of outer top cover plate and DSC shell within the axial retainer area (3 inch x 2.44 inch) are also restrained in the axial direction. The boundary conditions are shown in Figure A.7-2.

Two different analyses are performed to encompass the directional loading of the basket and spent fuel assemblies. The first analysis is performed where the basket and spent fuel assemblies mass is lumped on the bottom of the top shield plug. This analysis simulates the axial direction seismic load. In the second analysis, the basket and spent fuel assemblies mass is lumped on the DSC shell inner surface. This analysis simulates the vertical and lateral direction seismic load.

The lowest mode for each model is shown in Figure A.7-3 and Figure A.7-4.

As shown in the modal analyses, the differences between all of the DSCs are minimal from the stiffness perspective. The 61BT and 61BTH Type 1 DSCs were shown to be stable when loaded in the HSM-HS [A.7-3]. The stability was shown by performing non-linear time-history analysis [Section U.3.7.2.1 of A.7-3]. The angle of the rail is at 30 degrees for both HSM-HS and HSM-80/102. Due to the same rail angle and a bounding spectra analysis, it is concluded that the DSCs will remain stable on the HSM rails.

Per Section 8.2.4.3 in Volume I and Section 8.3.2.2 in Volume II of [A.7-4] 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 (spacer disc, support rods) are evaluated for 1.5g and 1.0g for the horizontal and vertical directions, respectively.

The seismic evaluation shows that the seismic accelerations used in the original seismic evaluations of the DSCs bound the seismic demand accelerations from the WCS CISF site-specific loading.

A.7.5.3 HSM Model 80

The seismic reconciliation of the HSM Model 80 is described in D.7.3.1.

A.7.6 Thermal Stress Reconciliation of the MP187 Cask System Components

From Chapter 1, the maximum ambient temperatures at the WCS CISF are 81.5°F, 113°F and 113°F for normal, off-normal, and accident conditions. Based on the discussion in Chapter 8, the corresponding 24-hour daily average temperatures of 95°F and 105°F for normal and off-normal conditions, respectively are justified for use in the structural reconciliation evaluations for the WCS CISF.

The lowest off-normal ambient temperature at the WCS CISF is 30.1°F. This is above the -20°F minimum temperature used in [A.7-4] and is bounded by the -40°F in [A.7-3].

A.7.6.1 Reconciliation of WCS CISF Environmental Ambient Conditions with Environmental Ambient Conditions in the Standardized NUHOMS® UFSAR

The HSM Model 80 structural analysis is performed for normal ambient temperature of 100°F and off-normal maximum temperature of 125°F, respectively in Section 8.1.1.5 of [A.7-3]. These temperatures bound the daily average ambient temperatures of 81.5°F and 105°F used for normal and off-normal conditions, respectively at the WCS CISF. The lowest off-normal ambient temperature at the WCS CISF is 30.1°F, which is bounded by the -40°F used in [A.7-3].

Table 8.1-17 of [A.7-3] show the temperatures in the HSM Model 80 resulting from the heat transfer analysis of the HSM Model 80 loaded with a 24kW heat load canister for the various design basis ambient thermal conditions. These temperatures are used for the thermal stress analyses.

Therefore, the maximum temperatures and thermal stress evaluation results reported in [A.7-3] for the HSM Model 80 remain bounding for the WCS CISF.

A.7.6.2 Reconciliation of WCS CISF Environmental Ambient Conditions with Environmental Ambient Conditions in the Rancho Seco ISFSI FSAR

As documented in Section 8.1.1.1 of Volume II of [A.7-4], a maximum ambient temperature of 101°F, 117°F and 117°F are used for normal, off-normal and accident conditions, respectively. These temperatures bound the daily average ambient temperatures of 95°F, 105°F and 105°F for normal, off-normal and accident conditions, respectively used at the WCS CISF. The lowest off-normal ambient temperature at the WCS CISF is 30.1°F, which is the same as that at the Rancho Seco ISFSI site.

Therefore, the maximum temperatures and thermal stress evaluation results reported in [A.7-4] for the MP187 cask loaded with a canister remain bounding for the WCS CISF.

Section A.8.4 and A.8.5 present additional discussions on the thermal analysis basis for the transfer and storage of canisters at the WCS CISF using the MP187 cask and the HSM Model 80.

A.7.7 Structural Evaluation of Canister Confinement Boundary under Normal Conditions of Transport

The FO-, FC- and FF- DSCs shell assemblies each consist of a cylindrical shell, top outer/inner cover plates, bottom inner/outer cover plates and bottom and top shield plugs. Each canister 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 A.4.6. The confinement boundaries are addressed in Section A.11.1. The FC- and FF-DSC shells are evaluated for Normal Conditions of Transport in the MP187 Transport cask in Section A.7.7.1 and the FO-DSC and 24PT1 DSC of the Standardized Advanced NUHOMS® System shells are evaluated in Section A.7.7.2.

A.7.7.1 Evaluation of FC- and FF-DSC Shells

A.7.7.1.1 Assumptions

1. Smaller components of the DSC, such as the siphon and vent block, keyways, and tapped holes in the shield plugs and in the inner top and bottom cover plates are not modeled due to negligible impact on the stiffness of the assembly and stresses.

2. A Single FE Model is used for analyzing both FC- and FF- DSCs with enveloping dimensions and loads.

3. The primary stresses evaluation assumes a uniform 400 °F temperature for all material components which conservatively bounds the actual temperatures, per reference [A.7-12].

4. Thermal Stress evaluation is not evaluated separately and the stress results presented in [A.7-13] are also applicable for this evaluation.

5. The guide sleeve evaluation performed in references [A.7-12] and [A.7-13] is still applicable for this calculation.

6. Enveloping DSC internal weight = 52,580 lbs per reference [A.7-14] is considered for the evaluation.

7. The NCT drop loads (25g) bound vibration loads which are on the order of a factor of 5 lower.

A.7.7.1.2 Material Properties

Material properties are based on reference [A.7-11] for the material at 400 °F. Table A.7-5 provides material properties for SA-240 Type 304 Steel (18CR-8Ni). Table A.7-6 provides a summary of stress criteria for subsection NB pressure boundary components in the DSC shell and cover plates. Table A.7-8 provides allowable weld stresses for pressure boundary partial penetration welds, material Type 304. Table A.7-9 provides Level A/B allowable membrane, membrane plus bending, and combined membrane, bending and secondary stresses for the FC- and FF- DSCs.

A.7.7.1.3 Design Criteria

Structural design criteria for the FC- and FF-DSCs are based on ASME B&PV Code, Section III, Division 1, Subsection NB, 1992, including 1993 addenda and Appendix F.

A.7.7.1.4 Methodology

A single Finite Element Model (FEM) is used for analyzing both FC- and FF-DSCs with enveloping dimensions and loads. The DSC shell assembly is analyzed for the postulated load conditions using a three-dimensional (3D) 180° half-symmetric FEM. The most limiting dimensional properties between the FC- and FF-DSCs were modeled using reference [A.7-17]. References [A.7-15] and [A.7-16] provide the different dimensions of the DSCs along with the model dimensions used.

The resulting stresses in the DSC structural components are compared with the allowable stresses set forth by ASME B&PV Code, Section III, Subsection NB [A.7-11] for normal (Level A) conditions.

The stress due to each load is differentiated by the type of stress induced, e.g. membrane, bending, etc., and the classification of stress, e.g. primary, etc. In some locations, stresses are also differentiated based upon their proximity to a gross structural discontinuity, boundary condition, or their proximity to the confinement boundary.

There are two welds in the DSC confinement boundary. The first joins the DSC shell and the OTCP and the second joins the ITCP with the DSC shell. An allowable load/stress reduction factor of 0.6 (joint efficiency factor is used for the weld evaluation in this calculation. The allowable weld stresses are listed in Table A.7-8.

A.7.7.1.5 Design and Input Loads & Data

Load Combinations for the Canisters include vertical (top and bottom end) drops and side drops. Three load cases are performed for top end drop including: top end drop, top end drop with internal pressure (8 psi), and top end drop with external pressure (8 psi). The bottom end drop has the same pressure applied internally and externally to the DSC with loads applied the opposite end of the DSC. Side drop loads have both toward and away-from-rail load conditions with 8psi internal or external pressure applied to the DSC.

The following sections are a summary of the structural analyses.

A.7.7.1.5.1 Vertical Drop

A.7.7.1.5.1.1 Bottom End Drop

In addition to pressure representing the payload inertia load, conservative internal pressure of 8 psig and external pressure of 8 psig are added.

Three load cases are performed for bottom end drop:

1. Bottom end drop
2. Bottom end drop with internal pressure (8 psi)
3. Bottom end drop with external pressure (8 psi)

A.7.7.1.5.1.2 Top End Drop

Three load cases are performed for top end drop:

1. Top end drop
2. Top end drop with internal pressure (8 psi)
3. Top end drop with external pressure (8 psi)

A.7.7.1.5.2 Side Drop on Cask Rails

Three load cases are analyzed for the side drop onto the cask rail:

1. Side drop onto the cask rail
2. Side drop onto the cask rail with internal pressure (8 psi)
3. Side drop onto the cask rail with external pressure (8 psi)

A uniform pressure load is applied to the DSC inner surface at rail location. The inner nodes of the DSC are selected at 30° rail and a uniform pressure is applied.

For side drop load cases onto the two transfer cask rails, inertia loads for canister internals is accounted for by applying equivalent pressure onto the rail. The total load on first rail is calculated as shown below:

Cavity Length, L = 160.0 in

Total weight of canister internal to be used W = 52580 lb (For 360° Model) (Assumption 6)

Total Load on Rail:

Width of Rail = 4.00 in

Area of first rail over which uniform pressure is applied = 4.0 in * 160 in = 640 in2

Uniform pressure over the first rail for 25g = 25*52580 / 2*640 = 1026.95 psi.

A.7.7.1.5.3 Side Drop Away from Cask Rails

Three load cases are analyzed for side drop away from the cask rail

1. Side drop away from the cask rail
2. Side drop away from the cask rail with internal pressure (8 psi)
3. Side drop away from the cask rail with external pressure (8 psi)

For side drop load cases away from rails, inertia loads for canister internals is accounted for by applying a cosine varying pressure on the inside surface of the canister shell. Assuming that the canister internals react upon 90° arc of the inside surface, then the inertial load of the internals, P(θ), which varies with angle, θ, (θ = 0 is at the impact point), is governed by the following expression

$$P_{(\theta)} = P_{max} \cos(2\theta) \quad (0° < \theta < 45°)$$

Where P_{max} is the maximum pressure at the impact point (θ = 0). Assuming the axial length of the applied load is L, the inside radius of the canister shell is R, and the load distribution, P(θ) above, then the total inertial load generated by the internals, F, is the following:

$$F = \int_{\frac{-\pi}{4}}^{\frac{\pi}{4}} P_{\max} \cos(2\theta)\cos(\theta) LR d\theta$$

$$\Rightarrow \quad F = \frac{P_{\max} LR}{2} \int_{\frac{-\pi}{4}}^{\frac{\pi}{4}} \left[\cos((2+1)\theta) + \cos((2-1)\theta)\right] d\theta$$

By integrating the equation above, we get the following:

$$F = \left[\frac{P_{\max} LR}{2}\right]\left[\frac{\sin(3\theta)}{3} + \sin(\theta)\right]\Bigg|_{\frac{-\pi}{4}}^{\frac{\pi}{4}}$$

Therefore,

$$F = \left[\frac{P_{\max} LR}{2}\right]\left[\frac{\sin\left(\frac{3\pi}{4}\right)}{3} + \sin\left(\frac{\pi}{4}\right) - \frac{\sin\left(\frac{-3\pi}{4}\right)}{3} - \sin\left(\frac{-\pi}{4}\right)\right]$$

$$F = P_{\max} LR\left[\frac{\sin\left(\frac{3\pi}{4}\right)}{3} + \sin\left(\frac{\pi}{4}\right)\right]$$

The canister shell inner radius, R = 32.965 in. The axial length of the applied load (basket length), L = 160.0 in. Weight of canister internals (Basket Assembly + Fuel) is 52580 lb. (Assumption 6).

Side Drop NCT G Load = 25g.

F = 52,580 × 25g = 1,314,500 [for NCT]

Therefore, Pmax for Normal Condition of Transport (NCT) is:

$$P_{\max} = \frac{1314500}{(160)(32.965)}\left[\frac{\sin\left(\frac{3\pi}{4}\right)}{3} + \sin\left(\frac{\pi}{4}\right)\right]^{-1} = 264.37 \text{ psi}$$

The equivalent pressure applied on the canister inside shell surface for load cases away from transfer cask rails is

$$P_{(\theta)} = 264.37\cos(2\theta)$$

θ = angle from the bottom (θ = 0) of the horizontal canister shell to the center of the shell element, up to 45°.

A.7.7.1.5.4 Load Combinations

A summary of load combinations examined for NCT conditions for the FC- and FF-DSCs is presented in Table A.7-3.

A.7.7.1.6 Stress Evaluation Results

Tables A.7-3 through A.7-9 and Figures A.7-7 through A.7-9 represent stress evaluations from the Vertical and Side Drop Cases for the FF and FC Canisters. Figure A.7-7 presents stress intensity plot for the FF and FC Canisters based on the most critical load case. For these canisters, the most critical load case for normal conditions of transport (NCT) is represented by the side drop away from rails with internal pressure shown in Figure A.7-7.

Figures A.7-8 and A.7-9 present the limiting weld stress intensities for the FF and FC Canisters. The limiting weld stress for the FF and FC Canisters for the Outer Top Cover Plate (Figure A.7-9) and the limiting weld stress for FF and FC Canisters for the Internal top cover plate (Figure A.7-8) is based on the side drop away-from-cask rails with internal pressure evaluation. For all analyzed load combinations, the worst-case stress results for each component of the DSC shell assembly along with the weld stresses are summarized in Table A.7-4.

The maximum component stress ratio is equal to 0.88 and occurs in the Cylindrical Shell for Side Drop away from the cask rails.

Results from the FC- and FF-DSCs structural analysis are acceptable for the loads and combinations described in Section A.7.7.1.5 and hence structurally adequate for normal conditions of transport loading conditions.

A.7.7.2 Structural Analysis of MP187 FO- and 24PT1 DSCs (Transport Configuration)

A.7.7.2.1 Assumptions

1. Smaller components of the DSC, such as the siphon and vent block, keyways, and tapped holes in the shield plugs and in the inner top and bottom cover plates are not modeled due to negligible impact on the stiffness of the assembly and stresses.

2. The primary stresses evaluation assumes a uniform 400 °F temperature for all material components which conservatively bounds the actual temperatures, per reference [A.7-19].

3. Thermal Stress evaluation is not evaluated separately and the stress results presented in reference [A.7-19] are also applicable for this calculation.

4. The guide sleeve evaluation performed in references [A.7-18] and [A.7-19] is still applicable for this calculation.

5. Other assumptions pertaining to specific sections have been provided as and when required.

6. Enveloping DSC internal weight = 52,580 lbs per reference [A.7-14] is considered for the evaluation.

7. The NCT drop loads (25g) bound vibration loads which are on the order of a factor of 5 lower.

A.7.7.2.2 Material Properties

Material properties are based on reference [A.7-11] for the material at 400 °F. Tables A.7-12 and A.7-13 provide properties for ASTM A-240 Type 316 and SA-36, respectively. Table A.7-7 provides a summary of the stress criteria used to determine stress allowables for pressure boundary components including the DSC shell and cover plates, while Table A.7-8 gives allowable weld stresses for pressure boundary partial penetration welds in the FO- and 24PT1 DSCs.

A.7.7.2.3 Design Criteria

Structural design criteria for the FO-DSC is based on ASME B&PV Code, Section III, Division 1, Subsection NB, 1992, including 1993 addenda and Appendix F. Structural design criteria for the 24PT1 DSC is based on ASME B&PV Code, Section III, Division 1, Subsection NB, 1992, including 1994 addenda and Appendix F. For the purposes of the evaluation of the DSC shells for Normal Conditions of Transport, the information taken from the 1992 and either addenda are identical, therefore only the N 1992, including 1993 addenda code years are referenced throughout this evaluation.

A.7.7.2.4 Methodology

A single Finite Element Model (FEM) is used for analyzing both FO- and 24PT1 DSCs with enveloping dimensions and loads. The DSC shell assembly is analyzed for the postulated load conditions using a three-dimensional (3D) 180° half-symmetric FEM. The FEM is developed using the nominal dimensions from Table A.7-10.The most limiting dimensional properties between the FO and 24PT1 DSCs were modeled using reference [A.7-17]. Table A.7-10 and references [A.7-15] and [A.7-21] provide the different dimensions of the DSCs along with the model dimensions used.

