3. PRINCIPAL DESIGN CRITERIA

The purpose of Chapter 3 is to provide the principal design criteria utilized in the design of the Waste Control Specialists, LLC (WCS) Consolidated Interim Storage Facility (CISF) and authorized storage systems.

The storage of spent nuclear fuel (SNF) and reactor related Greater-than-Class C (GTCC) waste at the WCS CISF is based on the use of cask systems that have been previously *licensed and/or* certified by the NRC. These cask systems are canister-based storage systems. Table 1-1 provides a listing of the cask systems authorized for use at the WCS CISF.

All indicated changes are in response to RSI NP-4.2

3.1 Stored Materials

The WCS CISF provides interim storage for SNF and GTCC waste loaded in canisterized systems until retrieval of the canisters for transport to a repository or other site. The SNF and GTCC waste is stored in sealed, metallic canisters inside storage overpacks. The canisters contain multiple SNF assemblies and associated hardware or GTCC waste in a dry, inert environment. The WCS Phase 1 CISF is designed to store approximately 470 casks with a canisters containing SNF or GTCC waste. The total storage capacity for the WCS CISF is 5,000 metric tons of heavy metal (MTHM) and *231.3 MT (510,000 pounds)* of GTCC waste.

Physical, thermal and radiological characteristics of stored SNF are described in the safety documentation for each cask system listed in Table 1-1. The physical, thermal and radiological characteristics of GTCC canisters are described in the *Rancho Seco FSAR, Appendix C [*3-18*], for the GTCC waste proposed for storage at the WCS CISF for storage in a NUHOMS® System. The GTCC waste stored in NAC systems is described in the applicable transportation cask SAR and Certificate of Compliance (CoC) listed by docket number in Table 1-1. GTCC waste for NAC systems will be received from Maine Yankee (GTCC-Canister-MY), Connecticut Yankee (GTCC-Canister-CY), Yankee Rowe (GTCC-Canister-YR), and Zion (GTCC-Canister-ZN). For GTCC-Canister-MY, the GTCC waste is described in the NAC-UMS transportation cask SAR, Section 1.3.1.1.2 [*3-20*]. For GTCC-Canister-CY and GTCC-Canister-YR, the GTCC waste is described in the NAC-STC transportation cask SAR, Section 1.2.3.2 [*3-19*]. For GTCC-Canister-ZN, the GTCC waste is described in the NAC-MAGNATRAN SAR, Section 1.3.2 [*3-21*].*

All indicated changes are in response to RSI NP-4.2

3.3 Design Criteria for WCS CISF ITS Structures, Systems and Components

This section lists the principal criteria utilized in the design of ITS systems and components for the WCS CISF. Table 1-2 provides a summary of WCS CISF principal design criteria. The principal design criteria considered for the design of ITS systems and components are defined in the system SARs and compared against the WCS CISF site-specific conditions to demonstrate that the existing designs bound the WCS CISF site conditions. For structural evaluations, specific load values based on these criteria are developed in Chapter 7 and compared against the design basis for each authorized cask system. For thermal evaluations, specific thermal conditions based on these criteria are developed in Chapter 8 and compared against the design basis for each authorized cask system. For shielding, criticality and confinement evaluations, specific conditions based on these criteria are developed in Chapters 9, 10 and 11, respectively, and evaluated against the design basis for each authorized cask system.

3.3.1 Structural

The principal design criteria applicable to the design of ITS systems and components are developed from the WCS CISF site characteristics and are used in the determination of structural loads and load combination analyses. Bounding load values against these criteria are evaluated in Chapter 7.

3.3.1.1 Tornado (Wind Load)

Design Basis Tornado (DBT) parameters are presented in Table 1-2. Design basis tornado characteristics are based on NRC Regulatory Guide 1.76 [3-2] and portions of NUREG-0800 [3-3]. Section 2.3.2.4 discusses observed tornados in the WCS CISF region.

3.3.1.2 Tornado (Missile Spectrum)

Three DBT missiles are defined for use in the WCS CISF design and presented in Table 1-2. The DBT parameters correspond with the parameters for Region II defined by NRC Regulatory Guide l.76 [3-2].

3.3.1.3 Floods

Table 3-1 provides the cross reference to the applicable appendix for each canister/storage overpack for the systems authorized for storage at the WCS CISF. In general, these systems are designed to withstand severe flooding, including full submergence as described in the reference appendices in Table 3-1 for each system. However, the WCS CISF site will remain dry in the event of a flood because the site location and site grade is above the elevation of the Probable Maximum Flood from offsite sources as documented in Section 2.4.2.2. The site area is designed to assure adequate drainage for heavy rainfall, including the 100-year event. Therefore, a flood event will not impact spent fuel and GTCC waste storage or transfer operations.

All indicated changes are in response to RSI NP-2.3

During operations, the amount of flammable liquids that are allowed in the Cask Handling Building is controlled. The only sources of flammable liquids in the Cask Handling Building are the locomotive used to move the railcars into and out of the Cask Handling Building, the Cask Transfer System, the Vertical Cask Transporter (VCT) and the transfer vehicle. The locomotive will not be allowed in the building during cask handling operation other than when the transportation casks are ready for transport. The Canister Transfer System and the Vertical Cask Transporter are quantity limited (< 50 gallons) and are described in SAR Section 12.2.1. The transfer vehicle for the NUHOMS® System is also quantity limited (<60 gallons) and will not be in the Cask Handling Building during handling of the vertical systems. As the NUHOMS® System is evaluated for fire with 300 gallons of diesel fuel, the quantity of fuel in the transfer vehicle is bounded for NUHOMS® Systems operations.

Due to the positive drainage of the WCS CISF approach slabs, a spill large enough to cause puddling would also tend to drain toward the storm drainage system and thus away from the storage overpacks. This drainage, coupled with the expected rapid detection of any fire by the fuel transfer personnel, will tend to limit the spread and severity of any fire. In addition, off-site firefighting assistance is available if required. The damage caused by any fire will be negligible given the massive nature of the casks. A spill too small to cause puddling would be very difficult to ignite due to the relatively high flash point of diesel fuel and such a small fire would not pose a credible threat to the WCS CISF.

There is no fixed fire suppression system within the boundaries of the WCS CISF; however, there is a fire detection system in the Cask Handling Building that will be installed to protect the investment in equipment but not to satisfy or imply any regulatory requirement for fire protection.

WCS CISF initiated explosions are not considered credible since no explosive materials are present. The effects of externally initiated explosions are bounded by the design basis tornado generated missile load analysis performed for the authorized storage systems.

3.3.2 Thermal

Thermal design criteria are derived from the WCS CISF site characteristics and include ambient temperature and insolation (solar load). These are used in the determination of thermal conditions to be addressed in the system and component analyses. Specific load values based on these criteria are developed in Chapter 8.

3.3.2.1 Ambient Temperature

Ambient normal, off normal and extreme temperatures are given in Table 1-2. These are documented in Section *2.3.3.1*.

3.3.2.2 Solar Load (Insolation)

The Solar Loads are given Table 1-2 and are taken from 10 CFR Part 71 [3-4].

All indicated changes are in response to RSI NP-6.3

- A recovery method for the unlikely loss of confinement event is independent of any bare fuel handling facilities.

- Cask systems utilizing vertical transfer must be qualified for a 6-inch drop of the storage cask or transportation cask lid during transfer operations.

The Cask Handling Building cranes and associated cask/canister lifting equipment are designed utilizing the standards identified in the Technical Specifications [3-1].

3.3.8 Satisfaction of ALARA Goals

In accordance with 10 CFR 20.1101(b), and to the extent practicable, WCS CISF procedures and engineering controls shall be based upon sound radiation protection principles to achieve occupational and public doses that are ALARA.

The ALARA principles of time, distance and shielding shall be considered throughout the design of the WCS CISF. For tasks requiring access to areas near transportation and storage casks, system design is based on minimizing the time spent near the casks.

Special consideration is given to systems located in radiation areas. Design of these systems minimizes the number of components and/or the need for maintenance on these components that pass through radiation areas. Where utility subsystem components must be routed through radiation areas, ALARA design principles shall be incorporated into system design.

All indicated changes are in response to RSI NP-10.1

4.1.2.7 Rail Side Track

The rail side track will depart from the existing WCS rail loop and extend north and to the east into the PA and the Cask Handling Building. There is sufficient rail length for 10 rail cars to be inside the PA before indexing *proceeding* the Cask Handling Building. Unloaded rail cars will exit the Cask Handling Building and continue east on the rail sidetrack which will connect back into the existing WCS rail loop.

4.1.2.8 Security and Administration Building

The Security and Administration Building will coordinate several functions for the WCS CISF. Security personnel will monitor sensors and intrusion alarms, control employee access, and process visitors into the WCS CISF. Health physics will operate and store equipment in this building and an administration staff will use this building for processing shipments and storing records. The building will contain the Central Alarm Station (CAS), Armory, locker rooms, break room, offices, health physics spaces, and records storage. The backup electrical generator system for the WCS CISF is located at this building. *See Figure 1-9 for the building layout. The building is a commercially designed and fabricated steel structure with reineforced concrete floors and foundations. The building is not important-to-safety and does not provide any confinement or radiation shielding functions. The building will be designed for protection against natural phenomena as required by standard local building codes.*

4.1.2.9 Receiving Area

When the shipping cask arrives at the WCS CISF, the shipping cask and cradle are visually inspected for damage prior to entry into the OCA.

4.1.2.10 Concrete Cask Staging Area

There is an area inside the Cask Handling Building for VCC staging for VCCs awaiting loading via the Canister Transfer System. Additional staging areas are available outside the security boundaries of the WCS CISF.

4.1.2.11 *Temporary Isolation Areas*

Transport casks arriving at the CISF via rail spur will be visually inspected and radiation dose rate and contamination surveys will be performed.

If initial radiological surveys preclude completion of the other steps of receipt inspection, WCS will isolate the rail car or move the rail car to the Cask Handling Building and establish appropriate radiological controls. WCS will document the damage, notify the NRC of the condition and develop a corrective action plan. WCS will evaluate the use of movable shielding to protect personnel from radiation exposure while the damaged cask is on site.

All indicated changes are in response to RSI NP-10.4

4.2 Spent Fuel Handling Systems

This section identifies the WCS CISF canister handling systems. Information is presented regarding system function, major components, design bases and design features, and associated safety features. The canister handling systems are designed to accommodate the systems authorized for use at the storage WCS CISF.

4.2.1 Cask Handling Building

This section describes the Cask Handling Building systems and associated operations. The Cask Handling Building is the primary facility for handling transportation casks and canisters at the WCS CISF and consists of two loading bays for shipping/receiving of transportation casks, and depending whether on the system will be moving the canister/cask to the on-site transfer vehicle for transfer to the storage pad or will be transferring the canister from the transportation cask to the VCC, which is then taken to the storage pad.

The Cask Handling Building loading bays are used to receive and prepare for shipment all transportation casks arriving at and departing from the WCS CISF. Rail shipments of transportation casks enter the loading bays through rollup doors. Two rail/truck lanes are provided in this area to meet the expected WCS CISF throughput requirements. The rail line serving the Cask Handling Building is equipped with a *derail device* to prevent inadvertent vehicular impacts. Two 130-ton overhead bridge cranes unload the NUHOMS® transportation cask from their transfer vehicle after appropriate contamination surveys and decontamination activities (if necessary) and place the transportation cask onto the on-site transfer vehicle. Empty NUHOMS® transportation casks are returned to the transfer vehicle and shipped, reversing the process. The VCT is used to unload the NAC transportation casks from their railcar, upright the cask and place it under the Canister Transfer System. The Canister Transfer System is used to transfer the canister from the NAC transportation cask to the NAC Storage Overpack. The VCT is also used to return the empty NAC transportation casks to the railcar by reversing the process.

4.2.1.1 Cask Off-loading and Loading System

For the NUHOMS® Systems, the transportation cask containing the loaded canister is received in the loading bay. After the cask has been received, including removal of the personnel barrier and impact limiters, the *WCS* Lift Beam Assembly is used to offload the transportation cask from the railcar to the transfer skid. *The WCS Lift Beam Assembly is shown in drawing WCS01-2100 included in Section 4.9.* The transfer vehicle then moves the cask and canister out to the storage pad where the canister is transferred to the HSM. Chapter 5 and applicable appendices provide the procedures for accomplishing the transfers. Equipment is provided for removing or attaching such items as impact limiters, personnel barriers and cask tiedowns from the transportation casks. *The NUHOMS® Transfer Equipment is shown in Figure 4-1 through Figure 4-3.*

All indicated changes are in response to RSI NP-4.3

For the NAC Systems, the transportation cask containing the loaded canister is also received in the loading bay. After the transportation cask has been received, including removal of the impact limiters, the VCT is driven over, essentially straddling, the railcar and is positioned to engage the transportation cask upper trunnions. The VCT then raises and moves towards the rear of the cask to raise and lift the transportation cask from the railcar. The VCT then lowers the transportation cask to 3-6" of the ground. The railcar is removed from the unloading area and the VCT moves the cask to the Canister Transfer System. *The VCT is shown in Figure 4-4.*

4.2.1.2 Cask Carrier System

The cask carrier system for the transportation cask is the VCT. The limit of this operation is removal of the transportation cask from the railcar and the movement of the cask to the Canister Transfer System. The same equipment, VCT, is used to move the loaded VCC to the storage pad.

4.2.1.3 Transfer Preparation System

Transfer preparations follow the placement of the transportation cask and VCC within the Canister Transfer System. Unloading operations for the transportation cask follow SAR requirements, which leaves the transportation cask in a state of readiness for content removal. The VCC is prepared for loading in accordance with SAR requirements, leaving it in readiness for the transfer operation. These operations do not require a "system", but will require lifting equipment in the area for handling the equipment indicated.

4.2.1.4 Canister Transfer System

The Canister Transfer System is used to remove the canistered contents from the transportation cask to the VCC. When a transportation cask is removed from the railcar, it is positioned within the Canister Transfer System. Additionally, a VCC is also positioned within the Canister Transfer System. Both the transportation cask and VCC are each fitted with a transfer adapter. The Canister Transfer System is pre-rigged with the transfer cask for the system being transferred (e.g. NAC-MPC, NAC-UMS, NAC-MAGNASTOR) that is designed to interface with the transportation and storage configurations in the Canister Transfer System.

4.2.1.5 Storage Mode Preparations Systems

There are no further preparations of the storage system after loading within the Canister Transfer System. Following placement of the canister into the VCC, the VCC lid is placed in accordance with the SAR and the cask is ready for placement on the storage pad in the Storage Area.

All indicated changes are in response to RSI NP-4.3

4.9 Supplemental Data Drawings

The following drawing is enclosed as noted below:

1. *"WCS Lift Beam Assembly (three sheets)," WCS01-2100, Revision 0 (Included at the end of this Section).*

All indicated changes are in response to RSI NP-4.3

This drawing added in response to RSI NP-4.3

PROPRIETARY AND SECURITY RELATED INFORMATION WITHHELD UNDER 10 CFR 2.390

REVISION	DESCRIPTION	DATE
0	INITIAL ISSUE	4/14/16

AREVA

PROJECT: PROJECT

WCS LIFT BEAM ASSEMBLY

DRAWING NO.	SCALE	SHEET
WCS01-2100	SHOWN	1 OF 3

This drawing added in response to RSI NP-4.3

PROPRIETARY AND SECURITY RELATED INFORMATION WITHHELD UNDER 10 CFR 2.390

DRAWING NO.	SHEET	REVISION
WCS01-2100	2 OF 3	0

This drawing added in response to RSI NP-4.3

8 7 6 5 4 3 2 1

SHEET 3 OF 3 DRAWING NO. WCS01-2100

F E D C B A

PROPRIETARY AND SECURITY RELATED INFORMATION WITHHELD UNDER 10 CFR 2.390

DRAWING NO.	SHEET	REVISION
WCS01-2100	3 OF 3	0

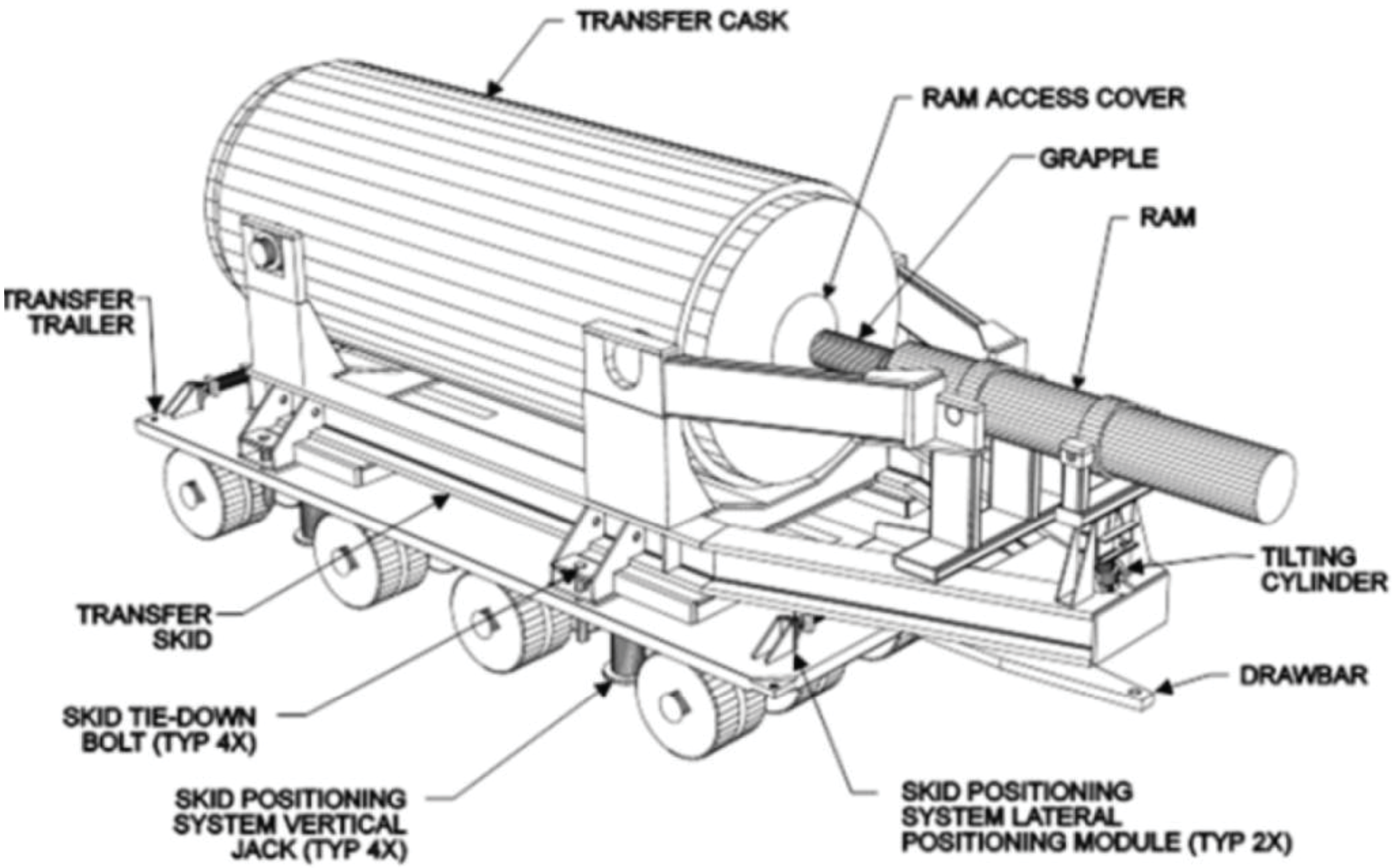

Figure 4-1
NUHOMS® Transfer System

All indicated changes are in response to RSI NP-4.3

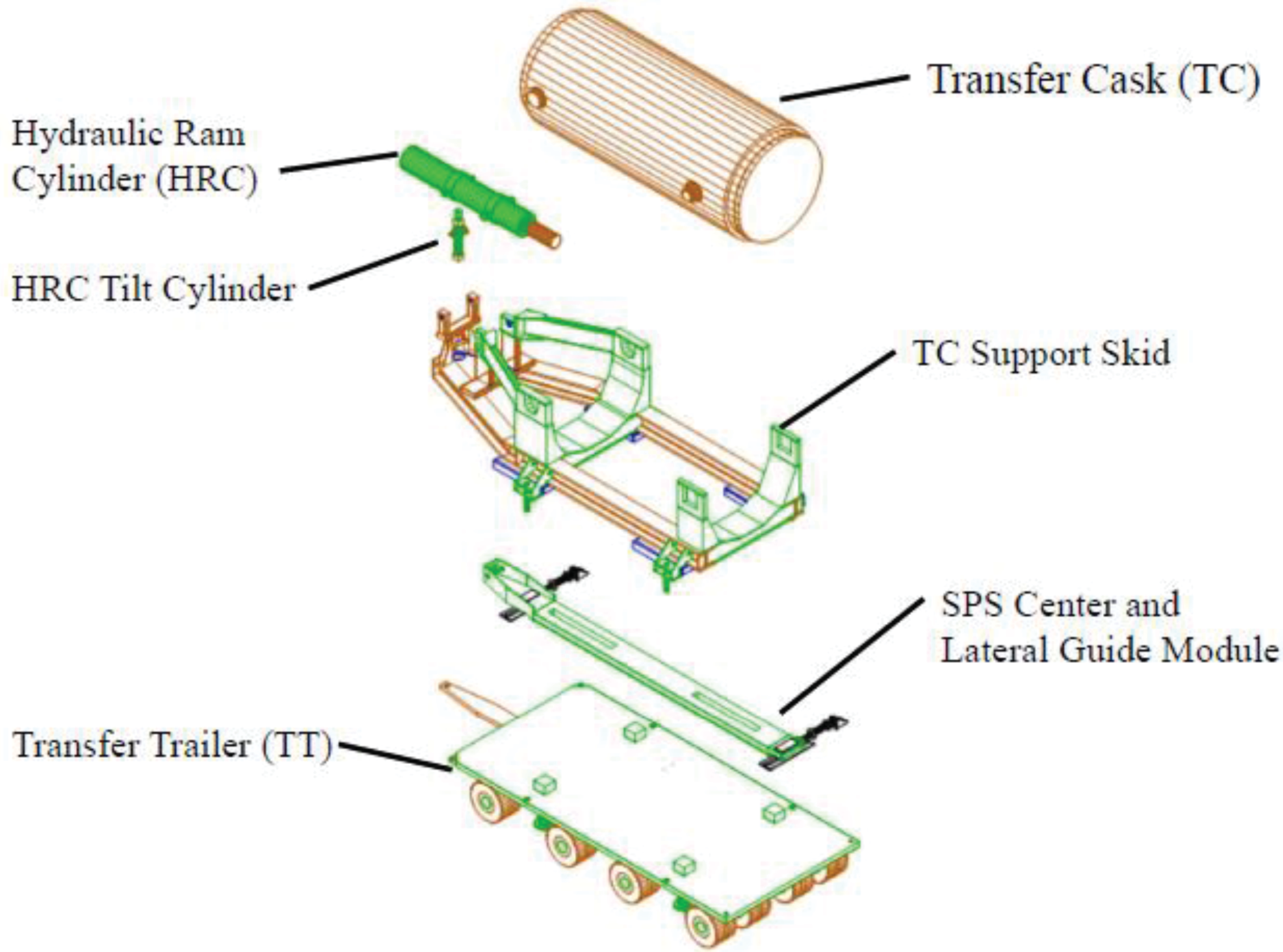

Figure 4-2
Exploded View of Transfer Components

All indicated changes are in response to RSI NP-4.3

Figure 4-3
Assembled Transfer Trailer

All indicated changes are in response to RSI NP-4.3

Proprietary Information on This Page
Withheld Pursuant to 10 CFR 2.390

Table 8-2
Maximum Ambient Temperatures for Section 8 of all WCS SAR Appendices

	Normal (°F)	**Off-Normal (°F)**	**Accident (°F)**
WCS CISF (Chapter 1, Table 1-2)	*81.5°F*	*113°F*	*113°F*
	Normal (°F)	**Off-Normal (°F)**	**Accident (°F)**
Appendix A.8	*101°F*	*120°F*	*Bounded by Off-Normal*
Appendix B.8	*110°F*	*120°F*	*Bounded by Off-Normal*
Appendix C.8	*100°F*	*125°F (Storage)* *105°F (Transfer)*	*Bounded by Off-Normal (Storage)*
Appendix D.8	*100°F*	*125°F (Storage)* *105°F (Transfer)*	*Bounded by Off-Normal (Storage*
WCS CISF (Chapter 1, Table 1-2)	*Yearly Avg 67.1°F*	*113°F* *3-Day Avg low temperature 27.9°F* *3-Day Avg high temperature 89.4°F*	*Min Temp -1°F* *Max Temp 113°F*
Appendix E.8	*Maximum yearly Avg 75°F*	*3-Day Avg 100°F (Yankee-MPC & CY-MPC)* *3-Day Avg 105°F (MPC-LACBWR)*	*Extreme low temperature -40°F* *Extreme high temperature 125°F*
Appendix F.8	*Maximum yearly Avg 76°F*	*3-Day Avg 106°F*	*Extreme low temperature -40°F* *Extreme high temperature 133°F*
Appendix G.8	*Maximum Yearly Avg 76°F*	*3-Day Avg 106°F*	*Extreme low temperature -40°F* *Extreme high temperature 133°F*

All indicated changes are in response to RSI NP-6.3

9.3.2.2 Restricted Area

The restricted area is located on the site such that a minimum distance from any stored SNF to the security boundaries is at least 330 feet in order to maintain exposures to the public within regulatory limits. The nearest property boundary is more than 4,300 feet from the Storage Area.

9.3.3 Shielding

Shielding design features are discussed in this section.

9.3.3.1 Cask Handling Building Shielding

The ALARA considerations for the CISF Cask Handling Building are the same as the transportation casks since the canisters will still be in the transportation cask. While shielding is provided by the Cask Handling Building no credit is taken in the shielding/exposure analysis. Shielding from the radiation sources within the canisters is provided by the Transportation/Transfer Casks, Transfer Casks and Storage Overpacks. The Table 9-4 provides the cross reference to the applicable appendix and section for each canister/storage overpack where each system is discussed.

As described in Section 9.4 of the SAR, the dose to workers due to a loading operations is estimated based upon dose rate information in existing storage FSARs and transportation cask SARs and is listed in Appendix A-9, specifically Table A.9-2 and Table A.9-3 for the respective configurations.

WCS will use stackable shield blocks to establish low dose areas during cask offloading operations to maintain radiation doses ALARA. The shield blocks are constructed out of 2,000 psi concrete and measuring approximately 2'H x 4'L x 2'W and provide 9.83 half-value layers of shielding. Administrative/Process controls will be implemented for the Cask Handling Building to establish an exclusion zone during offloading operations for the exterior of the building and rail area. Specifically, WCS will exclude workers from the Administrative Storage/Office Area and Cask Storage and Maintenance Area during offloading of canisters. See Figure 1-7.

The CISF protected area boundary will be posted and controlled as a "restricted area, radioactive material area, dosimetry and RWP required for entry." The CISF Cask Handling Building will be posted and controlled as a radiation are or high radiation are per 10 CFR Part 20.

CISF personnel involved in canister handling activities will be trained in accordance with 10 CFR Part 19. These workers are considered "Radiation Workers" and the occupation radiation dose limits specified in 10 CFR Part 20 Subpart C apply.

9.3.3.2 Receiving Area Shielding

Shielding is provided by the 10 CFR Part 71 certified transportation cask.

All indicated changes are in response to RSI NP-4.3

9.4 Estimated On-Site Collective Dose Assessment

On-site dose rates are computed for the proposed storage configuration using the MCNP5 v1.40 and MCNP6 version 1.0 computer programs. The dose to workers due to a loading operation is also estimated based upon dose rate information in existing storage FSARs and transportation SARs. The dose to workers due to loading is provided in the Appendices for each system as listed in Table 9-4.

9.4.1 Radiation Dose Rate Within the Controlled Area

Figure 9-1 provides an overview of the WCS CISF Facility and the surrounding area. Detector locations D1 through D16 are placed in the vicinity of the CISF, as indicated in Figure 9-1 to provide an idea of the general dose rates. Detector locations P-001 through P-008 are for various locations around the facility.

A close-up view of the storage area is provided in Figure 9-2 with detector locations for DSB-01 through DSB-10 located within the protected area.

Alarming Radiation Monitoring (ARM) and dosimeter locations in the Cask Handling Building are shown in Figure 1-7.

NUHOMS® Systems

The HSMs are loaded back-to-back in a single row. Sacramento Municipal Utility District (SMUD) fuel is modeled in a 2x11 array of HSM Model 80s at the eastern end of the WCS CISF. San Onofre Nuclear Generating Station (SONGS) fuel is modeled in a 2x10 array of AHSMs, and Millstone fuel is modeled in two arrays (2x25 and 2x28) of HSM Model 102s.

On-site dose rate contributions from the NUHOMS® Storage Overpacks are computed for the proposed storage configuration using MCNP5. Average calculated neutron and gamma dose rates on the surfaces of the various HSM modules are obtained from the respective FSARs [9-3, 9-4, 9-5] and are summarized in Table 9-1. Note that the HSM surface dose rates for the HSM Model 102 are conservatively increased from the reference FSAR values.

The arrays of HSMs are modeled as solid concrete boxes resting on a concrete pad 1.5 feet thick, and a surface source is modeled on each of the HSM array surfaces to reproduce the applicable HSM surface dose rates indicated in Table 9-1. Source particles are started using an outward cosine distribution and spectra applicable to each HSM system.

The outer boundary of the MCNP5 models is a sphere with a radius of approximately 7.6 km. Gamma and neutron radiation may scatter from atmospheric air down to the detector dose points (i.e., skyshine). Ground is modeled as soil 3 feet thick to capture ground scatter. Therefore, skyshine radiation is explicitly included in the dose rate results, as well as direct radiation and ground scatter.

All indicated changes are in response to RSI NP-7.1

- Counting laboratory
- *Counting laboratory locations are shown in Figure 9-6. Figure 9-7 shows building layouts and general equipment for each laboratory.*

Equipment and instrumentation provided to support radiation protection functions are as follows.

- A proportional counter for contamination smears to define surface contamination and the need for decontamination
- Hand and foot contamination monitors stationed at building exits to prevent the spread of contamination
- Portable monitoring equipment to augment fixed detector systems
- Personnel protective equipment and clothing
- Personnel dosimetry instrumentation and equipment, including the following.
  - Optically stimulated luminescence monitoring for permanent exposure records
  - Self-reading dosimeters for instantaneous readout and personnel exposure control
  - Computer hardware/software to record and analyze radiological monitoring/sampling and personnel exposure data.

9.5.3 Procedures

Radiation Protection activities are performed in accordance with procedures. Radiation Protection staff utilize procedures to perform the following.

