CHAPTER 3
PRINCIPAL DESIGN CRITERIA

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3. PRINCIPAL DESIGN CRITERIA

The purpose of Chapter 3 is to provide the principal design criteria utilized in the design of the Interim Storage Partners' (ISP's) WCS Consolidated Interim Storage Facility (WCS 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.

3.1 Purposes of Installation

The purpose of the WCS CISF is to provide interim storage for pressurized water reactor (PWR) and boiling water reactor (BWR) SNF from commercial nuclear power plants throughout the United States and GTCC waste. The initial phase, Phase 1, is designed to store approximately 470 canisters containing SNF and GTCC waste. The total storage capacity for Phase 1 is limited to 5,000 metric tons of heavy metal (MTHM) for SNF and 510,000 pounds of GTCC waste.

The WCS CISF utilizes dry cask storage systems. These systems store canisters of SNF and GTCC waste inside a storage overpack which provides physical protection, heat removal, radiation shielding, criticality control, and confinement for the safe storage of SNF.

The dry cask storage systems used at the WCS CISF include the NUHOMS®-MP187 Storage System (SNM License 2510), the Standardized NUHOMS® 61BT Storage System and the Standardized NUHOMS® 61BTH Type 1 Storage System (NRC Certificate of Compliance 72-1004), the Standardized Advanced NUHOMS® Storage System (NRC Certificate of Compliance 72-1029), the NAC-MPC Storage System (NRC Certificate of Compliance 72-1025), the NAC-UMS Storage System (NRC Certificate of Compliance 72-1015), and the MAGNASTOR Storage System (NRC Certificate of Compliance 72-1031).

3.1.1 Materials to Be Stored

3.1.1.1 Spent Fuel and Other Radioactive Materials Associated with Fuel Assemblies

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 Phase 1 CISF is designed to store approximately 470 casks with canisters containing SNF or GTCC waste. The total SNF storage capacity for the WCS CISF is 5,000 MTHM.

All of the types of canisterized SNF that would be stored at the WCS CISF during Phase 1 have previously been approved for storage in one of the six storage overpack systems. The physical, thermal and radiological characteristics for these SNF types are described in detail in the final safety analysis reports (FSAR) for cask storage systems identified in Section 2.1 of the Technical Specifications and listed in Table 1-1.

3.1.1.2 Greater than Class C Waste

The WCS CISF is designed to store up to 231.3 MT (510,000 pounds) of reactor related GTCC waste. GTCC waste containers will contain solid reactor-related waste only, consisting of activated reactor vessel internals and other in-core instrumentation. A description and characterization of the GTCC waste is provided in Appendix H, Section H.3.1.1. There will be no liquid or process GTCC waste stored at the WCS CISF.

The physical, thermal and radiological characteristics of the canisters that would be used to store GTCC waste in a NUHOMS® system are described in the Rancho Seco FSAR, Appendix C [3-18]. GTCC waste stored in NAC systems can be received from the Maine Yankee, Connecticut Yankee, Yankee Rowe, and Zion power plants. For Maine Yankee, the GTCC waste is described in Section 1.3.1.1.2 of the SAR for the NAC-UMS transportation cask, and in Certificate of Compliance No. 9270, Condition 5.(b)(1)(iv) [3-20]. For Connecticut Yankee and Yankee Rowe, the GTCC waste is described in Section 1.2.3.2 of the SAR for the NAC-STC transportation cask and Certificate of Compliance No. 9235, Condition 5.(b)(1)(iii) [3-19]. For Zion, the GTCC waste is described in Section 1.3.2 of the SAR for the NAC-MAGNATRAN, NRC Docket No. 9356 [3-21]. See Appendix H for more details on GTCC waste.

3.1.2 General Operating Functions

3.1.2.1 Transportation and Storage Operations

The WCS CISF is designed to use storage overpacks that use both horizontal (NUHOMS®) and vertical (NAC) storage systems. The major activities at the WCS CISF for horizontal storage systems include the receipt of the MP187 and MP197HB transportation casks, the lifting of MP187 and MP197HB casks onto transfer vehicles, moving the casks to the outdoor storage pad, and placing SNF canisters into the NUHOMS® horizontal concrete storage vaults. The major activities at the WCS CISF for vertical storage systems include the receipt and unloading of transportation casks, the transfer of SNF canisters from transportation casks to the vertical concrete casks, and the transfer and placement of vertical concrete casks on outdoor storage pads.

3.1.2.2 Onsite Generated Waste Processing, Packaging and Storage

The storage overpack systems used at the WCS CISF are designed to confine SNF and GTCC waste within seal-welded canisters. The WCS CISF handles only canisterized SNF and GTCC waste; therefore, the only radioactive wastes are solid wastes generated from residual quantities of radioactive contamination that may be encountered on the surfaces of the transportation casks due to weeping.

As addressed in Section 6.1, this solid waste would be packaged and temporarily stored in a designated radiologically controlled area until the waste is characterized and shipped to a licensed disposal facility.

There are no other systems or facilities for processing, packaging, storing, or transporting any other type of radioactive waste at the WCS CISF. Waste confinement and management requirements are further described in Chapter 6.

3.1.2.3 Utilities

The WCS CISF is supported by utility systems necessary for facility operation. Electrical power is provided for the operation of lights, monitoring equipment, communication systems, security systems, and support equipment. Backup electrical power is provided for essential security and emergency systems. Mechanical utility systems are provided for the facility to provide water, building HVAC systems, fire detection and suppression, compressed air, and sewage handling systems.

3.2 Structural and Mechanical Safety Criteria

This section establishes requirements that satisfy 10 CFR 72.122(b), which identifies the general design criteria that require structures, systems, and components (SSCs) classified as Important-to-Safety (ITS) be designed to accommodate the effects of, and to be compatible with, site characteristics and environmental conditions associated with normal operation of the facility. In addition, appropriate consideration of off-normal and accident conditions must be determined so that SSCs ITS can be designed to withstand the effects of these conditions without impairing their ability to perform their safety functions.

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.

The authorized storage systems are designed to provide long-term storage of SNF. The canister materials are selected to protect against degradation during the storage period, including the application of system specific aging management programs. Section 2.1 of the Technical Specifications [3-1] lists the SNF canisters authorized for storage at the WCS CISF. Table 3-1 provides the cross reference to the applicable appendix for each canister/storage overpack where the design criteria for each system is provided and comparison of those criteria to the WCS CISF specific criteria to demonstrate that the identified systems are safe for storage at the WCS CISF.

The safety classification for SSCs for the storage systems and transportation/transfer casks used at the WCS CISF will be the same as those specified in the referenced previously approved NRC Certificates of Compliance or site-specific licenses.
Table 3-4 provides the specific references to where SSCs deemed ITS for the storage systems used at the WCS CISF are located.

Loads considered for the WCS CISF are categorized as follows:

Loads	**Normal**	**Off-Normal**	**Accident-Level**
Dead Loads	X		
Live Loads	X		
Handling Loads	X	X	
Snow and Ice Loads	X		
Wind Loads	X		
Internal/External Pressure	X	X	

Lateral Soil Pressure	X	X	
Thermal Loads	X	X	X
Explosion Overpressure			X
Drop/Tipover			X
Accident Pressurization			X
Fire			X
Tornado Wind/Missiles			X
Floods			X
Earthquake			X

Design criteria for these loads are described in this chapter and are used in the design of all SSCs classified as ITS. The SSCs that are classified as ITS are discussed in Section 3.4.

The NUHOMS® and vertical storage system design criteria are fully described in Appendices A-G. Chapter 12 addresses site specific accident conditions and Table 12-1 provides a cross-walk that points to the appropriate Appendix for each authorized canister/cask system.

3.2.1 Tornado and Wind Loadings

The design of SSCs considers the loads resulting from tornado and extreme wind. The design basis tornado is presented in Table 1-2. Design basis tornado characteristics are based on NRC Regulatory Guide 1.76 [3-2], and NUREG-0800 [3-3].

3.2.1.1 Applicable Design Parameters

The facility, except the cask storage system components, is designed for wind velocities of 120 mph as shown in Figure 26.5-1D of ASCE 7-16 [3-35]. The design basis wind is defined as a 3-second gust for Exposure C category.

The cask storage systems are designed to withstand a tornado from Region II as defined by Regulatory Guide 1.76 [3-2]. The design basis tornado characteristics for Region II are listed in Table 1-2.

3.2.1.2 Determination of Forces on Structures

Forces on structures from the design basis wind and the design basis tornado are addressed in the design. The method used to convert wind loading into forces on a structure is in accordance with NUREG-0800 (Section 3.3.1, Wind Loadings, and Section 3.3.2, Tornado Loadings) [3-3].

3.2.1.3 Not Used

3.2.1.4 Tornado Missiles

SSCs that are classified as ITS are designed for, or administrative provisions are implemented to protect against impacts from, tornado-generated missiles. The loaded storage overpacks are designed to remain stable and to maintain the confinement boundary when subjected to tornado-generated missiles. The Cask Handling Building (CHB) is designed to withstand tornado-generated wind loading and missiles without collapse so as to prevent reducing packaging effectiveness of casks contained within. Preventing penetration of tornado-generated missiles is not considered a CHB structural design requirement, as the casks themselves are designed to withstand these impacts. Tornado-generated missiles are not required to be considered in the design of the canister since the canister is protected by the storage overpack.

NUHOMS® equipment used during the canister transfer operations is explicitly evaluated for tornado generated missile impacts. However, NAC transfer casks are not explicitly evaluated for tornado generated missile impacts. Thus, administrative controls are implemented to prevent the opportunity for such a condition to exist. These administrative controls and requirements are detailed in Section 5.4 of the proposed Technical Specifications [3-1] for the NAC Vertical systems. Justification for use of the administrative controls to address tornado generated missile impacts is provided in Section 7.5.3.2.1.

Similarly, NAC transportation casks are not explicitly evaluated for tornado generated missile impacts. However, transportation casks are exposed to external environmental conditions during transportation and 10 CFR Part 71 requires the cask to be analyzed for conditions more severe than just a tornado generated missile condition. Examples include a 30m drop test and a 1 foot puncture drop test. All NAC transportation casks meet these requirements. Therefore, all NAC transportation casks are designed such that they can survive any tornado generated missile impacts at the WCS CISF.

Tornado missile load conditions are based on the design basis tornado addressed in Section 3.2.1.1. The evaluation cases required by NUREG-0800, Section 3.5.1.4 [3-3] include at least three objects as potential tornado missiles: a massive high kinetic energy missile which deforms on impact, a rigid missile to test penetration resistance, and a small rigid missile of a size sufficient to just pass through any openings in protective barriers. Tornado missile load cases are established in Table 1-2.

3.2.2 Water Level (Flood) Design

The WCS CISF is located in Andrews County, Texas which has a semi-arid climate with approximately 16 inches of rain per year. There are no lake systems or flowing or intermittent streams nearby.

3.2.2.1 Flood Elevations

The Probable Maximum Flood (PMF) elevation established in the Floodplain analysis (Chapter 2, Attachment B) is 3488.9 ft msl at the WCS CISF. The elevations of the storage pads vary with the lowest point being 3489 ft msl. The finish floor elevation of the CHB is 3493 ft msl and the finish floor elevation of the Security and Administration Building is 3496 ft msl.

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 PMF 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 SNF and GTCC waste storage or transfer operations.

3.2.2.2 Phenomena Considered in Design Load Calculations

SSCs are not in a floodplain and are above the PMF elevation. Therefore, they are not required to consider flood design loads.

3.2.2.3 Flood Force Application

SSCs are not in a floodplain and are above the PMF elevation. Therefore, they are not required to consider flood design loads.

3.2.2.4 Flood Protection

SSCs are not in a floodplain and are above the PMF elevation. Therefore, they are not required to consider flood design loads.

3.2.3 Seismic Design

The design of SSCs classified as ITS consider loadings based on the WCS CISF design basis ground motion, which was determined by a probabilistic seismic hazard analysis (PSHA) as discussed in Section 2.6. Probabilistic analysis does not result in the determination of a unique Design Earthquake, such as is the case for a deterministic analysis. Instead, several scenarios and models are used to estimate the likelihood of earthquake ground motions at a site and systematically take into account uncertainties that exist in various hazard parameters. The outcomes are in the form of hazard curves that show the mean annual probabilities or frequencies with which various levels of fault displacement and ground motion are expected to be exceeded.

3.2.3.1 Input Criteria

Andrews County is located within the Southern Great Plains physiographic and tectonic province. As described in Section 2.6, a PSHA was performed to establish the appropriate seismic design basis for the facility. A return period of 10,000 years was determined to be appropriate.

Section 2.6.2 documents the evaluation that demonstrates that the ground surface design response spectrum peak horizontal acceleration for 0.01 seconds is 0.25 g and the vertical is 0.175 g.

To estimate ground motions, four Next Generation of Attenuation (NGA)-West2 ground motion prediction models for the western U.S. (WUS) and the EPRI [3-32] models for the central and eastern U.S. (CEUS) were utilized. For the NGA-West2 models, a time-averaged shear wave velocity (VS) in the top 100 ft (VS30) of 760 m/sec was used. The EPRI [3-32] ground motion models are defined for hard rock or a VS30 of 2,830 m/sec and greater. It is unclear whether the site area should be considered a tectonically active region like the WUS or a stable continental region like the CEUS. It may likely be located in a transition between the WUS and CEUS.

Hence the question arises whether the NGA-West2 ground motion models or the EPRI [3-32] models are more appropriate for the region around the site. Geologic and geophysical data suggests the former but to address the epistemic uncertainty on which models are appropriate, both the NGA-West2 and EPRI [3-32] models were used in the PSHA weighted 0.60 and 0.40, respectively.

In addition, a site-specific geotechnical investigation (Chapter 2, Attachment E) was performed to ensure the geological characteristics and soil are stable under earthquake conditions as described in Section 2.6.

There is no surface faulting in the vicinity of the WCS CISF. The closest Quaternary fault is an unnamed fault at the base of the Guadalupe Mountains, listed as fault No. 907 in the USGS database and located approximately 104 miles southwest of the WCS CISF in Guadalupe Mountains National Park in Culberson County, Texas as documented in Section 2.6.3.

3.2.3.2 Design Response Spectra

Based on the PSHA and the inputs of the seismic source model and ground motion models, seismic hazard curves for both firm and hard rock were calculated. The absence of late-Quaternary faulting and the low to moderate rate of background seismicity, even that associated with petroleum recovery activities, results in relatively low seismic hazard at the WCS CISF. The largest contributor to the hazard at the WCS CISF is the background seismicity (the Southern Great Plains seismic source zone and Gaussian smoothing).

A site response analysis was performed to estimate the ground motions at the WCS CISF incorporating the site-specific geology. Using a random vibration theory-based equivalent-linear site response approach, the VS data collected by the University of Texas, Austin, and dynamic material property curves, both the hard rock and firm rock hazard curves from the PSHA were adjusted to the ground surface. The hazard curves were weighted based on the weights assigned to the NGA-West2 and EPRI [3-32] ground motion models and a 10,000 year return period horizontal Uniform Hazard Spectrum (UHS) was calculated. A 10,000-year return period vertical UHS was also calculated using the NRC V/H ratios.

The horizontal and vertical UHS for a return period of 10,000 years represent the recommended DRS for seismic design of the CISF. The DRS peak horizontal acceleration is 0.25 g. Three sets of three-component time histories were developed by spectral matching to the 5%-damped DRS. Also estimated for use in seismic design analyses as a function of depth were strain-compatible shear-wave velocity, density, effective strains, and damping.

3.2.3.3 Design Response Spectra Derivation

The seismic analysis for the CISF was performed to be consistent with 10 CFR 72.103 [3-23], U.S. Nuclear Regulatory Commission's NUREG- 0800 "Standard Review Plan (SRP) for the Review of Safety Analyses Reports for Nuclear Power Plants: LWR Edition" [3-3] and NUREG/CR-6728 "Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard- and Risk-Consistent Ground Motion Spectra Guidelines" [3-25].

3.2.3.4 Design Time History

Consistent with NRC requirements, horizontal and vertical DRS for a 10,000 year return period and associated strain-compatible properties were developed and provided for the SSI analysis. Three three-component sets of time histories were developed through spectral matching. A final report was produced that describes and summarizes the above analyses in Chapter 2, Attachment D. All calculations were performed in accordance with AECOM's NQA-1 Program. Detailed calculations are contained in calculation WCS-12-05-200-001 in Chapter 2 Attachment D.

Design time histories are used to verify all required components are considered acceptable. Chapter 7 includes further details.

3.2.3.5 Use of Equivalent Static Loads

Chapter 7 of the SAR details the load analyses used in the seismic design and analysis.

For the Vertical Storage Systems storage pad and the NUHOMS® NITS storage pad, the soil material properties used are the static properties, equal to or lower than the dynamic soil properties and, therefore, conservative for use in an equivalent static analysis. The soil properties used in the equivalent static analyses for the Vertical Storage System storage pads and the NUHOMS® NITS storage pads are given in Appendix D of [3-33] and are listed in Table 7-38.

The design criteria used for the Canister Transfer System (CTS) is specified in ASME NOG-1, Section 4000 [3-34]. All of the load combinations identified in paragraph 4140 have been evaluated. Controlling load combinations have been used to determine component stresses and then are compared to applicable allowable stresses. The sum of simultaneously applied loads (static and dynamic) do not result in stress levels which would cause any permanent deformation, and thus, the CTS fully meets the requirements of ASME NOG-1 [3-34].

CHB structural steel components are analyzed and designed using static analysis methods for determining forces and moments on structural steel members as a result of applied service loading conditions. Dynamic analysis methods are used for determining structural steel member forces and moments for factored loading conditions where structural components are subjected to seismic loads.

Seismic analysis information for the NUHOMS® and Vertical Storage System design criteria are fully described in Appendices A.3, B.3, C.3, D.3, E.3, F.3 and G.3.

3.2.3.6 Critical Damping Values

Critical damping values are in accordance with Regulatory Guide 1.61 [3-27] for a SSE.

3.2.3.7 Basis for Site-Development Analysis

Site-specific vibratory ground motion is determined through evaluation of the seismology, geology, and the seismic and geologic history of the site and surrounding region. This information is contained in the site-specific PSHA (Chapter 2, Attachment D).

3.2.3.8 Soil Supported Structures

The soil supported structures that are analyzed for the CISF design basis ground motion are the ITS Storage Pads, the CTS, and the CHB.

3.2.3.9 Soil-Structure Interaction

Soil-structure interaction (SSI) is considered in the design of the storage pads and the CTS. Assessment of the site soil properties and the CHB dynamic response indicates that Soil-Structure Interaction (SSI) effects on the overall seismic response of the CHB are minimal as demonstrated in Section 7.5.3.3.3. During final design of the CHB, SSI analysis will be performed in accordance with ASCE 4-16. The soil-supported structures requiring SSI are evaluated by considering the properties and effects of the subsurface established during the geotechnical investigation (Chapter 2, Attachment E). Soil boring logs and soil properties of the WCS CISF site are contained in Chapter 2, Attachment E.

3.2.3.10 Seismic-Systems Analysis

3.2.3.10.1 Seismic Analysis Methods

Seismic Analysis for SSCs designated ITS can be found in Chapter 7.

3.2.3.10.2 Natural Frequencies and Response Loads

A modal analysis studies the dynamic properties of structures under vibrational excitation and determines modes of the structure defined by natural frequencies and other factors. Response loads are developed based on the response-spectrum analysis at the appropriate frequencies.

3.2.3.10.3 Procedure Used to Lump Masses

The mass of a system is distributed throughout the actual structure. Lumping mass is an idealized method that concentrates the mass of a system at the nodes of the structure model. The lumped masses at the nodes of a structure are the sums of the actual system mass that can be reasonably attributed to that specific node point represented in the analysis model.

3.2.3.10.4 Methods Used to Couple Soil with Seismic-System Structures

The soil can be represented by discrete springs or a finite element model to represent the soil subgrade.

3.2.3.10.5 Methods Used to Account for Torsional Effects

The storage pads and the CHB are modeled to consider torsional effects due to the eccentricities of the masses.

3.2.3.10.6 Methods for Seismic Analysis of Dams

There are no dams onsite or in the immediate area.

3.2.3.10.7 Methods to Determine Overturning Moments

Stability of the storage overpacks on the storage pads is evaluated to ensure stability. Overturning moments are developed using site-specific seismic design parameters.

3.2.3.10.8 Analysis Procedure for Damping

Critical damping values are developed in accordance with Regulatory Guide 1.61 [3-27].

3.2.3.10.9 Seismic Analysis of Overhead Cranes

The CTS is analyzed for seismic effects in accordance with the requirements of NUREG-0554 [3-29] for single-failure-proof cranes.

The overhead cranes in the CHB are analyzed for the seismic effects in accordance with the requirements in NOG-1-2015 [3-36] for Type 1, single-failure-proof cranes. Seismic clips are provided on the overhead crane bridge trucks and trolley to limit uplift during a seismic event, thereby eliminating the potential for the bridge or trolley to fall onto loaded SNF casks inside the CHB.

3.2.3.10.10 Seismic Analysis of Specific Safety Features

SSCs classified as ITS meet the requirements of 10 CFR 72.122(b)(2) [3-23], which requires SSCs be designed such that design basis ground motion will not impair the capability to perform their safety functions.

3.2.4 Snow and Ice Loadings

The maximum recorded snowfall in any month near the WCS CISF is less than 14 inches per Table 2-4 and the bounding snow load is 10 psf as documented in Section 2.3.3.4.

3.2.5 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 for these criteria are addressed in Chapter 8.

3.2.5.1 Ambient Temperature

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

3.2.5.2 Solar Load (Insolation)

The solar loads are given in Table 1-2 and are taken from 10 CFR Part 71 [3-4].

3.2.6 Volcanic Eruption (Ash Fall)

No volcanic ash fall criteria are specified. The probability of a volcanic eruption near the WCS CISF is extremely low, as discussed in Section 2.6.6, such that no specific design considerations are made for ash fall.

3.2.7 Lightning

The design of the SSCs that have the potential to be outdoors and exposed to lightning are designed to withstand the effects of lightning without impairing their capability to perform their safety function. The Security and Administration Building and the CHB are provided lightning protection in accordance with the IBC to protect personnel and equipment. Site light poles and perimeter fences are connected to grounding systems to protect personnel and equipment during the event of lightning strikes.

3.2.8 Combined Load Criteria

This design considers all appropriate loads and load combinations required by the applicable SSC design codes. Design loads are determined from normal, off-normal, and accident-level conditions. Design loads are combined to simulate the most adverse load conditions.

3.2.8.1 NUHOMS® and Vertical Cask Systems

The NUHOMS® storage systems and the Vertical storage systems are designed to provide long-term storage of SNF. The canister materials are selected to protect against degradation during the storage period, including the application of system specific aging management programs.

3.2.8.2 Cask Storage Pad Load Combinations

The storage pads for the Vertical system storage modules are ITS. Load combinations are provided in Section 7.6.1.4.

3.2.8.3 Canister Transfer System

The CTS is ITS. Load combinations are in accordance with ASME NOG-1 [3-34].

3.2.8.4 Cask Handling Building Load Combinations

The CHB is a structural steel building with metal siding. The building will support two overhead cranes (themselves evaluated in accordance with NOG-1-2015 [3-36]) and consider their effects on loading combinations. The design of the structure is in accordance with nuclear facility codes. The design will consider load combinations as required by these codes. Section 7.5.3 provides additional information on the CHB design criteria.

3.2.8.5 Cask Handling Building Foundation

The foundation for the CHB is a conventional mat foundation of reinforced concrete construction. Loads, load combinations, load factors, and allowable stresses used in the design are in accordance with ACI 349-13, refer to Section 7.5.3.2.3.

3.2.8.6 Cask Handling Building Cranes

The overhead bridge cranes are classified as Important-to-Safety (ITS) along with the seismic clips and runway beams and supports, and are designed as Single Failure Proof (SFP) in accordance with ASME NOG-1-2015, "Rules for Construction of Overhead Gantry Cranes (Top Running Bridge, Multiple Girder)" [3-36] for defense in depth. The overhead bridge cranes rails are attached to the CHB structure in a manner that provides adequate assurance that the rails will remain attached to the CHB structure. The cranes are procured and designed to follow the loading conditions and combinations established in NOG-1-2015.

3.3 Safety Protection Systems

3.3.1 General

The WCS CISF is designed for safe storage of the SNF and GTCC waste during normal, off-normal, and accident conditions. The primary components that assure that the safety objectives are met are the storage overpack systems, the cask storage pads, the CHB, the CTS, and the Vertical Cask Transporter (VCT).

The components of the storage overpack systems are the Canister, Storage Overpack, and the Transfer Cask. The major safety functions of the storage system components are as follows:

Canister

The canister shell that provides confinement. The canister shell and basket provide heat transfer capabilities, criticality control and radiation shielding when used in conjunction with the storage overpack or transfer cask.

Storage Overpacks (NUHOMS® HSMs or VCCs)

The storage overpack provides protection to the canister from natural phenomena and environmental conditions. The storage overpack also facilitates heat transfer from the canister and provides radiation shielding.

Transfer Cask (NUHOMS® and Vertical Storage System)

The transfer cask provides physical protection and radiation shielding of the canister during transfer operations.

The primary safety function of the storage pads is to provide a stable and level surface for the storage modules.

The primary safety function of the CTS and CHB overhead cranes is to provide single-failure proof lifting capability for canister transfer operations and transportation cask load/unload operations.

The primary safety function of the Cask Handling Building is to provide protection from building structural members or overhead cranes from falling on transportation equipment or storage overpack systems during seismic or weather events.

3.3.2 Protection by Multiple Confinement Barriers and Systems

This section of the principal design criteria establishes requirements that satisfy 10 CFR 72.122(h) [3-23], which identifies requirements for confinement and ventilation of SNF and GTCC waste during storage.

3.3.2.1 Confinement Barriers and Systems

The primary confinement barrier for SNF and GTCC waste is the canister shell. The canister provides confinement for normal, off-normal, and accident storage conditions when inside the storage overpack or transfer cask.

Criteria utilized in the confinement design of the cask systems are not based on site-specific confinement criteria. Chapter 11 addresses confinement criteria adopted for each of the canisters authorized for storage at the WCS CISF identified in Table 1-1.

3.3.2.2 Ventilation-Offgas

There are no ventilation offgas systems required by the WCS CISF due to the sealed canister.

3.3.3 Protection by Equipment and Instrumentation Selection

3.3.3.1 Equipment

The SSCs that have been identified as ITS are described in Section 3.4. The design criteria for these components are summarized in Table 1-2.

3.3.3.2 Instrumentation

This section of the principal design criteria establishes requirements that satisfy 10 CFR 72.122(i) [3-23], which identifies general design criteria that require instrumentation and control systems be provided to monitor systems that are ITS. The instrumentation and control systems at the WCS CISF are classified as NITS.

Temperature monitors may be installed on HSMs to monitor the air outlet temperatures in place of regular visual inspection for inlet and outlet blockage to ensure the overpack remains operable. Temperature monitors are installed on the VCCs to monitor the air outlet temperatures to ensure the overpack remains operable.

Radiation monitors are utilized during canister transfer operations to verify that occupational exposures are within 10 CFR Part 20 [3-22] limits and during the storage life to ensure that doses to the public are within 10 CFR 72.104 [3-23] limits.

3.3.4 Nuclear Criticality Safety

Storage and transportation cask systems received at the WCS CISF are designed to ensure that the stored materials remain subcritical under normal, off-normal and accident conditions during all WCS CISF operations, transfers and storage. Chapter 10 presents criticality safety criteria and summarizes design features which ensure criticality safety at the WCS CISF. The design of the canisters is such that, under all credible conditions, the highest effective neutron multiplication factor (k_{eff}) remains less than 0.95.

Criteria utilized for criticality safety of the canister/cask systems are not based on site specific criticality safety criteria, therefore no additional criticality evaluations are required specific to this application. Chapter 10 addresses the criticality criteria for each of the canisters authorized for storage at the WCS CISF identified in Table 1-1.

3.3.5 Radiological Protection

This section of the principal design criteria establishes requirements that satisfy 10 CFR 72.126(a) [3-23], which identifies design criteria that requires radiation protection systems be provided to minimize personnel radiation exposure; 10 CFR 72.126(b) [3-23], which identifies design criteria that requires radiological alarm systems be provided in accessible work areas to warn operating personnel of radiation concentrations above given set points; and 10 CFR 72.126(c) [3-23], which identifies design criteria that requires a means for measuring and monitoring radioactive effluents and direct radiation be provided.

In accordance with 10 CFR 20.1101(b) [3-22], and to the extent practicable, WCS CISF procedures and engineering controls are based upon sound radiation protection principles to achieve occupational and public doses that are ALARA.

The ALARA principles of time, distance and shielding are considered throughout the design of the WCS CISF. For tasks requiring access to areas near transportation and storage overpacks, 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 are incorporated into system design.

Radiation protection is provided in accordance with 10 CFR 72.126(a) [3-23]. The following design criteria apply.

- During normal operations and all anticipated occurrences, the annual dose equivalent for any individual located beyond the controlled area shall not exceed 25 mrem to the whole body, 75 mrem to the thyroid or 25 mrem to any other organ, as a result of exposure to planned discharges of radioactive materials (radon and its decay products excepted), to the general WCS CISF environment or to direct radiation from WCS CISF operations.
- The dose in any unrestricted area from external sources shall not exceed 2 mrem in any one hour, per 10 CFR 20.1301(a)(2) [3-22].
- The maximum individual dose at or beyond the WCS CISF site boundary, resulting from a design-basis accident, shall be less than 5 rem to the whole body or any organ, per the limits set forth in 10 CFR 72.106(b) [3-23].

The WCS CISF design includes the means to measure and control contamination of areas requiring access, per 10 CFR 72.126(a)(4) [3-23]. Radiation monitoring and surveys are conducted in accordance with 10 CFR 20.1501 [3-22], and as necessary to comply with the operating limits imposed by Technical Specifications [3-1].

Radiological protection provided by confinement barriers and systems are addressed in Section 3.3.2.1.

3.3.5.1 Access Control

The WCS CISF design includes the means to measure and control contamination of areas requiring access, per 10 CFR 72.126(a)(4). Radiation monitoring and surveys are conducted in accordance with 10 CFR 20.1501.

The storage area is defined as a radiation area requiring radiological control, per 10 CFR 72.126(a). The WCS CISF is provided with systems for measuring the direct radiation levels in and around areas containing radioactive materials, per 10 CFR 72.126(c)(2).

Occupational radiation exposure protection for the WCS CISF is provided in accordance with 10 CFR Part 20 requirements.

3.3.5.2 Shielding

The design of the WCS CISF, including the cask systems, shield personnel from radiation exposure in accordance with 10 CFR 72.126. Whenever possible, equipment that normally operates in a radioactive environment is designed to allow removal to a nonradioactive environment for maintenance and repair. When this is not possible, the design allows for installation of temporary shielding.

In accordance with 10 CFR 72.106(b), the WCS CISF is designed, constructed and operated to provide shielding and confinement for radioactive materials to limit the maximum individual dose at or beyond the WCS CISF site-controlled area boundary to 1) five rem (to the whole body) and/or 2) the sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue (other than the lens of the eye) of 50 rem and/or 3) the lens dose equivalent may not exceed 0.15 Sv (15 rem) and the shallow dose equivalent to skin or any extremity may not exceed 50 rem; as the result of a design-basis accident.

3.3.5.3 Radiological Alarm Systems

There are no credible events that could result in releases of radioactive effluents from inside the canister or unacceptable increases in direct radiation as is discussed in Chapter 12. Therefore, no radiological alarm systems are needed in storage pad areas. However, area radiation monitors with audible alarms will be provided in the CHB for canister transfer operations.

Continuous air monitors will be provided in the CHB. They are provided as a prudent measure and not required for any identified hazard.

3.3.6 Fire and Explosion Protection

This section of the principal design criteria establishes requirements that satisfy 10 CFR 72.122(c) [3-23], which identifies design criteria that requires SSCs classified as ITS be designed and located so they can continue to perform their safety functions effectively under credible fire and explosion exposure conditions.

The WCS CISF is a low fire load facility. The Protected Area consists of a crushed rock surfaced area (Figure 1-2). Potential vegetation which could increase the fire load will be mitigated through a maintenance program to control any significant growth of vegetation through the crushed rock surface of the Protected Area and the Isolation Zone. Therefore, the surface of the Protected Area is non-combustible.

The WCS CISF contains no permanent flammable material other than some electrical and electronic components within the CHB. The other WCS CISF materials of construction, concrete and steel, can withstand any credible fire hazard. Flammable materials that may be brought into the WCS CISF on a temporary basis include fuel for necessary vehicles and construction materials. Use of non-flammable consumable materials is emphasized. All wood scaffolding and cribbing is treated with fire retardant paint. Any fuel spill within the WCS CISF boundary following storage overpack loading will involve only fuel (the contents of the fuel tanks on the cask moving vehicles, the crane and a few other small vehicles) which has a flash point of over 120° F. Vehicles other than electric or diesel fuel vehicles will not be permitted near loaded canisters or in the storage area where the storage overpacks are stored.

During operations, the amount of flammable liquids that are allowed in the CHB is controlled. The only sources of flammable liquids in the CHB are the locomotive used to move the railcars into and out of the CHB, the CTS, the VCT and the transfer vehicle. The locomotive will not be allowed in the buildingduring cask handling operation other than when the transportation casks are ready for transport. The CTS and the VCT are quantity limited (< 50 gallons) and are described in Section 12.2.1. The transfer vehicle for the NUHOMS® System is also quantity limited (< 60 gallons) and will not be in the CHB 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 away from the storage modules. 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 is 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 a fire suppression system in the CHB that is installed to mitigate the consequences of a fire.

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.

3.3.7 Material Handling and Storage

This section of the principal design criteria establishes requirements that satisfy 10 CFR 72.128(a) and (b) [3-23], which identify general design criteria that requires SNF storage and handling systems be designed to ensure adequate safety under normal and accident conditions and that radioactive waste treatment facilities be provided.

3.3.7.1 Spent Fuel or High-Level Radioactive Waste Handling and Storage

To meet WCS CISF functional requirements to receive, transfer, store and retrieve canisterized SNF and GTCC waste, the following criteria are established for the WCS CISF design.

Storage and handling systems are designed to allow ready retrieval of the canisters for shipment off-site, and the cask/canister handling systems are designed in accordance with 10 CFR 72.128(a) [3-23] to ensure adequate safety under normal and accident conditions. The following criteria for cask systems are also satisfied.

- Cask systems are designed and certified to withstand a drop event from heights specified in the Technical Specifications [3-1] for each individual system. WCS CISF operation procedures and limitations ensure casks are within these heights.
- Cask systems designed to transfer canisters are designed to withstand the impact of the postulated tornado missiles or administrative provisions are implemented to protect against impacts from tornado missiles during transfer operations. For this event, "designed to withstand" is defined as no impact on ITS functions except the following: A partial loss of shielding is allowed to the extent evaluated.
- Cask systems utilizing vertical transfer must be qualified for a 6-inch drop of the storage overpack or transportation cask lid during transfer operations.

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

3.3.7.2 Radioactive Waste Treatment

Radioactive contamination is anticipated to be negligible because SNF and GTCC waste is packaged in sealed canisters. Small volumes of solid radioactive wastes are expected. Waste will be managed in accordance with Section 3.3.7.3.

3.3.7.3 Waste Storage Facilities

As addressed in Section 6.1, solid waste from health physics survey material and dry active waste would be packaged and temporarily stored in a designated radiologically controlled area until the waste is characterized and shipped to a licensed disposal facility.

3.3.8 Industrial and Chemical Safety

Canister transfer operations at the WCS CISF are performed in accordance with Occupational Safety and Health (OSHA) standards.

3.4 Classification of Structures, Components, and Systems

The WCS CISF classifies SSCs as either ITS or NITS. The criteria for selecting the classification of particular SSCs are based on the following definitions:

Important-to-Safety (ITS)

A classification per 10 CFR 72.3 for any SSC whose function is to maintain the conditions required to safely store SNF and GTCC waste, prevent damage to SNF, GTCC waste, or their containers during handling and storage, or provide reasonable assurance that SNF and GTCC waste can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public.

Not-Important-to-Safety (NITS)

A quality classification for items or services that do not have a safety related function and that are not subject to special requirements or NRC imposed regulatory requirements.

SSCs classified as ITS are designed, fabricated, constructed, and tested in accordance with the Quality Assurance (QA) Program referenced in Section 1.4.4.3. Each SSC classified as ITS is given a level of importance based on QA classification categories as detailed in NUREG/CR-6407 [3-31]. The classifications are intended to standardize the QA control applied to activities involving SNF storage systems. Each classification is defined below.