The resulting stresses in the DSC structural components are compared with the allowable stresses set forth by ASME B&PV Code, Section III, Subsection NB [A.7-11] for normal (Level A) conditions.

The stress due to each load is differentiated by the type of stress induced, e.g. membrane, bending, etc., and the classification of stress, e.g. primary, etc. In some locations, stresses are also differentiated based upon their proximity to a gross structural discontinuity, boundary condition, or their proximity to the confinement boundary.

There are two welds in the DSC confinement boundary. The first joins the DSC shell and the OTCP and the second joins the ITCP with the DSC shell. An allowable load/stress reduction factor of 0.6 (joint efficiency factor is used for the weld evaluation in this calculation. The allowable weld stresses are listed in Table A.7-8.

A.7.7.2.5 Design and Input Loads & Data

The following represent design and input loads for the FO- and 24PT1 DSCs:

A.7.7.2.5.1 Vertical Drop

Load Combinations for the Canisters include Vertical drops. Three load cases are performed for bottom end, top, and side drop.

In addition to pressure representing the payload inertia load, conservative internal pressure of 10.5 psig or external pressure of 8 psig are added

A.7.7.2.5.1.1 Bottom End Drop

Three load cases are performed for bottom end drop:

1. Bottom end drop
2. Bottom end drop with internal pressure (10.5 psi)
3. Bottom end drop with external pressure (8 psi)

A.7.7.2.5.1.2 Top End Drop

Three load cases are performed for top end drop:

1. Top end drop
2. Top end drop with internal pressure (10.5 psi)
3. Top end drop with external pressure (8 psi)

A.7.7.2.5.2 Side Drop on Cask Rails

Three load cases are analyzed for the side drop onto the cask rail:

1. Side drop onto the cask rail
2. Side drop onto the cask rail with internal pressure (10.5 psi)

3. Side drop onto the cask rail with external pressure (8 psi)

For side drop load cases onto the cask rail, inertia loads for canister internals is accounted for by applying equivalent pressure onto the rail only. The total load on rail is calculated as shown below:

Width of Rail w = 4 in [A.7-20]

Cavity Length, l = 160 in

Total weight of canister internal to be used W = 52,580 lb (For 360° Model)

Area of rail over which uniform pressure is applied = 4 in * 160 in = 640 in^2

Uniform pressure over the rail P = W / (2*640) = 41.078 psi.

P= 41.078 x 25g = 1026.95 psi [For NCT at 25g]

A.7.7.2.5.3 Side Drop Away from Cask Rails

Three load cases are analyzed for side drop away from the cask rail

1. Side drop away from the cask rail

2. Side drop away from the cask rail with internal pressure (10.5 psi)

3. Side drop away from the cask rail with external pressure (8 psi)

For side drop load cases away from transfer cask rails, inertia loads for canister internals is accounted for by applying a cosine varying pressure on the inside surface of the canister shell. Assuming that the canister internals react upon 90° arc of the inside surface, then the inertial load of the internals, P(θ), which varies with angle, θ, (θ = 0 is at the impact point), is governed by the following expression:

$$P_{(\theta)} = P_{max} \cos(2\theta) \quad (0° < \theta < 45°)$$

Where P_{max} is the maximum pressure at the impact point (θ = 0). Assuming the axial length of the applied load is L, the inside radius of the canister shell is R, and the load distribution, P(θ) above, then the total inertial load generated by the internals, F, is the following:

$$F = \int_{\frac{-\pi}{4}}^{\frac{\pi}{4}} P_{\max} \cos(2\theta)\cos(\theta) LR d\theta$$

$$\Rightarrow \quad F = \frac{P_{max} LR}{2} \int_{\frac{-\pi}{4}}^{\frac{\pi}{4}} [\cos((2+1)\theta) + \cos((2-1)\theta)] d\theta$$

By integrating the equation above we get the following.

$$F = \left[\frac{P_{max} LR}{2}\right]\left[\frac{\sin(3\theta)}{3} + \sin(\theta)\right]\Bigg|_{\frac{-\pi}{4}}^{\frac{\pi}{4}}$$

Therefore,

$$F = \left[\frac{P_{max} LR}{2}\right]\left[\frac{\sin\left(\frac{3\pi}{4}\right)}{3} + \sin\left(\frac{\pi}{4}\right) - \frac{\sin\left(\frac{-3\pi}{4}\right)}{3} - \sin\left(\frac{-\pi}{4}\right)\right]$$

$$F = P_{max} LR\left[\frac{\sin\left(\frac{3\pi}{4}\right)}{3} + \sin\left(\frac{\pi}{4}\right)\right]$$

The canister shell inner radius, R = 32.97 in. The axial length of the applied load (basket length), L = 160 in.

Weight of canister internals (Basket Assembly + Fuel) for 24 PT1 Canister with long cavity is 52,580 lb. [A.7-14].

Side Drop NCT G Load = 25g.

F = 52,580 × 25g = 1,314,500 [for NCT]

Therefore, P_{max} for Normal Condition of Transport (NCT) is:

$$P_{max} = \frac{1314500}{(160)(32.97)}\left[\frac{\sin\left(\frac{3\pi}{4}\right)}{3} + \sin\left(\frac{\pi}{4}\right)\right]^{-1} = 264.26 \text{ psi}$$

The equivalent pressure applied on the canister inside shell surface for load cases away from transfer cask rails is:

$$P_{(\theta)} = 264.26 \cos(2\theta)$$

θ = angle from the bottom (θ = 0) of the horizontal canister shell to the center of the shell element, up to 45°.

A.7.7.2.5.4 Load Combinations

A summary of load combinations examined for NCT conditions for the FO- and 24PT1 DSCs is presented in Table A.7-3.

A.7.7.2.6 Stress Evaluation Results

Table A.7-3, A.7-4, A.7-7, A.7-8, A.7-10 through A.7-13 and Figures A.7-10 through A.7-12 represent stress evaluations from the Vertical and Side Drop Cases for the FO and 24PT1 Canisters. Figure A.7-10 presents stress intensity plot for the FO and 24PT1 Canisters based on the most critical load case. For these canisters, the most critical load case for normal conditions of transport (NCT) is represented by the side drop away from rails with internal pressure shown in Figure A.7-10.

Figures A.7-11 and A.7-12 show that the limiting weld stress for FO- and 24PT1 DSCs is at the Outer top cover plate based on the side drop away-from-cask rails with internal pressure. The limiting weld stress for the FO- and 24PT1 DSCs for the Outer Top cover Plate is shown in Figure A.7-11 and the limiting weld stress for the FO- and 24PT1 DSCsfor the inner top cover plate is shown in Figure A.7-12. The limiting weld stress is based on side drop away-from –cask rails evaluation with internal pressure. . For all analyzed load combinations, stress results for each component of the DSC shell assembly along with the weld stresses are summarized in Table A.7-11.

The maximum component stress ratio is equal to 0.78 and occurs in the Cylindrical Shell for Side Drop away from rails. The maximum weld stress ratio is 0.96 for all conditions.

Result from the FO- and 24PT1 DSCs structural analysis are acceptable for the loads and combinations described in Table A.7-3 and hence structurally adequate for normal conditions of transport loading conditions.

A.7.8 Conclusions of the Structural Analysis

This appendix demonstrates that the HSM as described in Volume II of [A.7-4] and the HSM Model 80 as described in [A.7-3] have the same geometry and are based on the same design criteria; i.e. they are essentially identical.

Furthermore, the design requirements and environmental conditions that form the design basis upon which the MP187 cask, the canisters, and the HSM Model 80 were licensed by the NRC bound the design requirements and environmental conditions at the WCS CISF. Therefore, the HSM Model 80 as described in [A.7-3] is acceptable for storage of the canisters at the WCS CISF.

The structural performance of the MP187 cask with canisters (Conditions of Storage) at the WCS CISF, evaluated under normal, off-normal, and accident conditions of operation, satisfies all of the 10 CFR Part 72 stress limits and criteria.

Finally, the structural performance of the canister confinement boundaries were evaluated for Normal Conditions of Transport against ASME B&PV Code Subsection NB Article NB-3200 (Level A allowables) and were found to satisfy all of the stress limits and criteria demonstrating that the confinement boundaries are not adversely impacted by transportation of the canisters to the WCS CISF in the MP187 transport cask.

A.7.9 References

A.7-1 U.S. Nuclear Regulatory Commission, "License for Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste," License Number SNM-2510, Docket Number 72-11.

A.7-2 U.S. Nuclear Regulatory Commission, "Certificate of Compliance No. 9255, Revision 12 for the Model No. NUHOMS®-MP187 Multi-Purpose Cask (Docket 71-9255).

A.7-3 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).

A.7-4 "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report," NRC Docket No. 72-11, Revision 4.

A.7-5 Appendix B to "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report," NRC Docket No. 72-11, Revision 4.

A.7-6 U.S. Nuclear Regulatory Commission, "Certificate of Compliance for Spent Fuel Storage Casks," Certificate No. 1004, Docket 72-1004, Amendment 13 for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel.

A.7-7 TN Document NUH-05-151 Rev. 17, "NUHOMS®-MP187 Multi-Purpose Transportation Package Safety Analysis Report." (Basis for NRC CoC 71-9255).

A.7-8 Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Revision 1, March 2007.

A.7-9 ANSYS Computer Code and User's Manual, Version 14.

A.7-10 Not Used.

A.7-11 ASME B&PV Code, Section III, Division 1, Subsection NB, 1992, including 1993 Addenda.

A.7-12 TN Document 2069.0201, Revision 0, "NUHOMS®-MP187 FC-DSC 10CFR72 Structural Analysis."

A.7-13 TN Document 2069.0205, Revision 0, "NUHOMS®-MP187 FF-DSC 10CFR72 Structural Analysis."

A.7-14 TN Document NUH005.0350, Revision 8, "Rancho Seco NUHOMS(R) Mass Properties Calculation."

A.7-15 TN Document NUH-05-4004, Revision 16, "NUHOMS FO-DSC and FC-DSC for PWR Fuel Main Assembly."

A.7-16 TN Document NUH-05-4005, Revision 14, "NUHOMS FF-DSC for PWR Fuel Main Assembly."

A.7-17 ANSYS Computer Code and Users Manual, Release 14.0.

A.7-18 TN Document, ANUH-01.0150, Revision 6, "Updated Final Safety Analysis Report for the Standardized Advanced NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel, NRC Docket No. 72-1029.

A.7-19 TN Document 2069.0200, Revision 0, "NUHOMS®-MP187 FO-DSC 10CFR72 Structural Analysis."

A.7-20 TN Document NUH-05-4001, Revision 15, "NUHOMS MP-187 Multi-purpose Cask Main Assembly."

A.7-21 TN Document NUH-05-4010, Revision 5, "General License NUHOMS® 24PT1-DSC Main Assembly."

Table A.7-1
Summary of FC and FF DSC Dimensions

	FC	FF	ANSYS Model
Outer Top Cover Plate (in)	1.25	1.25	1.25
Inner Top Cover Plate (in)	0.75	0.75	0.75
Top Shield Plug Assembly (in)	5.13	5.00	5.00
Inner Bottom Cover Plate (in)	0.75	0.75	0.75
Bottom Shield Plug Assembly (in)	5.25	5.25	5.25
DSC Shell Outer Diameter (in)	67.19	67.19	67.19
DSC Shell Thickness (in)	0.63	0.63	0.63
Total Length (except grapple ring) (in)	186.2	186.5	186.2
Basket + Spent fuel assemblies weight (kips)	58.31	52.10	60.00

Table A.7-2
Summary of FO, 61BT, and 61BTH Type 1 Dimensions

	FO	61BT	61BTH Type 1	ANSYS Model
Outer Top Cover Plate (in)	1.25	1.25	1.25	1.25
Inner Top Cover Plate (in)	0.75	0.75	0.75	0.75
Top Shield Plug (in)	8.25	7.00	7.00	7.00
Inner Bottom Cover Plate (in)	0.75	0.75	1.69	0.75
Outer Bottom Cover Plate (in)	1.75	1.75	1.70	1.75
Bottom Shield Plug (in)	6.25	5.00	4.00	5.00
DSC Shell Outer Diameter (in)	67.19	67.25	67.25	67.25
DSC Shell Thickness (in)	0.63	0.5	0.5	0.5
Total Length (except grapple ring) (in)	186.2	196.04	196.04	196.04
Basket + Spent fuel assemblies weight (kips)	55.20	65.9	66.4	70.00

Table A.7-3
Load Cases for End/Side Drop Normal Condition of Transport (NCT)

Load Case Number	Loading Condition	Service Level	Case Description
1	25g Lateral Load (Side Drop Away From Rails)	A	Horizontal cask, supported on side, 25g transverse acceleration. Impact away from transport cask rails.
2	25g Lateral Load + 8psi Internal Pressure (Side Drop Away From Rails with Internal Pressure)	A	Horizontal cask, supported on side, 25g transverse acceleration + 8 psi Internal Pressure. Impact away from transport cask rails.
3	25g Lateral Load + 8psi External Pressure (Side Drop Away From Rails with External Pressure)	A	Horizontal cask supported on side, 25g transverse acceleration + 8 psi External Pressure. Impact away from transport cask rails.
4	25g Lateral Load (Side Drop on Rails)	A	Horizontal cask, supported on side, 25g transverse acceleration. Impact onto the cask rails.
5	25g Lateral Load + 8psi Internal Pressure (Side Drop on Rails with Internal Pressure)	A	Horizontal cask supported on side, 25g transverse acceleration + 8 psi Internal Pressure. Impact onto the cask rails.
6	25g Lateral Load + 8psi External Pressure (Side Drop on Rails with External Pressure)	A	Horizontal cask supported on side, 25g transverse acceleration + 8 psi External Pressure. Impact onto the cask rails.
7	30g Vertical Load on Top End (Top End Drop)	A	Vertical cask, supported on top end, 30g axial acceleration. Impact onto the OTCP
8	30g Vertical Load on Top End + 8psi Internal Pressure (Top End Drop with Internal Pressure)	A	Vertical cask supported on top end, 30g axial acceleration + 8 psi Internal Pressure. Impact onto the OTCP
9	30g Vertical Load on Top End + 8psi External Pressure (Top End Drop with External Pressure)	A	Vertical cask supported on top end, 30g axial acceleration + 8 psi External Pressure. Impact onto the OTCP
10	30g Vertical Load on Bottom End (Bottom End Drop)	A	Vertical cask, supported on top end, 30g axial acceleration. Impact onto the BSP Assembly
11	30g Vertical Load on Bottom End + 8psi Internal Pressure (Bottom End Drop with Internal Pressure)	A	Vertical cask supported on top end, 30g axial acceleration + 8 psi Internal Pressure. Impact onto the BSP Assembly
12	30g Vertical Load on Bottom End + 8psi External Pressure (Bottom End Drop with External Pressure)	A	Vertical cask supported on top end, 30g axial acceleration + 8 psi External Pressure. Impact onto the BSP Assembly

Table A.7-4
Stress Results FC- and FF-DSC – Stress Results Summary

Part. No	Component	Stress Category	BED (ksi)	TED (ksi)	SD (ksi)	Allowable Stress (ksi)	Max Stress Ratio
1	Cylindrical Shell	Pm	5.07	4.40	13.60	18.60	0.73
		PL + Pb	9.17	9.71	24.68	27.90	0.88
2	Outer Top Cover Plate	Pm	0.59	1.08	7.97	18.60	0.43
		PL + Pb	2.05	1.15	11.14	27.90	0.40
3	Inner Top Cover Plate	Pm	1.71	1.78	8.52	18.60	0.46
		PL + Pb	2.30	2.30	10.32	27.90	0.37
4	Inner Bottom Cover Plate	Pm	7.47	2.30	10.49	18.60	0.56
		PL + Pb	8.76	3.65	18.70	27.90	0.67
5	Cylindrical Shell - OTCP Weld	PL	3.01	1.16	15.70	16.74	0.94
		PL (Impact Zone)			19.95	33.48	0.60
6	Cylindrical Shell - ITCP Weld	PL	3.40	2.79	12.37	16.74	0.74
		PL (Impact Zone)			18.19	33.48	0.54