- Take contamination swipes of potentially contaminated areas (transportation casks)
- Perform radiation surveys to define and maintain radiation dose rates in the radiation areas
- Post areas based on surveys
- Provide radiation work permits and perform pre-operational briefings
- Cover jobs to ensure radiation protection
- Evaluate personnel occupational radiation doses to determine if ALARA objectives are met
- Administer Personnel Dosimetry programs
- Perform instrument calibration and testing
- Provide ALARA review of site procedure and monitoring of operations
- Perform radiological safety training and refresher training

All indicated changes are in response to RSI NP-12.2

Table 9-6
Dose Rates around *the* Facility *and the Protected Area*

	Coordinates (ft)		Dose Rate (mrem/hr)						
Detector	**Easting**	**Northing**	**Gamma**	**Neutron**	**(n,γ)**	**Total**	**σ**	**Direct**	**Skyshine**
Locations around Facility									
P-001 *(Site turn off)*	560770.85	6878102.44	2.85E-03	2.05E-04	3.94E-05	3.09E-03	3%	4.49E-04	2.65E-03
P-002 *(Rail line)*	561762.03	6877972.59	8.79E-02	6.32E-03	4.97E-04	9.48E-02	3%	1.66E-02	7.82E-02
P-003 *(Security and Admin. Building)*	562193.28	6878120.44	6.29E-01	4.87E-02	2.32E-03	6.80E-01	1%	1.98E-01	4.82E-01
P-004 *(Rail line)*	562816.16	6877498.49	6.43E-01	5.70E-02	3.28E-03	7.03E-01	1%	4.92E-02	6.54E-01
P-005 *(CHB)*	563088.75	6877495.24	7.12E-01	6.62E-02	3.36E-03	7.82E-01	1%	6.28E-02	7.19E-01
P-006 *(CHB)*	563039.04	6877384.55	4.17E-01	4.05E-02	2.05E-03	4.60E-01	1%	2.58E-02	4.34E-01
P-007 *(Existing rail line)*	562618.87	6876671.78	2.27E-02	2.00E-03	1.85E-04	2.48E-02	2%	9.45E-04	2.39E-02
P-008 *(Corner of Storage Area)*	562452.84	6877970.98	2.66E+00	2.04E-01	1.15E-02	2.88E+00	1%	1.03E+00	1.85E+00
Locations around the Protected Area									
DSB-01	562386.26	6878066.83	2.68E+00	1.59E-01	7.27E-03	2.85E+00	2%	1.24E+00	1.60E+00
DSB-02	562580.56	6877804.00	1.64E+00	1.71E-01	9.80E-03	1.83E+00	1%	2.82E-01	1.54E+00
DSB-03	562465.86	6877548.58	3.82E-01	4.27E-02	2.08E-03	4.27E-01	2%	2.51E-02	4.02E-01
DSB-04	562805.88	6878305.73	4.54E+00	2.82E-01	1.05E-02	4.84E+00	1%	2.25E+00	2.59E+00
DSB-05	562740.16	6877732.33	1.77E+00	1.70E-01	1.06E-02	1.95E+00	1%	3.22E-01	1.63E+00
DSB-06	562625.45	6877476.91	4.46E-01	4.22E-02	2.34E-03	4.91E-01	3%	2.71E-02	4.64E-01
DSB-07	562965.47	6878234.06	5.06E+00	2.82E-01	1.19E-02	5.35E+00	1%	2.45E+00	2.90E+00
DSB-08	563083.74	6877578.04	1.13E+00	1.11E-01	5.56E-03	1.25E+00	2%	1.60E-01	1.09E+00
DSB-09	562969.03	6877322.61	3.14E-01	2.85E-02	1.57E-03	3.44E-01	2%	1.71E-02	3.27E-01
DSB-10	563309.05	6878079.77	2.95E+00	1.77E-01	7.12E-03	3.14E+00	1%	1.27E+00	1.87E+00

All indicated changes are in response to RSI NP-7.1

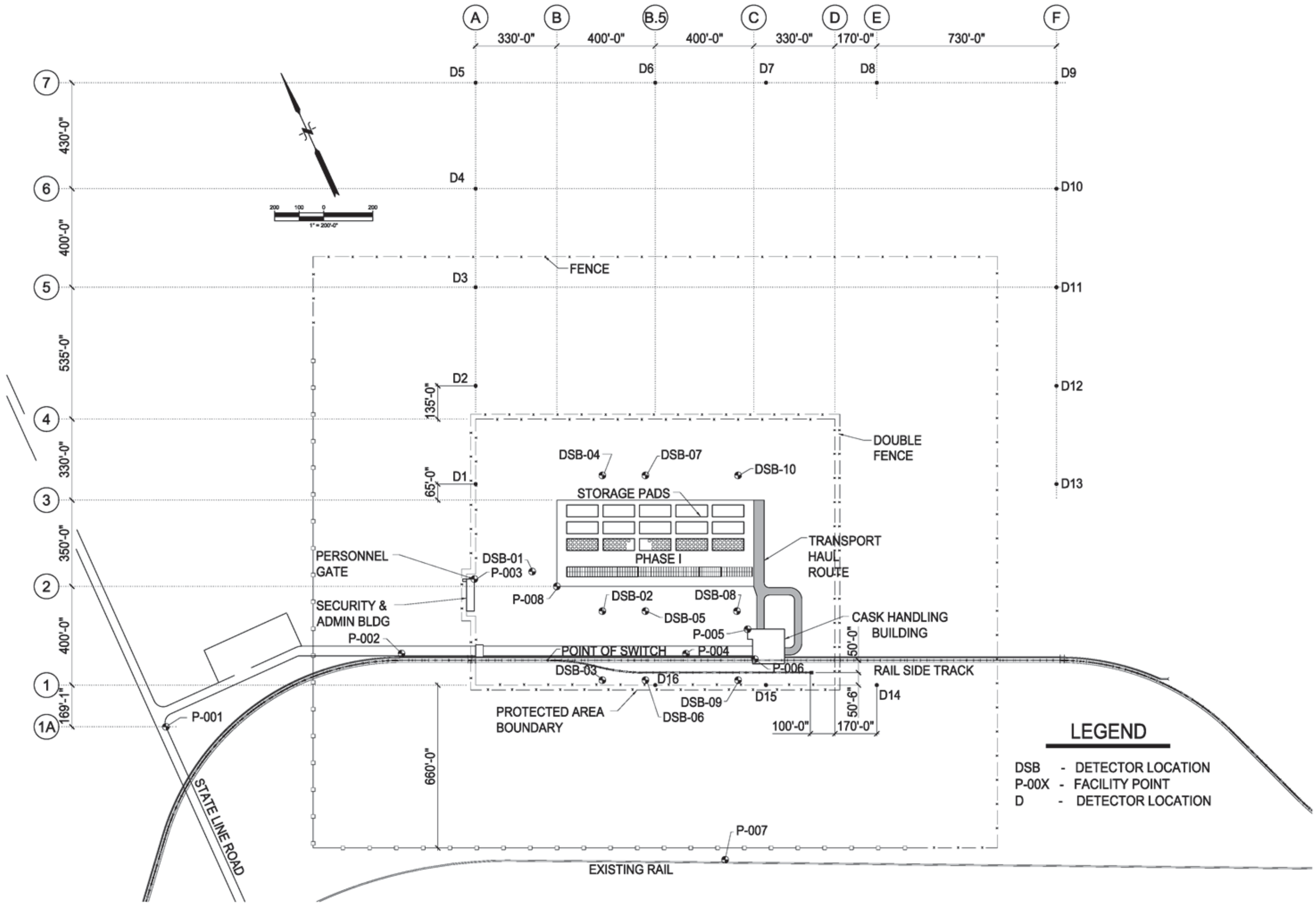

Figure 9-1
WCS CISF Conceptual Plan

All indicated changes are in response to RSI NP-7.1

Figure 9-3
Deleted

Figure 9-4
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All indicated changes are in response to RSI NP-4.3

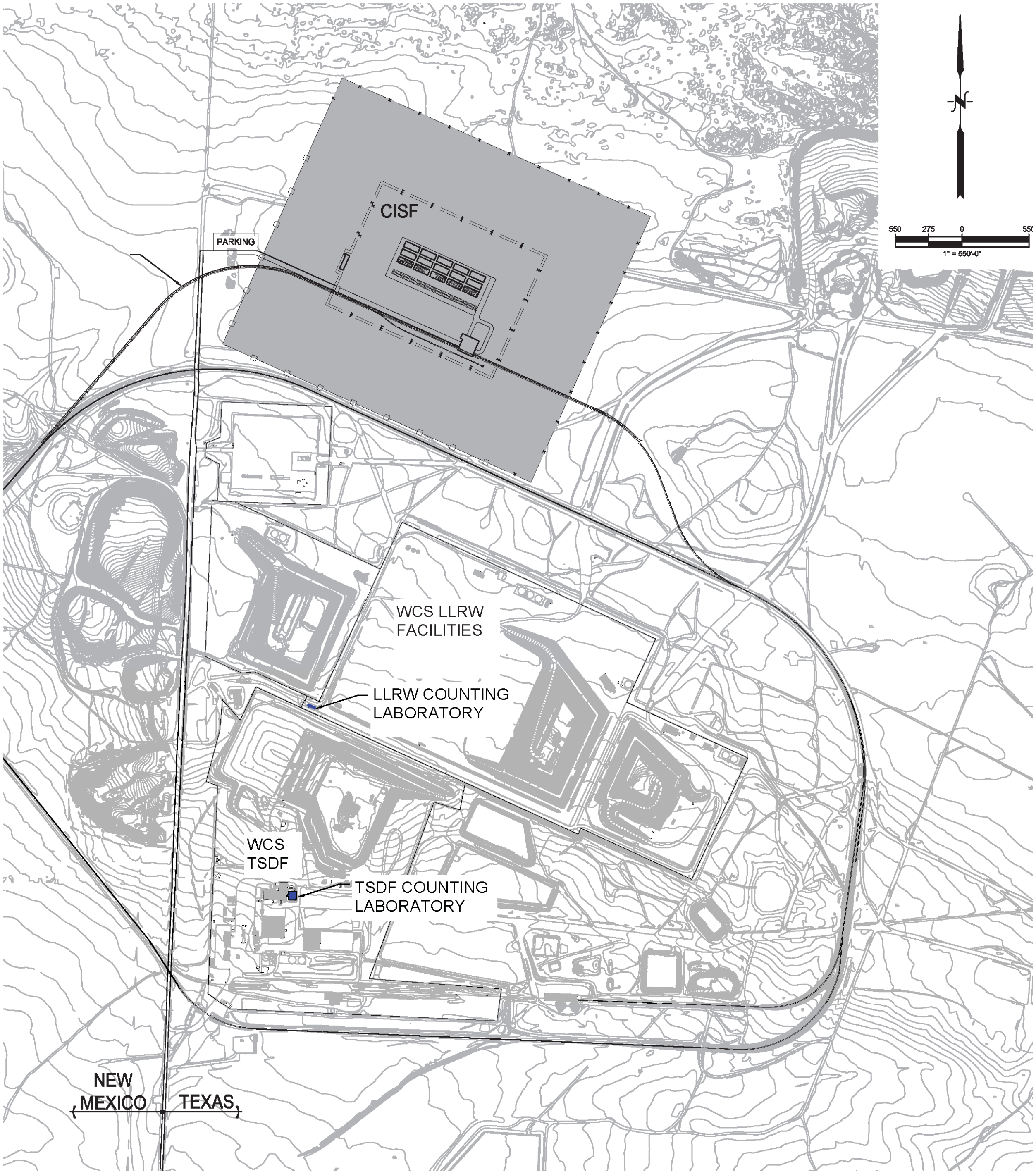
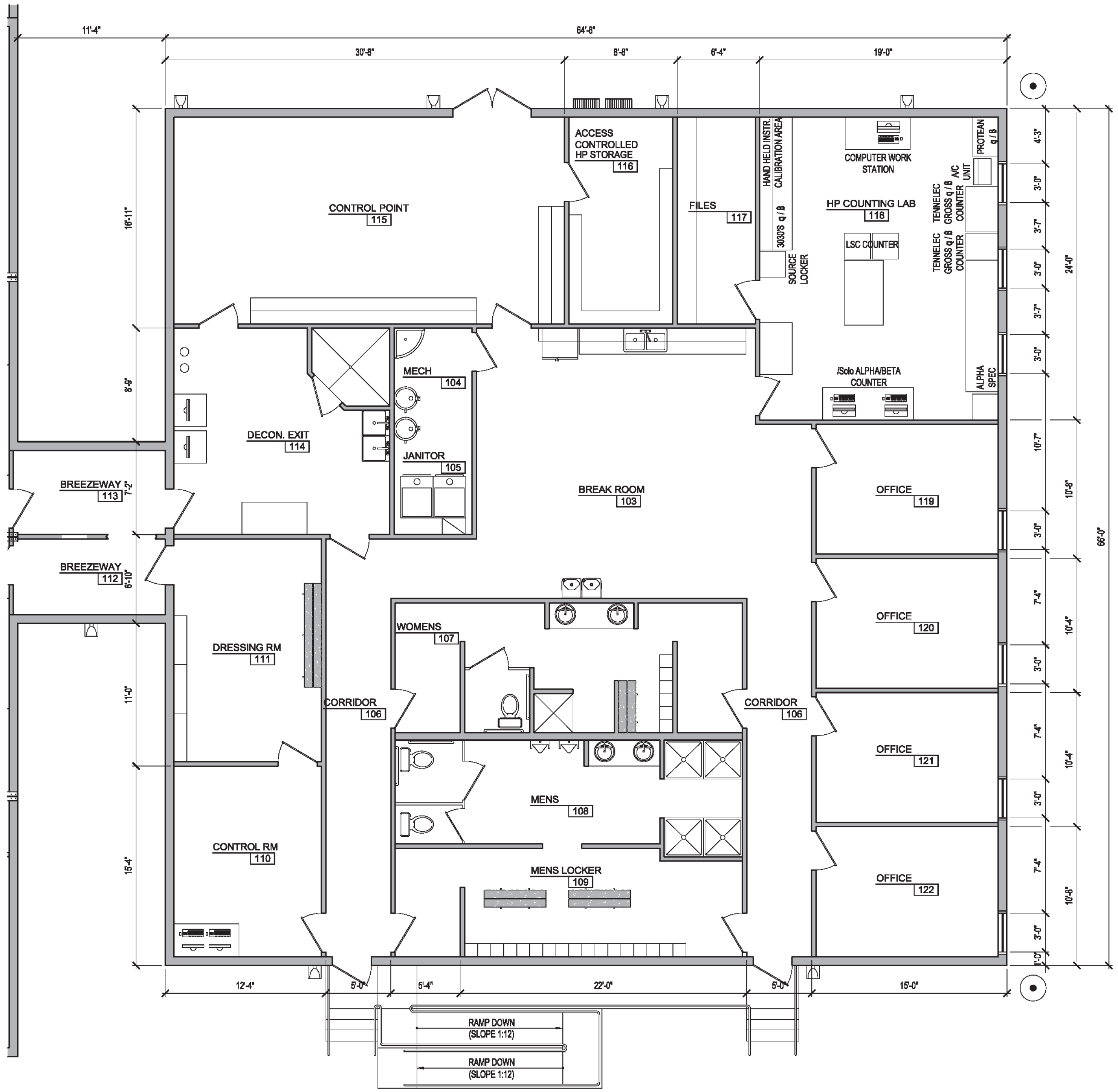
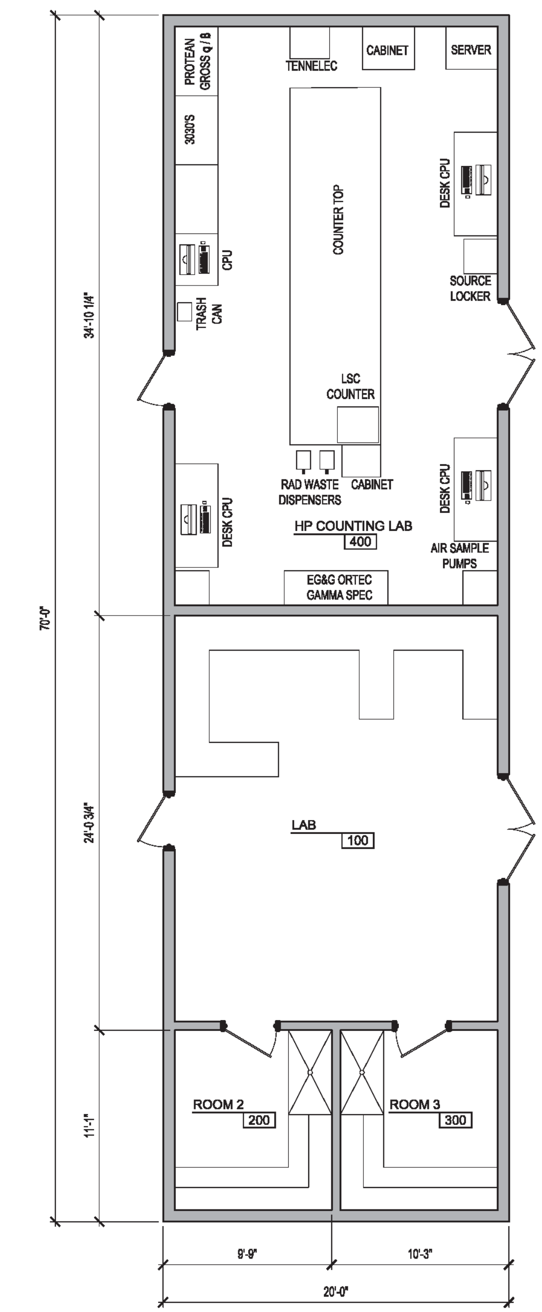


Figure 9-6
WCS Shared Laboratory Locations

All indicated changes are in response to RSI NP-4.3



TSDF Counting Laboratory Building



LLRW Counting Lab Building

Figure 9-7
Shared Laboratory Facilities

All indicated changes are in response to RSI NP-4.3

Package confinement systems are likewise protected from damage. Canister cavity confinement features provide a defense-in-depth criticality control function by precluding the risk that any hydrogenous neutron moderator will be introduced into the SNF basket cavity of any package received for storage. Canister confinement features are summarized in Chapter 11. All of the canisters and associate storage overpacks have been evaluated for a 50-foot flood. The evaluations demonstrate that there is no breach of the *confinement* boundary (well beyond water tight) as discussed in Chapters 11, A.11, B.11, C.11, D.11, E.11, F.11 and G.11. In addition, the maximum postulated flood at the WCS CISF is 1.*1* inches as documented in Section 2.4.2.2.

Under 10 CFR 72.124 storage systems must be designed to be maintained subcritical and to ensure that, before a nuclear criticality accident is possible, at least two unlikely, independent, and concurrent or sequential changes have occurred in the conditions essential to nuclear criticality safety. The two unlikely events for the WCS site are canister breach and severe flooding. As documented in Sections 2.4.2.2 and 3.3.1.3, 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. There are no other sources of standing water at the WCS CISF. Thus, there is no standing water to cause a criticality event.

All indicated changes are in response to RSI NP-2.3

11. CONFINEMENT EVALUATION

Storage and transportation cask systems received at the Waste Control Specialists, LLC (WCS) Consolidated Interim Storage Facility (CISF) are designed to ensure confinement of stored materials under normal, off-normal, and accident conditions during all operations, transfers, and storage. *In addition, the confinement boundary of each canister type authorized for storage at the WCS CISF is evaluated to demonstrate that loads during normal conditions of transport do not exceed ASME B&PV Subsection NB Article NB-3200 (Level A allowables) to ensure that the confinement boundary of the canisters is not adversely impacted during transport to the WCS CISF.* 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.

All indicated changes are in response to RSI NP-9.3

11.3 Potential Release Source Term

Only canisterized SNF and canisterized GTCC waste are authorized for shipment to and storage at the WCS CISF. No repackaging of individual SNF assemblies is performed at the WCS CISF. As stated above, in general, all of the canisters to be stored at the WCS CISF are designed and tested to be leak tight under all normal, off-normal, and accident conditions *and normal conditions of transport*. Therefore, the confinement of the SNF is maintained under all conditions. The only exceptions to this are the FO-, FC-, FF-DSCs that were only leak tested to a leakage rate of 10^{-5} $std{\cdot}cm^3/sec$. The potential release source terms for these canisters are presented in Section A.11.3. *The analysis presented in that section satisfies the regulatory requirement for confinement evaluation.*

All indicated changes are in response to RSI NP-9.3

11.5 Protection of Stored Materials from Degradation

The canister materials for the authorized design were selected such that degradation is not expected during *normal conditions of transport to the WCS CISF and* the storage period *at the WCS CISF*.

As described in Section 7.2, it is required that packages received at the WCS CISF are loaded in accordance with SAR and regulatory requirements applicable at the site where the SNF was originally loaded and stored. To provide assurance that the packages received at the WCS CISF are acceptable for storage, prior to receipt of a canister, a records review is performed to verify that the canister being received was fabricated, loaded, stored and maintained in accordance with the Site Specific or General License requirements prior to shipment. In addition, the receipt inspection of the canisters upon arrival at the WCS CISF is to be in accordance with reference [11-2].

In addition, the License Condition 20 requires that the CoC 1004 aging management program (AMP) be incorporated in this WCS CISF license for the NUHOMS® Systems upon approval by the NRC. Similarly, License Condition 20 requires that as the AMPs for the NAC International systems are approved by the NRC, these also are incorporated into this WCS CISF license. The AMPs are applied based on the age of the canister when it was originally loaded under the applicable Site Specific or General License at the site of origin.

Fuel cladding integrity is ensured by maintaining the storage cladding temperatures below levels that are known to cause degradation of the cladding. In addition, the SNF is stored in an inert helium atmosphere to prevent degradation of the cladding, specifically cladding rupture due to oxidation and its resulting volumetric expansion of the SNF.

There is no significant degradation of any safety components caused by the effects of galvanic or chemical reactions or by the effects of the reactions combined with the effects of long-term exposure of the materials to neutron or gamma radiation, high temperatures or other possible conditions.

All indicated changes are in response to RSI NP-9.3

12.1 Off-Normal Events

Off-normal operations are design events of the second type (Design Event II) as defined in ANSI/ANS 57.9 [12-2]. Off-normal conditions consist of that set of events that, although not occurring regularly, can be expected to occur with moderate frequency or approximately once during a calendar year of WCS CISF operation.

For an operating NUHOMS® systems used at the WCS CISF, off-normal events could occur during cask handling, transfer vehicle moving, canister transfer and other operational events. Two off-normal events are defined which bound the range of off-normal conditions. In some cases, release of radionuclides are also evaluated, however this is not a limiting condition. The limiting off-normal events are defined as a jammed canister during loading or unloading from the HSM, and the extreme ambient temperatures of 30.1°F (winter) and *113*°F (summer) and shown in Table 1-2. These events envelope the range of expected off-normal structural loads and temperatures acting on the canister, transfer cask, and HSM.

The off-normal conditions considered for the NAC system components at the WCS CISF are as follows:

- Blockage of half the storage cask air inlets
- Canister off-normal handling load
- Failure of instrumentation
- Severe environmental conditions (100°F and -40°)
- Small Release of Radioactive Particulate from the Canister Exterior

The MAGNASTOR System also considers the following:

- Crane Failure during Loaded Transfer Cask Movements
- Crane/Hoist Failure during TSC Transfer to VCC

Table 12-1 points to the appropriate Appendix for each authorized canister/cask system listed in the Technical Specifications [12-3] for the thermal-hydraulic, structural, and radiological analyses associated with these events.

All indicated changes are in response to RSI NP-6.3

12.2 Accidents

The design basis accident events specified by ANSI/ANS 57.9-1984, and other credible accidents postulated to affect the normal safe operation of the WCS CISF are described in this section. Analyses are provided for a range of hypothetical accidents, including those with the potential to result in an total effective dose equivalent of greater than 5 Rem outside the owner controlled area or the sum of the deep-dose equivalent specified in 10 CFR 72.106.

Table 12-1 points to the appropriate Appendix for each authorized canister/cask system listed in the Technical Specifications [12-3] where each accident condition is analyzed to demonstrate that the requirements of 10 CFR 72.122 are met and that adequate safety margins exist for the WCS CISF system design. Radiological calculations are provided to confirm that on-site and off-site dose rates are within acceptable limits. The resulting accident condition stresses in the WCS CISF system components are evaluated, and compared with the applicable code limits. Where appropriate, the accident condition stresses are combined with those of normal operating loads in accordance with the load combination definitions. Load combination results for the WCS CISF and the evaluation for fatigue effects are also presented.

The postulated accident conditions addressed, as applicable to each system, in the Appendices are:

- *Adiabatic Heat Up/*Blockage of Air Inlets/Outlets *(Also see Section 12.2.3)*
- Drop Accidents
- Earthquakes
- Lightning
- Fire/Explosion
- Flood
- Tornado Wind and Missiles
- Tip Over/ Overturning

12.2.1 Canister Transfer System Fire Accident

In the unlikely event of a fire inside the Cask Handling Building during canister (TSC) transfer operations of the Canister Transfer System (CTS), there is the potential that either the vertical cask transporter (VCT) or the CTS will be in proximity with the loaded TSC. There are no other combustible or flammable materials within the transfer area and as such only fuel supporting the operation of the VCT or CTS can contribute to this postulated fire accident. Three conditions are considered:

a. Loaded Transport Cask positioned in the VCT

All indicated changes are in response to RSI NP-6.2

12.2.1.3 Analysis of Fire

[ ]

12.2.1.4 Corrective Actions

Immediately upon detection of the fire, appropriate actions should be taken by site personnel to extinguish the fire. The exterior surfaces of the cask should then be visually inspected for general deterioration (i.e. damaged concrete, loss of shielding, or surface discoloration that may indicate damage) could affect cask performance. This inspection will be the basis for the determination if any repair activities are necessary to maintain or return the cask to its design basis configuration.

12.2.1.5 Radiological Impact

There are no significant radiological consequences for this accident. There may be local spalling of concrete or reduction of neutron shield properties during the fire event, which could lead to some minor reduction in shielding effectiveness and an insignificant increase in radiation dose rates on the cask surface.

12.2.2 Offsite Accident Analysis

Section 2.2 "Nearby Industrial, Transportation and Military Facilities," indicates that there are no facilities that could contribute to the potential for significant explosions located within five miles of the CISF facility. There are no chemical processing facilities, petroleum refineries, natural gas facilities or munition depots that could contribute to the potential for significant explosions located within five miles of the CISF.

All indicated changes are in response to RSI NP-16.1

The neighboring facility to the west of WCS is a uranium enrichment facility, URENCO, and the distance is approximately 7,277 feet from the interior fence of the CISF to the closest building. The process used is a physical rather than a chemical process, and no chemical reactions are initiated although process hazards include possible chemical reactions in some accident scenarios. Some chemical reactions that may take place at URENCO are controlled by utility systems that decontaminate equipment and remove contaminants from effluent streams and lubricating oil [12-4]. Process Hazards identified by URENCO include radioactivity and toxicity of UF_6 release were found to be intermediate and high consequence. The potential accident sequences and consequences are discussed in greater detail in Section 3.7 of the Integrated Safety Analysis (ISA) Summary for the URENCO facility [12-4]. In the event of an accidental release, URENCO has calculated the 2-hour and 8-hour Total Effective Dose Equivalent (TEDE) doses at the site boundary and they are 3.1 mSv (310 mRem) and 8.0 mSv (800 mRem), respectively; these doses include the prompt gamma radiation and the released cloud contributions under accident meteorology (5^{th} percentile). Figure 3.7-1 of the URENCO ISA shows corresponding doses as a function of distance from the criticality site, and since the WCS CISF is over 2,000 meters from the URENCO facility, the results indicate that the consequences of a postulated criticality event upon members of the public at or beyond the site boundary would be considerably below the threshold for an intermediate consequence event, as defined by 10 CFR 70.61 [12-4].

Regulatory Guide 1.91 provides guidance for calculating safe distances from transportation routes, based on calculated overpressures at the nuclear site created by postulated explosions from transportation accidents. The Regulatory Guide indicates that overpressures that do not exceed 1 psi at the storage site would not cause significant damage and states that "under these conditions, a detailed review of the transport of explosives on these transportation routes would not be required." Using the methodology of Regulatory Guide 1.91, the nearest transportation routes are located much further from the CISF than the distances to exceed 1 psi overpressure. Based on the Regulatory Guide, the maximum probable hazardous solid cargo for a single highway truck is 50,000 lb, and detonation of this quantity of explosives could produce a 1 psi overpressure at a distance of approximately 1,660 ft (0.31 mile) from the detonation. Since Texas Highway 176 is approximately 8,000 feet (1.5 miles) from the southernmost edge of the storage pad for the canisters, explosions involving vehicles travelling on this road would not produce significant overpressures at these locations.

The effects of explosions on the storage systems are discussed in the SAR Appendices, and it is determined that the canisters are protected from the effects of explosions. Overpressures of substantially greater than 1 psi would be required to cause damage to the cask storage systems.

All indicated changes are in response to RSI NP-16.1

Permian Basin Materials LLC is a quarry located northwest of the facility. The quarry periodically employs blasting techniques for quarrying materials; however, this is outsourced to a third party and no explosives are stored onsite. The quarry is located beyond 1,660 feet from the proposed CISF and thus any accidental explosions would not produce overpressures greater than 1 psi to cause damage at the CISF.

Immediately south of the proposed WCS CISF is the currently operating WCS commercial waste disposal facility. The site has two propane tanks that are 2,600 gallons and 1,000 gallons and several smaller propane tanks. The explosion and vapor clouds of these propane tanks would not impact the CISF. Listed below are the distances of various gasoline and diesel storage locations that could be a potential explosion source; however, each location is over 1,660 feet (0.31 mile) from the CISF and none of the locations have quantities that would create overpressures in excess of 1 psi at the CISF.

WCS Gasoline and Diesel Locations, Quantities and Distance from proposed CISF:

- *Mixed Waste Treatment Facility (MWTF) – Gas Storage Tank – 5,000 gallons – 4,732 feet from CISF*
- *MWTF – Diesel Storage Tank – 8,000 gallons – 4,732 feet from CISF*
- *MWTF – Diesel Storage Tank (Green Fuel) – 500 gallons – 4,732 feet from CISF*
- *Low Level Radioactive Waste Facility – Diesel Storage Tank – 3,384 gallons – 3,478 feet from CISF*
- *Fire Pump – 850 gallons Diesel – 3,205 feet from CISF*
- *4 Generators – Diesel – 350 gallons each – 3,205 feet to 5,885 feet from CISF*
- *3 Mobile Storage Tanks – Diesel – 475 gallons each – 3,483 feet to 7,777 feet from CISF*

Oil industry pipelines are located near the facility. Based on detailed probabilistic analysis by the neighboring URENCO facility, the hazards due to thermal radiation, missile generation and plant contamination by gas and/or explosion were shown to have an annual probability less than 1.0E-5 thus, by definition, meet the definition of 'highly unlikely' (see Section 3.2.2.4 of the URENCO ISA) [12-4]. The chance of oil industry pipeline explosion affecting the WCS CISF site is highly unlikely.

All indicated changes are in response to RSI NP-16.1

RSI NP-16.1

The Cask Handling Building is an important to safety (ITS) Structure and is designed to withstand extreme winds, pressure drops of 1.5 psi, and missiles associated with the design tornado. The effects of credible explosions occurring on Texas Highway 176, with resultant overpressures less than 1 psi at the CISF, would not challenge the Canister Transfer Building's structural integrity. Therefore, the canister storage and transfer systems meet the general design criteria of 10 CFR 72.122(c), as it applies to explosion, which states that ITS structures, systems, and components must be designed and located so that they can continue to perform their safety functions effectively under credible fire and explosion conditions. The building structure is designed to withstand seismic events in order to prevent collapse of the building (including overhead cranes) onto the canister transfer operations inside. While the building structure will be designed to resist and protect the contents of the building from accident scenarios, there is the potential that small items on the interior of the building such as ductwork, lighting, and conduit may shake loose during a seismic event and fall on the transfer operation. Canisters being transferred inside the building will be inside either a transport cask, transfer cask, or a storage cask while in the building. These casks meet the design requirements listed in Chapter 1, Table 1-2, specifically the tornado missile requirements, which exceed potential impacts from small items shaken loose from a seismic event.

RSI NP-6.2

12.2.3 Adiabatic Heat Up/Blockage of Air Inlets/Outlets

The accident evaluated in the Appendices Chapter 12 (e.g., A.12, B.12, etc.) for each system that considers adiabatic heat up is the "Blockage of Air Inlets/Outlets." An accident scenario using the blockage of air inlets and outlets to analyze adiabatic heat up is consistent with the guidance given to NRC reviewers in NUREG 1567 [12-5].

For example, NUREG-1567, Section 6.5.1, "Decay Heat Removal Systems" describes "full blockage of ventilation passages" as a required thermal analysis for determining the performance of cask heat removal systems. Likewise, Section 15.5.2.8 of NUREG-1567, "Adiabatic Heatup," states that "the reviewer should verify that the configuration of the SSCs has been defined, (i.e., all inlets and outlets blocked (for casks) and cooling systems or pumps inoperable (for pools))."

In addressing accidents that involve adiabatic heatup, WCS considered the following guidance in NUREGs-1567 and 1536 [12-6]:

a. *Section 5.4.1.1 of NUREG -1567 – "For a site-specific ISFSI, the application may involve use of a cask certified under 10 CFR 72, Subpart L, including the SAR for the certified cask system by reference. Additional information relating to the cask should also be provided, including the applicant's evaluations that establish that site parameter limits are within the bounds of those established as limiting conditions as set forth in the Certificate of Compliance."*

b. *Section 6.5.1.2 of NUREG -1567 – "The reviewer should evaluate the thermal performance of the cask in accordance with Chapter 4 of NUREG-1536." (Section 4.5.4.5 of NUREG-1536 addresses adiabatic heatup.)*

c. *Section 6.5.1.1 of NUREG -1567 – "The reviewer should verify that technical specifications relating to heat removal capability have been included in the technical specification chapter of the SAR."*

Each of the storage systems to be used at the WCS CISF have been analyzed under near-adiabatic conditions to determine technical specifications (TS) relating to heat removal capability. These analyses have been reviewed and approved by the NRC as part of either a Certification or a Specific License.

As shown in Chapter 2 of the WCS CISF SAR, there are no credible accident scenarios at the WCS CISF site that would result in a full adiabatic condition for the storage systems (i.e., entombment of the storage overpacks from volcanic or seismic activity, landslides, etc.).

In addition, the TS for the six storages cask systems are based on heat loads that are higher than the heat loads requested for storage at the WCS CISF. The TS proposed for the WCS CISF are derived from TS that the NRC has previously approved for these cask systems.

All indicated changes are in response to RSI NP-6.2

12.3 References

12-1 NRC Regulatory Guide 3.48, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)," Rev. 1.

12-2 American National Standards Institute, American Nuclear Society, ANSI/ANS 57.9 1984, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type).

12-3 Proposed SNM-1050, WCS Interim Storage Facility Technical Specifications, Amendment 0.

RSI NP-16.1

12-4 Louisiana Energy Services, "Integrated Safety Analysis Summary," Revision 4, 2005.

12-5 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.

12-6 *NUREG-1536, "Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility," Revision 1, U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, July 2010.*

RSI NP-6.2

15.1 Material Selection

15.1.1 ITS Storage Pads

The materials used in the construction of the ITS storage pads are:

Reinforcing bar	ASTM A615/A615M Carbon Steel
Concrete	ASTM C150 Type II Portland Cement

15.1.2 Canister Transfer System

The materials used in the construction of the Canister Transfer System are:

Lift Tower	ASTM A572, Grade 50 Carbon Steel
Lift Beam	ASTM A514 Carbon Steel
Canister Adapter	ASTM A516, Grade 70 Carbon Steel
Base and Top Plates	ASTM A572, Grade 50 Carbon Steel
Lift Pins/Bolts	ASTM A693/564, Type 630 17-4PH
	ASTM A325 & ASTM A311

15.1.3 Vertical Cask Transporter

The materials used in the construction of the VCT are:

Lift Tower	ASTM A572, Grade 50 Carbon Steel
Lift Beam	ASTM A514 Carbon Steel
Lift Links	ASTM A514 Carbon Steel
Lift Pins/Bolts	ASTM A693/564, Type 630 17-4PH
	ASTM A325 & ASTM A311

15.1.4 Canisters and Storage Overpacks

Only canisters that have been approved by the NRC to store and transport commercial light water (PWR and BWR) spent nuclear fuel and*/or* GTCC waste will be received at the WCS CISF. The controls for limiting the types and forms of spent nuclear fuel received at the WCS CISF are the same as those placed on the cask systems by the NRC-issued site licenses or certificates of compliance for the included transportation and storage systems. The approved systems are listed in Section 2.1 of the Technical Specifications [15-6]. As demonstrated in Chapter 2, the WCS CISF is not located in an area where the canisters will experience atmospheric chloride corrosion. However, when the Aging Management Program for a give canister is invoked at the WCS CISF, the conditions at the point of origin for the canister will be used to determine which portions of the Aging Manager Program will be applied to the canister at the WCS CISF. (See License Condition 20 for Aging Management Program Commitments for the WCS CISF).

All indicated changes are in response to RSI NP-4.2

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 3.3.1.3, 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 WCS 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.*

All indicated changes are in response to RSI NP-2.3

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.

All indicated changes are in response to RSI NP-4.1

Table A.3-1
Summary of WCS CISF Principal Design Criteria
(4 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 SAR 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 SAR 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 SAR 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 SAR 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 SAR 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 SAR Appendix B page 8.1-29* Maximum insertion load 80 kips Maximum extraction load 80 kips
Ambient Temperatures	Normal temperature 44.1 – 81.5°F	Normal (Bounded)	*Rancho Seco SAR Section 8.1.1.3 of Volume 1* Normal temperature 0 - *101*°F(1)

All indicated changes are in response to RSI NP-2.3

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

Design Parameter	WCS CISF Design Criteria	Condition	NUHOMS®-MP187 Design Criteria
Off-Normal Temperature	Minimum temperature 30.1°F Maximum temperature *113*°F	Off-Normal (Bounded)	*Rancho Seco SAR 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 SAR 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 (Same)	*Rancho Seco FSAR Table 8-1 of Volume 2* Horizontal flat surface insolation 2949.4 BTU/day-ft^2 Curved surface solar insolation Not Specified
Snow and Ice	Snow Load 10 psf	Normal (Bounded)	*Rancho Seco SAR Section 3.2.4 Volume 1* Snow Load 110 psf
Dead Weight	Per design basis for systems listed in Table 1-1	Normal (Same)	*Section 8.1.1.1 of Volume 1of* Reference [A.3-1]
Internal and External Pressure Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	*Sections 3.2.2 and 8.1.1.2 of Volume 1 of* Reference [A.3-1]
Design Basis Thermal Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	*Sections 8.1.1.4, 8.1.1.5, 8.1.1.7 and 8.1.1.8 of Volume 1 of* Reference [A.3-1]
Operating Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	See Reference [A.3-1]
Live Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	*Rancho Seco SAR Section 3.2.4 of Volume 1* Design Load (including snow and ice) 200psf

All indicated changes are in response to RSI NP-6.3

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]. Any conflicts between the following steps and [A.5-1] shall be resolved, recognizing that a revision to the transport license may be required to alter any steps required by [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.