Classification Category A - Critical to Safe Operation

Category A items include SSCs whose failure or malfunction could directly result in a condition adversely affecting public health and safety. The failure of a single item could cause loss of primary containment leading to release of radioactive material, loss of shielding, or unsafe geometry compromising criticality control.

Classification Category B - Major Impact on Safety

Category B items include SSCs whose failure or malfunction could indirectly result in a condition adversely affecting public health and safety. The failure of a Category B item, in conjunction with the failure of an additional item, could result in an unsafe condition.

Classification Category C - Minor Impact on Safety

Category C items include SSCs whose failure or malfunction would not significantly reduce the packaging effectiveness and would not be likely to create a situation adversely affecting public health and safety.

Criteria utilized for criticality safety of the canister/cask systems are not based on site-specific criticality safety criteria, therefore no additional criticality evaluations are required specific to this application. Chapter 10 addresses the criticality criteria for each of the canisters authorized for storage at the WCS CISF identified in Table 1-1.

Table 3-5 describes the Quality Assurance classifications for major SSCs as utilized at the WCS CISF per NUREG/CR-6407 [3-31]. Quality Assurance Classifications for each of the Storage Systems SSCs are addressed in Table 3-4. The canisters are classified as Category A because a failure could lead in loss of primary containment. The Storage Overpacks, CTS, VCT, and CHB have been classified as Category B because the failure of these components would require the failure of an additional component to result in an unsafe condition. The Storage Pads for the Vertical Storage System have been classified as Category C because the failure of these components would not likely result in an unsafe situation.

All other components are NITS because their failure would not result in an unsafe condition.

The classification of the components that make up the cask systems authorized for storage at the WCS CISF, including canister, transfer casks, storage overpacks, transfer equipment and storage pads are provided in Appendices A.3, B.3, C.3, D.3, E.3, F.3 and G.3, depending on the canister/cask system. Section 2.1 of the Technical Specifications [3-1] lists the SNF canisters authorized for storage at the WCS CISF. Table 3-1 provides the cross reference to the applicable appendix and section for each canister/storage overpack where the classifications of the components of that system are identified.

3.4.1 Cask Handling Building Quality Classification

The purpose of the CHB and associated lifting equipment is to receive, inspect and prepare for storage, shipments of canisterized SNF and GTCC waste canisters and to provide for cask and rail car light maintenance. The CTS and associated lifting hardware used for stack up and transfer operations for the NAC canisters is located inside the building. The NUHOMS® MP197HB and MP187 Casks Lift Beam Assembly is NITS because the NUHOMS® cask and canister are not lifted above the Technical Specifications [3-1] height limits. The building structure (structural steel and column foundations) is classified as ITS, Category B to meet the requirements of 10 CFR 72.122(b)(2)(ii) [3-23] and to prevent massive building collapse onto cask systems and related ITS SSCs. The overhead crane bridge overhead cranes, runway beams, integral crane structure consisting of the bridge rails, bridge girders, and trucks, as well as the trolley structure and the various drive components are ITS. The CHB overhead cranes shall meet the single-failure-proof criteria of NUREG-0612, and are designed as Type I, per ASME NOG-1 [3-36] for compliance with NUREG-0554, are capable of handling critical loads of the rated capacity (130 tons), are classified as Important to Safety (ITS) Quality Category B, as defined in the WCS CISF Quality Assurance Program. Quality categories for the individual subcomponents for the CHB overhead cranes will be determined based on the description of Quality Categories in Section 3.4. The quality assurance program of the Manufacturer of the two 130 ton overhead cranes in the CHB shall meet the Basic and Supplemental Requirements of ASME NQA-1. All components that are located in the load path between the load and the source of energy holding the load are classified as ITS Category B. The cranes shall be manufactured in accordance with Section 7200 *Manufacturing* of NOG-1[3-36] for Type 1 cranes. The Special Lifting Devices used to offload the NAC transportation casks from the railcar are ITS. The balance of the facility is also NITS as the fuel remains sealed from the environment inside the confinement boundary provided by the canister for all operations and the overpacks provide protection from natural phenomena and postulated off-normal and accident events.

3.4.2 Design Criteria for Other SSCs Not Important-to-Safety

The classification of SSCs allows the application of design criteria in a graded manner. The system classifies SSCs by function in order to apply the appropriate design criteria. Design criteria for NITS buildings and structures are discussed in this section.

The design criteria for SSCs classified as NITS, but that have importance to operations, such as transport vehicles, fire detection and suppression systems, security systems, radiation monitoring systems, and temperature monitoring systems, are addressed in subsequent chapters of this SAR. These SSCs are designed in accordance with their applicable codes and standards.

The WCS CISF radiation monitors are classified as NITS. The radiation monitors are not used to prevent or mitigate any credible accidents. The WCS CISF will utilize several types of radiation monitors including area monitors, thermoluminescent dosimeters (TLD), portable hand held monitors, personnel dosimetry, and portable airborne monitors. The use of several different types of monitors ensures that redundant methods are in place to detect high radiation conditions and provide warning for onsite personnel.

The temperature monitoring system where used is classified as NITS. The purpose of the temperature monitoring system is to provide continuous surveillance of each cask's temperature to ensure proper operation. The temperature monitoring system is designed so that a monitor failure would result in a loss of signal to the monitoring computer. The loss of signal would initiate an alarm informing security personnel of a potential cask temperature problem. Security personnel would then contact operations personnel. In place of temperature monitoring, regular visual inspection for inlet and outlet blockage to ensure that the overpacks remain operable may be implemented.

3.4.2.1 Important to Physical Protection of Facility and Materials

10 CFR Part 72, Subpart H [3-23] details requirements for a physical security and safeguards contingency plan, and physical protection design. The detailed physical security plan and a safeguards contingency plan are provided separately. Physical protection design requirements and criteria are described in Section 4.8. SSCs related to physical protection of the facility and materials satisfy the applicable requirements of 10 CFR Part 73. To assure that the final security system meets the design criteria for the WCS CISF physical protection, the physical protection system will be treated as ITS Quality Category C with the exception that 10 CFR Part 21 does not apply.

3.4.2.2 Conventional Quality

WCS CISF SSCs not designated as ITS are considered to be of conventional quality. Conventional quality SSCs are designed and constructed in accordance with commercial standards as described below. The design of conventional structures conforms with the requirements of ACI 318 [3-6] for concrete and the AISC Manual of Steel Construction [3-7] for structural steel.

3.4.2.2.1 Security and Administration Building

The Security and Administration Building is considered NITS and is designed, constructed, maintained, and tested as commercial-grade. The function of the building is summarized in Table 1-3.

3.4.2.2.2 Receiving Area

The receiving area is considered NITS and is designed, constructed, maintained, and tested as commercial-grade. The function of the area is summarized in Table 1-3.

3.4.2.2.3 Storage Pad for NUHOMS® Storage Modules

The Storage Pad for the NUHOMS® Storage Modules is considered NITS and is designed, constructed, maintained, and tested as commercial-grade.

3.4.2.2.4 Design and Construction Standards

SSCs important to fire protection will comply with the design requirements of applicable National Fire Protection Association (NFPA) codes. Protection of personnel is also ensured in accordance with NFPA 101 [3-8]. The design and installation of piping systems at the WCS CISF pertaining to water, compressed air, oil and sewer services will conform to the requirements of the American Society of Mechanical Engineers/American National Standards Institute (ASME/ANSI) B31.1-2104 Code [3-9]. This code invokes appropriate American Society for Testing and Materials (ASTM) Standards, American Welding Society (AWS) Standards, and American Water Works Association (AWWA) Standards. Additionally, the design and installation of piping systems located inside buildings (including vent and drainage systems) will conform to the applicable IBC [3-10], National Plumbing Code [3-11], and good work practices.

The design of conventional HVAC systems at the WCS CISF conforms to the design criteria contained in applicable American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), Air-conditioning and Refrigeration Institute (ARI), and NFPA standards, which are selected to satisfy building heating, ventilation, and cooling load requirements.

The design of conventional electrical systems will conform to ANSI/NFPA 70e-2012, National Electric Code [3-12], ANSI C2-2012 National Electric Safety Code [3-13], NEMA Standards and applicable state, county, municipal and other local regulations, building and zoning codes. The switchyard and electrical distribution designs will conform to Institute for Electrical and Electronic Engineers (IEEE) Standard 141-1993, IEEE Recommended Practice for Electric Power Distribution and Industrial Plants [3-14]; IEEE 142-1991, Recommended Practice for Grounding of Industrial and Commercial Power Systems [3-15]; and IEEE 80-1991, Guide for Safety in Substation Grounding [3-16]. Lightning protection for all structures will comply with NFPA 780-2011, Lightning Protection Code [3-17].

3.5 Decommissioning Considerations

This section of the principal design criteria satisfies 10 CFR 72.130, which requires provisions be made to facilitate decontamination of structures and equipment, minimize the quantity of radioactive wastes and contaminated equipment, and facilitate the removal of radioactive wastes and contaminated materials.

The canisters are all licensed for, and are maintained for, off-site transportation. The loaded canisters will be shipped to a Department of Energy (DOE) facility when DOE is ready to take the fuel or as directed by the holders of the title to SNF and GTCC waste at commercial nuclear power facilities (SNF and GTCC waste Title Holder(s)). Because of the minimal contamination of the outer surface of the canister, no contamination is expected on any WCS CISF equipment or on the internal passages or other surfaces of the storage overpacks. The storage overpacks may become slightly radioactive due to neutron activation. If necessary, the storage overpacks will remain at the WCS CISF until they can be dismantled and disposed of using commercial demolition and disposal techniques.

The design and function of the WCS CISF facilitates decommissioning activities and maintains radiation exposures ALARA during all decommissioning and decontamination activities.

Further decommissioning considerations are addressed in Appendix B of the WCS CISF License Application, “Preliminary Decommissioning Plan.”

3.6 Performance Requirements

The function of the WCS CISF is to store canisterized SNF and GTCC waste resulting from commercial nuclear activities in an NRC-approved storage facility, until removal from the WCS CISF for disposal in a repository or other site as directed by the DOE or other Title Holder of the SNF/GTCC waste. This section provides principal performance requirements imposed upon the design to ensure the facility can function as required.

3.6.1 Receipt Rate Capability

The WCS CISF has the capability to receive SNF at the rates (MTHM/year) listed in Table 3-2. The WCS CISF has the capability to receive casks and canisters containing commercial SNF at the annual rates (casks/year) specified in Table 3-3.

3.6.2 SNF and GTCC Waste Receiving Mode

The WCS CISF is designed to receive, handle, transfer, store and ship SNF and GTCC waste contained in canisters in Section 2.1 of the Technical Specifications [3-1] and Table 1-1 via rail in the transportation casks identified in Sections 1.6.1.1 and 1.6.2.1.

3.6.3 Storage Capacity

Phase 1 of the WCS CISF has a SNF storage capacity of 5,000 MTHM with an ultimate capacity of 40,000 MTHM at full build out and 231.3 MT (510,000 pounds) of GTCC waste.

3.6.4 Facility Service Life

The WCS CISF is initially licensed for 40 years with the option for renewals for time periods allowable by regulation.

3.7 Summary of WCS Consolidated Interim Storage Facility Principal Design Criteria

A summary of principal design criteria is shown in Table 1-2. The table summarizes design parameters developed in this chapter, including the SNF stored at the WCS CISF site, and structural, thermal, radiation protection/shielding, criticality, and confinement design of the SSCs that are ITS.

3.8 References

3-1 SNM-2515 Technical Specifications (See [Gen-1]).

3-2 Reg Guide 1.76, "Design-Basis Tornado And Tornado Missiles For Nuclear Power Plants," Revision 1, March 2007.

3-3 NUREG-0800, Standard Review Plan, Section 3.3.1 "Wind Loading," 3.3.2 "Tornado Loads" and Section 3.5.1.4 "Missiles Generated by Tornado and Extreme Winds," Rev 3, March 2007.

3-4 Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."

3-5 Not Used.

3-6 ACI 318, "Building Code Requirements for Structural Concrete and Commentary," American Concrete Institute, 2011.

3-7 American Institute of Steel Construction, AISC Manual of Steel Construction, 14th Edition.

3-8 NFPA 101 (2015 Edition), National Fire Protection Association.

3-9 ASME/ANSI B31.1, American Society of Mechanical Engineers/American National Standards Institute.

3-10 IBC, 2006, International Building Code.

3-11 NPC, 2009, National Plumbing Code.

3-12 ANSI/NFPA 70e-2012, National Electric Code.

3-13 ANSI C1-212, National Electric Safety Code.

3-14 IEEE 141-1993, Institute for Electrical and Electronic Engineers.

3-15 IEEE 142-1991, Recommended Practice for Grounding of Industrial and Commercial Power System.

3-16 IEEE 80-1991, Guide for Safety in Substation Grounding.

3-17 NFPA 780-2011, Lightning Protection Code.

3-18 RS ISFSI FSAR, Volume I (See [Gen-2]).

3-19 NAC International, "NAC-STC, NAC Storage Transport Cask Safety Analysis Report," Revision 17, CoC 9235 Revision 13, USNRC Docket Number 71-9235.

3-20 NAC International, "Safety Analysis Report for the UMS® Universal Transport Cask," Revision 2, CoC 9270 Revision 4, USNRC Docket Number 71-9270.

3-21 NAC International, "Safety Analysis Report for the MAGNATRAN Transport Cask," Revisions 12A, 14A, 15A, and 16A, USNRC Docket Number 71-9356.

3-22 Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation."

3-23 Title 10, Code of Federal Regulations, Part 72, "License Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste."

3-24 ASCE-7 (formerly ANSI A58.1), Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers, 1995.

3-25 McGuire, R.K., Silva, W.J. and Constantino, C.J., 2001, Technical basis for revision of regulatory guidance on design ground motions: Hazard- and risk-consistent ground motion spectra guidelines, U.S. Nuclear Regulatory Commission NUREG/CR-6728.

3-26 Not Used.

3-27 Regulatory Guide 1.61, Damping Values For Seismic Design of Nuclear Power Plants, U.S. Nuclear Regulatory Commission, October 1973.

3-28 Not Used.

3-29 NUREG-0554, Single-Failure-Proof Cranes for Nuclear Power Plants, U.S. Nuclear Regulatory Commission, 1979.

3-30 ASME B30.2-2005 Overhead and Gantry Cranes.

3-31 NUREG/CR-6407, (INEL-95/0551), Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety, 1996.

3-32 Electric Power Research Institute (EPRI), 2013, Ground motion model (GMM) review project, Final Report.

3-33 Geoservices, LLC, Project No. 31-151247, "Report of Geotechnical Exploration: Consolidated Interim Storage Facility (CISF) Andrews, Texas," August 20, 2015.

3-34 ASME NOG-1-2010, "Rules for Construction of Overhead Gantry Cranes (Top Running Bridge, Multiple Girder)," The American Society of Mechanical Engineers, 2010.

3-35 ASCE 7-16, "Minimum Design Loads for Buildings and Other Structures."

3-36 ASME NOG-1-2015, "Rules for Construction of Overhead Gantry Cranes (Top Running Bridge, Multiple Girder)," The American Society of Mechanical Engineers, 2015.

Table 3-1
Physical Design Characteristics of Storage Systems at the WCS CISF

Cask System	Canister	Overpack	Appendix
NUHOMS®-MP187 Cask System	FO-DSC	HSM (Model 80)	Appendix A.3
	FC-DSC		
	FF-DSC		
	GTCC Canister		
Standardized Advanced NUHOMS® System	NUHOMS® 24PT1	AHSM	Appendix B.3
Standardized NUHOMS® System	NUHOMS® 61BT	HSM Model 102	Appendix C.3
	NUHOMS® 61BTH Type 1		Appendix D.3
NAC-MPC	Yankee Class	**VCC**	Appendix E.3
	Connecticut Yankee		
	LACBWR		
	GTCC-Canister-CY		
	GTCC-Canister-YR		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.3
	GTCC-Canister-MY		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.3
	GTCC-Canister-ZN		

Table 3-2
WCS CISF Receipt
Rate Capability

Year	SNF (MTHM/year)
1	1,000
2+	2,000

Table 3-3
WCS CISF Receipt
Rate Capability
(Casks)

Year	Rail Casks
1	100
2+	200

Table 3-4
References for WCS CISF Storage System Components Important–to-Safety

Storage System	Section in WCS CISF SAR	Section in Specific License or Certificate SAR	Drawings Containing ITS Items
NUHOMS® - MP187 Cask System	Appendix A.3.1 with Table A.3-2, Table A.3-3, Table A.3-4, Table A.3-5, and Table A.3-6	Section 3.4 and Table 3-11 of Ref. [A.3-1]	Drawings listed in Appendix A.4.6
Standardized Advanced NUHOMS® System	Appendix B.3.1 Table B.3-2	Section 2.5 and Table 2.5-1 of Ref. [B.3-1]	Drawings listed in Appendix B.4.6 and Appendix A.4.6 numbers 14 and 15
Standardized NUHOMS®-61-BT System	Appendix C.3.1 Table C.3-2	Section K.2.3.1 and Table K.2-8 of Ref. [C.3-1] and the Quality Category Column of the parts lists on Drawing MP197-HB-71-1002, Rev.6 in Section A.1.4.10.1 of Ref. [C.3-2]	Drawings listed in Appendix C.4.6 and Appendix A.4.6 numbers 5 through 13 inclusive
Standardized NUHOMS®-61BTH Type 1 System	Appendix D.3.1 Table D.3-2	Section T.2.3 and Table T.2-15 of Ref. [D.3-1]	Drawings listed in Appendix D.4.6 and C.4.6 numbers 8 through 12 inclusive and Appendix A.4.6 numbers 5 through 13 inclusive
Yankee-MPC	Appendix E.3.1.2.1	Section 2.3.1 and Table 2.3-1 of Ref. [E.4-1]	Drawings listed in Appendix E.4.4
CY-MPC	Appendix E.3.1.2.1	Section 2.3.1 and Table 2.3-2 of Ref. [E.4-1]	Drawings listed in Appendix E.4.4
MPC-LACBWR	Appendix E.3.2.2.1	Section 2.A.3.1 and Table 2.A.3-1 of Ref. [E.4-1]	Drawings listed in Appendix E.4.4
NAC-UMS	Appendix F.3.1.2.1	Section 2.3.1 and Table 2.3-1 of Ref. [F.4-1]	Drawings listed in Appendix F.4.3
NAC-MAGNASTOR	Appendix G.3.1.2.1	Section 2.4.1 and Table 2.4-1 of Ref. [F.4.-1]	Drawings listed in Appendix G.4.3

Table 3-5
Quality Assurance Classification of Structures, Systems, and Components as Utilized at the WCS CISF(1)(4)

Important-To-Safety	Not Important-To-Safety
Classification Category A	Facility Infrastructure
SNF Canister	Security and Administration Building
	Storage Pads (NUHOMS® Storage Overpacks)
Classification Category B	
Storage Overpacks	Overhead Building Crane Lifting Devices for NUHOMS® Transportation Casks
Canister Transfer System (See Note 3)	Electrical Power
Vertical Cask Transporter	
Cask Handling Building	
Overhead Building Cranes	
Special Lifting Devices for NAC Transportation Casks	
Classification Category C	Facility Lighting
Storage Pads (Vertical Concrete Storage overpacks)	NUHOMS® Cask Transfer Trailer
Canister Transfer System Pad in Cask Handling Building	Radiation Monitors
	Temperature Monitoring System
Treated as Category C	Communication System
Derailer (See Note 2)	Fire Protection System
CAS (See Note 2)	Potable Water System
Security Lighting (See Note 2)	Sanitary Waste/Septic Systems
Security Cameras (See Note 2)	Facility Roads
Security Alarm Systems (See Note 2)	Railroad Line Components
Backup Electric Power (Generators) (See Note 2)	Associated Support Equipment

Notes:

(1) Quality Assurance Classifications for each of the Storage Systems SSCs are addressed in Table 3-4.

(2) Treated as ITS Category C with the exception 10 CFR Part 21 does not apply.

(3) The Canister Transfer System includes transfer casks for the NAC MAGNASTOR, UMS, and MPC systems.

(4) Quality categories for the individual subcomponents are further evaluated based on the description of Quality Categories in Section 3.4, and on the guidance provided in NUREG/CR- 6407 [3-31].

CHAPTER 4
FACILITY DESIGN

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4. FACILITY DESIGN

Chapter 4 describes the main operating functions of the Interim Storage Partners' (ISP's) WCS Consolidated Interim Storage Facility (WCS CISF) and the systems needed to perform these functions. The chapter follows the guidance of NUREG-1567 [4-1]; and also, includes a description of the WCS CISF layout and principal features in accordance with Regulatory Guide 3.48 [4-2]. General arrangements of the Cask Handling Building (CHB) are presented in this chapter. The major systems necessary for handling canisterized spent nuclear fuel (SNF) and Greater-than-Class C (GTCC) waste and the supporting auxiliary systems are described.

4.1 Summary Description

This section provides a description of the WCS CISF layout and design and description of the systems needed to perform the main operating functions for the WCS CISF based on the principal design criteria provided in Chapter 3. The description of structures, systems, and components (SSCs) discussed in this chapter focus primarily on SSCs that perform an important-to-safety (ITS) function. SSCs that are ITS are identified in Table 3-5.

Storage System Components

The storage systems used at the WCS CISF for storage of containerized SNF and GTCC waste are identified in Table 1-1 and have been approved by the NRC for spent nuclear fuel. The NUHOMS® MP187 GTCC waste canister is currently included in a specific license for storage and is also certified by the NRC for transport under 10 CFR Part 71. The GTCC waste canisters for the NAC systems are certified by the NRC for transport under 10 CFR Part 71.

The quality classification for each SSC associated with a given storage system is identified in the corresponding cask SAR incorporated by reference. Table 3-4 provides a list of the storage system components used at the WCS CISF and provides a reference to the quality classification in the corresponding approved SAR for each component.

The principal design criteria for the WCS CISF are listed in Table 1-2. Table 1-4 provides locations for specific design criteria information for each storage system used in conjunction with the WCS CISF. This table provides a reference to the appropriate Appendix Section of this SAR for each Cask System as well as the corresponding approved SAR for each system.

4.1.1 Location and Layout of Installation

The WCS CISF is located in Andrews County, Texas near the Texas and New Mexico state line. The WCS CISF is to the north and adjacent to the existing Waste Control Specialists facilities. The entrance to the WCS CISF is located approximately 1.5 miles north of the existing entrance to Waste Control Specialists on Texas State Highway 176. Figure 1-1 shows the location of the WCS CISF in relation to existing Waste Control Specialists facilities, structures, rail lines, and the Texas New Mexico state line.

The WCS CISF is served by an existing rail spur off of the Texas and New Mexico Railway that originates at Eunice, NM and terminates at the Waste Control Specialists facilities. The Texas and New Mexico Railway passes approximately five miles west of the WCS CISF and provides freight service from a connection with the Union Pacific at Monahans, TX to Lovington, NM (approximately 105 miles of track). Primary traffic on the Texas and New Mexico Railway consists of oilfield commodities, aggregates, chemicals, scrap metal, hydrochloric acid, and hazardous waste.

4.1.2 Principle Features

The WCS CISF is a SNF and GTCC waste dry storage system facility with a capacity of 5,000 MTHM and 231.3 MT (510,000 pounds) of GTCC waste. Only canisterized SNF and GTCC waste will be received at the WCS CISF. The storage overpacks used at the WCS CISF are a combination of those designed by TN Americas and NAC International. Waste shipments arrive at the WCS CISF by rail car and the transportation cask will be unloaded from the rail car to either a Canister Transfer System (CTS) for vertical systems; or directly to a transfer vehicle, for the horizontal systems. For the vertical systems, the CTS is used to transfer the loaded canisters from the transportation cask to a storage overpack which is then moved to the Storage Pad via the Vertical Cask Transporter (VCT). For the horizontal systems, the transportation cask is used as the transfer cask to move the loaded canister out to the Storage Pad where the canister is transferred directly to its storage overpack. Figure 1-3 shows the WCS CISF layout.

The principal features of the WCS CISF are the Storage Area and Storage Pads, shown on Figure 1-3, the CHB, shown on Figure 1-7, and the Security and Administration Building shown on Figure 1-9. The Storage Pads, the CHB, and the Security and Administration Building are located within the Protected Area (PA). The CHB receives transportation casks as they arrive by rail. The building overhead crane unloads transportation casks and, for the horizontal storage systems, loads the cask onto a transfer trailer which takes the cask to the storage pads. For vertical storage systems, the VCT retrieves the transportation cask and positions it under the CTS. The CHB also houses the CTS which transfers the canister from the transportation cask to the storage overpack that is then moved to the appropriate Storage Pad. The Security and Administration Building is the access point for personnel to the PA and holds offices and equipment for security, administrative, and health physics personnel.

The PA is approximately 36 acres within the Owner Controlled Area (OCA) which includes the concrete storage pads, storage overpacks, CHB, and the Security and Administration Building. The PA is surrounded by a double fence with a 30-foot space between each fence. The exterior fence acts as a “nuisance” fence and the interior fence is the primary fence for intruder barrier and detection. Personnel will access the PA through the Security and Administration Building. There is a minimum of 200 meters between the PA fence and the OCA fence. Figure 1-2 shows the fence boundaries in relation to the components of the CISF.

The facility layout and location is designed to be accessible by on-site and off-site emergency services in accordance with 10 CFR 72.122(g). The facility is accessible from Texas State Highway 176 by on-site roads maintained for use by highway and heavy vehicles. Roads within the facility that provide access to SSCs that are ITS have sufficient width and functionality to accommodate vehicles and equipment associated with emergency services.

The WCS CISF SSCs that are ITS are completely independent and not shared with other existing Waste Control Specialists facilities. While some SSCs will be shared, such as the counting laboratories referenced in Section 9.5.2, these are not classified as ITS.

4.1.2.1 Site Boundary

The Waste Control Specialists property is approximately 14,000 acres in Texas and New Mexico. The WCS CISF will be located in Texas on approximately 155 acres of land. Adjacent to the WCS CISF will be the Waste Control Specialists Low-Level Radioactive Waste (LLRW) and Hazardous Waste Treatment, Storage, and Disposal Facility (TSDF) operations.

4.1.2.2 Owner Controlled Area

The OCA is the outer controlled boundary of the WCS CISF. This fenced in area encloses approximately 155 acres within the 14,000 acres of Waste Control Specialists property. Special authorization is required for access to this area. The location of the OCA in relation to the CISF is shown on Figure 1-2.

The OCA establishes a minimum distance of 200 meters from storage and handling operations of SNF and GTCC waste to the nearest controlled boundary in accordance with 10 CFR 72.106 [4-5]. This boundary encompasses the 155 acres referenced in Section 4.1.2.1.

4.1.2.3 Site Utility Supplies and Systems

Utility systems for the WCS CISF are limited to basic services. The SSCs classified as ITS do not require utility services to maintain their safety function. Therefore, utility services and systems at the facility are not required to be classified as ITS and do not need to include redundant capabilities as otherwise would be required by 10 CFR 72.122(k).

Waste Control Specialists site electrical service exists at the WCS CISF location. This infrastructure will be upgraded to accommodate the WCS CISF needs. Electric power is provided to the WCS CISF for lighting, general utilities, security system, and overhead cranes. Although the CTS is ITS, its safety function does not rely on electric power. A standby diesel-generator provides backup power for the security system, emergency lighting loads, storage overpack temperature monitoring system, and communication systems.

Potable water will be supplied to the WCS CISF from the existing Waste Control Specialists potable water system. The WCS CISF potable water system will tie-in to the existing potable water system at Waste Control Specialists. Fire protection will be maintained in accordance with National Fire Protection Association (NFPA) standards.

Storage tanks are used in a limited capacity. The WCS CISF will have an above ground holding tank at the Security and Administration Building.

4.1.2.4 Storage Facilities

There are no significant storage facilities such as holding ponds, fuel storage tanks, or other items required to maintain ITS functions at the facility. As mentioned in Section 4.1.2.3, there will be a sanitary/septic holding tank (or tanks) at the Security and Administration Building with a total capacity less than 10,000 gallons. Fuel tanks are not located at the WCS CISF and are discussed in the Offsite Accident Analysis in Section 12.2.2.

4.1.2.5 Stacks

There are no stacks at the WCS CISF.

4.2 Storage Structures

Storage Area systems and operations are described in this section. The main function of the Storage Area is to provide a location to place the storage overpacks containing the canisters received at the WCS CISF. The Storage Area is designed for the transfer, storage and retrieval of canisterized SNF and GTCC waste. The Storage Area is constructed in stages, as needed, to support WCS CISF operational throughput requirements, and is contained within the double fence of the OCA. (Figures 1-2 and 1-3).

The Storage Area is designed to accommodate both horizontal and vertical systems. There are NUHOMS® pads with space for up to 148 horizontal storage systems (24HSM Model 80s, 20 AHSMs and 104HSM Model 102s). There are thirteen separate pads for the vertical systems that hold up to 319 storage overpacks (169 UMS, 59 MPC and 91 MAGNASTOR VCCs).

The storage SSCs are used to store canisters at the WCS CISF. The storage SSCs consist of Cask Systems and Storage Pads. The storage SSCs are designed to withstand the effects of site environmental conditions, natural phenomena, and accidents in accordance with 10 CFR 72.122(b) and 10 CFR 72.128(a).

Storage Systems

Six storage systems were evaluated for use in the WCS CISF Storage Area. These storage systems contain SNF or GTCC waste in sealed canisters. Table 4-1 provides a cross reference to the applicable appendix and section for each canister/storage overpack where the individual storage systems are discussed and drawings are provided or incorporated by reference.

The methodologies used for analysis of tornado, earthquake, fire, explosion, and differential subsidence effects have been previously reviewed and approved by the NRC and are described in the corresponding SAR for each storage system at the WCS CISF. These analyses are incorporated by reference into the WCS CISF SAR as shown in Table 1-4.

Storage Pads

SNF is placed in storage overpacks located on concrete pads in the Storage Area shown on Figure 1-3. The Storage Area is 350 feet wide by 800 feet long and consists of concrete storage pads, concrete access aprons, and access roadways. There is a minimum of 100 meters between the Storage Area and the PA fence. Storage overpack design details and criteria for confinement, shielding, structural, and protection from natural phenomena are provided in Appendices A-G.

Concrete pad thickness and steel reinforcing depends on the type of storage overpack that is used on each pad. Concrete aprons and access roadways are constructed as necessary to facilitate VCT and transfer vehicle access and final storage placement of canisters. Storage Pad design details and criteria for natural phenomena and accidents are located in Sections 7.6.1 and 7.6.5.

Six storage systems were evaluated for storage in the WCS CISF Storage Area. These six storage systems are divided into two categories: Vertical Concrete Cask (VCC) Systems and NUHOMS® Horizontal Storage Modules (HSM). These storage systems each have their own unique storage pad requirements. Table 4-1 provides a cross reference to the applicable appendix and section for each canister/storage overpack where the concrete pads structures are discussed. Two Storage Pad designs have been created to accommodate the two categories of storage systems.

4.2.1 Structural Specifications for Storage Pads

The WCS CISF storage pads for VCCs are conventional cast-in-place reinforced concrete mat foundation structures. The pads are designed for normal operating loads, severe environmental loads and extreme environmental loads as referenced by NUREG-1567 [4-10]. Design information for the storage pads for VCCs is contained in Section 7.6.1. The storage pads for VCCs are classified as ITS.

The WCS CISF storage pads for NUHOMS® HSMs are a commercial grade reinforced concrete surface structure that is classified as not-important-to-safety (NITS). The storage pad consists of a 36 inch thick reinforced concrete basemat structure. Additional information about the storage pads for HSMs is contained in Section 7.6.5.

4.2.2 Storage Pad Layout

4.2.2.1 Storage Pad Plans and Sections

Figure 1-3 shows the locations of the concrete storage pads. Concrete storage pad plan, cross section, and details for the VCC storage pads are shown in Drawing NAC004-C-002, Rev. 0, "ISFSI Pad Licensing Design Structural Concrete Plan, Sections, and Details" [4-11]. Plan, cross section, and details for the HSM storage pads are shown in Figure 7-53.

4.2.2.2 Confinement Features

The storage pads are not counted on for any confinement features.

4.2.3 Storage Pad Description

The WCS CISF storage pads are conventional cast-in-place reinforced concrete mat foundation structures.

4.2.3.1 Storage Pad Function

The function of the storage pads is to provide a level and stable surface for placement and storage of storage overpacks.

4.2.3.2 Storage Pad Components

The components of the storage pads consist of the materials of construction as specified in Section 7.6.

4.2.3.3 Design Bases and Safety Assurance

Analysis and design of storage pads is provided and described in Section 7.6.

4.3 Auxiliary Systems

4.3.1 Ventilation and Offgas Systems

The storage systems use a sealed canister and do not require an offgas system or ventilation. No canisters will be opened at the WCS CISF.

4.3.2 Electrical Systems

4.3.2.1 Major Components and Operating Characteristics

Site power currently exists at the WCS CISF. The existing overhead power lines will be upgraded to provide the necessary service. Site power will enter the WCS CISF at the Security and Administration Building and be distributed to the rest of the WCS CISF from that point through an underground distribution system. A backup diesel generator system at the Security and Administration Building will supply emergency power to essential systems (security system) in case of a power failure.

WCS CISF electrical systems will provide power for operation of the two buildings (CHB and Security and Administration Building). The remaining electrical systems are those used for site security and lighting requirements.

Emergency backup power is provided at the WCS CISF by a diesel-generator system. Emergency backup power will be limited to the security systems, communication systems, emergency lighting, and applicable temperature monitoring systems.

The emergency backup power system will consist of a diesel generator, Uninterruptible Power Source (UPS), starting batteries, fuel supply, and auxiliary system components. The system will be designed and installed to comply with the requirements of IEEE 692 [4-6]. The backup power system is located at the Security and Administration Building within the PA.

4.3.2.2 Safety Considerations and Controls

The emergency backup power system will be designed to automatically switch to battery power in the event of loss of power to the WCS CISF. Batteries will provide power to the site for the brief period it takes the diesel generator to start and begin producing power at design capacity. At this point the diesel generator will take over supplying power to the facility.

SSCs at the facility that have a potential for being struck by lightning, such as the CHB or light poles, are grounded to ensure that the current from a lightning strike is conducted to ground per the National Electric Code (NEC) [4-7].

4.3.3 Air Supply Systems

An air supply system is provided at the WCS CISF in the CHB for the use of tools and small equipment. The CTS has an air operated hoist and is discussed in Sections 7.5.1, 7.5.1.2, and 7.5.1.7.

4.3.4 Steam Supply and Distribution System

A steam supply system is not needed or provided at the WCS CISF.

4.3.5 Water Supply System

Water is supplied to the WCS CISF by the existing potable water system at the Waste Control Specialists site. The water supply system is provided for normal facility services and operation and maintenance functions. Water will be supplied to the Security and Administration Building and CHB using underground pipes from the Waste Control Specialists Facility Potable Water System. There are no safety related SSCs classified as being ITS that require water for operation.

4.3.6 Sewage Treatment System

All wastewater from the WCS CISF will be drained or pumped into above ground holding tanks for removal to an off-site publicly owned treatment works (POTW). The sanitary drainage system will be provided at the WCS CISF in accordance with the applicable codes referenced in Section 3.4.2.2.4.

The only sanitary drainage system at the WCS CISF will be at the Security and Administration Building. The system will utilize a septic tank and a holding tank system with no drain field. The septic tank and holding tank will be located near the Security and Administration Building. The holding tank (or tanks) are expected to have a total combined volume of less than 10,000 gallons and will be pumped for off-site treatment as required.

4.3.7 Communications and Alarm Systems

The WCS CISF will utilize a variety of communications and alarm systems with redundancy provided for emergency communication situations.

A telephone system will be installed at the WCS CISF. This system will have access to other Waste Control Specialists facilities outside of the WCS CISF and outside lines. The telephone service will be used to provide normal communication to and from the site and emergency communications with local authorities.

A Public Address System will be installed at the WCS CISF. This system allows emergency messages and alarms to be broadcast for all personnel in the WCS CISF boundary to hear. In the event of an emergency, facility personnel and visitors on site are notified by an announcement over the Public Address System. Offsite emergency response personnel are notified by means of personal cell phones and/or using the notification list of telephone numbers located in the Emergency Plan implementing procedures. Alarms at the WCS CISF are only used on area radiation monitors to notify nearby personnel of doses that exceed the alarm setpoint.