Table A.7-5
SA-240-304 Steel (18CR-8Ni) Material Properties

Temp. (°F)	E Modulus of Elasticity (ksi)	S_m Allow. Stress Intensity (ksi)	S_y Yield Stress (ksi)	S_u Ultimate Tensile Strength (ksi)	α_{AVG} Coeff. of Thermal Expansion (x 10^{-6} °F^{-1})
70	28,300	20.0	30.0	75.0	8.5
100	----	20.0	30.0	75.0	8.6
200	27,600	20.0	25.0	71.0	8.9
300	27,000	20.0	22.4	66.2	9.2
400	26,500	18.6	20.7	64.0	9.5
500	25,800	17.5	19.4	63.4	9.7
600	25,300	16.6	18.4	63.4	9.8
700	24,800	15.8	17.6	63.4	10.0

Table A.7-6
SA-36 Carbon Steel Material Properties

Temp. (°F)	E Modulus of Elasticity (ksi)	S_m Allow. Stress Intensity (ksi)	S_y Yield Stress (ksi)	S_u Ultimate Tensile Strength (ksi)	α_{AVG} Coeff. of Thermal Expansion (x 10^{-6} °F^{-1})
-100	30,200	----	----	----	----
-20	----	19.3	36.0	58.0	----
70	29,400	19.3	36.0	58.0	6.4
100	----	19.3	36.0	58.0	6.5
200	28,800	19.3	33.0	58.0	6.7
300	28,300	19.3	31.8	58.0	6.9
400	27,900	19.3	30.8	58.0	7.1
500	27,300	19.3	29.3	58.0	7.3
600	26,500	18.4	27.6	53.3	7.4
700	25,500	17.3	25.8	53.3	7.6

Table A.7-7
Summary of Stress Criteria for Subsection NB Pressure Boundary Components
DSC Shell and Cover Plates

Service Level	Stress Category	References	Notes
Design [NB-3221]	$P_m \leq 1.0 S_m$ $P_L \leq 1.5 S_m$ $P_m (or\ P_L) + P_b \leq 1.5 S_m$ $F_p \leq 1.0 S_y\ or\ 1.5 S_y$ $\sigma_1 + \sigma_2 + \sigma_3 \leq 4 S_m$ External Pressure: NB-3133	NB-3221.1, NB-3221.2, NB-3221.3, NB-3227.1 and NB-3227.4	Note 2
Level A [NB-3222]	$P_m \leq 1.0 S_m$ $P_L \leq 1.5 S_m$ $P_m (or\ P_L) + P_b \leq 1.5 S_m$ $P_m (or\ P_L) + P_b + Q \leq 3.0 S_m$ $F_p \leq 1.0 S_y\ or\ 1.5 S_y$ $\sigma_1 + \sigma_2 + \sigma_3 \leq 4 S_m$ External Pressure: NB-3133	NB-3222, NB-3227.1, & NB-3227.4	Notes 1 & 2

Notes:

1. The Level A limit of NB-3222.2 may be exceeded provided the criteria of NB-3228.5 are satisfied.
2. There are no specific limits on primary stresses for Level A events. However, the stresses due to primary loads during normal service must be computed and combined with the effects of other loadings in satisfying other limits. See NB-3222.1. The Code Design limits on primary stresses shall be used for Service Level A.

Table A.7-8
Allowable Weld Stresses for Pressure Boundary Partial Penetration Welds, Material Type 304

<table>
<tr><th>Service Level</th><th>Stress Region / Category</th><th>Stress Criteria</th><th>Allowable Stress Value at 400 °F (ksi)</th></tr>
<tr><td colspan="4">Pressure Boundary Partial Penetration Welds</td></tr>
<tr><td rowspan="2">Level A / Level B</td><td>Weld Stress away from Impact Zone</td><td>0.6 [1.5 Sm]</td><td>16.83</td></tr>
<tr><td>Weld Stress in local area near Impact Zone</td><td>0.6 [3 Sm]</td><td>33.66</td></tr>
<tr><td colspan="4">Non-Pressure Boundary Partial Penetration and Fillet Welds</td></tr>
<tr><td>Service Level</td><td colspan="2">Allowable Stress</td><td>Basis</td></tr>
<tr><td>Level A</td><td colspan="2">F_w=0.30S_u (weld metal)
F_w=0.40S_y (base metal)</td><td>Table NF-3324.5(a)-1</td></tr>
</table>

Table A.7-9
SA-240 Type 304 - Stress Allowables

Temp (^oF)	S_m (ksi)	S_y (ksi)	S_u (ksi)	Level A/B		
				P_m	$P_m + P_b$	$P_m + P_b + Q$
70	20.0	30.0	75.0	20.0	30.0	60.0
200	20.0	25.0	71.0	20.0	30.0	60.0
300	20.0	22.4	66.2	20.0	30.0	60.0
400	18.6	20.7	64.0	18.7	27.9	55.8
500	17.5	19.4	63.4	17.5	26.25	52.5
600	16.6	18.4	63.4	16.4	24.9	49.8
700	15.8	17.6	63.4	16.0	23.7	47.4

Table A.7-10
Summary of FO- and 24PT1 DSC Dimensions

	FO	24PT1	ANSYS Model
Outer Top Cover Plate (in)	1.25	1.37	1.25
Inner Top Cover Plate (in)	0.75	1.24	0.75
Top Shield Plug (in)	8.00	7.55	7.61
Outer Bottom Cover Plate (in)	1.75	1.87	1.75
Inner Bottom Cover Plate (in)	0.75	1.63	0.75
Bottom Shield Plug (in)	6.25	5.17	5.29
DSC Shell Outer Diameter (in)	67.19	67.19	67.19
Cylindrical Shell Thickness (in)	0.625	0.61	0.625
Total Length (except grapple ring) (in)	186.17	186.40	186.40

Table A.7-11
Stress Results FO- and 24PT1 DSCs – Stress Results Summary

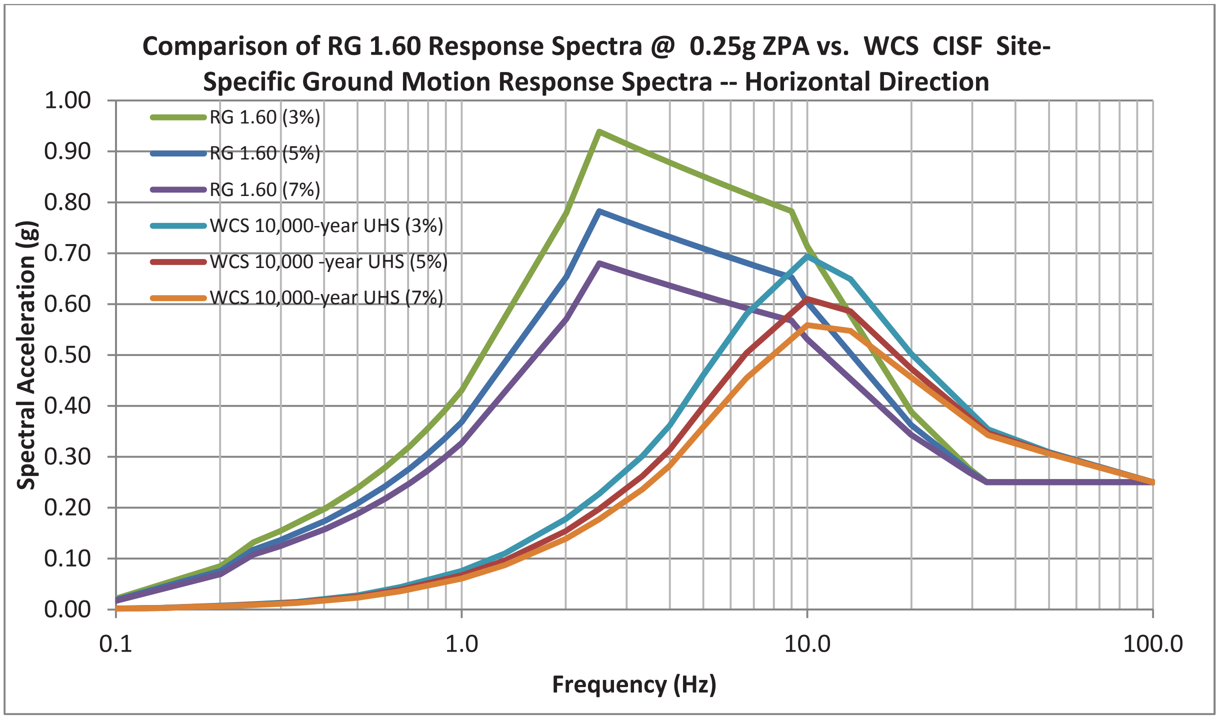
Sl. No	Component	Stress Category	BED (ksi)	TED (ksi)	SD (ksi)	Allowable Stress (ksi)	Max Stress Ratio
1	Cylindrical Shell	Pm	4.10	4.04	13.09	19.3	0.68
		PL	NA	NA	19.83	28.95	0.68
		Pm + Pb	6.53	10.78	22.05	28.95	0.76
2	Outer Top Cover Plate	Pm	0.15	0.68	7.81	19.3	0.40
		Pm + Pb	0.49	0.69	12.79	28.95	0.44
3	Inner Top Cover Plate	Pm	0.18	0.72	8.32	19.3	0.43
		Pm + Pb	0.42	0.72	11.27	28.95	0.39
4	Outer Bottom Cover Plate	Pm	2.16	0.31	8.52	19.3	0.44
		Pm + Pb	2.63	1.32	14.46	28.95	0.50
5	Inner Bottom Cover Plate	Pm	0.78	1.37	14.39	19.3	0.75
		Pm + Pb	1.99	8.57	15.98	28.95	0.55
6	Grapple Support Plate	Pm	0.57	0.79	1.18	19.3	0.06
		Pm + Pb	1.31	1.79	1.90	28.95	0.07
7	Grapple Ring	Pm	0.07	0.10	1.27	19.3	0.07
		Pm + Pb	0.17	0.26	1.40	28.95	0.05
8	Support Ring	Pm	2.43	1.98	12.79	19.3	0.66
		Pm + Pb	4.20	3.57	22.63	28.95	0.78
9	Cylindrical Shell - OTCP Weld	PL (Away Impact Zone)	0.26	1.10	16.63	17.37	0.96
		PL (Near Impact Zone)	NA	NA	21.13	34.74	0.61
10	Cylindrical Shell - ITCP Weld	PL (Away Impact Zone)	0.94	0.63	11.53	17.37	0.66
		PL (Near Impact Zone)	NA	NA	18.15	34.74	0.52
11	Cylindrical Shell - OBCP Weld	PL (Away Impact Zone)	1.33	0.73	8.07	17.37	0.46
		PL (Near Impact Zone)	NA	NA	14.49	34.74	0.42
12	Cylindrical Shell - Support Ring Weld	PL	4.74	3.98	12.86	17.37	0.74

Table A.7-12
SA-240/ SA-479/ ASTM A-240 Type 316 Steel (18Cr-8Ni) Material Properties

Temp. (°F)	E Modulus of Elasticity (ksi)	S_m Allow. Stress Intensity (ksi)	S_y Yield Stress (ksi)	S_u Ultimate Tensile Strength (ksi)	α_{AVG} Coeff. of Thermal Expansion (x 10^{-6} °F^{-1})
-100	29,100	----	----	----	----
-20	----	20.0	30.0	75.0	----
70	28,300	----	----	----	----
100	----	20.0	30.0	75.0	8.54
200	27,600	20.0	25.8	75.0	8.76
300	27,000	20.0	23.3	73.4	8.97
400	26,500	19.3	21.4	71.8	9.21
500	25,800	18.0	19.9	71.8	9.42
600	25,300	17.0	18.8	71.8	9.60
700	24,800	16.3	18.1	71.8	9.76

Table A.7-13
SA-36 Carbon Steel Material Properties

Temp. (°F)	E Modulus of Elasticity (ksi)	S_m Allow. Stress Intensity (ksi)	S_y Yield Stress (ksi)	S_u Ultimate Tensile Strength (ksi)	α_{AVG} Coeff. of Thermal Expansion ($x\ 10^{-6}\ °F^{-1}$)
-100	30,200	----	----	----	----
-20	----	19.3	36.0	58.0	----
70	29,400	19.3	36.0	58.0	6.4
100	----	19.3	36.0	58.0	6.5
200	28,800	19.3	33.0	58.0	6.7
300	28,300	19.3	31.8	58.0	6.9
400	27,900	19.3	30.8	58.0	7.1
500	27,300	19.3	29.3	58.0	7.3
600	26,500	18.4	27.6	53.3	7.4
700	25,500	17.3	25.8	53.3	7.6



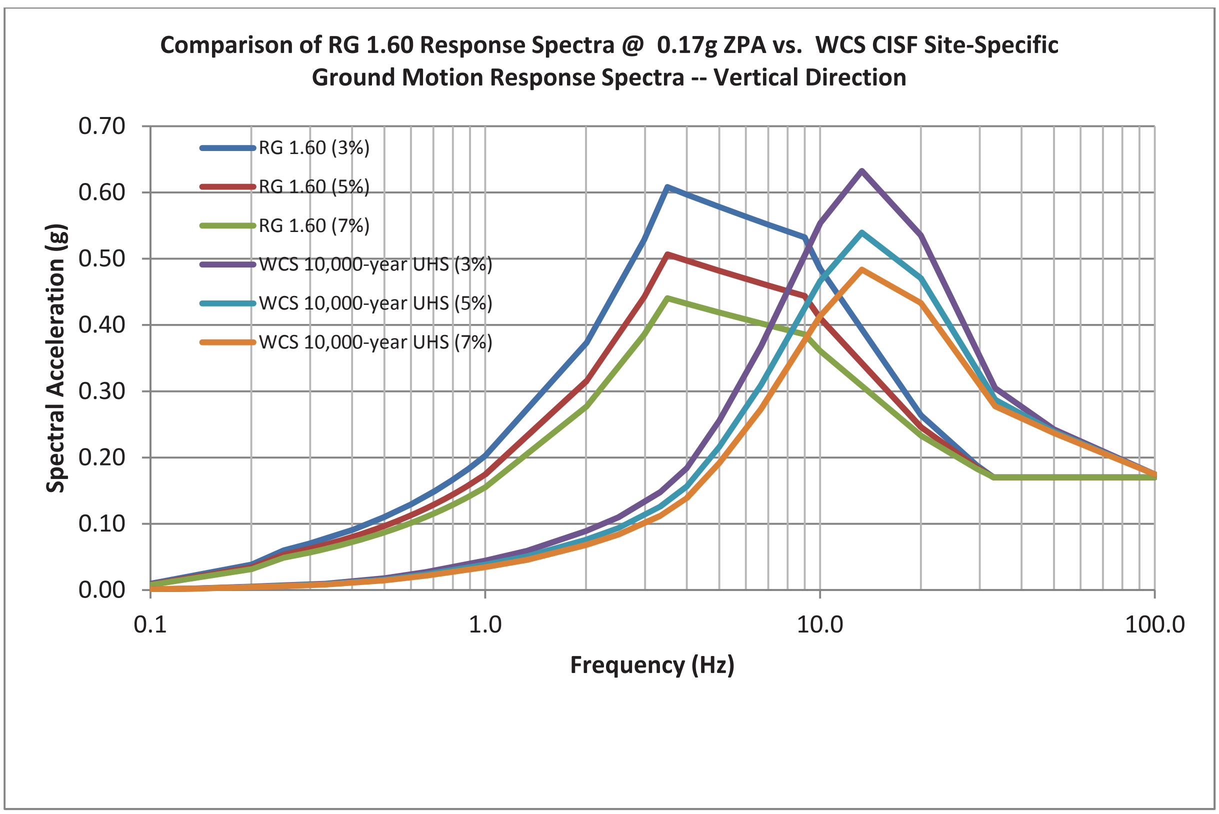


Figure A.7-1
Rancho Seco ISFSI FSAR and Standardized NUHOMS® UFSAR Design Basis Response Spectra (R.G. 1.60) vs. WCS CISF Site-Specific 10,000-year UHS