All indicated changes are in response to RSI NP-4.3

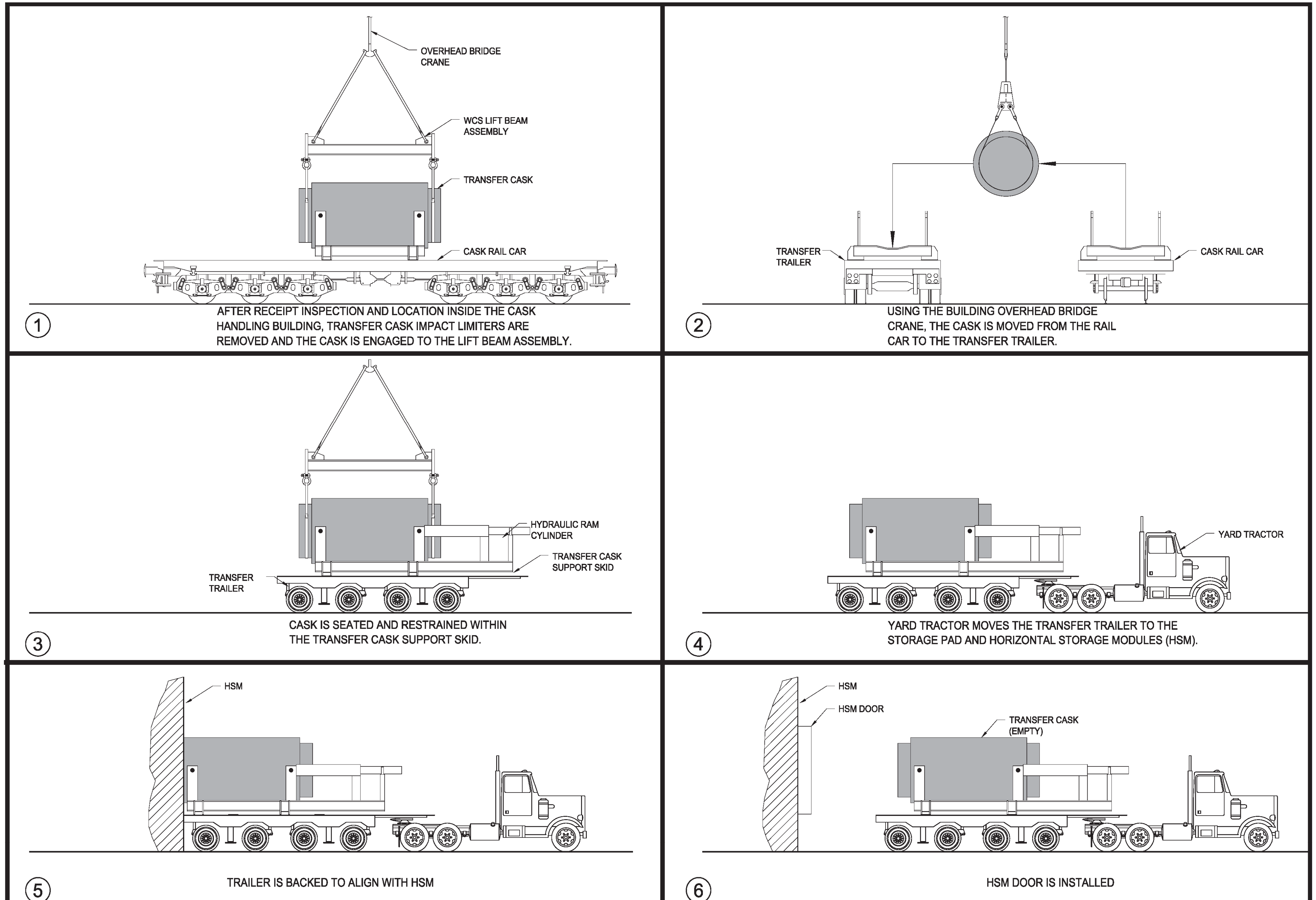


Figure A.5-1
NUHOMS®-MP187 System Operations

All indicated changes are in response to RSI NP-4.3

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 Waste Control Specialists, LLC (WCS) Consolidated Interim Storage Facility (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.

All indicated changes are in response to RSI NP-9.3

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.

All indicated changes are in response to RSI NP-9.3

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.

All indicated changes are in response to RSI NP-6.3

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.*

All indicated changes are in response to RSI NP-9.3

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.

All indicated changes are in response to RSI NP-9.3

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)*

All indicated changes are in response to RSI NP-9.3

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:

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

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

By integrating the equation above, we get the following:

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

All indicated changes are in response to RSI NP-9.3

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.

$$F = 52{,}580 \times 25g = 1{,}314{,}500 \qquad \text{[for NCT]}$$

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.

All indicated changes are in response to RSI NP-9.3

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.*

All indicated changes are in response to RSI NP-9.3

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 WCS 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.

All indicated changes are in response to RSI NP-9.3

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

All indicated changes are in response to RSI NP-9.3

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:*

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

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

By integrating the equation above we get the following.

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

All indicated changes are in response to RSI NP-9.3

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.

$$F = 52{,}580 \times 25g = 1{,}314{,}500 \qquad [\text{for NCT}]$$

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 ($\theta = 0$) 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.

All indicated changes are in response to RSI NP-9.3

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.

All indicated changes are in response to RSI NP-9.3

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.

All indicated changes are in response to RSI NP-9.3

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

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

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

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

A.7-16 AREVA 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.

All indicated changes are in response to RSI NP-9.3

A.7-18 AREVA 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 AREVA TN Document 2069.0200, Revision 0, "NUHOMS®-MP187 FO-DSC 10CFR72 Structural Analysis."

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

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

All indicated changes are in response to RSI NP-9.3

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*

All indicated changes are in response to RSI NP-9.3

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*

All indicated changes are in response to RSI NP-9.3

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

All indicated changes are in response to RSI NP-9.3

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

All indicated changes are in response to RSI NP-9.3

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]	$P_m \leq 1.0S_m$ $P_L \leq 1.5S_m$ $P_m(or\ P_L) + P_b \leq 1.5S_m$ $F_p \leq 1.0S_y\ or\ 1.5S_y$ $\sigma_1 + \sigma_2 + \sigma_3 \leq 4S_m$ 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]	$P_m \leq 1.0S_m$ $P_L \leq 1.5S_m$ $P_m(or\ P_L) + P_b \leq 1.5S_m$ $P_m(or\ P_L) + P_b + Q \leq 3.0S_m$ $F_p \leq 1.0S_y\ or\ 1.5S_y$ $\sigma_1 + \sigma_2 + \sigma_3 \leq 4S_m$ 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.*

All indicated changes are in response to RSI NP-9.3

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

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

All indicated changes are in response to RSI NP-9.3

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

Temp (°F)	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

All indicated changes are in response to RSI NP-9.3

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*

All indicated changes are in response to RSI NP-9.3

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

All indicated changes are in response to RSI NP-9.3

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

All indicated changes are in response to RSI NP-9.3

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

All indicated changes are in response to RSI NP-9.3

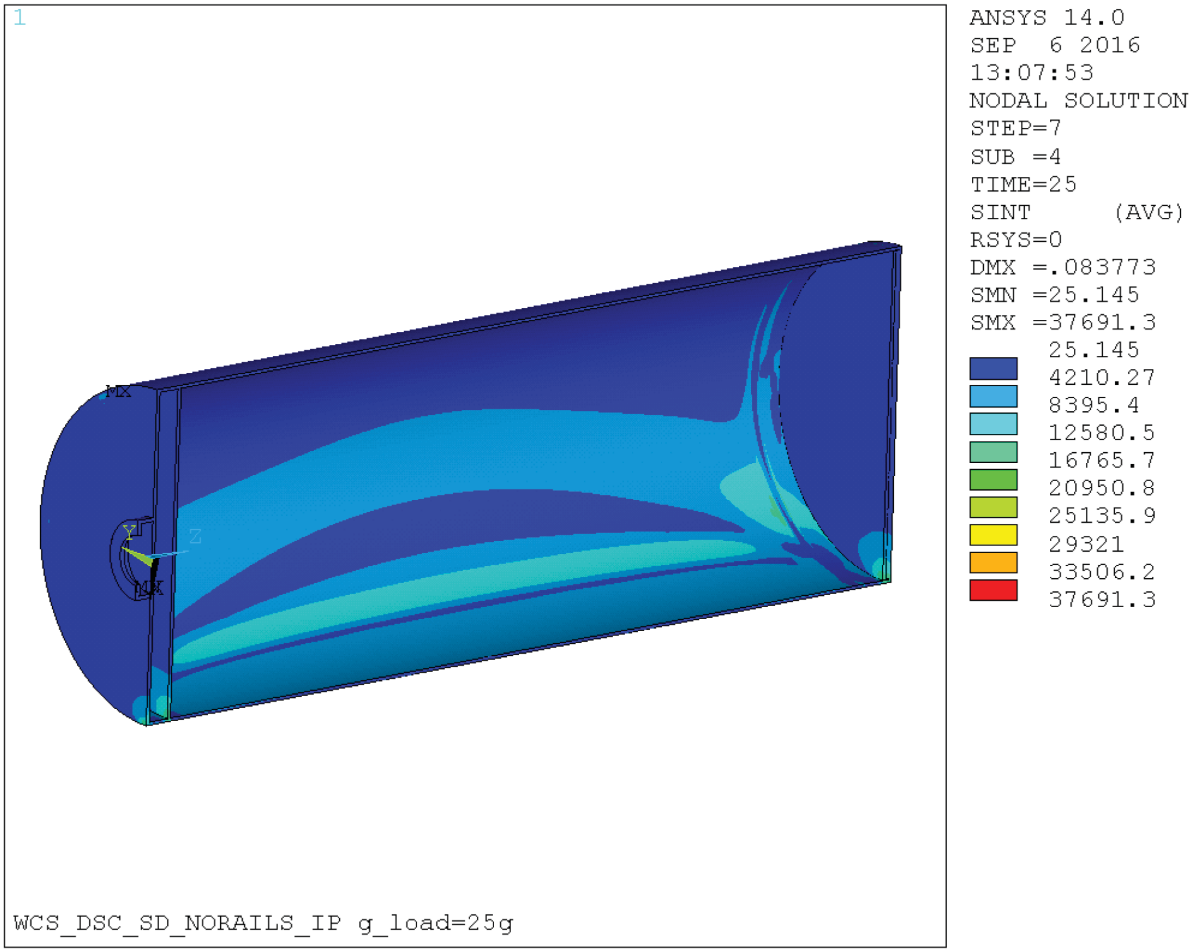


Figure A.7-7
Stress Intensity Plot for Most Critical Load Case (Side Drop Away from Rails with Internal Pressure) FC- and FF-DSCs

All indicated changes are in response to RSI NP-9.3

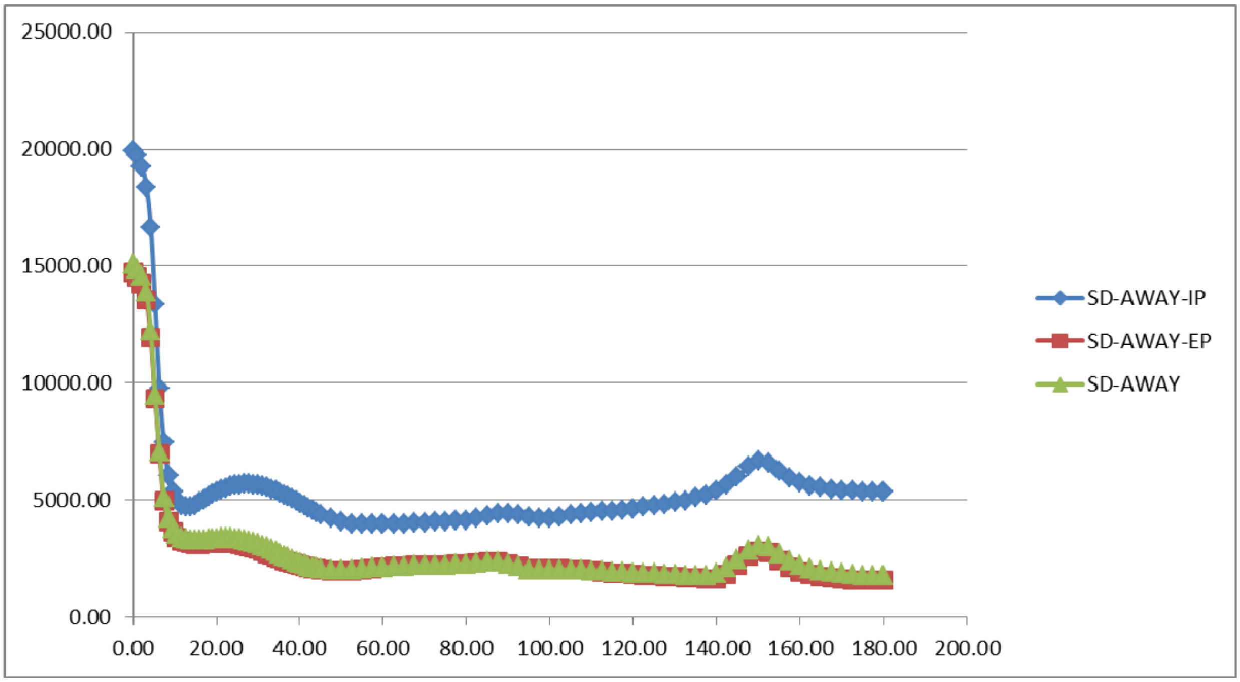


Figure A.7-8
Variation of OTCP – DSC Shell Weld Stress Intensity with Angle (ɵ) FC- ad FF-DSCs

All indicated changes are in response to RSI NP-9.3

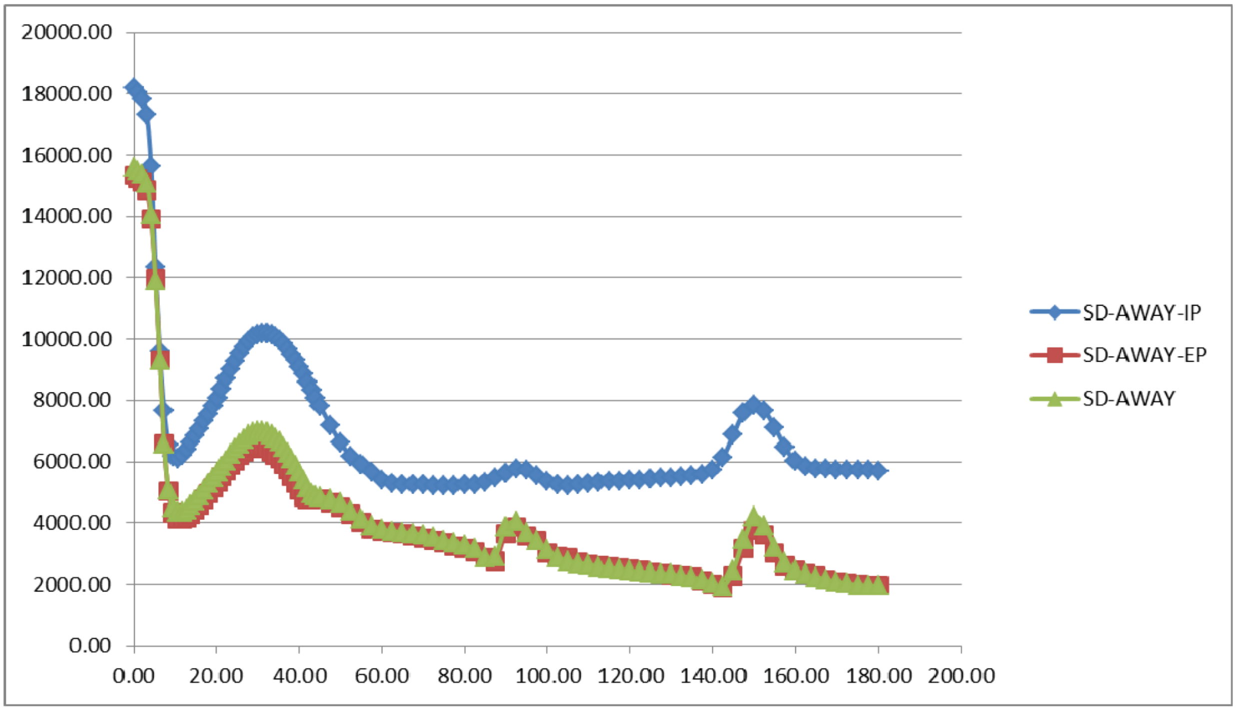


Figure A.7-9
Variation of ITCP – DSC Shell Weld Stress Intensity with Angle (ө) FC- ad FF-DSCs

All indicated changes are in response to RSI NP-9.3

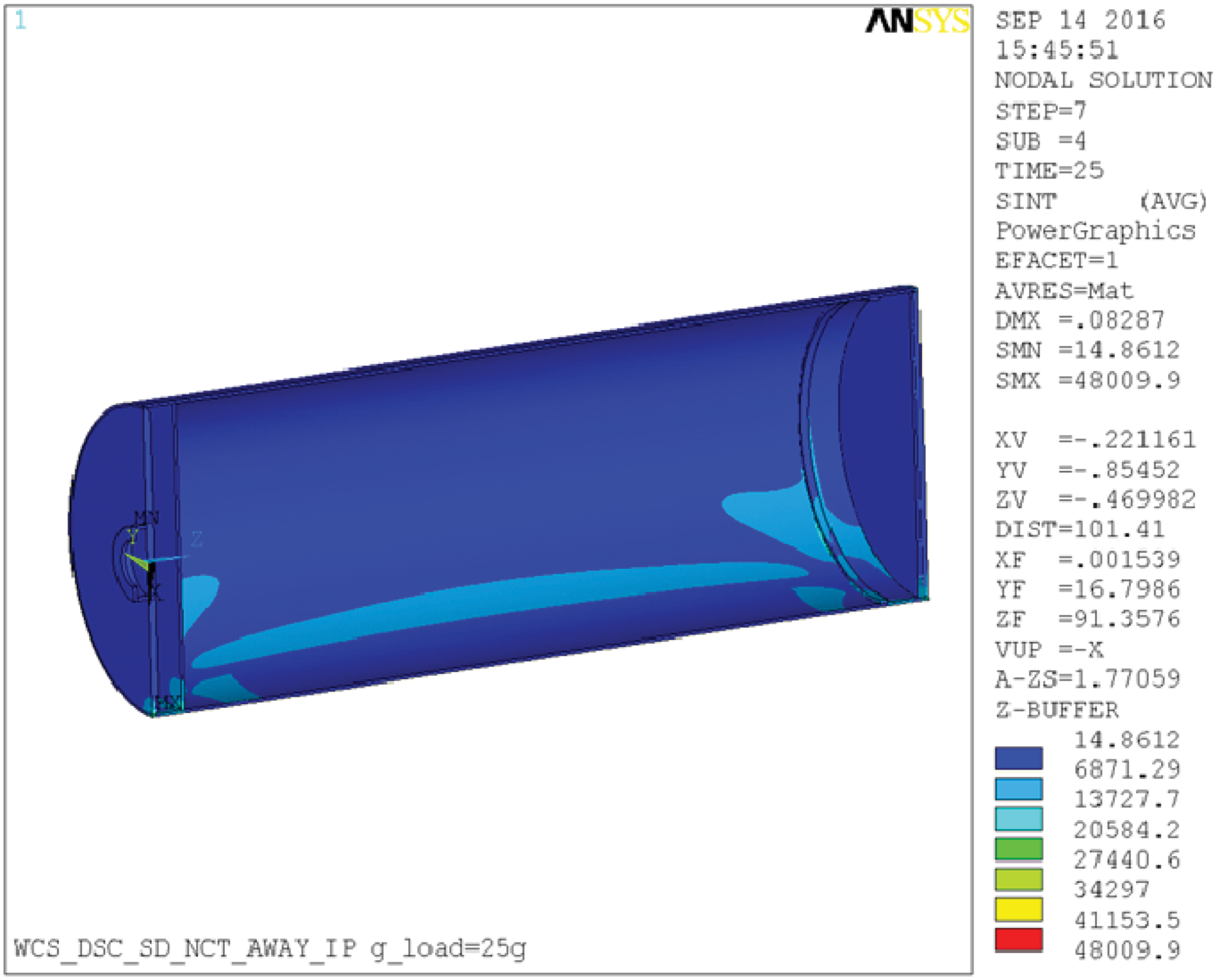


Figure A.7-10
Stress Intensity Plot for Most Critical Load Case (Side Drop Away from Rails with Internal Pressure) FO- and 24PT1 DSCs

All indicated changes are in response to RSI NP-9.3

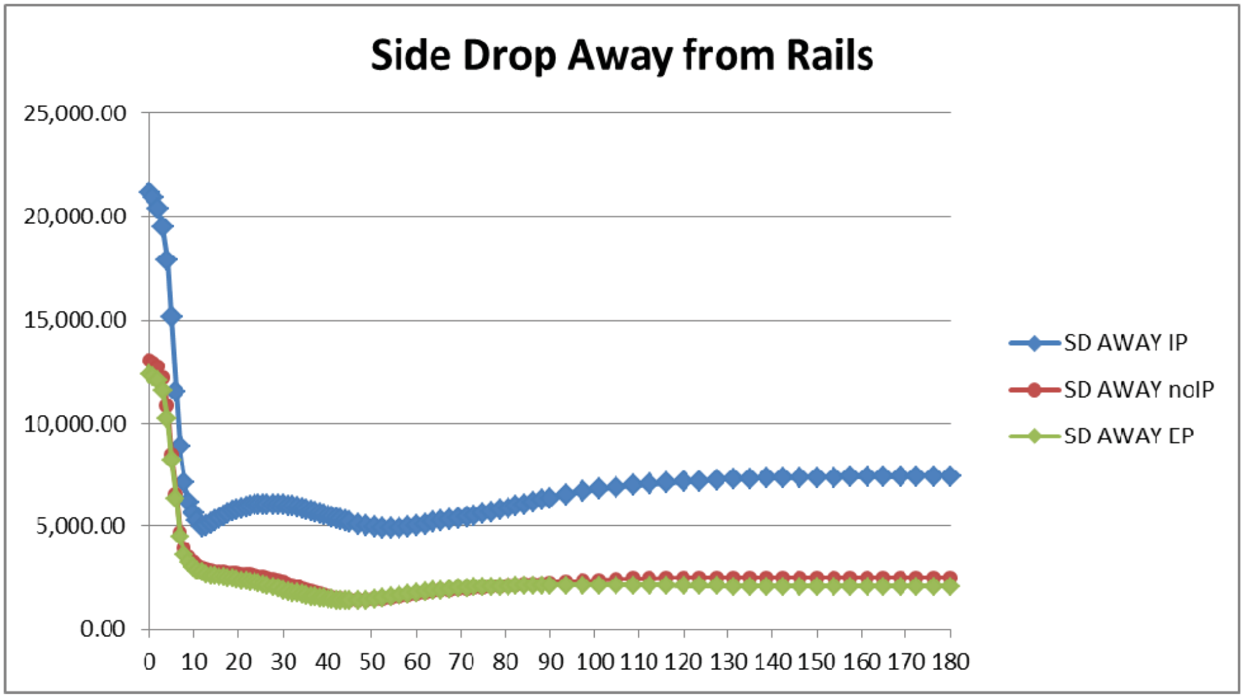


Figure A.7-11
Variation of OTCP – DSC Shell Weld Stress Intensity with Angle (θ) FO- and 24PT1 DSCs

All indicated changes are in response to RSI NP-9.3

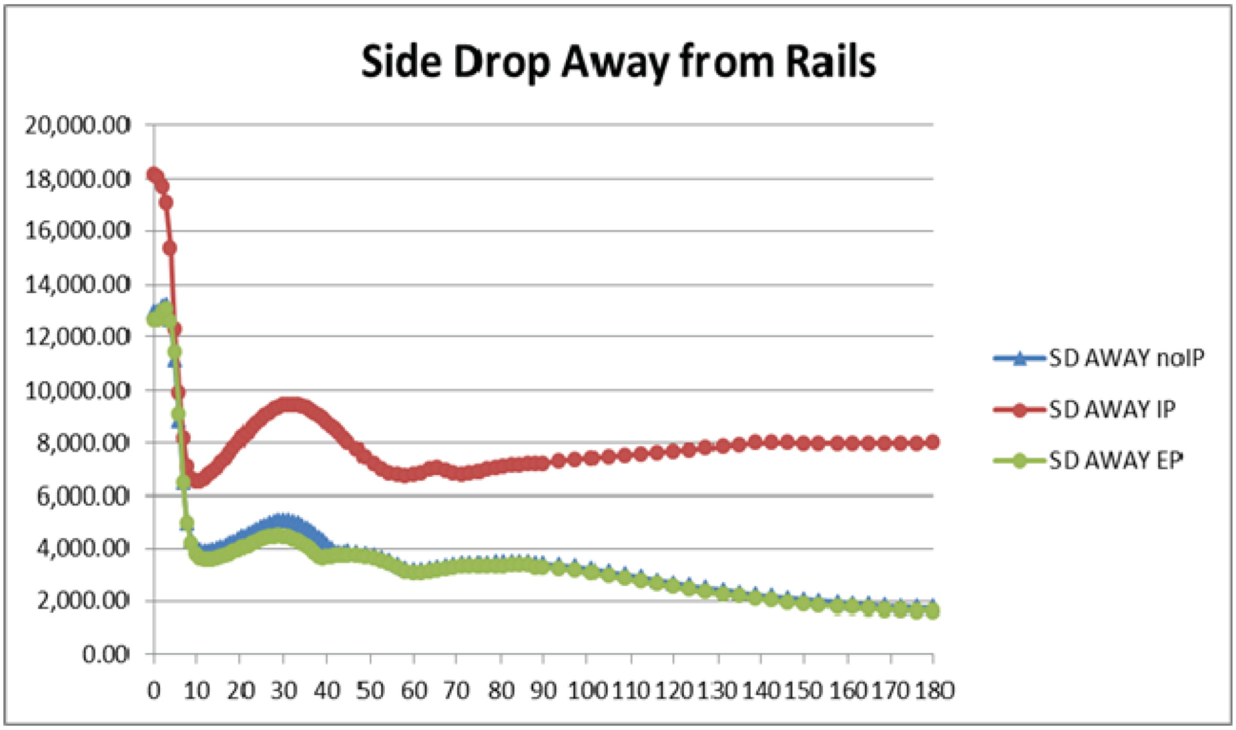


Figure A.7-12
Variation of ITCP – DSC Shell Weld Stress Intensity with Angle (θ) FO- and 24PT1 DSCs

All indicated changes are in response to RSI NP-9.3

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 SAR [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. Similarly, the lowest off-normal ambient temperature evaluated for the WCS CISF is *30.1°F and is bounded by 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.

All indicated changes are in response to RSI NP-6.3

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.

All indicated changes are in response to RSI NP-4.4

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 LC 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.

All indicated changes are in response to RSI NP-9.3

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 3.3.1.3, 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].

All indicated changes are in response to RSI NP-2.3

B.3.3 Design Criteria for Environmental Conditions and Natural Phenomena

B.3.3.1 Tornado Wind and Tornado Missiles

The design basis tornado wind and tornado missiles for the Standardized Advanced NUHOMS® Horizontal Modular Storage System AHSM are provided in Section 2.2.1 of reference [B.3-1] and for the NUHOMS®-MP187 cask in Section 3.2.1 of Volume 1 of reference [B.3-2]. The Standardized Advanced NUHOMS® Horizontal Modular Storage 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 [B.3-9]) while the WCS CISF is in Region II, a less severe location with respect to tornado and tornado missiles.

The AHSM protects the DSC from adverse environmental effects and is the principal structure exposed to tornado wind and missile loads. Furthermore, all components of the AHSM (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.

B.3.3.2 Water Level (Flood) Design

The 24PT1 DSCs and AHSMs are designed for an enveloping design basis flood, postulated to result from natural phenomena as specified by 10 CFR 72.122(b). The system is evaluated for a flood height of 50 feet with a water velocity of 15 fps.

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

As documented in Sections 2.4.2.2 and 3.3.1.3, 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.

B.3.3.3 Seismic Design

The seismic criteria for the Standardized Advanced NUHOMS® Horizontal Modular Storage System AHSM are provided in Section 2.2.3 of reference [B.3-1]. This system was designed for very high seismic regions, such as the west coast, and as such the design basis earthquake shown in Figures 2.2-1 and 2.2-2 of reference [B.3-1] for the AHSM easily envelops *the enveloping acceleration response spectra at the WCS concrete pad base and HSM center of gravity obtained by the WCS CISF soil-structure interaction (SSI) analysis* at all frequencies as demonstrated in Sections B.7.5 and B.7.8. Due to the very low accelerations, the ties between the individual modules and the shear keys used to transfer vertical motions are not required at the WCS CISF.

All indicated changes are in response to RSI NP-2.3

B.3.4.3 Thermal

The thermal performance requirements for the Standardized Advanced NUHOMS® Horizontal Modular Storage System are described in Section 2.3.2 of the "Advanced NUHOMS® Horizontal Modular Storage System Safety Analysis Report" [B.3-1]. The AHSM relies on natural convection through the air space in the AHSM 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 AHSM air outlet. This pressure difference is greater than the flow pressure drop (ΔP_f) at the design air inlet and outlet temperatures.

B.3.4.4 Shielding/Confinement/Radiation Protection

The shielding performance and radiation protection requirements for the Standardized Advanced NUHOMS® Horizontal Modular Storage System are described in Sections 2.3.2.5 and 2.3.5 of the "Advanced NUHOMS® Horizontal Modular Storage System Safety Analysis Report" [B.3-1]. The confinement performance requirements for the Standardized NUHOMS® Horizontal Modular Storage System are described in Section 2.3.2 of the "Advanced NUHOMS® Horizontal Modular Storage System Safety Analysis Report" [B.3-1] *for storage conditions. In addition, a bounding evaluation in WCS CISF SAR Section A.7.7 (also referenced in Section B.7.9) is performed to demonstrate that the confinement boundary for the 24PT1-DSC does not exceed ASME B&PV Subsection NB Article NB-3200 (Level A allowables) during normal conditions of transport to provide reasonable assurance that the confinement boundary is not adversely impacted by transport to the WCS CISF*.

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

B.3.4.5 Criticality

The criticality performance requirements for the Standardized Advanced NUHOMS® Horizontal Modular Storage System are described in Section 2.3.4 of the "Advanced NUHOMS® Horizontal Modular Storage System Safety Analysis Report" [B.3-1].

All indicated changes are in response to RSI NP-4.1

Table B.3-1
Summary of WCS CISF Principal Design Criteria
(4 pages)

Design Parameter	WCS CISF Design Criteria	Condition	Standardized Advanced NUHOMS® System Design Criteria
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)	*Advanced NUHOMS® SAR Section 2.2.1* Automobile 4000 lb, 195 ft/s 8" diameter shell 276 lb, 185 ft/s Solid Steel Sphere 0.147 lb, 23 ft/s 12" OD Steel Pipe 1500 lb, 185 fps Wood pole 1500 lb, 294 ft/s
Floods	*The WCS CISF is not in a floodplain and is above the Probable Maximum Flood elevation and will remain dry in the event of a flood.*	Accident (Bounded)	*Advanced NUHOMS® SAR Section 2.2.2* Flood height 50 ft Water velocity 15 ft/s
Seismic (Ground Motion)	Site-specific ground-surface uniform hazard response spectra (UHRS) with 1E-4 annual frequency of exceedance (AFE) having peak ground acceleration (PGA) of 0.250 g horizontal and 0.175 g vertical. (Table 1-5 and Figure 1-5)	Accident (Bounded)	*Advanced NUHOMS® SAR Section 2.2.3* Reg Guide 1.60 Response Spectra anchored at 1.5 g horizontal and 1.0 g vertical peak accelerations
Vent Blockage	For NUHOMS® Systems: Inlet and outlet vents blocked 40 hrs	Accident (Same)	*Advanced NUHOMS® SAR Section 4.6.2* Inlet and outlet vents blocked 40 hrs
Fire/Explosion	For NUHOMS® Systems: Equivalent fire 300 gallons of diesel fuel	Accident (Same)	*Advanced NUHOMS® SAR Section 4.6.4* 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)	*Section B.7.3 (New Evaluation)* 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	Off-Normal/ Accident (Same)	*Section B.7.3 (New Evaluation) and Advanced NUHOMS® FSAR Section 3.6.2.2.7* Normal insertion load 60 kips Normal extraction load 60 kips

All indicated changes are in response to RSI NP-2.3

Table B.3-1
Summary of WCS CISF Principal Design Criteria
(4 pages)

Design Parameter	WCS CISF Design Criteria	Condition	Standardized Advanced NUHOMS® System Design Criteria
Transfer Load	For NUHOMS® Systems only: Maximum insertion load 80 kips Maximum extraction load 80 kips	Off-Normal/ Accident (Same)	*Section B.7.3 (New Evaluation) and Advanced NUHOMS® FSAR Section 3.6.2.2.7* Maximum insertion load 80 kips Maximum extraction load 80 kips
Ambient Temperatures	Normal temperature 44.1 – 81.5°F	Normal (Bounded)	*Advanced NUHOMS® SAR Table 4.1-1* Normal temperature 0 - 110°F(1)
Off-Normal Temperature	Minimum temperature 30.1°F Maximum temperature *113*°F	Off-Normal (Bounded)	*Advanced NUHOMS® SAR Table 4.1-1* Minimum temperature -40.0°F Maximum temperature 120°F(2)
Extreme Temperature	Maximum temperature 113°F	Accident (Bounded)	*Advanced NUHOMS® SAR Table 4.1-1* Maximum temperature 120°F
Solar Load (Insolation)	Horizontal flat surface insolation 2949.4 BTU/day-ft^2 Curved surface solar insolation 1474.7 BTU/day-ft^2	Normal (Same)	*Advanced NUHOMS® SAR Section 4.4.2.2* Horizontal flat surface insolation 2952 BTU/day-ft^2 Curved surface solar insolation 1474.7 BTU/day-ft^2
Snow and Ice	Snow Load 10 psf	Normal (Bounded)	*Advanced NUHOMS® SAR Section 2.2.4* Snow Load 110 psf
Dead Weight	Per design basis for systems listed in Table 1-1	Normal (Same)	*Section 3.1.2.1.3.1, 3.6.1.1.3, and 3.6.2.2.1 of* reference [B.3-1]
Internal and External Pressure Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	Section 3.1.2.1.3.2 of reference [B.3-1]
Design Basis Thermal Loads	Per design basis for systems listed in Table 1-1	Normal (Same)	Section 3.1.2.1.3.3 of reference [B.3-1]

All indicated changes are in response to RSI NP-6.3

B.5.1 Procedures for Loading the DSC and Transfer to the AHSM

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

B.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 [B.5-1]. Any conflicts between the following steps and [B.5-1] shall be resolved, recognizing that a revision to the transport license may be required to alter any steps required by [B.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 [B.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 [B.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.