A wireless radio system will be used at the WCS CISF for standard communication needs. Portable two-way radios are used by security personnel to maintain continuous communications with the Security and Administration Building while on patrol.

4.3.8 Fire Protection System

4.3.8.1 Design Basis

Fires that could affect SSCs classified as ITS are likely to result from diesel fuel sources originating from the VCT, Transfer Trailer/Truck, CTS auxiliary power unit or the Rail Locomotive. SSCs affected include the storage overpacks in the storage area and the shipping and storage system components and cranes in the CHB. Scenarios have been evaluated for a fire in each location considering fire location, intensity, and duration. The storage overpack accident analysis is referenced in Table 12-1. The CTS is evaluated in Section 12.2.1 and the controls instituted in the CHB are discussed in Section 7.5.3.8. The analysis determined that the fires will not compromise the safety provisions of the SSCs. No other major fire fuel sources are located in areas near SSCs classified as ITS.

4.3.8.2 System Description

Cask Handling Building

The CHB will be designed with a fire protection system. Fire protection will be in accordance with the requirements of the NFPA [4-9] and the IBC [4-8].

Security and Administration Building

The Security and Administration Building fire protection provisions will be designed in accordance with the requirements of the IBC [4-8] and NFPA [4-9] as applicable.

Fire detection systems are located in both the facility buildings. The detectors within each building are connected to a central alarm panel located in the Security and Administration Building. Alarms will sound within both the building where the detector is located and the central alarm panel.

4.3.8.3 System Evaluation

An evaluation of potential fires affecting SSCs classified as ITS is addressed in Section 4.3.8.1. The referenced analysis concludes that the postulated fires will not preclude the ability of SSCs from performing their safety related function.

ISP will perform a Fire Hazards Analysis (FHA) prior to detailed design of the facility. Based on evaluations referenced in Section 4.3.8.1, the FHA will demonstrate that the WCS CISF is sufficiently protected against the effects of major fires. This conclusion is based on the low fire loading, fire detection and suppresion systems, and compliance with the requirement of the IBC and applicable NFPA standards.

4.3.8.4 Inspection and Testing Requirements

Inspection and preoperational testing of the fire detection and fire suppression systems will be performed in accordance with the requirements of Section 13.2.2.1. Preoperational and periodic inspection and testing will be performed in accordance with NFPA 25 [4-12].

4.3.8.5 Personnel Qualification and Training

Training and qualification requirements for the testing, inspection, and operation of the fire systems will be in accordance with the requirements of NFPA 25 [4-12].

4.3.9 Maintenance System

4.3.9.1 Major Components and Operating Characteristics

No special maintenance techniques are necessary that would require a safety analysis. There is preventative maintenance performed on a regular basis on the CTS, transfer equipment and transportation casks. Maintenance of these SSCs, which are classified as ITS, ensure that they are safe and reliable throughout the life of the WCS CISF per 10 CFR 72.122(f).

The storage systems at the WCS CISF have minor maintenance requirements due to their passive design and function. Periodic inspection and maintenance to keep the storage overpack air vents unobstructed is required to meet the requirements given in the Technical Specifications [4-3]. Likewise, the CHB structural members, with their passive design function to prevent structural failure, require infrequent periodic inspection to ensure structural function is not significantly degraded, e.g. by weathering effects. Other components at the WCS CISF that require routine periodic maintenance include the overhead bridge crane, fire suppression system located in the CHB, the rail cars, the cask transporters, the backup diesel generator, and the temperature monitoring equipment.

4.3.9.2 Safety Considerations and Controls

Preventive and routine maintenance activities are scheduled and established to ensure that SSCs are being maintained according to equipment manufacturer's recommended standards. WCS CISF procedures prevent maintenance activities of equipment in the CHB when overpacks loaded with canisters are in the building to minimize personnel radiation doses. Maintenance activities at the storage area will be monitored and controlled by WCS CISF procedures to ensure that inspections and maintenance work is performed ALARA.

4.3.10 Cold Chemical Systems

There are no cold chemical systems at the WCS CISF.

4.3.11 Air Sampling Systems

Air monitoring is described in Section 5.6.4.

4.3.12 Gas Utilities

There is no propane or natural gas at the WCS CISF. There are existing propane tanks at the existing Waste Control Specialists facilities. These are discussed in Section 12.2.2.

4.3.13 Fueling of on-site vehicles used at the WCS CISF

Fueling of on-site vehicles including the Rail Locomotive will occur from existing Waste Control Specialists LLRW and TSDF fuel tanks. As stated in SAR Section 12.2.2, diesel fuel oil storage tanks are located outside the PA at the Waste Control Specialists LLRW and TSDF Facilities. The closest Diesel Fuel storage tank is approximately 3,500 feet from the WCS CISF. The station tank will be supplied with fuel from a bulk fuel service. A fuel truck may be used to provide fuel to some onsite components at the CHB such as the CTS auxiliary power supply fuel tank and the VCT if necessary. This activity is administratively controlled so that the fuel truck is at the CHB only when loaded canisters are not in the building.

4.3.14 Radiation Monitoring Systems

Occupational radiation dose at the WCS CISF is measured by optically stimulated luminescence (OSL) dosimetry devices for beta and photon radiation, along with CR-39 dosimetry devices for fast and thermal neutron monitoring. Monitoring will cover the PA and the OCA to ensure the dose is within 10 CFR 20.1301 and 10 CFR 72.104 limits.

4.3.15 Control Room and Control Area

The WCS CISF is a passive installation, with no need for operator actions. No control room is needed for normal operations; however, the instrumentation used to monitor storage overpack temperatures have readouts in the Security and Administration Building.

4.3.16 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 reinforced concrete floors and foundations. The building is NITS 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.

The Security and Administration Building as well as the CHB will utilize commercial grade HVAC systems and ductwork. The Security and Administration Building HVAC will be used for employee comfort and equipment protection.

4.3.17 Operation Support Systems

The storage overpacks have thermal monitoring capabilities as described in the Technical Specifications [4-3] applicable to each system. Table 4-1 provides a cross reference to the applicable appendix and section for each canister/storage overpack where the individual storage overpack thermal monitoring systems are discussed.

4.3.18 Temporary Facilities

Additional security positions and receiving and inspection areas will be used and located as needed.

4.4 Decontamination Systems

4.4.1 Equipment Decontamination

The WCS CISF handles only canisterized SNF and GTCC waste; therefore, the only radioactive wastes are solid wastes generated from residual quantities of radioactive contamination that may be encountered on the surfaces of the transportation casks due to weeping (See Reference [4-13] for discussion related to weeping).

The potential for radionuclide contamination of the outside surface of the canisters and inner surfaces of the transportation/transfer casks is minimized by using design concepts for each of the canisters identified in Table 1-1 that preclude intrusion of spent fuel pool water into the annular gap between the transfer cask and the canister while they are submerged in the pool water at the originating nuclear power plants. Similarly, the transfer casks used to transfer the canisters included as part of the NAC vertical systems from their transportation casks to the VCCs are never submerged in contaminated water and, as the exterior surfaces of the canisters are clean, the transfer cask does not require decontamination.

The transportation cask externals are also surveyed and decontaminated, as necessary, before the cask leaves the originating site for transport to the WCS CISF. Radioactive wastes generated during the canister and transportation cask loading operations are processed at the originating site.

After a transportation cask arrives at the WCS CISF, if the outer surface of the transportation cask is found to be contaminated, decontamination methods would be conducted using dry decontamination methods only resulting in the generation of Dry Active Wastes (DAW). The DAW that may be generated would consist of anti-contamination garments, rags, and associated health physics material. This solid waste would be packaged and temporarily stored in a designated radiologically controlled area until the waste is characterized and shipped to a licensed disposal facility. Section 6.1 addresses onsite waste sources.

4.4.1.1 Major Components and Operating Characteristics

The WCS CISF is designed as a "start-clean/stay-clean" facility. The spent fuel storage canisters are sealed by welding at the originating nuclear power plants to preclude any leakage of radionuclides. As a result of the "start-clean/stay-clean" operational design, incidental radioactive waste volumes generated by the WCS CISF operations are reduced to the extent practicable, in compliance with 10 CFR 72.24(f) and 10 CFR 72.128(a)(5).

4.4.1.2 Safety Considerations and Controls

Operation of receipt, transfer, and storage operations is governed by the WCS CISF radiation protection program in accordance with the requirements of 10 CFR Part 20. ALARA (as low as reasonably achievable) principles are incorporated into the radiation protection program to maintain exposure to radiation as far below the dose limits of Part 20 as is practical, consistent with the purpose for which the licensed activity is undertaken.

4.4.2 Personnel Decontamination

Under normal operation of the WCS CISF, contamination of personnel is not anticipated to occur. Any decontamination of personnel will be conducted using methods that produce only dry solid waste.

4.5 Transportation Casks and Associated Components

Transportation casks are used to transport the canisters from the originating sites to the WCS CISF. The transportation casks are designed in accordance with 10 CFR Part 71 requirements.

The transportation casks are shipped by rail to and from the WCS CISF with impact limiters, a shipping cradle, and tie downs. At the WCS CISF, the transportation cask is unloaded from the rail car inside the CHB and, depending on the Cask System, moved to the CTS where the transportation cask is opened and the canister is removed or transferred to the Storage Pad where the canister is removed. After the canister is unloaded, the transportation cask is resealed and shipped off site.

Transportation casks used at the WCS CISF are referenced in Sections 1.6.1.1 and 1.6.2.1. The additional components discussed in this section include:

- Transportation Cask repair and maintenance
- Rail Side Track
- Transportation Cask Queuing Areas
- Receiving Area
- Temporary Isolation Areas

4.5.1 Transportation Cask Repair and Maintenance Activities

If visual inspections reveal the need for repairs or maintenance, these activities will be performed either at the WCS CISF or in another appropriate location, based on the nature of the work to be performed. Radiation protection personnel will provide input and monitor these activities. Work will be performed under the NRC approved WCS CISF Quality Assurance Program Description [4-4] in accordance with written procedures that meet the transportation license requirements under 10 CFR Part 71.

If transportation cask repair or maintenance activities are necessary, the designated location for them to be conducted is in a section of the CHB as shown on Figure 1-7 or at a vendor designated location. Special contamination control measures are not required because the SNF or GTCC waste is contained within a sealed canister.

The following describes the types of repair and maintenance activities that will be performed at the CHB on the transportation casks transporting canisters to the WCS CISF. Maintenance activities are limited primarily to those needed to support routine use of transportation casks. Those maintenance activities are required in the transportation certificates, which reference Chapter 8 of the Transportation Cask SARs. The only expected radiological hazards would be from surface contamination on the outsides of the casks due to weeping from the cask surfaces that were exposed to contaminated SNF pool water. Prior to performing any maintenance activities, health physics personnel will survey the casks as required and incorporate the appropriate restrictions and controls to be observed during the planned maintenance activity.

The maintenance activities that may be carried out at the CHB include, but are not limited to:

- Leak Tests
- Fastener Inspections and Replacement
- Impact Limiter Inspections
- Seal Areas and Groove Inspections
- Trunnion Inspections
- Rupture Disk and Gasket Inspections

Any transportation cask maintenance and repair activity conducted at WCS CISF will be performed in accordance with the applicable NRC Certificate of Compliance for Radioactive Materials Packages (Part 71), and Chapter 8 of the Transportation SAR referenced in the Certificate. ISP will be a registered user for all transportation casks used at WCS CISF and perform any transportation cask maintenance and repair activity under an approved NRC Quality Assurance Program.

4.5.2 Rail Side Track

A rail side track will depart from the existing Waste Control Specialists rail loop and extend northwest into the PA and the CHB. There is sufficient rail length for 10 rail cars to be inside the PA but outside the CHB. Unloaded rail cars will exit the CHB and when all casks have been removed, the train will back up onto the Waste Control Specialists rail loop from the direction it came. Figure 1-1 shows the Waste Control Specialists Site, Existing Rail Loop, and the new WCS CISF Side Track.

4.5.3 Transportation Cask Queuing Areas

The rail side track that brings rail cars to the CHB has queuing length of approximately 1,000 feet inside of the PA. This length will accommodate five primary rail cars and five accompanying buffer cars, all within the PA. Once a rail car has been unloaded, it will be released through the east end of the CHB and outside of the PA.

In addition to the main side track, there is an additional parallel storage rail line that departs the new sidetrack to inside the PA. This line terminates near the western edge of the PA. This provides approximately 800 feet of additional track length inside the PA for rail car storage and staging. Figure 1-3 shows the main side track as well as the parallel storage rail line.

4.5.4 Receiving Area

When the transportation cask arrives at the WCS CISF, the transportation cask and cradle are visually inspected for damage prior to entry into the OCA. The receiving area is shown on Figures 1-2 and 1-3.

4.5.5 Temporary Isolation Areas

Transportation 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, ISP will isolate the rail car or move the rail car to the CHB and establish appropriate radiological controls. ISP will document the damage, notify the NRC of the condition and develop a corrective action plan. ISP will evaluate the use of movable shielding to protect personnel from radiation exposure while the damaged cask is on site.

If initial radiological surveys do not prevent further receipt inspection, ISP will move the transportation cask to the CHB. ISP will assess the safety features of the transportation cask including seal leak testing and an evacuated volume helium leak test of each canister as prudent measures to verify that the canister integrity is intact. If ISP concludes that the transportation cask is capable of performing its intended safety functions, ISP will proceed with the receipt as per established procedure.

If the assessment indicates that the transportation cask integrity is not intact, ISP will ensure the cask continues to be isolated, document the damage, notify the NRC of the condition and develop a corrective action plan. ISP will establish measures to ensure control for contamination and maintain doses ALARA.

ISP will utilize swipes and air samples that will be processed on ISP calibrated Canberra® gas flow proportional gross alpha/beta counters, ISP calibrated Perkin & Elmer® Liquid Scintillation Counters, and ISP calibrated Ortec® Gamma Spectroscopy counters or equivalent equipment. Sipping analysis will be performed on a calibrated gas chromatograph or equivalent equipment.

4.6 Cathodic Protection

There are no cathodic protection systems required or provided at the WCS CISF. Underground piping used for the water supply and septic systems consists of nonmetallic piping. Underground conduit consists of non-metallic conduit encased in concrete duct banks.

4.7 Canister Handling Operation 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 design to accommodate the systems authorized for use at the WCS CISF.

The canister handling operation systems serve to transfer the canisters from the transportation cask to the storage overpack. During transfer operations, the SNF or GTCC waste remains confined within the sealed canister at all times.

The canister handling operation systems used to handle SNF and GTCC waste canisters at the WCS CISF include the following:

- Cask Handling Building
- Overhead Bridge Cranes
- NUHOMS® Transfer System
- NAC Cask Transfer System
- Vertical Cask Transporter

The canister handling systems are designed to ensure adequate safety and to withstand the effects of site environmental conditions, natural phenomena, and accidents in accordance with 10 CFR 72.122(b) and 10 CFR 72.128(a).

10 CFR 72.122(l) requires that the storage systems be designed to allow ready retrieval of SNF for further processing or disposal. The storage systems used at the WCS CISF are designed to allow retrieval of SNF or GTCC waste canisters for further processing or disposal.

Chapter 5 addresses cask handling operations required for transportation of the canisters offsite.

Each of the canister handling systems is described in the following sections. Figures are provided to illustrate the major components of the systems and their function.

4.7.1 Cask Handling Building

Transfer of each transportation cask from the rail car to the transfer vehicle or CTS occurs inside the CHB. The CHB contains two overhead cranes capable of lifting and manipulating the transportation cask. For canisters stored in horizontal storage overpacks, the overhead bridge crane is used to transfer the transportation cask from the rail car to a transfer vehicle that will move the canister to the concrete pad. For canisters stored in VCCs, the CTS and VCT are used to transfer the canister from the transportation cask to a VCC that is then moved to the Storage Area. Figures 1-7 and 1-8 show the CHB layout and elevation section. The CHB does not provide confinement or radiation shielding other than a concrete masonry unit wall between the main building section and the office area. Section 7.5.3 describes building design criteria for protection from natural phenomena and accidents.

The CHB loading bays are used to receive and prepare for shipment of 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 CHB is equipped with a derail device to prevent inadvertent vehicular impacts. Two 130-ton overhead bridge cranes unload the NUHOMS® transportation cask from its 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 overhead bridge cranes are also used to unload the NAC transportation casks from their railcar and upright the cask. The VCT is used to place the transportation cask under the CTS. The CTS is used to transfer the canister from the NAC transportation cask to the VCC.

The CHB is a designed and fabricated steel framed structure with metal siding designed to support two overhead cranes. The CHB and overhead cranes are classified as ITS, Category B. Section 7.5.3 provides additional information about the building.

There are several doors in the building to allow access by railroad cars and transfer vehicles. Roll-up or sliding doors will be provided to minimize the potential for rain and snow that may blow into the building. No floor drains are located in the CHB to preclude the possibility of contamination entering a sanitary waste system. If there is any water collected in the building, it will be sampled to ensure no contamination is present and then pumped for discharge.

4.7.1.1 Design Specifications

The CHB structure is designed to withstand snow, rain, wind, and tornado loads. Section 7.5.3.2 describes the design specifications for the CHB.

4.7.1.2 Plans and Sections

The CHB is shown in Figures 1-7 and 1-8.

4.7.1.3 Confinement Features

The CHB is not counted on to provide confinement for SNF or GTCC waste.

4.7.1.4 Function

The CHB facilitates cask handling operations at the WCS CISF. Those operations are described in more detail in Chapter 5. The functions of the CHB include: loading and unloading transportation casks from rail cars; general weather protection for the handling operations; a location for the CTS; support structure for overhead cranes; staging area for storage overpacks; and storage and staging for other transfer and shipping equipment. The CHB is not counted on to provide shielding or confinement.

4.7.1.5 Components

The major components that comprise the CHB are two 130 ton overhead bridge cranes. Minor components include a compressed air supply system for tools as discussed in Section 4.3.3 and the CHB will have a standard commercial HVAC system in the Utility and Storage room area of the building. The larger building will not be heated or cooled. Ventilation will be commercial grade equipment and materials.

In addition to components that are part of the CHB, all or parts of the transfer systems will operate within the building. Six storage systems were evaluated for storage in the WCS CISF Storage Area. These storage systems use various cask transfer systems. These transfer systems are described in Sections 4.7.3 and 4.7.4. Table 4-1 provides a cross-reference to the applicable appendix and section for each canister/storage overpack where the individual cask transfer systems are discussed.

4.7.1.6 Design Bases and Safety Assurance

The CHB is classified as being ITS Category B. The design bases for the CHB are described in Section 7.5.3.

4.7.2 Overhead Bridge Cranes

The CHB houses two 130 ton overhead bridge cranes. These cranes are classified as ITS along with the seismic clips, runway beams, and support structures, and are designed as Type 1, Single Failure Proof cranes in accordance with NOG-1-2015 to provide defense in depth. The cranes are provided for the purpose of loading and unloading NUHOMS® transportation casks off or on the rail car and to or from the Transfer Trailer. The cranes shall include limit switches that shall be procedurally verified to be pre-set, limiting the travel (lifting height) so that they do not lift the NUHOMS® casks above their analyzed drop height. Section 7.5.3.1 and the CHB Specification for Cask Handling Overhead Bridge Crane [4-14] provide additional information on the overhead bridge cranes. The NUHOMS® casks will be lifted by the crane utilizing the WCS Lift Beam Assembly, which is referenced in Section 4.10. The NAC casks will be removed from the railcars using the applicable Special Lifting Device, which are also referenced in Section 4.10.

4.7.3 NUHOMS® Transfer 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 4.10). The transfer vehicle then moves the cask and canister out to the storage pad where the canister is transferred to the HSM. Equipment is provided for removing or attaching such items as impact limiters, personnel barriers and cask tie downs from the transportation casks. The NUHOMS® Transfer Equipment is shown in Figure 4-1 through Figure 4-3. Section 5.1.3.1.1 describes the transfer process for the NUHOMS® system.

4.7.4 NAC Cask Transfer System

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 appropriate lifting device for the cask being received is used to offload the transportation cask from the railcar. The VCT is then used to lift the the transportation cask to 3-6" off the ground and move the cask to the CTS. The NAC Special Lifting Devices are shown in drawings included in Section 4.10 and the VCT is shown in Figure 4-4.

Transfer preparations follow the placement of the transportation cask and VCCs within the CTS. 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.

There is an area inside the CHB for VCC staging for VCCs awaiting loading via the CTS. Additional staging areas are available outside the security boundaries of the WCS CISF.

The CTS 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 CTS. Additionally, a VCC is also positioned within the CTS. Both the transportation cask and VCC are each fitted with a transfer adapter. The CTS 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 CTS.

The CTS is used to transfer the canister from the transportation casks into the storage overpacks. The CTS is essentially a hydraulic gantry crane with a dedicated transfer cask. Figure 7-1 is a rendering of the CTS. Section 7.5.1 provides information on the CTS.

There are no further preparations of the storage system after loading within the CTS. Following placement of the canister into the VCC, the VCC lid is placed in accordance with the SAR and the storage overpack is ready for placement on the storage pad in the Storage Area. Section 5.1.3.1.2 describes the transfer process for the NAC System.

4.7.4.1 Vertical Cask Transporter

The VCT is the component used to lift, stabilize and move both the transportation cask and the VCC storage overpacks during loading operations at the WCS CISF. The VCT is used to to move the vertical transportation cask to/from the CTS and is also used to move the loaded VCC to/from the storage pad. Section 7.5.2 provides a description of the VCT.

4.7.4.2 Plans and Sections

The VCT is shown in Figure 4-4.

4.7.4.3 Function

The function of the cask transporter is to enable transfer of the loaded storage overpack between the CHB and the concrete storage pads.

4.7.4.4 Components

The VCT is the component used to lift, stabilize and move both the transportation cask and the VCC storage overpacks during loading operations at the WCS CISF. The VCT components are described in Section 7.5.2.

4.7.4.5 Design Bases and Safety Assurance

The VCT design bases and safety assurance is described in Section 7.5 and Section 7.5.2.

4.7.5 CISF Heavy Loads Program

4.7.5.1 Purpose

Provides administrative controls for safely handling heavy loads and is intended to be used in conjunction with approved site-specific procedures.

4.7.5.2 Definitions

A. Alternate Safe Load Path – Similar to Safe Load Path; however, determined on a case-by-case basis and not pre-designated on drawings.

B. Dedicated Rigging – Rigging that is certified and reserved for handling a specific load or loads.

C. Dynamic Loading – The loading that occurs from a force generated by acceleration or deceleration. A dynamic load results from a force applied to the load/rigging (e.g., during operation of the crane moving the load). Dynamic load is equal to static load plus the dynamic force applied to the rigging as a result of accelerating or decelerating the crane hook carrying the load (e.g., typically about 15% greater than the load weight to be lifted).

D. Dynamic Load Factor – The safety factor used to select the properly rated slings/rigging for a specific load to be lifted. Multiply the Dynamic Load Factor times the weight of the load to be rigged (i.e., static load).

E. Handling Equipment – All load bearing components used to lift a load, including the crane or hoist, the lifting device, and interfacing load lift points.

F. Heavy Load Handler – A person that has successfully completed a required WCS CISF heavy loads training program.

G. Heavy Load – A critical load carried in an area that contains spent nuclear fuel (SNF) or carried over equipment, whose uncontrolled movement or release could adversely affect safety. Any load that weighs more than the 1,700 lb. (American National Standards Institute (ANSI) N14.6 and NUREG-0612)

H. Rigging – Chain, hooks, shackles, links, wire rope, slings, eye bolts, chain blocks and other portable items. Engineering shall assign an appropriate dynamic load factor.

I. Safe Load Path – A path defined for transport of a heavy load that will minimize adverse effects, if the load is dropped, in terms of releases of radioactive material and damage equipment important to safety.

J. Single-Failure Proof – Each listed item is single-failure proof if it meets the following condition:

1. Cranes: meeting the requirements of NUREG-0554.
2. Special lifting devices: meeting the requirements of ANSI N14.6 (Section 7 Titled – "Special Lifting devices for Critical Loads").
3. Slings and rigging components: use redundant rigging or use rigging that is rated at two times the calculated combined maximum static and dynamic load capacity.

K. Single-Failure-Proof Lift - All the following conditions must exist simultaneously:

1. Cranes: meeting the requirements of NUREG-0554.
2. Special lifting devices: meeting the requirements of ANSI N14.6 (Section 7 Titled – "Special Lifting devices for Critical Loads"), OR;

3. Slings and Rigging Components: use redundant rigging or use rigging that is rated at two times the calculated combined maximum static and dynamic load capacity.

L. Special Lifting Device – A lifting device that is designed specifically for handling a certain load or loads, such as the lifting rigs for the transportation casks or transfer casks. Special lifting devices shall be used when required by Procedure or when normal rigging is not adequate. (ANSI N14.6).

4.7.5.3 Responsibilities

NOTE: The following guidelines apply to the movement of heavy loads. Actions taken should be commensurate with the projected significance of the heavy load movement and the impacts to operations and personnel if an uncontrolled load were to occur.

The roles and responsibilities for the movement of heavy loads are as follows:

A. Engineering – Generate and control Safe Load Path drawings and evaluate Alternate Safe Load Paths. Assigns dynamic load factor and performs required load drop analysis including identification of impacted equipment should load drop occur.

B. Training – Qualify heavy load handling personnel in accordance with requirements of ANSI/American Society of Mechanical Engineers (ASME) B30.2.

C. Heavy Load Handling Personnel (Supervisor, Craft and Contractors):

1. Perform heavy load handling operations and maintains, controls, and inspects heavy load equipment.

2. Identify/validate heavy loads lifts, assure heavy load lifts activities are included in planning and scheduling processes to ensure risk is evaluated and properly communicated.

3. Request assistance from Engineering as necessary.

4. Follow all invoked Heavy Load Lift procedures.

D. Operations:

1. Radiation Safety Officer (RSO)/Director of Health and Radiation Safety – Certify the medical qualifications of lift support personnel in accordance with ANSI/ASME B30.2.

2. Obtain Director of Operations/Construction or designee approval prior to the lift if required.

4.7.5.4 Main Body

A. Personnel Qualification and Certification

1. Crane Operators shall successfully complete a medical evaluation ordered by RSO/Director of Health and Radiation Safety.
   a) Crane Operators whose medical certification is not current shall not operate heavy load handling equipment until re-certification is completed.
   b) Physical restrictions issued by RSO/Director of Health and Radiation Safety, such as the need to wear corrective lenses shall be strictly adhered to and is the responsibility of the crane operator to ensure compliance.
   c) RSO/Director of Health and Radiation Safety shall maintain records of crane operator medical qualifications for the period of qualification.
   d) The medical status of each crane operator shall be maintained electronically or by hard copy.

2. Crane operators shall attend and successfully complete Crane Operator Training.
   a) The training status of each crane operator shall be maintained electronically or by hard copy.

3. Heavy Load Handling Personnel other than crane operators shall attend and successfully complete a Nuclear Training program that contains the job performance measures for heavy load handling.

4. The training status of each qualified person(s) shall be maintained electronically or by hard copy.

B. Handling Equipment Certification

1. Heavy load handling equipment should be identified with unique identification.
   a) Identification for permanent and portable heavy load handling equipment shall be controlled and issued by designated personnel.
   b) Identification shall be traceable to the equipment's Certificate of Test, including other information relevant to certification.
   c) A "Certificate of Test" shall be available and traceable to each piece of heavy load handling equipment and rigging to verify compliance with applicable ANSI/ASME standards.
   d) Heavy load handling equipment shall be certified in accordance with applicable ANSI/ASME standard as listed on Table 4-3.
   e) Special lifting devices shall be certified in accordance with ANSI N14.6 or alternate inspection and load test criteria approved by Engineering.
   f) Completion of a Load Test Procedure may be used in lieu of a Certificate of Test for portable or manually operated heavy load handling equipment and rigging.
   g) Designated personnel shall be responsible for control and certification of rigging and special lifting devices.

2. Certificates of Test (or Alternate Test Procedures) shall be maintained. For all configurations, lifting devices that are not specially designed should be installed and used in accordance with ANSI B30.9. In selecting the proper sling, the load should be the sum of the static and maximum dynamic load. The rating on the sling should be determined according to the "static load" that produces the maximum static and dynamic load.

   For the purpose of selecting the proper sling, loads imposed by the design basis earthquake (DBE) need not be included in the dynamic loads imposed on the sling or lifting device.

3. Use a "Dynamic Load Factor" of 1.15 times the load to be lifted (i.e., static load rating) when selecting rigging (e.g., wire/synthetic/nylon slings) unless another value is specified by Engineering.

4. Verification status of heavy load handling equipment inspection(s) shall be made before each use.

5. Heavy loads handling operations where no load drop analysis has been performed, but are bounded by an existing load drop analysis, require the same accident mitigators as the analyzed load drop (i.e., maintaining height restrictions).

C. Handling Equipment Inspection

1. Inspections of heavy load handling equipment shall be controlled by designated personnel and performed in accordance with approved procedures.

2. Special lifting devices shall be controlled per applicable site documents in accordance with ANSI N14.6.

   NOTE: If the device has not been used for a period exceeding one year and there is no intention to place it into service in the foreseeable future, this testing shall not be required. However, in this event the testing shall be applied before returning the device to service.

3. Each special lifting device shall be subjected annually (i.e., period not to exceed 14 months) to either of the following:
   a) A test load equal to 150% of the maximum service load. After sustaining the test load for a period of not less than 10 minutes, critical areas, including major load bearing welds, shall be subjected to visual inspection for defects and all components shall be inspected for permanent deformation.
   b) In the case where surface cleanliness and conditions permit, the load testing may be omitted and dimensional testing, visual inspection and non-destructive testing of major load carrying welds and critical areas shall suffice as an alternate to 3.a).

4. Inspection frequency for heavy load handling equipment shall be performed in accordance with applicable approved site-specific procedures.

5. Pre-Operational Inspections of slings, rigging, and hooks performed in accordance with approved procedures shall satisfy periodic inspection requirements. A schedule for inspections of heavy load handling equipment including rigging and special lifting device shall be maintained to ensure timeliness of inspection.

6. Inspection records shall be maintained electronically or by hard copy.

D. Handling Equipment Maintenance

1. Maintenance to heavy load handling equipment shall be performed by designated personnel or approved service vendor.

2. Permanent heavy load handling equipment shall be maintained in accordance with the applicable ANSI/ASME standard.

3. Load bearing components of heavy load handling equipment that has been extensively repaired, repaired by welding, or otherwise modified shall be re-certified before being placed into service in accordance with applicable ANSI/ASME criteria.

4. Test criteria used for re-certification shall be the same criteria used for the original certification unless otherwise stated by Engineering (Table 4-3).

5. Non-permanent heavy load handling equipment shall be stored in areas to protect it from damage or adverse environments.

E. Safe Loads Path

1. Safe Load Paths shall be established to designate avenues for movement of heavy loads by handling equipment to minimize the potential for those heavy loads if dropped, to impact SNF or to impact equipment important to safety.
   a) Safe Load Paths shall be developed in accordance with NUREG-0612.

2. Safe Load Paths shall be identified by drawings or other approved drawings or methods and available for general facility use.
   a) Safe Load Path drawings shall be approved by Engineering.
   b) Safe Load Path drawings shall be controlled in accordance with approved procedures.

3. In situations where a Safe Load Path does not exist, cannot be followed, or the transient load will depart from the Safe Load Path, an Alternate Safe Load Path shall be established.
   a) Alternate Safe Load Paths shall be determined in accordance with NUREG-0612, Section 5.1.1.

b) Alternate Safe Load Paths shall be evaluated and approved by Engineering before use.
c) Heavy load handling operations requiring deviation from Alternate Safe Load Paths shall:
   (1) Utilize Single-Failure-Proof rigging, or;
   (2) Have a load drop analysis performed, or;
d) Heavy load handling operations shall meet the requirements of this procedure and be performed in accordance with existing approved load handling procedures if applicable.
e) Heavy load handling operations shall be performed by qualified crane operators and qualified persons assigned by the responsible Supervisor.
f) Operators of heavy load handling equipment shall be familiar with the procedures, height and weight restrictions, and Safe Load Path applicable to the handling operations.
g) Heavy load handling operations shall be conducted in accordance with the height and weight restrictions at the lowest practicable lift height as defined in approved procedures.
h) Heavy load handling operations requiring deviation from height and weight restrictions shall be approved by Engineering.
i) Heavy load rigging used shall be rated based on the combined maximum static and dynamic load of the item to be lifted.

F. Material Properties

1. Per Section 2.4 of NUREG-0554, structural steel shapes and plate rolled from carbon steel may have brittle-fracture tendencies when exposed to lower operating temperatures. For lower operating temperatures, toughness tests of the base metals may be necessary.

2. Per Section 4 of ANSI N14.6, material identification, qualification and control and fabrication practices shall be documented. Brittle-fracture of ferritic load-bearing members shall be drop-weight or Charpy tested per Section 4.2.6.

4.7.5.5 Documentation

The following documents shall be maintained as quality records electronically or by a hard copy for the retention period identified by the Quality Program and Implementing Procedures.

A. Certificates of Load Testing

B. Handling equipment operational test and inspection records

C. Maintenance records

D. Crane operator qualification records

E. Crane operator medical evaluations

4.7.5.6 Standards

A. ANSI/ASME B30.2, “Overhead and Gantry Cranes”

B. ANSI/ASME B30.5, “Mobile and Locomotive Cranes”

C. ANSI/ASME B30.9, “Slings”

D. ANSI/ASME B30.10, “Hook”

E. ANSI/ASME B30.16, “Overhead Hoists”

F. ANSI/ASME B30.20, “Below-the-Hook Lifting Devices”

G. ANSI N14.6; “Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 pound or more for Nuclear Materials”

H. NUREG-0554, “Single Failure Proof Cranes for Nuclear Power Plants”

I. NUREG-0612; “Control of Heavy Loads at Nuclear Power Plants”

4.8 Physical Protection

4.8.1 Introduction

ISP will use multiple technologies, physical barriers, and an armed security force to protect ISP personnel. All safeguard information associated with SNF and GTCC waste inventory, security, and transportation will be protected inside the WCS CISF PA. The WCS CISF is subject to the requirements in the Physical Security Plan for the site.

4.8.2 Security System Functions

ISP will have multiple security technologies controlling access, assisting with personnel identification, intrusion detection, alarm assessment, and threat delay. These systems will employ line monitoring, redundant power, and networking. All systems will feed into a user station. A backup user station will be available in the event the primary station is not available.

4.8.3 Physical Protection Plan Components

The Physical Security Plan will include the general security posture, an overview of the security features, guard force requirements, responses to alarms, and other security functions.

4.8.3.1 General Performance Objectives

The general performance objectives of security are to detect, assess and respond to alarms, prevent introduction of prohibited items, and control access to the PA.

4.8.3.2 Security Organization

The security organization will consist of security officers, an assistant officer-in-charge and/or an officer-in-charge on each shift. All uniformed security officers, assistant supervisors, and supervisors will report to a security manager assigned to the WCS CISF. The Facility Security Officer will have responsibility over all WCS CISF security personnel, programs and systems.

4.8.3.3 Physical Barrier System

The WCS CISF will use a fence posted with signage at the OCA boundary, a nuisance fence just outside of the PA fence and the PA fence inside of the nuisance fence.

4.8.3.4 Access Control Subsystems and Procedures

ISP will control unescorted access to the WCS CISF. Only individuals meeting the unescorted access requirements pursuant to 10 CFR Part 73 will be given this access type. The WCS CISF will use dual authentication identity verification before unescorted access is granted at the WCS CISF. Procedures will define the WCS CISF clearance practices and security practices for ensuring that only individuals approved for unescorted access are able to gain unescorted access to the WCS CISF.

4.8.3.5 Detection, Surveillance and Alarm Subsystems

The WCS CISF will use outward looking cameras and lighting for early detection and assessment of potential intruders and additional cameras to view the PA to assess areas of alarm from the intrusion detection systems. Alarms will communicate to alarm stations where posted security force employees will receive alarm signals.

4.8.3.6 Communication Subsystems

ISP will use wired and wireless communication devices to communicate between stationary posts, mobile posts and off-site resources.

4.8.3.7 Test and Maintenance Program

The WCS CISF will contract technology and equipment maintenance. Security will follow developed security procedures for equipment and alarm testing.

4.8.3.8 Contingency Response Plans and Procedures

The WCS CISF will work to operational procedures and a contingency plan addressing required actions for events including but not limited to intrusion, equipment failure, and natural disasters.

4.9 References

4-1 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.

4-2 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.

4-3 SNM-2515 Technical Specifications (See [Gen-1]).

4-4 "TN Americas LLC Quality Assurance Program Description Manual for 10 CFR Part 71, Subpart H and 10 CFR Part 72, Subpart G," current revision.