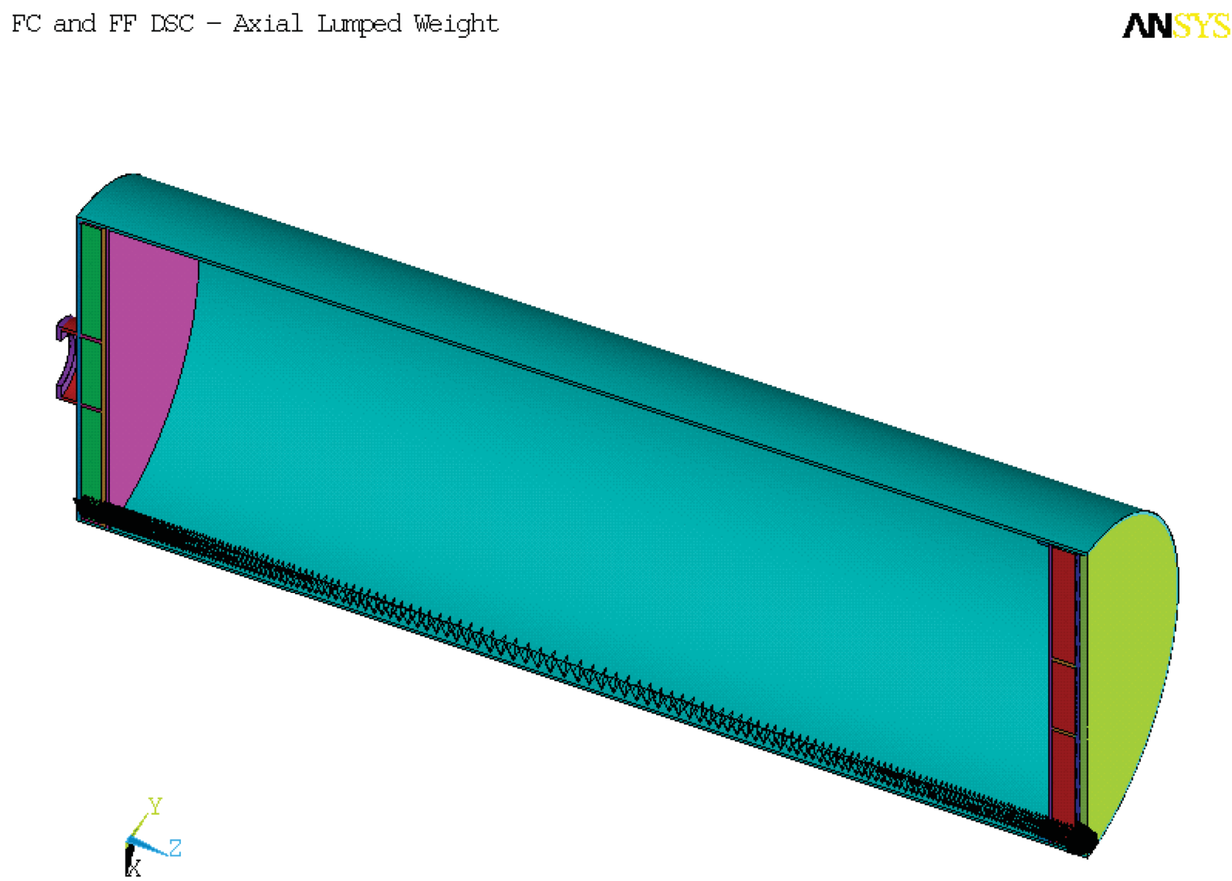


Figure A.7-2
DSC Models Boundary Conditions

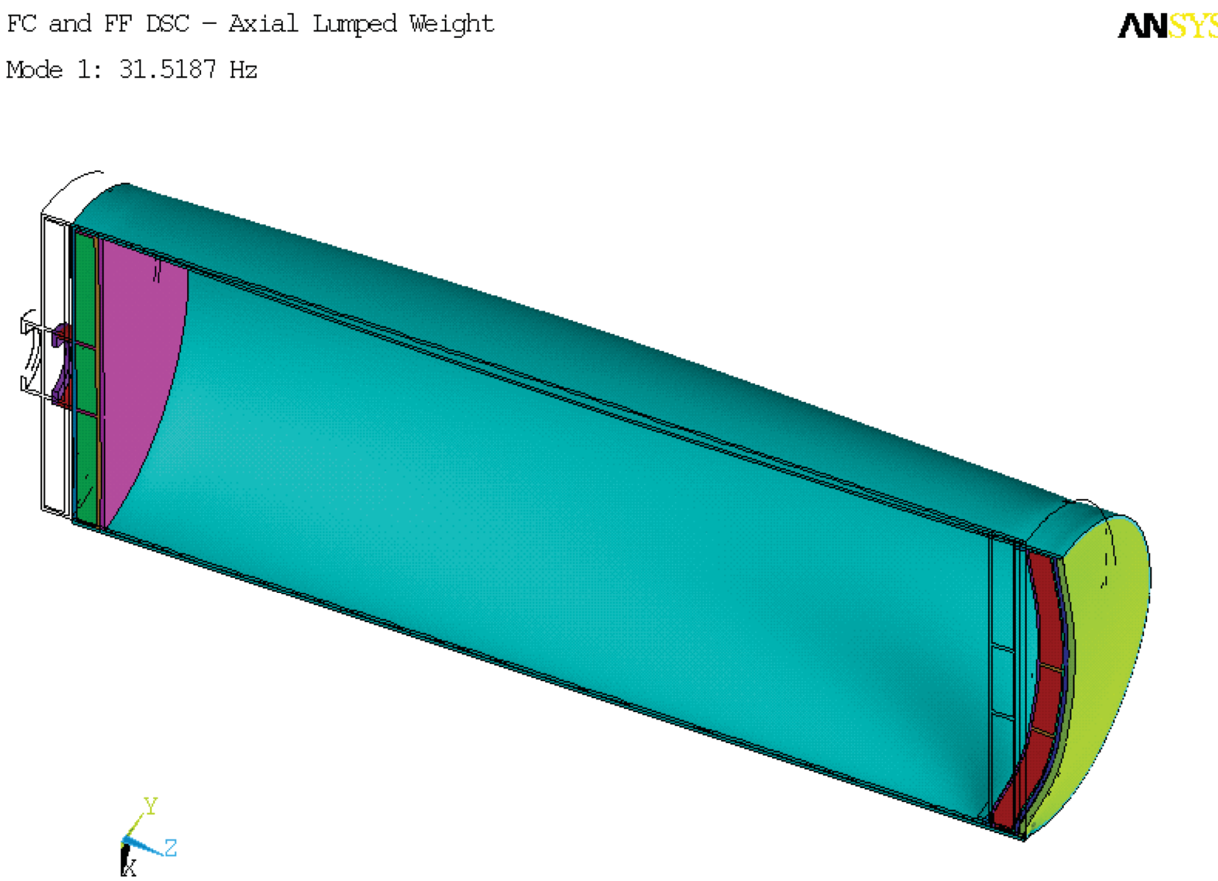


Figure A.7-3
FC and FF Axial Direction DSC Model – First Mode Shape

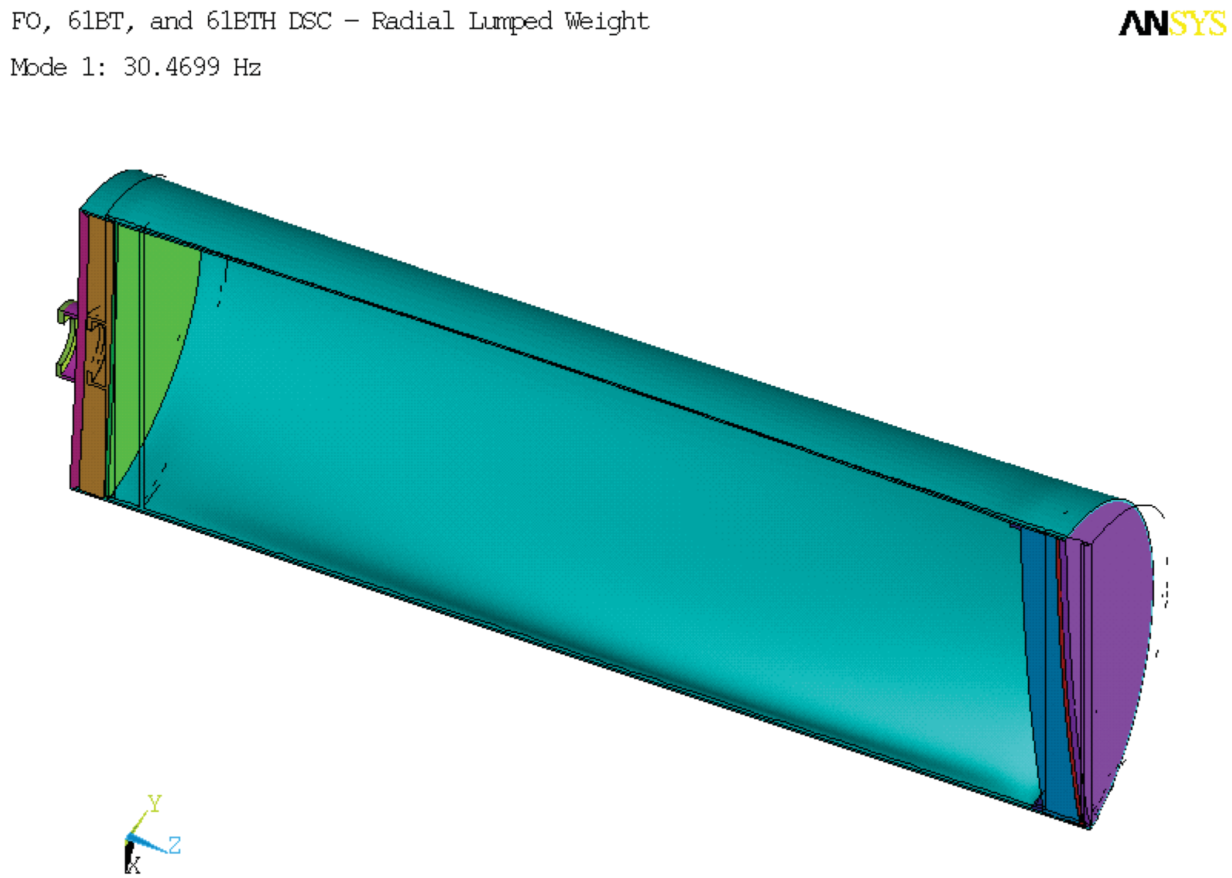


Figure A.7-4
FO, 61BT, and 61BTH Type 1 Radial Direction DSC Model – First Mode Shape

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Withheld Pursuant to 10 CFR 2.390

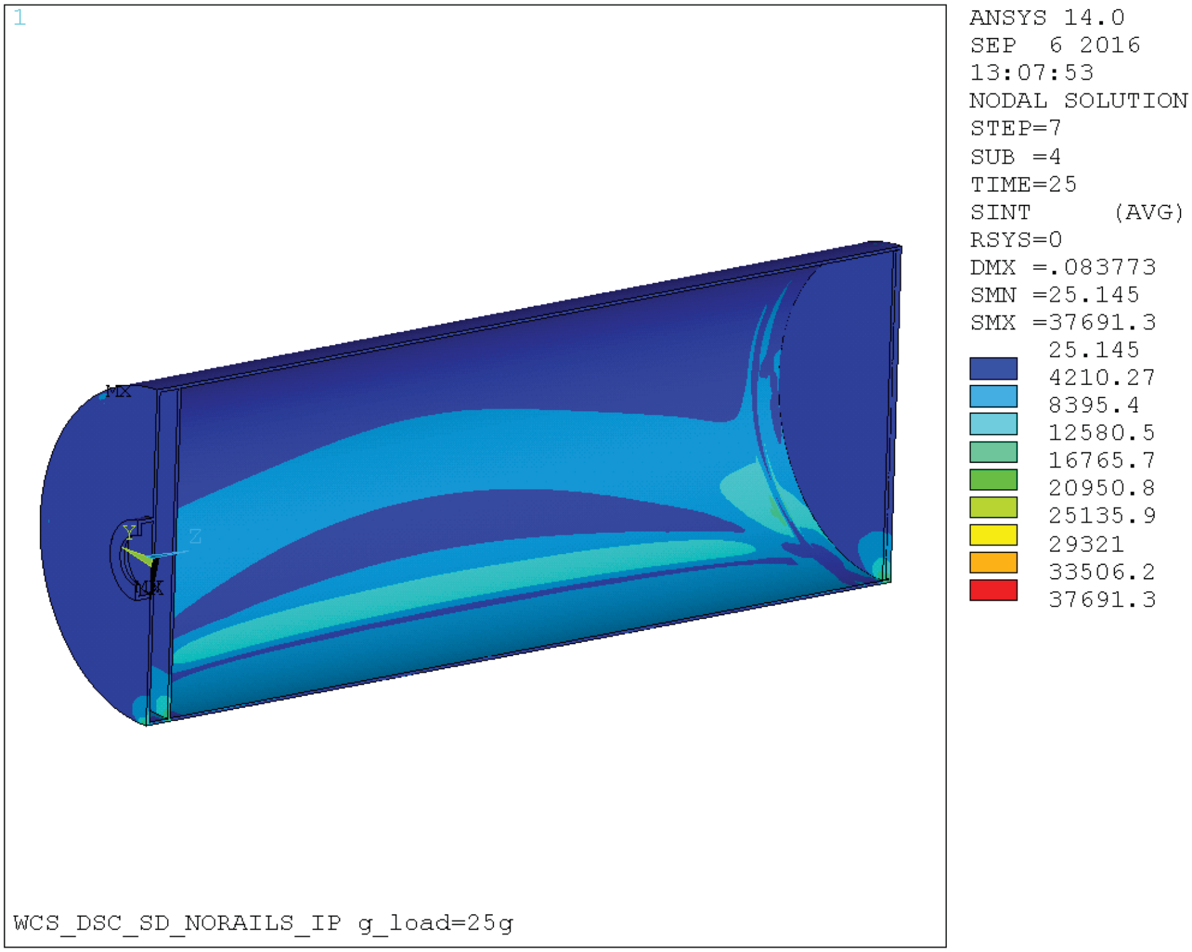

Figure A.7-7
Stress Intensity Plot for Most Critical Load Case (Side Drop Away from Rails with Internal Pressure) FC- and FF-DSCs

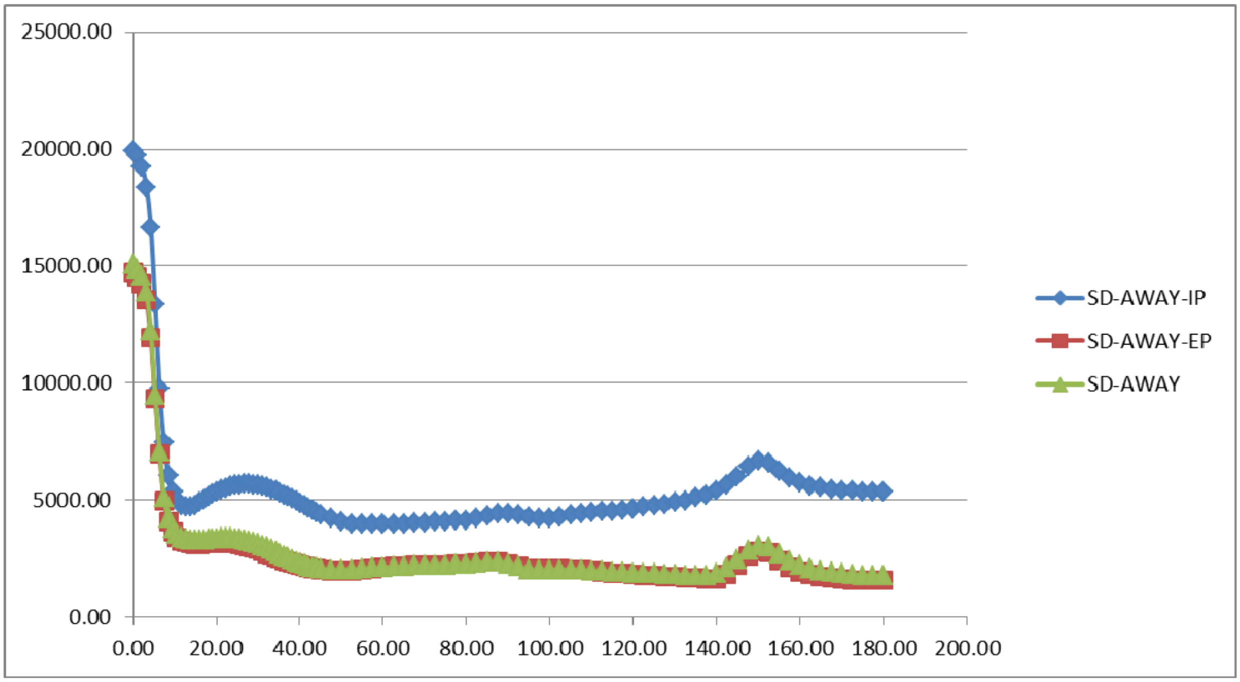

Figure A.7-8
Variation of OTCP – DSC Shell Weld Stress Intensity with Angle (θ) FC- ad FF-DSCs