All indicated changes are in response to RSI NP-4.3

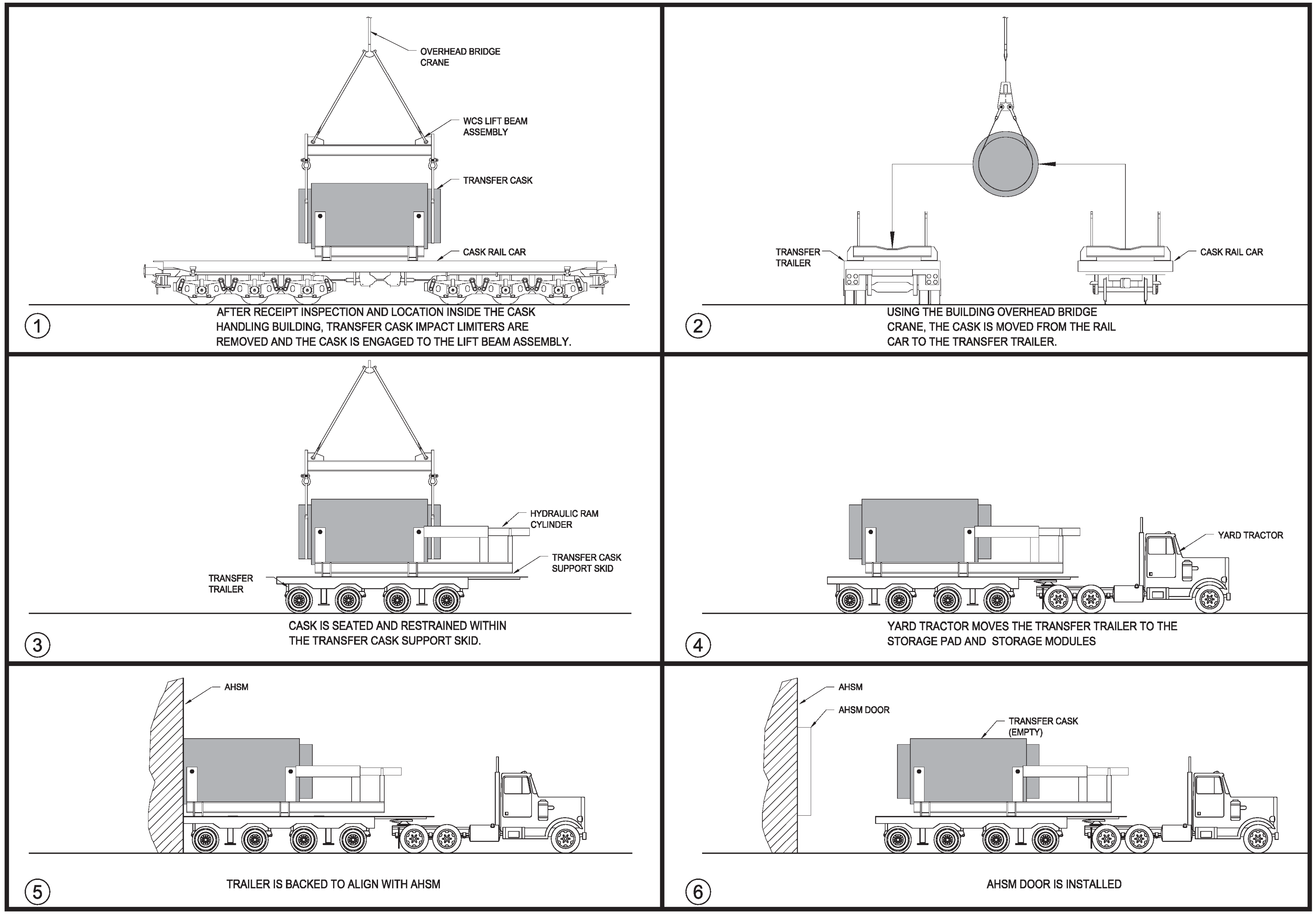


Figure B.5-1
Standardized Advanced NUHOMS® System Loading Operations

All indicated changes are in response to RSI NP-4.3

B.7. STRUCTURAL EVALUATION

This Appendix describes the structural evaluation of the Standardized Advanced NUHOMS® System components utilized for storage of canisterized spent nuclear fuel (SNF) at the Waste Control Specialists, LLC (WCS) Consolidated Interim Storage Facility (CISF). As presented in Chapter 1, Table 1-1, the Standardized Advanced NUHOMS® System storage components include the 24PT1 Dry Shielded Canister (DSC or canister) and the AHSM concrete overpack.

The 24PT1 DSC is described in Section 3.1.1.1 of the Standardized Advanced NUHOMS® Updated Final Safety Analysis Report (UFSAR) [B.7-1]. The AHSM is described in Section 3.1.1.2 of [B.7-1]. Both of these components are approved by the NRC [B.7-6] for storage of SNF under the requirements of 10 CFR Part 72.

At the WCS CISF, the NUHOMS®-MP187 cask will be used for on-site transfer operations. The MP187 cask is a multi-purpose cask approved by the NRC for on-site transfer of the FO-, FC-, and FF- DSCs and Greater Than Class C (GTCC) waste canisters [B.7-2], and as a transportation cask for off-site shipments of the FO-, FC-, FF-, 24PT1 DSCs [B.7-3]. Volume I and Volume III of the Rancho Seco Independent Spent Fuel Storage Installation Final Safety Analysis Report (ISFSI FSAR) [B.7-4] describe the MP187 cask when used as on-site transfer cask under 10 CFR Part 72. Section 1.2 of the NUHOMS®-MP187 Multi-Purpose Transportation Package Safety Analysis Report (SAR) [B.7-5] describes the MP187 cask when used as a transportation cask under 10 CFR Part 71.

This appendix is prepared to demonstrate that the licensed canisters and AHSM storage components are qualified to safely transfer and store SNF and GTCC waste at the WCS CISF. Additionally, this appendix provides the justification to allow use of the MP187 cask for on-site transfer of the canister, consistent with the cask's allowable payloads in the MP187 cask's transportation license.

The structural evaluations presented herein are based on existing analyses as documented in [B.7-1] for the 24PT1 DSC and the AHSM and [B.7-4] for the MP187 cask *except for the qualification of the 24PT1-DSC confinement boundary during Normal Conditions of Transport in Section B.7.9 which points to the evaluation documented in Section A.7.7.2*.

<u>MP187 Cask</u>

The design basis design criteria for the MP187 cask as an on-site transfer cask for the canisters is provided in [B.7-4] Volume I Table 3-4, Table 3-8, Table 3-9, and Table 3-10. The loading criteria summary shown in [B.7-4] Table 3-4 bounds the loading criteria for the WCS CISF as specified in Appendix B.3, Table B.3-1 (with the exception of seismic loading which is addressed in Section B.7.5).

All indicated changes are in response to RSI NP-9.3

B.7.1 Discussion

As discussed in Chapter 1, the 24PT1 DSCs, currently stored inside AHSMs at the San Onofre Nuclear Generating Station (SONGS) ISFSI, will be transported to the WCS CISF utilizing the NUHOMS®-MP187 Transportation Cask. The canisters and the AHSM are Standardized Advanced NUHOMS® System components for the storage of SNF under NRC Certificate of Compliance No. 1029 [B.7-6] and are described in Chapter 1 of [B.7-1]. The MP187 transportation cask is licensed under NRC Certificate of Compliance (CoC) No. 9255 [B.7-3].

At the WCS CISF, the canisters will be stored inside newly fabricated AHSMs utilizing the MP187 cask for on-site transfer operations. The MP187 cask is a multi-purpose cask licensed as an on-site transfer cask [B.7-2] under 10 CFR Part 72 as described in [B.7-4].

As described in [B.7-1] the canister and the AHSM utilize the OS197 transfer cask for on-site transfer operations. The OS197 transfer cask is licensed under CoC No. 1004 and is described in the Standardized NUHOMS® UFSAR [B.7-7]. This appendix reconciles the design basis analyses of the 24PT1 DSC in the OS197 transfer cask to justify use of the MP187 cask for transfer of the 24PT1 DSC at the WCS CISF.

The design basis seismic criteria for the canister and AHSM significantly exceed the seismic criteria for the WCS CISF (see Figure B.7-2). Hence, no reconciliation for seismic loads for the canister and AHSM need to be performed in this appendix.

The qualification of the MP187 cask for use as the on-site transfer cask at WCS CISF is based on the design basis analysis as documented in [B.7-4]. The cask stability evaluations in [B.7-4] use the hypothetical case of the cask as a storage component, and hence in the vertical configuration, as bounding the horizontal configuration in the transfer mode.

Finally, a bounding evaluation in Section B.7.9 is performed to demonstrate that the confinement boundaries for the 24PT1-DSC does not exceed ASME B&PV Subsection NB Article NB-3200 (Level A allowables) during normal conditions of transport to provide reasonable assurance that the confinement boundary is not adversely impacted by transport to the WCS CISF.

All indicated changes are in response to RSI NP-9.3

B.7.6 Thermal Stress Reconciliation of the Standardized Advanced NUHOMS® System Components

From Chapter 3, 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 [B.7-4] (for use of the MP187) and is bounded by the -40°F in [B.7-1] (for use of the canister and AHSM).

B.7.6.1 Reconciliation of WCS CISF Environmental Ambient Conditions with Environmental Ambient Conditions used for the AHSM Analyses in the Standardized Advanced NUHOMS® UFSAR

The AHSM structural analysis is performed for normal ambient temperature range of 0 °F to 104 °F and off-normal maximum temperature range of -40 °F to 117°F, respectively, in Section 3.6.2 of [B.7-1]. These temperatures bound the daily average ambient temperatures of 95°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 [B.7-1]. Therefore, the maximum temperatures and thermal stress evaluation results reported in [B.7-1] for the AHSM remain bounding for the WCS CISF.

B.7.6.2 Reconciliation of WCS CISF Environmental Ambient Conditions with Environmental Ambient Conditions used for the Canister Analysis in the Standardized Advanced NUHOMS® UFSAR

As documented in Table 4.1-1 (See also Table 3.1-8) of [B.7-1], the ambient temperature range for normal conditions is 0 °F to 104 °F. The ambient temperature range for off-normal and accident conditions is -40 °F to 117 °F. 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. Therefore, the maximum temperatures and thermal stress evaluation results reported in [B.7-1] for the canister in the AHSM remain bounding for the WCS CISF.

All indicated changes are in response to RSI NP-6.3

B.7.7 Conclusions of the Structural Analysis

This appendix demonstrates that the AHSM and the canister as described in [B.7-1] are suitable for storage at the WCS CISF. This appendix also demonstrates that the MP187 cask as described in [B.7-4] is suitable for transfer of the canister at the WCS CISF.

Furthermore, the design requirements and environmental conditions that form the design basis upon which the MP187 cask, the canister, and the AHSM components were licensed by the NRC bound the requirements and environmental conditions at the WCS CISF (with the exception of the seismic loading on the MP187 cask which is addressed in Section A.7.5.1). Therefore, the AHSM as described in [B.7-1] is acceptable for storage of the canister at the WCS CISF.

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

Finally, the structural performance of the canister confinement boundary was evaluated for Normal Conditions of Transport (See Section B.7.9) against ASME B&PC 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.

All indicated changes are in response to RSI NP-9.3

B.7.9 Structural Evaluation of 24PT1-DSC Confinement Boundary under Normal Conditions of Transport

The 24PT1-DSC shell assembly consists of a cylindrical shell, top outer/inner cover plates, bottom inner/outer cover plates and bottom and top shield plugs. The 24PT1-DSC consists of a shell, which is a welded, stainless steel cylinder with a stainless steel bottom closure assembly, and a stainless steel top closure assembly. Additional details, geometry and shell and plate thicknesses are provided on the drawings in Section B.4.6. The confinement boundary is addressed in Section B.11.1. The 24PT1-DSC shell is evaluated for Normal Conditions of Transport in the MP187 Transport cask in Section A.7.7.2 with the FO-DSC of the NUHOMS® MP187 Cask System.

Result of 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.

All indicated changes are in response to RSI NP-9.3

B.8.4 Ambient Conditions at the WCS CISF

B.8.4.1 Ambient Temperature Specification at WCS CISF

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

B.8.4.2 Comparison of WCS CISF Ambient Conditions with Ambient Conditions Used in the AHSM Thermal Evaluation from ANUH UFSAR [B.8-1] for Storage Conditions

A review of the ambient temperatures used in the thermal evaluation of AHSM in Section 4.1.2 of [B.8-1] shows that average daily ambient temperatures of 97°F and 107°F *corresponding to a maximum ambient temperatures of 101°F and 117°F* are used for normal and off-normal hot storage conditions, respectively. These temperatures bound the ambient temperatures for normal and off-normal conditions at the WCS CISF. *In addition, the accident ambient temperature of 113°F listed in Table 1-2 for the WCS CISF is the daily maximum ambient temperature. This is bounded by the daily maximum temperature of 117°F considered for the off-normal conditions.* Similarly, the lowest off-normal ambient temperature at the WCS CISF is *30.1*°F, which is bounded by the -40°F considered for the off-normal conditions as noted in Table 4.1-1 of [B.8-1].

Based on this discussion, the ambient conditions used for the thermal evaluations for storage operations in the thermal evaluation of AHSM in [B.8-1] are bounding for the WCS CISF.

B.8.4.3 Comparison of WCS CISF Ambient Conditions with Ambient Conditions Used in the Rancho Seco ISFSI SAR [B.8-4] for Transfer Conditions

A review of the thermal evaluation presented in Section 8.1.1.1, Volume II of [B.8-4] 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 ambient temperatures for normal*,* off-normal*, and accident* conditions, respectively at the WCS CISF. Similarly, the lowest off-normal ambient temperature at the WCS CISF is *30.1°F and is bounded by the* -20°F, cold conditions considered in [B.8-4].

Based on this discussion, the ambient conditions used for the thermal evaluations for transfer operations in [B.8-4] are bounding for the WCS CISF.

All indicated changes are in response to RSI NP-6.3

B.9.2 Occupational Exposure Evaluation

B.9.2.1 Analysis Methodology

Dose rates are known in the vicinity of the AHSM and MP187 cask based upon the existing FSAR[B.9-1] and SAR[B.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.

B.9.2.2 Dose Assessment

A dose assessment is performed for receipt and transfer of an NUHOMS®-24PT1 DSC to AHSM using the MP187 cask.

Seven general locations around the cask are defined, as shown in the top half of Figure B.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 B.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 *[B.9-2]*. Dose rates for the transfer operations are obtained from *Table 5.1-2 of* the storage FSAR *[B.9-1]* for the AHSM.

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

- For transfer of the 24PT1 DSC inside the MP187 cask, bounding dose rates for transfer of the 24PT1 DSC inside the OS197 transfer cask *from Tables 5.1-3, 5.1-4 and 5.1-5 of reference [B.9-1]* are utilized. This approach is conservative because the OS197 transfer cask contains less shielding than the MP187 cask.

All indicated changes are in response to RSI NP-4.4

B.11.1 Confinement Boundary

The 24PT1 DSC confinement is documented in Chapter 7 of the "Standardized Advanced NUHOMS® System Updated Final Safety Analysis Report" [B.11-1]. Section 7.1 of [B.11-1] details the requirements of the confinement boundary. *Figure 7.1-1 of reference [B.11-1] provides a figure that shows the components and welds that make up the confinement boundary for the 24PT1-DSC. Drawings for the canisters, including the confinement boundary are referenced in Section B.4.6. In addition, a bounding evaluation in Section A.7.7 (also referenced in Section B.7.9) is performed to demonstrate that the confinement boundary for the 24PT1-DSC does not exceed ASME B&PV Subsection NB Article NB-3200 (Level A allowables) during normal conditions of transport to provide reasonable assurance that the confinement boundary is not adversely impacted by transport to the WCS CISF.*

The Technical Specifications for Standardized Advanced NUHOMS® [B.11-2] outline the requirements for preventing the leakage of radioactive materials in the 24PT1 DSC. Section 4.3, "Codes and Standards," lists the codes and standards for design, fabrication, and inspection of the 24PT1 DSC, including alternatives to the ASME Code for the 24PT1 DSC shell assembly and basket.

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

All indicated changes are in response to RSI NP-9.3

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

Accident Analysis

The structural and thermal consequences of a fire accident are addressed in Section 12.2.4.2 of [B.12-1]. Appendix B.8 demonstrates that the MP187 cask performs its safety functions during and after the postulated fire/explosion accident. As stated above, the maximum flammable fuel either during the transfer operation or inside the WCS CISF is 300 gallons of diesel fuel.

Accident Dose Calculations

As documented in Section 11.2.4.3 of [B.12-1], there are minimal radiological consequences for this accident condition.

Corrective Actions

Consistent with Section 11.2.4.4 of [B.12-1], evaluation of AHSM or cask neutron shield damage as a result of a fire is to be performed to assess the need for temporary shielding (for AHSM or cask, if fire occurs during transfer operations) and repairs to restore the transfer cask and AHSM to pre-fire design conditions.

B.12.2.6 Flood

Cause of Accident

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

Accident Analysis

As documented in Sections 2.4.2.2 and 3.3.1.3, 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.

All indicated changes are in response to RSI NP-2.3

C.3.3 Design Criteria for Environmental Conditions and Natural Phenomena

C.3.3.1 Tornado Wind and Tornado Missiles

The design basis tornado wind and tornado missiles for the Standardized NUHOMS® Horizontal Modular Storage System HSM Model 102 are provided in Section K.2.2.1 and Section 3.2.1 of reference [C.3-1] and in Table C.3-1 for the NUHOMS®-MP197HB cask. The 61BT-DSC and HSM Model 102 components are designed and conservatively evaluated for the most severe tornado winds and missiles postulated to occur anywhere within the United States (Region I as defined in NRC Regulatory Guide 1.76 [C.3-8]) while the WCS CISF is in Region II, a less severe location with respect to tornado and tornado missiles. The MP197HB cask is evaluated against the Region II tornado and tornado missiles as described in Appendix C.7.

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

C.3.3.2 Water Level (Flood) Design

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

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

As documented in Sections 2.4.2.2 and 3.3.1.3, 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.

C.3.3.3 Seismic Design

The seismic criteria for the Standardized NUHOMS® System HSM Model 102 are provided in Section K.2.2.3 and Section 3.2.3 of reference [C.3-1]. *The site-specific seismic ground motion developed for the WCS CISF in the form of the 10,000-year return period uniform hazard response spectrum for the horizontal and vertical directions are described in Chapter 2. Those spectra are used to derive the enveloped acceleration spectra at the WCS concrete pad base and HSM center of gravity. These enveloped spectra are the design seismic basis for the NUHOMS®-61BT System components.*

All indicated changes are in response to RSI NP-2.3

C.3.4.4 Shielding/Confinement/Radiation Protection

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

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

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

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

C.3.4.5 Criticality

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

All indicated changes are in response to RSI NP-4.1

Table C.3-1
Summary of WCS CISF Principal Design Criteria
(4 pages)

Design Parameter	WCS CISF Design Criteria	Condition	NUHOMS®-61BT Design Criteria
Tornado (HSM Missile)	Automobile 4000 lb, 112 ft/s Schedule 40 Pipe 287 lb, 112 ft/s Solid Steel Sphere 0.147 lb, 23 ft/s	Accident (Bounded)	*Standardized NUHOMS® SAR Section 3.2.1 and Section K.2.2.1* Automobile 4000 lb, 195 ft/s 8" diameter shell 276 lb, 185 ft/s Solid Steel Sphere 0.147 lb, 23 ft/s Wood plank missile 1500 lb, 440 ft/s
Tornado (MP197HB Missile)	Automobile 4000 lb, 112 ft/s Schedule 40 Pipe 287 lb, 112 ft/s Solid Steel Sphere 0.147 lb, 23 ft/s	Accident (Same)	*Section C.7.7.1 (New Evaluation)* Automobile 4000 lb, 112 ft/s Schedule 40 Pipe 287 lb, 112 ft/s Solid Steel Sphere 0.147 lb, 23 ft/s
Floods	*The WCS CISF is not in a floodplain and is above the Probable Maximum Flood elevation and will remain dry in the event of a flood.*	Accident (Bounded)	*Standardized NUHOMS® SAR Sections 3.2.2 and Section K.2.2.2* Flood height 50 ft Water velocity 15 ft/s
Seismic (Ground Motion)	Site-specific ground-surface uniform hazard response spectra (UHRS) with 1E-4 annual frequency of exceedance (AFE) having peak ground acceleration (PGA) of 0.250 g horizontal and 0.175 g vertical. (Table 1-5 and Figure 1-5)	Accident (*Evaluated*)	*See Evaluations in Section 7.6.4, 7.6.5, C.7.3 and C.7.5.3.*
Vent Blockage	For NUHOMS® Systems: Inlet and outlet vents blocked 40 hrs	Accident (Same)	*Standardized NUHOMS® SAR Section K.4.6.1* Inlet and outlet vents blocked 40 hrs
Fire/Explosion	For NUHOMS® Systems: Equivalent fire 300 gallons of diesel fuel	Accident (Same)	*Section C.8.5 (New Evaluation) Standardized NUHOMS® SAR Section K.4.6.5* Equivalent fire 300 gallons of diesel fuel

All indicated changes are in response to RSI NP-2.3

Table C.3-1
Summary of WCS CISF Principal Design Criteria
(4 pages)

Design Parameter	WCS CISF Design Criteria	Condition	NUHOMS®-61BT Design Criteria
Cask Drop	For NUHOMS® Systems: Transfer Cask Horizontal side drop or slap down 80 inches(2)	Accident (Same)	*Section C.7.7 (New Evaluation)* Transfer Cask Horizontal side drop or slap down 80 inches(2)
Transfer Load	For NUHOMS® Systems only: Normal insertion load 60 kips Normal extraction load 60 kips	Normal (Same)	*Sections C.7.7 (New Evaluation) and Standardized NUHOMS® SAR Section K.3.6.1.1* 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)	*Sections C.7.7 (New Evaluation) and Standardized NUHOMS® SAR Section K.3.6.2.1* Maximum insertion load 80 kips Maximum extraction load 80 kips
Ambient Temperatures	Normal temperature 44.1 – 81.5°F	Normal (Bounded)	*Sections C.8.5 (New Evaluation) and Standardized NUHOMS® SAR Section K.4.4.1* Normal temperature 0 - 100°F(1)
Off-Normal Temperature	Minimum temperature 30.1°F Maximum temperature *113*°F	Off-Normal (Bounded)	*Sections C.8.5 (New Evaluation) and Standardized NUHOMS® SAR Section K.5.2* Minimum temperature -40.0°F Maximum temperature 125°F
Extreme Temperature	Maximum temperature 113°F	Accident (Bounded)	*Sections C.8.5 (New Evaluation) and Standardized NUHOMS® SAR Section K.5.2* Maximum temperature 125°F

All indicated changes are in response to RSI NP-6.3

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

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

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

Procedures for receiving the loaded TC after shipment are described in this section. These procedures are taken from reference [C.5-1]. Any conflicts between the following steps and [C.5-1] shall be resolved, recognizing that a revision to the transport license may be required to alter any steps required by [C.5-1].

1. Verify that the tamperproof seals are intact.

2. Remove the tamperproof seals.

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

4. Remove the impact limiters from the TC.

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

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

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

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

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

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

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

11. Remove the *WCS Lift Beam Assembly*.

12. Install the TC shear key plug assembly.

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

All indicated changes are in response to RSI NP-4.3

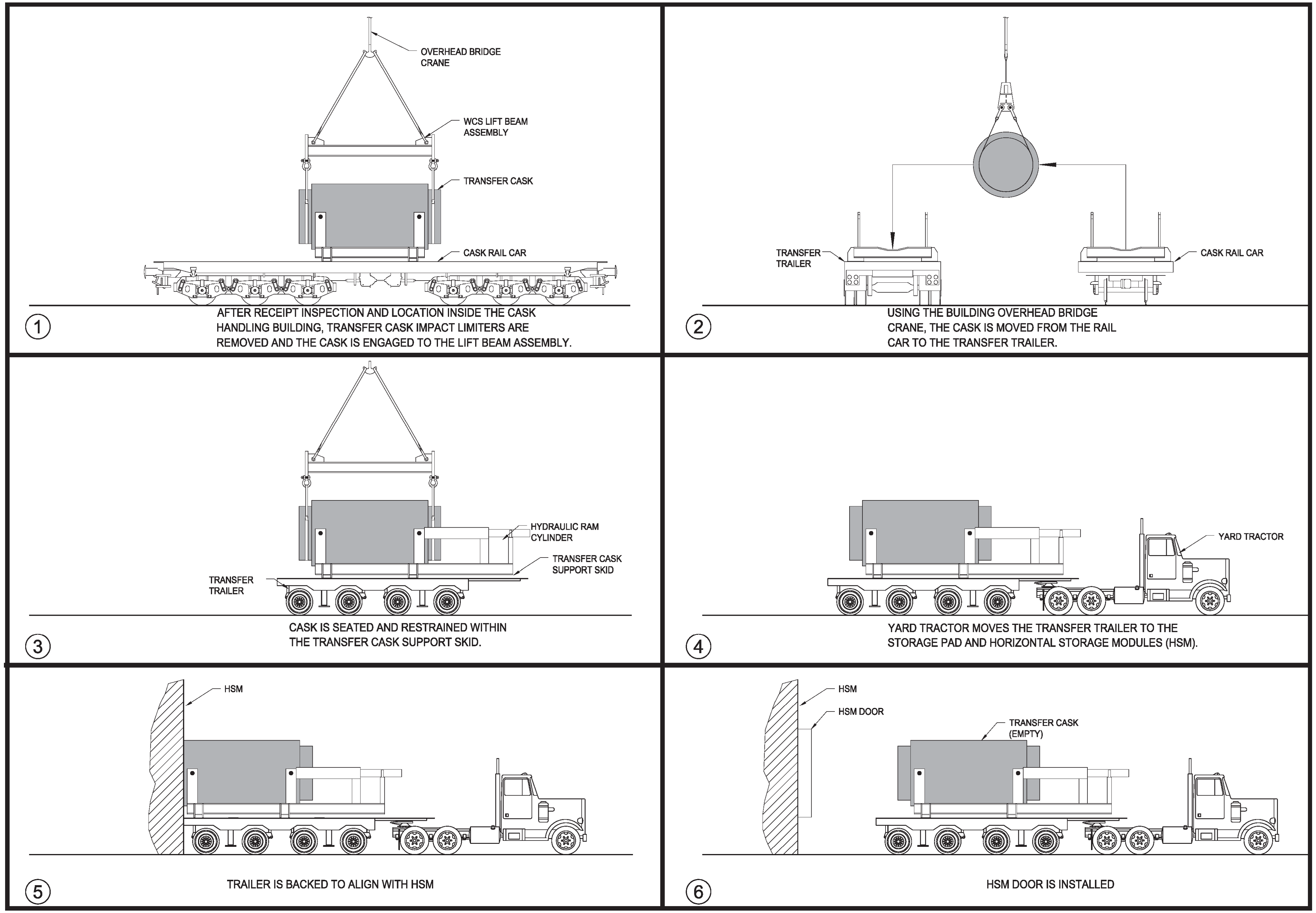


Figure C.5-1
Standardized NUHOMS®-61BT System Loading Operations

All indicated changes are in response to RSI NP-4.3

C.7. STRUCTURAL EVALUATION

This Appendix describes the structural evaluation of the Standardized NUHOMS®-61BT System components utilized for transfer and storage of canisterized spent nuclear fuel (SNF) at the Waste Control Specialists, LLC (WCS) Consolidated Interim Storage Facility (CISF). As presented in Chapter 1, Table 1-1, the Standardized NUHOMS®-61BT System storage components include the 61BT Dry Shielded Canister (DSC or canister) and the HSM Model 102 concrete overpack. At the WCS CISF, the MP197HB transportation cask is used for on-site transfer activities.

The HSM Model 102 is described in detail in Section 4.2.3.2 of the Standardized NUHOMS® Updated Final Safety Analysis Report (UFSAR) [C.7-13]. The 61BT DSC is described in detail in Section K.1.2 of [C.7-13]. Both of these components are approved by the NRC [C.7-13] for transfer and storage of SNF under the requirements of 10 CFR Part 72.

The MP197HB cask is described in detail in Section A.1.2 of the NUHOMS®-MP197 Transportation Package Safety Analysis Report (SAR) [C.7-1]. The MP197HB cask is approved by the NRC for off-site transport of canisters under the requirements of 10 CFR Part 71. This SAR presents the analyses required for approval of the MP197HB cask as the on-site transfer cask at the WCS CISF under the requirements of 10 CFR Part 72. The structural evaluation of the MP197HB cask as the on-site transfer cask is contained in this appendix. The evaluation of the canisters for transfer and storage is contained in Appendix K of [C.7-13] for the Standardized NUHOMS®-61BT System [C.7-13]. The evaluation of the HSM Model 102 is contained in Chapter 8 of [C.7-13].

This appendix is prepared to demonstrate that these licensed Standardized NUHOMS®-61BT System components are also qualified to safely transfer and store SNF at the WCS CISF. In addition to the seismic reconciliation evaluation presented in Section C.7.3, this appendix presents the analyses required to qualify the MP197HB cask for on-site transfer activities per 10 CFR Part 72 for the 61BT and 61BTH Type 1 canisters. These analyses, in combination with existing evaluations in [C.7-13], demonstrate that the MP197HB / Canisters / HSM Model 102 transfer and storage system satisfies all of the 10 CFR Part 72 requirements for storage at the WCS CISF. *Qualification of the 61BT DSC confinement boundary during Normal Conditions of Transport is addressed in Section C.7.8.*

MP197HB Cask

The principal design criteria for the MP197HB cask for service at the WCS CISF are described in Table C.7-1 and below in Section C.7.7.1. The design approach, design criteria and loading combinations for the MP197HB cask are also described in Section C.7.7.1.

All indicated changes are in response to RSI NP-9.3

C.7.1 Discussion

As discussed in Chapter 1, the canisters from an ISFSI site will be transported to the WCS CISF in the NUHOMS®-MP197HB Cask under NRC Certificate of Compliance (CoC) 9302 [C.7-1]. At the WCS CISF, the 61BT DSCs, described in Appendix K of [C.7-13], are to be stored inside the Standardized NUHOMS® HSM Model 102 described in Chapter 4 of [C.7-13].

The 61BT DSC is licensed under NRC Certificate of Compliance 1004 [C.7-13] for storage in the HSM Model 102 and for transfer operations in the OS197 cask. This appendix will reconcile the analyses of the canister for transfer operations in the OS197 cask with the transfer operations in the MP197HB cask specified for the WCS CISF. Additionally, this appendix provides the structural analysis required to support the licensing of the MP197HB cask under 10 CFR Part 72 for on-site transfer operations at the WCS CISF.

As described in Chapter 3, with the exception of seismic loading, the design criteria for the Standardized NUHOMS® components used in [C.7-13] envelops the design criteria for the WCS CISF.

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

All indicated changes are in response to RSI NP-9.3

C.7.8 Structural Evaluation of 61BT DSC Confinement Boundary under Normal Conditions of Transport

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

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

All indicated changes are in response to RSI NP-9.3

C.8.4 Thermal Analysis of HSM Model 102 with 61BT DSC for Storage Conditions

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

C.8.4.1 Ambient Temperature Specification at WCS CISF

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

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

A review of the thermal evaluation presented in Section K.4.4.1, Chapter K.4 of [C.8-3] shows that average daily ambient temperatures of 100°F and 125°F are used for normal and off-normal hot storage conditions, respectively. These temperatures bound the ambient temperatures for normal, off-normal, *and accident* conditions at the WCS CISF. Similarly, the lowest off-normal ambient temperature at the WCS CISF is *30.1°F and* is bounded by the -40°F used in [C.8-3].

Based on this discussion, the thermal evaluation for storage conditions presented in Chapter K.4 of [C.8-3] is bounding for the WCS CISF and no additional evaluations are performed. Sections C.8.4.2 through C.8.4.4 present the references to the appropriate section within [C.8-3] as it relates to the thermal evaluations performed for 61BT DSC and HSM Model 102 for storage conditions.

C.8.4.2 Thermal Model of HSM Model 102 with 61BT DSC

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

The three-dimensional ANSYS model of the 61BT DSC with a heat load of 18.3 kW is described in Appendix K, Section K.4.4.1 of [C.8-3].

The 61BT DSC model for accident analysis is based on the HSM model described in Section 8.1.3.1 of [C.8-3]. The accident analysis is performed with HSM vents totally blocked for 40 hours and with a maximum ambient steady state temperature of 125°F.

All indicated changes are in response to RSI NP-6.3

Effective Thermal Conductivity of MP197HB Cask Inner Sleeve with Air Gap

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

C.8.5.2 MP197HB Cask Thermal Model Results

Normal and Off-Normal Conditions:

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

The maximum temperatures of the components of the MP197HB cask loaded with the 61BT DSC for transfer at the WCS CISF *at an* ambient temperature of 105°F) are presented in the table below. Also listed for comparison are the maximum component temperatures of the MP197HB cask loaded with the 61BT DSC for transportation [C.8-4].

All indicated changes are in response to RSI NP-6.3

C.9.2 Occupational Exposure Evaluation

C.9.2.1 Analysis Methodology

Dose rates are known in the vicinity of the HSM Model 102 and MP197HB casks based upon the existing FSAR [C.9-1] and SAR [C.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.

C.9.2.2 Dose Assessment

A dose assessment is performed for receipt and transfer of an 61BT DSC to HSM Model 102 using the MP197HB cask.

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

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

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

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

All indicated changes are in response to RSI NP-4.4

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

The configurations used in the dose rate analysis are summarized in Table C.9-1. Results for the various loading scenarios are provided in Table C.9-2 and Table C.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 NUHOMS®-61BT DSC to an HSM Model 102 using the MP197HB cask: 1016 person-mrem.