4-5 Title 10, Code of Federal Regulations, Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste."

4-6 IEEE 692, 2013, Institute of Electrical and Electronics Engineers, "Criteria for Security Systems for Nuclear Power Generating Stations".)

4-7 NFPA 70, 2016, National Fire Protection Association, "National Electric Code"

4-8 IBC, 2009, International Building Code.

4-9 NFPA 101, 2015, National Fire Protection Association, "Life Safety Code."

4-10 Not Used.

4-11 Drawing NAC004-C-002, Rev. 0, "ISFSI Pad Licensing Design Structural Concrete Plan, Sections, and Details."

4-12 NFPA 25. 2014, National Fire Protection Association, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

4-13 NRC Information Notice No. 85-46, "Clarification of Several Aspects of Removable Surface Contamination Limits for Transport Packages," dated June 10, 1985.

4-14 AECOM Specification SPEC-15-1001, "Cask Handling Building (CHB) Specification for Cask Handling Overhead Bridge Crane," Revision A.

Table 4-1
Operating Systems Associated with the Storage Systems at the WCS CISF

Cask System	Canister	Overpack	Appendix
NUHOMS®-MP187 Cask System	FO-DSC	HSM (Model 80)	Appendix A.4 (Drawings are listed in Section A.4.6)
	FC-DSC		
	FF-DSC		
	GTCC Canister		
Standardized Advanced NUHOMS® System	NUHOMS® 24PT1	AHSM	Appendix B.4 (Drawings are listed in Section B.4.6)
Standardized NUHOMS® System	NUHOMS® 61BT	HSM Model 102	Appendix C.4 (Drawings are listed in Section C.4.6)
	NUHOMS® 61BTH Type 1		Appendix D.4 (Drawings are listed in Section D.4.6)
NAC-MPC	Yankee Class	VCC	Appendix E.4 (Drawings are listed in Section E.4.4)
	Connecticut Yankee		
	LACBWR		
	GTCC-Canister-CY		
	GTCC-Canister-YR		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.4 (Drawings are listed in Section F.4.3)
	GTCC-Canister-MY		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.4 (Drawings are listed in Section G.4.3)
	GTCC-Canister-ZN		

Table 4-2
WCS CISF Compliance with General Design Criteria
(10 CFR 72, Subpart F)
(6 Sheets)

10 CFR 72 Requirement	Requirement Summary	SAR Section Where Compliance Is Demonstrated
72.122(a) Quality standards	Structures, systems, and components Important to Safety must be designed, fabricated, erected, and tested to quality standards commensurate with the importance to safety of the function to be performed.	• Section 3.4 provides the QA classifications for SSCs Important to Safety. • Chapter 4 describes the design of SSCs Important to Safety. • Section 13.2 describes the Preoperational Test Plan. • TN Americas Quality Assurance Program Description Manual (QAPDM) docket 71-0250 describes the QA procedures requirements and shows that the QA Program is in accordance with 10 CFR 72.140.
72.122(b) Protection against environmental conditions and natural phenomena	Structures, systems, and components Important to Safety must be designed to accommodate the effects of, and to be compatible with, site characteristics and environmental conditions and to withstand postulated accidents.	• Sections 3.2 and 3.2.3 provide requirements for environmental and site design criteria for SSCs Important to Safety. • Sections 4.2 and 4.7 describe the design to mitigate environmental effects. • Chapter 12 demonstrates the capability of SSCs Important to Safety to withstand postulated accidents.
72.122(c) Protection against fires and explosions	Structures, systems, and components Important to Safety must be designed and located so that they can continue to perform their safety functions under credible fire and explosion exposure conditions.	• Section 3.3.6 provides fire and explosion protection requirements. • Sections 4.3.8 and 7.5.3 describe the design that provides fire and explosion protection. • Sections 4.3.8 and Tables A.3-1, B.3-1, C.3-1, D.3-1, E.3-1, F.3-1 and G.3-1 show the capability of SSCs ITS to withstand postulated fire and explosion accidents.
72.122(d) Sharing of structures, systems, and components	Structures, systems, and components Important to Safety must not be shared between the WCS CISF and other facilities unless it is shown that such sharing will not impair the capability of either facility to perform its safety functions.	• Section 4.1.2 verifies that the WCS CISF does not share SSCs ITS with other facilities.

Table 4-2
WCS CISF Compliance with General Design Criteria
(10 CFR 72, Subpart F)
(6 Sheets)

10 CFR 72 Requirement	Requirement Summary	SAR Section Where Compliance Is Demonstrated
72.122(e) Proximity of sites	An ISFSI located near other nuclear facilities must be designed and operated to ensure that the cumulative effects of their combined operations will not constitute an unreasonable risk to the health and safety of the public.	• Section 9.4.3.3 evaluates the radiological impacts attributable to Waste Control Specialists's present operations, those from the National Enrichment Facility, and radiation doses estimated for storing up to 40,000 MTHM of SNF at the CISF.
72.122(f) Testing and maintenance of systems and components	Systems and components that are Important to Safety must be designed to permit inspection, maintenance, and testing.	• Section 4.3.9 describes the capability of SSC's to permit inspection, maintenance, and testing.
72.122(g) Emergency capability	Structures, systems, and components Important to Safety must be designed for emergencies. The design must provide for accessibility to the equipment of onsite and available offsite emergency facilities and services.	• Section 4.1.2 specifies that the WCS CISF is designed for accessibility. • Section 13.5 summarizes the Emergency Plan for the WCS CISF.

Table 4-2
WCS CISF Compliance with General Design Criteria
(10 CFR 72, Subpart F)
(6 Sheets)

10 CFR 72 Requirement	Requirement Summary	SAR Section Where Compliance Is Demonstrated
72.122(h) Confinement barriers and systems	The spent fuel cladding must be protected during storage against degradation that leads to gross ruptures or the fuel must be otherwise confined. Ventilation systems must be provided to ensure the confinement of airborne radioactive particulate materials during normal or off-normal conditions. Storage confinement systems must have the capability for continuous monitoring to maintain safe storage conditions.	• Chapter 11 provides the requirements to ensure confinement of the spent fuel. • Section 11.1 describes the confinement design features. • Chapter 12 (accident analysis) shows that there is no loss of confinement during an accident. • Section 11.5 shows that the fuel cladding is protected. • Section 9.3.5 describes the area radiation and airborne radioactivity monitoring system.
72.122(i) Instrumentation and control systems	Instrumentation and control systems must be provided to monitor systems that are Important to Safety over anticipated ranges for normal operation and off-normal operation.	• Section 5.4 provides the requirements to monitor systems Important to Safety. • Section 5.4.1 describes the instrumentation and control systems.
72.122(j) Control room or control area	A control room or control area, if appropriate, must be designed to permit occupancy and actions to be taken to monitor the WCS CISF safely under normal conditions, and to provide safe control of the WCS CISF under off-normal or accident conditions.	• Sections 4.3.15 and 5.5 show that a control room/area is not required. • Section 4.3.17 describes the operational systems that ensure safe conditions during cask storage and canister transfer. • Chapter 5 defines the operational controls and limits to be used for the WCS CISF.

Table 4-2
WCS CISF Compliance with General Design Criteria
(10 CFR 72, Subpart F)
(6 Sheets)

10 CFR 72 Requirement	**Requirement Summary**	**SAR Section Where Compliance Is Demonstrated**
72.122(k) Utility or other services	Each utility service system must be designed to meet emergency conditions. The design of utility services and distribution systems that are Important to Safety must include redundant systems to the extent necessary to maintain, with adequate capacity, the ability to perform safety functions assuming a single failure.	• Section 4.1.2.3 and 4.3 verify that the WCS CISF does not rely on utility systems to ensure the safe operation of the facility.
72.122(l) Retrievability	Storage systems must be designed to allow ready retrieval of spent fuel and reactor-related GTCC waste for further processing or disposal.	• Section 4.7 explains that the WCS CISF provides the retrievability capability.
72.124(a) Design for criticality safety	Spent fuel handling, packaging, transfer, and storage systems must be designed to be maintained subcritical.	• Section 3.3.4 and Chapter 10 provides the requirements to ensure subcriticality is maintained. • Section 10.1 describes the criticality safety design.
72.124(b) Methods of criticality control	When practicable, the design of an ISFSI must be based on favorable geometry; permanently fixed neutron absorbing materials (poisons), or both.	• Chapter 10 provides the requirements for the means of subcriticality control and describes the components that maintain subcritical conditions.
72.124(c) Criticality monitoring	A criticality monitoring system shall be maintained in each area where special nuclear material is handled, used, or stored which will energize clearly audible alarm signals if accidental criticality occurs.	• Section 10.1.2 describes why criticality monitoring is not applicable for dry storage systems where the spent fuel is packaged in its stored configuration.

Table 4-2
WCS CISF Compliance with General Design Criteria
(10 CFR 72, Subpart F)
(6 Sheets)

10 CFR 72 Requirement	Requirement Summary	SAR Section Where Compliance Is Demonstrated
72.126(a) Exposure control	Radiation protection systems must be provided for all areas and operations where onsite personnel may be exposed to radiation or airborne radioactive materials.	• Section 3.3.5 provides the radiological protection design criteria. • Section 9.3 describes the components that provide shielding for exposure control. • Sections 9.1 describes the program features for ensuring that occupational exposures are ALARA.
72.126(b) Radiological alarm systems	Radiological alarm systems must be provided in accessible work areas as appropriate to warn operating personnel of radiation and airborne radioactive material concentrations above a given setpoint and of concentrations of radioactive material in effluents above control limits.	• Section 11.2 concludes that no confinement monitoring is required for any of the canisters stored at the WCS CISF because all canisters include welded closures. • Section 9.5 describes the radiation protection program during operations including radiological monitoring.
72.126(c) Effluent and direct radiation monitoring	As appropriate for the handling and storage system, a means to measure effluents must be provided. Areas containing radioactive materials must be provided with systems for measuring the direct radiation levels in and around these areas.	• Operation of the WCS CISF is not expected to result in radioactive contamination of any effluents (Chapter 6). • Section 9.5 describes the radiation protection program during operations including radiological monitoring.
72.126(d) Effluent control	The ISFSI must be designed to provide means to limit to ALARA levels the release of radioactive materials in effluents during normal operations; and control the release of radioactive materials under accident conditions.	• Section 6.5 describes why effluent control is not applicable at the WCS CISF and demonstrates that the dose limits specified in 72.104 are met.

Table 4-2
WCS CISF Compliance with General Design Criteria
(10 CFR 72, Subpart F)
(6 Sheets)

10 CFR 72 Requirement	Requirement Summary	SAR Section Where Compliance Is Demonstrated
72.128(a) Spent fuel storage and handling systems	Spent fuel storage, reactor-related GTCC waste storage and other systems that might contain or handle radioactive materials associated with spent fuel or reactor-related GTCC waste, must be designed to ensure adequate safety under normal and accident conditions.	• Chapters 8, 9, and 11 describe the design features of the storage and handling systems to provide adequate shielding, confinement, and heat removal capability.
72.128(b) Waste treatment	Radioactive waste treatment facilities must be provided.	• Chapter 6 addresses the generation and treatment of radioactive wastes.
72.130 Criteria for decommissioning	The ISFSI must be designed for decommissioning.	• Section 13.6 provides the requirements for decommissioning the site. • Section 13.6.3 describes the design considerations to facilitate decommissioning. • The Decommissioning Plan (License Application, Appendix B) presents an overall description of the decommissioning requirements.

Table 4-3
Heavy Load Handling Equipment Certification and Inspection

HANDLING EQUIPMENT TYPE	ANSI/ASME STANDARD
Overhead Cranes	B30.2
Mobile Cranes	B30.5
Slings and Rigging	B30.9
Hooks	B30.10
Overhead Hoists	B30.16
Below-the-Hook Lifting Devices	B30.20
Special Lifting Devices	N14.6
Vertical Cask Transporter (VCT)	B30.1 NOG-1 N14.6
Canister Transfer System (CTS)	B30.1 B30.10 NOG-1 N14.6 NUM-1

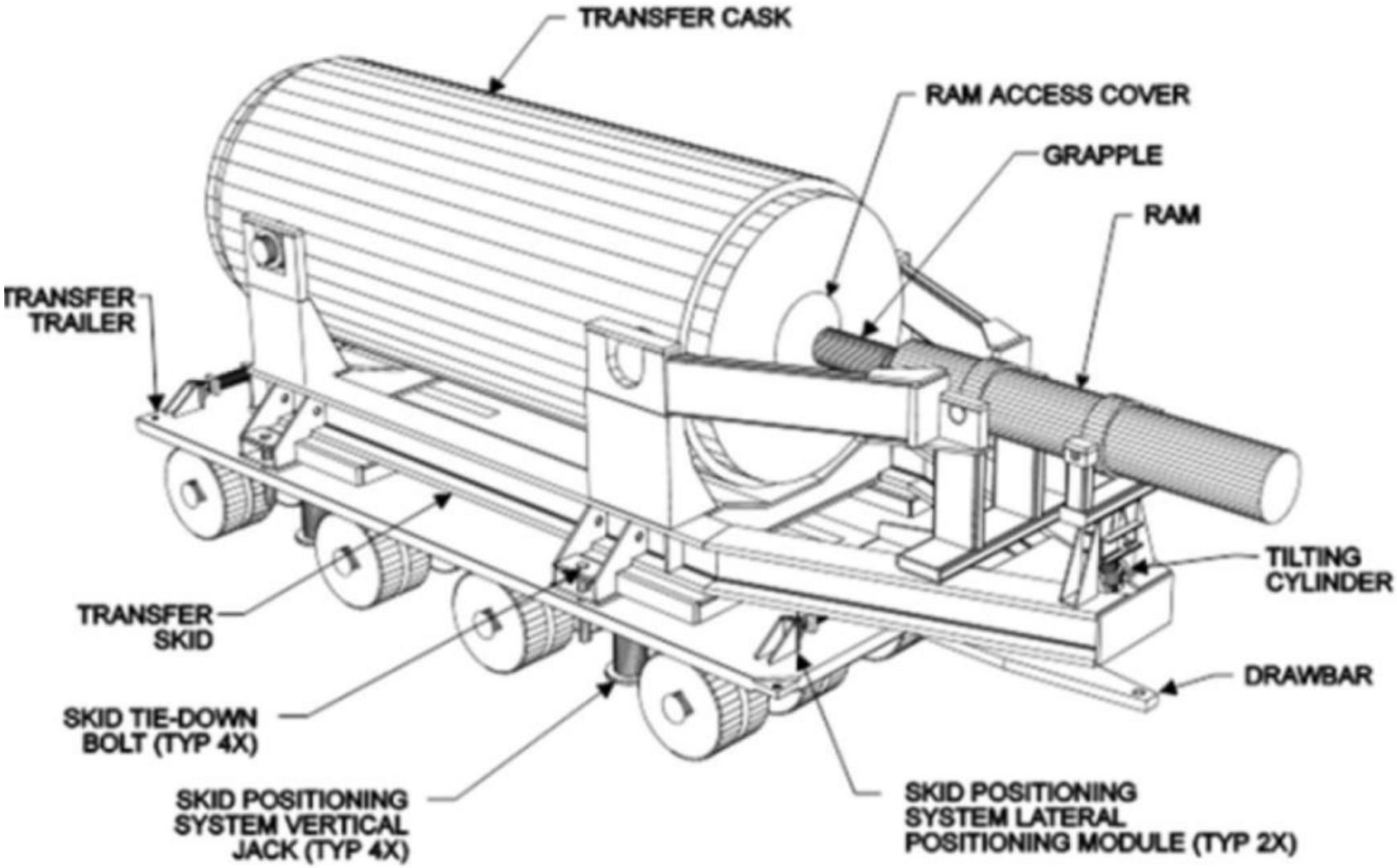

Figure 4-1
NUHOMS® Transfer System

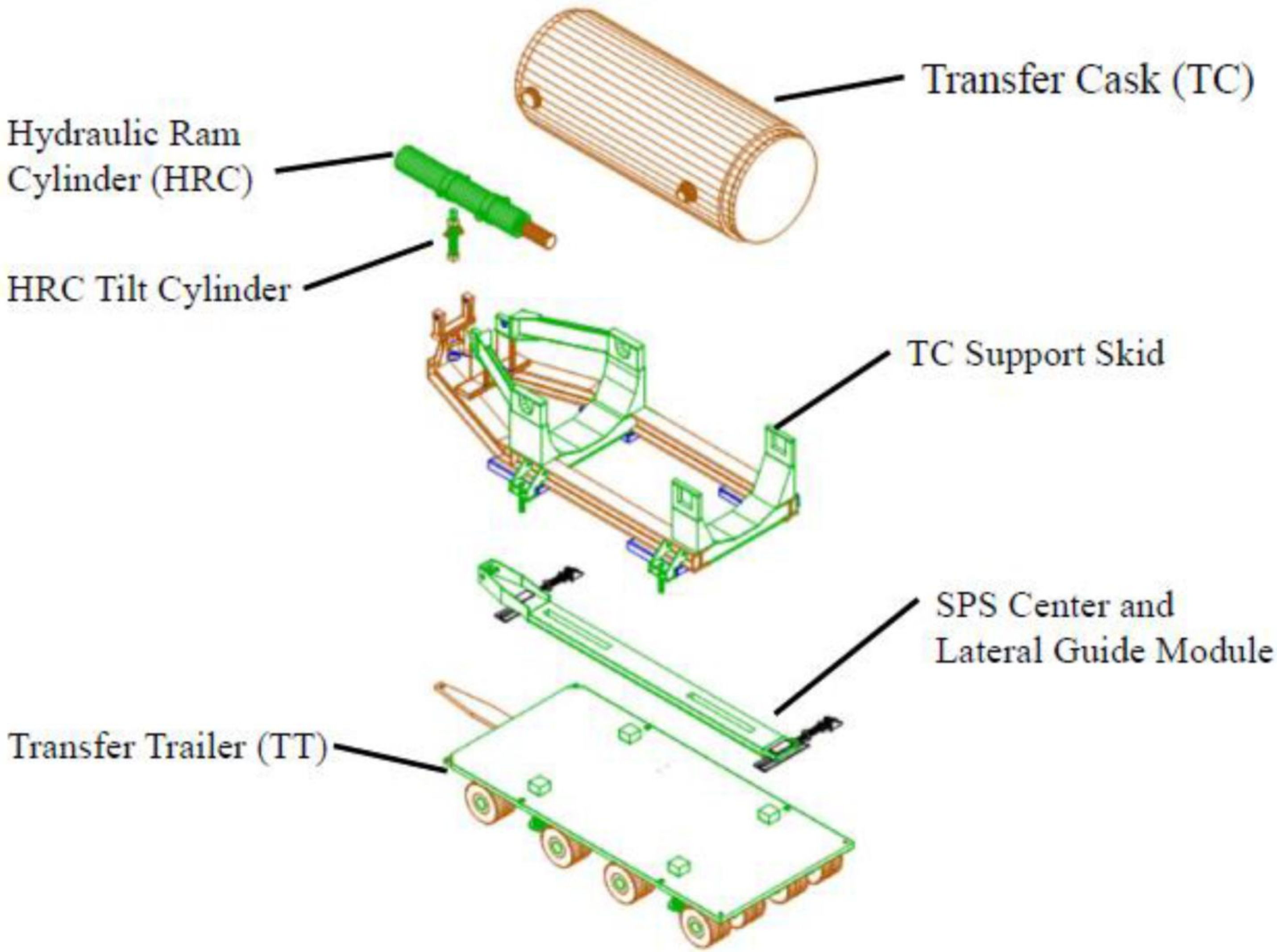

Figure 4-2
Exploded View of Transfer Components

Figure 4-3
Assembled Transfer Trailer

Proprietary Information on This Page
Withheld Pursuant to 10 CFR 2.390

4.10 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).

2. "Lift Yoke, Transport Cask, NAC-STC," 30039-L024, Revision 0 (Included at the end of this Section).

3. "Lift Yoke, Transport Cask, NAC-UMS™," 30039-L022, Revision 0 (Included at the end of this Section).

4. "Lift Yoke, Transport Cask, MAGNATRAN," 30039-L023, Revision 0 (Included at the end of this Section).

8 7 6 5 4 3 2 1

H G F E D C B A

Proprietary and Security Related Information for Drawing WCS01-2100, Rev. 0 Withheld Pursuant to 10 CFR 2.390

8 7 6 5 4 3 2 1

H G F E D C B A

Proprietary and Security Related Information for Drawing 30039-L024, Rev. 0 Withheld Pursuant to 10 CFR 2.390

8 7 6 5 4 3 2 1

H G F E D C B A

Proprietary and Security Related Information
for Drawing 30039-L022, Rev. 0
Withheld Pursuant to 10 CFR 2.390

8 7 6 5 4 3 2 1

H G F E D C B A

Proprietary and Security Related Information
for Drawing 30039-L023, Rev. 0
Withheld Pursuant to 10 CFR 2.390

8 7 6 5 4 3 2 1

H G F E D C B A

CHAPTER 5
OPERATION SYSTEMS & PROCEDURES

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5. OPERATION SYSTEMS & PROCEDURES

5.1 Operation Description

This chapter addresses operations at the Interim Storage Partners' (ISP's) WCS Consolidated Interim Storage Facility (WCS CISF) using the NUHOMS® and vertical storage systems described in Section 1.2.4.1.

Those operations for the storage of canisterized spent fuel and Greater Than Class C (GTCC) waste at the WCS CISF are performed at the originating site and at the WCS CISF itself. Canister loading and storage operations at the originating site are performed in accordance with the originating site owner's 10 CFR Part 50 or Part 72 license. Transport of the canisterized spent fuel and the GTCC waste from the originating site to the WCS CISF is performed under 10 CFR Part 71 and 49 CFR Parts 171, 172, 173, and 174.

The casks used to transport canisterized spent fuel and GTCC waste to the WCS CISF are the NUHOMS®-MP187 and -MP197HB casks, the NAC-STC and UMS casks and the MAGNATRAN cask. Storage of the canisterized spent fuel and GTCC waste at the WCS CISF follows the requirements of the WCS CISF license issued under 10 CFR Part 72.

The operations at the WCS CISF include: receiving and inspecting transportation casks with canisters containing spent fuel or GTCC waste; transferring canisters to storage overpacks; placing storage overpacks on the CISF storage pads; surveillance of the storage overpacks; security; health physics; maintenance; and removal of canisters from the CISF.

ISP will work according to detailed procedures for the activities described above for the WCS CISF storage systems. The detailed procedures will be developed as described in Chapter 13 and will integrate appropriate information from the Technical Specifications [5-1]. These procedures will ensure that the spent fuel and GTCC waste storage operations described above are completed in accordance with the WCS CISF Safety Analysis Report (SAR).

5.1.1 Operations at Originating Site

A canister will be removed from the storage overpack at the originating site and transferred to an authorized transportation cask. This process is done under the site's 10 CFR Part 50 or Part 72 license, as applicable, and related procedures.

As described in Section 1.2.4.2, ISP will verify that canisters shipped to the WCS CISF comply with the terms, conditions of use, and the technical specifications of one of the six storage systems listed in Section 1.2.4.1.

5.1.2 Operations Between the Originating Sites and the WCS CISF

Transportation casks containing the canisterized spent fuel or GTCC waste are shipped by rail to the WCS CISF. The WCS CISF is located approximately 5 miles east of the Texas New Mexico (TNMR) rail mainline. ISP joint venture member Waste Control Specialists owns the rail spur from the mainline to the WCS CISF boundary. Transportation is performed under 10 CFR Part 71 and 49 CFR Parts 171, 172, 173, and 174.

5.1.3 Operations at the WCS CISF

Section 1.2.4.1 lists the canisters and storage system configurations authorized for storage at the WCS CISF. Table 5-1 provides the cross reference to the applicable appendix and section for each canister/storage overpack where the system specific operating procedures are presented.

The following subsections provide a high-level narrative for receiving and dispatching the canisterized spent fuel or GTCC waste in the authorized transportation casks at the WCS CISF and an overview of operations for the NUHOMS® and NAC systems.

5.1.3.1 Receiving and Dispatch Operations for All Cask/Canister Systems

Receipt operations involve site receipt systems and the Cask Handling Building cask off-loading and loading systems.

In addition, the receipt inspection of the canisters upon arrival at the WCS CISF will be in accordance with the procedures in Sections A.5.1.1, B.5.1.1, C.5.1.1, D.5.1.1, E.5.1.4, E.5.2.4, F.5.1.4, G.5.1.4 and reference [5-2]. Post-transportation verification will invoke visual inspections of the two most limiting canisters from each reactor site and an evacuated volume helium leak test of each canister as prudent measures to confirm that a canister remains able to perform its safety function and is, therefore, acceptable for storage at the WCS CISF. As described in reference [5-2], the helium leak test will be performed by flushing the cavity between the transportation cask and the canister and then evacuating the space and sampling the space for helium coming from the canister. The helium leak test procedures used to perform the post-transportation evacuated volume helium leak tests shall be approved by an ASNT NDT Level III examiner prior to use.

The rail cars are picked up at the Waste Control Specialists spur using the Waste Control Specialists-owned locomotive. The loaded transportation casks are delivered to the WCS CISF. Bills of lading, manifests and other shipping papers are inspected and a security inspection and radiation survey of the incoming transportation casks are performed. The casks are moved to the Cask Handling Building for transfer and storage preparation. Once access is obtained to the transportation cask test ports for the cask cavity, a helium leak test will be performed to verify the integrity of the canister inside the cask in accordance with the requirements of reference [5-2]. The visual inspection of the two limiting canisters from each site will take place during the transfer of the canister to the storage overpack. The identification of the canisters subject to the visual inspections, and the requirements for the inspections are identified in Reference [5-2].

Receipt of the loaded transportation casks takes place in the Cask Handling Building.

Dispatch of empty or loaded transportation casks also takes place from the Cask Handling Building. Dispatch of empty transportation casks occurs after spent fuel or GTCC waste canisters are received, transferred and placed into storage. After the empty or loaded transportation casks are ready for shipment in the Cask Handling Building, shipping paperwork is prepared and the casks are dispatched off-site.

5.1.3.1.1 NUHOMS® Systems

The NUHOMS® system includes a NUHOMS® transportation/transfer cask and a Horizontal Storage Module (HSM) along with the associated transfer equipment. The NUHOMS® transportation/transfer casks are metal, cylindrical multi-wall transportation casks that contain a welded canister. The casks are designed and qualified for both transportation and storage (transfer) operations.

For storage (transfer) operations, the NUHOMS® cask in the transportation configuration (containing welded canisters) is received at the site and taken to the Cask Handling Building. The cask is radiologically surveyed, the cask cavity is vented and leak tested, and the cask is decontaminated (if required). The cask is placed in its transfer configuration to prepare for transfer operations. This includes removing the impact limiters and lifting it (horizontal lift) off the rail car and placing it on the transfer vehicle with one of the 130-ton overhead bridge cranes. All lifts of the loaded cask, regardless of configuration (transportation or transfer) are maintained below 80 inches.

The transfer vehicle moves the cask to the Storage Area, where operators prepare for field transfer of the canister into an HSM. The cask is moved to within a few feet of the HSM, positioned and approximately aligned and the top cover plate is removed. The transfer vehicle is backed to the HSM and docked. The cask is final aligned with the HSM, and a hydraulic ram system is extended and engaged to push the canister into the HSM.

The hydraulic ram system is disengaged and removed, and the empty cask is retracted and moved clear. The HSM door is installed using a portable yard crane. The top cover plate of the empty cask is reinstalled. The empty cask is moved to the Cask Handling Building and prepared for dispatch.

For retrieval operations, the NUHOMS® cask is received at the site and taken to the Cask Handling Building. The cask is radiologically surveyed, the impact limiters are removed, the cask cavity is vented and tested, and the cask is decontaminated (if required). The cask is then converted to the transfer configuration and lifted and placed horizontally on the transfer vehicle by one of the overhead bridge cranes. The transfer vehicle takes the cask to the Storage Area, where operators prepare for field transfer of the canister from the HSM to the cask. The cask is moved to within a few feet of the HSM and approximately aligned, and the top cover plate is removed. The transfer vehicle is backed to the HSM and the cask is docked. The cask is final aligned to the HSM and the hydraulic ram system is extended and engaged to pull the canister from inside the HSM into the cask.

The hydraulic ram system is then disengaged and moved. The cask is retracted and moved clear, the cask's top cover plate is reinstalled, and the cask is transported to the Cask Handling Building to be prepared for dispatch. The cask is horizontally lifted from the transfer vehicle by an overhead bridge crane and positioned over the rail car in the Cask Handling Building shipping/receiving area by the overhead bridge crane, lowered, secured and prepared for dispatch (placed in transportation configuration), including radiological surveys and decontamination (if required).

5.1.3.1.2 NAC Systems

The NAC systems include the NAC transportation casks, Vertical Cask Transporter (VCT), Canister Transfer System (CTS) and the Vertical Concrete Cask (VCC) storage overpack. The NAC transportation casks are a metal, cylindrical multi-wall transportation cask that contains a welded canister. At the Cask Handling Building, the NAC transportation cask is received, radiologically surveyed and decontaminated (if required), the impact limiters are removed, the cask is upended and removed from the railcar using the CHB overhead crane and approved Special Lifting Device. The VCT is used to lift the transportation cask between 3 and 6 inches off the ground and place the cask under the CTS. Drawings for the approved Special Lifting Devices for each transportation cask are included in Section 4.10. The canister is then removed vertically from the transportation cask and placed into the VCC via the appropriate transfer cask which is part of the CTS. Once the lid is installed on the VCC, the VCT is used to move the VCC to the Storage Area where it is placed on the appropriate storage pad.

For retrieval operations, the VCT retrieves the VCC, and moves it to the Cask Handling Building and places it under the CTS. The NAC transportation cask is received and radiologically surveyed and decontaminated (if required) and placed under the CTS using the VCT. The canister is then removed vertically from the storage overpack and placed into the transportation cask via appropriate transfer cask with the CTS. The transportation cask is then down ended onto the transporter with the CHB overhead crane and approved Special Lifting Device, assembled, secured and prepared for dispatch, including radiological surveys and decontamination (if required).

5.1.3.2 Surveillance of the Storage Overpacks

While in storage, the proper operation of the storage overpacks is verified by surveillance procedures conducted to meet Sections 3.2.2, 3.3.2, 3.4.2, and 5.1.3 of the WCS CISF technical specifications [5-1]. An overall site observation surveillance is also performed on a periodic basis to detect any storage overpack damage or accumulation of site debris.

Radiation doses emitted from the storage overpacks are measured by radiation dosimeters located at the protected area (PA) and owner controlled area (OCA) boundaries to ensure doses are within 10 CFR 20.1301 and 10 CFR 72.104 or 40 CFR Part 191 limits.

5.1.3.3 Security Operations

WCS CISF security personnel perform a variety of functions, including continuous surveillance for intruders, evaluation of intrusion alarms, coordination with local law enforcement agencies, and coordination with appropriate emergency response personnel, if necessary. They also process visitors, issue badges to workers, and perform any necessary searches of packages and vehicles. The security personnel identify, assess and report any off-normal and emergency events during off-shift hours of WCS CISF operation. Further information regarding security personnel is outlined in the CISF Physical Security Plan [5-3].

5.1.3.4 Health Physics Operations

WCS CISF Health Physics personnel monitor onsite and offsite radiation levels to ensure doses comply with applicable regulatory requirements. Health Physics personnel also calibrate radiation protection instrumentation.

Health Physics personnel perform radiation dose and contamination surveys on spent fuel and GTCC waste shipments received at the CISF. To maintain the WCS CISF philosophy of ALARA, Health Physics personnel ensure that contamination levels on the incoming transportation casks are within the Department of Transportation (DOT) and Technical Specifications limits. Transportation casks exceeding those limits are decontaminated onsite before they are shipped offsite.

Health Physics personnel also monitor doses during transfer to ensure that workers are not exposed to unnecessary radiation. If necessary, temporary shielding (such as lead blankets, neutron shielding, and portable shield walls) can be used to support ISP's ALARA philosophy.

5.1.3.5 Maintenance Operations

Storage overpacks require little maintenance over the lifetime of the WCS CISF. Typical maintenance includes occasional replacement and recalibration of temperature monitoring instrumentation.

Periodic maintenance is required on the VCT, CTS, overhead bridge crane, approved Special Lifting Devices, and transportation casks. Maintenance of these SSCs, which are classified as important-to-safety (ITS), ensure that they are safe and reliable throughout the life of the WCS CISF per 10 CFR 72.122(f).

Maintenance is also required on the following components not-important-to-safety (NITS): Waste Control Specialists' locomotive, NUHOMS® transfer equipment, security systems, temperature and radiation monitoring systems, diesel generator, electrical systems, fire protection systems, and site infrastructure.

5.1.3.6 Transfer of Canisters from WCS CISF Offsite

A 10 CFR Part 71 licensed transportation cask will be used for transport of canisters offsite to another facility. Retrieval operations for the NUHOMS® systems are described in Section 5.1.3.1.1. Retrieval operations for the vertical storage systems are described in Section 5.1.3.1.2.

5.1.4 Flow Sheets

Flow sheets illustrating operations for canister receipt, transfer, and placement into storage are shown in Figures A.5-1, B.5-1, C.5-1, D.5-1, E.5-1, F.5-1 and G.5-1 in the Appendices. The sequence of operations to remove canisters from the WCS CISF is the reverse of the receipt, transfer and placement operation. The personnel and time requirements for the operations are provided in Tables A.9-2, A.9-3, B.9-2, B.9-3, C.9-2, C.9-3, D.9-2, D.9-3, E.9-1, F.9-1 and G.9-1. These tables are used to develop the occupational exposures in Chapter 9 and Appendices A.9, B.9, C.9, D.9, E.9, F.9 and G.9.

5.1.5 Identification of Subjects for Safety Analysis

5.1.5.1 Criticality Prevention

As addressed in Chapter 10, criticality is controlled by the design features of the storage overpack. No further criticality control measures within the storage installation are necessary with the canister dry and sealed.

5.1.5.2 Chemical Safety

No chemical hazards exist as part of WCS CISF operations.

5.1.5.3 Operation Shutdown Modes

No routine operational shutdown modes are needed during normal operations of the storage systems because they are passive and rely on natural air circulation for cooling. All operational shutdown modes at the WCS CISF are safe shutdown modes due to the design features of the facility. Operation procedures ensure that no shutdown occurs in the middle of an operational step. The transfer process will not be shut down until transfer operations are completed. Operational shutdown steps following emergency or accident events also are addressed by the WCS CISF operational procedures.

5.1.5.4 Instrumentation

Instrumentation is not needed to perform safety functions of the storage overpacks. Temperature monitors are used to monitor the storage overpack temperature during storage for some systems. Additionally, WCS CISF personnel are equipped with personnel dosimeters whenever in the PA and radiation doses are monitored at the perimeters of the PA and OCA. Area radiation monitors are used to measure radiation levels in the Cask Handling Building during transfer operations and in the areas where low-level radioactive waste is stored. Portable radiation detectors are used to measure radiation levels of storage overpacks following canister transfer. Temperature and radiation detectors are classified as NITS.

5.1.5.5 Maintenance Techniques

Maintenance operations are subject to radiological and occupational health and safety review. Periodic preventative maintenance is performed on the overhead transfer crane, canister lifting equipment, NUHOMS® transfer equipment, VCT, radiation detection and monitoring equipment, storage overpack temperature monitoring equipment, security equipment, fire detection and suppression equipment, etc. Maintenance is performed in accordance with 10 CFR 72.122(f) and relevant manufacturer's requirements.

5.2 Canister Handling Systems

5.2.1 Canister Receipt, Handling, and Transfer

Operations for the systems used for the receipt, handling, transfer and storage of spent fuel and GTCC waste canisters are discussed below, including special features to ensure safe handling of the canisters.

5.2.1.1 Canisterized Spent Fuel and GTCC Waste Receipt

5.2.1.1.1 Functional Description

The canisters are contained in the transportation casks and impact limiters when they arrive at the WCS CISF. The transportation cask protects the enclosed canister from physical damage, provides shielding and criticality safety, and allows sufficient cooling of the canister while in route to the WCS CISF.

NUHOMS®

Upon arrival at the WCS CISF, the cask is inspected and the integrity of the tamperproof seals are verified. The impact limiters are removed and the cask is staged for removal from the rail car. Surface contamination surveys of the transportation cask are performed.