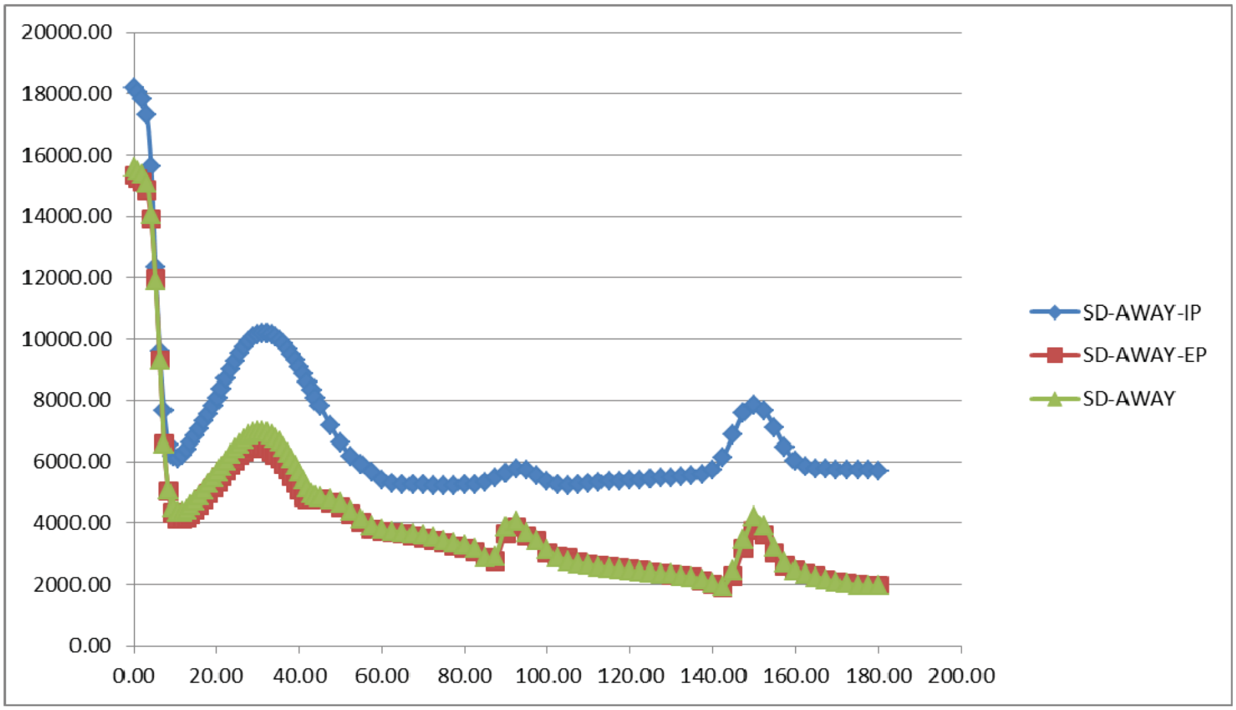

Figure A.7-9
Variation of ITCP – DSC Shell Weld Stress Intensity with Angle (θ) FC- ad FF-DSCs

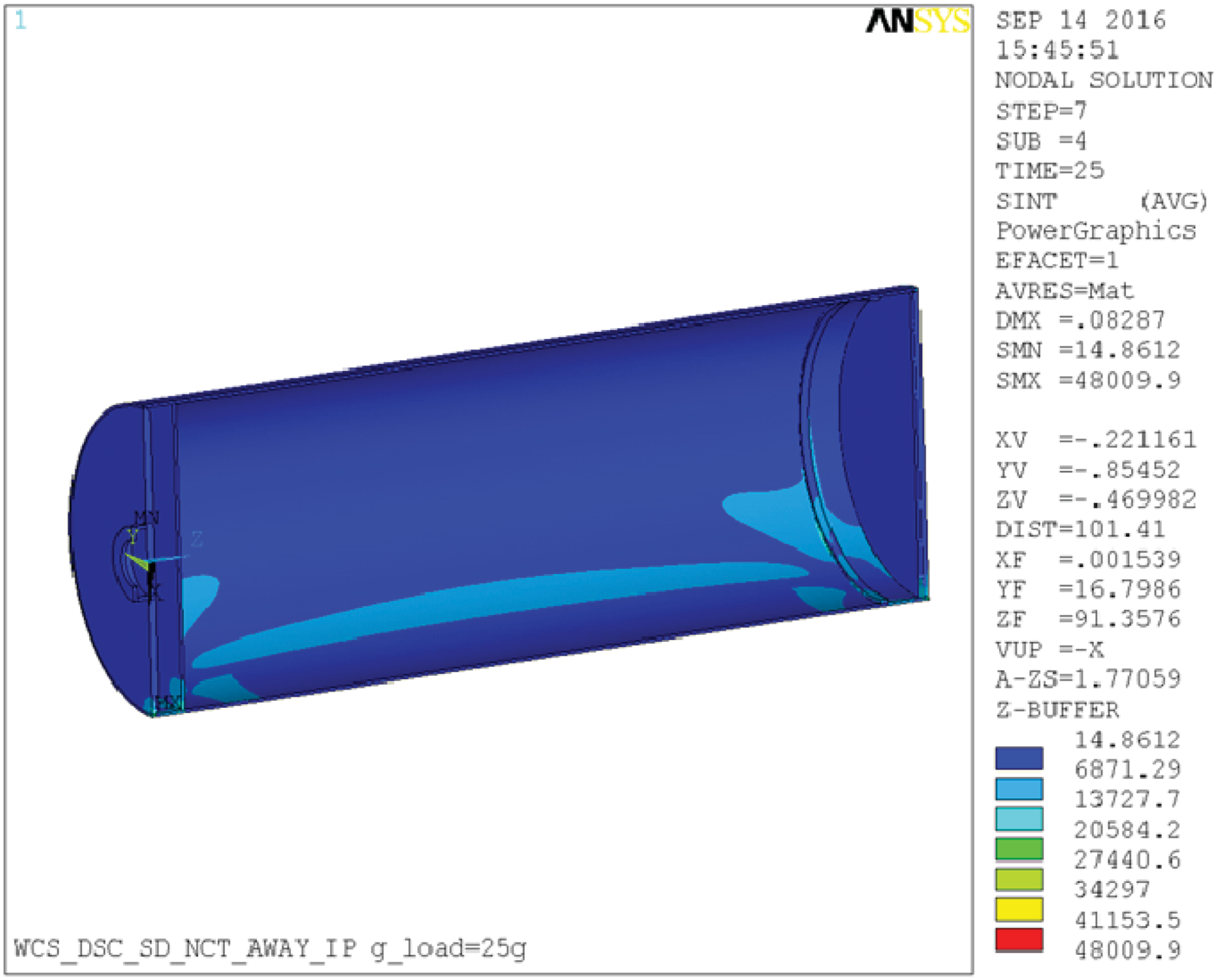

Figure A.7-10
Stress Intensity Plot for Most Critical Load Case (Side Drop Away from Rails with Internal Pressure) FO- and 24PT1 DSCs

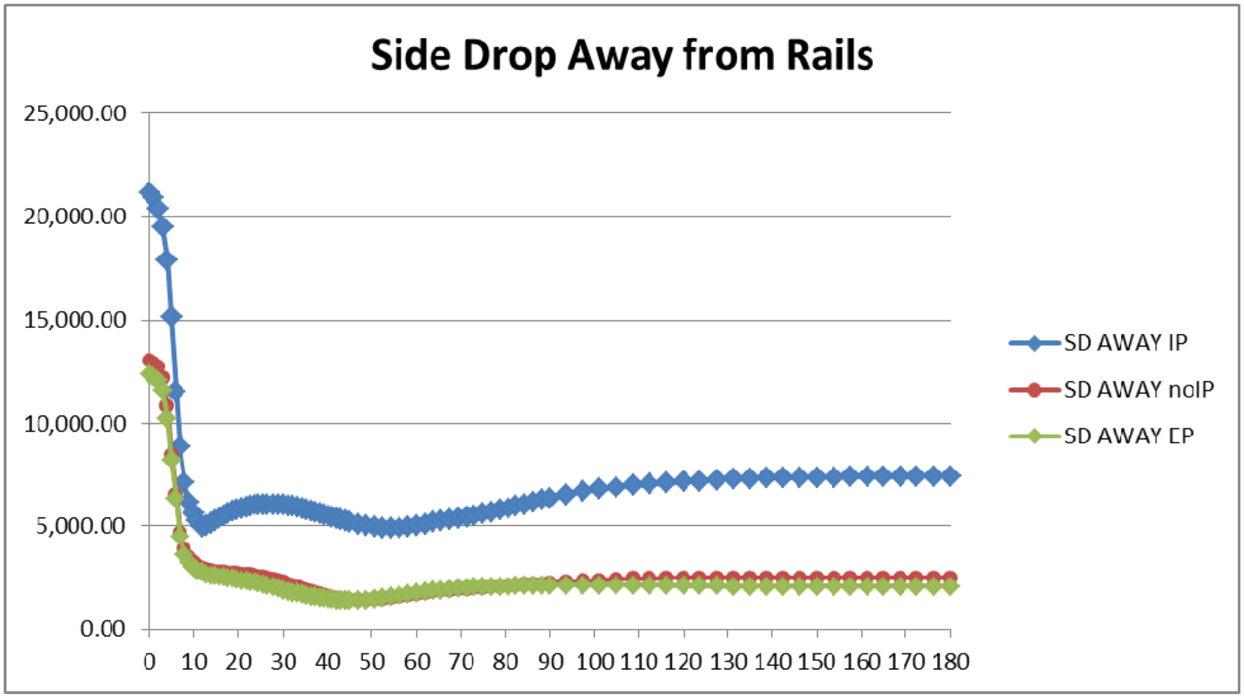

Figure A.7-11
Variation of OTCP – DSC Shell Weld Stress Intensity with Angle (θ) FO- and 24PT1 DSCs

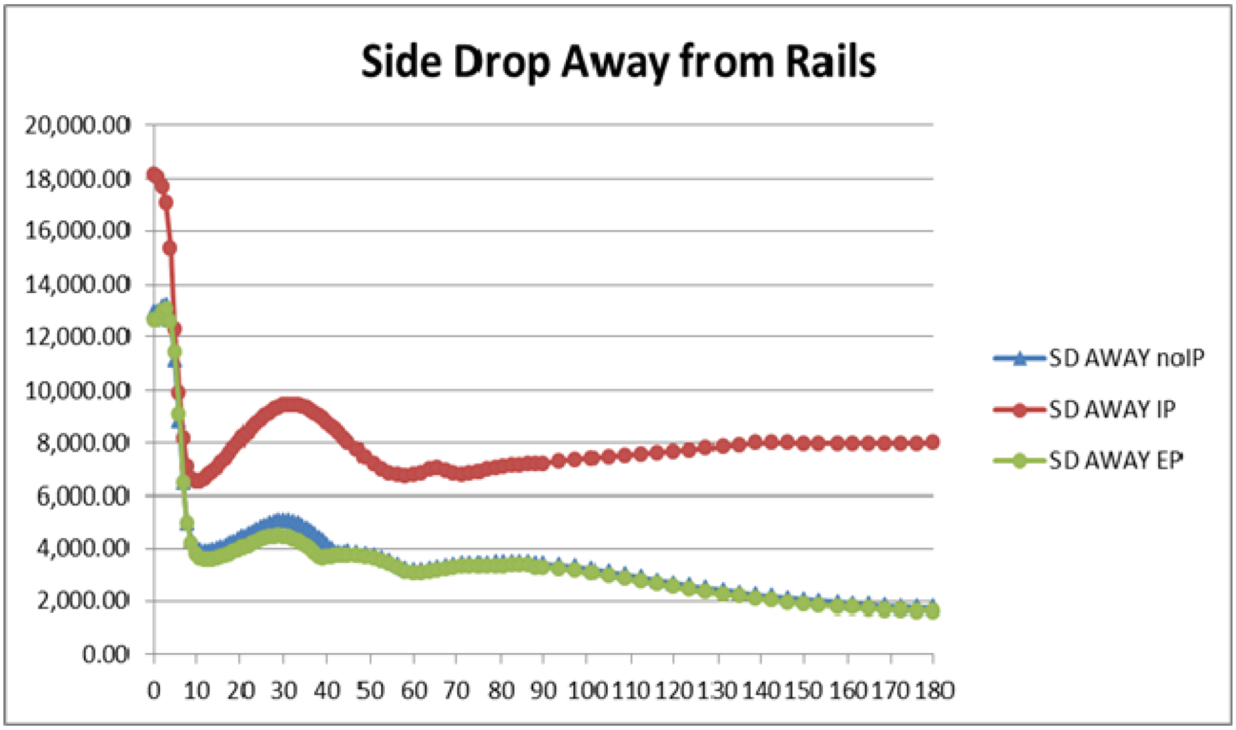

Figure A.7-12
Variation of ITCP – DSC Shell Weld Stress Intensity with Angle (θ) FO- and 24PT1 DSCs

APPENDIX A.8
THERMAL EVALUATION
NUHOMS®-MP187 Cask System

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A.8. THERMAL EVALUATION

This Appendix qualifies the NUHOMS®-MP187 Cask System for storage and transfer at the WCS Consolidated Interim Storage Facility (*WCS* CISF) with the same heat load of 13.5 kW under the WCS CISF environmental conditions. No new thermal analysis is performed in this Appendix. This qualification demonstrates that all the 10 CFR Part 72 thermal requirements for storage and transfer of the FO-, FC-, and FF-Dry Shielded Canisters (DSCs) (hereafter canisters) and GTCC canister at the WCS CISF are met.

A.8.1 Discussion

As discussed in Chapter 1, the canisters from the Rancho Seco Nuclear Generating Station Independent Spent Fuel Storage Installation (ISFSI) will be transported to the WCS CISF in the NUHOMS® MP187 Transportation Cask (MP187 cask) under NRC Certificate of Compliance 9255 [A.8-1]. At the WCS CISF, the canisters, described in Section 4.2.5.2, Volume I of the Rancho Seco SAR [A.8-3], are to be stored inside the HSM Model 80 described in Chapter 4 of the Standardized NUHOMS® UFSAR [A.8-2]. The use of the HSM Model 80 for storing the canisters is justified in Section A.8.4.1.

The canisters at the Rancho Seco site are licensed for storage in the Rancho Seco HSM modules and on-site transfer in the MP187 cask with a design basis heat load of 13.5 kW [A.8-3]. The thermal analysis for storage of the canisters is presented in Sections 8.1.1.2, Volume II of [A.8-3] while the thermal analysis for the transfer of these DSCs is presented in Section 8.1.1.1, Volume III of [A.8-3]. As documented in Section 3.1.1.2. of Appendix C of [A.8-3] the GTCC canister is bounded by the evaluations for the FO-. FC- and FF-DSCs; therefore, no additional discussion of the GTCC canister is required in this chapter.

This Appendix qualifies the canisters for storage in HSM Model 80s and transfer operations with the MP187 cask at the WCS CISF with the same heat load of 13.5 kW under the WCS CISF environmental conditions. No new thermal analysis is performed in this Appendix. This demonstrates that all the 10 CFR Part 72 thermal requirements for storage and transfer of the canisters at the WCS CISF are met.

A.8.2 Summary of Thermal Properties of Materials

The canister designs are based on the Standardized NUHOMS®-24P DSC design from [A.8-2] and as described in Section 1.2.2, Volume I of [A.8-3]. The material properties of the HSM Model 80 storage module and the 24P DSC are presented in Table 8.1-8 and Table 8.1-9 of [A.8-2].

The properties of the materials used in the thermal analysis of the MP187 cask are defined in Section 8.1.1.1, Volume III of [A.8-3].

A.8.3 Ambient Conditions at the WCS CISF

A.8.3.1 Ambient Temperature Specification at WCS CISF

As specified in Table 1-2 the 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.

A.8.3.2 Comparison of WCS CISF Ambient Conditions with Ambient Conditions Used in the Rancho Seco ISFSI FSAR [A.8-3]

A review of the thermal evaluation presented in Section 8.1.1.1, Volume II of [A.8-3] shows that average daily ambient temperatures of 101°F and 117°F are used for normal and off-normal hot storage conditions, respectively. These temperatures bound the temperatures for normal, off-normal conditions, and accident conditions at the WCS CISF. The lowest off-normal ambient temperature evaluated is the -20°F cold conditions considered in [A.8-3].

Based on this discussion, the ambient conditions used for the thermal evaluations for storage and transfer operations in [A.8-3] are bounding for the WCS CISF.