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

All indicated changes are in response to RSI NP-4.4

C.11.1 Confinement Boundary

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

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

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

All indicated changes are in response to RSI NP-9.3

Corrective Actions

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

C.12.2.6 Flood

Cause of Accident

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

Accident Analysis

As documented in Sections 2.4.2.2 and 3.3.1.3, 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.

C.12.2.7 Tornado Wind and Missiles

Cause of Accident

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

Accident Analysis

The structural and thermal consequences of the effects of tornado wind and missile loads on the HSM and canister are addressed in Sections K.11.2.3.2, 8.2.2 and K.3.7.2 of [C.12-1]. Similarly, the structural and thermal consequences of tornado wind and missile loads for the MP197HB cask area addressed in Appendices C.7 and C.8.

Accident Dose Calculations

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

All indicated changes are in response to RSI NP-2.3

D.3.3 Design Criteria for Environmental Conditions and Natural Phenomena

D.3.3.1 Tornado Wind and Tornado Missiles

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

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

D.3.3.2 Water Level (Flood) Design

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

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

As documented in Sections 2.4.2.2 and 3.3.1.3, the WCS CISF is not in a floodplain and is above the Probable Maximum Flood elevation and, therefore, will remain dry in the event of a flood.

D.3.3.3 Seismic Design

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

All indicated changes are in response to RSI NP-2.3

D.3.4.4 Shielding/Confinement/Radiation Protection

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

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

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

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

D.3.4.5 Criticality

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

All indicated changes are in response to RSI NP-4.1

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

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

All indicated changes are in response to RSI NP-2.3

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

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

All indicated changes are in response to RSI NP-6.3

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

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

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

Procedures for receiving the loaded TC after shipment are described in this section. These procedures are taken from reference [D.5-1]. Any conflicts between the following steps and [D.5-1] shall be resolved, recognizing that a revision to the transport license may be required to alter any steps required by [D.5-1].

1. Verify that the tamperproof seals are intact.
2. Remove the tamperproof seals.
3. Remove the holddown bolts from the impact limiters and install the impact limiter hoist rings provided.
4. Remove the impact limiters from the TC.
5. Remove the transportation skid personnel barrier and tie-down straps.
6. Take contamination smears on the outside surfaces of the TC. If necessary, decontaminate the TC until smearable contamination is at an acceptable level.
7. Install the front and rear trunnions and torque the bolts to 1000-1100 ft-lbs for double shoulder trunnions and 800-900 ft-lbs for single shoulder trunnions following the torqueing sequence in accordance with the transport license requirements [D.5-1].

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

8. Attach *the WCS Lift Beam Assembly* to TC top and bottom ends.
9. Using the overhead crane, lift the TC from the conveyance. Place the TC onto the transfer cask skid trunnion towers.

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

10. Inspect the trunnions to ensure that they are properly seated onto the skid.
11. Remove the *WCS Lift Beam Assembly*.
12. Install the cask shear key plug assembly.
13. Install the on-site support skid pillow block covers.

All indicated changes are in response to RSI NP-4.3

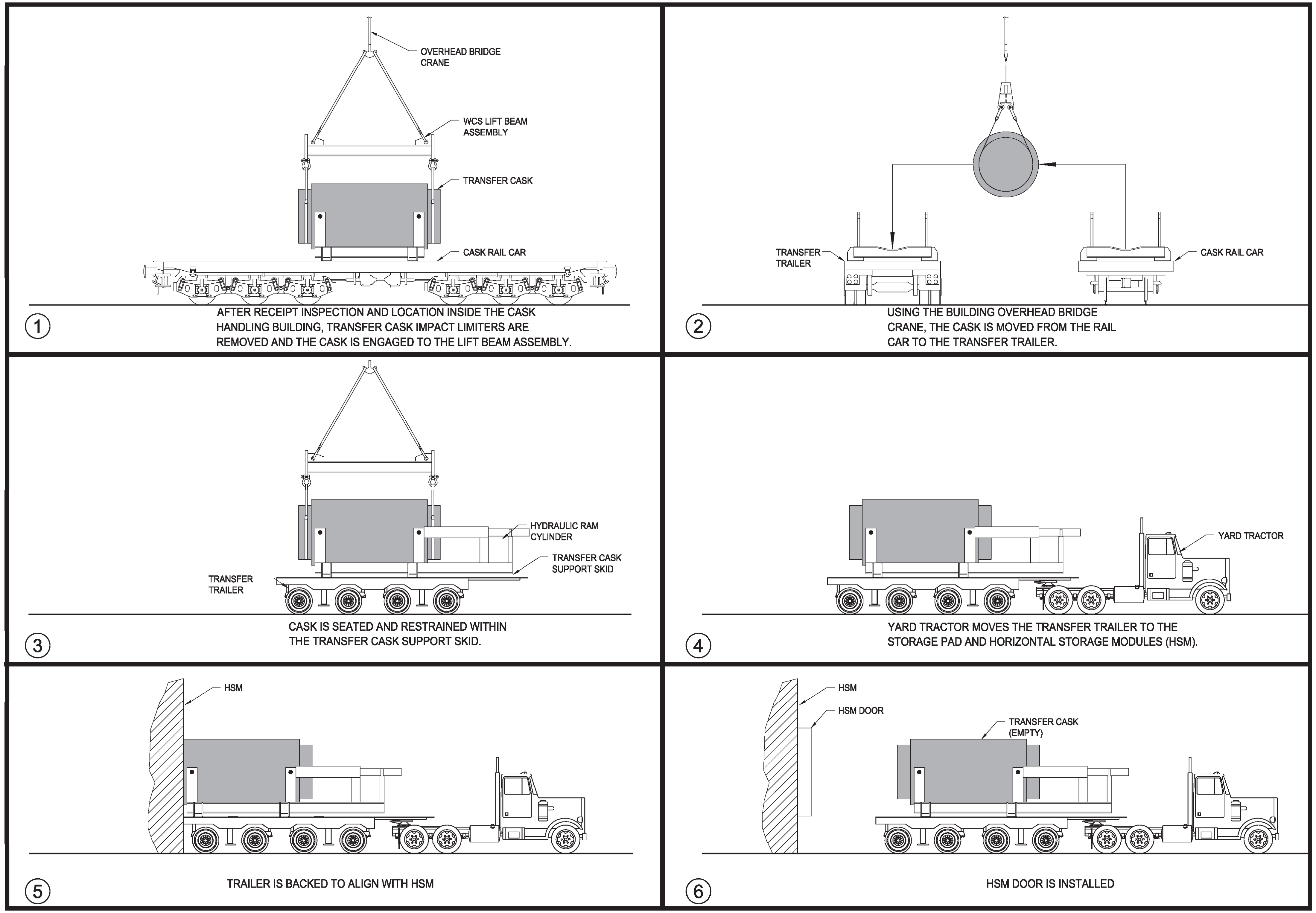


Figure D.5-1
Standardized NUHOMS®-61BTH Type 1 System Loading Operations

All indicated changes are in response to RSI NP-4.3

D.7. STRUCTURAL EVALUATION

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

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

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

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

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

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

Transfer Cask

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

All indicated changes are in response to RSI NP-9.3

D.7.1 Discussion

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

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

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

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

All indicated changes are in response to RSI NP-9.3

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

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

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

All indicated changes are in response to RSI NP-9.3

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

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

D.8.4.1 Ambient Temperature Specification at WCS CISF

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

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

As described in Chapter T.4, Section T.4.4 of [D.8-3], the thermal evaluation for HSM is presented in Section 8.1.3 of [D.8-3]. A review of the thermal evaluation presented in Section 8.1.3 of [D.8-3] shows that average daily ambient temperatures of 100°F and 125°F are used for normal and off-normal hot storage conditions, respectively. These temperatures bound the ambient temperatures for normal*,* off-normal*, and accident* conditions at the WCS CISF. Similarly, the lowest off-normal ambient temperature at the WCS CISF is *30.1*°F *and* is bounded by the -40°F used in [D.8-3].

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

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

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

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

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

All indicated changes are in response to RSI NP-6.3

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

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

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

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

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

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

2 – From Table A.3-8 of [D.8-4].

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

All indicated changes are in response to RSI NP-6.3

D.9.2 Occupational Exposure Evaluation

D.9.2.1 Analysis Methodology

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

C = D*N*T,

where

C is the collective dose (person-mrem),

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

N is the number of workers for that operation, and

T is the duration of the operation (hr)

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

D.9.2.2 Dose Assessment

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

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

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

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

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

All indicated changes are in response to RSI NP-4.4

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

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

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

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

All indicated changes are in response to RSI NP-4.4

D.11.1 Confinement Boundary

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

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

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

All indicated changes are in response to RSI NP-9.3

Corrective Actions

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

D.12.2.6 Flood

Cause of Accident

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

Accident Analysis

As documented in Sections 2.4.2.2 and 3.3.1.3, the WCS CISF is not in a floodplain and is above the Probable Maximum Flood elevation and, therefore, will remain dry in the event of a flood.

D.12.2.7 Tornado Wind and Missiles

Cause of Accident

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

Accident Analysis

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

Accident Dose Calculations

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

All indicated changes are in response to RSI NP-2.3

E.3.1.1.2 Water Level (Flood) Design

The NAC-MPC may be exposed to a flood during storage on an unsheltered concrete storage pad at an ISFSI site. The source and magnitude of the probably maximum flood depend on several variables. The NAC-MPC is evaluated for a maximum flood water depth of 50 feet above the base of the storage cask. The flood water velocity is considered to be 15 feet per section.

As documented in Sections 2.4.2.2 and 3.3.1.3, 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.

E.3.1.1.3 Seismic Design

The NAC-MPC may be exposed to a seismic event (earthquake) during storage on an unsheltered concrete pad at an ISFSI. The seismic response spectra experienced by the cask will depend upon the geographical location of the specific site and distance from the epicenter of the earthquake. The only significant effect of a seismic event on an NAC-MPC would be a possible tip-over; however, tip-over does not occur in the evaluated design basis earthquake.

Seismic response of the NAC-MPC is presented in Section 11.2.2 of Reference E.3-1. The seismic ground acceleration that will cause the NAC-MPC to tip over is calculated in Section 11.2.2 using quasi-static analysis methods. Evaluation of the consequences of a tip over event is provided in Section 11.2.12 of Reference E.3-1. Based on these evaluations, the maximum permitted ground accelerations that do not result in cask tip over are 0.25g horizontal and 0.167g vertical at the top surface of the ISFSI. The WCS pad design meets the NAC-MPC pad requirements and is consistent with analyses performed within Reference E.3-1. The existing analysis bounds the WCS site pad design limits for accelerations at the top pad surface. Therefore, no further evaluations are required.

E.3.1.1.4 Snow and Ice Loadings

The criteria for determining design snow loads is based on ANSI/ASCE 7-93, Section 7.0. The NAC-MPC is assumed to have a site location typical for siting Category C, which is defined to be “locations in which snow removal by wind cannot be relied on to reduce roof loads because of terrain, higher structures, or several trees near by.” Ground snow loads for the contiguous United States are given in Figures, 5, 6 and 7 of ANSI/ASCE 7-93. A worst case value of 100 pounds per square foot was assumed. Section 2.2.4 of Reference E.3-1 demonstrates the snow load is bounded by the weight of the loaded transfer cask. The snow load is also considered in the load combinations described in Section 3.4.4.2.2 of Reference E.3-1. Therefore, no further WCS site-specific evaluations are required.

All indicated changes are in response to RSI NP-2.3

1. Protection by multiple confinement barriers and systems
2. Protection by equipment and instrumentation selection
3. Nuclear criticality safety
4. Radiological protection
5. Fire and explosion protection

The confinement performance requirements for the NAC-MPC System are described in Chapter 7, Section 7.1.1.3 of Reference E.3-1 for storage conditions. In addition, "NAC-STC Safety Analysis Report" [E.3-2] demonstrates that the confinement boundary is not adversely affected by normal conditions of transport. Specifically, Chapter 2, Section 2.6.13 for the Yankee-MPC and Chapter 2, Section 2.6.15 for the CY-MPC. Therefore, transport to the WCS CISF will not adversely impacted confinement integrity of the NAC-MPC canister.

All indicated changes are in response to RSI NP-4.1

E.3.2.1 Design Criteria for Environmental Conditions and Natural Phenomena

The design criteria defined in this section identifies the site environmental conditions and natural phenomena to which the storage system could reasonably be exposed during the period of storage. Analyses to demonstrate that the NAC-MPC design meets these design criteria are presented in the relevant chapters of Reference E.3-1.

E.3.2.1.1 Tornado and Wind Loadings

The tornado and wind loadings design criteria that are defined in Section 2.2 of Reference E.3-1 for the NAC-MPC apply to the MPC-LACBWR system in their entirety. These design criteria are described in WCS SAR Appendix E, Section E.3.1.1.1. Therefore, no further WCS site-specific evaluations are required.

E.3.2.1.2 Water Level (Flood) Design

The water level (flood) design criteria that are defined in Section 2.2 of Reference E.3-1 for the NAC-MPC apply to the MPC-LACBWR system in their entirety. These design criteria are described in WCS SAR Appendix E, Section E.3.1.1.2. *As documented in Sections 2.4.2.2 and 3.3.1.3, 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.*

E.3.2.1.3 Seismic Design

The MPC-LACBWR may be exposed to a seismic event (earthquake) during storage on an unsheltered concrete pad at an ISFSI. The seismic response spectra experienced by the cask will depend upon the geographical location of the specific site and distance from the epicenter of the earthquake. The only significant effect of a seismic event on an MPC-LACBWR would be a possible tip-over; however, tip-over does not occur in the evaluated design basis earthquake.

Seismic response of the MPC-LACBWR is presented in Section 11.A.2.2 of Reference E.3-1. The seismic ground acceleration that will cause the MPC-LACBWR to tip over is calculated in Section 11.A.2.2 using quasi-static analysis methods. Evaluation of the consequences of a tip over event is provided in Section 11.A.2.12 of Reference E.3-1. Based on these evaluations, the maximum permitted ground accelerations that do not result in cask tip over are 0.45g horizontal and 0.3g vertical at the top surface of the ISFSI. The WCS pad design meets the MPC-LACBWR pad requirements and is consistent with analyses performed within Reference E.3-1. The existing analysis bounds the WCS site pad design limits for accelerations at the top pad surface. Therefore, the MPC-LACBWR design criteria bounds the WCS site and no further evaluations are required.

All indicated changes are in response to RSI NP-2.3

As discussed in Section 2.A.3 of Reference E.3-1, the MPC-LACBWR design incorporates features addressing the above design considerations to assure safe operation during fuel loading, handling, and storage. This section addresses the following:

1. Protection by multiple confinement barriers and systems
2. Protection by equipment and instrumentation selection
3. Nuclear criticality safety
4. Radiological protection
5. Fire and explosion protection

The confinement performance requirements for the NAC-MPC System are described in Chapter 7, Section 7.1.1.3 of Reference E.3-1 for storage conditions. In addition, Reference E.3-2 demonstrates that the confinement boundary is not adversely affected by normal conditions of transport. Specifically, Chapter 2, Section 2.11.6.13 for the MPC-LACBWR. Therefore, transport to the WCS CISF will not adversely impacted confinement integrity of the NAC-MPC canister.

All indicated changes are in response to RSI NP-4.1

E.3.3 References

E.3-1 NAC-MPC Final Safety Analysis Report, Revision 10, January 2014

E.3-2 NAC-STC Safety Analysis Report, Revision 17, April 2011

All indicated changes are in response to RSI NP-4.1

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

Design Parameter	***WCS CISF Design Criteria***	***Condition***	***NAC-MPC Design Criteria***
Type of fuel	*Commercial, light water reactor spent fuel*	*Normal (Bounded)*	*NAC-MPC FSAR Section 2.1*
Storage Systems	*Transportable canisters and storage overpacks docketed by the NRC*	*Normal (Bounded)*	*72-1025* *71-9235*
Fuel Characteristics	*Criteria as specified in previously approved licenses for included systems*	*Normal (Bounded)*	*NAC-MPC FSAR Section 2.1*
Tornado (Wind Load)	*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)*	***NAC-MPC FSAR Section 2.2.1.1*** *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 (Missile)	*Automobile: 4000 lb, 112 ft/s (76.4 mph)* *Schedule 40 Pipe: 287 lb, 112 ft/s (76.4 mph)* *Solid Steel Sphere: 0.147 lb, 23 ft/s (15.7 mph)*	*Accident (Bounded)*	***NAC-MPC FSAR Section 2.2.1.3*** *Massive Missile: 3960 lb, 126 mph* *Rigid hardened steel: 275 lb, 126 mph* *Solid Steel Sphere: 0.15 lb, 126 mph*
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)*	***NAC-MPC FSAR Section 2.2.2.1*** *Flood height: 50 ft* *Water velocity: 15 ft/s*

All indicated changes are in response to RSI NP-2.3

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

Design Parameter	***WCS CISF Design Criteria***	***Condition***	***NAC-MPC Design Criteria***
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 (Bounded)*	***NAC-MPC FSAR Section 2.2.3.1*** *Yankee-MPC and CY-MPC are designed to 0.25 g horizontal and 0.167 g vertical* ***NAC-MPC FSAR Section 2.A.2.1.1*** *MPC-LACBWR is designed to 0.45 g horizontal and 0.3 g vertical* ***NAC-MPC CoC, Technical Specification B 3.4, Section 3.c)*** *Alternatively, the design basis earthquake motion of the ISFSI pad maybe limited so that the acceleration g-load resulting from the collision of the two sliding casks remains bounded by the accident condition analyses presented in Chapter 11 of the NAC-MPC FSAR.*
Vent Blockage	*For MPC Systems:* *Inlet and outlet vents blocked 24 hrs*	*Accident (Same)*	***Yankee-MPC, NAC-MPC FSAR Section 11.2.8.4*** ***CY-MPC, NAC-MPC FSAR Section 11.2.8.4*** ***MPC-LACBWR, NAC-MPC FSAR Section 11.2.8.4*** *Inlet and outlet vents blocked: 24 hrs*
Fire/Explosion	*For MPC Systems:* *Equivalent fire 50 gallons of diesel fuel*	*Accident (Same)*	***NAC-MPC FSAR Section 11.2.5*** *Equivalent fire 50 gallons of diesel fuel*
Cask Drop	*For MPC Systems:* *Drop height 6 inches*	*Accident (Same)*	***NAC-MPC FSAR Section 11.2.11.2*** ***NAC-MPC FSAR Section 11.A.2.11.2*** *Drop height 6 inches*
Ambient Temperatures	*Yearly average temperature 67.1°F*	*Normal (Bounded)*	***NAC-MPC FSAR Section 2.2.6*** *Average Annual Ambient Temperature 75°F*
Off-Normal Temperature	*Minimum 3 day avg. temperature 27.9°F* *Maximum 3 day avg. temperature 89.4°F*	*Off-Normal (Bounded)*	***NAC-MPC FSAR Section 2.2.6*** *Minimum 3 day avg. temperature -40°F* *Maximum 3 day avg. temperature 100°F*

All indicated changes are in response to RSI NP-6.3

E.5 OPERATING PROCEDURES

The following are operating procedures for using the NAC-MPC spent fuel storage system configured for the Yankee MPC (Yankee-MPC), Connecticut Yankee MPC (CY-MPC), and the La Crosse MPC (MPC-LACBWR) for storage operations. These procedures are based on the general guidance found in Chapter 8 and Appendix 8.A of the NAC-MPC Final Safety Analysis Report (FSAR) [Reference E.5-1]. The procedures covered are:

1. Installing the transportable storage canister (TSC) in the vertical concrete cask (concrete cask) and transferring it to the storage (ISFSI) pad, and
2. Removal of the loaded canister from the concrete cask.
3. Receipt of the NAC-STC Transport Cask and removal of the loaded canister.

The detailed operating procedures for receiving a loaded NAC Storage Transport Cask (NAC-STC) and unloading the transportable storage canister are described in Section 7.3.1 of the NAC-STC Safety Analysis Report, Docket 71-9235.

Note, Reference E.5-1 does not include a concrete cask design with lifting lugs for vertical lifts. The design of a concrete cask with lifting lugs is shown in References E.5-2 thru Reference E.5-7 for the CY-MPC, Yankee-MPC, and MPC-LACBWR. The design has been analyzed in Reference E.5-8.

Pictograms of the NAC-MPC System operations are presented in Figure E.5-1.

All indicated changes are in response to RSI NP-4.3

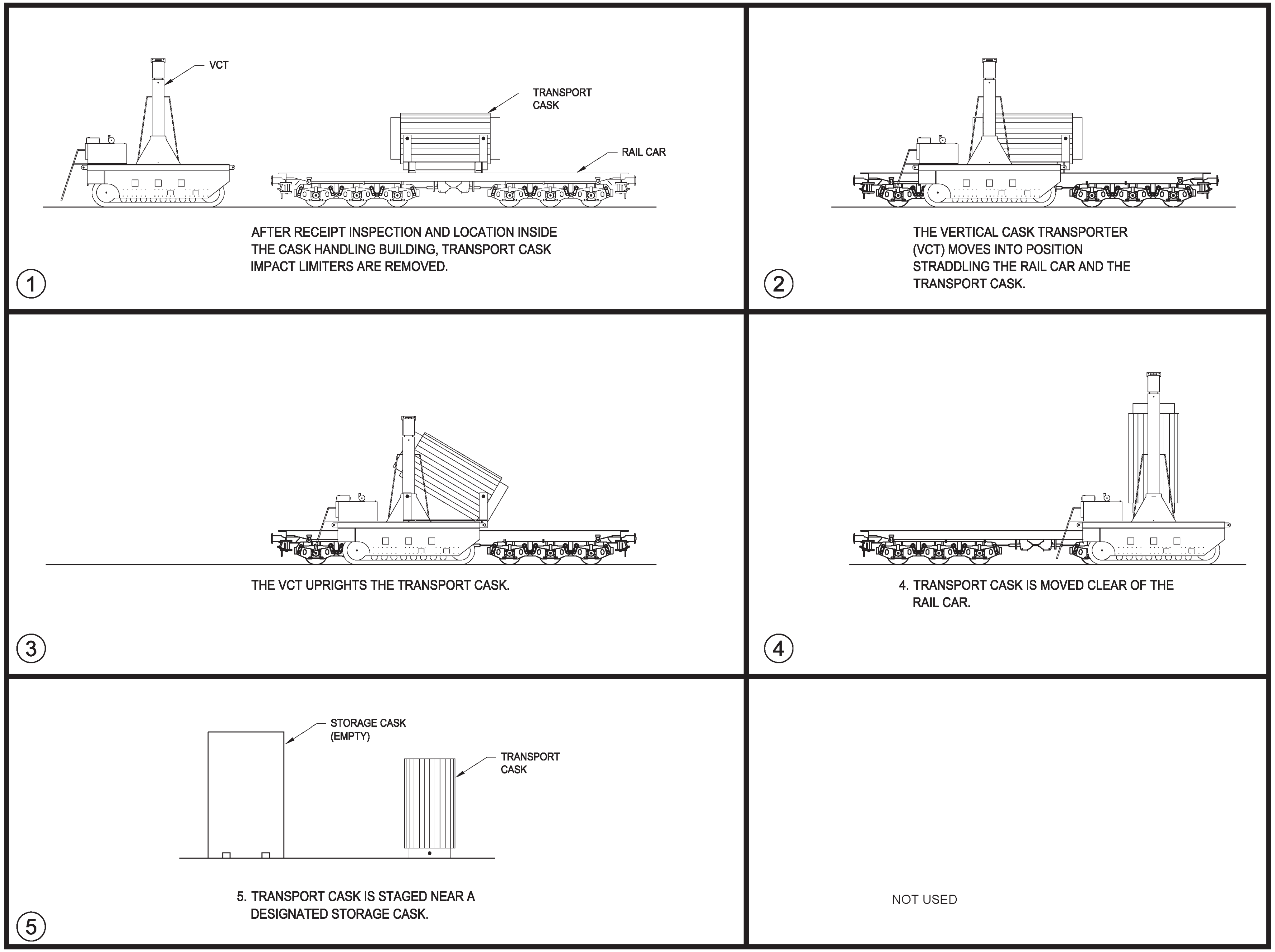


Figure E.5-1
Canister Transfer Operations
2 Pages

All indicated changes are in response to RSI NP-4.3

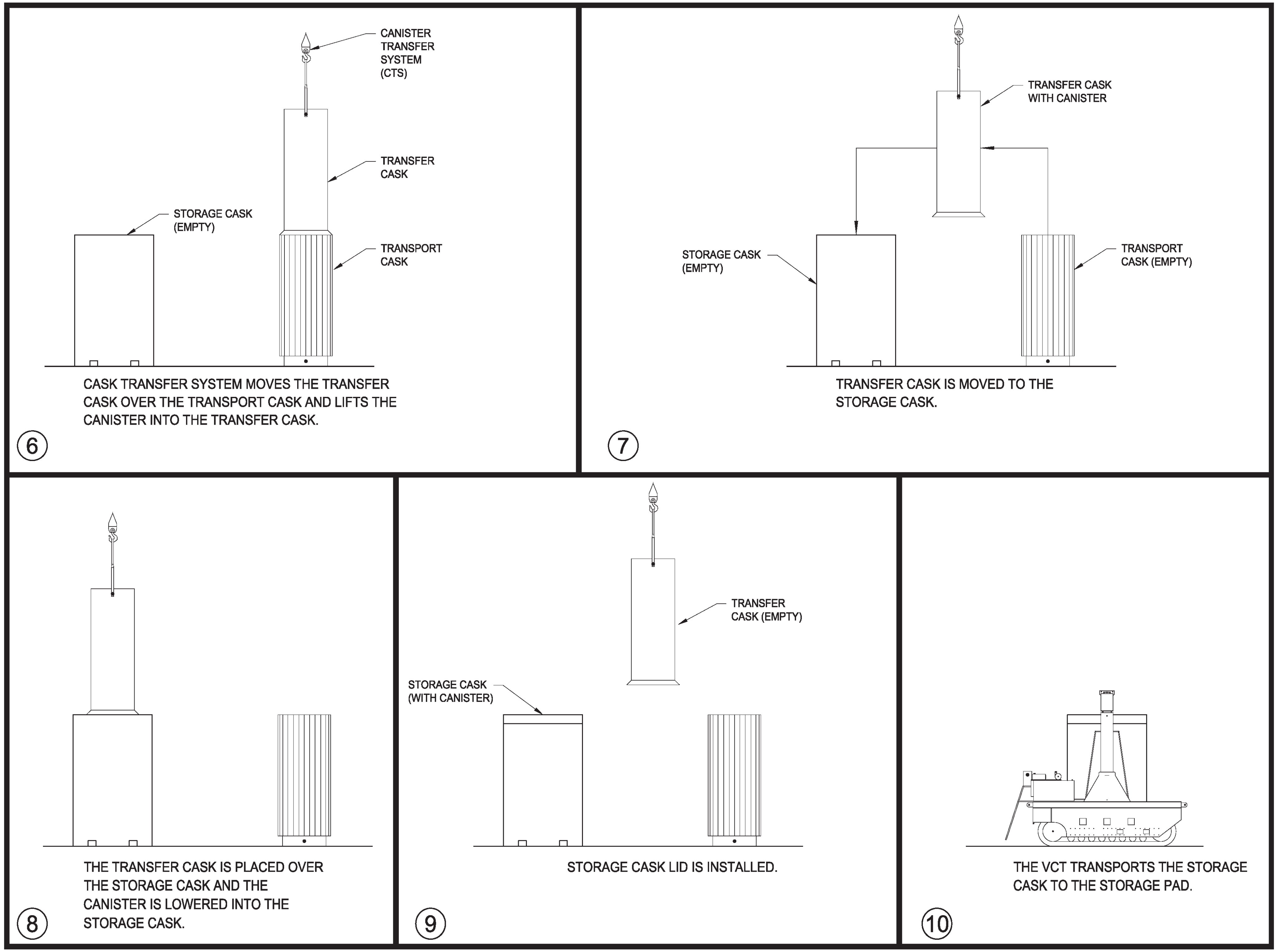


Figure E.5-1
Canister Transfer Operations
2 Pages

All indicated changes are in response to RSI NP-4.3

E.7.1 Yankee Rowe MPC and Connecticut Yankee MPC

The Yankee-MPC and CY-MPC are generically referred to as the NAC-MPC and *Sections E.7.1.1 through E.7.1.10* outline the structural analyses for normal operating conditions presented in Reference *E.7-1*. *Finally, bounding evaluations in Section E.7.1.11 are referenced to demonstrate that the confinement boundaries for the Yankee-MPC and CY-MPC canisters 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.*

E.7.1.1 Structural Design

The structural design of the NAC-MPC system for the Yankee-MPC and CY-MPC are provided in Section 3.1 of Reference E.7-1.

E.7.1.2 Weights and Centers of Gravity

The weights and centers of gravity of the NAC-MPC system for the Yankee-MPC and CY-MPC are provided in Section 3.2 of Reference E.7-1.

E.7.1.3 Mechanical Properties of Materials

The mechanical properties of materials of the NAC-MPC system for the Yankee-MPC and CY-MPC are provided in Section 3.3 of Reference E.7-1.

E.7.1.4 Chemical and Galvanic Reactions

The chemical and galvanic reactions evaluations of the NAC-MPC system for the Yankee-MPC and CY-MPC are provided in Section 3.4.1 of Reference E.7-1.

E.7.1.5 Positive Closure

The positive closure evaluation of the NAC-MPC system for the Yankee-MPC and CY-MPC are provided in Section 3.4.2 of Reference E.7-1.

E.7.1.6 Lifting Devices

The evaluations of the NAC-MPC system lifting devices for the Yankee-MPC and CY-MPC are provided in Reference E.7-1. Note, Reference E.7-1 does not include a concrete cask design with lifting lugs for vertical lifts. The design of a concrete cask with lifting lugs is shown in References E.7-2 thru E.7-5 for the CY-MPC and Yankee-MPC. The design has been analyzed in Reference E.7-8.

E.7.1.7 NAC-MPC Components Under Normal Operating Loads

The evaluations of the NAC-MPC components under normal operating loads for the Yankee-MPC and CY-MPC are provided in Section 3.4.4 of Reference E.7-1.

All indicated changes are in response to RSI NP-9.3

E.7.1.8 Cold

As described in Section 3.4.5 of Reference E.7-1, the evaluation for severe cold environments for the NAC-MPC system for the Yankee-MPC and CY-MPC are provided in Section 11.1.4 of Reference E.7-1. Stress intensities corresponding to thermal loads in the canister are evaluated by using a finite element model as described in Section 3.4.4 of Reference E.7-1. The thermal stresses that occur in the canister as a results of the maximum off-normal temperature gradients in the canister are bounded by the analysis of extreme cold in Section 11.1.4 of Reference E.7-1. The canister and basket are fabricated from stainless steel an aluminum, which are not subject to a ductile-to-brittle transition in the temperature range of interest.

E.7.1.9 Fuel Rods

The evaluations of the Yankee-MPC and CY-MPC fuel rods are provided in Section 3.5 of Reference E.7-1.

E.7.1.10 Coating Specifications

The coating specifications for the NAC-MPC vertical concrete cask and transfer cask exposed carbon steel surfaces associated with the Yankee-MPC and CY-MPC are provided in Section 3.8 of Reference E.7-1.

E.7.1.11 Structural Evaluation of Yankee-MPC and CY-MPC Canister Confinement Boundaries under Normal Conditions of Transport

The Yankee-MPC and CY-MPC canister primary confinement boundaries consist of a canister shell, bottom closure plate, shield lid, the two (2) port covers, and the welds that join these components. Redundant closure is provided by a structural lid and adjoining canister weld. Additional details, geometry and shell and plate thicknesses are provided on the drawings in Section E.4.4. The confinement boundary is addressed in Section E.11.1.1. The Yankee-MPC and CY-MPC canister shells are evaluated for Normal Conditions of Transport in the NAC-STC Transport cask in Sections 2.6.13 and 2.6.15 of [E.7-9].

The result of the structural analysis is acceptable for the loads and combinations described in Sections 2.6.13 and 2.6.15 of [E.7-9] and hence structurally adequate for normal conditions of transport loading conditions.

All indicated changes are in response to RSI NP-9.3

E.7.2 La Crosse MPC

Sections E.7.2.1 through E.7.2.10 outline the structural analyses for normal operating conditions presented in Reference E.7-1 for the La Crosse MPC (MPC-LACBWR). *Finally, bounding evaluations in Section E.7.2.11 are referenced to demonstrate that the confinement boundaries for the MPC-LACBWR canisters 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.*

E.7.2.1 Structural Design

The structural design of the MPC-LACBWR is provided in Section 3.A.1 of Reference E.7-1.

E.7.2.2 Weights and Centers of Gravity

The weights and centers of gravity of the MPC-LACBWR is provided in Section 3.A.2 of Reference E.7-1.

E.7.2.3 Mechanical Properties of Materials

The mechanical properties of materials of the MPC-LACBWR is provided in Section 3.A.3 of Reference E.7-1.

E.7.2.4 Chemical and Galvanic Reactions

The chemical and galvanic reactions evaluations of the MPC-LACBWR is provided in Section 3.A.4.1 of Reference E.7-1.

E.7.2.5 Positive Closure

The positive closure evaluation of the MPC-LACBWR is provided in Section 3.A.4.2 of Reference E.7-1.

E.7.2.6 Lifting Devices

The evaluations of the MPC-LACBWR lifting devices is provided in Section 3.A.4.3 of Reference E.7-1. Note, Reference E.7-1 does not include a concrete cask design with lifting lugs for vertical lifts. The design of a concrete cask with lifting lugs is shown in References E.7-6 and E.7-7 for the MPC-LACBWR. The design has been analyzed in Reference E.7-8

E.7.2.7 MPC-LACBWR Components Under Normal Operating Loads

The evaluations of the MPC-LACBWR components under normal operating loads is provided in Section 3.A.4.4 of Reference E.7-1.

All indicated changes are in response to RSI NP-9.3

E.7.2.8 Fuel Rods

The evaluations of the MPC-LACBWR fuel rods is provided in Section 3.A.5 of Reference E.7-1.

E.7.2.9 Canister Closure Weld Evaluation

The evaluations of the MPC-LACBWR closure weld is provided in Section 3.A.6 of Reference E.7-1.

E.7.2.10 Coating Specifications

The coating specifications for the MPC-LACBWR vertical concrete cask and transfer cask exposed carbon steel surfaces are provided in Section 3.A.8 of Reference E.7-1.