Vertical Storage Systems

Upon arrival at the WCS CISF, radiation and contamination surveys of the transport vehicle are conducted in accordance with 10 CFR Part 71. After confirming radiation and contamination levels are within safety limits, the personnel barrier is removed. While the cask is in the horizontal position, it is inspected for physical damage potentially incurred during transportation and the transportation seals are inspected to ensure they are intact. The top and bottom impact limiters and the tiedown assembly are removed. The approved Special Lifting Device is attached to the transportation cask and the cask is lifted into the vertical position using the CHB overhead crane.

5.2.1.1.2 Safety Features

Safety features include the design, materials, and construction of the transportation casks. The casks provide gamma and neutron shielding, conductive and radiant cooling, and structural strength to protect the canister. A tamperproof device on the cask indicates any unauthorized attempt to access to the cask. These safety features are more fully described in the transportation cask SARs listed in Sections 1.6.1.1 and 1.6.2.1.

5.2.1.2 Canister Handling

5.2.1.2.1 Functional Description

The Cask Handling Building is a two bay ITS – Category B steel structure designed to support two bridge cranes used to lift loaded transportation casks from rail cars and to remove / install personnel barriers, impact limiters and small items from the transportation casks upon receipt of the rail car at the Cask Handling Building.

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After receipt inspection and removal of the impact limiters, the cask lifting device is attached to the top and bottom of the cask and the cask is lifted from the rail car onto the transfer cask support skid on the transfer trailer. The yard tractor moves the transfer trailer to the storage pad and HSM.

Vertical Storage Systems

After a preliminary receipt inspection, the rail car and the transportation cask are moved into the Cask Handling Building where the receipt inspection is completed. The transportation cask impact limiters are removed. The transportation cask is then removed from the railcar using the CHB overhead crane and approved Special Lifting Device. The VCT is used to lift the transportation cask between 3 and 6 inches off the ground and place the cask under the CTS and staged near a designated storage overpack.

5.2.1.2.2 Safety Features

The Cask Handling Building houses the equipment used to handle the transition between transportation configurations under 10 CFR Part 71 to transfer operations under 10 CFR Part 72 for the canisters. All transfer operations to move the NUHOMS®-MP187 and -MP197HB transportation casks are accomplished with the transportation casks in a horizontal orientation utilizing a bridge crane, as all lifts are limited to a maximum height of 80 inches. The Cask Handling Building also houses the stand-alone CTS that is classified as an ITS component.

5.2.1.3 Canister Transfer

5.2.1.3.1 Functional Description

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Prior to the transfer cask arrival at the HSM, the HSM door is removed and the cavity of the HSM is inspected. The transfer cask is moved from the Cask Handling Building to the storage pad along the designated transfer route. Once at the storage pad, the transfer vehicle is positioned to within a few feet of the HSM. The transfer cask top cover plate is unbolted and removed. The transfer vehicle is moved to within a few inches of the HSM. The bottom ram access cover plate is removed and the ram is positioned behind the transfer cask. The ram is activated to initiate insertion of the dry storage canister into the HSM. When the canister reaches the back of the storage module, the ram is retracted. The transfer cask is undocked and moved clear of the HSM. The HSM door is installed and secured in place.

Vertical Storage Systems

After the transportation cask is positioned near the designated storage overpack, the CTS moves over the transportation cask. The canister is pulled up into the transfer cask and moved to the storage overpack. The transfer cask is positioned over the storage overpack and the canister is lowered into the storage overpack. The storage overpack lid is installed and the VCT moves the loaded storage overpack to the designated storage pad.

5.2.1.3.2 Safety Features

The CTS and CHB overhead bridge cranes fully meet the single-failure-proof criteria of NUREG-0612 [5-4], providing a combination of fail-safe features and redundant design factors, as well as structures designed to the criteria of ASME NOG-1 for compliance with NUREG-0554 for single-failure-proof critical load handling. Additionally, failure modes and effect analyses (FMEA) have been performed to further demonstrate the design adequacy.

5.2.2 Canister Storage

Storage consists of the NUHOMS® HSM and the VCC storage systems, which include spent fuel and GTCC waste canisters placed in the steel and concrete storage overpacks located on the storage pads. These storage systems are passive and require no support systems for long-term storage.

The storage systems perform their functions under normal conditions, off-normal and accident-level conditions. Limits of operation associated with various normal and off-normal conditions are contained in the WCS CISF Technical Specifications. Surveillance requirements are also contained in the WCS CISF Technical Specifications.

5.2.2.1 Safety Features

The NUHOMS® storage overpacks (HSM) are ITS, Quality Category B components.

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

5.3 Other Operating Systems

The storage overpacks are passive and do not require any other operating systems for safe storage of the spent fuel or GTCC waste once they are placed into storage. The WCS CISF operating systems are described in Sections 5.1 and 5.2.

5.4 Operation Support Systems

5.4.1 Instrumentation and Control Systems

10 CFR 72.122(i) requires that instrumentation and control systems be provided to monitor systems that are classified as ITS over anticipated ranges of normal operation and off-normal operation. The operation of the WCS CISF is passive and self-contained and does not require control systems to ensure safe operation. However, storage overpack temperatures are monitored in some cases to provide a means for assessing thermal performance. Temperature monitoring is addressed in Section 3.4.2.

Radiation monitoring provided to ensure doses remain ALARA is addressed in Sections 3.4.2 and 9.5.2. Radiation monitoring is not required to support systems that are classified as ITS.

No other instrumentation or control systems are necessary or are utilized. Therefore, the requirements of 10 CFR 72.122(i) are satisfied.

5.4.2 System and Component Spares

Spare temperature monitoring devices are maintained at the site. However, these devices are not required to maintain safe conditions at the WCS CISF. No other instrumentation spares are required.

5.5 Control Room and Control Areas

10 CFR 72.122(j) requires a control room or control area, if appropriate for the facility design, be designed to permit occupancy and actions to be taken to monitor the facility safely under normal conditions, and to provide safe control of the facility under off-normal or accident conditions. This requirement is not applicable to the WCS CISF because the storage systems are passive and require no control room to ensure safe operation.

5.6 Analytical Sampling

No sampling is required for the safe operation of the WCS CISF or to ensure operations remain within prescribed limits. The cask system designs preclude the release of effluents generated during interim storage for normal, off-normal and accident conditions. Since the sampling is not required for nuclear safety of the WCS CISF, it is not subject to ITS requirements. While not required, it is prudent to establish a monitoring system for surface water runoff as an additional step in the radiation control process. Since the surface water drainage paths are normally dry, it is not possible to monitor runoff in a continuous or batch mode basis. Instead, quarterly soil sampling coupled with weekly/monthly radiological surveys on the storage overpacks and storage pad will be conducted. Soil and sewage samples will be analyzed at an offsite certified laboratory. Onsite surveys will be conducted and analyzed using calibrated Canberra® gas flow proportional gross alpha/beta counters, calibrated Perking & Elmer® Liquid Scintillation Counters, and calibrated Ortec® gamma Spectroscopy counters as needed/required or equivalent equipment.

5.6.1 Liquid Radioactive Waste Sampling

No liquid radioactive waste is generated; therefore, no liquid waste sampling is required for the safe operation of the WCS CISF.

5.6.2 Solid Radwaste Sampling

No sampling is required for the safe operation of the WCS CISF.

5.6.3 Gaseous Radioactive Waste Sampling

No sampling is required for the safe operation of the WCS CISF.

5.6.4 Area Air Monitoring

Air monitoring (i.e., Low Volume air sampling or High Volume air sampling as applicable) is conducted for each offload. Should contamination be detected above DOT conveyance limits, proper notification is given to all the applicable regulatory entities.

The surveys will be performed per approved procedures for direct alpha/beta/gamma/neutron measurements and removable contamination swipes. The direct measurements will be conducted using Ludlum hand held instruments models 9-3, 12-4, 78, 2360, 2241, 19, and 3 or equivalent equipment.

The swipes will be processed on calibrated Canberra® gas flow proportional gross alpha/beta counters, calibrated Perkin & Elmer® Liquid Scintillation Counters, and calibrated Ortec® Gamma Spectroscopy counters or equivalent equipment.

The environmental air samples will be collected using Hi-Q Low Volume (0.5 – 4 cfm) air samplers or equivalent.

The environmental dosimeter monitoring will be conducted using Landauer® Inlight® Environmental X9 (beta/X/gamma) or equivalent.

Area Dosimetry Monitoring will be conducted using Landauer® Luxel + (beta/X/gamma/neutron) or equivalent.

5.7 References

5-1 SNM-2515 Technical Specifications (See [Gen-1]).

5-2 "Post Transport Package Evaluation," QP-10.02, Revision 2.

5-3 "WCS Consolidated Interim Storage Facility (CISF) Physical Security Plan," Revision 5, dated September 18, 2019.

5-4 NUREG-0612, Control of Heavy Loads at Nuclear Power Plants, U.S. Nuclear Regulatory Commission, July 1980.

Table 5-1
Operating Procedures for the Storage Systems at the WCS CISF

Cask System	Canister	Overpack	Appendix
NUHOMS®-MP187 Cask System	FO-DSC	HSM (Model 80)	Appendix A.5
	FC-DSC		
	FF-DSC		
	GTCC Canister		
Standardized Advanced NUHOMS® System	NUHOMS® 24PT1	AHSM	Appendix B.5
Standardized NUHOMS® System	NUHOMS® 61BT	HSM Model 102	Appendix C.5
	NUHOMS® 61BTH Type 1		Appendix D.5
NAC-MPC	Yankee Class	VCC VCC VCC	Appendix E.5
	Connecticut Yankee		
	LACBWR		
	GTCC-Canister-CY		
	GTCC-Canister-YR		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.5
	GTCC-Canister-MY		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.5
	GTCC-Canister-ZN		

CHAPTER 6
WASTE CONFINEMENT AND MANAGEMENT

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6. WASTE CONFINEMENT AND MANAGEMENT

Unless otherwise specified, all reference to “waste” in this chapter is to waste that is generated as a result of the WCS CISF operation. It does not refer to the Spent Nuclear Fuel (SNF) or Greater-Than-Class-C (GTCC) wastes that may be stored in the WCS CISF.

This chapter describes the waste management systems of the WCS CISF and demonstrates that waste materials generated as a result of WCS CISF operations are safely contained and disposed. The WCS CISF handles only canisterized SNF and GTCC waste; therefore, the only radioactive wastes are solid wastes generated from residual quantities of radioactive contamination that may be encountered on the surfaces of the transportation casks due to weeping.

No waste processing facilities are provided by the WCS CISF design; however, the design of the CISF includes the capability for packing site-generated, low-level radioactive wastes (LLRW) in a form suitable for storage onsite while awaiting transfer to a licensed disposal site, in compliance with 10 CFR 72.128(b). Additionally, the WCS CISF does not have a SNF pool or any associated wastes generated as a result of pool operations or pool maintenance.

By design, there are no radioactive or chemical gaseous or liquid effluent releases from the WCS CISF operations; therefore, effluent monitoring systems are not required, and such systems do not need to be designed to limit effluent releases.

The waste confinement and management activities described below constitute routine radiological evaluations and the waste incidental to those activities and will not endanger public health and safety. Likewise, the effects of operation of the WCS CISF, combined with those of ISP joint venture member Waste Control Specialists waste management and disposal facilities at the Waste Control Specialists site will not constitute an unreasonable risk to the health and safety of the public.

6.1 On-Site Waste Sources

The WCS CISF is designed as a "start-clean/stay-clean" facility. All SNF and GTCC waste at the WCS CISF is contained in canisters that are sealed by welding at the originating sites. Additionally, as a result of the operational design, incidental radioactive waste volumes generated by the WCS CISF operations are reduced to the extent practicable, in compliance with 10 CFR 72.24(f) and 10 CFR 72.128(a)(5). The design and operational considerations preclude the release of radioactive materials from the canisters under all normal, off-normal, and credible accident conditions.

Contamination on the outside surface of canisters is limited by the design of the systems (e.g., preclude intrusion of SNF pool water) identified in Table 1-1 and the operations for loading those canisters at the originating sites. Additionally, the external surfaces of the transportation casks are surveyed and decontaminated, as necessary, before the cask leaves the originating site for the WCS CISF. Any radioactive wastes generated during the loading operations at the originating site are processed at the originating site.

There are no potential gaseous or liquid wastes generated as a result of WCS CISF operations. As a result, there is no equipment needed to be installed to maintain control over radioactive materials in gaseous and liquid effluents. Similarly, given the absence of gaseous and liquid radioactive effluents, no provisions for packaging, storage, and disposal of solid wastes containing radioactive materials resulting from treatment of gaseous and liquid effluents have been made, although such measures have been provided for incidental solid radioactive wastes generated from transportation cask receipt operations, in compliance with 10 CFR 72.24(l).

For those solid radioactive wastes, radioactive isotopes anticipated in facility waste consist of very small quantities of mixed fission products and activation products associated with light water reactor operation.

For transportation cask arrivals at the WCS CISF, operations personnel verify the shipping manifest, conduct dose measurements, and perform contamination surveys of the external surfaces of the cask to satisfy requirements in the manifest and U.S. Department of Transportation (DOT) regulations (49 CFR 173.443 [6-3]). Any necessary decontamination would be performed using dry methods that only result in the generation of Dry Active Wastes (DAW). Any DAW would consist of anti-contamination garments, rags, and associated health physics material. The DAW would be packaged and temporarily stored in a designated radiologically controlled area until the waste is characterized and shipped to a licensed disposal facility.

Waste sources not containing radioactive materials (e.g., sanitary waste) do not constitute a potential safety problem. Additionally, there are no combustion products requiring treatment or chemical wastes generated at the WCS CISF.

6.1.1 Gaseous Wastes

Discrete or containerized gaseous wastes are not generated at the WCS CISF.

6.1.2 Liquid Wastes

6.1.2.1 Low-Level Liquid Radioactive Waste Water

There are no radioactive liquid wastes generated by the receipt, transfer and storage of canisterized SNF or GTCC waste at the WCS CISF.

6.1.2.2 Non-Radioactive Waste Water

Non-radioactive or conventional waste water may potentially be generated at the WCS CISF, largely due to testing and any use of a fire protection system, and such wastes do not constitute a potential safety issue.

6.1.3 Sanitary Wastes

Sanitary wastes generated at the WCS CISF do not constitute a potential safety issue.

6.1.4 Solid Wastes

Very small quantities of solid radioactive wastes are generated at the WCS CISF as a result of cask contamination surveys and decontamination activities. These wastes generally consist of paper or cloth smears, paper towels, protective clothing, and other job control wastes contaminated with low levels of radioactivity. These wastes are classified as DAW.

As addressed in Section 6.1, this solid waste would be packaged and temporarily stored in a designated radiologically controlled area until the waste is characterized and shipped to a licensed disposal facility.

6.2 Off-Gas Treatment and Ventilation

There is no radioactive off-gas generated by the receipt, transfer and storage of SNF or GTCC waste canisters at the WCS CISF because the confinement boundaries for canisters are designed to perform their safety function (provide confinement) for all normal, off-normal and accident conditions as described in Chapters 7, 11 and 12 and associated appendices. Given that a gaseous or aerosol release is not credible, no ventilation or off-gas systems are required to ensure the confinement of airborne radioactive particulate materials during normal or off-normal conditions.

6.3 Liquid Waste Treatment and Retention

There are no radioactive liquid wastes generated by the receipt and transfer of canisterized SNF or GTCC waste at the WCS CISF. Any non-radioactive liquid waste generated at the WCS CISF does not constitute a potential safety issue.

6.4 Solid Wastes

Very small quantities of solid LLRW is generated at the WCS CISF as a result of contamination surveys and transportation cask decontamination activities. Any such decontamination would be undertaken using dry methods, and any related waste would consist of tape, disposable clothing, smears, rags, and related radiological control material. These wastes are collected, packaged and temporarily stored at the WCS CISF as described below.

The Radiation Safety Program governs the processes for the collection, handling and disposal of LLRW resulting from receipt inspection activities and is designed to minimize both the spread of radioactive contamination and the quantity of radioactive waste generated.

6.4.1 Design Objectives

The radiological evaluations conducted during canister receipt and transfer operations are designed to minimize the amount of LLRW generated.

6.4.2 Equipment and System Description

Solid LLRW is collected in containers and located in areas where waste is expected to be generated. When the containers are full they are sealed and surveyed for external radiation levels and transferrable contamination. The sealed containers are then placed in containers compliant with licensed disposal facility requirements and temporarily stored until they are transported for disposal. All LLRW containers are labeled in accordance with 10 CFR 20.1904 requirements.

6.4.3 Operating Procedures

LLRW containers are temporarily stored in an area specifically designated for that purpose. The temporary storage area is roped off or otherwise barricaded and clearly posted. As discussed in Section 6.1, this solid waste would be packaged and temporarily stored in a designated radiologically controlled area until the waste is characterized and shipped to a licensed disposal facility. Transfers are made in accordance with 10 CFR 20.2006 [6-4] requirements.

6.4.4 Characteristics, Concentrations, and Volumes of Solid Wastes

For solid radioactive wastes, radioactive isotopes anticipated in facility waste consist of very small quantities of mixed fission products and activation products in particulate form associated with light water reactor operation that may be detected on the transportation casks. Based on Waste Control Specialists operating experience handling various transportation casks that are routinely loaded in spent fuel pools and subsequently received at the Waste Control Specialists LLRW disposal facility, the amount of waste expected to be generated per cask received is minimal.

6.4.5 Packaging

Solid LLRW will be packaged in suitable, secure radioactive waste containers and staged in a designated radiologically controlled area pending characterization and transport to a licensed waste disposal facility.

6.4.6 Storage Facilities

No long term LLRW storage is required for the WCS CISF. Temporary storage areas will be designated as needed during offloading and decontamination operations. As discussed in Section 6.1, this solid waste would be packaged and temporarily stored in a designated radiologically controlled area until the waste is characterized and shipped to a licensed disposal facility.

6.5 Radiological Impact of Normal Operations Summary

Only solid radioactive wastes are generated by the receipt and inspection operations conducted under the requirements of the Radiation Safety Program. There are no radioactive gaseous or liquid effluents released from the WCS CISF. Additionally, no releases of radioactive material are expected to the environment during normal CISF operations.

Any solid radioactive waste is stored in radiologically controlled areas while awaiting shipment offsite. As addressed in Section 6.4.4, the amount of solid waste expected to be generated per cask received is minimal.

Radioactive isotopes anticipated in facility waste consist of very small quantities of mixed fission products and activation products associated with light water reactor operation that may be detected on the transportation casks. The predominant isotopes are expected to be Cs-137 and Co-60 on an activity basis.

There are no areas beyond the Protected Area and Owner Controlled Area that are potentially impacted by radioactive materials in effluents.

Given that there are no radioactive effluents, there are likewise no person-rem radiation dose estimates to human occupants of those areas that can accrue under normal operating conditions. There are no gaseous or liquid effluents generated by the storage of canisterized SNF or GTCC waste at the WCS CISF. The only operation at the WCS CISF that may generate small volumes of solid waste is the decontamination of transportation casks, which will have no significant impact on the existing Waste Control Specialists licensed or permitted disposal facilities.

6.5.1 Additional Considerations

6.5.1.1 Shipping and Canister Transfer Operations

Under normal operating conditions, no releases of radioactivity are expected to occur. This includes operations related to receipt of transportation casks, canister transfer operations, and movement of the loaded storage casks to the storage pads.

6.5.1.2 Spent Fuel Storage

No radiological waste impacts occur due to storage, because no releases of any type of radioactive material occur during storage.

6.6 References

6-1 ASME/ANSI B31.1-2014, "Power Piping," American Society of Mechanical Engineers/American National Standards Institute.

6-2 10 CFR 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater-Than-Class-C Waste."

6-3 49 CFR 173, "Shippers — General Requirements for Shipments and Packagings."

6-4 10 CFR 20, "Standards for Protection Against Radiation."

CHAPTER 7
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7. INSTALLATION DESIGN AND STRUCTURAL EVALUATION

This chapter presents the structural description, design, design criteria and design analysis for important-to-safety (ITS) structures to be employed at the Interim Storage Partners' (ISP's) WCS Consolidated Interim Storage Facility (WCS CISF) including:

1. The NUHOMS® system HSMs (Model 80, Model 102 and AHSM), the various models of DSCs, and the use of the MP197HB and MP187 transportation casks for on-site transfer of the DSCs.

2. The NAC system Vertical Concrete Casks (VCCs) and canisters (UMS, MPC and MAGNASTOR), Vertical Cask Transporter (VCT), and the Canister Transfer System (CTS) including transfer casks. Note: "VCC" is used generically to refer to the different vertical concrete overpack designs for the NAC-MPC, NAC-UMS, and MAGNASTOR storage systems and includes all of the vertical overpacks listed in Table 7-2.

Structures described in this chapter include the confinement structures, systems and components (SSCs), CTS, VCT, storage pads for the vertical systems and structures classified as ITS.

7.1 Descriptions of Systems, Structures and Components

SSCs that are ITS at the WCS CISF are listed in Tables 3-5 and 7-1. They are described in sufficient detail to evaluate their structural stability, functional suitability, and to provide an adequate basis for WCS CISF approval. Details of the individual NUHOMS® and NAC systems are included in Appendices A.7 through G.7.

Table 7-1 lists the base WCS CISF structures and their QA classifications. The locations of these structures are shown in Figure 1-3.

The Security and Administration Building and access gates (Vehicle Sally Ports) are commercial grade construction classified as not-important-to-safety (NITS), are designed to industrial standards and are not discussed in this chapter. The NUHOMS NITS storage pad design is discussed in this chapter.

7.2 Confinement SSCs

Only NRC-approved storage systems are used at the WCS CISF. The proposed cask systems to be utilized at the WCS CISF are evaluated against site parameters and are generally shown to bound the site parameters. Sections 3.2 and 3.3 address the design criteria for the WCS CISF ITS Structures, Systems and Components. Section 3.3.2 specifically addresses confinement. Section 3.2 addresses the design criteria for the cask systems authorized for storage at the WCS CISF. Table 3-1 cross-references the appendices that discuss those design criteria in more detail. Tables A.3-1, B.3-1, C.3-1, D.3-1, E.3-1, F.3-1, and G.3-1 compare the WCS CISF design criteria with the design criteria for each cask system. Where the actual site parameters exceed the bounds of those assumed in the individual cask certificates of compliance, the difference is addressed for those areas affected by the variations and are documented in the appropriate WCS CISF SAR Chapter, and associated Appendices. No new analyses are required for the NAC storage systems except those provided in SAR Section 7.6.3, "Soil Structure Interaction of the VCC Storage Pad," to demonstrate seismic stability of the VCCs using the site-specific design basis earthquake motions. Tables A.3-1, B.3-1, C.3-1, and D.3-1 include cross references where new evaluations are described for the NUHOMS® Systems.

Spent nuclear fuel (SNF) characteristics are addressed in the individual canister/cask system structural evaluations which are provided in Appendices A.7, B.7, C.7, D.7, E.7, F.7 and G.7 and thermal safety evaluations which are provided in Appendices A.8, B.8, C.8, D.8, E.8, F.8 and G.8, for each canister/cask system. 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 and will comply with WCS CISF License Conditions and Technical Specifications. In addition, a receipt inspection of the canisters is performed upon arrival at the WCS CISF, which includes a post transport package evaluation in accordance with reference [7-1].

The primary confinement boundary for each of the six storage systems used at the WCS CISF is a metal canister that is welded shut. All components of the canister confinement boundary are classified as important-to-safety. Section 3.4 and Table 3-4 provide references where the classification of the SSCs can be found in the WCS CISF SAR Appendices and in the FSARs for each of the storage systems.

A description of the confinement boundary for each of the six systems used at the WCS CISF is provided in the locations in the Appendices of the WCS CISF SAR identified in Table 7-24.

7.3 Pool and Pool Confinement Facilities

There are no pools at the WCS CISF.

7.4 Reinforced Concrete Structures – Important To Safety

The NUHOMS® Horizontal Storage Modules (HSMs), NAC VCCs, storage pads for the vertical systems, and the CHB foundation and floor slab comprise the only WCS CISF reinforced concrete structures that are ITS. The individual Appendices describing each of the proposed system components provide the structural descriptions and evaluations for each of the selected cask systems. Table 7-2 provides the cross reference to the applicable appendix and section for each canister/storage overpack where the structural evaluation is discussed.

Reinforced structures associated with the CHB are discussed in Sections 7.5.3.2.3 and 7.5.3.5.

7.5 Cask Handling Building

The Cask Handling Building (CHB) is a two-bay ITS - Category B steel structure. The CHB is 175 feet by 193 feet and approximately 72 feet tall with rail access to facilitate cask unloading operations, canister transfer operations, and miscellaneous maintenance activities. Figures 1-7 and 1-8 show the general building layout and building cross section. CHB Structural Design is discussed in Section 7.5.3.

To facilitate rail car unloading activities, the CHB design incorporates two overhead bridge cranes rated at 130 tons each for lifting loaded transportation casks from the rail car, removal of impact limiters, and shielding, etc.

All transfer operations to move the NUHOMS® System MP187 and MP197HB transportation casks are accomplished with the transportation casks in a horizontal orientation utilizing a bridge crane with lifts limited to a maximum height of 80 inches. The vertical systems will utilize the overhead bridge cranes to remove impact limiters and personnel barriers, and the NAC transportation casks from the rail car. The Vertical Cask Transporter (VCT) is used to move the uprighted NAC transportation cask to the Cask Transfer System (CTS).

The CHB also houses operations involving both a CTS and a VCT in support of unloading transportation casks and transferring canisters from the NAC transportation casks into the storage casks. Both systems are considered ITS, although the VCT transport of a storage cask to the pad has been evaluated for limited lift height drops.

The CTS and VCT are independently designed and analyzed to meet the intent of NUREG-0612 [7-3], "Control of Heavy Loads at Nuclear Power Plants,"

> "To provide adequate measures to minimize the occurrence of the principal causes of load handling accidents and to provide an adequate level of defense-in-depth for handling heavy loads near spent fuel and safe shutdown systems".

Understanding the WCS CISF will not have safe shutdown equipment or spent fuel pools, it is recognized that the canisters loaded with fuel must be safely and securely handled thereby protecting the fuel from damage and protecting the site and surrounding areas from any potential radiological impacts. Even though the potential for a radiological release is very low, the WCS CISF objective is to prevent the occurrence of load handling accidents. Therefore, the licensing basis is to provide handling systems that are robust to failure which makes the likelihood of a load drop event extremely small.

NUREG-0612, Section 5 provides the general guidelines for controlling heavy loads and specifically, paragraph 5.1.6 provides guidance in establishing the criteria for single-failure-proof handling through the use of redundant load paths or the implementation of increased factors of safety. NUREG-0612 also points to NUREG-0554 [7-2], "Single-Failure-Proof Cranes for Nuclear Power Plants", to provide guidance on design, fabrication, installation, and testing of new cranes that are of a highly reliable design. The limitation of NUREG-0612 and its associated reference to NUREG-0554 is that it provides guidance only for cranes and hoisting systems that are "single failure proof" electric wire rope hoists, and does not provide specific guidance for other types of cranes and hoisting systems that may be better suited for a specific application.

As stated in Regulatory Issue Summary (RIS) 2005-25, Sup 1, "…the application of the criteria for Type 1 cranes from ASME NOG-1, "Rules for Construction of Overhead and Gantry Cranes," to the design of new overhead heavy load handling systems is an acceptable method for satisfying the guidelines of NUREG-0554, "Single-Failure-Proof Cranes for Nuclear Power Plants".

Additionally, from NUREG-0800, Section 9.1.5, "Overhead Load Handling Systems", Section I.4.C, "The probability for a load drop is minimized by an overhead handling system designed to comply with the guidelines of NUREG-0554 and lifting devices that comply with American National Standards Institute (ANSI) N14.6 or an alternative based on American Society of Mechanical Engineers (ASME) B30.9. An overhead handling system that complies with ASME NOG-1 criteria for Type 1 cranes is an acceptable method for compliance with the NUREG-0554 guidelines."

For the CTS, NAC has used applicable portions of ASME NOG-1 as guidance for the hydraulic gantry crane and bridge components. CTS components not within the scope of ASME NOG-1, such as the lift links, shackles, slings, transfer cask lift plates, chain hoist and canister lift adapter, invoke applicable ANSI or ASME B30 Standards and are designed with increased factors of safety and/or implemented redundancy. Special lifting devices, per ANSI N14.6, have factors of safety of at least six on material yield strength and at least ten on material ultimate strength. For the chain hoist, ASME NUM-1 Type IB requirements are invoked. All of the components and their standards work together to provide a lifting system that is designed for the specific and limited purpose of safely transferring canisters from transport casks to transfer casks and to storage casks, and vice versa.

For the VCT, the same lifting methodology (i.e., heavy loads lifting components) used for the CTS is incorporated into a drivable piece of equipment for handling both the transportation casks and the storage casks. Again, all of these components work together to provide a lifting system that is designed for the specific purpose of safely transferring canisters from transport casks to storage casks.

CHB Specification for Cask Handling Overhead Bridge Crane [7-77] provides additional detail to address how the CHB overhead cranes are evaluated and provides supplementary information that demonstrate compliance with NUREG-0612 and applicable NUREG-0554 requirements.

As both the CTS and VCT are essentially longitudinally moving jacking towers, and not electric overhead traveling cranes, as described in NUREG-0612 and NUREG-0554, their component parts must be addressed individually, with regards to applicable criteria located within U.S. NRC regulatory guides and nuclear & non-nuclear industry standards, for the purpose of confirming their single-failure-proof handling capability. The following sections, 7.5.1 and 7.5.2, will outline the integration of the standards and substantiate the safety of the described systems.

7.5.1 Canister Transfer System

7.5.1.1 Introduction

Three (3) types of storage systems, provided by NAC International, are implemented at the WCS CISF – the NAC MAGNASTOR, NAC-UMS and NAC-MPC. Each storage system has an associated transportation configuration in which the canister arrives at the WCS CISF. The CTS is used to transfer the contents of the transportation casks into the storage casks. The CTS is essentially a hydraulic gantry crane with a dedicated transfer cask (which is unique for each of the three system types being loaded). Figure 7-1 is a rendering of the CTS.

For NAC's vertical concrete cask storage systems, the transfer of the canister (TSC) occurs in a configuration referred to as a "stack-up". Stack-up occurs when the transfer cask, which is a shielded handling device for the TSC, is placed on top of a vertical concrete cask storage system (VCC). The objective is to ensure the shielded transfer of the TSC from the transportation cask into the transfer cask and then into the VCC.

Sections 7.5.1.4 through 7.5.1.15 follow NUREG-0554's table of contents as a means to present how the CTS is evaluated and provide the necessary information to demonstrate compliance with NUREG-0612 and applicable NUREG-0554 requirements.

The canister being handled by the CTS is classified as a critical load, per NUREG-0554 and NUREG-0612. Safe handling of this critical load is accomplished by ensuring, through the use of redundancy in active components or load paths and through the use of increased factors of safety, that failure of the heavy load system is highly unlikely and therefore provides adequate defense-in-depth for the CTS heavy loads.

As noted above, the CTS, specifically the lifting boom, trolley and lift beams, and seismic cross bracing, is designed in accordance with the American Society of Mechanical Engineers, ASME NOG-1 [7-4]. Components not within the scope of ASME NOG-1, such as the lift links, shackles, slings, transfer cask lift plates, chain hoist and canister lift adapter, are designed with redundancy and/or increased factors of safety.

The CTS major design data is tabulated in Table 7-3. Design parameters for the major components are presented in Table 7-4.

7.5.1.2 Code Applicability

NUREG-0612 Criteria:

- Scope is control of heavy loads over SNF pool, fuel in core, or equipment that may be required to achieve safe shutdown (Section 1.1).
- Special lifting devices should satisfy ANSI N14.6 [7-9] (paragraph 5.1.1(4)).
- Twice the design safety factor is required for lifting devices (paragraph 5.1.6(1)(a)).
- New cranes shall be designed to meet NUREG-0554 (paragraph 5.1.6(2)).

NUREG-0554 Criteria:

- Single-failure-proof features are limited to hoisting and braking systems for trolley and bridge. Other load-bearing items such as the girders are conservatively designed but need not be considered single failure proof (Section 1, second paragraph).

NUREG-0800, 9.1.5, Criteria:

- An overhead handling system that complies with ASME NOG-1 criteria for Type 1 cranes is an acceptable method for compliance with the NUREG-0554 guidelines (Section I. 4.C).

ASME NOG-1 Criteria:

- NRC position as documented in RIS 2005-25 and NUREG-0800, 9.1.5, [7-43] is that ASME NOG-1 is an acceptable method for satisfying the guidelines of NUREG-0554.
- Type I crane is used to handle a critical load. It is designed to support the critical load during a seismic event, but does not have to be operational after the event (Section 1150).
- Load combinations provided in Section 4140.
- Operating load allowable stress is 0.5 of yield and extreme environmental load allowable stress is 0.9 of yield (Table 4311-1).
- Gantry overturning shall have a safety factor of 1.5, unrestrained, for operational loading, and 1.1 under extreme environmental, with restraints (paragraph 4457).

ANSI N14.6 Criteria:

- Does not apply to cranes.
- Scope is special lifting device that transmits the load from structural parts of the container to the hook of an overhead hoisting system (paragraph 1.3).
- Load bearing members shall have a factor of safety of 3 to yield and 5 to ultimate (para.4.2.1.1).
- For critical loads, load bearing members shall have twice the normal stress design factor (paragraph 7.2.1).

ASME NUM-1 Criteria:

- Type I equipment is a hoist used to handle a critical load. Type IB equipment is a Type I hoist with enhanced safety features, including increased design factors that minimize the potential for failure that would result in the loss of capability to stop and hold the critical load [NUM-I-1100].

- The hoist has limit switches which prevent two-blocking and will be functionally tested for two-blocking and load hang-up [NUM-1-7930].
- Hoist braking is a multiple disc design, spring applied and air released. Sudden loss in air pressure to the hoist results in the brake being automatically applied and hold the load in place. Failure of brake results in an airmotor/gearbox controlled rate of descent [NUM-I-7946].
- The MCL of 50 metric tons will be marked on the hoist, in lieu of the 100 metric ton load rating, hoist is designed for 2X MCL, load is half the torque rating of the gears [NUM-I-7945].
- ASME B30.16, ASME B30.10 hoist testing and hook testing [NUM-I-8500].

7.5.1.3 Component Design Basis

Gantry Crane Telescoping Booms

ASME NOG-1 for operating loads and seismic: For seismic analytical model use Maximum Critical Load (MCL) of 100 Metric Tons (MT). Refer to NOG-1, paragraph 4140 for load combinations and Section 4300 for allowable stress criteria. Use LSI Model 24PT500WXTDPIC lift booms, with a combined lifting capacity of 454 MT (500 tons).

Lift Beams Connecting the Tops of the Telescoping Booms

ASME NOG-1 for operating loads and seismic: MCL = 100 MT. Load split equally between two lift beams. Controlling design case is with the trolley beam at the centerline of the bridge girder.

Trolley Beam between the Lift Beams

ASME NOG-1 for operating loads and seismic: MCL = 100 MT. Load applied at two points, 50 MT each, spread equal to the spread of the transfer cask trunnions. Lifting links on the trolley beam for slings between the trolley beam and the transfer cask trunnions, each set of two lifting links with a 6” pin between, designed for 100 MT (double the applied static load of the loaded transfer cask). Lifting links on the trolley beam centerline for attachment of the upper end of the chain hoist; set of two links designed for 100 MT (double the applied static load of the loaded canister). The loaded canister load on the center of the trolley beam is not applied coincident with the loaded transfer cask load. The transfer cask rests on top of the VCC during lowering of the loaded canister into the VCC. Thus, there are three sets of lifting links on the trolley beam of identical design.

Chain hoist between Trolley Beam and Canister Lift Adapter

ASME HST-5 and ASME B30.16, with safety factor of 5 on the rated load: Uses commercial hardware with rated load at least twice the design basis load of the loaded canister (50 MT), incorporates two-block mitigation and redundant braking in order to meet the criteria of ASME NUM-1. The chain hoist is a 100 tonne (110 US ton) Ingersoll Rand hoist, Model HA3-100, with top pin factors of safety of 6 and 10 per ANSI N14.6 and hoist hook (ASME B30.10) rated at 2x MCL.

Canister Lift Adapter

ANSI N14.6 with factors of safety of 6 and 10: Design load of 100 MT.

Slings between Trolley Beam and Transfer Cask Trunnions

ASME B30.9 with a safety factor of 5 on the rated load: Use commercial hardware with rated load at least twice the design load of the loaded transfer cask in order to meet the criteria of NUREG 0612. Each twin-path sling, doubled in a basket hitch, and two shackles designed for 50 MT each.