A.8.4 Thermal Analysis of HSM Model 80 with FO/FC/FF DSCs

A.8.4.1 Qualification of the HSM Model 80 for Storage of Canisters

As discussed in Section A.8.1, the canisters will be stored inside the HSM Model 80 at the WCS CISF and not in the Rancho Seco HSMs as licensed under site specific license [A.8-3].

However, a review of the thermal evaluation presented in Section 8.1.1, Volume II of [A.8-3] indicates that the Rancho Seco HSMs are similar to HSM Model 80. As described in Item 4 Section 8.1.1, Volume II of [A.8-3], the geometries and thermophysical properties of the materials used for the two HSMs are identical as it relates to the thermal performance. In addition, based on the discussion in Item 5 of Section 8.1.1, Volume II of [A.8-3], the thermal evaluation performed for the HSM Model 80 in [A.8-2] is bounding for the Rancho Seco HSM due to the lower maximum heat load of 13.5 kW versus the 24 kW analyzed in the for the HSM Model 80.

Based on the above discussion, the use of a HSM Model 80 in place of the Rancho Seco HSM will not alter the thermal performance. Therefore, the maximum temperatures for the canisters with a maximum heat load of 13.5 kW during storage in HSM Model 80 are bounded by the results presented in [A.8-3].

Sections A.8.4.2 through A.8.4.4 summarize the thermal evaluation of canisters during storage in HSM based on [A.8-3].

A.8.4.2 Thermal Model of Rancho Seco HSM and Canisters

The HEATING7 thermal model of the Rancho Seco HSM with a canister is the same as the HSM Model 80 with 24P DSC described in Section 8.1.3 of [A.8-2]. This is appropriate based on the justification provided in Section 8.1.1.1 Item 4, Volume II of [A.8-3] that “the geometries of the DSC and HSM at Rancho Seco ISFSI are similar to the NUHOMS®-24P design” of [A.8-2]. The HEATING7 thermal model of the canister basket assemblies is described in Volume II, Section 8.1.1.2 of [A.8-3].

A.8.4.3 Rancho Seco HSM Thermal Model Results

Section 8.1.1.1, Volume II of [A.8-3] presents the HSM thermal analysis with the canisters. The Rancho Seco HSM thermal model results for the canisters for normal, off-normal and accident conditions are presented in Table 8-4, Volume II of [A.8-3]. These results are based on a design basis heat load of 24 kW for a NUHOMS®-24P DSC in a HSM Model 80 [A.8-2].

As discussed in Section A.8.3, the normal, off-normal and accident ambient conditions at the WCS CISF are bounded by the Rancho Seco site ambient conditions. Also, the Rancho Seco HSM design is similar to the HSM Model 80 based on the discussion in Section A.8.4.1. Hence, the thermal analysis results of the canister with a design basis heat load of 13.5 kW, when stored in the HSM Model 80 at the WCS CISF, are bounded by the results presented in Table 8-4, Volume II of [A.8-3].

The maximum fuel cladding temperature for the canisters for long term storage and accident conditions is presented in Table 8-5, Volume II of [A.8-3]. Table 8-2a and Table 8-2b, Volume 1 of [A.8-3] present the maximum internal pressure for canisters with and without the control components, respectively for both transfer and storage conditions. Based on the discussion in Section A.8.3, the normal, off-normal and accident ambient conditions at the WCS CISF are bounded by the Rancho Seco site ambient conditions. Therefore, the maximum fuel cladding temperature and internal pressures determined in [A.8-3] are also applicable to the WCS CISF.

A.8.4.4 Evaluation of HSM Model 80 Performance with a Canister

The thermal performance of the HSM Model 80 with a canister at the WCS CISF under normal, off-normal, and accident conditions of operation is bounded by the evaluation documented in [A.8-3]. The bounding evaluation demonstrates that all the 10 CFR Part 72 thermal limits and criteria for the WCS CISF are met.

A.8.5 Thermal Analysis of MP187 Cask with FO/FC/FF DSCs

As discussed in Section A.8.1, on-site transfer operations of the canisters will be performed using MP187 cask at the WCS CISF. This configuration is licensed as described in [A.8-3]. Based on the discussion in Section A.8.3, the ambient conditions at the WCS CISF are bounded by those considered in [A.8-3]. Therefore, no further evaluations are performed and the thermal evaluations performed for the Rancho Seco ISFSI bound are applicable for the WCS CISF. Sections A.8.5.1 through A.8.5.3 present an overview of the thermal evaluations performed for transfer conditions from [A.8-3].

A.8.5.1 Thermal Model MP187 Cask with FO/FC/FF DSCs

The MP187 cask thermal model is described in Section 8.1.1.1, Volume III of [A.8-3].

A.8.5.2 MP187 Cask Thermal Model Results

Normal and Off-Normal Conditions:

The results of the thermal evaluation for on-site transfer operations of canisters in MP187 cask described in Section 8.1.1.1, Volume III of [A.8-3] and Table 8-1, Volume III of [A.8-3]. The resulting canister shell temperature is used as a boundary condition to calculate maximum fuel cladding temperature, which is presented in Table 8-2, Volume III of [A.8-3].

A.8.5.3 Accident Conditions

The ISFSI at the Rancho Seco site is analyzed for a design basis fire accident during transfer as described in Section 8.2.5, Volume I of [A.8-3]. The results of this evaluation are also applicable to the WCS CISF.

A.8.5.4 Evaluation of MP187 Cask Performance

The thermal performance of the MP187 cask with the canisters at the WCS CISF, evaluated under normal, off-normal, and accident conditions of operation, satisfy all the 10 CFR Part 72 thermal limits and criteria.

A.8.6 References

A.8-1 U.S. Nuclear Regulatory Commission, "Certificate of Compliance No. 9255, Revision 12 for the Model No. NUHOMS®-MP187 Multi-Purpose Cask (Docket 71-9255).

A.8-2 TN, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," NUH-003, Revision 14, September 2014.

A.8-3 "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report," NRC Docket No. 72-11, Revision 4.

APPENDIX A.9
RADIATION PROTECTION
NUHOMS®-MP187 Cask System

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A.9. RADIATION PROTECTION

The NUHOMS®-MP187 Cask System radiation protection evaluations are documented in Section 7 of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" (FSAR) [A.9-1].

A.9.1 Radiation Protection Design Features

Details of the Storage Area shielding design features for the NUHOMS®-MP187 Cask System which includes the FO-, FC-, FF- Dry Shielded Canisters (DSCs) and Greater Than Class C (GTCC) waste canisters stored in an HSM Model 80 are documented in Section 7.3.2.1 and Appendix C, Section 7.3.1.1 of reference [A.9-1]. Drawings showing the shield thicknesses for the canisters, HSM Model 80 and MP 187 cask are listed in Section A.4.6.

A.9.2 Occupational Exposure Evaluation

A.9.2.1 Analysis Methodology

Dose rates are known in the vicinity of the HSM Model 80 and MP187 cask based upon the existing FSAR[A.9-1] and SAR[A.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.

A.9.2.2 Dose Assessment

A dose assessment is performed for receipt and transfer of an FO-, FC-, or FF-DSC to HSM Model 80 using the MP187 cask. GTCC waste canisters are bounded by the spent nuclear fuel (SNF) canisters with respect to dose rates on the surface of the cask and storage overpack.

Seven general locations around the cask are defined, as shown in the top half of Figure A.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 A.9-1: top, side, and bottom.

A loading operation is divided into receipt and transfer operations. Dose rates for receipt operations are obtained from Table 5.1-1 of the transportation SAR for the MP187 cask [A.9-2]. Dose rates for the transfer operations are obtained from Table 7-1 of Volume II of the storage FSAR [A.9-1] for the HSM Model 80.

The configurations used in the dose rate analysis are summarized in Table A.9-1. Results for the various loading scenarios are provided in Table A.9-2 and Table A.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 FO-, FC-, or FF-DSC or GTCC waste canister to an HSM Model 80 using the MP187 cask: 1057 person-mrem.

The total collective dose for unloading, an FO-, FC-, or FF-DSC or reactor related GTCC waste canister from an HSM Model 80 and preparing it for transport off-site is bounded by the loading operations (1057 person-mrem). Operations for removing these canisters from the HSM Model 80 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 the receipt, transfer, retrieval, and shipment is 2114 person-mrem.

A.9.3 References

A.9-1 "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report," NRC Docket No. 72-11, Revision 4.

A.9-2 TN Document NUH-05-151 Rev. 17, "NUHOMS®-MP187 Multi-Purpose Transportation Package Safety Analysis Report." (Basis for NRC CoC 71-9255).

Table A.9-1
Receipt and Transfer Configurations

Actual Configuration	Receipt Analysis Configuration	Transfer Analysis Configuration
FO-, FC-, or FF-DSC transferred from the MP187 cask into an HSM Model 80	FC-DSC (bounds FO- and FF-DSC and GTCC waste canister) inside MP187 cask [A.9-2]	FC-DSC (bounds FO- and FF-DSC) inside MP187 cask [A.9-1]

Table A.9-2
Occupational Collective Dose for Receipt of MP187 Cask Loaded with FO-, FC-, or FF-DSC

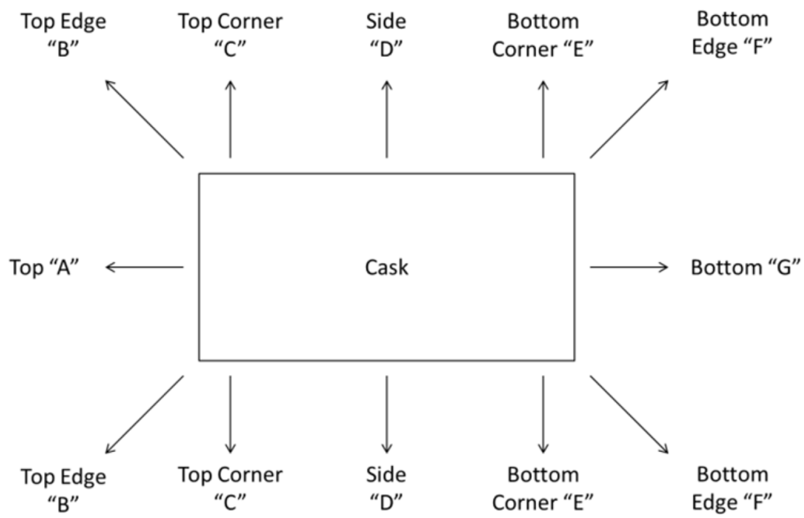
Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)*
Verify that the tamperproof seals are intact.	1	0.07	Top	1	0.847	1
	1	0.07	Bottom	1	1.62	
Remove the tamperproof seals.	1	0.07	Top	1	0.847	1
	1	0.07	Bottom	1	1.62	
Remove personnel barrier	3	0.5	Side	1	55.6	84
Remove the impact limiter attachment bolts from each impact limiter and remove the impact limiters from the cask.	2	0.5	Top Edge	1	0.847	3
	2	0.5	Bottom Edge	1	1.62	
Remove the transportation skid closure assembly.	2	0.25	Top Corner	1	55.6	56
	2	0.25	Bottom Corner	1	55.6	
Take contamination smears on the outside surfaces of the cask. If necessary, decontaminate the cask until smearable contamination is at an acceptable level.	2	0.17	Top	1	36	52
	2	0.17	Side	1	55.6	
	2	0.17	Bottom	1	59	
Place suitable slings around the cask top and bottom ends.	2	0.5	Top Corner	1	55.6	112
	2	0.5	Bottom Corner	1	55.6	
Using a suitable crane lift the cask from the railcar	2	0.1	Side	1	55.6	12
Remove the cask trunnion plugs.	2	0.5	Top Corner	1	55.6	112
	2	0.5	Bottom Corner	1	55.6	
Inspect the trunnion sockets and install the upper and lower trunnions. Torque the trunnion attachment screws for each of the four trunnions.	2	0.5	Top Corner	1	55.6	112
	2	0.5	Bottom Corner	1	55.6	
Place cask onto the on-site transfer vehicle.	2	0.5	Side	2	55.6	56
Remove the slings from the cask.	2	0.5	Top Corner	1	55.6	112
	2	0.5	Bottom Corner	1	55.6	
Install the on-site support skid pillow block covers.	1	0.2	Side	2	55.6	12
Transfer the cask to a staging module.	1	0.2	Side	2	55.6	12
					Total (person-mrem)	737

*Rounded up to nearest whole number

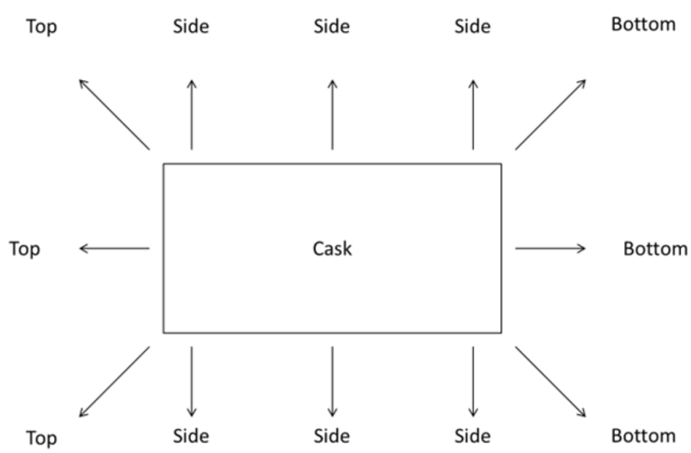
Table A.9-3
Occupational Collective Dose for Transfer of FO-, FC-, or FF-DSC from MP187 Cask to HSM Model 80

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	3	1	Top	1	28	84
Align and Dock the Cask with the HSM	2	0.25	Top/Half Front HSM	1	126.55	64
Lift the Ram into Position and Align with Cask	2	0.5	Bottom	1	58.3	59
Transfer the DSC to the HSM	---	---	---	Far	Background	0
Lift the Ram Onto transfer vehicle and Un-Dock the Cask	2	0.25	Top/Front Vent HSM	1	136.5	69
Install the HSM Access Door	2	0.5	Top/Front HSM	1	43.9	44
Total (person-mrem)						320

*Rounded up to nearest whole number



Detailed Cask Locations



Simplified Cask Locations

Figure A.9-1
Worker Locations Around Cask

APPENDIX A.10
CRITICALITY EVALUATION
NUHOMS®-MP187 Cask System

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A.10. CRITICALITY EVALUATION

The design criteria for the NUHOMS® MP187 Cask System requires that the canisters be designed to remain subcritical under normal, off-normal, and accident conditions. The design of the canister is such that, under all credible conditions, the highest effective neutron multiplication factor (k_{eff}) remains less than 0.95 including uncertainties and bias.

A.10.1 Discussion and Results

The NUHOMS®-MP187 Cask System criticality analysis is documented in Section 3.3.4, Volume I of the "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report" [A.10-1] and in Chapter 6 of the "Safety Analysis Report for the NUHOMS®-MP187 Multi-purpose Cask" [A.10-2]. 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 71 transportation conditions evaluated in [A.10-1] and [A.10-2]. Specific information on the criticality safety analysis which bounds the WCS CISF is discussed in this section.

The FO- and FC-DSCs consist of a shell assembly and an internal basket assembly. The basket assemblies are composed of four axially oriented support rods and twenty-six spacer discs. This basket assembly provides positive location for twenty-four spent nuclear fuel (SNF) assemblies under normal operating conditions, off-normal operating conditions and accident conditions. The basket assembly uses fixed neutron absorbers that isolate each SNF assembly. Guide sleeves are designed to permit unrestricted flooding and draining of SNF cells. The FC-DSC is designed with a longer internal cavity length to accommodate SNF assemblies with control components. No credit is taken for the presence of control hardware, thus the FC-DSC is identical to the FO-DSC for the purpose of criticality analysis.

The FF-DSC is different from the FO-DSC in its capacity, function, and design. The FF-DSC's capacity is thirteen SNF assemblies and is intended to package SNF with cladding defects. SNF assemblies cladding damage is limited to no more than 15 SNF pins with known or suspected cladding damage greater than hairline cracks and pinhole leaks. Missing cladding and/or crack size in the SNF pins is limited such that a SNF pellet is not able to pass through the gap created by the cladding opening during normal handling. Each assembly is placed in a separate, removable can with a fixed mesh screen on the bottom and similarly screened lid on top. These cans have slightly larger interior dimensions than the FO-DSCs (9.00 in. vs. 8.90 in.) to accommodate bowed or twisted SNF. Due to its smaller payload and the relatively massive nature of the FF-DSC cans, the FF-DSC does not require borated neutron absorbers. The SNF cans are designed to permit unrestricted flooding and draining of SNF cells.