E.7.2.11 Structural Evaluation of MPC-LACBWR Canister Confinement Boundaries under Normal Conditions of Transport

The MPC-LACBWR canister primary confinement boundaries consist of a canister shell, bottom closure plate, closure lid, the two (2) port covers, and the welds that join these components. Redundant closure is provided by two (2) outer port covers and a closure ring. Additional details, geometry and shell and plate thicknesses are provided on the drawings in Section E.4.4. The confinement boundary is addressed in Section E.11.2.1. The MPC-LACBWR canister shell is evaluated for Normal Conditions of Transport in the NAC-STC Transport cask in Section 2.11.6.13 of [E.7-9].

The result of the structural analysis is acceptable for the loads and combinations described in Section 2.11.6.13 of [E.7-9] and hence structurally adequate for normal conditions of transport loading conditions.

All indicated changes are in response to RSI NP-9.3

E.7.3 References

E.7-1 NAC-MPC Final Safety Analysis Report, Revision 10, January 2014

E.7-2 NAC License Drawing, 414-862, “Loaded Vertical Concrete Cask (VCC) CY-MPC”, Rev. 6

E.7-3 NAC License Drawing, 414-866, “Reinforcing Bar and Concrete Placement, Vertical Concrete Cask (VCC) CY-MPC”, Rev. 6

E.7-4 NAC License Drawing, 414-862, “Loaded Vertical Concrete Cask (VCC) MPC-YANKEE”, Rev. 9

E.7-5 NAC License Drawing, 455-866, “Reinforcing Bar and Concrete Placement, Vertical Concrete Cask (VCC) MPC-YANKEE”, Rev. 6

E.7-6 NAC License Drawing, 630045-862, “Loaded Vertical Concrete Cask (VCC) MPC-LACBWR”, Rev. 1

E.7-7 NAC License Drawing, 630045-866, “Reinforcing Bar and Concrete Placement, Vertical Concrete Cask (VCC) MPC-LACBWR”, Rev. 2

E.7-8 NAC Calculation 30039-2020, “MPC Concrete Cask Lift Evaluation”, Rev. 0

E.7-9 NAC-STC Safety Analsyis Report, Revision 17, April 2011

All indicated changes are in response to RSI NP-9.3

E.8.1 Connecticut Yankee MPC, Yankee Rowe MPC, and La Crosse MPC

Reference E.8-1 provides the thermal evaluations used to determine the limiting environmental conditions (thermal) for the use of the CY-MPC, Yankee-MPC, and MPC-LACBWR. The following are those limiting thermal environmental conditions.

E.8.1.1 Maximum Average Yearly Ambient Temperature

For the CY-MPC, Yankee-MPC, and MPC-LACBWR, the maximum average yearly temperature allowed is 75°F. The average yearly temperature for the site is conservatively bounded by using the maximum average annual temperature in the 48 contiguous United States, of 75°F. This temperature meets the normal condition thermal boundary defined in NUREG-1536. Therefore, no further WCS site-specific evaluations are required.

E.8.1.2 Maximum Average 3-Day Ambient Temperature

The maximum average 3-day ambient temperature allowed is 100°F for the CY-MPC and the Yankee-MPC. The maximum average 3-day ambient temperature allowed for the MPC-LACBWR is 105°F. These limits bound the WCS facility maximum average 3-day ambient temperature *89.4*°F. Therefore, no further site-specific evaluations are needed.

E.8.1.3 Maximum Extreme 3-Day Ambient Temperature Range

For the CY-MPC, Yankee-MPC, and MPC-LACBWR, the maximum allowed temperature extremes, averaged over a 3-day period, shall be greater than -40°F and less than 125°F. This bounds the WCS facility maximum temperature extremes of *-1*°F and *113*°F. No further site-specific evaluations are needed.

All indicated changes are in response to RSI NP-6.3

E.9 RADIATION PROTECTION

Chapter 5 of Reference E.9.3-1 provides the shielding evaluation of the NAC-MPC storage system. The system is provided in three configurations. The Yankee Class NAC-MPC is designed to store up to 36 Yankee Class spent fuel assemblies or Yankee Class reconfigured fuel assemblies and is referred to as the Yankee-MPC. The Connecticut Yankee-MPC, referred to as the CY-MPC, is designed to store up to 26 Connecticut Yankee spent fuel assemblies, CY-MPC reconfigured fuel assemblies or CY-MPC damaged fuel cans. The analysis of the Yankee Class spent fuel is performed using the SAS4 code series. The analysis of the Connecticut Yankee spent fuel is performed using the MCBEND code. Separate models are used for each of the fuel types.

The Dairyland Power Cooperative (DPC) La Crosse Boiling Water Reactor (LACBWR) MPC, referred to as MPC-LACBWR, is designed to store up to 68 LACBWR spent fuel assemblies, including up to 32 LACBWR damaged fuel cans. The shielding evaluation of the MPC-LACBWR system is presented in Appendix 5.A of Chapter 5 to Reference E.9.3-1.

The regulation governing spent fuel storage, 10 CFR 72, does not establish specific cask dose rate limits. However, 10 CFR 72.104 and 10 CFR 72.106 specify that for an array of casks in an Independent Spent Fuel Storage Installation (ISFSI), the annual dose to an individual outside the controlled area boundary must not exceed 25 mrem to the whole body, 75 mrem to the thyroid and 25 mrem to any other organ during normal operations. In the case of a design basis accident, the dose to an individual outside the area boundary must not exceed 5 rem to the whole body or any organ. The ISFSI must be at least 100 meters from the owner controlled area boundary. In addition, the occupational dose limits and radiation dose limits for individual members of the public in 10 CFR Part 20 (Subparts C and D) must be met. Reference E.9.3-1, Chapter 10, Section 10.3, demonstrates NAC-MPC compliance with the requirements of 10 CFR 72 with regard to annual and occupational doses at the owner controlled area boundary. Chapter 5 of Reference E.9.3-1 presents the shielding evaluations of the NAC-MPC storage system. Dose rate profiles are calculated as a function of distance from the side, top and bottom of the NAC-MPC storage and transfer casks. Shielded source terms from the NAC-MPC storage cask are calculated to establish owner controlled area boundary dose estimates due to the presence of the ISFSI.

Table E.9-1 provides estimated occupational exposures for receipt and handling of the YR-MPC, CY-MPC, and MPC-LACBWR at the WCS CISF facility. For each procedural step, the number of workers, occupancy time, worker distance, dose rates, and total dose are estimated. Dose rates used were obtained and estimated via the listed references in the table. The total occupational exposure for receiving, transferring and placing these canisters on the storage pad in their storage overpack (VCC) is 823 person-mrem each. The total collective dose for unloading a YR-MPC, CY-MPC or MPC-LACBWR canister from its VCC and preparing it for transport off-site is bounded by the loading operations (823 person-mrem). Operations for retrieving these canisters from the VCC and off-site shipment are identical to loading operations, except in reverse order.

All indicated changes are in response to RSI NP-12.6

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 1,646 person-mrem.

All indicated changes are in response to RSI NP-12.6

Maximum dose rates for the transfer cask with design basis intact and damaged fuel and with a wet and dry canister cavity are shown in Tables 5.1.1-2 and 5.1.1-3, of Reference E.9.3-1 respectively. The maximum dose rates with design basis fuel and the canister cavity wet during shield lid welding operations are 210.2 (0.8%), 188.7 (1.1%) and 77.2 (0.7%) mrem/hr on the side, top, and bottom, respectively. The maximum dose rates with design basis fuel and the canister cavity dry during structural lid welding operations are 413.4 (1.5%), 358.9 (2.6%) and 398.0 (3.9%) mrem/hr on the side, top, and bottom, respectively. These values include the addition of 5 inches of carbon steel operational shielding installed on the shield lid during its closure and on the structural lid during its handling and closure. In normal operations during welding of the canister lids, the bottom of the transfer cask is generally inaccessible.

For the damaged fuel can evaluation, additional shielding at the ports is modeled to maintain dose rates ALARA for the shield lid with weld shield models. In the wet canister model, the port cover zone is modeled with half-density stainless steel to simulate the quick disconnect fittings at the ports. For both the dry and wet canister models, an inch of lead is modeled above the ports to simulate additional temporary shielding employed during the welding operations. The maximum dose rate with design basis fuel and the canister cavity wet during shield lid welding operations is 214.1 (0.1%) mrem/hr. An azimuthal peak of 4.0 rem/hr is calculated at the port radius. The maximum dose rate with design basis fuel and the canister cavity dry during structural lid welding operations is 387.9 (0.6%) mrem/hr. Maximum dose rates for the transfer cask with design basis damaged fuel are shown in Table 5.1.1-3 of Reference E.9.3-1.

The damaged fuel case is modeled assuming the fuel content of 20 fuel rods from each of four damaged assemblies is displaced to the lower end fitting region, where the added material is homogeneously represented. No credit is taken for shielding capability of the damaged fuel can; however it is assumed that the can will physically contain the fuel debris. In addition, no credit is taken for the ability of the displaced material to shield the hardware and remaining intact fuel assemblies. Also, no reduction in the intact fuel source term is made to compensate for the displaced material. Results show that the maximum additional contribution to the cask surface dose rate is less than 40 mrem/hr under both wet and dry canister conditions. Specifically, under dry conditions, the maximum radial and bottom axial transfer cask surface dose rates are 444.8 (1.6%) mrem/hr and 435.7 (0.9%) mrem/hr, respectively. Under wet conditions, the maximum bottom axial transfer cask surface dose rate is 96.3 (0.6%) mrem/hr. The wet condition maximum radial surface dose rate is unchanged due to the presence of damaged fuel in the lower end fitting, since the location of the peak remains near the top of the cask due to the assumed draining of water from the cask to facilitate lid welding operations.

All indicated changes are in response to RSI NP-12.6

During shield lid welding operations, including a wet canister cavity, the maximum dose rates with stainless steel clad fuel are 226 (1.2%) and 3830 (5.5%) mrem/hr on the radial surface and top axial surface, respectively. The bottom surface of the cask has a maximum dose rate of 95 (2.2%) mrem/hr with the stainless steel fuel. For Zircaloy-clad fuel, the maximum radial, top axial and bottom axial surface dose rates are 241 (2.2%), 4050 (1.9%), and 84 (2.0%) mrem/hr, respectively. With eight flow mixer components inserted in the centermost basket positions, the additional dose rate in the top axial position is 46 (3.5%) mrem/hr.

During structural lid welding operations, including a dry canister cavity, the maximum dose rates with stainless steel clad design basis fuel are 405 (3.3%) mrem/hr and 2179 (6.5%) mrem/hr on the radial and top axial surfaces, respectively. The bottom surface of the cask has a maximum dose rate of 307 (1.0%) mrem/hr with the stainless steel fuel. For Zircaloy-clad design basis fuel, the maximum side, top, and bottom dose rates are 394 (2.0%), 2117 (3.5%), and 407 (0.8%) mrem/hr, respectively.

The calculated values for the transfer cask shield lid and structural lid configurations include the addition of 5 inches of carbon steel operational shielding installed on top of the shield lid during its closure and on the structural lid during its handling and closure. As shown in the dose rate profiles presented in Section 5.4.2 of Reference E.9.3-1, the maximum top axial surface dose rates are highly localized to the annular region between the operational shield and the inner shell of the transfer cask. This region will not normally be occupied during welding operations.

Damaged Fuel Dose Rates

To ensure that the worst case configuration is considered, two damaged fuel scenarios are evaluated for the 32 peripheral basket locations.

The first scenario assumes the damaged fuel collects over the active fuel length of the fuel assembly. This scenario is modeled by filling the fuel rod interstitial volume with UO2 and increasing the fuel neutron, gamma, and n-gamma source consistent with this increase in mass. A comparison of dose rate profiles for the 68 assembly intact fuel results and 36 intact and 32 damaged assemblies in Section 5.A.4 of Reference E.9.3-1 demonstrates that the damaged fuel model dose rates are less due to the increase in self-shielding from the 32 peripheral assemblies compensating for the increase in source strength.

In the second scenario, damaged fuel is assumed to migrate from the active fuel into the lower end fitting region of the fuel assembly, filling all the modeled void space. However, no credit is taken for the reduction in lower end fitting hardware dose rate due to the added UO2 mass and self-shielding nor for the reduction in fuel mass migrated from the active fuel region. In this case, storage cask inlet and transfer cask bottom surface dose rates increase due to the addition of damaged fuel. The storage cask inlet dose rate increase is 36.7 mrem/hr, effectively doubling the air inlet dose rate. The transfer cask bottom axial dose rate increase is 22.1 mrem/hr, increasing the bottom axial dose rate by approximately 41%. Note that the radial location of the maximum dose rate at the bottom of the transfer cask differs between the undamaged and damaged fuel models. Damaged fuel maximum dose rates are summarized in Table 5.A.1-5 and Table 5.A.1-6 of Reference E.9.3-1.

All indicated changes are in response to RSI NP-12.6

Table E.9-1
Estimated Occupational Collective Dose for Receipt of NAC-STC Cask Loaded with YR-MPC, CY-MPC, or MPC-LACBWR TSC and Transfer to MPC VCC

8 Sheets

Process Step	***Number of Workers***	***Occupancy Time (hours)***	***Worker Location Around Cask***	***Worker Distance (m)***	***Total Dose Rate (mrem/hr)***	***Total Dose (person-mrem)***[1]	***Reference SAR/FSAR Section/Table/Figure***
Perform radiation and contamination survey of STC Cask.	*2*	*0.5*	*All Around*	*2*	*4*	*2*	*SAR Figure 5.1-6, Figure 5.1-11, and Table 5.1-10*
Inspect top impact limiter security seal and verify it is intact and correct ID.	*1*	*0.25*	*Surface of Top Impact Limiter*	*<1*	*<1*	*1*	*SAR Figure 5.1-6, Figure 5.1-11, and Table 5.1-10*
Remove Personnel Barrier and complete surveys.	*2*	*0.5*	*Center of cask*	*1.5*	*15*	*15*	*SAR Figure 5.1-6, Figure 5.1-11, Figure 5.4-10, and Table 5.1-10*
Visually inspect Cask surface for transport/road damage and record.	*1*	*0.25*	*All Around*	*2*	*<4*	*1*	*SAR Figure 5.1-6, Figure 5.1-11, Figure 5.4-10, and Table 5.1-10*
Attach slings to top Impact Limiter and remove attachment nuts/rods. Remove and store Impact Limiter.	*2*	*0.5*	*Surface of Top Impact Limiter*	*1*	*< 1*	*1*	*SAR Figure 5.1-6, Figure 5.1-11, and Table 5.1-10*
Attach slings to bottom Impact Limiter and remove attachment nots/rods. Remove and store Impact Limiter.	*2*	*0.5*	*Surface of Bottom Impact Limiter*	*1*	*< 1*	*1*	*SAR Figure 5.1-6, Figure 5.1-11, and Table 5.1-10*

All indicated changes are in response to RSI NP-12.6

Table E.9-1
Estimated Occupational Collective Dose for Receipt of NAC-STC Cask Loaded with YR-MPC, CY-MPC, or MPC-LACBWR TSC and Transfer to MPC VCC

8 Sheets

Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)[1]	Reference SAR/FSAR Section/Table/Figure
Release Front Tie-Down Assembly.	*2*	*1*	*Top Side STC Cask Surface*	*1*	*25*	*50*	*SAR Figure 5.1-6, Figure 5.1-11, Figure 5.4-10, and Table 5.1-10*
Engage Vertical Cask Transporter (VCT) Lift Arms to Front Trunnions and rotate cask to vertical orientation.	*2*	*1*	*Top Side STC Cask Surface*	*>2*	*5*	*10*	*SAR Figure 5.1-6, Figure 5.1-11, Figure 5.4-10, and Table 5.1-10*
Lift and Remove Cask from Transport Skid Rear Rotation Trunnions and move cask to Canister Transfer Facility (CTF), set cask down and release VCT Lift Arms. Establish Radiation Control boundaries.	*2*	*1*	*Top Side STC Cask Surface*	*>2*	*10*	*20*	*Semi-remote operation*
Using VCT, move empty MPC VCC to transfer position in CTF and set down adjacent to STC cask. Set up appropriate work platforms/man lifts for access to top of casks.	*2*	*1*	*Top of Empty VCC*	*>2*	*0*	*0*	*Empty VCC Handling*
Remove VCC Lid and VCC Shield Plug (if installed).	*2*	*1*	*Top of Empty VCC*	*1*	*0*	*0*	*Empty VCC Handling*

All indicated changes are in response to RSI NP-12.6

Table E.9-1
Estimated Occupational Collective Dose for Receipt of NAC-STC Cask Loaded with YR-MPC, CY-MPC, or MPC-LACBWR TSC and Transfer to MPC VCC

8 Sheets

Process Step	***Number of Workers***	***Occupancy Time (hours)***	***Worker Location Around Cask***	***Worker Distance (m)***	***Total Dose Rate (mrem/hr)***	***Total Dose (person-mrem)[1]***	***Reference SAR/FSAR Section/Table/Figure***
Install Transfer Adapter on VCC and connect hydraulic system.	*2*	*1*	*Top of Empty VCC*	*1*	*0*	*0*	*Empty VCC Handling*
Remove STC Cask Interlid Port Cover and check for excessive pressure. If pressure is high, take sample and check. If clean vent to HEPA filter.	*1*	*0.5*	*Top of STC*	*0.5*	*10*	*5*	*Top side of STC Upper Forging. SAR Figure 5.1-6, Figure 5.1-11, Figure 5.4-10, and Table 5.1-10*
Remove outer lid bolts, install alignment pins and lifting hoist rings, and remove outer lid and store. Remove alignment pins.	*2*	*1*	*Top of STC*	*0.5*	*20*	*40*	*Top side of STC Upper Forging. SAR Figure 5.1-6, Figure 5.1-11, Figure 5.4-10, and Table 5.1-10. FSAR Table 5.1.2-3 plus STC Inner Lid (7 inch SS and 2 inch NS-4-FR) and STC Outer Lid (5.25 inch SS)*

All indicated changes are in response to RSI NP-12.6

Table E.9-1
Estimated Occupational Collective Dose for Receipt of NAC-STC Cask Loaded with YR-MPC, CY-MPC, or MPC-LACBWR TSC and Transfer to MPC VCC

8 Sheets

Process Step	***Number of Workers***	***Occupancy Time (hours)***	***Worker Location Around Cask***	***Worker Distance (m)***	***Total Dose Rate (mrem/hr)***	***Total Dose (person-mrem)[1]***	***Reference SAR/FSAR Section/Table/Figure***
Remove vent and drain port covers, and connect pressure test system to vent port to check for excessive pressure. If pressure is high, take sample and check. If clean vent to HEPA filter.	*1*	*0.5*	*Top of STC*	*0.5*	*40*	*20*	*Top side of STC Upper Forging. SAR Figure 5.1-6, Figure 5.1-11, Figure 5.4-10, and Table 5.1-10. FSAR Table 5.1.2-3 plus STC Inner Lid (7 inch SS and 2 inch NS-4-FR)*
Remove all inner lid bolts, install alignment pins and lid lifting hoist rings/slings and remove inner lid and store. Remove alignment pins.	*2*	*1*	*Top of STC*	*0.5*	*40*	*80*	*Top side of STC Upper Forging SAR Figure 5.1-6, Figure 5.1-11, Figure 5.4-10, and Table 5.1-10. FSAR Table 5.1.2-3 plus STC Inner Lid (7 inch SS and 2 inch NS-4-FR)*
If present, remove top spacer (YR-MPC and MPC-LACBWR only).	*2*	*0.5*	*Top of STC*	*2*	*40*	*40*	*Performed from side of STC FSAR Table 5.1.2-3*
Install adapter ring to inner lid recess and torque captured bolts.	*2*	*0.5*	*Top of STC*	*0.5*	*20*	*20*	*Performed from side of STC FSAR Table 5.1.2-3*
Install transfer adapter plate on adapter ring and install and torque the four bolts.	*2*	*1*	*Top of STC*	*1*	*20*	*40*	*Performed from side of STC FSAR Table 5.1.2-3*

All indicated changes are in response to RSI NP-12.6

Table E.9-1
Estimated Occupational Collective Dose for Receipt of NAC-STC Cask Loaded with YR-MPC, CY-MPC, or MPC-LACBWR TSC and Transfer to MPC VCC

8 Sheets

Process Step	***Number of Workers***	***Occupancy Time (hours)***	***Worker Location Around Cask***	***Worker Distance (m)***	***Total Dose Rate (mrem/hr)***	***Total Dose (person-mrem)[1]***	***Reference SAR/FSAR Section/Table/Figure***
Install TSC Lid Lifting Adapter Plate on the Structural Lid.	*2*	*1*	*Top of STC*	*0.5*	*30*	*60*	*Performed from side of STC FSAR Table 5.1.2-3*
Using the CTF crane, lower the appropriate MPC Transfer Cask (TFR) and set it down on the transfer adapter on the STC Cask.	*2*	*1.5*	*Top of STC*	*>2*	*<1*	*3*	*Remote handling operation*
Remove the TFR door lock pins and open shield doors with hydraulic system.	*1*	*0.5*	*Top of STC*	*1*	*40*	*20*	*Performed from side of STC FSAR Table 5.1.2-3 and Figure 5.4.2-7*
Using the CTF, lower the Air-Powered Chain Hoist hook through the TFR and engage to the TSC Lift Adapter Plate.	*2*	*1.5*	*Remote Operating Location*	*>2*	*<5*	*15*	*Remote operation using CTF mounted cameras*
Using the Chain Hoist System slowly lift the TSC into the TFR.	*1*	*1*	*Remote Operating Location*	*>2*	*<5*	*5*	*Remote operation using CTF mounted cameras*

All indicated changes are in response to RSI NP-12.6

Table E.9-1
Estimated Occupational Collective Dose for Receipt of NAC-STC Cask Loaded with YR-MPC, CY-MPC, or MPC-LACBWR TSC and Transfer to MPC VCC

8 Sheets

Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)[1]	Reference SAR/FSAR Section/Table/Figure
Close the TFR shield doors and install TFR shield door lock pins.	1	0.5	Bottom of TFR	0.5	40	20	Remote operation to close doors and pins installed from side of STC FSAR Table 5.1.2-3 and Figure 5.4.2-7
Lower the TSC onto the shield doors and using the CTF, lift the TFR off of the STC adapter plate.	1	1	Remote Operating Location	>2	<5	5	Remote operation using CTF mounted cameras
Move the TFR over the VCC and lower onto the VCC adapter plate.	1	1	Remote Operating Location	>2	<5	5	Remote operation using CTF mounted cameras
Remove the TFR shield door lock pins.	1	0.5	Bottom of TFR	0.5	40	20	Pins removed from side of STC FSAR Table 5.1.2-3 and Figure 5.4.2-7
Using the Chain Hoist System, lift the TSC off of the shield doors and open the shield doors.	1	0.5	Remote Operating Location	>2	<5	3	Remote operation using CTF mounted cameras
Using the chain hoist lower the TSC into the VCC.	1	1	Remote Operating Location	>2	<5	5	Remote operation using CTF mounted cameras

All indicated changes are in response to RSI NP-12.6

Table E.9-1
Estimated Occupational Collective Dose for Receipt of NAC-STC Cask Loaded with YR-MPC, CY-MPC, or MPC-LACBWR TSC and Transfer to MPC VCC

8 Sheets

Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)[1]	Reference SAR/FSAR Section/Table/Figure
Release chain hoist system hook from the TSC Lift Adapter Plate and retract through the TFR.	1	0.5	Remote Operating Location	>2	<5	3	Remote operation using CTF mounted cameras
Close TFR shield doors and install TFR shield door lock pins.	1	0.5	Bottom of TFR	0.5	30	15	Pins installed from side of STC FSAR Table 5.1.2-3 and Figure 5.4.2-7
Using the CTF, lift and remove the TFR from the top of the VCC.	1	0.5	Remote Operating Location	>2	<5	3	Remote operation using CTF mounted cameras
Using mobile crane, remove transfer adapter plate from VCC and store.	2	1	Top of VCC	1	45	90	FSAR Figure 5.4.2-9 and operation performed on top of transfer adapter mounted on VCC
Unbolt and remove TSC Lift Adapter Plate from the top of the TSC.	2	1	Top of TSC	1	60	120	FSAR Figure 5.4.2-9 and operation performed on top of VCC
Install the VCC Shield Plug (YR-MPC and CY-MPC only).	2	0.5	Top of VCC	1	35	35	FSAR Figure 5.4.2-9 and operation performed on top of VCC

All indicated changes are in response to RSI NP-12.6

Table E.9-1
Estimated Occupational Collective Dose for Receipt of NAC-STC Cask Loaded with YR-MPC, CY-MPC, or MPC-LACBWR TSC and Transfer to MPC VCC

8 Sheets

Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)[1]	Reference SAR/FSAR Section/Table/Figure
Install and bolt in place the VCC lid.	2	1	Top of VCC	1	25	50	FSAR Figure 5.4.2-9 and operation performed on top of VCC.
Using the VCT, lift and move loaded MPC VCC and position it in the designated storage location.	2	1	VCT Platform	>2	10	20	Operation performed from VCT and FSAR Figure 5.4.2-7
Prepare empty STC cask for empty return transport.	2	4	CTF	1	0	0	Empty cask preparation activities
					Total (person-mrem)	823	

Note:
1. Rounded up to the nearest whole number

All indicated changes are in response to RSI NP-12.6

E.11.1 Yankee Rowe MPC and Connecticut Yankee MPC

The Transportable Storage Canister (canister) provides long-term storage confinement of the Yankee Class and Connecticut Yankee spent fuel. The canister confinement boundary is closed by welding, which presents a leaktight barrier to the release of contents in all of the evaluated normal, off-normal and accident conditions. The method of closing the confinement boundary is the same for both NAC-MPC configurations.

The NAC-MPC canister contains an inert gas (helium). The confinement boundary retains the helium and also prevents the entry of outside air into the NAC-MPC. The exclusion of air precludes degradation of the fuel rod cladding over time, due to cladding oxidation failures.

The NAC-MPC canister confinement system meets the requirements of 10 CFR 72.24 for protection of the public from release of radioactive material, and 10 CFR 72.122 for protection of the spent fuel contents in long-term storage such that future handling of the contents would not pose an operational safety concern.

The helium purity level of at least 99.9% maintains the quantity of oxidizing contaminant to less than one mole per canister for all loading conditions. Based on the calculations presented in Sections 4.4.5 and 4.5.5 of Reference E.11-1, respectively, the free gas volume of the empty Yankee-MPC or CY MPC canister is less than 300 moles. Conservatively assuming that all of the impurities in 99.9% pure helium are oxidents, a maximum of 0.3 moles of oxidants could exist in the NAC-MPC canister during storage. By limiting the amount of oxidants to less than one mole, the recommended limits for preventing cladding degradation found in the Pacific Northwest Laboratory, "Evaluation of Cover Gas Impurities and Their Effects on the Dry Storage of LWR Spent Fuel," PNL-6365 are satisfied.

E.11.1.1 Confinement Boundary

The confinement boundary is described in detail for the Yankee-MPC and CY-MPC in Section 7.1 of Reference E.11-1. Specific details for the confinement vessel, confinement penetrations, seals & welds, and closure are in Sections 7.1.1, 7.1.2, 7.1.3, and 7.1.4, respectively. *In addition, a bounding evaluation in Section E.7.1.11 is presented to demonstrate that the confinement boundary for the Yankee-MPC and CY-MPC canisters 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.*

E.11.1.2 Requirements for Normal Conditions of Storage

The requirements for normal conditions of storage are described in detail in Section 7.2 of Reference E.11-1. Specific details on the release of radioactive materials and pressurization of the confinement vessel are in Sections 7.2.1 and 7.2.2, respectively.

All indicated changes are in response to RSI NP-9.3

E.11.2 LaCrosse MPC

The MPC-LACBWR Transportable Storage Canister (TSC) provides confinement for its radioactive contents in long-term storage. The confinement boundary provided by the TSC is closed by welding, creating a solid barrier to the release of contents in the design basis normal conditions and off-normal or accident events. The welds are visually inspected and nondestructively examined to verify integrity.

The sealed TSC contains helium, an inert gas, at atmospheric pressure. The confinement boundary retains the helium and also prevents entry of outside air into the TSC in long-term storage. The exclusion of air from the confinement boundary precludes fuel rod cladding oxidation failures during storage.

The TSC confinement system meets the requirements of 10 CFR 72.24 for protection of the public from release of radioactive material. The design of the TSC allows the recovery of stored spent fuel should it become necessary per the requirements of 10 CFR 72.122. The TSC meets the requirements of 10 CFR 72.122 (h) for protection of the spent fuel contents in long-term storage such that future handling of the contents would not pose an operational safety concern.

The MPC-LACBWR TSC provides an austenitic stainless steel closure design sealed by welding, precluding the need for continuous monitoring. The analysis for normal conditions and off-normal or accident events demonstrates that the integrity of the confinement boundary is maintained in all the evaluated conditions. Consequently, there is no release of radionuclides from the TSC resulting in site boundary doses in excess of regulatory requirements. Therefore, the confinement design of the MPC-LACBWR system meets the regulatory requirements of 10 CFR 72 and the acceptance criteria defined in NUREG-1536.

E.11.2.1 Confinement Boundary

The confinement boundary is described in detail for the MPC-LACBWR in Section 7.A.1 of Reference E.11-1. Specific details for the confinement vessel, confinement penetrations, seals & welds, and closure are in Sections 7.A.1.1, 7.A.1.2, 7.A.1.3, and 7.A.1.4, respectively. *In addition, a bounding evaluation in Section E.7.2.11 is presented to demonstrate that the confinement boundary for the MPC-LACBWR canister does not exceed ASME B&PV Subsection NB Article NB-3200 (Level A allowables) during normal conditions of transport to provide reasonable assurance that the confinement boundary is not adversely impacted by transport to the WCS CISF.*

E.11.2.2 Requirements for Normal Conditions of Storage

The requirements for normal conditions of storage are described in detail in Section 7.A.2 of Reference E.11-1. Specific details on the release of radioactive materials and pressurization of the confinement vessel are in Sections 7.A.2.1 and 7.A.2.2, respectively.

All indicated changes are in response to RSI NP-9.3

As documented in Sections 2.4.2.2 and 3.3.1.3 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.

F.3.1.1.3 Seismic Design

The NAC-UMS may be subject to a seismic event (earthquake) during storage on an unsheltered concrete pad at an ISFSI. The seismic response spectra experienced by the cask will depend upon the geographical location of the specific site and distance from the epicenter of the earthquake. The only significant effect of a seismic event on a NAC-UMS would be a possible tip-over of the cask or a collision of two casks due to sliding; however, neither tip-over nor sliding occurs in the evaluated design basis earthquake.

The evaluation of the seismic response of the NAC-UMS to the design basis earthquake is presented in Section 11.2.8 of Reference F.3-1. The seismic ground acceleration that will cause the NAC-UMS to tip over is calculated in Section 11.2.8 using quasi-static analysis methods. Evaluation of the consequences of a tip over event is provided in Section 11.2.12 of Reference F.3-1. Based on these evaluations, the maximum ground acceleration that does not result in cask tip over is 0.42g at the top surface of the ISFSI pad and the maximum ground acceleration that does not result in cask sliding is 0.29g at the top surface of the ISFSI pad. The WCS pad design meets the NAC-UMS pad requirements and is consistent with analyses performed within Reference F.3-1. The existing analysis bounds the WCS site pad design limits for accelerations at the top pad surface. Therefore, no further evaluations are required.

F.3.1.1.4 Snow and Ice Loadings

The criteria for determining design snow loads is based on ANSI/ASCE 7-93, Section 7.0. The NAC-UMS is assumed to have a site location typical for siting Category C, which is defined to be "locations in which snow removal by wind cannot be relied on to reduce roof loads because of terrain, higher structures, or several trees nearby." Ground snow loads for the contiguous United States are given in Figures, 5, 6 and 7 of ANSI/ASCE 7-93. A worst case value of 100 pounds per square foot was assumed. Section 2.2.4 of Reference F.3-1 demonstrates that the snow load is bounded by the weight of the loaded transfer cask.

The snow load is also considered in the load combinations described in Section 3.4.4.2.2 of Reference F.3-1. Therefore, no further WCS site-specific evaluations are required.

All indicated changes are in response to RSI NP-2.3

The confinement performance requirements for the NAC-UMS System are described in Chapter 7, Section 7.1.1.2 of Reference F.3-1 for storage conditions. In addition, "NAC-UMS Universal Transport Cask Safety Analysis Report" [F.3-2] demonstrates that the confinement boundary is not adversely affected by normal conditions of transport. Specifically, Chapter 2, Section 2.6.12 for the PWR canister. Therefore, transport to the WCS CISF will not adversely impacted confinement integrity of the NAC-UMS canister.

F.3.1.3 Decommissioning Considerations

The principle elements of the NAC-UMS storage system are the vertical concrete cask and the transportable storage canister. Section 2.4 of Reference F.3-1 discusses decommissioning considerations of these principle elements.

All indicated changes are in response to RSI NP-4.1

F.3.2 References

F.3-1 NAC-UMS Universal Storage System Final Safety Analysis Report, Revision 10, October 2012.

F.3-2 NAC-UMS Universal Transport Cask Safety Analysis Report, Revision 2, 2005.