7.5.1.4 Operations Specification and Design Criteria

The CTS is a shielded handling system used to remove the canister contents from the transportation cask and placing them into the VCC. It is specifically used for NAC vertical storage systems.

The operational period, including system dry-runs and loading the projected eight phases of VCC is between twenty and forty years. There may be up to three hundred sixty loading cycles per phase. Even at this demand, a metal fatigue analysis is not required, due to the combined effect of the low number of full-load cycles and the very low allowable stresses of ASME NOG-1.

Lifting and lowering speeds for the CTS raising the transfer cask to the top of the VCC are limited to 30 cm/minute. Loaded CTS propel speed during transition to the empty VCCs is 60 to 90 cm/minute. Powered side shifters at the ends of the trolley beam, driven by a hydraulic motor, are used for slight adjustment (less than 5 cm) under load to center the transfer cask into the transfer cask adapter on top of the transportation cask and the VCC. The powered side shifter propel speed under load is controlled to a maximum of a 10 centimeters per minute. Table 7-5 summarizes the component speed limits.

The design criteria used for the CTS is specified in ASME NOG-1, Section 4000. All of the load combinations identified in paragraph 4140 have been evaluated. Controlling load combinations have been used to determine component stresses and then are compared to applicable allowable stresses. The sum of simultaneously applied loads (static and dynamic) do not result in stress levels which would cause any permanent deformation, and thus, the CTS fully meets the requirements of ASME NOG-1.

Maximum Critical Load

CTS Maximum Critical Load

The maximum critical load (MCL) is the weight of the transfer cask containing a MAGNASTOR loaded canister with the canister lift adapter bolted to the top of the canister. The resulting total weight is rounded up and specified as the maximum critical load (MCL), which is 100 MT. The MCL is also the Design Rated Load (DRL) for the CTS system.

The canister air chain hoist, trolley beam lifting links, transfer cask seismic restraint ring and transfer cask lift rigging are included in the crane dead load. Dead load is the weight of all components prior to lifting the loaded transfer cask or loaded canister.

Additional design margins are inherently applied to mechanical and electrical components subject to wear, to allow for possible degradation due to wear. The mechanical and electrical components are designed for use on a 454 MT rated gantry crane versus the CTS 100 MT MCL.

Chain Hoist MCL

The CTS MCL of 100 MT are prominently marked on the CTS lift beams in large letters and numbers. The chain hoist MCL of 50 metric tons is marked on the chain hoist load block.

No noncritical loads of a magnitude greater than the indicated MCL are anticipated. Thus, the DRL of the crane is the same as the MCL. Only the MCL is displayed on the crane lift beams (bridge girders).

Operating Environment

The Crane is located inside the Cask Handling Building (CHB) adjacent to the WCS CISF Storage Area in a controlled environment. The design basis temperature is 0°C to 40°C with humidity of 0% to 100%.

Radiation doses from the loaded transfer cask, the loaded transportation cask or loaded VCCs are extremely low, and there are no identified hazardous chemical conditions. The CTS paint system, although protected by the CHB, is suitable for outdoor exposure in a marine environment. General CTS maintenance includes monthly cleaning and recoating of any paint damaged areas.

Material Properties

ASME NOG-1 addresses the concern for material brittle fracture more comprehensively than NUREG-0554. Thus, the CTS material testing follows the criteria specified in ASME NOG-1. The CTS is primarily constructed from ASTM A572 Grade 50 plate material. Material Properties can be found in Chapter 15

In accordance with the requirements of ASME NOG-1 and ASME Section III, carbon steel materials exceeding 5/8 inch (16 mm) are impact tested in accordance with ASTM A370. Weld filler materials for welds with an effective throat exceeding 5/8 inch (16 mm) are also impact tested.

ASME NOG-1 requires that the impact test temperature be at least 30°F below the minimum operating temperature. Acceptance values shall be per ASTM A370 Section 26.1 with the lowest service temperature of 32°F (0°C).

Seismic Design

Incorporation of the CTS into the Cask Handling Building utilizes an independent pad design, thicker than that of the CHB floor. In the typical installation detail (Figure 7-32), the rail system is shown integrated with an ISFSI pad design with a thickness of 3' and have ISFSI pad reinforcement. The pad will span an area of approximately 42' wide and up to 60' long, essentially the size of an ISFSI pad for a 2 x 4 cask array. This allows adequate spacing for the placement of 2 transportation systems and 2 storage systems for content transfer in the CTS. As can be seen in Figure 7-32, the rail embedment is integrated into the ISFSI pad rebar design and is located at the edges of the pad. The figure only shows a single rail system whereas two systems, mirror image, are required for the CTS gantry crane.

As the CTS pad is essentially a small ISFSI pad for VCCs as described in Section 7.6.1, the CTS pad is bounded by the evaluations provided in Section 7.6.1 and is ITS to the same degree as an ISFSI pad. Tip-over has been evaluated for both the transport casks (Section 7.6.6) and storage casks (Section 7.6.1.6) and would be applicable for those components during their period of placement on the CTS pad.

The following Codes and Standards are used in the analysis, fabrication and installation of the CTS rail installation and supporting pad design.

1. ACI "Building Code Requirements for Reinforced Concrete", American Concrete Institute, ACI 318-2008
2. ACI "Code Requirements for Nuclear Safety Related Concrete Structures", American Concrete Institute, ACI 349-2006
3. AISC "American Institute for Steel Construction, AISC 1989, ASD
4. ASTM "American Society for Testing and Materials"
5. ASME "Rules for Construction of Overhead and Gantry Crane (Top Running Bridge, Multiple Girder), NOG-1-2010
6. AWS "American Welding Society", AWS 1996

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Lamellar Tearing

The lift and trolley beams and the hydraulic booms are fabricated from plate steel, not rolled structural members. Primary loads are not applied in the through thickness of the material without adequate stiffening. Joints subject to lamellar tearing are avoided in the design, except for possible low loading conditions not susceptible to lamellar tearing.

All butt welds, as defined by ASME, are radiographed and all other primary welds are magnetic particle or dye penetrant examined in accordance with the requirements of ASME NOG-1, Section 4251.4.

Structural Fatigue

A fatigue analysis is not necessary if the loading cycles are less than twenty thousand full-load cycles. The load cycles for the CTS are less than two hundred for the construction period and operations loading of twenty-seven hundred VCCs.

Welding Procedures

All welds and welding procedures are performed and qualified in accordance with the ASME Boiler and Pressure Vessel Code Section IX [7-7] or AWS D1.1 [7-8], including preheat and post-weld heat treatment recommendations.

7.5.1.5 Safety Features

The CTS System fully meets the single-failure-proof criteria of NUREG-0612, providing a combination of fail-safe features (i.e., redundancy in two-block mitigation and dual braking capability, and increased load design factors, as well as structures designed to the criteria of ASME NOG-1 for compliance with NUREG-0554 for single-failure-proof critical load handling. Additionally, failure modes and effect analysis (FMEA) have been performed to further demonstrate design adequacy.

Auxiliary Systems

Auxiliary systems or dual components are provided so that, in case of a single component failure, the load is retained and held in a stable or immobile safe position. Single-failure-proof features of critical component parts of the CTS system are identified below.

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Withheld Pursuant to 10 CFR 2.390

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Electrical Control Systems

The CTS is designed with automatic controls and limiting devices so that when disorders due to inadvertent operator action, component malfunction, or disarrangement of subsystem control functions occur during the load handling, these disorders do not prevent the system from stopping and holding the load.

Hoist and propel (travel) motions are controlled to be very slow. [

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7.5.1.6 Emergency Repairs

If the CTS is immobilized because of malfunction or failure of controls or components while holding the load, the crane can hold the load indefinitely while repairs or adjustments are made. The repairs may be made at any location or the gantry propel system can be put into a coast position and the CTS pulled to the loading zones at the ends of the operations area.

In lieu of a “manual operation” to lower the load to the ground, a back-up electric motor and hydraulic pump are provided in each of the two control modules. If there were a malfunction of the remote control CARL, manual control levers on the control module may be used to propel the crane and lower the load.

7.5.1.7 Hoisting Machinery

The CTS is designed in accordance with NUREG-0554 and ASME NOG-1 to lift the 100 metric ton loaded transfer cask and move it to the top of the VCC. All static and dynamic loadings during gantry crane travel and seismic loading with the transfer cask in the extended position have been evaluated. Wedge locks on the hydraulic booms and hydraulic locking valves on the hydraulic lift cylinders provide single-failure-proof redundancy. Lifting devices are designed for twice the lifted load, in accordance with NUREG 0612 and ANSI N14.6, as applicable.

Proprietary Information on This Page
Withheld Pursuant to 10 CFR 2.390

For removing the 50 metric ton TSC from the transport cask and lowering it into the VCC, the CTS utilizes a 100 metric ton air operated chain hoist attached to the lift beam. This approach allows the CTS to remain engaged to the transfer cask during the downloading and reduce operator intervention in the process. This system of utilizing an independent chain hoist to lower the canister into the VCC has been successfully employed at the Big Rock Point, Catawba and McGuire nuclear plants.

The canister chain hoist utilizes a duplex hook, with two attachment points to the canister lift adapter which is bolted to the canister lid. The canister chain hoist and sister hook are sized for 200% of the weight of a loaded canister and thus, satisfy the single failure proof criteria of NUREG-0612. The canister chain hoist is designed in accordance with ASME B30.16 [7-13] and is compliant with the design features and safety factors required by ASME NUM-1 [7-14].

The chain hoist with enhanced safety factors is dynamically load tested in accordance with ASME B30.16 to at least 125MT. The chain hoist duplex hook is load tested by the manufacturer in accordance with ASME B30.10 [7-16] to at least 181.4 metric tons prior to shipment.

<u>Reeving System</u>

<u>Drum Support</u>

<u>Head and Load Blocks</u>

[ ]

Hoisting Speed

CMAA Specification #70 [7-10] recommends that the hoist raising and lowering speed for a 100 ton crane be no more than 122 cm/minute. The lift and lower speed for the CTS booms are limited to 30 cm/minute, which is also much less than the 152 cm/minute allowed by NOG-1 Table 5331.1-1. The lowering speed of the canister air hoist is 46 cm/minute. These low lift and lower speeds of the CTS and canister air hoist provide an extra margin of safety for the operator.

Designing Against Two-Blocking and Load Hang-up

"Load Hang-Up" is an act in which the load is stopped by a fixed object during hoisting, thereby possibly overloading the hoisting system. "Two-Blocking" is an act of continued hoisting to the extent that the upper head block and the load block are brought into contact, and unless additional measures are taken to prevent further movement of the load block, excessive loads are created in the reeving system. [

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Lifting Devices

Standard and special lifting devices that are attached to the CTS are conservatively designed to factors of safety of at least ten on ultimate, and thus, satisfy the required single-failure-proof criteria. Standard lifting devices include the three sets of double lifting links on the CTS trolley beam used to support the transfer cask rigging and the canister chain hoist. The transfer cask rigging includes Twin-Path slings and shackles extending from the double lifting links to transfer cask lift plates which engage with the transfer cask trunnions.

Wire Rope Protection

Side loads may be generated with a wire rope reeving system if hoisting is done at angles departing from a normal vertical lift. The CTS does not utilize a wire rope reeving system for hoisting, thus wire rope protection against side loads due to hoisting angles departing from a normal vertical lift is not needed. The canister chain hoist can only operate vertically because it is positioned on the centerline of the transfer cask, between the two transfer cask lifting points. Thus, the CTS and canister chain hoist are not susceptible to a side load failure mechanism due to hoisting angles departing from a normal vertical lift.

Machinery Alignment

The proper functioning of the canister chain hoist and CTS during load handling is ensured by providing adequate support strength of the individual component parts and the welds or bolting that binds them together. Gear trains used to propel the CTS and the trolley beam powered side shifters each have redundancy or more than twice the required capacity.

Hoist Braking System

The CTS wedge locks automatically engage if there is any loss of hydraulic pressure for the lift cylinders. The wedge locks have the capacity for holding over four times the MCL. The canister chain hoist disc air brake has a 100 metric ton stopping capability, which is double the chain hoist MCL. Additional braking safety provided by the inherent drive train braking of the rotary piston motor, which limits lowering speed to approximately 1/2 the normal lowering speed of 0.46 m/minute. This is demonstrated during factory testing.

The chain hoist "drive train braking" is verified by releasing the holding brake while supporting the hoist MCL (50 metric tons), and recording the maximum lowering speed. The hoist is rated for more than twice the load to be lifted.

7.5.1.8 Bridge and Trolley

Braking Capacity

The CTS has enhanced safety features because the base lift housings and the trolley beam powered side shifters does not move unless power is applied to the drive motor. This ensures that the crane motion stops whenever power is shut off.

Safety Stops

7.5.1.9 Drivers and Controls

Driver Selection

The horsepower rating of the canister chain hoist driving motor is matched with the design load and acceleration to avoid overpowering. The hoist is equipped with limiting devices to shut off power when the chain hoist hook approaches the end of travel.

Driver Control Systems

The control systems include consideration for the hoisting of all loads. There are separate control systems for the canister hoist and the CTS. Interlocks prevent simultaneous raising or lowering of the transfer cask, movement of the crane, or movement of the trolley beam. Procedure controls ensure that the chain hoist is not operated during crane movements. The air hose line is not hooked up to the chain hoist until after the transfer cask is seated into the transfer cask adapter. Additionally, the transfer cask closed doors and the transfer cask top retaining ring limit inadvertent movement of the canister out of the transfer cask when unloading/loading with the CTS.

Malfunction Protection

Means are provided in the control circuits to sense and respond to abnormal conditions. The wedge lock brakes are automatically engaged with a loss of hydraulic pressure. Boom and chain hoist brakes are capable of holding the MCL. Limit switches are provided to prevent chain hoist over travel or two blocking.

Slow Speed Drives

Jogging is not used with the CTS. Raising/lowering and propel speeds are much lower than NUREG-0554 or ASME NOG-1 recommendations.

Safety Devices

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Control Stations

The CTS is provided with two gantry control modules designed to run on the gantry track, tied to the gantry base module for tag-a-long travel. The control modules are positioned between the Gantry Crane base modules so that they do not restrict activities in the loading area. [

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7.5.1.10 Installation Instructions

Crane assembly and installation instructions are provided by LSI for the CTS and by Ingersoll Rand for the chain hoist. A LSI field technician supports and advises crane assembly and load testing.

Operation and Maintenance manuals include a full explanation of the crane handling system, its controls, and the limitations for the system, and includes the requirements for installation, testing, preparation for operation and maintenance.

7.5.1.11 Testing and Preventative Maintenance

Assembly, inspection and testing of the CTS are performed in accordance with ASME NOG-1, Section 7000, under the approved Quality Assurance (QA) program. All required documentation is verified prior to shipment.

Electrical inspection of the LSI fabricated hydraulic booms and controls are performed by LSI at the LSI shop prior to shipment. NAC is also witness operations and load testing of the hydraulic booms. LSI field technicians provide oversight during assembly and testing of the crane at the WCS CISF.

7.5.1.12 Static and Dynamic Load Tests

Two-Block Tests

Operational Tests

Operational tests of the CTS components and the site assembly are performed to verify the proper functioning of limit switches and other safety devices and performance of the crane as designed (Table 7-9).

7.5.1.13 Maintenance

After installation, the crane may be subject to degradation due to use and exposure. Good maintenance practices, inspection prior to each cask loading, and additional design margins ensure that the crane operates safely and maintains its full MCL rating of 100 metric tons. The crane is in service for approximately 20 to 40 years, loading as many as 2000 VCCs. Typical maintenance steps to maintain the CTS while in service would be similar to those when the crane was initially placed into service. These steps are described in the gantry crane operations manual and include the following pre-start checks:

- Verify adequate fuel level.
- Verify proper engine oil level.
- Verify proper hydraulic oil level with lift cylinders fully retracted.
- Check oil for cloudy or milky appearance.
- Check twin line hoses for damage.
- Perform full lubrication.
- Ensure no leaks around the tops of the cylinders or component damage.

- Check hose reel hoses for damage.
- Check all hoses that are exposed to sunlight for cracks.
- Check cylinder bolts and lock washers.
- Check wheel box bolts for tightness.
- Check pressure gauges and operating pressure.
- Visually check all boom and base exterior welds for cracks.
- Check the hydraulic oil filter.
- Verify lift and propel handles are shifted to the desired position.
- Thoroughly clean all hydraulic connection points.
- Engage all safety devices.
- Check all system surfaces to be sure they are clean.
- Touch-up any paint damaged areas.
- Check track and top of lift beams for debris.
- Perform a "no-load" test for the full range of motion and speed. Perform a functional test using the transfer cask and empty canister.
- The hydraulic gantries shall be maintained in accordance with ASME B30.1-Chapter1-6 [7-27].
- The chain hoists shall be maintained in accordance with ASME B30.16-Chapter 16-2 [7-13].

Local firms with hydraulic gantry crane operating and maintenance experience are used to perform specialized periodic inspection and maintenance.

7.5.1.14 Operating Manual

Operating and maintenance manuals for the gantry crane and the canister chain hoist are provided at the conclusion of shop manufacturing and load testing. The manuals incorporate features of the equipment specific to WCS CISF. The manuals provide information and procedures for use in checking, testing and operating the CTS and the canister chain hoist.

7.5.1.15 Quality Assurance

The WCS CISF Quality Assurance Program is implemented to ensure that the requirements of NUREG-0554 with regards to design, fabrication, installation, testing and operation of crane systems for safe handling of critical loads are implemented. The CTS and associated components are procured under the QA program. Detailed quality assurance requirements for suppliers are identified in the supporting QA plan. There are two graded quality categories for the CTS, defined as Quality Categories B and C.

ASME NOG-1, Section 2000 requires that the manufacturer of Type I cranes (a crane that is used to handle a critical load) meet the basic and supplemental requirements of ASME NQA-1 [7-11]. The CTS is procured under the QA program, which fully complies with ASME NQA-1.

Testing Requirements for the CTS are summarized in Table 7-10. Assembly and load testing of the crane component parts are performed under the QA program.

7.5.2 Vertical Cask Transporter (VCT)

7.5.2.1 Description

The VCT is the component used to lift, stabilize and move both the transportation cask and the VCC storage overpacks during loading operations at the WCS CISF. Typical applications for the VCT are the handling of VCCs at operating or decommissioning nuclear power plants.

VCT delivery of the loaded VCC is via a designated 'haul path' that is evaluated for this activity. The haul path is from the Cask Handling Building to the Storage Area.

The VCT is a commercially developed, self-contained, on-site vehicle designed, fabricated and tested under the following code related references:

- ASME B30.1 [7-27] (Jacks, Industrial Rollers, Air Casters, and Hydraulic Gantries).
- ANSI N14.6 [7-9] (For Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10 000 Pounds (4500 kg) or More).

During commissioning of the VCT, following completion of fabrication, the VCT is statically load tested to 125% rated load and functionally tested with 100% of rated load to demonstrate proper operation. Personnel designated to operate the VCT receive training and the movement of the cask systems is well controlled.

7.5.2.2 VCT Operations

Personnel are trained to operate the VCT in accordance with approved procedures and all the controls used on the VCT are fail safe ('dead man') type controls.

7.5.2.3 VCT Inspections

VCT inspections are based on their associated Code requirements (ANSI N14.6 and ASME B30.1), as applicable, and good operating/engineering practices. Inspections are performed to ensure equipment is in good working order and that any postulated failures, which would result in equipment damage or personnel injury, do not occur.

VCT inspections are required IAW requirements specified in ASME B30.1. In summary, these inspections are based on type of inspection (Frequent or Periodic). Only Periodic inspections require formal documentation. Any rigging or other hardware is inspected per the appropriate ASME Chapter. Any deficiency identified that meets the Removal Criteria is corrected before allowing the VCT to return to service.

The VCT lift links, lifting pins and associated header beam are designed to the ANSI N14.6 design criteria for "Special lifting devices for Critical Loads", from ANSI N14.6. As such, annual inspections of these components are performed in accordance with the requirements specified in ANSI N14.6 (e.g. testing to verify continuing compliance, Maintenance & Repair, etc.). Nil-ductility testing will be performed in accordance with ANSI N14.6-1993, Section 4.2.6 where "... ferritic materials for load-bearing members shall be subjected to a drop-weight test in accordance with ASTM E20884 or a Charpy impact test in accordance with ASTM A 370-77."

7.5.2.4 Summary

The VCT is a uniquely designed on-site vehicle used to lift and move transportation casks and VCC overpacks containing canisters of SNF or GTCC waste inside and outside of the Cask Handling Building. Handling of the VCC's is not considered ITS, as the VCC has been evaluated for drops within the range of lift for placement onto the storage pads. Moving the uprighted transportation cask under and from under the Cask Transfer System is a lift considered ITS.

The 'haul path' is analyzed, and where necessary, enhancements to the travel path are implemented to ensure that any sensitive underground utilities.

The VCT is not an overhead hoisting system as defined by any ASME Standard, rather it is a mobile hydraulic gantry crane and adheres to applicable ASME B30.1 requirements. The lift links, lifting pins and header beam are designed, load tested and inspected in accordance with the requirements as specified in ANSI N14.6.

7.5.3 Cask Handling Building Structural Design

This section presents the structural description and design criteria, and analysis for the WCS CISF Cask Handling Building (CHB). The CHB structures are designed to meet the applicable requirements for ITS structures in 10 CFR 72.122 as outlined in NUREG-1567 Section 5.4.4. The CHB is a two bay steel frame structure with metal siding and roofing designed to provide a weather-protective enclosure for cask handling operations and to support two overhead cranes used to move transportation casks from the rail car. The CHB and its foundations are ITS - Category B. The overhead cranes will also be used to remove or install personnel barriers, impact limiters from the transportation casks. All operations to move the NUHOMS® System MP187 and MP197HB transportation casks are accomplished with the transportation casks in a horizontal orientation.

7.5.3.1 Descriptions of Systems, Structures, and Components

Three separate structural systems are included within the CHB structural design, including the steel-framed building itself, the reinforced concrete foundations for the steel building, and the two overhead bridge cranes. Arrangement of the CHB structures and description of each system are provided in the following subsections. Material specifications utilized for the primary structural components of all CHB structures are summarized in Table 15-1.

7.5.3.1.1 Description of CHB Steel Building

As shown in Figures 7-54 through 7-61, the CHB steel building is a braced frame structure with column centerline grid plan dimensions of 175′-0″ (north-south) by 193′-0″ (east-west) and an eave height 72′-0″ above the top of the concrete foundation (Elevation 100′-0″ in the figures). The roof is gabled with 1/4-inch per foot slope on each side and peak ridge elevation of 174′-0 1/8″. The north-south plan dimension of the building comprises seven equal bays of 25′-0″ spacing, with vertically braced interior bays similar to those shown in Figure 7-56 on column lines A, C, F, H, K, and M. The east-west plan dimension comprises two crane bays with 64′-0″ spacing between independent crane support columns that are laterally supported by three separate vertically braced frames at column lines A-C, F-H, and K-M (see Figures 7-55 and 7-56). All seven east-west column lines support a primary lateral roof truss system that is tied together with a secondary north-south bridging roof truss system and horizontal roof bracing at the top and bottom truss chord levels. The primary roof trusses vary in depth from 7′-6″ at the eave to 9′-6 1/8″ at the ridge. The vertical bracing and primary roof truss arrangement is shown in Figure 7-56, with the secondary bridging roof trusses and horizontal roof truss chord bracing shown in Figures 7-60 and 7-61, respectively.

The objective of the CHB analysis and design for tornado missile impacts is to ensure that structural integrity and stability of the primary framing system is maintained. Therefore, only those members critical to lateral and/or vertical stability of the overall structure are required to survive under any potential tornado missile impact scenario, as demonstrated by sufficient code-based capacity to resist the combination of gravity and tornado wind, APC, and impact demands present in the design load combinations. Other members not required to survive tornado missile impact scenarios are identified as sacrificial, or not critical to structural stability. Two categories of sacrificial members are defined: 1) members that do not serve as critical elements of the overall structure primary lateral or vertical load paths and are not required for overall structural stability, such as beams not serving as collectors or struts; and 2) members that are part of the primary lateral or vertical load paths but have redundant counterparts that are assured to survive if the sacrificial member fails. This second category includes several types of horizontal struts, vertical braces, and the center 'zipper' column of each three-column set on the east-west column lines; in each of these cases the redundant framing arrangement provides secondary lateral and/or vertical load paths and stability framing in case of sacrificial member failure.

The design of sacrificial members and their connections does not require the members to remain attached to the structure after impact (i.e., the sacrificial members may themselves become airborne). This is permitted because the safety-related fuel bearing SSCs for NUHOMS® inside the building have been designed to resist the full spectrum of Regulatory Guide 1.76 tornado missiles representing the range of potential missiles on the plant site. The sacrificial members are considered rigid building debris components as defined in the missile criteria in Regulatory Guide 1.76 [7-35]. Chapter 12 of the appendices (A.12, B.12, etc.) demonstrate that each cask system component is 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 [7-35]), therefore, the impact of the sacrificial members on the cask systems is bounded. Administrative Controls will be used to mitigate impacts of design-basis tornado loading for the transportation casks (during overhead crane operations) and NAC transfer casks. As described in Section 7.5.3.2.1, the transportation casks will not be moved into the building to begin the railcar unloading process unless current and forecasted weather meets the requirements described in Section 5.4 of the proposed Technical Specifications [7-78]. In addition, similar controls, as addressed in Section 3.2.1.4 and Section 5.4 of the proposed Technical Specifications, will be applicable during the time that the canisters are in the NAC transfer casks. Finally, Section 3.2.1.4 describes how the NAC transportation casks are qualified for tornado generated missile impacts.

During detailed design tornado missile impact, evaluations will verify sufficient capacity of all stability-critical (non-sacrificial) members in the absence of the sacrificial members shown to fail under a given postulated tornado missile strike. This includes evaluation of the remaining structure for all gravity and tornado wind pressure/missile impact demands without any stabilization by or load distribution to the failed sacrificial member(s). The complete set of impact locations includes impacts on representative stability-critical members as well as impacts on representative sacrificial members. The latter cases are necessary to evaluate the demands on the surrounding structural elements when the sacrificial member is impacted.

The framing arrangement shown in Figure 7-56 and utilized on all seven east-west column lines provides lateral system redundancy, distributed lateral stiffness with limited torsional irregularity, and sufficient lateral stiffness to meet drift limitations for bridge crane supporting structures. These design objectives are further achieved via the arrangement of the roof bracing system (i.e., diaphragm); see Figures 7-54, 7-60, and 7-61. As shown, the primary east-west roof trusses are laterally supported by the secondary bridging trusses framed along the full north-south length of the building at the two wind column lines in each crane bay (Column lines D.1, D.2, I.1, and I.2; a typical section at line I.2 is shown in Figure 7-60). Horizontal diagonal roof bracing in the planes of the top and bottom chords is then provided between the primary and secondary trusses to create a continuous roof diaphragm that assures system redundancy by distributing lateral loads among the north-south and east-west braced column lines. The continuous roof diaphragm also limits relative drift of individual vertical frames subjected to localized lateral forces imparted by the cranes.

The bridge crane support system consists of simply-supported runway girders spanning 25 feet between the aforementioned independent crane support columns. As illustrated in Figure 1-7, the crane runways provide crane access to the complete length of the building in the east crane bay, while in the west crane bay the runways span only the four southernmost east-west column lines (from Line 1 to Line 4). Similar to the main building column lines, vertical bracing is provided in two bays of each crane column line (Lines D, E, I, and J); see the typical section shown in Figure 7-59. The runway girders are built-up steel sections with overall depth of 5′-6″. At the top girder flange and at Elevation 136′-2″, crane runway tie-back elements are provided to transfer lateral loads from the runway girders to the supporting vertically braced frames. The tie-back elements and their connections are detailed to accommodate flexural displacements of the runway without experiencing fatigue. The crane rail supported by the runway girders is 175 lb-per yard, ASTM A759 crane rail with rail clips sized and spaced to ensure both the rails and rail clips can withstand lateral crane operating loads as well as seismic loads.

Ordinary Concentrically Braced Frames (OCBFs) are selected as the seismic lateral force resisting system for the CHB in both the north-south and east-west directions, in accordance with ASCE 43-05 Table 4-1. Although ASCE 7-16 is not a governing code for CHB design (see Section 15.2.4), OCBFs are permitted by ASCE 7-16 Table 12.2-1 for buildings of any height in Seismic Design Category C and lower. For the seismic site coefficients given in the project geotechnical report (SAR Attachment E), Seismic Design Category C would apply to the CHB per ASCE 7-16 Section 11.6.

All vertical braces in the CHB are ASTM A1085 round HSS sections, which are the most efficient sections meeting the seismic ductility and slenderness requirements of AISC 341-16. Vertical braces are arranged in multi-story X configurations in both the north-south and east-west directions, to balance braces in tension and compression under lateral loads and to limit unbalanced forces on intersecting columns and struts. For the east-west braced frames, the three-column arrangement for each of the braced frames illustrated in Figure 7-56 is selected to provide vertical and lateral load path redundancy in the event of column damage due to tornado missile impact. Similarly, redundancy is achieved in the north-south braced frames by providing two bays of multi-story X braces (four vertical brace members per level) in each of the north-south braced frames and redundant longitudinal struts between columns (see Figure 7-58). For this configuration, the loss of an individual brace, or connection thereto, would only reduce the contribution of the given braced frame to the strength of the associated building story by 25%. This will result in no loss in overall structural integrity.

Figure 7-55 through Figure 7-60 illustrate typical member size groups utilized for CHB primary framing. Member size classes utilized for each primary framing member category are also summarized in Table 7-41. Further discussion of the CHB structural steel analysis and design is given in Sections 7.5.3.3 and 7.5.3.4.

7.5.3.1.2 Description of CHB Foundation

The principal safety function of the foundation system for the CHB is to transfer design-basis normal operating and extreme environmental loading demands from the building columns and crane support columns to the supporting soils, while providing sufficient resistance to sliding and overturning. These functions are achieved with a foundation consisting of cast-in-place, reinforced concrete footings and pedestals supporting the CHB column base plates. The use of shallow spread-footing type foundations is in accordance with recommendations in the project geotechnical report (see SAR Attachment E). The general foundation arrangement consists of three continuous strip mat footings running north-south, each supporting one of three column line groups shown in Figure 7-55: Lines A-D, Lines E-I, and Lines J-M. Separate footings are provided for the wind column vertical trusses at the north and south ends of the building. All footings are founded at a minimum depth of 9 feet below grade. This depth is selected to provide sufficient pedestal depth for development of the reinforcement and anchor rods required for resistance of tornado-induced uplift demands on the CHB columns. Excavation to the bearing stratum depth ensures the foundations will bear on competent material below the maximum 6.5-foot depth of loose overburden material encountered in boring activities documented in the project geotechnical report. See Section 7.5.3.3.3 for evaluation of soil-structure interaction effects. Further discussion of CHB foundation analysis and design is given in Section 7.5.3.5.

The working floor of the CHB is provided by a reinforced concrete slab on grade that is structurally isolated from the CHB foundations and the CTS foundation. The slab is founded on compacted structural fill placed to a sufficient depth to remove loose in-situ materials, in accordance with the project geotechnical report. Thickened reinforced concrete sections are provided for support of the rails and railcars at the south end of the building (see Figure 1-7).

7.5.3.1.3 Description of CHB Overhead Cranes

To facilitate rail car unloading activities, the CHB design incorporates two overhead bridge cranes rated at 130 tons each for lifting loaded transportation casks from the rail car, removal of impact limiters, and shielding, etc. The VCT is used to move the uprighted NAC transportation casks to the CTS.

The two cranes are identical in terms of geometry and configuration, which generally consists of two box-beam bridge girders supporting a top-running trolley. As shown conceptually in Figures 1-8 and 7-56, the bridge girders span 64'-0” between crane runway rails, and a minimum height of 40'-2″ is provided from hook to finished floor. Bridge and trolley travel are limited by structural steel end stops installed on the crane runway girders and bridge girders, respectively. The end stops engage bumpers installed on the crane and trolley that are sized and configured to limit impact forces applied to the supporting structure. A minimum of 3 inches of clearance is provided in all directions between crane components and surrounding obstructions in the building, in accordance with ASME NOG-1 and CMAA-70.

The overhead bridge cranes are classified as ITS including the seismic clips and runway beams and supporting structures, and are designed in accordance with NOG-1-2015 [7-70] "Rules for Construction of Overhead Gantry Cranes (Top Running Bridge, Multiple Girder)." The overhead bridge cranes rails are attached to the CHB structure in a manner that provides adequate assurance that the rails will remain attached to the CHB structure during the above-described seismic event. Seismic clips are provided on the overhead crane bridge trucks and trolley to limit uplift during a seismic event, thereby eliminating the potential for the bridge or trolley to fall onto loaded casks inside the CHB.

Lifts performed by the overhead bridge crane are governed by the guidance of NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants: Resolution of Generic Technical Activity A-36," to minimize the potential for release of radioactive material from a spent fuel cask. NUHOMS® transportation/transfer cask lifts are performed using the overhead bridge crane and the lift height is administratively controlled to ensure that the 80-inch design basis drop accidents previously approved by the NRC remain bounding (Reference WCS CISF SAR Tables A.3-1, B.3-1, C.3-1, and D.3-1). The overhead cranes may be used for miscellaneous lifts that do not involve lifting of loads over loaded transportation or storage casks inside the CHB.

7.5.3.2 Design Criteria

Analysis and design of the CHB structures are governed by nuclear facility codes and standards. NUREG-1567 Section 5.4.4, "Other SSCs Important to Safety," references ANSI/ANS 57.9 and the codes and standards cited therein as the basic references for ISFSI structures important to safety. Although ANSI/ANS 57.9 is no longer maintained as an American National Standard, the principal references it cites for analysis and design of ITS steel and concrete structures are consistent with current codes and standards applicable to safety-related nuclear facilities. As also summarized in Section 15.2.4, the following codes and standards are utilized for the given purposes:

- ANSI/AISC N690-18, Specification for Safety-Related Steel Structures for Nuclear Facilities. Applicable to definition of steel design load combinations and steel member and connection design requirements. ANSI/AISC 360-16, Specification for Structural Steel Buildings, is the baseline document modified in part by ANSI/AISC N690-18 for application to nuclear facilities.
- ANSI/AISC 341-16, Seismic Provisions for Structural Steel Buildings. Applicable to definition of seismic design and detailing requirements for the CHB structural steel seismic lateral force resisting system.
- ACI 349-13, Code Requirements for Nuclear Safety-Related Concrete Structures. Applicable to definition of concrete design load combinations and design of reinforced concrete structures and anchorages.
- ASCE 43-05, Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities. Applicable to evaluation of seismic demand and capacity of the CHB structures.

- ASCE/SEI 4-16, Seismic Analysis of Safety-Related Nuclear Structures. Applicable to seismic analysis procedures for the Cask Handling Building and its foundations.
- ASCE/SEI 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. Applicable to development of normal operating wind loads, snow and rain loads, and overhead crane operating loads.
- ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures. Applicable to transforming tornado wind speed into pressures applicable to the CHB, in accordance with NUREG-0800 Section 3.3.2, Tornado Loads.
- ASME NOG-1-2015, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder). Applicable to analysis and design of the two 130-ton overhead cranes supported by the CHB.
- CMAA-70 2015, Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes. Applicable to design of the CHB crane runway system.

7.5.3.2.1 Load Definitions

The CHB structure is designed to withstand snow and rain in accordance with the International Building Code. In addition, it is designed to resist failure of structural members under concurrent loading by design-basis tornado winds, atmospheric pressure change (APC), and tornado missiles.

Administrative Controls will be used to mitigate impacts of design-basis tornado loading. The transportation cask will not be moved into the building to begin the railcar unloading process unless current and forecasted weather meets the requirements described in Section 5.4 of the proposed Technical Specifications [7-78]. Eight hours is the estimated time to move any of the casks from the railcar to a stable configuration within the CHB in which the crane is no longer overhead or adjacent. For the NUHOMS® systems, eight hours bounds the approximate time (6.4 hours for MP187 casks, 4.3 hours for MP197HB casks) from entry of the cask railcar into the CHB, to the point where the cask has been placed on the transfer skid and the overhead crane can be relocated to the south end of the CHB. For the NAC systems, eight hours bounds the approximate time (5.5 hours for NAC-STC casks, 6.5 hours for NAC-UTC casks, and 8 hours for NAC-MAGNATRAN casks) from entry of the cask railcar into the CHB, to placement of the canister on the Canister Transfer Facility pad, at which point the overhead crane will no longer be overhead or adjacent to the cask on the railcar. Estimated time to perform cask receipt and transfer activities are provided as occupancy times in the occupational collective dose tables in each cask model’s respective Appendix, refer to Tables A.9-2, B.9-2, C.9-2, D.9-2, E.9-1, F.9-1, and G.9-1.