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 MP187 cask as documented in Section 6.1.2, 6.1.3, 6.1.4 and 6.3 of [A.10-2].

The design basis criticality analysis performed for the NUHOMS®-MP187 Cask System 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 less than 0.95.

A.10.2 Package Fuel Loading

Section 2.1 of the Technical Specifications [A.10-3] lists the SNF canisters authorized for storage at the WCS CISF. Section 3.3.4.2, Volume I Spent Fuel Loading of [A.10-1] provides the Package Fuel Loading.

A.10.3 Model Specification

Section 3.3.4.3, Volume I Model Specification of [A.10-1] provides a discussion of the criticality model cask regional densities used to calculate the bounding k_{eff} for the NUHOMS®-MP187 Cask System.

A.10.4 Criticality Calculation

Section 3.3.4.4 Criticality Calculation and 3.3.4.5 Error Contingency Criteria, Volume I of [A.10-1] provides a discussion of the criticality calculations that demonstrate that the maximum calculated k_{eff} for the NUHOMS®-MP187 Cask System is less than 0.95.

A.10.5 Critical Benchmark Experiments

Section 3.3.4.6 Verification Analysis, Volume I of [A.10-1] provides a discussion of the benchmark experiments and applicability, details of benchmark calculations, and the results of benchmark calculations.

A.10.6 References

A.10-1 "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report," NRC Docket No. 72-11, Revision 4.

A.10-2 TN Document NUH-05-151 Rev. 17, "NUHOMS®-MP187 Multi-Purpose Transportation Package Safety Analysis Report." (Basis for NRC CoC 71-9255).

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

APPENDIX A.11
CONFINEMENT EVALUATION
NUHOMS®-MP187 Cask System

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A.11. CONFINEMENT EVALUATION

The design criteria for the NUHOMS® MP187 Cask System requires that the FO-, FC, FF- Dry Shielded Canisters (DSCs or canisters) and GTCC Canister are designed to ensure confinement of stored materials under normal, off-normal, and accident conditions during all operations, transfers, and storage. This chapter summarizes the system design features that ensure radiological releases are within limits and will remain As Low As Reasonably Achievable (ALARA), and that spent nuclear fuel (SNF) cladding and SNF assemblies are protected from degradation during storage. As documented in Section 8.2.2 of Appendix C of [A.11-1] the confinement evaluation for the FO-, FC- and FF- DSCs bound the GTCC canister; therefore, no additional discussion for the GTCC canister is required in this chapter.

A.11.1 Confinement Boundary

The confinement boundary for the FO-, FC- and FF-DSCs is documented in Section 3.3.2.1 of [A.11-1]. Reference [A.11-1] does not include a figure showing the confinement boundary for the FO-, FC- and FF-DSCs. However, Figure 7.1-1 of reference [A.11-12] provides a figures that shows the component and welds that make up the confinement boundary for the 24PT1-DSC which is also applicable to the FO-, FC-, and FF-DSCs with one exception, the FO-, FC-, and FF-DSCs do not have a “helium Leak Test Plug” in the Outer Top Cover Plate. Drawings for the canisters, including the confinement boundary are referenced in Section A.4.6.

The canisters will not release radioactive contents under all normal, off-normal, and accident conditions; see Section 3.3.2 and Section 8.2.2 of [A.11-1]. However, during fabrication and closure operations the confinement boundary was leak tested to 10^{-5} std cm^3/sec in accordance with ANSI N14.5 [A.11-2]. Therefore, for these canister designs, a non-mechanistic release is postulated based on a leakage rate of 10^{-5} std cm^3/sec. In addition, bounding evaluations in Section A.7.7 are performed to demonstrate that the confinement boundaries for the FO-, FC-, FF-DSCs do 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.

Section 4.3, Codes and Standards, of the Technical Specifications for the Rancho Seco ISFSI [A.11-11] cites the applicable ASME Code for the MP187 FO-, FC-, and FF-DSCs.

Section 3.1, “DSC Integrity,” of the Technical Specifications for the Rancho Seco ISFSI; [A.11-11] includes limiting condition for operation (LCO) 3.1.1 for DSC vacuum pressure, LCO 3.1.2 for DSC helium leakage rate, and LCO 3.1.3 for DSC helium backfill pressure. These LCOs create dry, inert, leak tight atmosphere, which contributes to preventing the leakage of radioactive material.

A.11.2 Potential Release Source Term

As noted in Section A.11.1 the FO-, FC-, FF- DSCs, a non-mechanistic leakage rate of 10^{-5} std cm^3/sec is postulated. The actinides and fission products for a B&W 15x15 fuel assembly are computed using SCALE6/ORIGEN-ARP. Two isotopic sets are considered, based on the design basis neutron and gamma sources. The design basis neutron source has a burnup of 38,268 MWd/MTU, enrichment of 3.18% U-235, and was discharged in 1983. The design basis gamma source has a burnup of 34,143 MWd/MTHM, enrichment of 3.21% U-235, and was discharged in 1989. The two source terms considered are decayed until June 2020, which corresponds to the placement of the first canisters at the WCS Consolidated Interim Storage Facility (*WCS* CISF). The reported source term in Table A.11-1 is the maximum value of the two isotopic sets considered. The design basis radioactive inventory for the confinement evaluation included in reference [A.11-1] was determined using these same bounding fuel assemblies as documented in Section 7.2.1 of Volume I of [A.11-1] (See also calculation 2069-0507, Revision 0 included in Volume IV of [A.11-1]).

The crud source is determined based on 140 μCi/cm^2 Co-60 on the surfaces of the SNF rods at the time of discharge [A.11-3]. The design basis gamma assembly was discharged in 1989, or 31 years decay until loading. Therefore, the crud source term in Table A.11-1 is decayed 31 years.

A.11.3 Confinement Analysis

Per Section A.11.1 the FO-, FC-, FF- DSCs, a non-mechanistic leakage rate of 10^{-5} std cm^3/sec is postulated. A confinement analysis is performed for normal, off-normal, and accident conditions to determine the dose to an individual due to inhalation and ingestion. There is no credible mechanism that would produce a leak of this magnitude through the confinement boundary of the canister. All welds in the canister shell are volumetrically examined, as is the weld between the inner bottom cover plate and the shell. Because it is not feasible to volumetrically examine the inner top cover plate weld, this weld is leak tested in accordance with the stated criteria. However, no credit is taken for the presence of the outer top cover plate, which is welded to the canister shell with a 0.5 inch weld that receives no fewer than three levels of dye-penetrant testing. The releases postulated in this analysis, therefore, are several orders of magnitude greater than any expected release.

A.11.3.1 Methodology

1. Calculate the specific activity (Ci/cm^3) in the canister cavity for each radioactive isotope based on the rod breakage fractions, release fractions, isotopic inventory, and cavity free volume. It is conservatively assumed that every SNF assembly in every canister has the same radiological source as the design basis SNF assembly. This assumption is conservative because many SNF assemblies will have less activity than the design basis source. Two sets of release fractions are considered: fuel-to-canister release fractions and Canister-to-Environment release fractions. The fuel-to-canister release fractions are the fraction of isotopes released from the interior of the SNF rod to the internal void region of the canister upon failure of the SNF rods. The fuel-to-canister release fractions used in this analysis are those specified in NUREG-1536 [A.11-4, Table 5-2] or NUREG-1567 [A.11-5, Table 9.2] and are summarized in Table A.11-2. The Canister-to-Environment release fractions are the fraction of isotopes released from the canister to the environment. As the radioactive materials from the SNF assembly will not be released directly to the environment, there will be some release retention in the canister. The fraction of radioactive materials released from the canister to the environment is justified and provided in [A.11-6, Table 3-5] and reproduced in Table A.11-3. These additional factors account for material that may condense, plate out or be filtered out before escaping the canister due to leakage hole size. This accounting of canister retention is also documented in other NRC documents [A.11-7, Section 7.3.8]. The two sets of release fractions are combined to create the fuel-to-environment release fractions in Table A.11-4. No credit is taken for retention of material released from the canister and potentially retained in the Horizontal Storage Module (HSM).

2. Using the as-tested leak rate and adjusting for normal, off-normal, and accident conditions in the canister cavity, determine the adjusted maximum canister leak rate for each set of conditions. The guidance of ANSI N14.5 [A.11-2] is used to calculate the adjusted leak rates.

3. Calculate the isotope specific leak rates by multiplying the specific activities by the seal leak rate for each condition.

4. Determine the dose to the whole body, thyroid, lens of the eye, skin, and other critical organs from inhalation and immersion exposures at the controlled area boundary. Atmospheric dispersion factors are determined using Regulatory Guide 1.145 [A.11-8] and dose conversion factors are taken from EPA Guidance Reports No. 11 [A.11-9] and No. 12 [A.11-10].

A.11.3.2 Specific Activities for Release

Specific activities for release are computed for the canister based on SNF assembly activities in Table A.11-1 and normal, off-normal, and accident release fractions in Table A.11-4. The specific activities are based on 24 SNF design basis assemblies per canister and a cavity free volume of 5,592,315 cm^3. The specific activities for release are provided in Table A.11-5. The maximum number of fuel assemblies in any canister is 24 SNF assemblies; therefore, this assumption bounds all of the loaded FO-, FC- and FF-DSCs.

A.11.3.3 Leakage Rates

A leak rate in the units std·cm^3/sec corresponds to a leak of dry air at a temperature of 25°C from a pressure of 1 atm (absolute) to a pressure of 0.01 atm (absolute). Because the canister contains an atmosphere that is primarily helium at various temperatures and pressures, the specified standard leak rate must be adjusted for the change in gas, temperature, and pressure. The design basis conditions for the canisters are provided in Table 8-2a of [A.11-1]. Using the method from ANSI N14.5 [A.11-2] and a leakage hole length assumed to be the size of the weld length (3/16 inches), the hole diameter is computed to be 4.7611×10^{-4} cm for a leakage rate of 10^{-5} std·cm^3/sec.

Based on ANSI N14.5, the computed leakage rates for the three operating conditions are:

- Normal condition leakage rate = 4.4914×10^{-6} cm^3/sec
- Off-normal condition leakage rate = 7.5892×10^{-6} cm^3/sec
- Accident condition leakage rate = 2.5413×10^{-5} cm^3/sec

The isotope specific leak rates (Q_i - Ci/sec) used in the exposure calculations are equal to the number of canisters, multiplied by the specific activity, multiplied by the leakage rate, or:

$$Q_i = N \cdot S_i \cdot L$$

where: N is the number of canisters

S_i is the specific activity of nuclide i (Ci/cm^3)

L is the leakage rate (cm^3/sec)

For normal operation, all 21 canisters are assumed to leak at the maximum normal condition leak rate. The presence of the 13 potentially damaged SNF assemblies in the FF-DSC is not expected to significantly affect the results of this calculation. For off-normal and accident conditions only a single canister is assumed to contribute. This assumption is consistent with the guidance of NUREG-1536 [A.11-4] and NUREG-1567 [A.11-5]. The isotope specific leak rates are shown in Table A.11-6.

A.11.3.4 Atmospheric Dispersion Coefficients

For normal and off-normal conditions, an atmospheric dispersion coefficient is calculated using D-stability and a wind speed of 5 m/sec and a 100 m distance to the controlled area boundary. The controlled area boundary is farther than 100 m from the WCS CISF so use of 100 m is conservative. For accident conditions, a dispersion coefficient is calculated using F-stability and a wind speed of 1 m/sec. These atmospheric conditions are consistent with the guidance of NUREG-1536 [A.11-4] and NUREG-1567 [A.11-5]. The smallest vertical plane cross-sectional area of one HSM is conservatively used as the vertical plane cross-sectional area of the building: area = HSM Width * HSM Height = 9’8” x 15’ = 20,880 in^2 = 13.47 m^2.

The atmospheric dispersion coefficients can be determined through selective use of Equations 1, 2, and 3 of Regulatory Guide 1.145 [A.11-8] for ground-level relative concentrations at the plume centerline. For D-stability, 5 m/sec wind speed and a distance of 100 m, the horizontal dispersion coefficient, σ_y, is 8 m per Figure 1 of [A.11-8]. The vertical dispersion coefficient, σ_z, is 4.6 m per Figure 2 of [A.11-8]. The correction factor at these conditions is determined to be 1.122 per Figure 3 of [A.11-8].

For F-stability, 1 m/sec wind speed and a distance of 100 m, the horizontal dispersion coefficient, σ_y, is 4 m per Figure 1 of [A.11-8]. The vertical dispersion coefficient, σ_z, is 2.3 m per Figure 2 of [A.11-8]. The correction factor at these conditions is 4 per Figure 3 of [A.11-8].

With the three values of χ/Q determined, the higher χ/Q value of the first two (Equation 1 and Equation 2) is compared with the last one (Equation 3) and the lower of those two is evaluated as the appropriate atmospheric dispersion coefficient per guidance of Regulatory Guide 1.145 [A.11-8].

The parameters used and the calculated atmospheric dispersion coefficients are summarized in Table A.11-7.

A.11.3.5 Dose Computations

Dose Conversion Factors (DCFs) for air submersion are taken from Table III.1 of Federal Guidance Report No. 12 [A.11-10], as specified in NUREG-1536 [A.11-4] and NUREG-1567 [A.11-5].

DCFs for inhalation are taken from Table 2.1 of Federal Guidance Report No. 11 [A.11-9] as specified in NUREG-1536 [A.11-4] and NUREG-1567 [A.11-5]. The worst case clearance class is conservatively used for each organ/nuclide combination. Note that because inhalation does not contribute to the shallow dose equivalent, the DCFs for skin are set equal to zero.

The Deep Dose Equivalent (DDE) due to air submersion for the whole body and each individual organ is given by:

$$DDE_{i,o} = Q_i \left({}^{Ci}\!/\!_{\sec} \right) \cdot DCF_{i,o} \left({}^{Sv \cdot m^3}\!/\!_{Bq \cdot \sec} \right) \cdot {}^{\chi}\!/\!_{Q} \left({}^{\sec}\!/\!_{m^3} \right) \cdot t(hr) \cdot C$$

where: $DDE_{i,o}$ is the deep dose equivalent contribution from nuclide i to organ o, mrem (this is the shallow dose equivalent (SDE) when used for the skin)

Q_i is the isotope specific leak rate per Table A.11-6, Ci/sec

$DCF_{i,o}$ is the dose *conversion* factor for nuclide i to organ o

χ/Q is the *atmospheric* dispersion factor per Table A.11-7.

t is the duration of the exposure, 8760 hours (1 year) for normal and off-normal conditions, 720 hours (30 days) for accident condition per [A.11-4]

C is a conversion factor equal to 1.332×10^{19} mrem-Bq-sec/(Sv-Ci-hr)

The Committed Dose Equivalent (CDE) for internal organ doses (Committed Effective Dose Equivalent, CEDE, for the internal whole body dose) due to inhalation is given by:

$$CDE_{i,o} = Q_i \left({}^{Ci}\!/\!_{\sec} \right) \cdot DCF_{i,o} \left({}^{Sv}\!/\!_{Bq} \right) \cdot {}^{\chi}\!/\!_{Q} \left({}^{\sec}\!/\!_{m^3} \right) \cdot R \left({}^{m^3}\!/\!_{\sec} \right) \cdot t(hr) \cdot C$$

where: $CDE_{i,o}$ is the committed dose equivalent contribution from nuclide i to organ o, mrem (this is the committed effective dose equivalent (CEDE) when used for the whole body)

Q_i is the isotope specific leak rate per Table A.11-6, Ci/sec

$DCF_{i,o}$ is the dose conversion factor for nuclide i to organ o

χ/Q is the atmospheric dispersion factor per Table A.11-7.

R is the respiration rate, a normal worker breathing rate, 3.3×10^{-4} m^3/sec [A.11-9]

t is the duration of the exposure, 8760 hours (1 year) for normal and off-normal conditions, 720 hours (30 days) for accident condition per [A.11-4]

C is a conversion factor equal to 1.332×10^{19} mrem-Bq-sec/(Sv-Ci-hr)

The Total Effective Dose Equivalent (TEDE) to the whole body is equal to the sum of DDE and CDE effective doses. The Total Organ Dose Equivalent (TODE) for a given organ is equal to the sum of the DDE and CDE for that organ. TODE for the lens of the eye is the sum of the SDE and TEDE.

The limiting results for normal, off-normal, and accident conditions are summarized in Table A.11-8. The limiting organ for all conditions is the bone surface. Calculated exposures for normal operation bound those for off-normal conditions due to the larger number of canisters (21) included in the normal condition calculation.