All indicated changes are in response to RSI NP-4.1

Table F.3-1
Summary of WCS CISF Principal Design Criteria
(4 pages)

Design Parameter	***WCS CISF Design Criteria***	***Condition***	***NAC-UMS® Design Criteria***
Type of fuel	*Commercial, light water reactor spent fuel*	*Normal (Bounded)*	*WCS CISF SAR Appendix F, Section F.3.2*
Storage Systems	*Transportable canisters and storage overpacks docketed by the NRC*	*Normal (Bounded)*	*72-1015* *71-9270*
Fuel Characteristics	*Criteria as specified in previously approved licenses for included systems*	*Normal (Bounded)*	*WCS CISF SAR Appendix F, Section F.3.2*
Tornado (Wind Load)	*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)*	***NAC-UMS FSAR Section 2.2.1.1*** *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 (Missile)	*Automobile: 4000 lb, 112 ft/s (76.4 mph)* *Schedule 40 Pipe: 287 lb, 112 ft/s (76.4 mph)* *Solid Steel Sphere: 0.147 lb, 23 ft/s (15.7 mph)*	*Accident (Bounded)*	***NAC-UMS FSAR Section 2.2.1.3*** *Massive Missile: 4000 lb, 126 mph* *Rigid hardened steel: 280 lb, 126 mph* *Solid Steel Sphere: 0.15 lb, 126 mph*
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)*	***NAC-UMS FSAR Section 11.2.9*** *Flood height: 50 ft* *Water velocity: 15 ft/s*

All indicated changes are in response to RSI NP-2.3

Table F.3-1
Summary of WCS CISF Principal Design Criteria
(4 pages)

Design Parameter	***WCS CISF Design Criteria***	***Condition***	***NAC-UMS® Design Criteria***
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 (Bounded)*	***NAC-UMS FSAR Section 11.2.8*** *The maximum allowable ground acceleration for the NAC-UMS system is 0.26g horizontal and 0.26g vertical.*
Vent Blockage	*For UMS Systems:* *Inlet and outlet vents blocked 24 hrs*	*Accident (Same)*	*Inlet and outlet vents blocked: 24 hrs*
Fire/Explosion	*For UMS Systems:* *Equivalent fire 50 gallons of diesel fuel*	*Accident (Same)*	***NAC-UMS FSAR Section 11.2.6.1*** *Equivalent fire 50 gallons of flammable fluid*
Cask Drop	*For UMS Systems:* *VCC's Drop height 24 inches*	*Accident (Same)*	***NAC-UMS FSAR Section 11.2.4*** *VCCs for UMS Systems:* *Drop height 24 inches*
Ambient Temperatures	*Yearly average temperature 67.1°F*	*Normal (Bounded)*	***NAC-UMS FSAR Section 2.2.6*** *Average Annual Ambient Temperature 76°F*
Off-Normal Temperature	*Minimum 3 day avg. temperature 27.9°F* *Maximum 3 day avg. temperature 89.4°F*	*Off-Normal (Bounded)*	***NAC-UMS FSAR Section 2.2.6*** *Minimum 3 day avg. temperature -40°F* *Maximum 3 day avg. temperature 106°F*
Extreme Temperature	*Maximum temperature 113°F*	*Accident (Bounded)*	***NAC-UMS FSAR Section 2.2.6*** *Maximum temperature 133°F*

All indicated changes are in response to RSI NP-6.3

F.5 OPERATING PROCEDURES

The following are operating procedures for using the NAC-UMS Universal Storage System configured for the Maine Yankee UMS storage operations. These procedures are based on the general guidance found in Chapter 8 of the NAC-UMS Final Safety Analysis Report (FSAR) [Reference F.5.2-1]. The procedures covered are:

1. Installing the transportable storage canister (TSC) in the vertical concrete cask (concrete cask) and transferring it to the ISFSI storage pad; and
2. Removing the loaded canister from the concrete cask.
3. Receipt of the NAC-UMS Transport Cask and removal of the loaded canister.

The detailed operating procedures for receiving a loaded NAC-UMS Transport Cask and unloading the transportable storage canister are described in Section 7.3 of the NAC-UMS Transport Cask SAR. [Reference F.5.2-3]

Pictograms of the NAC-UMS System operations are presented in Figure F.5-1.

All indicated changes are in response to RSI NP-4.3

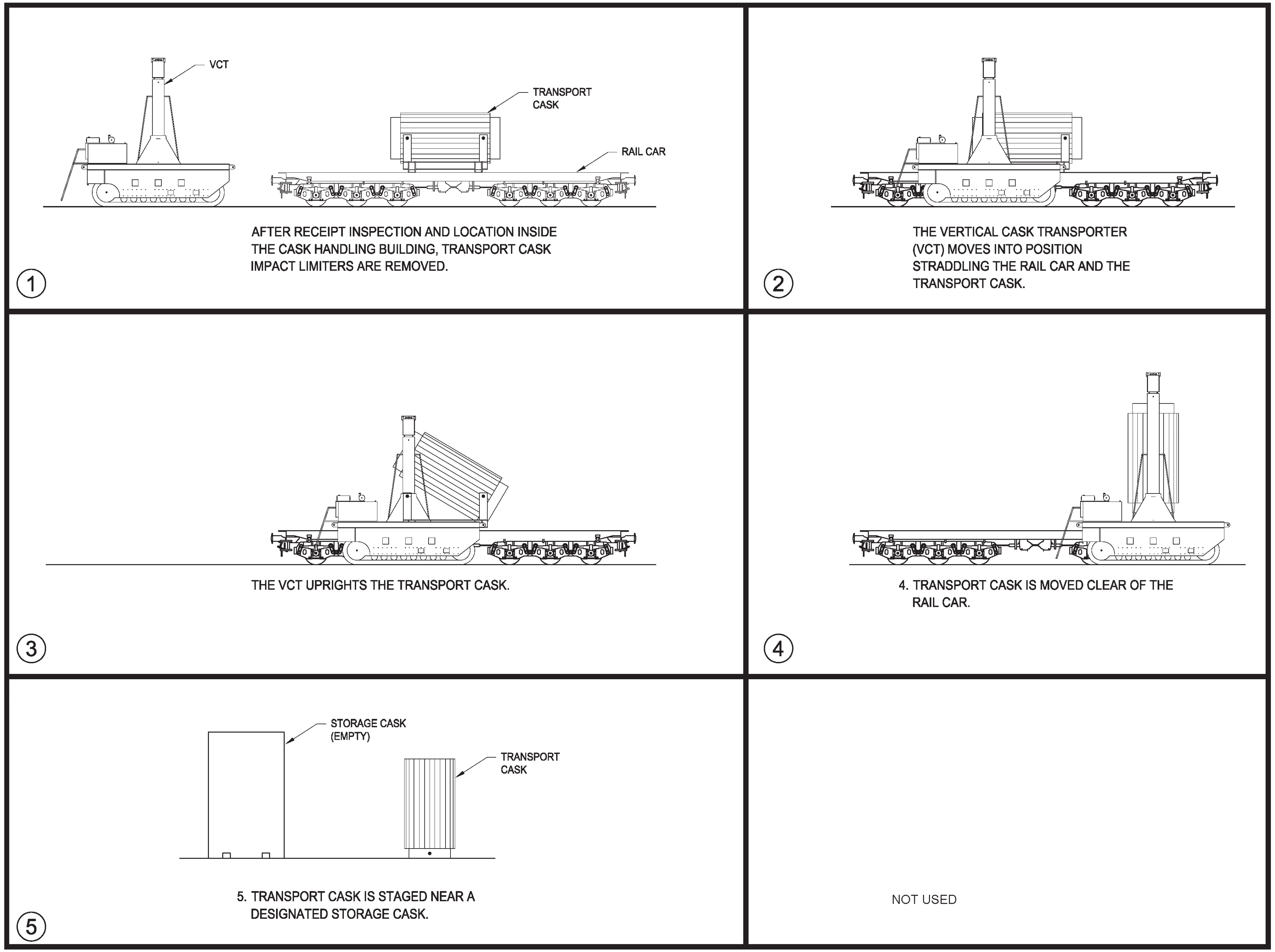


Figure F.5-1
Canister Transfer Operations
2 Pages

All indicated changes are in response to RSI NP-4.3

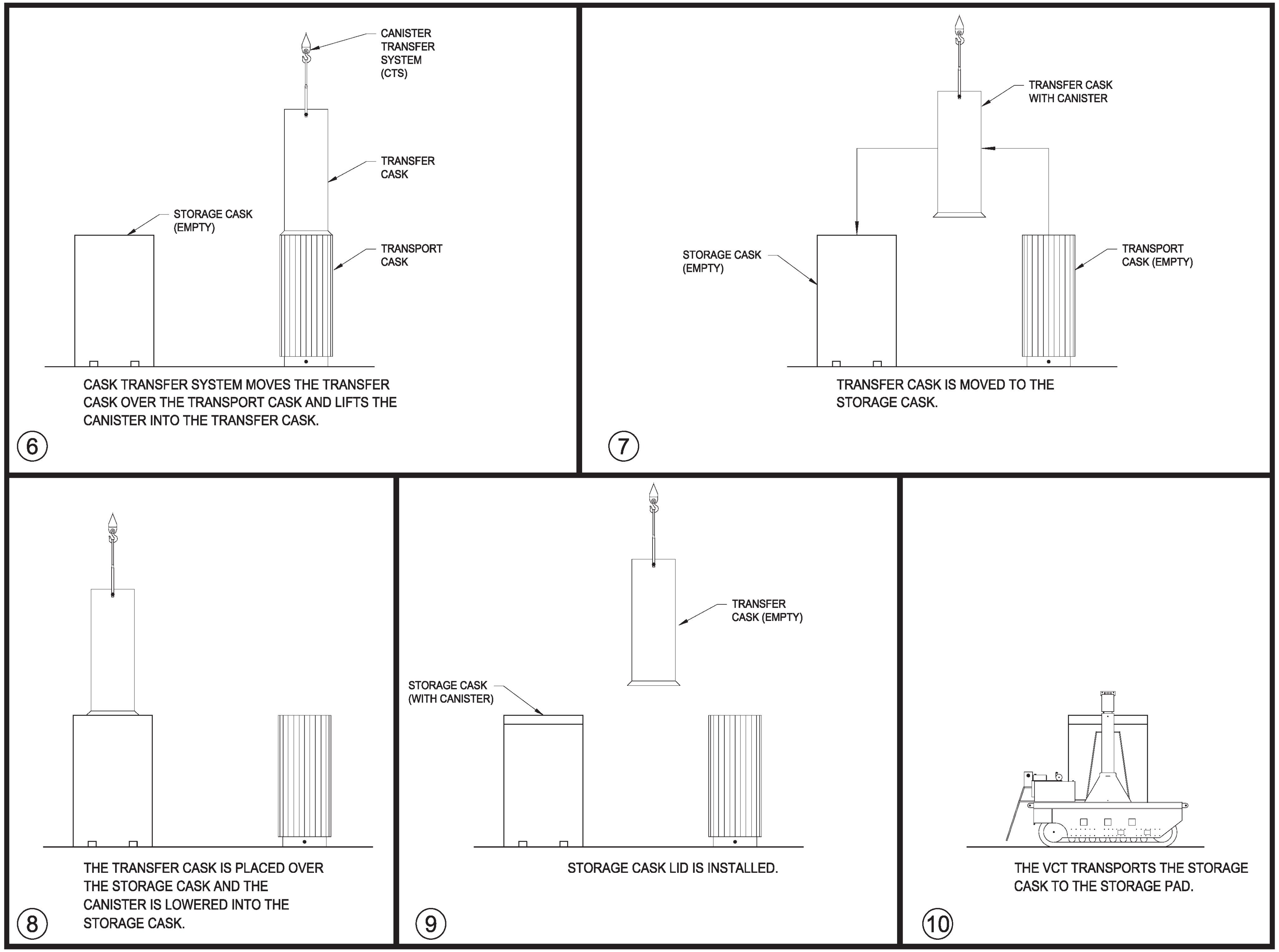


Figure F.5-1
Canister Transfer Operations
2 Pages

All indicated changes are in response to RSI NP-4.3

F.7.1 Maine Yankee

Sections F.7.1.1 through F.7.1.10 identify the sections of the NAC-UMS FSAR, Reference F.7.2-1, where the detailed structural analyses for the NAC-UMS for normal operating conditions are presented. *Finally, bounding evaluations in Section F.7.1.11 are referenced to demonstrate that the confinement boundaries for the NAC-UMS canisters 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.*

F.7.1.1 Structural Design

The structural design and design criteria for the NAC-UMS system are presented in Section 3.1 of the NAC-UMS FSAR, Reference F.7.2-1. The design criteria for environmental conditions and natural phenomena is presented in WCS SAR Appendix F.3. The following components are described and evaluated in FSAR Chapter 3: canister lifting devices; canister shell, bottom, and structural lid; canister shield lid support ring; fuel basket assembly; transfer cask trunnions, shells, retaining ring, bottom doors, and support rails; vertical concrete cask body; and concrete cask steel components - reinforcement, inner shell, lid, bottom plate, bottom, etc.

F.7.1.2 Weights and Centers of Gravity

The weights and centers of gravity (CGs) for the NAC-UMS system components are presented in Section 3.2 of the NAC-UMS FSAR, Reference F.7.2-1. The component weights and under-the-hook weights for the five system configurations are summarized in Tables 3.2-1 through 3.2-3 of the FSAR.

F.7.1.3 Mechanical Properties of Materials

The materials used in the fabrication of the NAC-UMS components and the mechanical properties of those materials are presented in Section 3.3 of the NAC-UMS FSAR, Reference F.7.2-1. The mechanical properties of the materials with respect to operating temperatures are tabulated in Tables 3.3-1 through 3.3-14 of the FSAR.

F.7.1.4 Chemical and Galvanic Reactions

The materials used in the fabrication and operation of the NAC-UMS are evaluated in Section 3.4.1 of the NAC-UMS FSAR, Reference F.7.2-1, to determine whether chemical, galvanic or other reactions among the materials, contents, and environments can occur Loading, unloading, handling, and storage operations are considered for the environments that may be encountered.

All indicated changes are in response to RSI NP-9.3

F.7.1.10 Coating Specifications

Coatings are applied to the exposed carbon steel surfaces associated with the NAC-UMS vertical concrete cask and transfer cask to protect those surfaces in their service environment. The coating specifications are provided in Section 3.8 of the NAC-UMS FSAR, Reference F.7.2-1.

Each coating meets the service and performance requirements that are established for the coating by the design and service environment of the component to be covered.

F.7.1.11 Structural Evaluation of NAC-UMS Canister Confinement Boundaries under Normal Conditions of Transport

The NAC-UMS canister primary confinement boundaries consist of a canister shell, bottom closure plate, shield lid, the two (2) port covers, and the welds that join these components. Redundant closure is provided by a structural lid and adjoining canister weld. Additional details, geometry and shell and plate thicknesses are provided on the drawings in Section F.4.3. The confinement boundary is addressed in Section F.11.1.1. NAC-UMS canister shell is evaluated for Normal Conditions of Transport in the NAC-UMS Transport cask in Section 2.6.12 of [F.7.2-3].

The result of the structural analysis is acceptable for the loads and combinations described in Section 2.6.12 of [F.7.2-3] and hence structurally adequate for normal conditions of transport loading conditions.

All indicated changes are in response to RSI NP-9.3

F.7.2 References

F.7.2-1 NAC-UMS Universal Storage System Final Safety Analysis Report, Revision 10, October 2012.

F.7.2-2 Amendment No. 5 to Certificate of Compliance No. 1015 for the NAC International, Inc., NAC-UMS Universal Storage System, January 12, 2008.

F.7.2-3 NAC-UMS Universal Transport Cask Safety Analysis Report, Revision 2, 2005.

All indicated changes are in response to RSI NP-9.3

F.8.1 Maine Yankee

Chapter 4 of the NAC-UMS Final Safety Analysis Report (FSAR), Reference F.8.2-1, presents the thermal design conditions, the allowable component temperatures and the thermal evaluations for the operation of the NAC-UMS spent fuel storage system. The established bounding thermal environmental conditions are summarized in FSAR Table 4.1-1. The maximum allowable component material temperatures are tabulated in FSAR Table 4.1-3. The bounding thermal environmental conditions are described in the following paragraphs.

F.8.1.1 Maximum Average Yearly Ambient Temperature

This is a long-term storage condition that is analyzed in FSAR Section 4.4. The maximum average yearly ambient design temperature for the NAC-UMS is 76°F. The average yearly temperature for the site is conservatively bounded by using the maximum average annual temperature in the 48 contiguous United States, of 76°F. This temperature meets the normal condition thermal boundary defined in NUREG-1536. Therefore, no further WCS site-specific evaluations are required.

F.8.1.2 Maximum Average 3-Day Ambient Temperature

This is an off-normal severe heat condition that is analyzed in FSAR Section 11.1.1. The maximum average 3-day ambient temperature for the NAC-UMS is 106°F. This temperature bounds the WCS facility maximum average 3-day ambient temperature of *89.4*°F. Therefore, no further site-specific evaluations are needed.

F.8.1.3 Maximum Extreme 3-Day Ambient Temperature

This is an extreme heat accident condition that is analyzed in FSAR Section 11.2.7. *For the NAC-UMS, the maximum allowed temperature extremes, average over a 3-day period, shall be greater than -40°F and less than 133°F.* This bounds the WCS facility maximum temperature extreme of *-1*°F *and 113°F.* No further site-specific evaluations are needed.

All indicated changes are in response to RSI NP-6.3

Maximum dose rates for the standard or advanced transfer cask with a wet and dry canister cavity are shown in Table 5.1-3 of Reference F.9.2-1, for design basis PWR fuel. Under wet canister conditions, the maximum surface dose rates with design basis PWR fuel are 259 (<1%) mrem/hr on the cask side and 579 (<1%) mrem/hr on the cask bottom. The cask side average surface dose rate under wet conditions is 137 (<1%) mrem/hr, and the bottom average surface dose rate is 258 (<1%) mrem/hr. Under dry conditions, the maximum surface dose rates are 410 (<1%) mrem/hr on the cask side and 819 (<1%) mrem/hr on the cask bottom. Cask average surface dose rates are 306 (<1%) mrem/hr on the side and 374 (<1%) mrem/hr on the bottom. In normal operation, the bottom of the transfer cask is inaccessible during welding of the canister lids.

Maine Yankee Site-Specific fuel assembly configurations are either shown to be bounded by the analysis of the standard design basis fuel assembly configuration of the same type (PWR or BWR), or are shown to be acceptable contents by specific evaluation of the configuration.

Table F.9-1 provides estimated occupational exposures for receipt and handling of the NAC-UMS system loaded with PWR fuel at the WCS CISF facility. For each procedural step the number of workers, occupancy time, worker distance, dose rates, and total dose are estimated. Dose rates used were obtained and estimated via the listed references in the table. The total occupational exposure for receiving, transferring and placing these canisters on the storage pad in their storage overpack (VCC) is 864 person-mrem each.

The total collective dose for unloading a NAC-UMS PWR canister from its VCC and preparing it for transport off-site is bounded by the loading operations (864 person-mrem). Operations for retrieving these canisters from the VCC 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 1,728 person-mrem.

All indicated changes are in response to RSI NP-12.6

Table F.9-1
Estimated Occupational Collective Dose for Receipt of NAC Universal Transport Cask Loaded with PWR SNF in Class 1 or 2 TSC and Transfer to UMS Class 1 or Class 2 VCC
6 Sheets

Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)[1]	Reference SAR/FSAR Section/Table/Figure
Perform radiation and contamination survey of UTC	2	0.25	All Around UTC Cask	>2	10	5	SAR Figure 5.1-1 and Table 5.1-1
Inspect top and bottom impact limiter security seals and verify they are intact and correct IDs.	1	0.5	Top and Bottom Impact Limiters	>1	<6	3	SAR Figure 5.1-1 and Table 5.1-1
Remove Personnel Barrier and complete surveys	2	0.5	Center of cask	>1	<20	20	SAR Figure 5.1-1 and Table 5.1-1
Visually inspect UTC Cask surface for transport/road damage and record	1	0.25	All Around UTC Cask	2	10	3	SAR Figure 5.1-1 and Table 5.1-1
Attach slings to top Impact Limiter and remove attachment nuts/rods. Remove and store Impact Limiter. Remove and store front impact limiter positioner and screws.	2	1	Top Impact Limiter Surface of UTC	1	< 1	2	SAR Figure 5.1-1 and Table 5.1-1
Attach slings to bottom Impact Limiter and remove attachment nots/rods. Remove and store Impact Limiter. Remove and store bottom impact limiter positioner and screws.	2	1	Bottom Impact Limiter Surface of UTC	1	6	12	SAR Figure 5.1-1 and Table 5.1-1
Release Front Tie-Down Assembly	2	1	Top Side UTC Surface	>1	50	100	SAR Figure 5.1-1 and Table 5.1-1

All indicated changes are in response to RSI NP-12.6

Table F.9-1
Estimated Occupational Collective Dose for Receipt of NAC Universal Transport Cask Loaded with PWR SNF in Class 1 or 2 TSC and Transfer to UMS Class 1 or Class 2 VCC
6 Sheets

Process Step	*Number of Workers*	*Occupancy Time (hours)*	*Worker Location Around Cask*	*Worker Distance (m)*	*Total Dose Rate (mrem/hr)*	*Total Dose (person-mrem)*[1]	*Reference SAR/FSAR Section/Table/Figure*
Engage Vertical Cask Transporter (VCT) Lift Arms to Primary Front Trunnions and rotate cask to vertical orientation	*2*	*1*	*Top Side UTC Surface*	*>2*	*10*	*20*	*SAR Figure 5.1-1 and Table 5.1-1*
Lift and Remove UTC from the Transport Skid Rear Rotation Trunnions and move cask to gantry Canister Transfer Facility (CTF), set cask down and release VCT Lift Arms. Establish Radiation Control boundaries.	*2*	*2*	*Top Side UTC Surface*	*>2*	*10*	*40*	*SAR Figure 5.1-1 and Table 5.1-1*
Using VCT, move empty UMS VCC (Class 1 or 2, as required) to transfer position in CTF and set down adjacent to UTC cask. Set up appropriate work platforms/man lifts for access to top of VCC and UTC.	*2*	*1*	*Top of Empty VCC*	*>2*	*0*	*0*	*Empty VCC*
Remove VCC Lid and bolts, and VCC Shield Plug.	*2*	*1*	*Top of Empty VCC*	*1*	*0*	*0*	*Empty VCC*
Install Transfer Adapter on VCC and connect hydraulic system.	*2*	*1*	*Top of Empty VCC*	*1*	*0*	*0*	*Empty VCC*

All indicated changes are in response to RSI NP-12.6

***Table* F.9-1**
Estimated Occupational Collective Dose for Receipt of NAC Universal Transport Cask Loaded with PWR SNF in Class 1 or 2 TSC and Transfer to UMS Class 1 or Class 2 VCC
6 Sheets

Process Step	***Number of Workers***	***Occupancy Time (hours)***	***Worker Location Around Cask***	***Worker Distance (m)***	***Total Dose Rate (mrem/hr)***	***Total Dose (person-mrem)***[1]	***Reference SAR/FSAR Section/Table/Figure***
Remove vent port cover and connect pressure test system to vent port to check for excessive pressure. If pressure is high, take sample and check. If clean vent to HEPA filter.	*1*	*0.5*	*Top of UTC*	*0.5*	*50*	*25*	*FSAR Table 5.1-3, FSAR Section 5.1.3.1 + UTC Closure Lid Thickness 6.5-inch SS*
Remove 48 UTC lid bolts, install alignment pins and lid lifting hoist rings/slings and remove inner lid and store. Remove alignment pins.	*2*	*1*	*Top of UTC*	*0.5*	*30*	*60*	*FSAR Table 5.1-3, FSAR Section 5.1.3.1 + UTC Closure Lid Thickness 6.5-inch SS Perform operation from side of UTC cask*
Install adapter ring to inner lid recess and torque captured bolts.	*2*	*0.5*	*Top of UTC*	*0.5*	*30*	*30*	*FSAR Table 5.1-3, and FSAR Section 5.1.3.1. Perform operation from side of UTC cask*
Install transfer adapter plate on adapter ring and install and torque the four transfer adapter plate bolts.	*2*	*1*	*Top of UTC*	*1*	*15*	*30*	*FSAR Table 5.1-3, and FSAR Section 5.1.3.1. Perform operation from side of UTC cask*
Install TSC Lid Lifting Adapter Plate on the Structural Lid.	*2*	*1*	*Top of UTC*	*0.5*	*60*	*120*	*FSAR Table 5.1-3, and FSAR Section 5.1.3.1. Perform operation from side of UTC cask*
Using the CTF crane, lower the appropriate MPC Transfer Cask (TFR) and set it down on the transfer adapter on the UTC Cask.	*2*	*1.5*	*Top of UTC*	*>4*	*<1*	*3*	*Remote handling operation*

All indicated changes are in response to RSI NP-12.6

Table F.9-1
Estimated Occupational Collective Dose for Receipt of NAC Universal Transport Cask Loaded with PWR SNF in Class 1 or 2 TSC and Transfer to UMS Class 1 or Class 2 VCC
6 Sheets

Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)[1]	Reference SAR/FSAR Section/Table/Figure
Remove the TFR shield door lock pins and open shield doors with hydraulic system.	*1*	*0.5*	*Top of UTC*	*1*	*15*	*8*	*SAR Figure 5.1-1 and Table 5.1-1 and FSAR Table 5.1-3, and FSAR Section 5.1.3.1. Perform operation from side of TFR and UTC cask*
Using the CTF, lower the Air-Powered Chain Hoist hook through the TFR and engage to the TSC Lift Adapter Plate.	*2*	*1.5*	*Remote Operating Location*	*>4*	*<5*	*15*	*Remote operation using CTF mounted cameras*
Using the Chain Hoist System slowly lift the TSC into the TFR.	*2*	*1*	*Remote Operating Location*	*>4*	*<5*	*10*	*Remote operation using CTF mounted cameras*
Close the TFR shield doors and install lock pins.	*1*	*0.5*	*Bottom of TFR*	*0.5*	*30*	*15*	*Operation from side of TFR. FSAR Section 5.4, Table 5.1-3 and Figure 5.4-11*
Lower the TSC onto the shield doors and using the CTF, lift the TFR off of the UTC transfer adapter plate.	*2*	*1*	*Remote Operating Location*	*>4*	*<5*	*10*	*Remote operation using CTF mounted cameras*
Move the TFR over the VCC and lower onto the VCC transfer adapter plate.	*1*	*1*	*Remote Operating Location*	*>4*	*<5*	*5*	*Remote operation using CTF mounted cameras*
Remove the TFR shield door lock pins.	*1*	*0.5*	*Bottom of TFR*	*0.5*	*30*	*15*	*Operation from side of TFR FSAR Section 5.4, Table 5.1-3 and Figure 5.4-11*

All indicated changes are in response to RSI NP-12.6

***Table* F.9-1**
Estimated Occupational Collective Dose for Receipt of NAC Universal Transport Cask Loaded with PWR SNF in Class 1 or 2 TSC and Transfer to UMS Class 1 or Class 2 VCC
6 Sheets

Process Step	*Number of Workers*	*Occupancy Time (hours)*	*Worker Location Around Cask*	*Worker Distance (m)*	*Total Dose Rate (mrem/hr)*	*Total Dose (person-mrem)*[1]	*Reference SAR/FSAR Section/Table/Figure*
Using the Chain Hoist System, lift the TSC off of the shield doors and open the shield doors.	*2*	*0.5*	*Remote Operating Location*	*>4*	*<5*	*5*	*Remote operation using CTF mounted cameras*
Using the chain hoist lower the TSC into the VCC.	*2*	*1*	*Remote Operating Location*	*>4*	*<5*	*10*	*Remote operation using CTF mounted cameras*
Release chain hoist system hook from the TSC Lift Adapter Plate and retract chain hoist hook through the TFR.	*1*	*0.5*	*Remote Operating Location*	*>4*	*<5*	*3*	*Remote operation using CTF mounted cameras*
Close TFR shield doors and install lock pins.	*1*	*0.5*	*Bottom of TFR*	*0.5*	*30*	*15*	*Operation from top of VCC. FSAR Section 5.4, Table 5.1-3 and Figure 5.4-5*
Using the CTF, lift and remove the TFR from the top of the VCC.	*1*	*0.5*	*Remote Operating Location*	*>4*	*<5*	*3*	*Remote operation using CTF mounted cameras*
Using mobile crane, remove transfer adapter plate from VCC and store.	*2*	*1*	*Top of VCC*	*1*	*10*	*20*	*Remote operation using CTF mounted cameras after connection of lifting slings*
Unbolt and remove TSC Lift Adapter Plate from the top of the TSC and store.	*2*	*1*	*Top of TSC*	*1*	*75*	*150*	*Operation performed on top of VCC Figure 5.4-5*

All indicated changes are in response to RSI NP-12.6

***Table* F.9-1**
Estimated Occupational Collective Dose for Receipt of NAC Universal Transport Cask Loaded with PWR SNF in Class 1 or 2 TSC and Transfer to UMS Class 1 or Class 2 VCC
6 Sheets

Process Step	***Number of Workers***	***Occupancy Time (hours)***	***Worker Location Around Cask***	***Worker Distance (m)***	***Total Dose Rate (mrem/hr)***	***Total Dose (person-mrem)[1]***	***Reference SAR/FSAR Section/Table/Figure***
Install the VCC Shield Plug.	*2*	*0.5*	*Top of VCC*	*1*	*25*	*35*	*Operation performed on top of VCC Figure 5.4-5*
Install and bolt in place the VCC lid.	*2*	*1*	*Top of VCC*	*1*	*25*	*50*	*Operation performed on top of VCC Figure 5.4-5*
Using the VCT, lift and move loaded UMS VCC and position it in the designated storage location.	*2*	*1*	*VCT Platform*	*>4*	*10*	*20*	*Operation performed from VCT and FSAR Figure 5.4-2*
Remove installed transport cavity spacer and place in approved IP-1 container. Prepare empty UTC cask for empty return transport. Transfer and rotate UTC on the transport/shipping frame. Install transport tie-downs and impact limiters.	*3*	*9*	*CTF/VCT/Rail Car*	*1 to 4*	*0*	*0*	*Empty cask preparation activities*
					Total (person-mrem)	*864*	

Note:
1. Rounded up to the nearest whole number

All indicated changes are in response to RSI NP-12.6

F.11.1 Maine Yankee

The Transportable Storage Canister (canister) provides long-term storage confinement of the NAC-UMS spent fuel. The canister confinement boundary is closed by welding, which is a leaktight barrier to the release of contents in all of the evaluated normal, off-normal and accident conditions. The method of closing the confinement boundary is the same for both PWR and BWR configurations.

The NAC-UMS canister is backfilled with an inert gas (helium). The confinement boundary retains the helium and prevents the entry of outside air into the NAC-UMS canister. The exclusion of air precludes degradation of the fuel rod cladding due to cladding oxidation failures over time. The helium purity level of at least 99.9% maintains the quantity of oxidizing contaminant to less than one mole per canister for all loading conditions. Conservatively, assuming that all of the impurities in 99.9% pure helium are oxidents, a maximum of 0.3 moles of oxidants could exist in the NAC-UMS canister during storage. By limiting the amount of oxidants to less than one mole, the recommended limits for preventing cladding degradation (Pacific Northwest Laboratory, "Evaluation of Cover Gas Impurities and Their Effects on the Dry Storage of LWR Spent Fuel," PNL-6365) are satisfied.

The NAC-UMS canister confinement system meets the requirements of 10 CFR 72.24 for protection of the public from release of radioactive material, and 10 CFR 72.122 for protection of the spent fuel contents in long-term storage such that future handling of the contents would not pose an operational safety concern. Maine Yankee site-specific spent fuel is stored in the NAC-UMS canister. As discussed in NAC-UMS FSAR (Reference F.11.2-1) Section 4.5.1, the Maine Yankee site-specific fuel configurations do not result in a canister pressure, or temperature, that exceeds the canister design basis. Therefore, there is no credible leakage from a canister containing Maine Yankee site-specific spent fuel.

F.11.1.1 Confinement Boundary

The confinement boundary is described in detail for the NAC-UMS in Section 7.1 of the NAC-UMS FSAR, Reference F.11.2-1. Specific details for the confinement vessel, confinement penetrations, seals & welds, and closure are in Sections 7.1.1, 7.1.2, 7.1.3, and 7.1.4, respectively. *In addition, a bounding evaluation in Section F.7.1.11 is presented to demonstrate that the confinement boundary for the NAC-UMS canister does not exceed ASME B&PV Subsection NB Article NB-3200 (Level A allowables) during normal conditions of transport to provide reasonable assurance that the confinement boundary is not adversely impacted by transport to the WCS CISF.*

All indicated changes are in response to RSI NP-9.3

G.3.1.1.1 Tornado Missiles and Wind Loadings

The concrete casks are typically placed outdoors on an unsheltered reinforced concrete storage pad at an ISFSI site. This storage condition exposes the casks to tornado and wind loading. The design basis tornado and wind loading is defined based on Regulatory Guide 1.76 Region 1 and NUREG-0800. The design basis tornado missile impacts are defined in Paragraph 4, Subsection III, Section 3.5.1.4 of NUREG 0800. Analyses presented in Reference G.3-1, Section 3.7.3.2 and discussed in Reference G.3-1, Section 12.2.11 demonstrates that the MAGNASTOR design meets these criteria. Therefore, no further WCS site-specific evaluations are required.

G.3.1.1.2 Water Level (Flood) Design

The loaded concrete cask may be exposed to a flood during storage on an unsheltered concrete storage pad at an ISFSI site. The source and magnitude of the probable maximum flood depend on specific site characteristics. The MAGNASTOR concrete cask design basis is a maximum floodwater depth of 50 feet above the base of the cask and a floodwater velocity of 15 ft per second.

As documented in Sections 2.4.2.2 and 3.3.1.3, 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.

G.3.1.1.3 Seismic Design

An ISFSI site may be subject to seismic events (earthquakes) during its lifetime. The seismic response spectra experienced by the concrete cask depends upon the geographical location of the specific site and the distance from the epicenter of the earthquake. The possible significant effect of a beyond-design-basis seismic event on the concrete cask would be a tip-over; however, the loaded concrete cask does not tip over during the design-basis seismic event. Although it is a nonmechanistic event, the loaded concrete cask design basis includes consideration of the consequences of a hypothetical cask tip-over event.

Seismic response of the MAGNASTOR system is discussed in Reference G.3-1, Section 12.2.8. The maximum horizontal acceleration at the surface of the concrete storage pad due to an earthquake is evaluated in Reference G.3-1, Section 3.7.3.4. This evaluation shows that MAGNASTOR is stable during a 0.37g earthquake horizontal acceleration (including a 1.1 factor of safety). The vertical acceleration for this evaluation is defined as two-thirds of the horizontal acceleration in accordance with ASCE 4-86.

All indicated changes are in response to RSI NP-2.3

Category C - Components whose failure would not significantly reduce the packaging effectiveness and would not likely result in conditions adverse to safe operations, integrity of spent fuel, or public health and safety.

As discussed in Section 2.4 of Reference G.3-1, the MAGNASTOR design incorporates features addressing the above design considerations to assure safe operation during fuel loading, handling, and storage of spent nuclear fuel. This section addresses the following:

- Confinement Barriers and Systems
- Concrete Cask Cooling
- Protection by Equipment
- Protection by Instrumentation
- Nuclear Criticality Safety
- Radiological Protection
- Fire Protection
- Explosion Protection
- Auxiliary Structures

The confinement performance requirements for the NAC-MAGNASTOR System are described in Chapter 7, Section 7.2 of Reference G.3-1 for storage conditions. In addition, MAGNATRAN Transport Cask SAR [G.3-2] demonstrates that the confinement boundary is not adversely affected by normal conditions of transport. Specifically, Chapter 2, Section 2.6.12 for the PWR canister. Therefore, transport to the WCS CISF will not adversely impacted confinement integrity of the NAC-MAGNASTOR canister.

G.3.1.3 Decommissioning Considerations

The principal components of MAGNASTOR are the concrete cask and the TSC. Decommissioning of these principal components is discussed in Chapter 15 of Reference G.3-1.