Administrative controls will restrict the movement of the overhead crane such that it will remain in the south-most bay of the CHB once railcar unloading has been completed. Administrative controls will prohibit additional non-empty casks on railcars inside the CHB, and thus adjacent to the crane, until the previous cask has been removed from the CHB and the next unloading evolution can proceed, weather conditions permitting. Similarly, for railcar loading operations following retrieval of a loaded canister, the loading process will not be permitted to proceed unless current and forecasted weather indicate safe weather conditions in accordance with Section 5.4 of the proposed Technical Specifications [7-78]. These actions eliminate the potential for collapse of overhead cranes onto canisters during receipt, transfer, and retrieval operations (with storage operations occurring outside the CHB).

Also, administrative controls are used to demonstrate compliance with 72.122(b) when the canisters are being transferred in the NAC transfer casks. NAC canister transfer operations typically take around 6 hours to complete. This is from the time the canister is lifted off the bottom of the transportation cask cavity, moved over to the VCC and lowered until it is resting on the VCC pedestal. This is consistent with the times estimated in Tables E.9-1, F.9-1 and G.9-1 for the NAC systems. Removal of the last three transportation cask lid bolts and installation of at least six lid bolts in the loaded VCC adds an estimated additional two hours to the transfer operation. Therefore, removal of the last three bolts from the transportation cask and the ensuing transfer operations will not be permitted unless current and forecasted weather meets the requirements described in Section 5.4 of the proposed Technical Specifications. (See Section 5.4 of the proposed Technical Specifications [7-78]) Thus, the total transfer time is typically 8 hours (i.e., 6 hours to complete the lifts and 2 hours to install the bolts for a total of 8 hours). Steps will be taken to improve on these times such as staging equipment in an efficient manner. Once the transportation casks for the Vertical Systems are moved into the CHB, Loading/Unloading and transfer operations will be performed in an expeditious manner to place the canister into the VCC.

A safe condition and forecast is considered to be the absence of: Tornado and Severe Thunderstorm Watches, Tornado and Severe Thunderstorm Warnings, and Hazardous Weather Outlook indicating a moderate to high risk of severe thunderstorms for the current date (Day 1). Weather forecasts will be accessed from the NOAA Weather Forecast Office prior to each railcar loading/unloading. The nearest NOAA Weather Forecast Office to the CISF is the Midland/Odessa Office. Administrative controls triggered by the presence of Tornado and Severe Thunderstorm Watches, Tornado and Severe Thunderstorm Warnings or a Hazardous Weather Outlook indicating a moderate to high risk of severe thunderstorms for the current date (Day 1) ensure avoidance of atmospheric conditions which are favorable for the development of severe thunderstorms capable of producing tornados within the specified period of time. In addition, as documented in Section 2.3.3.3 of the SAR only two (2) F2 Class tornadoes have been recorded in Andrews County, TX from 1950 through 2015 according to data from the National Oceanic and Atmospheric Administration (NOAA) and only eight (8) F1 Class tornadoes. Therefore, the risk of an unexpected tornado within eight hours of the time that no severe weather is predicted is extremely remote.

This section describes loads, loading combinations and analysis methods to be met for design of the WCS CISF reinforced concrete and structural steel structures.

Loads

Loads used in analysis and design of CHB structure include the following:

- D Dead load
- L Live load
- C – Crane operating and lifted (hoist) loads
- S – Snow load
- H lateral soil pressure load
- T_o Thermal load
- W Wind load
- W_t Tornado load
- F’ Flood load
- E’ Design Basis Earthquake seismic load

Load Definitions

- **Dead Load (D) –** Defined as any load, including related internal moments and forces, that is constant in magnitude, orientation, and point of application. Dead loads include the mass of the structure, and any permanent equipment loads including the overhead crane bridge and trolley weights. A minimum uniform load allowance of 20 lb/ft^2 is applied to roof and elevated platform areas to account for miscellaneous electrical conduits, handrails and ladders for which the actual dead load contribution is not precisely known at the time the analysis or design is performed.
- **Live Load (L)** – Defined as any normal load, including related internal moments and forces that may vary with intensity, orientation and/or location of application. Movable equipment loads, other than crane loads, loads due to vibration and any support movement effects and operating load are types of live loads. The following descriptions provide design requirements for various types of live loads.
  - **Transportation Vehicle Loads and Heavy Floor Loads** – Loads due to vehicular truck and rail traffic in designated building areas are in accordance with standard loadings defined by the American Association of State Highway and Transportation Officials (AASHTO) and by the American Railway Engineers Association. Special heavy loading conditions resulting from transport of SNF and storage casks on truck and rail transporters/carriages are considered. Design basis cask weights bound the worst-case condition of all vendor designs handled at the WCS CISF. Floor loadings from transportation,

transfer and storage casks are also considered, along with sufficient allowance for any impact resulting from placing the moving loads with the loaded VCT on the floor or other areas of the structure. Within the building, the floor under the Canister Transfer System will be designed to handle the specific loads produced by the hydraulic gantry system.

- **Floor Live Loads** – A floor live load of 6,000 lbs/ft^2 is applied to the concrete floor in the CHB. Live load for stairs, walkways, and platforms is 100 lb/ft^2.

- **Crane and Hoist Loads (C)** – Design loads for the CHB permanently installed cranes and hoists envelop the full rated capacity of the cranes, including allowances for impact loads and test load requirements. The rated capacity of each of the two overhead bridge cranes in the CHB is 130 tons. Crane test loads are considered in the design at 125% of the rated capacity of the cranes, increased by an additional 5% in accordance with ASME NOG-1-2015 Section 7423. Forces induced by crane movement are calculated in accordance with ASCE 7-16, as follows:
  - Vertical impact: 25% of maximum wheel loads (including lifted load and crane self-weight).
  - Lateral side thrust: 20% of the sum of the rated hoist capacity, plus the weight of the crane trolley and hoist.
  - Longitudinal traction: 10% of maximum wheel loads (including lifted load and crane self-weight).
- **Snow Load (S)** – As described in Chapter 3, the design live load due to rain, snow, and ice is 10 lb/ft^2, which is the ground snow load. Determination of roof snow and ice loads is in accordance with the requirements of ASCE 7-16.
- **Hydrostatic Fluid Pressure Loads** – Are due to fluids held in internal building compartments, such as tanks. There are no reinforced concrete tanks in the CHB. All tanks located in the CHB are designed in accordance with mechanical equipment design criteria.
- **Soil Load (H)** – Based on the density of the soil and includes the effects of groundwater, see attachment E of the WCS CISF SAR Chapter 2. Since the WCS CISF site is a dry, relatively flat site and the CHB is a slab-on-grade structure, no groundwater or soil pressure loads are exerted on building structures. Therefore, determination of lateral soil pressure loads is not necessary for structural analysis or design.

- **Thermal Load (T_o)** – Consists of thermally induced forces and moments resulting from operation and environmental conditions affecting the CHB. The design temperature changes (ΔT) used for structural analysis and design of the CHB are the differences between expected construction temperatures and winter or summer operating temperatures, assuming the building is unheated and without air conditioning. The temperatures considered for these ΔT calculations are based on data for Midland, Texas in Technical Report No. 65, Expansion Joints in Buildings, which include a 66°F mean temperature during construction, a summer operating temperature of 100°F (exceeded, on average, only 1% of the time between June and September), and a winter operating temperature of 19°F (exceeded, on average, 99% of the time between December and February). This results in a positive ΔT of 34°F and a negative ΔT of 47°F for consideration in the CHB analysis. In accordance with NUREG-1536 and ANSI/ANS 57.9, thermal loads are not combined with tornado or seismic loads given that the CHB thermal loading is self-limiting and will be relieved during response of the structure to these extreme loading conditions.
- **Wind Loads (W)** – Are those pressure loads generated by the design (or "normal") wind. The basic wind speed used to determine design wind loads on the CHB walls and roof is 116 miles per hour. Design wind loads are determined in accordance with the requirements of ASCE 7-16 [7-69], which consider ultimate strength level (limit state) wind speeds rather than service level wind speeds. The resulting pressures are intended for use with unity (1.0) LRFD wind load factors in the steel and concrete design load combinations. Wind loading conditions applicable to the CHB Main Wind Force Resisting System are determined in accordance with the Directional Procedure given in ASCE 7-16, Chapter 27 Part 1. Internal pressure coefficients are based upon an enclosed structure, given use of rated doors and operational protocols to shut all CHB doors during inclement weather. Design velocity pressures (q_Z) are determined using ASCE 7-16 Equation 26.10-1:

  $$q_z = 0.00256 K_z K_{zt} K_d K_e V^2$$

  where:

  K_z = velocity pressure exposure coefficient, equal to 1.18 for Exposure Category C and eave height of 73 feet above ground

  K_{zt} = topographic factor, taken as 1.0

  K_d = wind directionality factor, equal to 0.85 for Building Main Wind Force Resisting System

  K_e = ground elevation factor, taken as 0.9 for site elevation of approximately 3500 feet

  V = basic wind speed, equal to 116 mph for the WCS CISF site.

- **Tornado Loads (W_t)** – Are those loads generated by the design basis tornado wind speed, atmospheric pressure change (APC), and tornado missiles, determined in accordance with NRC Regulatory Guide 1.76. Per RG 1.76 Figure 1, the WCS CISF site is located in tornado intensity Region II, for which the maximum design wind speed is 200 miles per hour and the APC pressure change is 0.9 psi (130 psf). The standard spectrum of tornado missiles identified in RG 1.76 Table 2 is considered. For Region II, this includes the 6.625 inch-diameter x 15 foot-long Schedule 40 pipe, a 4000-lb automobile, and a 1 inch-diameter steel sphere travelling at the stated Region II velocities.

  Windward, leeward, sidewall, and internal pressures due to the 200-mph tornado wind speed are calculated in accordance with ASCE 7-05 [7-34] Main Wind Force Resisting System procedures, with no variation in windward pressure vs. height of the building. All factors in the velocity pressure (q_z) equation are defined in accordance with NRC Standard Review Plan, NUREG-0800, Section 3.3.2. Operational protocols during inclement weather require all doors in the CHB to be closed. Although the siding, roofing, and doors may not remain intact under tornado wind loading, the design will conservatively assume an enclosed structure, subject to the full outward-acting APC internal pressure (130 psf).

  The tornado (W_t) primary load case within the load combinations used for CHB design comprises two basic tornado wind loading conditions, in accordance with NRC Standard Review Plan Section 3.3.2:

  $W_t = W_p$

  $W_t = W_w + 0.5W_p + W_m$

  Where:

  $W_t =$ total tornado load

  $W_w =$ windward, leeward, sidewall, and roof pressures associated with the full tornado wind speed

  $W_p =$ internal pressure from atmospheric pressure change

  $W_m =$ load from tornado missile impacts

  Since the CHB is not credited as tornado missile protection for the spent fuel casks, analysis of tornado missiles is limited to missile impacts with the potential to damage or destabilize primary framing. Preventing penetration of the steel pipe or steel sphere missiles is not considered a CHB structural design requirement, as the casks are designed to withstand these impacts. Thus, design of the building for tornado missile impacts is limited to evaluation of demands induced by impacts from the bounding design-basis missile (the automobile) on primary structural framing; i.e., columns, vertical braces, and struts required to maintain structural stability.

Per NRC RG 1.76, the automobile missile impact is applicable to framing members over all heights from grade to 30 feet above all grade levels within 0.5 miles of the CHB. Based on the stated automobile parking administrative control and minimal elevation changes at the WCS CISF site, the lower 30 feet of primary framing members are considered subject to missile impact. A representative set of all potential strike angles on external framing members is evaluated. Internal primary framing impacts (e.g., crane support columns) afforded by the 25-foot north-south column spacing are also evaluated.

A linear elastic analysis and design approach is taken for missile impact loading on framing members, such that calculated demands can be superimposed on those due to tornado wind, atmospheric pressure change, and other normal loading conditions. The impulsive force magnitude of the automobile traveling at the prescribed velocity is determined using an impulse-momentum procedure. The magnitudes of demands induced in the impacted framing members are a function of both the impulsive force magnitude and the dynamic behavior of the impacted structure. Therefore, for each potential impact location considered, the impulsive force is applied to the structural analysis model as a rectangular step-function load in a transient dynamic analysis. The peak structural demands resulting from these analyses are then superimposed upon those due to tornado wind, atmospheric pressure change, and gravity load cases, in accordance with the design load combinations. Design of CHB primary framing members for these load combination demands ensures that neither the building nor the crane runway support structures will fail under design basis tornado loading, thereby eliminating the potential for damage to canisters during receipt, transfer, and retrieval operations (with storage operations occurring outside the CHB).

For further discussion of tornado missile impact analysis, see Section 7.5.3.3.4.

- **Flood Loads (F')** – Are due to exterior flood waters from the design-basis flood exerting forces and moments on exterior buildings structures, or entering a building and exerting loads on interior building structures. As described in Chapter 2, the CHB finished floor elevation is above the PMF elevation and flood loads are not applicable.
- **Seismic Loads (E')** – Loads are determined using nuclear facility standards, including ASCE 4-16 [7-69] and ASCE 43-05 [7-44]. In accordance with seismic analysis requirements in these codes, modal response spectrum analysis is performed to determine seismic demands for structural design of the CHB. The input response spectra for this analysis are developed from the site-specific response spectra generated by the Probabilistic Seismic Hazard Analysis for the WCS CISF site (discussed in WCS CISF SAR Chapter 2). Design spectral response accelerations will be used in the analysis and design of the building structure, crane supports, and seismic clips used as restraint for the overhead bridge crane and trolley.

Assessment of the site soil properties and the CHB dynamic response indicates that Soil-Structure Interaction (SSI) effects are minimal, such that the criteria of ASCE 4-16, Section 5.1.1 can be applied to justify fixed-base analysis in lieu of detailed SSI analysis. Section 5.1.1(a) permits seismic response analysis without consideration of soil-structure interaction (i.e., fixed-base analysis) if the frequencies of a rigid structure supported on soil springs representing site-specific soil properties are more than twice the dominant frequencies of the actual structure. This condition is present for the dominant lateral, rocking, and torsional response frequencies of the CHB, given the stiff soils at the WCS CISF site. Therefore, the design of the CHB for seismic loading presented herein, is performed using fixed-base analysis utilizing the surface Design Response Spectra (DRS) developed in the Probabilistic Seismic Hazard Analysis for the WCS CISF (discussed in SAR Chapter 2).

It is noted that the ratio of soil-supported to fixed-base response frequencies for vertical response of the crane support system is less than 2 (See Table 7-42). Although this is not a dominant mode with respect to the overall structure (mass participation is less than 10%), the result indicates amplification of the vertical runway response due to SSI effects may occur. Detailed design of the CHB will consider an SSI analysis performed in accordance with ASCE 4-16 [7-71]. The current design of the runway girder presented herein using the fixed base analysis results retains a low maximum demand/capacity ratio (0.29; see Table 7-43) to accommodate potential increased seismic demands during detailed design. The crane-level ISRS utilized for detailed crane design will be generated from the results of SSI analysis as discussed in Section 7.5.3.3.3.

Fixed-base analysis considered for the CHB design is further justified by the separation between the frequency range of the amplified portion of the DRS (approximately 6-20 Hz) and the dominant structural frequencies (less than 4 Hz). ASCE 4-16, Sections 5.1(b) and C5.1.1 indicate that this assessment is a prerequisite for considering a fixed-base analysis in accordance with Section 5.1.1. Regarding the additional fixed-base analysis criteria in ASCE 4-16, Section 5.1.1(b) related to embedment effects, the CHB will be founded on shallow mat foundations in accordance with the geotechnical report recommendations (SAR Attachment E), such that embedment effects will not be significant. Finally, the criterion in ASCE 4-16, Section 5.1.1(c), which requires SSI analysis in all cases where wave incoherency effects are to be considered, is not applicable to the CHB analysis. In accordance with the provisions in ASCE 4-16, Section 5.1.10, ground motion incoherency is conservatively neglected for WCS CISF structures.

For further discussion of CHB seismic load development, see Sections 7.5.3.3.3 (steel building) and 7.5.3.6 (overhead cranes).

7.5.3.2.2 Structural Steel Load Combinations

Structural steel load combinations applicable to the CHB are based on the LRFD load combinations given in ANSI/AISC N690-18, with the following three basic assumptions:

1. The design-basis seismic load case discussed above (E) is utilized where the safe-shutdown earthquake load (SSE) appears in the ANSI/AISC N690-18 load combinations. Load combinations with operating-basis earthquake loads applicable to nuclear power plant SSCs are not applicable to CHB design.

2. As previously stated, self-limiting operating thermal loads are not combined with tornado or seismic loads, in accordance with ANSI/ANS 57.9.

3. Since wind loads are developed per ASCE 7-16 using ultimate wind speeds, use of a 1.0 load factor on the wind load case (W) is appropriate in the severe environmental load combinations.

4. Crane load (C) is included with normal wind load (W) and seismic load, but is neglected with tornado loads (W_t) given the aforementioned crane administrative controls for tornado warnings. This is in accordance with ANSI/AISC N690-18 Equations NB2-4 and NB2-7.

5. For uplift load combinations, 90% of dead load is considered in conjunction with 100% of operating crane loads with a destabilizing effect (i.e., crane vertical impact, side thrust, and longitudinal traction loads). This is in accordance with ANSI/AISC N690-18 Section NB2.5d(4).

The following are structural steel design load combinations that result from these assumptions, when reduced to contain only the load cases previously defined as applicable to the CHB:

1. $1.4D + C + T_o$

2. $1.2D + 1.6L + 1.4C + 0.5S + 1.2T_o$

3. $1.2D + 0.8L + 1.4C + 1.6S + 1.2T_o$

4. $1.2D + W + 0.8L + C + 0.5S + T_o$

5. $D + 0.8L + C + E$

6. $D + 0.8L + W_t$

7. $0.9D + C + W$

8. $0.9D + C + E$

9. $0.9D + W_t$

7.5.3.2.3 Reinforced Concrete Load Combinations

Reinforced concrete load combinations applicable to the CHB foundations and floor slab are based on the load combinations given in ACI 349-13 [7-68], with similar assumptions to those applied to the structural steel load combinations:

1. The design-basis seismic load case discussed above (E) is utilized where the safe-shutdown earthquake (SSE) load appears in the ANSI/ACI 349-13 load combinations. Load combinations with operating-basis earthquake loads are not applicable.

2. As previously stated, self-limiting operating thermal loads are not combined with tornado or seismic loads, in accordance with ANSI/ANS 57.9.

3. Since wind loads are developed per ASCE 7-16 [7-69] using ultimate wind speeds, use of a 1.0 load factor on the wind load case is appropriate in the concrete load combinations.

4. For consistency with the CHB steel design load combinations, crane load (C) is included with normal wind load (W) and seismic load but is neglected with tornado loads (W_t) given the aforementioned crane administrative controls for tornado warnings.

5. For uplift load combinations, 90% of dead load is considered in conjunction with 100% of operating crane loads with a destabilizing effect (i.e., crane vertical impact, side thrust, and longitudinal traction loads).

The following are concrete design load combinations that result from these assumptions, when reduced to contain only the load cases previously defined as applicable to CHB concrete structures:

1. $1.4D + T_o$

2. $1.2D + 1.6L + 1.4C + 0.5S + 1.2T_o$

3. $1.2D + 0.8L + 1.4C + 1.6S$

4. $1.2D + 1.6L + W + C$

5. $D + 0.8L + C + E$

6. $0.9D + C + W$

7. $0.9D + C + E$

8. $0.9D + W_t$

7.5.3.2.4 Overhead Crane Load Combinations

Crane Load combinations applicable to the design of the overhead bridge cranes are developed in accordance with ASME NOG-1 Section 4140. The design-basis seismic load (E) discussed above is considered in the safe-shutdown earthquake (SSE) load case in the ASME NOG-1 extreme environmental load combinations.

7.5.3.3 CHB Steel Building Structural Analysis

To evaluate the performance of the CHB steel framing shown in Figures 7-54 through 7-61, the building is modeled in a detailed three-dimensional structural analysis model and subjected to all of the applicable design load cases and load combinations defined above in Sections 7.5.3.2.1 and 7.5.3.2.2. The assumption of linear elastic response for static, seismic, and tornado wind loads permits separate analysis of each loading condition and superposition of applicable load case member forces and moments to determine total load combination demands for evaluation vs. code defined member capacities.

In accordance with ANSI/AISC 360-16 Chapter C (as referenced by ANSI/AISC N690-18 Chapter NC), the First-Order Analysis Method is used to address stability analysis requirements. The CHB meets AISC limitations for use of this method, since the lateral system consists of a highly redundant braced frame with minimal second-order deformations (P-Δ). This method is also considered the most appropriate approach for dynamic analysis of the CHB. The member stiffness reductions required by other stability methods, such as the Direct Analysis Method, would result in unrealistic modal responses for the CHB braced frames, as the columns and struts are expected to remain elastic under design basis seismic loading. In addition, the Direct Analysis Method requires second-order, nonlinear analysis, which is not compatible with the modal response superposition performed in both the CHB seismic and tornado missile analyses.

7.5.3.3.1 CHB Steel Building Structural Analysis Model

Figure 7-62 shows an isometric view of the three-dimensional finite element analysis model generated in program STAAD.Pro (STAAD). The STAAD version utilized is the CONNECT Edition, Version 22.01.00.38, which is verified and validated under an ASME NQA-1 compliant quality program.

The global coordinate system for the CHB STAAD model is defined with positive X eastward, positive Y upward, and positive Z southward. The global boundary conditions modeled in all static and dynamic loading cases in STAAD consist of pinned supports at the base of each column. Each pinned base restrains the global UX, UY, and UZ translations, as well as ROTY rotations for analysis stability. The pinned base nodes are modeled at the bottom of column base plate elevation. Local boundary conditions applicable to individual members typically involve pinned member end releases (local ROTY and ROTZ) for all beams, vertical braces, and horizontal braces, as well as at the top of columns where they connect to the continuous roof truss chords.

The model includes approximately 3100 nodes and 5800 beam elements, with the intent of sufficient refinement to provide an accurate assessment of structure response to static and dynamic loading. The STAAD beam elements are formulated with six degrees of freedom per node (three translations and three rotations) and with shear deformation effects included in the member stiffness matrix. STAAD utilizes a diagonal, lumped mass matrix approach, with mass terms at all active degrees of freedom. Since dynamic analysis is performed to evaluate the CHB for seismic and tornado missile loading, members with significant transverse loading between points of support (e.g., beams and girders) are subdivided into multiple beam elements to capture dynamic flexural responses while utilizing the STAAD lumped mass formulation. At a minimum, three intermediate nodes (four elements) are used for all beams and girders.

Member stiffness properties for all rolled shapes are assigned using built-in AISC section property tables provided in STAAD, while properties for built-up sections such as the crane runway girders are manually calculated and inputted. Bridge crane and trolley members are not modeled in the CHB STAAD model; rather, the mass of the bridge is proportionally distributed to the runway girders while the trolley and lifted load mass is distributed to the runways according to trolley position along the bridge. Other entities modeled only as applied mass include secondary framing members and elements, such as girts, purlins, siding, roofing, and floor deck.

Linear elastic, isotropic material properties are assigned for all steel members in the CHB analysis model, including elastic modulus (E), Poisson's ratio (ν), unit weight (γ), and coefficient of thermal expansion (α). See Table 15-2 for the material property values utilized.

7.5.3.3.2 Static Analysis

Static analyses are performed to determine member forces, column reactions, and structure deflections due to gravity loads, crane operating loads, and wind/tornado pressures. The overall dead (D), crane (C), wind (W), and tornado wind (W_t) load cases defined in Section 7.5.3.2 are subdivided into several separate static load cases as needed to develop design load combinations that include enveloping directional permutations. Separate static load cases are modeled and analyzed for structure dead load, live load, crane dead load, crane lifted load, and crane impact loads in each direction (vertical, lateral, and longitudinal). With regard to wind load (W), separate static load cases are modeled for each primary direction of wind loading (i.e., +X, -X, +Z, and –Z), each containing the associated windward, leeward, sidewall, and roof pressures. Internal pressures are also addressed in a separate static load case. These are then combined in accordance with the ASCE7-16 Directional Procedure, as discussed in Section 7.5.3.2. A similar approach is used for tornado wind pressures, with a separate static load case for each primary direction of wind pressure loads (W_w) and for atmospheric pressure change (W_p).

Static analysis is also performed for the operating thermal (T_o) load case to evaluate forces induced in the CHB due to restraint of building temperature changes between ambient construction and winter or summer operating temperatures, as discussed in Section 7.5.3.2.1. Two load cases are developed to apply uniform temperature changes (ΔT) to all CHB framing equal to +34°F and -47°F, as previously defined. In accordance with ANSI/ANS 57.9, the resulting forces and moments are combined with gravity load cases within normal operating load combinations, but are not applied for extreme environmental conditions.

7.5.3.3.3 Seismic Analysis

The seismic response of the CHB is evaluated using modal response spectrum analysis, in accordance with ASCE 43-05 and ASCE 4-16. The input response spectra for the analysis are developed from the site-specific response spectra generated by the PSHA for the WCS CISF site (discussed in SAR Chapter 2).

Evaluation of Soil Structure Interaction Effects

Per ASCE 43-05 [7-44] Section 3.1 and ASCE 4-16 [7-71] Section 5.1(a), soil-structure interaction (SSI) effects must be considered. To evaluate the significance of SSI effects for the CHB, an assessment of site soil properties and dominant structural frequencies is performed in accordance with ASCE 4-16 Section 5.1.1. This evaluation entails calculation of soil frequencies based on a single degree-of-freedom system consisting of the lateral, vertical, torsional, or rocking soil spring and the relevant mass or mass moment of inertia for the overall CHB. The mass of the embedded CHB foundation is neglected in this calculation. Equivalent soil spring stiffness terms are calculated in accordance with ASCE 4-16 Table 5-2, using strain-compatible shear modulus determined from the site PSHA. In accordance with report NIST GCR 12-917-21 [7-72], soil shear modulus was averaged over an effective depth equal to half the effective footing width for the given direction of motion. Equivalent rectangular foundation dimensions for horizontal, rocking, and torsional responses are calculated on the basis of the combined contact areas of the three primary strip mat foundations as preliminarily sized. For vertical response, the dimensions of a single strip mat are considered, since the most significant mode involves vertical response of the crane runway support systems supported on the center strip mat.

As shown in Table 7-42, all soil/structure frequency ratios for lateral responses, torsion, and rocking in the east-west direction exceed 2. The ratio for rocking in the north-south direction is very nearly 2 (1.98). These results indicate that evaluation of overall structural response of the CHB to seismic loading based on a fixed-base analysis is acceptable with respect to ASCE 4-16 Section 5.1.1. However, the ratio of the rigid/soil-supported frequency to fixed-base structure frequency for vertical response of the crane support system is substantially less than 2 (1.64 for analysis including 130-ton cranes). Although the vertical response frequencies considered for these ratios are not associated with dominant modes involving overall structure response (the modes have small overall mass participation of approximately 10% in the vertical direction), the given frequency ratios indicate that some amplification due to soil-structure interaction effects may occur in the crane support system vertical seismic response. For the design presented herein, considering fixed-base analysis, the demand/capacity ratios of the crane runway girder are held lower to accommodate potentially larger seismic demands (maximum calculated DCR is currently 0.29; see Table 7-43). Detailed design of the CHB will consider an SSI analysis performed in accordance with ASCE 4-16. Performing an SSI analysis will ensure amplification due to SSI effects is captured in the crane support system response and in the resulting crane ISRS needed for detailed design of an ASME NOG-1 crane.

Use of a fixed-base analysis for this stage of the CHB seismic design presented herein is further justified by the relatively low Demand/Capacity Ratios (DCRs) calculated for the selected member sizes under seismic load combinations. As shown in Table 7-43, tornado wind/missile load combinations govern the design for the vast majority of CHB framing member types. The tornado loading DCRs for CHB primary framing elements, such as columns, roof truss chords, and vertical bracing, are more than twice the corresponding seismic DCRs. Thus, any small increases in seismic demands that may result from SSI analysis performed in final design are not expected to require changes to the CHB primary framing design. With regard to the runway girder design, the governing DCR in the current design has been held to a low value (0.29 from Table 7-43) to accommodate final design, including potentially increased seismic demands resulting from SSI analysis performed in final design.

Seismic Mass

In accordance with ASCE 43-05 Section 3.4.2, the effective seismic mass of the CHB is taken as the sum of the weight of the structure, permanent equipment, and the expected live load, taken as 25% of the specified design live loads. Also per ASCE 43-05 Section 3.4.2, snow load need not be included in seismic mass since it is less than 30 psf (10 psf is the ground snow load; see Section 7.5.3.2.1). The overhead crane bridge and trolley mass are included for seismic mass in all directions, while the lifted load mass is only considered as seismic mass in the vertical direction. This is based on the assumption that the pendulum motion of the lifted load is of sufficiently low frequency to be considered as fully out-of-phase with the dynamic response of the supporting structure.

Damping

A constant modal damping ratio of 7% is used for CHB seismic analysis. This is based on ASCE 43-05 Table 3-2, considering welded or friction-bolted structures at Response Level 3. In accordance with AISC 341-16 Section D.2.2, all OCBF bolted connections will be classified as friction-bolted, as they are required to utilize fully pretensioned bolts with faying surfaces prepared to a slip coefficient of Class A or better. Per ASCE 43-05 Section 3.4.3, Response Level 3 damping may be used for evaluating seismic-induced forces and moments in structural members by elastic analysis, without consideration of the actual response level for Limit States A, B, or C. The CHB analysis considers Limit State C, corresponding to limited permanent distortion per ASCE 43-05 Table 1-4.

Modal Analysis

Modal response of the CHB for seismic response spectrum analysis is evaluated in STAAD using the Load-Dependent Ritz eigensolver. This solver is used because it is more efficient than other solvers in extracting modes of significance to the seismic response of the building. As a result, fewer overall modes are required to obtain sufficient mass participation. 500 modes are extracted, capturing more than 90% mass participation in all three global directions.

Response Spectrum Analysis Methodology

Response spectrum analyses for the CHB are performed using the Lindley-Yow method described in NRC Regulatory Guide 1.92 and endorsed by ASCE 4-16 Section 4.3.2. The Lindley-Yow method divides the total seismic response into two components: response in-phase with the ground motion (i.e., the “rigid” response) and response out-of-phase with the ground motion (i.e., the “periodic” response). A typical seismic response spectrum can be divided into three regions, as shown in Figure 7-63. Defining f_{SP} as the frequency corresponding to the peak spectral value on the response spectrum curve and f_{ZPA} as the frequency corresponding to the zero-period ground acceleration (ZPA), the regions may be categorized as follows:

- Modes having a frequency less than f_{SP} (low-frequency range) are predominately out-of-phase with the ground motion and thus have no contribution to the in-phase response.
- Modes having a frequency between f_{SP} and f_{ZPA} (mid-frequency range) contribute to both the in-phase and out-of-phase responses.
- Modes having a frequency greater than f_{ZPA} (high-frequency range) are in-phase with the ground motion.

The total in-phase response is calculated using the “Static ZPA Method” outlined in Regulatory Guide 1.92. This involves a static analysis in which the ZPA is applied to the total in-phase mass, equal to the total structure mass minus the sum of modal masses for modes with $f < f_{sp}$. Applying the ZPA to the in-phase mass automatically accounts for the so-called “missing mass,” or that portion of the structural mass that does not participate in the amplified modal responses.

The out-of-phase response is determined by performing a response spectrum analysis combining the response of modes having a frequency less than or equal to the frequency corresponding to the ZPA (f_{ZPA}). Modified spectral accelerations, $S'_{ai} = S_{ai} [1- \alpha_i^2]^{1/2}$ are used in the analysis, where S_{ai} equals the unmodified spectral acceleration for mode “i”. For modes that have a frequency less than f_{SP} (low-frequency range) and are predominately out-of-phase with the ground motion, $\alpha i = 0$. For modes having a frequency between f_{SP} and f_{ZPA} (mid-frequency range), $\alpha_i = ZPA/S_{ai}$.

Modal responses obtained using the modified spectra are combined in STAAD using the Complete Quadratic Combination (CQC) method, in accordance with ASCE 4-16 Section 4.3.2. The total seismic response in each direction is calculated as the square root of the sum of the squares (SRSS) of the in-phase and out-of-phase components, in accordance with the Lindley-Yow Method outlined in Regulatory Guide 1.92. Finally, the three directional responses (or spatial components) are combined by SRSS, in accordance with ASCE 4-16 Section 4.3.3.

Accidental Torsion

In accordance with ASCE 4-16 Section 3.1(i), the effect of accidental torsion is addressed in static analysis considering a torsional moment equal to the story shear at each level multiplied by 5% of the plan dimension perpendicular to the direction of motion. Two accidental torsion load cases are defined; one involving all story shears in the X direction with corresponding Z-direction eccentricity, and one with all story shears in the Z direction and corresponding X-direction eccentricity. In accordance with ASCE 4-16, the resulting forces must only be used to increase member design forces. Therefore, the magnitudes of the demands calculated in these two load cases are added to the corresponding demands obtained from the response spectrum analysis, which do not have signs as a result of CQC and SRSS squaring procedures.

7.5.3.3.4 Tornado Missile Impact Analysis

Refer to the discussion of Tornado Loads in Section 7.5.3.2.1 for an introduction to the Tornado Missile Impact Analysis.

The transient dynamic analysis performed in STAAD utilizes the mode superposition method of calculating structural response at each time step. Similar to the seismic response spectrum analysis, the Load-Dependent Ritz eigensolver is utilized, as it is more effective in capturing high frequency modes important to tornado missile response. A sufficient number of modes are extracted to capture more than 90% mass participation. A time step of 0.0001 seconds is considered for the transient analysis, which is well less than $1/20^{th}$ of the shortest structural response period of interest, in accordance with industry practice. A constant modal damping ratio of 5% is assumed. The impulsive missile loading for the given impact location is applied as a nodal load with a rectangular load vs. time function that has a magnitude equal to that of the calculated impulsive force and a duration of 0.05 seconds. This duration is in accordance with guidance on automobile tornado missile impacts in UCRL-ID-115234, Title I Wind/Tornado Design Guidelines for New Production Reactors," Lawrence Livermore National Laboratory, September 1993. As maximum member forces are shown to occur within the first second of dynamic response, the total duration of the transient analysis is two seconds.

For each impact location of interest, a separate STAAD model is executed to perform static analyses for all other tornado wind, APC, and gravity load cases in the tornado load combinations, along with the mode superposition transient analysis for the single automobile impact case under consideration. Member demands are calculated in accordance with the design load combinations for each tornado missile impact model for all primary framing members in the STAAD model, and the envelope of all load combination demands from all models are considered in the member design checks.

7.5.3.4 CHB Steel Building Design

Design of the CHB steel framing is performed in accordance with the requirements of ANSI/AISC N690-18, which overlays additional requirements on the provisions of ANSI/AISC 360-16. This is in general accordance with the NUREG-1567 reference to ANSI/ANS 57.9, which in turn references ANSI/AISC N690-1984 for steel structure load combinations and design limits. ANSI/AISC N690 is considered for CHB design because it provides specific requirements for safety-related nuclear structures, including load combinations containing tornado loading. The 2018 version is utilized for compatibility with current national consensus codes and standards providing requirements for building structures (e.g., IBC 2016 and ASCE 7-16).

With regard to seismic design, the CHB lateral force resisting system is evaluated in accordance with the design requirements and acceptance criteria given in ASCE 43-05. ASCE 43-05 identifies OCBFs as acceptable structural systems for use in nuclear facilities, and permits design of steel structures in accordance with LRFD requirements given in AISC specifications (AISC 360 or AISC N690), as modified by the AISC Seismic Provisions (see ASCE 43-05 Section 4.2.4.) Thus, the CHB OCBFs are designed to meet the system, member, and connection requirements given in ANSI/AISC 341-16, Section F1.