The maximum normal-operation TEDE due to the release is 7.77E-3 mrem, which satisfies the NUREG-1536 [A.11-4] and NUREG-1567 [A.11-5] criteria of “a small fraction of the limits prescribed in 10CFR72.104(a)”. This result must be added to the direct and air-scattered radiation from the WCS CISF at all distances at or beyond 100 meters to demonstrate final compliance with 10CFR72.104(a). As shown in Table A.11-8, normal operation doses to the thyroid and other organs are also within the 10CFR72.104(a) limits. All calculated accident doses are well below the applicable 10CFR72.106(b) limits. It is therefore concluded that the NUHOMS® system at the WCS CISF satisfies the confinement criteria.

A.11.4 References

A.11-1 “Rancho Seco Independent Spent Fuel Storage Installation, Final Safety Analysis Report, Volume 1, ISFSI System,” NRC Docket No. 72-11, Revision 4.

A.11-2 ANSI N14.5, "Leakage Tests on Packages for Shipment of Radioactive Materials,” 1997.

A.11-3 NRC Spent Fuel Project Office, Interim Staff Guidance, ISG-5, Rev. 1, “Confinement Evaluation.”

A.11-4 NUREG-1536, Revision 1, "Standard Review Plan for Spent Fuel Dry Cask Storage Systems at a General License Facility," U.S. 200 Regulatory Commission, Office of Nuclear Material Safety and Safeguards.

A.11-5 NUREG-1567, “Standard Review Plan for Spent Fuel Dry Storage Facilities,” Revision 0, U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, March 2000.

A.11-6 Calvert Cliffs Nuclear Power Plant Calculation CA07718, “2011 Update of ISFSI USAR DSC Leakage Dose Analysis,” NRC Ascension Number ML11364A025.

A.11-7 NUREG/CR-6672, Sandia National Laboratories, “Reexamination of Spent Fuel Shipment Risk Estimates,” Volume 1, NRC Ascension Number ML003698324.

A.11-8 U.S. NRC Regulatory Guide 1.145, “Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants,” Revision 1, November 1982.

A.11-9 Federal Guidance Report No. 11, “Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion,” EPA-520/1-88-020, September 1988.

A.11-10 Federal Guidance Report No. 12, “External Exposure to Radionuclides in Air, Water, and Soil,” EPA 402-R-93-081, September 1993.

A.11-11 “Technical Specifications for the Rancho Seco Independent Spent Fuel Installation,” Amendment 3, U.S. NRC Docket Number 72-0011.

A.11-12 TN document, ANUH-01.0150, Revision 6, “Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated nuclear Fuel,” U.S. NRC Docket 72-1029.

Table A.11-1
SNF Assembly Activities

Nuclide	Type	Activity as of June 2020 (Ci/FA)	Activity Fraction
Cs-137	Volatile	2.324E+04	24.82%
Ba-137m	Volatile	2.195E+04	23.44%
Y-90	Volatile	1.498E+04	16.00%
Sr-90	Volatile	1.497E+04	15.99%
Pu-241	Fine	1.414E+04	15.10%
Am-241	Fine	2.050E+03	2.19%
Pu-238	Fine	1.488E+03	1.59%
Cm-244	Fine	5.221E+02	0.56%
Kr-85	Gas	4.816E+02	0.51%
Pu-240	Fine	2.807E+02	0.30%
Eu-154	Fine	2.442E+02	0.26%
Pu-239	Fine	1.711E+02	0.18%
Ni-63	Fine	1.592E+02	0.17%
Sm-151	Fine	1.544E+02	0.16%
H-3	Gas	6.704E+01	0.07%
Np-239	Fine	1.559E+01	0.02%
Am-243	Fine	1.559E+01	0.02%
Am-242m	Fine	1.400E+01	0.01%
Am-242	Fine	1.394E+01	0.01%
Cm-242	Fine	1.155E+01	0.01%
Cm-243	Fine	9.250E+00	0.01%
I-129	Gas	1.493E-02	0.00%
Co-60	Crud	7.158E-01	-
TOTAL	-	9.364E+04	-

Table A.11-2
Fuel-to-Canister Release Fractions

Group	Normal/ Off-Normal	Accident
Rod Breakage Percentage	0.01/0.1	1
Fraction of Gases Released	0.3	0.3
Fraction of Volatiles Released	2×10^{-4}	2×10^{-4}
Fraction of Fuel Fines Released	3×10^{-5}	3×10^{-5}
Fraction of Crud Released	0.15	1.0

Table A.11-3
Canister-to-Environment Release Fractions [A.11-6, Table 3-5]

Group	Normal/ Off-Normal	Accident
Gases	1	1
Volatiles	7E-05	8E-04
Fines	2E-03	2E-02
Crud	2E-03	2E-02

Table A.11-4
Fuel-to-Environment Release Fractions

Group	Normal/ Off-Normal	Accident
Rod Breakage Percentage	0.01/0.1	1
Fraction of Gases Released	0.3	0.3
Fraction of Volatiles Released	1.40E-08	1.60E-07
Fraction of Fuel Fines Released	6.00E-08	6.00E-07
Fraction of Crud Released	3.00E-04	2.00E-02

Table A.11-5
Specific Activities for Release per Canister

Nuclide	Type	Normal (Ci/cm^3)	Off-Normal (Ci/cm^3)	Accident (Ci/cm^3)
Cs-137	Volatile	1.396E-11	1.396E-10	1.596E-08
Ba-137m	Volatile	1.396E-11	1.396E-10	1.596E-08
Y-90	Volatile	9.000E-12	9.000E-11	1.029E-08
Sr-90	Volatile	9.000E-12	9.000E-11	1.029E-08
Pu-241	Fine	3.641E-11	3.641E-10	3.641E-08
Am-241	Fine	5.279E-12	5.279E-11	5.279E-09
Pu-238	Fine	3.832E-12	3.832E-11	3.832E-09
Cm-244	Fine	1.344E-12	1.344E-11	1.344E-09
Kr-85	Gas	6.201E-06	6.201E-05	6.201E-04
Pu-240	Fine	7.228E-13	7.228E-12	7.228E-10
Eu-154	Fine	6.288E-13	6.288E-12	6.288E-10
Pu-239	Fine	4.406E-13	4.406E-12	4.406E-10
Ni-63	Fine	4.099E-13	4.099E-12	4.099E-10
Sm-151	Fine	3.976E-13	3.976E-12	3.976E-10
H-3	Gas	8.631E-07	8.631E-06	8.631E-05
Np-239	Fine	4.014E-14	4.014E-13	4.014E-11
Am-243	Fine	4.014E-14	4.014E-13	4.014E-11
Am-242m	Fine	3.605E-14	3.605E-13	3.605E-11
Am-242	Fine	3.589E-14	3.589E-13	3.589E-11
Cm-242	Fine	2.974E-14	2.974E-13	2.974E-11
Cm-243	Fine	2.382E-14	2.382E-13	2.382E-11
I-129	Gas	1.922E-10	1.922E-09	1.922E-08
Co-60	Crud	9.216E-12	9.216E-11	6.144E-08

Table A.11-6
Isotope Specific Release Rates, Q_i

Nuclide	Type	Normal (Ci/sec)	Off-Normal (Ci/sec)	Accident (Ci/sec)
Cs-137	Volatile	1.317E-15	1.060E-15	4.055E-13
Ba-137m	Volatile	1.317E-15	1.060E-15	4.055E-13
Y-90	Volatile	8.489E-16	6.831E-16	2.614E-13
Sr-90	Volatile	8.489E-16	6.831E-16	2.614E-13
Pu-241	Fine	3.434E-15	2.763E-15	9.253E-13
Am-241	Fine	4.979E-16	4.006E-16	1.341E-13
Pu-238	Fine	3.614E-16	2.908E-16	9.737E-14
Cm-244	Fine	1.268E-16	1.020E-16	3.416E-14
Kr-85	Gas	5.848E-10	4.706E-10	1.576E-08
Pu-240	Fine	6.817E-17	5.485E-17	1.837E-14
Eu-154	Fine	5.931E-17	4.772E-17	1.598E-14
Pu-239	Fine	4.155E-17	3.344E-17	1.120E-14
Ni-63	Fine	3.866E-17	3.111E-17	1.042E-14
Sm-151	Fine	3.750E-17	3.017E-17	1.010E-14
H-3	Gas	8.141E-11	6.550E-11	2.193E-09
Np-239	Fine	3.786E-18	3.047E-18	1.020E-15
Am-243	Fine	3.786E-18	3.047E-18	1.020E-15
Am-242m	Fine	3.400E-18	2.736E-18	9.161E-16
Am-242	Fine	3.386E-18	2.724E-18	9.122E-16
Cm-242	Fine	2.805E-18	2.257E-18	7.558E-16
Cm-243	Fine	2.247E-18	1.808E-18	6.053E-16
I-129	Gas	1.813E-14	1.459E-14	4.885E-13
Co-60	Crud	8.692E-16	6.994E-16	1.561E-12

Note: Normal conditions based on 21 canpoisters, while off-normal and accident conditions based on a single canister.

Table A.11-7
Atmospheric Dispersion Coefficients

Parameter	Normal/Off-Normal	Accident
Stability	D	F
$\overline{U_{10}}$ (m/sec)	5	1
A (m^2)	13.47	13.47
σ_y (m)	8	4
σ_z (m)	4.6	2.3
M	1.122	4
Equation 1 of [A.11-8] (sec/m^3)	1.635E-03	2.806E-02
Equation 2 of [A.11-8] (sec/m^3)	5.766E-04	1.153E-02
Equation 3 of [A.11-8] (sec/m^3)	1.542E-03	8.650E-03
χ/Q (sec/m^3)	1.542E-03	8.650E-03

Table A.11-8
Summary of Dose Results

Normal Conditions		
Organ	**10CFR72.104(a) Limit (mrem)**	**Dose (mrem)**
Whole Body (TEDE)	25	7.77E-03
Thyroid (TODE)	75	1.78E-03
Other Critical Organ (TODE) (bone surface)	25	1.37E-01
Off-Normal Conditions		
Organ	**10CFR72.104(a) Limit (mrem)**	**Dose (mrem)**
Whole Body (TEDE)	25	6.25E-03
Thyroid (TODE)	75	1.43E-03
Other Critical Organ (TODE) (bone surface)	25	1.10E-01
Accident Conditions		
Organ	**10CFR72.106(b) Limit (mrem)**	**Dose (mrem)**
Whole Body (TEDE)	5.00E+03	9.51E-01
Organ (TODE) (bone surface)	5.00E+04	1.70E+01
Lens of Eye (LDE) (TEDE+SDE)	1.50E+04	9.68E-01
Skin (SDE)	5.00E+04	1.73E-02

Note: Normal conditions based on 21 canisters, while off-normal and accident conditions based on a single canister.

APPENDIX A.12
ACCIDENT ANALYSIS
NUHOMS®-MP187 Cask System

Table of Contents

A.12. ACCIDENT ANALYSIS

This section describes the postulated off-normal and accident events that could occur during transfer and storage for the NUHOMS® MP187 Cask System. Detailed analysis are provided in the “Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report” [A.12-1] are referenced herein. As documented in Section 8.2 and associated subsections in Appendix C of [A.12-1] the evaluations for the FO-, FC- and FF-DSCs bound the GTCC Canister, therefore no additional discussion for the GTCC canister is required in this chapter.

A.12.1 Off-Normal Operations

The off-normal conditions considered for the NUHOMS® MP187 Cask System are off-normal transfer loads, extreme temperatures and a postulated release of radionuclides.

A.12.1.1 Off-Normal Transfer Loads

The causes of, detection of, evaluation and corrective actions of off-normal transfer loads are addressed in Section 8.1.1.5 of Volume I of [A.12-1].

A.12.1.2 Off-Normal HSM Storage Events (Extreme Temperatures)

Postulated Cause of Event

The postulated cause of extreme temperatures is documented in Section 8.1.1.1 Item 2 of Volume II of [A.12-1].

Analysis of Effects and Consequences

Section A.8.4 demonstrates that the evaluations presented in Section 8.2 of Volume II of [A.12-1] bound the WCS Consolidated Interim Storage Facility (*WCS* CISF) conditions in the HSM Model 80. Section A.8.5 demonstrates that the evaluations presented in Section 8.2 of Volume III of [A.12-1] bound the WCS CISF conditions in the MP187 cask.

A.12.1.3 Off-Normal Release of Radionuclides

Postulated Cause of Event

In accordance with NUREG-1536 [A.12-2], for off-normal conditions, it is conservatively assumed that 10% of the fuel rods fail.

Analysis of Effects and Consequences

Section A.11.3 provides the bounding confinement analysis for the NUHOMS® MP187 Cask System canisters. Table A.11-8 shows that the off-site doses are very small at 100 meters from the storage pad. The actual boundary is approximately 0.75 miles from the storage pads. Therefore, dose from off-normal condition leakage is significantly less than the regulatory limits.

Corrective Actions

None Required.

A.12.2 Postulated Accident

The postulated accident conditions for the NUHOMS® MP187 Cask System addressed in this SAR section are:

- Blockage of Air Inlets/Outlets
- Drop Accidents
- Earthquakes
- Lightning
- Fire/Explosion
- Flood
- Tornado Wind and Missiles

A.12.2.1 Blockage of Air Inlets/Outlets

Cause of Accident

Section 8.3.5 of Volume II of [A.12-1] provides the potential for blocked air vents for the HSM Model 80.

Accident Analysis

The structural, thermal, and radiological consequences and the recovery measures required to mitigate the blocking of the air inlets and outlets are addressed in Section 8.3.5 of Volume II of [A.12-1]. In addition, Chapter A.8 demonstrates that the thermal analysis performed for the NUHOMS® MP187 Cask System in [A.12-1] is bounding for WCS CISF conditions.

A.12.2.2 Drop Accidents

Cause of Accident

Section 8.2.1.1 of Volume I of [A.12-1] discusses the cask drop for the MP187 cask in the transfer configuration.

Accident Analysis

The structural, thermal, and radiological consequences and the recovery measures required to mitigate the effects of a drop accident are addressed in Section 8.2.1.3 of Volume I of [A.12-1]. In addition, Chapter A.8 demonstrates that the thermal analysis performed for the NUHOMS® MP187 Cask System in [A.12-1] is bounding for WCS CISF conditions.

A.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 A.7.5 demonstrates that the enveloping WCS CISF site-specific seismic forces remain below their applicable capacities for the NUHOMS® MP187 Cask System components.

Accident Analysis

The structural, thermal, and radiological consequences and the recovery measures required to mitigate an earthquake are addressed in Sections 8.3.2.2, 8.3.2.1 of Volume II and 8.3.2.1 of Volume III of [A.12-1]. In addition, Chapter A.8 demonstrates that the thermal analysis performed for the NUHOMS® MP187 Cask System in [A.12-1] is bounding for WCS CISF conditions.

A.12.2.4 Lightning

Cause of Accident

The likelihood of lightning striking the HSM Model 80 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

A.12.2.5 Fire and Explosion

Cause of Accident

Sections 3.3.6 and 8.2.5 of Volume I of [A.12-1] provide the potential sources of fire and explosion that may occur at the WCS CISF.

Accident Analysis

The structural, thermal, and radiological consequences and the recovery measures required to mitigate a fire accident are addressed in Section 8.2.5 of Volume I of [A.12-1]. Per Section 8.2.5.3 of Volume I of [A.12-1] the maximum flammable fuel either during the transfer operation or inside the WCS CISF is 300 gallons of diesel fuel.

A.12.2.6 Flood

Cause of Accident

The Probable Maximum flood elevation 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.

A.12.2.7 Tornado Wind and Missiles

Cause of Accident

In accordance with ANSI-57.9 [A.12-4] and 10 CFR 72.122, the NUHOMS® MP187 Cask System components are designed for tornado effects including tornado wind effects. In addition, the HSM and MP187 cask in the transfer configuration are also design for tornado missile effects. The NUHOMS® MP187 Cask System 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 [A.12-5]) while the WCS CISF is in Region II, a less severe location with respect to tornado and tornado missiles.

Accident Analysis

The structural, thermal, and radiological consequences and the recovery measures required to mitigate the effects of tornado wind and missile loads are addressed in Section 8.3.1 of Volume II and Table 8-13 and Section 8.3.1.3 of Volume III of [A.12-1].

A.12.3 References

A.12-1 "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report," NRC Docket No. 72-11, Revision 4.

A.12-2 NUREG-1536, Revision 1, "Standard Review Plan for Spent Fuel Dry Cask Storage Systems at a General License Facility," U.S. 200 Regulatory Commission, Office of Nuclear Material Safety and Safeguards.

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

A.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).

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