All indicated changes are in response to RSI NP-4.1

G.3.2 References

G.3-1 MAGNASTOR Final Safety Analysis Report, Revision 7, July 2015

G.3-2 MAGNATRAN Transport Cask SAR, Revision 12A, October 2012

All indicated changes are in response to RSI NP-4.1

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

Design Parameter	***WCS CISF Design Criteria***	***Condition***	***MAGNASTOR® Design Criteria***
Type of fuel	*Commercial, light water reactor spent fuel*	*Normal (Bounded)*	*MAGNASTOR FSAR Section 2.2*
Storage Systems	*Transportable canisters and storage overpacks docketed by the NRC*	*Normal (Bounded)*	*72-1031* *71-9356 (Pending)*
Fuel Characteristics	*Criteria as specified in previously approved licenses for included systems*	*Normal (Bounded)*	*MAGNASTOR FSAR Section 2.2*
Tornado (Wind Load)	*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)*	***MAGNASTOR FSAR Section 2.3.1.1*** *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 (Missile)	*Automobile: 4000 lb, 112 ft/s (76.4 mph)* *Schedule 40 Pipe: 287 lb, 112 ft/s (76.4 mph)* *Solid Steel Sphere: 0.147 lb, 23 ft/s (15.7 mph)*	*Accident (Bounded)*	***MAGNASTOR FSAR Section 2.3.1.3*** *Massive Missile: 4000 lb, 126 mph* *Rigid hardened steel: 280 lb, 126 mph* *Solid Steel Sphere: 0.15 lb, 126 mph*
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)*	***MAGNASTOR FSAR Section 2.3.2.1*** *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 (Bounded)*	***MAGNASTOR FSAR Section 2.3.3*** *The maximum allowable ground acceleration for the MAGNASTOR system is 0.37g horizontal and 0.25g vertical when the ISFSI pad does not incorporate the use of bollards*

All indicated changes are in response to RSI NP-2.3

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

Design Parameter	*WCS CISF Design Criteria*	*Condition*	*MAGNASTOR® Design Criteria*
Vent Blockage	*For MAGNASTOR® Systems:* *Inlet vents blocked 72 hrs*	*Accident (Same)*	***MAGNASTOR FSAR Section 4.6.3*** *Inlet vents blocked 72 hrs*
Fire/Explosion	*For MAGNASTOR® Systems:* *Equivalent fire 50 gallons of diesel fuel*	*Accident (Same)*	***MAGNASTOR FSAR Section 4.6.2*** *Equivalent fire 50 gallons of flammable liquid*
Cask Drop	*For MAGNASTOR® Systems:* *VCCs Drop height 24 inches*	*Accident (Same)*	***MAGNASTOR FSAR Section 12.2.4*** *VCCs for MAGNASTOR Systems:* *Drop height 24 inches*
Ambient Temperatures	*Yearly average temperature 67.1°F*	*Normal (Bounded)*	***MAGNASTOR FSAR Section 2.3.6*** *Normal operations temperature 76°F*
Off-Normal Temperature	*Minimum 3 day avg. temperature 27.9°F* *Maximum3 day avg. temperature 89.4°F*	*Off-Normal (Bounded)*	***MAGNASTOR FSAR Section 2.3.6*** *Minimum 3 day avg. temperature -40°F* *Maximum 3 day avg. temperature 106°F*
Extreme Temperature	*Maximum temperature 113°F*	*Accident (Bounded)*	***MAGNASTOR FSAR Section 2.3.6*** *Maximum temperature 133°F*
Solar Load (Insolation)	*Horizontal flat surface insolation 2949.4 BTU/day-ft²* *Curved surface solar insolation 1474.7 BTU/day-ft²*	*Normal (Same)*	***MAGNASTOR FSAR Section 4.4.1.1*** *Curved Surface: 1475 Btu/ft² for a 24-hour period.* *Flat Horizontal Surface: 2950 Btu/ft² for a 24-hour period.*
Snow and Ice	*Snow Load 10 psf*	*Normal (Bounded)*	***MAGNASTOR FSAR Section 2.3.4*** *Snow Load: 100 psf*
Dead Weight	*Per design basis for systems listed in Table 1-1*	*Normal (Same)*	*TSC Dead Load – MAGNASTOR FSAR Section 3.5.1.2* *Cask – MAGNASTOR FSAR Section 3.5.3.2*
Internal and External Pressure Loads	*Per design basis for systems listed in Table 1-1*	*Normal (Same)*	*TSC – MAGNASTOR FSAR Section 3.5.1*

All indicated changes are in response to RSI NP-6.3

G.5 OPERATING PROCEDURES

The following are operating procedures for using the MAGNASTOR spent fuel storage system. These procedures are based on the general guidance found in Chapter 9 of the MAGNASTOR Final Safety Analysis Report (FSAR) [Reference G.5-1]. The procedures covered are:

1. Transferring the loaded TSC to the Concrete Cask.

2. Transporting and placing the loaded Concrete Cask.

3. Removing the loaded TSC from a Concrete Cask.

4. Receiving the MAGNATRAN Transport Cask and Unloading the loaded TSC.

The operating procedure for transferring a loaded TSC from a MAGNASTOR concrete cask to the MAGNATRAN Transport Cask is described in the MAGNATRAN Safety Analysis Report, Docket 71-9356. Also, the detailed operating procedures for receiving a loaded MAGNATRAN Transport Cask and unloading the transportable storage canister are described in Section 7.2 of the MAGNATRAN Safety Analysis Report.

System user personnel shall use this information to prepare the detailed, site-specific procedures for loading, handling, storing, and unloading MAGNASTOR. Users may add, delete, or change the sequence of specific steps of the procedures to accommodate site-specific requirements provided that the general order of the tasks associated with TSC closure and storage is preserved and that the specific requirements for fastener torque values, temperature limits for operations, and other defined values in the procedure are also met.

All facility-specific procedures prepared by users must fully comply with the MAGNASTOR Certificate of Compliance (CoC) and Technical Specifications, including the approved contents and design features.

Tables in Chapter 3 of Reference G.5-1 provide the handling weights for the major components of MAGNASTOR and the loads to be lifted during various phases of the loading and unloading operations. Licensees/users must perform appropriate reviews and evaluations to ensure that the lifted loads do not exceed rated load limits of user-supplied lifting equipment and comply with the facility's heavy-load program.

Pictograms of the NAC-MAGNASTOR System operations are presented in Figure G.5-1.

All indicated changes are in response to RSI NP-4.3

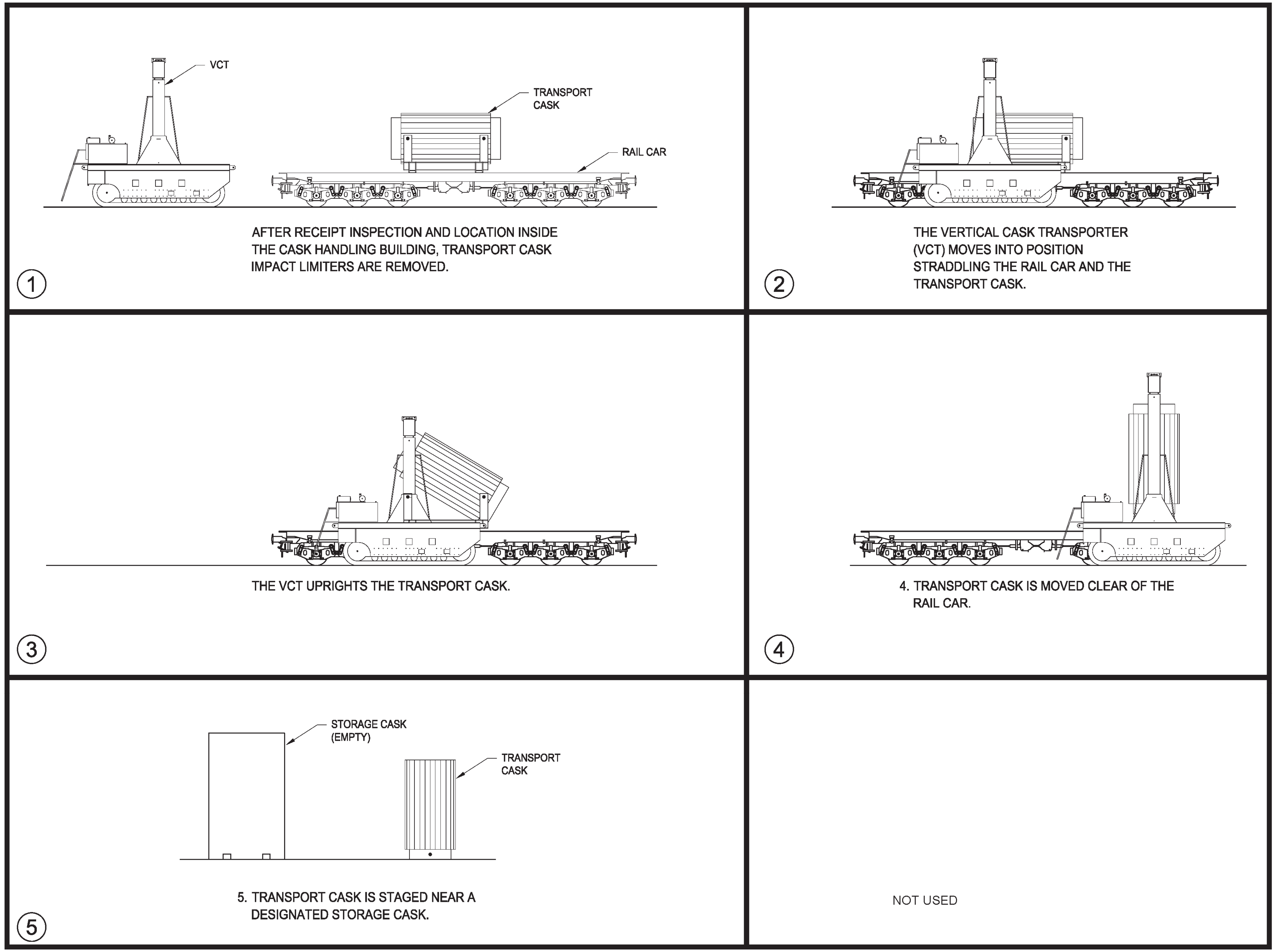


Figure G.5-1
Canister Transfer Operations
2 Pages

All indicated changes are in response to RSI NP-4.3

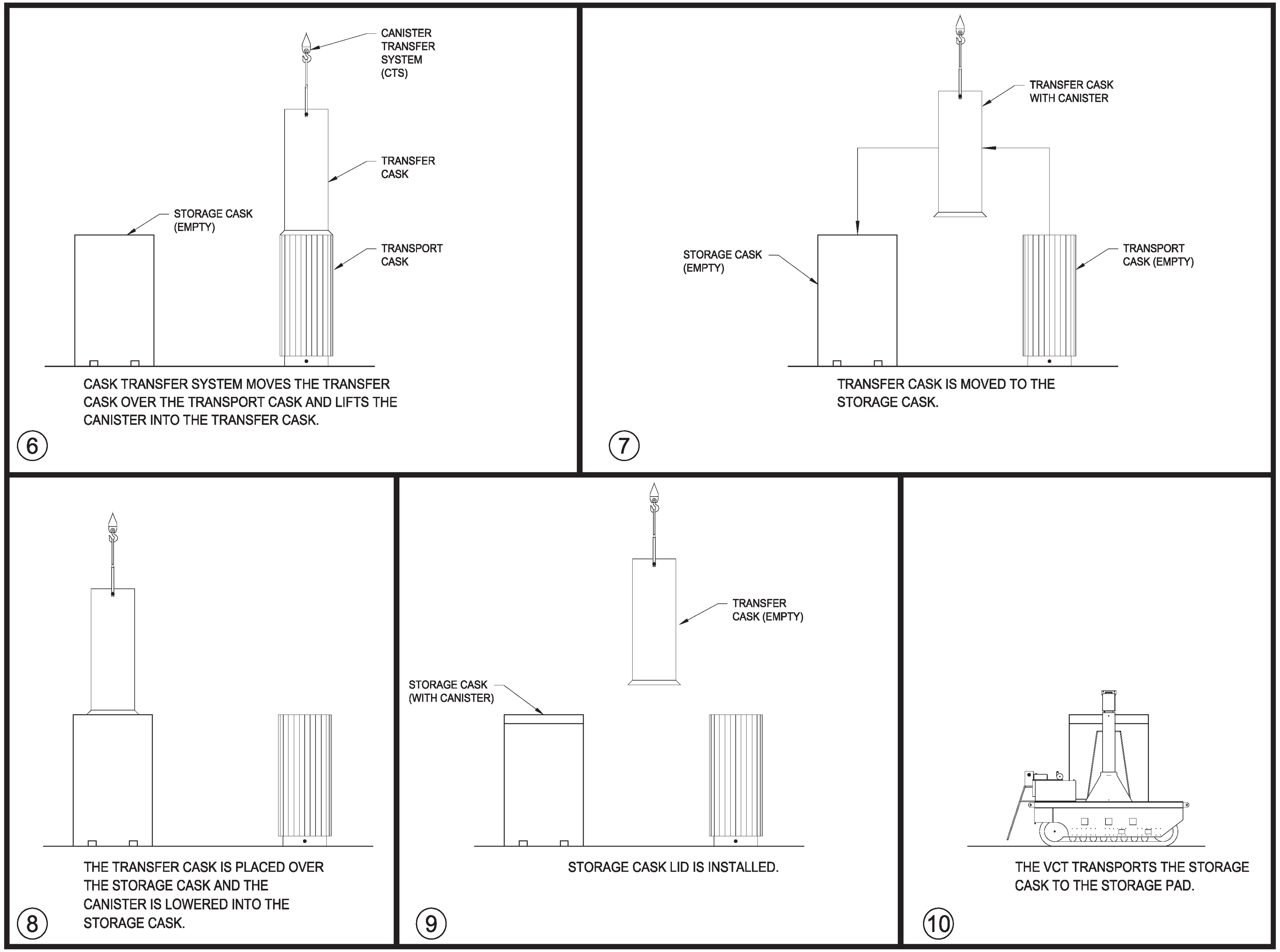


Figure G.5-1
Canister Transfer Operations
2 Pages

All indicated changes are in response to RSI NP-4.3

G.7.1 Undamaged and Damaged PWR Fuel

Sections G.7.1.1 through G.7.1.8 outline the structural analyses of normal operating conditions for MAGNASTOR with undamaged and damaged PWR fuel presented in Reference G.7-1. *Finally, bounding evaluations in Section G.7.1.9 are referenced to demonstrate that the confinement boundaries for the MAGNASTOR canisters 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.*

G.7.1.1 Structural Design

Details of the structural design of the MAGNASTOR system are provided in Section 3.1 of Reference G.7-1.

G.7.1.2 Weights and Centers of Gravity

The weights and centers of gravity of the MAGNASTOR system are provided in Section 3.2 of Reference G.7-1.

G.7.1.3 Materials

The significant physical, chemical, mechanical, and thermal properties of materials used in components of MAGNASTOR are defined, and the material specifications, tests and acceptance conditions important to material use are identified in Chapter 8 of Reference G.7-1.

G.7.1.4 Chemical and Galvanic Reactions

The materials used in the fabrication and operation of MAGNASTOR are evaluated in Section 8.10 of Reference G.7-1 to determine whether chemical, galvanic or other reactions among the materials, contents, and environments can occur.

G.7.1.5 Positive Closure

The positive closure evaluation for MAGNASTOR is provided in Section 3.4.2 of Reference G.7-1.

G.7.1.6 Lifting Devices

The evaluations of the MAGNASTOR system's lifting devices are provided in Section 3.4.3 of Reference G.7-1.

G.7.1.7 Normal Operating Conditions

The analyses of the major structural components of MAGNASTOR for normal conditions of storage are provided in Section 3.5 of Reference G.7-1.

All indicated changes are in response to RSI NP-9.3

G.7.1.8 Fuel Rods

The structural evaluations of PWR fuel rods for the storage conditions of the MAGNASTOR system are provided in Section 3.8 of Reference G.7-1.

G.7.1.9 Structural Evaluation of NAC-MAGNASTOR Canister Confinement Boundaries under Normal Conditions of Transport

The NAC-MAGNASTOR canister primary confinement boundaries consist of a canister shell, bottom closure plate, closure lid, the two port covers, and the welds that join these components. Redundant closure is provided by two outer port covers and a closure ring. Additional details, geometry, and shell and plate thicknesses are provided on the figures in Section G.4. The confinement boundary is addressed in Section G.11.1.1. The evaluation findings for the NAC-MAGNASTOR canister shell for normal conditions of transport are provided in Section 2.6.12 of [G.7-2].

The result of the structural analysis is acceptable for the loads and combinations described in Section 2.6.12 of [G.7-2], and is therefore structurally adequate for normal conditions of transport loading conditions.

All indicated changes are in response to RSI NP-9.3

G.7.2 References

G.7-1 MAGNASTOR Final Safety Analysis Report, Revision 7, July 2015.

G.7-2 *MAGNATRAN Transport Cask Safety Analysis Report, Revision 12A, October 2012.*

All indicated changes are in response to RSI NP-9.3

G.8.1 Undamaged and Damaged PWR Fuel

Chapter 4 of Reference G.8-1 provides the thermal analyses used evaluate the thermal performance of the MAGNASTOR system. The limiting environmental conditions (thermal) used in these evaluations are presented and compared to WCS site specific conditions in the following sections. Additionally, surveillance requirements used to ensure the concrete cask heat removal system is operable are presented.

G.8.1.1 Maximum Average Yearly Ambient Temperature

For the MAGNASTOR system, the maximum average yearly temperature allowed is 76°F. The the average yearly temperature for the site is conservatively bounded by using the maximum average annual temperature in the 48 contiguous United States, of 75.6°F. This temperature meets the normal condition thermal boundary defined in NUREG-1536. Therefore, no further WCS site-specific evaluations are required.

G.8.1.2 Maximum Average 3-Day Ambient Temperature

The maximum average 3-day ambient temperature allowed is 106°F for the MAGNASTOR system. This temperature bounds the WCS facility maximum average 3-day ambient temperature of *89.4*°F. Therefore, no further site-specific evaluations are needed.

G.8.1.3 Maximum Extreme 3-Day Ambient Temperature Range

For the MAGNASTOR system, the maximum allowed temperature extremes, averaged over a 3-day period, shall be greater than -40°F and less than 133°F. This bounds the WCS facility maximum temperature extreme of *-1*°F and *113*°F. No further site-specific evaluations are needed.

G.8.1.4 Thermal Performance Surveillance Requirements

For the MAGNASTOR system, in order to confirm that the concrete cask heat removal system is operable, one of the following two surveillance options with a frequency of 24 hours is required:

1. Visually verify all concrete cask air inlet and outlet screens are free of blockage.
2. Verify the difference between the concrete cask air outlet average temperature and the ambient temperature is less than 119ºF for the PWR concrete cask configurations CC1, CC2, and CC4 or less than 134ºF for PWR concrete cask configuration CC3.

All indicated changes are in response to RSI NP-6.3

PWR fuel assemblies may contain nonfuel hardware – i.e., reactor control components (RCCs), burnable poison rod assemblies (BPRAs), guide tube plug devices (GTPDs), neutron sources/neutron source assemblies (NSAs), hafnium absorber assemblies (HFRAs), instrument tube tie components, in-core instrument thimbles, and steel rod inserts (used to displace water from the lower section of guide tubes), and components of these devices, such as individual rods. The analysis shows that for the design basis fuel, the system meets the requirements of 10 CFR 72.104 and 10 CFR 72.106 and complies with the requirements of 10 CFR 20 with regard to annual and occupational doses at the owner-controlled area boundary.

Minimum cool times prior to fuel transfer and storage are specified as a function of minimum assembly average fuel enrichment and maximum assembly average burnup (MWd/MTU). To minimize the number of loading tables, PWR and BWR fuel assemblies are grouped by bounding fuel and hardware mass. Key characteristics of each assembly grouping are shown in Section 5.2 of Reference G.9-1. Refer to Section 5.8.9 of Reference G.9-1 for detailed loading tables meeting the system heat load limits.

Source terms for the various vendor-supplied fuel types are generated using the SCALE 4.4 sequence as discussed in Section 5.2 of Reference G.9-1. Three-dimensional MCNP shielding evaluations provide dose rates for transfer and concrete casks at distances up to four meters. NAC-CASC, a modified version of the SKYSHINE-III code, calculates site boundary dose rates for either a single cask or cask array. See Section 5.6 of Reference G.9-1 for more detail on the shielding codes.

Table G.9-1 provides estimated occupational exposures for receipt and handling of the NAC-MAGNASTOR system loaded with PWR fuel at the WCS CISF facility. For each procedural step the number of workers, occupancy time, worker distance, dose rates, and total dose are estimated. Dose rates used were obtained and estimated via the listed references in the table. The total occupational exposure for receiving, transferring and placing these canisters on the storage pad in their storage overpack (VCC) is 1,023 person-mrem each.

The total collective dose for unloading a NAC-MAGNASTOR PWR canister from its VCC and preparing it for transport off-site is bounded by the loading operations (1,023 person-mrem). Operations for retrieving these canisters from the VCC 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 2,046 person-mrem.

All indicated changes are in response to RSI NP-12.6

Table G.9-1
Estimated Occupational Collective Dose for Receipt of NAC MAGNATRAN Cask Loaded with PWR SNF in MAGNASTOR TSC and Transfer to MAGNASTOR VCC
7 Sheets

Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)[1]	Reference SAR/FSAR Table/Figure
Perform radiation and contamination survey of MAGNATRAN Cask.	2	0.5	All Around MAGNATRAN Cask	>2	10	10	SAR Figure 5.1-1, Table. 5.1-3, Figure 5.8-7, Figure 5.8-11, Figure 5.8-14, Figure 5.8-15
Inspect top impact limiter security seal and verify it is intact and correct ID.	1	.25	Top Impact Limiter	>1	<20	1	SAR Figure 5.1-1, Table. 5.1-3, Figure 5.8-7, Figure 5.8-11, Figure 5.8-14, Figure 5.8-15
Remove Personnel Barrier and complete surveys.	2	0.5	Center of MAGNATRAN Cask	1	<20	32	SAR Figure 5.1-1, Table. 5.1-3, Figure 5.8-7, Figure 5.8-11, Figure 5.8-14, Figure 5.8-15
Visually inspect MAGNATRAN Cask surface for transport/road damage and record.	1	0.25	All Around Cask	>2	10	3	SAR Figure 5.1-1, Table. 5.1-3, Figure 5.8-7, Figure 5.8-11, Figure 5.8-14, Figure 5.8-15
Attach slings to top Impact Limiter and remove 32 retention nuts/rods. Remove and store Impact Limiter.	2	1	Top of MAGNATRAN Cask	>1	< 5	10	SAR Figure 5.1-1, Table. 5.1-3, Figure 5.8-7, Figure 5.8-11, Figure 5.8-14, Figure 5.8-15
Attach slings to bottom Impact Limiter and remove 32 retention nuts/rods. Remove and store Impact Limiter.	2	1	Bottom of MAGNATRAN Cask	>1	< 5	10	SAR Figure 5.1-1, Table. 5.1-3, Figure 5.8-7, Figure 5.8-11, Figure 5.8-14, Figure 5.8-15
Release Front Tie-Down Assembly.	2	1	Top Side MAGNATRAN Cask Surface	1	50	100	SAR Figure 5.1-1, Table. 5.1-3, Figure 5.8-7, Figure 5.8-11, Figure 5.8-14, Figure 5.8-15

All indicated changes are in response to RSI NP-12.6

Table G.9-1
Estimated Occupational Collective Dose for Receipt of NAC MAGNATRAN Cask Loaded with PWR SNF in MAGNASTOR TSC and Transfer to MAGNASTOR VCC
7 Sheets

Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)[1]	Reference SAR/FSAR Table/Figure
Remove front trunnion plugs and bolts, and ring segments, and store.	2	0.5	Top Side MAGNATRAN Cask Surface	1	50	50	SAR Figure 5.1-1, Table. 5.1-3, Figure 5.8-7, Figure 5.8-11, Figure 5.8-14, Figure 5.8-15
Install front trunnions and bolts and torque to specified value.	2	1	Top Side MAGNATRAN Cask Surface	1	50	100	SAR Figure 5.1-1, Table. 5.1-3, Figure 5.8-7, Figure 5.8-11, Figure 5.8-14, Figure 5.8-15
Engage Vertical Cask Transporter (VCT) Lift Arms to Front Trunnions and rotate cask to vertical orientation on rear rotation trunnions.	2	1	Top Side MAGNATRAN Cask Surface	>2	10	20	SAR Figure 5.1-1, Table. 5.1-3, Figure 5.8-7, Figure 5.8-11, Figure 5.8-14, Figure 5.8-15
Lift and Remove MAGNATRAN from the Transport Skid Rear supports and move cask to gantry Canister Transfer Facility (CTF), set cask down and release VCT Lift Arms. Establish Radiation Control boundaries.	2	2	Top Side MAGNATRAN Cask Surface	>2	10	40	SAR Figure 5.1-1, Table. 5.1-3, Figure 5.8-7, Figure 5.8-11, Figure 5.8-14, Figure 5.8-15

All indicated changes are in response to RSI NP-12.6

Table G.9-1
Estimated Occupational Collective Dose for Receipt of NAC MAGNATRAN Cask Loaded with PWR SNF in MAGNASTOR TSC and Transfer to MAGNASTOR VCC
7 Sheets

Process Step	***Number of Workers***	***Occupancy Time (hours)***	***Worker Location Around Cask***	***Worker Distance (m)***	***Total Dose Rate (mrem/hr)***	***Total Dose (person-mrem)***[1]	***Reference SAR/FSAR Table/Figure***
Using VCT, move empty MAGNASTOR VCC to transfer position in CTF and set down adjacent to MAGNATRAN cask. Set up appropriate work platforms/man lifts for access to top of VCC and MAGNATRAN.	*2*	*1*	*Top Of Empty MAGNASTOR VCC*	*>2*	*0*	*0*	*Empty VCC*
Remove VCC Lid and bolts, and VCC Shield Plug.	*2*	*1*	*Top Of Empty MAGNASTOR VCC*	*1*	*0*	*0*	*Empty VCC*
Install Transfer Adapter on VCC and connect hydraulic system.	*2*	*1*	*Top Of Empty MAGNASTOR VCC*	*1*	*0*	*0*	*Empty VCC*
Remove vent port cover and connect pressure test system to vent port to check for excessive pressure. If pressure is high, take sample and check. If clean vent to HEPA filter.	*1*	*0.5*	*Top of Cask*	*0.5*	*50*	*25*	*FSAR Table 5.1.3.1, FSAR Section 5.8.3.3.2 + MAGNATRAN Closure Lid Thickness 7.75 in.*
Remove 48 MAGNATRAN lid bolts, install alignment pins and lid lifting hoist rings/slings and remove inner lid and store. Remove alignment pins.	*2*	*1*	*Top of Cask*	*0.5*	*30*	*60*	*FSAR Table 5.1.3.1, FSAR Section 5.8.3.3.2 + MAGNATRAN Closure Lid Thickness 7.75 in.*

All indicated changes are in response to RSI NP-12.6

Table G.9-1
Estimated Occupational Collective Dose for Receipt of NAC MAGNATRAN Cask Loaded with PWR SNF in MAGNASTOR TSC and Transfer to MAGNASTOR VCC
7 Sheets

Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)[1]	Reference SAR/FSAR Table/Figure
Install adapter ring to inner lid recess and torque captured bolts.	2	0.5	Top of Cask	0.5	30	30	FSAR Table 5.1.3.1, FSAR Section 5.8.3.3.2 Remote operation from side of MAGNATRAN
Install transfer adapter plate on adapter ring and install and torque the four transfer adapter plate bolts.	2	1	Top of Cask	1	15	30	FSAR Table 5.1.3.1, FSAR Section 5.8.3.3.2 Remote operation from side of MAGNATRAN
Install TSC Lid Lifting Adapter Plate and bolts on the MAGNASTOR Closure Lid, and torque to specified value.	2	1	Top of Cask	0.5	75	150	FSAR Table 5.1.3.1, FSAR Section 5.8.3.3.2 Remote operation from side of MAGNATRAN
Using the CTF crane, lower the appropriate MAGNASTOR Transfer Cask (MTC) and set it down on the transfer adapter on the MAGNATRAN Cask.	2	1.5	Top of Cask	>4	<1	3	Remote handling operation
Remove the MTC door lock pins and open shield doors with hydraulic system.	1	0.5	Top of Cask	1	15	8	FSAR Table 5.1.3.1, FSAR Section 5.8.3.3.2 + 2 inch TSC Lid Lift Adapter Plate Remote operation from side of MTC/MAGNATRAN

All indicated changes are in response to RSI NP-12.6

Table G.9-1
Estimated Occupational Collective Dose for Receipt of NAC MAGNATRAN Cask Loaded with PWR SNF in MAGNASTOR TSC and Transfer to MAGNASTOR VCC
7 Sheets

Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)[1]	Reference SAR/FSAR Table/Figure
Using the CTF, lower the Air-Powered Chain Hoist hook through the MTC and engage to the TSC Lift Adapter Plate.	2	1.5	Remote Operating Location	>4	<5	15	Remote operation using CTF mounted cameras
Using the Chain Hoist System slowly lift the TSC into the MTC.	2	1	Remote Operating Location	>4	<5	10	Remote operation using CTF mounted cameras
Close the MTC shield doors and install lock pins.	1	0.5	Bottom of MTC	0.5	30	15	Operation from side of MTC FSAR Section 5.8.3.3.2 and Figure 5.8.3-17
Lower the TSC onto the shield doors and using the CTF, lift the MTC off of the MAGNATRAN transfer adapter plate.	2	1	Remote Operating Location	>4	<5	10	Remote operation using CTF mounted cameras
Move the MTC over the VCC and lower onto the VCC transfer adapter plate.	1	1	Remote Operating Location	>4	<5	5	Remote operation using CTF mounted cameras
Remove the MTC door lock pins.	1	0.5	Bottom of MTC	0.5	30	15	Operation from side of MTC on top of VCC transfer adapter FSAR Section 5.8.3.3.2 and Figure 5.8.3-17 and Figure 5.8.3-10

All indicated changes are in response to RSI NP-12.6

Table G.9-1
Estimated Occupational Collective Dose for Receipt of NAC MAGNATRAN Cask Loaded with PWR SNF in MAGNASTOR TSC and Transfer to MAGNASTOR VCC
7 Sheets

Process Step	***Number of Workers***	***Occupancy Time (hours)***	***Worker Location Around Cask***	***Worker Distance (m)***	***Total Dose Rate (mrem/hr)***	***Total Dose (person-mrem)***[1]	***Reference SAR/FSAR Table/Figure***
Using the Chain Hoist System, lift the TSC off of the shield doors and open the shield doors.	*2*	*0.5*	*Remote Operating Location*	*>4*	*<5*	*5*	*Remote operation using CTF mounted cameras*
Using the chain hoist lower the TSC into the VCC.	*2*	*1*	*Remote Operating Location*	*>4*	*<5*	*10*	*Remote operation using CTF mounted cameras*
Release chain hoist system hook from the TSC Lift Adapter Plate and retract chain hoist hook through the MTC.	*1*	*0.5*	*Remote Operating Location*	*>4*	*<5*	*3*	*Remote operation using CTF mounted cameras*
Close MTC shield doors and install lock pins.	*1*	*0.5*	*Bottom of MTC*	*0.5*	*30*	*15*	*Operation from side of MTC on top of VCC transfer adapter FSAR Figure 5.8.3-10*
Using the CTF, lift and remove the MTC from the top of the VCC.	*1*	*0.5*	*Remote Operating Location*	*>4*	*<5*	*3*	*Remote operation using CTF mounted cameras*
Unbolt and remove TSC Lift Adapter Plate from the top of the TSC and store.	*2*	*1*	*Top of MAGNASTOR TSC*	*1*	*75*	*150*	*FSAR Figure 5.8.3-20 and operation performed on top of transfer adapter mounted on VCC*

All indicated changes are in response to RSI NP-12.6

Table G.9-1
Estimated Occupational Collective Dose for Receipt of NAC MAGNATRAN Cask Loaded with PWR SNF in MAGNASTOR TSC and Transfer to MAGNASTOR VCC
7 Sheets

Process Step	Number of Workers	Occupancy Time (hours)	Worker Location Around Cask	Worker Distance (m)	Total Dose Rate (mrem/hr)	Total Dose (person-mrem)[1]	Reference SAR/FSAR Table/Figure
Using mobile crane, remove transfer adapter plate from VCC and store.	2	1	Top of MAGNASTOR VCC	1	10	20	Remote operation using CTF mounted cameras after connection of lifting slings
Install and bolt in place the VCC lid.	2	1	Top of MAGNASTOR VCC	1	25	50	Operation performed from top of VCC Figure 5.8.3-10
Using the VCT, lift and move loaded UMS VCC and position it in the designated storage location.	2	1	VCT Platform	>4	10	20	Operation performed from VCT and FSAR Figure 5.8.3-8
Prepare empty MAGNATRAN cask for empty return transport. Transfer and rotate to horizontal MAGNATRAN cask on the transport/shipping frame. Install transport tie-downs, impact limiters and personnel barrier.	3	9	CTF/VCT/Rail Car	1 to 4	0	0	Empty cask preparation activities
					Total (person-mrem)	1,023	

Note:

1. *Rounded up to the nearest whole number*

All indicated changes are in response to RSI NP-12.6

G.11.1 Undamaged and Damaged PWR Fuel

The confinement boundary of the TSC consists of the TSC shell, bottom plate, closure lid, inner vent and drain port covers, and the welds that join these components. The redundant closure of the TSC confinement boundary consists of the closure ring, the outer vent and drain port covers, and the welds that join these components to the TSC shell and closure lid. The confinement boundary is shown in Figure 7.1-1 of Reference G.11-1. The confinement boundary does not incorporate bolted closures or mechanical seals. The confinement boundary welds are described in Table 7.1-1 of Reference G.11-1.

G.11.1.1 Confinement Boundary

The confinement boundary of the MAGNASTOR system is described in detail in Section 7.1 of Reference G.11-1. Specific details for the confinement vessel, confinement penetrations, seals and welds, and closure are in Sections 7.1.1, 7.1.2, 7.1.3, and 7.1.4, respectively. *In addition, a bounding evaluation in Section G.7.1.9 is presented to demonstrate that the confinement boundary for the NAC-MAGNASTOR canister does not exceed ASME Boiler and Pressure Vessel 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.*

G.11.1.2 Requirements for Normal Conditions of Storage

The requirements for normal conditions of storage for the MAGNASTOR system are described in detail in Section 7.2 of Reference G.11-1. Specific details on the release of radioactive materials and pressurization of the confinement vessel are in Sections 7.2.1 and 7.2.2, respectively.

G.11.1.3 Confinement Requirements for Hypothetical Accident Conditions

The requirements for hypothetical accident conditions are described in detail in Section 7.3 of Reference G.11-1.

All indicated changes are in response to RSI NP-9.3