Both ASCE 43-05 and ANSI/AISC 341-16 ensure acceptable seismic performance of OCBF systems by requiring design of critical members and connections for larger seismic demands than those considered for vertical brace member design. In the design of the CHB OCBFs in accordance with ASCE 43-05, the full seismic force developed from the elastic analysis is considered for design of all members and connections except vertical brace members. The design seismic force for the vertical braces is taken as the elastic seismic demand divided by the specified System Inelastic Energy Absorption Factor ($F\mu s$; see ASCE 43-05 Section 5.1.2). For design of the CHB to Limit State C, the $F\mu s$ factor applicable to OCBF vertical bracing members is 1.5 (see ASCE 43-05 Table 5-1). The CHB has no weak or soft stories and its fundamental frequencies are less than the amplified acceleration region of the design response spectrum; therefore $F\mu s = F\mu$. Thus, design of the CHB per ASCE 43-05 ensures that inelastic response under seismic loading will first occur in the vertical braces, while the columns and beams are designed not to buckle under the design-basis seismic loads (i.e., those calculated in the elastic analysis with $F\mu = 1.0$).

7.5.3.4.1 Member Design

Design of the CHB structural steel framing confirms that no applicable strength or serviceability limit state is exceeded when the structure is subjected to the design load combinations. In terms of strength limit states, the design compares all individual and combined loading member demands calculated from the design load combinations evaluated in the STAAD analysis model with the corresponding LRFD design strengths. In accordance with ANSI/AISC N690-18, member design strengths are calculated per ANSI/AISC 360-16 Chapters D through H, without modification. In general, the design for each member and each applicable strength limit state confirms:

$$R_u \leq \phi R_n$$

where R_u is the required strength (load combination demand), R_n is the nominal strength, and ϕ is the applicable resistance factor defined in ANSI/AISC 360-16.

With regard to serviceability, seismic story drifts are confirmed to meet the drift ratio limit specified in ASCE 43-05 for concentrically braced frames designed to Limit State C, which is 0.005. Additionally, the crane runway girders are confirmed to have lateral and vertical deflections less than the serviceability limits specified in CMAA-70 (L/400 for lateral deflection and L/600 for vertical deflection) under service level loading conditions.

STAAD Code Checking

Member strength design checking is performed in accordance with ANSI/AISC 360-16 LRFD provisions using the code checking capabilities provided in STAAD. Code checks are executed for all analyzed members and all design load combination demands calculated in each STAAD analysis model. This includes the primary model executed to determine gravity, normal wind, and seismic load combination demands, and separate models executed to determine load combination demands due to the combined effects of tornado wind, APC, and tornado missile impacts at each of the locations considered. Within the primary model used for seismic analysis and design, additional load combinations applicable only to vertical brace member design are defined with seismic load case demands divided by $F_{\mu\sigma} = 1.5$.

Execution of ANSI/AISC 360-16 code checks within STAAD requires user entry of all applicable member design parameters required for calculation of member design strengths. This includes the specified minimum yield strength of the modeled members, equal to 50 ksi for all CHB members, and various parameters defining the unbraced lengths for each member. Unbraced length parameter inputs include the following:

- K: Effective length factor, taken as 1.0 for all members in accordance with the First-Order Analysis Method (see AISC 360-10 Appendix 7.3).
- LX: Member unbraced length for torsional and flexural torsional buckling.
- LY / LZ: Member unbraced lengths for compression buckling about the member Y and Z axes.
- UNT / UNB: Unsupported lengths of member top and bottom flanges in flexural compression, for evaluation of lateral torsional buckling.

STAAD performs member strength checks for the demands calculated at each end of every member, as well as at 11 equally-spaced points along the member length ($1/12^{th}$ points). The maximum Demand/Capacity Ratio (DCR) for any of these points is presented for each member in the STAAD postprocessor, along with the governing load combination and the governing ANSI/AISC 360-16 strength equation. The governing DCR for each CHB member is taken as the maximum DCR calculated in all STAAD CHB models.

It is noted that STAAD AISC code checking considers the limiting width-to-thickness (member slenderness) ratios defined for members subjected to axial compression and flexure in ANSI/AISC 360-16 Chapter B. However, the seismic ductility and slenderness limits specified in ANSI/AISC 341-16 are not evaluated in STAAD. In accordance with ANSI/AISC 341-16 Section F1.5, all OCBF vertical braces are confirmed in separate calculations to be moderately ductile and to have member slenderness ratios (L/r) less than $4\sqrt{(E/F_y)}$.

7.5.3.4.2 Connection Design

CHB structural steel framing connections utilize shop-welded and field-bolted detailing, to minimize field welding and field weld inspection. Design of CHB framing connections is performed in accordance with ANSI/AISC 360-16 Chapter J, as modified by ANSI/AISC N690 Chapter NJ, and AWS D1.1 and AWS D1.8 where required. The required strengths of connections are determined from all applicable design load combinations, including seismic and tornado load combinations. In addition to meeting the general requirements of ANSI/AISC 360-16, all primary lateral force resisting system connections are designed and detailed in accordance with the provisions applicable to OCBFs in ANSI/AISC 341-16. The following is a summary of applicable requirements implemented in the CHB design:

- All bolts are high strength bolts installed with full pretension.
- Bolts and welds do not share the same force component in any connection.
- Bolts are installed in standard holes or in short slots perpendicular to the applied load.
- The available shear strength of bolted joints is calculated as that for bearing-type joints in accordance with ANSI/AISC 360-16 Chapter J.
- Faying surfaces are prepared to satisfy slip-critical connection requirements in ANSI/AISC 360-16 and are prepared to have a Class A slip coefficient or higher.
- The required strength of OCBF vertical brace connections is determined using the overstrength seismic loads, in accordance with AISC 341-16 Section F1.6a. This requirement is met by designing for $F_\mu = 1.0$ seismic demands, in accordance with ASCE 43-05.
- All OCBF welded connections are detailed and installed in accordance with the applicable requirements of AWS D1.1 and D1.8 as required.

- Column base connections and splices are designed for the required axial, shear, and flexural forces defined in ANSI/AISC 341-16 Sections D2.5 and D2.6.
- The available strengths of concrete and reinforcing steel utilized in column base anchorage to the foundation are determined in accordance with ACI 349-13.

7.5.3.5 Reinforced Concrete Structural Analysis and Design

Analysis and design of the CHB reinforced concrete foundations is performed in accordance with the requirements of ACI 349-13, considering all design load combinations defined in Section 7.5.3.2.3. This is in general accordance with the NUREG-1567 reference to ANSI/ANS 57.9, which in turn references ACI 349-85 for concrete load combinations and design limits. Design of CHB column baseplate anchorage is in accordance with the requirements of ACI 349-13 Appendix D.

Material properties considered in foundation analysis and design, including specified strengths for structural concrete, reinforcing steel, anchor rods, and steel plate (utilized for baseplate shear lugs) are summarized in Table 15-2. Soil properties considered in foundation design are those specified in the project geotechnical report (SAR Attachment E). This includes an allowable bearing pressure of 4000 lb/ft^2 and a subgrade modulus of 150 lb/in^3. As stated in the geotechnical report, the allowable bearing pressure is permitted to be increased to 6000 lb/ft^2 for limit state loadings. The unit weight of structural fill considered in foundation stability calculations is assumed to be 110 lb/ft^3.

Foundation stability is evaluated for the west strip mat foundation, which is considered representative of all three strip mats. The east and west strip mats have a narrower plan dimension in the east-west direction than the center strip mat, while the west strip mat has somewhat less applied dead load with fewer crane columns than the east strip mat. A minimum factor of safety of 1.5 is required for sliding and overturning when evaluated for the stability load combination containing normal wind and crane operating loads in Section 7.5.3.2.3 (load combination #6). For the seismic and tornado uplift load combinations (#7 and #8 in Section 7.5.3.2.3), the minimum factor of safety for sliding and overturning is 1.1. This is in accordance with ASCE 43-05 Section 7.2 for seismic stability.

7.5.3.6 Overhead Crane Analysis and Design

To ensure the CHB overhead cranes can withstand design-basis seismic loading and will not fall and damage ITS equipment, the cranes are analyzed and designed as Type 1, single-failure-proof cranes in accordance with ASME NOG-1. NUREG-0800 Section 9.1.5, Subsection I.4.C, states that an acceptable approach for ensuring overhead crane safety is to comply with NUREG-0554, and that design in accordance with NOG-1 criteria for Type 1 cranes is an acceptable method of compliance with NUREG-0554. Type 1 criteria require the cranes to be designed to ensure that any credible failure involving a single component does not result in loss of capability to stop and hold the critical load. In the case of the CHB overhead cranes, the critical load is conservatively considered as the rated crane capacity (130 tons).

In accordance with ASME NOG-1-2015 Section 4150 [7-70], seismic demands on the cranes are determined from modal response spectrum analysis of a three-dimensional finite element model meeting all requirements of Section 4153, including requirements for model geometry, boundary conditions, and trolley and hook positions. Input to the response spectrum analysis consists of broadened in-structure response spectra (ISRS) computed in each of three directions at the crane support level of the CHB. The crane-level ISRS are developed from coupled analysis of the building and crane, in accordance with the requirements of ASCE 4-16 [7-71], Section 3.7. For response spectrum analysis of the crane in the vertical direction, the crane model includes the mass of the credible critical load, defined by NOG-1 as the lifted load with a probability of occurrence in conjunction with the Design Basis Earthquake (DBE) greater than or equal to 10-7. For analysis of CHB ITS structures, the DBE return period is 10,000 years (1x10-4 annual probability) and the expected number of rated load lifts per year, per crane is approximately 200, with an assumed duration of two hours per lift. As the combined probabilities of both cranes lifting a rated load in conjunction with the DBE exceeds 10-7, the rated load is considered as the credible critical load for seismic analysis of the cranes. For response spectrum analysis in the horizontal directions, response of the lifted load mass is addressed in accordance with NOG-1 Section 4153.3 criteria for separation between the frequency of pendulum motion and the fundamental horizontal frequencies of the crane. All operational hook positions are considered when calculating the pendulum frequency of the lifted load.

Normal operating crane loads, including dead loads of trolley and bridge, lifted loads, and crane impact/inertial forces, are developed in accordance with NOG-1 Section 4130. Combinations of normal operating loads and seismic loads are developed in accordance with NOG-1 Section 4140, with the DBE seismic loads discussed above considered in the Safe-Shutdown Earthquake (SSE) load case in the extreme environmental load combinations. As discussed above, the credible critical load for seismic load combinations is the rated load.

7.5.3.7 Summary of Maximum Design Capacity Ratios

Design Capacity Ratios DCRs are specified for key structural elements of the CHB, which include main columns, sacrificial zipper columns, sacrificial and non-sacrificial struts, built-up crane runway girder, top and bottom roof truss chords, roof truss web members, and sacrificial vertical bracing. The governing DCR for an element group are taken directly from the CHB STAAD model and submodels considering gravity, seismic, tornado wind pressure, and tornado missile impact with tornado wind pressure load combinations. The maximum DCRs for the primary framing structural steel in the CHB STAAD model and submodels are provided in Table 7-43.

7.5.3.8 On-Site Accidents

WCS CISF-initiated explosions are not considered credible since insufficient explosive materials are present to initiate an event that would result in the destruction of the building. During operations, the amount of flammable liquids that are in the CHB will be administratively controlled to ensure the amount of flammable liquids is maintained below the fire load limits for the respective systems (e.g., 300 gallons of diesel fuel equivalent for NUHOMS® and 50 gallons of diesel fuel equivalent for the NAC-MPC, NAC-UMS, and MAGNASTOR Systems). In combination with fuel limitations and a fire suppression system, the fire hazard for the building is adequately mitigated (see WCS CISF SAR Section 3.3.6).

7.5.3.9 Off-Site Accidents

Off-site accidents are addressed in WCS CISF SAR Section 12.2.2.

7.6 Other Structures, Systems, and Components Subject to NRC Approval

This section describes the structural design, design criteria and design analysis for the storage pads for the NUHOMS® and NAC Systems.

7.6.1 Storage Pads for VCCs

The WCS CISF storage pads are conventional cast-in-place reinforced concrete mat foundation structures. They provide a level and stable surface for placement and storage of VCCs. The pads are designed for normal operating loads, severe environmental loads and extreme environmental loads as referenced by NUREG-1567 [7-28]. The storage pads for the NAC VCCs are designed as ITS structures as described below.

The purpose of this evaluation is to structurally qualify the WCS CISF Storage Pad designs for the vertical systems. The licensing-basis WCS CISF VCC configuration is a 3x8 array of MAGNASTOR casks, which envelopes the other NAC International casks to be stored at the WCS CISF. The qualification is conducted in accordance with the NUREG-0800 [7-43], NUREG-1536 [7-42] and NUREG-1567 [7-28]. A geotechnical liquefaction analysis and elastic settlement analysis is performed as part of the Geotechnical Exploration Report [7-32] and Calculation NAC004-CALC-02 [7-48].

7.6.1.1 Design Inputs

Material Properties

Soil Properties

Modulus of subgrade reaction, K_s

The modulus of subgrade reaction is calculated based on an iterative process conducted between the geotechnical model of the substrate underneath the pad and the structural model of the concrete ISFSI pad. Further details regarding the calculation of the modulus of subgrade reaction below the different areas of the ISFSI pad are documented in Section 4.3.3 and Appendix H of Reference [7-32].

Foundation friction coefficient (between concrete and bearing soils),
$\mu = 0.35$ (Ref. [7-32], Section 4.4)

Subsurface water was not observed at the WCS CISF. (Ref. [7-32], Section 3.2.2)

Design Loads

Dead Load:

The design dead loads are the weight of the concrete.

Live Load:

Live load includes the weight of loaded VCCs and VCT, operational loads of handling equipment and occupancy load as listed below.

Snow Load:

Snow load is considered to be enveloped by the live load to simplify the load combinations. Per ASCE 7- 05 (Ref. [7-34], Figure 7-1) the ground snow load is 10 psf at the WCS CISF, which is small relative to the live load.

Thermal Load:

Two thermal load cases are considered: the normal operating thermal loads and accident thermal loads. The MAGNASTOR cask elevated temperatures bound all other cask system design types to be stored on the ITS storage pads for NAC systems.

[ ]

Rain Load:

The rain load is negligible for the Storage Area given that the storage pads are constructed to levelness and flatness criteria per classification “super flat” which limits ponding and there are no curbs being installed.

Wind Load Casks:

Two wind load cases are considered to act on the casks: the normal operating basis wind load and the design basis tornado wind load. Per NUREG-1536 (Ref. [7-42], Table 3-2) wind loads are to be calculated utilizing ASCE 7.

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Seismic Inertia Load

The seismic accelerations for the 10,000-year return period earthquake response spectrum were developed as part of the site-specific seismic hazard evaluation in reference [7-33]. The site-specific seismic hazard evaluation presents the safe-shutdown earthquake (SSE) as the 10,000-year period earthquake. The site-specific seismic hazard evaluation [7-33] was used as an input to the subsequent soil-structure interaction (SSI).

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7.6.1.2 Design Basis

The design of WCS CISF is based on NUREG-1567 [7-28] with reference to NUREG-1536 [7-42] and NUREG-0800 [7-43]. Guidance from NUREG-1567 is utilized for this design. Codes of record and regulatory guides referenced in NUREG-1567 are utilized throughout the design. The code and regulatory guide years/revisions are based on the reference year for IBC 2009 [7-45] (building code for Texas) and the newest revision of the regulatory guides. The codes of record and regulatory guides used for the design, where applicable, are as follows:

- ACI 318-08 [7-39]
- ACI 349-06 (latest revision endorsed by the NRC) [7-31]
- ASCE 7-05 [7-34]
- ASCE 43-05 [7-44]
- Regulatory Guide 1.61, Rev. 1 [7-38]
- Regulatory Guide 1.76, Rev. 1 [7-35]

7.6.1.3 Design Load Considerations

Thermal Load

Thermal loading of the storage pad is not considered in detail given that the heat transferred to the storage pad is very small and is only in relatively small localized areas. Furthermore, the local cask concrete elevated temperature, which occurs only near the cask top, is less than the ACI 349-06 (Ref. [7-31], Section E.4) accident temperature limits of 350 °F for the concrete surface.

Cask Drop Load

The cask drop accident has been considered with respect to the structural integrity of the cask as part of the MAGNASTOR FSAR [7-40]. The cask drop impact to the storage pad is not considered here because such an accident would result in localized damage to the storage pad, but not result in a loss of stability of the storage pad. In the case of such an accident, the storage pad would need to be evaluated and repaired as needed.

Tornado-Missile Impact Load

Tornado-missile impact load has been considered with respect to the structural integrity of the cask as part of the MAGNASTOR FSAR [7-40]. Tornado-missile impact to the directly to the storage pad or to a cask on the storage pad is not considered here because such an extreme condition would result in localized damage to the storage pad, but not result in a loss of stability of the storage pad. In the case of such an accident, the storage pad would need to be evaluated and repaired as needed. This is consistent with NUREG-1536 (Ref. [7-42], Table 3-3), which states for the tornado load case "[t]he load combination (capacity/demand >1.00 for all sections) shall be satisfied without missile loadings. Missile loadings are additive (concurrent) to the loads caused by wind pressure and other loads; however, local damage may be permitted at the point of impact if there is no loss of intended function of any structure important to safety."

Seismic Inertia Loading

The seismic load case includes various cask layouts, but not does not consider short-term configurations (e.g., VCT in operation). All three directions of seismic excitation are conservatively considered simultaneously.

Wind Load on Transporter:

The operational wind load of 25.34 kip is determined in Section 7.6.1.1. Because the transporter is not included in the GTSTRUDL model, the loads are applied directly as nodal joint forces representing the self-weight. The operational wind load creates an overturning moment on the VCT that is resolved into a vertical force couple.

The load from the operating wind load on the VCT is very small when compared to load due to self-weight of VCT. Instead of creating additional load combinations for operating wind load on the VCT, the wind load is added to vertical load self-weight which equals

= 1.33 kip/in + 0.18 kip/in = 1.51 kip/in. Use 1.55 kip/in.

7.6.1.4 Load Combinations

Per NUREG-1567 (Ref. [7-28], Section 5.4.3.4), load combinations for reinforced concrete structures including Independent Spent Fuel Storage Installations (ISFSIs) are per NUREG-1536 (Ref. [7-42], Table 3-3) and ACI 349 [7-31]. Load combinations from the two sources are presented only with applicable load cases. Note that ACI 318-08 [7-39] are enveloped by ACI 349 [7-31] load combinations. Thermal, piping, pipe break, soil, snow and flooding load cases are not included for clarity. Vertical cask transporter loads are considered as live loads as opposed to crane loads.

ACI 349-06 Load Combinations

$U = 1.4D$ (Ref. [7-31], Eq. 9-1)

$U = 1.2D + 1.6L$ (Ref. [7-31], Eq. 9-2)

$U = 1.2D + 0.8L$ (Ref. [7-31], Eq. 9-3)

$U = 1.2D + 1.6(L + E_O)$ (Ref. [7-31], Eq. 9-4)

$U = 1.2D + 1.6(L + W)$ (Ref. [7-31], Eq. 9-5)

$U = D + 0.8L + E_{SS}$ (Ref. [7-31], Eq. 9-6)

$U = D + 0.8L + W_t$ (Ref. [7-31], Eq. 9-7)

$U = D + 0.8L$ (Ref. [7-31], Eq. 9-8)

$U = D + 0.8L + E_{SS}$ (Ref. [7-31], Eq. 9-9)

*Note: All dead loads shall be considered at 0.9 where dead load reduces the effects of other loads. Similarly, live load shall be considered zero where live load reduces the effects of other loads.

Section 9.2.2 of ACI 349-06 [7-31] states that “Where the structural effects of differential settlement, creep, shrinkage, or expansion of shrinkage-compensating concrete are significant, they shall be included with the dead load in Eq. (9-4) through (9-9).”

The maximum settlements at the different sections of the storage pad have been calculated in the revised Geotechnical Exploration Report [7-32]. The maximum differential settlement based on the settlements reported in Appendix H of reference [7-32] is calculated to be 0.70 inches. Per Table 5-7 of reference [7-54], the recommended maximum limit for the differential settlement of buildings with rafts type footings (similar to the concrete pad under consideration) on clayey soils and sandy soils is 35 mm (1.38 in.) and 25 mm (0.98 in.), respectively.

Since the calculated maximum differential settlements are significantly lower than the permissible limits as defined in Table 5-7 of reference [7-54], it is considered that the additional loads on the concrete due to the differential settlements of the pad would be negligible when compared with the other relatively large design loads, including various dead and live loads. Consequently, the loads due to the differential settlements have not been considered together with the dead load in the load cases listed above.

NUREG-1536 Load Combinations

$U = 1.4D + 1.7L$ (Ref. [7-42], Table 3-3)

$U = 1.05D + 1.275L$ (Ref. [7-42], Table 3-3)

$U = 1.05D + 1.275(L + W)$ $U = D + L + E_{SS}$ (Ref. [7-42], Table 3-3)

$U = D + L + W_t$ (Ref. [7-42], Table 3-3)

*Note: All dead loads shall be varied by 5% where dead load reduces the effects of other loads.

NUREG-1536 Stability Load Combinations (Overturning and Sliding)

$O/S \geq 1.5D$ (Ref. [7-42], Table 3-3)

$O/S \geq 1.1(D + E_{SS})$ (Ref. [7-42], Table 3-3)

$O/S \geq 1.1(D + W_t)$ (Ref. [7-42], Table 3-3)

Governing Load Combinations

Governing load combinations are compiled based on code load combinations, considerations for reduced dead and live load effects, and directions of seismic excitation. Furthermore, SSE seismic load is shown to envelope the tornado wind load (Section 7.6.1.6); therefore, tornado wind load combinations are not included. Because the operational wind load is applied to the transporter, but the seismic load is not considered for the transporter, the operational wind load case is included.

Strength

$U \geq 1.4D + 1.7L$

$U \geq 1.2D + 1.6(L \pm E_O)$

$U \geq 0.9D + 0.9\,L^{**} + 1.6(\pm E_O)$

$U \geq 1.2D + 1.6(L \pm W)$

$U \geq 0.9D + 0.9\ L^{**} + 1.6(\pm W)$

$U \geq D + L \pm E_{SS}$

$U \geq 0.9D \pm E_{SS}$

$U \geq 1.4D + 1.7L^{*}$

Notes:

L* includes the weight of the loaded vertical cask transporter L** includes the weight of the casks, but not occupancy live load.

Stability

$S/1.5 \geq D + L^{**}$

$S/1.1 \geq D + L^{**} \pm E_{SS}$

Notes:

L** includes the weight of the casks, but not occupancy live load

7.6.1.5 Cask Layout Configurations

During the life of the storage pad, several different configurations and numbers of casks are possible. The analysis has been performed on four representative enveloping configurations. The configurations are based on initially loading one of the short sides of the storage pad and then adding casks systematically across the pad. There are also several permutations of VCT locations (one VCT on pad considered per VCT load combination). The considered cask and VCT configurations are presented in Figure 7-9. The VCT locations are shown as the transporter tread locations. Note that for the VCT load combinations, the cask is considered to be supported by the VCT.

GTSTRUDL Modeling

The static GTSTRUDL model utilizes a six-degree-of-freedom plate bending and stretching element (SBHQ6) to represent the concrete pad. The slab stiffness is reduced to account for cracking (Concrete Pad Stiffness Properties). The concrete pad is supported on nonlinear (compression only) soil springs.

The casks are modeled with rigid frame members originating at the 8 contact points (between top of concrete and bottom of cask, spaced at 45 degrees around the cask outer perimeter) and terminating at the cask center of gravity (CG). The weight of the cask and the seismic forces are applied at the CG, located at the apex of the frame members. The lower ends of the rigid frame members are pin connected to the top of mat; thus, they do not transfer bending moments, but sliding and uplifting of the casks is inhibited. The cross-sectional area and moments of inertia of the frame members are large, resulting in high axial, torsional, and flexural stiffness, in order to simulate the rigid behavior of the cask. Since sliding would reduce the magnitude of the forces transmitted to the pad, this approach is conservative. Furthermore, the cask is not released vertically from its foundation as cask overturning is unlikely. The cask overturning stability evaluation is performed as part of the SSI analysis in Reference [7-26] and provides further evidence that cask overturning will not occur under the governing design loads. Since the pad is modeled by plate elements, the horizontal membrane (in- plane) stiffness added to the slab by the frame members acts at the centerline of the plate and does not affect its bending stiffness. However, the frame members do add vertical stiffness to the mat. It is estimated that this increased vertical stiffness reduces the vertical deflection of the mat, but the bending moments and shears are aggravated due to the increased mat curvature between adjacent casks and the more severe application of cask seismic moments (as opposed to the cask just "sitting" on the pad, unable to exert uplift forces). Overall, these modeling features produce conservative moments and shears in the pad. Element body forces are used to represent the self-weight of the concrete. Element surface loads are used to represent live loads on the pad. Joint forces are used for the cask and VCT loads.

Concrete Pad Stiffness Properties

From ACI 349-06 (Ref. [7-31], Section 8.6.1) and ACI 318-08 (Ref. [7-39], Section 8.7.1), "[u]se of any set of reasonable assumptions shall be permitted for computing relative flexural and torsional stiffness…" To approximate the effective stiffness of the storage pad, effective stiffness for reinforced concrete members provided in ASCE 43-05 (Ref. [7-44], Table 3-1) are used conservatively considering "[w]alls and diaphragms – cracked" because slabs- on-grade are not addressed. The effective stiffness' are as follows:

Effective flexural rigidity: $0.5E_cI_g$ (Ref. [7-44], Table 3-1)

Effective shear rigidity: $0.5G_cA_w$ (Ref. [7-44], Table 3-1)

Shear modulus, $G_e = 0.4E_C = 0.4 \cdot 3{,}605$ ksi = 1,442 ksi (Ref. [7-44], Table 3-1)

To represent the effective flexural rigidity and shear rigidity, 50 percent of the elastic modulus and shear modulus are used in the GTSTRUDL model and the actual 36-in thickness is used.

Effective elastic modulus, $E_{e,eff}$ = 1,803 ksi

Effective shear modulus, $G_{e,eff}$ = 721 ksi

Nonlinear Soil Springs

Nonlinear (compression only) springs are included at each storage pad node using the GTSTRUDL function “CALCULATE SOIL SPRING VALUES COMPRESSION ONLY DIR Y….”

[ ]

7.6.1.6 Analysis

Comparison of Wind and Seismic Load

Wind loads and seismic loads need to be considered for the design of the storage pad.

[ ]

Cask Stability Analysis

[ ]

Sliding Cask Stability:

Overturning Cask Stability:

[ ]

7.6.1.7 Design Forces from Analysis

[ ]

Cask Configuration 1

[ ]

Cask Configuration 2

Cask Configuration 3

Cask Configuration 4

Summary of Maximum Design Forces:

Assessment of VCT Loading:

Multiple VCT locations were considered in the analyses. [

]

7.6.1.8 Concrete Pad Capacity

Minimum Shrinkage and Temperature Reinforcement:

[

]

Design Flexural Capacity:

The maximum moment for both directions (across length and width) are evaluated. Note that the top and bottom reinforcement (each face) are equal; therefore, the maximum design moment is taken as the maximum of the positive and negative moments. [

]

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One-Way Shear Capacity:

Punching (Two-Way) Shear Capacity:

[ ]

Stability of Storage Pad:

[ ]

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Storage Pad Soil Bearing Evaluation:

7.6.1.9 Construction and Detailing Evaluations

Various reinforced concrete detailing requirements are discussed in the subsequent sections. In all cases, it has been verified that the requirements in ACI 349-06 [7-31] are consistent with those in ACI 318-08 [7-39].

Durability Considerations:

Bar Development and Lap Splices:

Maximum Aggregate Size:

Minimum Clear Spacing of Reinforcing Bars:

Minimum Footing Depth:

Construction/Control Joint Interfaces:

[ ]

7.6.1.10 Results and Conclusions

Based on the evaluations performed, it is concluded that the licensing design of the NAC storage pad for Andrews, TX meets all of the applicable structural requirements of NUREG-1567 [7-28] with reference to NUREG-1536 [7-42] and NUREG-0800 [7-43].

The WCS CISF licensing design includes consideration of four cask configurations on the pad based on systematically loading the pad with casks from one short side moving across to the other. Seismic, operational wind, and tornado wind were all considered to act on the casks. In the case of an SSE event, the VCCs do not overturn; however, the casks could slide up to 1.20 in (considering a safety factor of two). Furthermore, the concrete pad could slide up to 1.0 in (considering a safety factor of two).

Impact from cask drop or tornado-generated missiles was not considered with respect to the storage pad. The casks are already qualified for impact conditions and impact to the storage pad is an accident condition where damage is acceptable as long as there is no loss of function. The VCT was considered at several locations while fully supporting a cask. Operational wind load was applied to the VCT; however, seismic and tornado wind were not considered given that cask movements are infrequent evolutions.

7.6.2 Soil Liquefaction and VCC Storage Pad Settlement

The purpose of this evaluation is to determine the liquefaction potential and elastic settlement of the VCC storage pad located at the WCS CISF in Andrews, Texas.

The scope of work included:

- Review of Drawing NAC004-C-001, Rev. 0 showing the dimensions and general arrangement of the storage pad [7-30], and review of Drawing NAC004-C-002, Rev. 0 showing the structural concrete plan, sections, and details [7-37].
- Review of "Report of Geotechnical Exploration" performed by GEOServices, LLC [7-32].
- Liquefaction potential evaluation using the data from reference [7-32].
- Elastic settlement evaluation under static loading conditions using the data from reference [7-32].

7.6.2.1 Design Basis

7.6.2.2 Design Inputs

Soil Properties

Relevant Concrete Pad Properties

7.6.2.3 Analysis

Liquefaction Potential Evaluation

Liquefaction potential evaluation was based on NRC Regulatory Guide 1.198 [7-52] and widely accepted empirical methodology using Standard Penetration Test (SPT) and laboratory test data [7-53].

7.6.2.4 Elastic Settlement Evaluation

7.6.2.5 Calculations

Liquefaction Potential

Total Stresses:

Hydrostatic stresses:

Effective stresses:

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[ ]

7.6.2.6 Results and Conclusions

Based on the evaluation contained, it is concluded that overall, the soils below the Storage Pad are not susceptible to liquefaction.

Based on the evaluation contained in reference [7-32], the estimated maximum settlement of the Storage Pad (assuming the pad to be flexible for settlement purposes) is on the order of 0.70 inch (Section 4.2, Ref. [7-32]).

7.6.3 Soil Structure Interaction of the VCC Storage Pad

This section documents the Soil Structure Interaction (SSI) analysis to support a concrete pad design for the VCC storage pads located at the WCS CISF in Andrews Country, Texas. The analysis is conducted in accordance with NUREG-0800 [7-43].

The SSI analysis considers the concrete pad design with the MAGNASTOR VCC, which envelopes the NAC-UMS and NAC-MPC VCCs to be stored at the WCS CISF, for 4 cask load configurations, 3 soil cases, and 3 time histories, totaling 36 analysis cases to obtain enveloping maximum accelerations at the VCC center of gravities, the concrete pad center of gravity, and an evaluation for sliding and overturning of the VCCs. The SSI analysis supports structural design of the VCC storage pad system.

7.6.3.1 Design Basis

[ ]

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7.6.3.2 Design Inputs

The inputs used to prepare and execute the SSI analysis are as follows:

Finite Element Model Inputs:

[ ]

Soil Model Inputs:

[ ]

Time History Inputs:

[ ]

SSI Analysis Inputs:

[ ]

[ ]

7.6.3.3 Calculations

The following sections detail the calculations of the inputs for the SSI analysis.

SSI Soil Model

[ ]

7.6.3.4 Results and Conclusions

Following SSI analysis of 36 analysis cases it was found that the enveloping maximum accelerations at the MAGNASTOR Cask center of gravity are as follows:

- 0.45g in the X/E-W Direction for Case 30, Coyote Lake earthquake on UB soil at cask CG B1 for cask configuration 4
- 0. 42g in the Y/N-S Direction for Case 30, Coyote Lake earthquake on UB at cask CG A2 for cask configuration 4
- 0.28g in the Z/Vertical Direction for Case 22, Norcia earthquake on LB soil at cask CG B3 for cask configuration 3

The MAGNASTOR cask envelopes all other vertical VCC types to be stored at the WCS CISF. Through examining the instantaneous coefficient of friction demand, it is deemed that cask sliding is likely to occur for at least 1 cask due to a maximum coefficient of friction demand of 0.46, which is greater than the coefficient of friction of 0.35 for cask steel-to-concrete contact for a light broom finish on the concrete pad.

Through examining the instantaneous factor of safety against overturning following evaluation of the cask CG accelerations obtained from deterministic SSI analysis, it is deemed that overturning will not occur for any casks with a minimum observed overturning factor of safety of 1.22, which is greater than the required factor of safety against overturning of 1.1.

7.6.4 Soil Structure Interaction of the NUHOMS® NITS Storage Pad

This section documents the soil-structure interaction (SSI) analysis performed for the NUHOMS® HSM storage pad located at the WCS CISF in Andrews County, Texas. The SSI analysis is conducted in accordance with the guidance in NUREG-0800 [7-43].

The SSI analysis considers the concrete pad loaded with all AHSMs. The AHSM bounds the weight and center of gravity (CG) height of the other NUHOMS® HSM types planned to be stored at the WCS CISF and, thus, represents a bounding HSM for purposes of the SSI analysis.

As shown in Table 7-29, the SSI analysis is performed using three HSM loading configurations, three sets of strain-compatible soil properties, and three sets of spectrally matched time histories. Thus, a total of 27 SSI analyses were performed, which addresses variations in the sequence of loading the storage pad, and uncertainties in the ground motions and soil parameters. The SSI results consist of enveloping accelerations at the center of gravity of the HSMs and acceleration response spectra at the base and center of gravity of the HSMs.

The maximum response accelerations at the center of gravity of the HSMs are used in the structural evaluation of the concrete pad, as documented in Section 7.6.5. The acceleration response spectra and the maximum accelerations at the center of gravity of the HSM are also used in the seismic evaluation of the HSMs for the SSI loading. Maximum HSM sliding and rocking uplift are also evaluated.

7.6.4.1 Strain-Compatible Soil Properties

7.6.4.2 Spectrally Matched Earthquake Time Histories

The input time histories for SSI analysis are provided in the Seismic Hazard Evaluation and Development of Seismic Design Ground Motions Report [7-33]. Three sets of input time history were developed in [7-33], in accordance with the Standard Review Plan [7-43], Section 3.7.1. The three sets of earthquake time histories are named after their respective seeds, namely the 1979 Coyote Lake, the 1979 Norcia (Italy) and the 1986 North Palm Springs earthquakes, each consisting of three orthogonal components (two horizontal and one vertical). The three time history sets are used for the SSI analyses and the results are enveloped to conservatively account for variability in the ground motions. The response spectra for the spectrally matched time histories, along with their respective acceleration, velocity, displacement, and normalized Arias intensity plots for each of the three components of the three sets of earthquakes used in the SSI analyses are shown in Figure 50 through Figure 67 of Reference [7-33].

7.6.4.3 SSI Analysis Model Description

The SSI analyses are performed using the SASSI computer code [7-63]. Analyses are performed separately for each earthquake component and for each directional component. The acceleration time histories used to generate response spectra are obtained by the arithmetic summation of the collinear contributions from each input direction. The maximum accelerations are obtained by combining the collinear responses by the SRSS combination rule.

To account for variability in sequence of loading the storage pad, three HSM loading sequence configurations are considered: two partial loading configurations consisting of arrays of 22 HSMs and 42 HSMs placed back-to-back, and the fully loaded configuration consisting of an array of 92 HSMs placed back-to-back. These loading configurations are shown schematically in Figure 7-31, as “Initial Loading”, “Second Loading,” and “Full,” respectively.

The SASSI SSI finite element model representing the concrete pad is generated with plate elements with the properties listed below.

- Pad Dimensions: Length = 478.82 ft; Width = 49.20 ft
- Thickness: 3.0 ft
- f'_c (28-day concrete strength) = 4,000 psi
- Unit weight = 0.15 kcf
- Poisson’s ratio = 0.17
- Young’s modulus $E = 57{,}000x(4{,}000)^{1/2} = 3.605x10^6$ psi = 519,120 ksf
- Damping: $\xi = 4\%$

Each HSM is modeled using a vertical beam from its base to the center of gravity of the loaded HSM. The weight and weight moments of inertia of each module are lumped at the center of gravity of the HSM. The material and geometric properties of the beam representing the module are adjusted to match the lowest frequencies of the AHSM in each direction.

The properties of the AHSM are given below:

- Dimensions: Width = 101 in.; Depth = 235 in.; Height w/o vent covers = 222 in.
- Center of gravity (loaded) with respect to a front corner:

  X = 50.50 in. (horizontal transverse direction)

  Y = 111.34 in. (horizontal longitudinal direction)

  Z = 121.34 in. (vertical direction)

- Weights and rotational inertia used in analyses

  Weight AHSM empty = 334.4 kips

  Weight of loaded DSC = 100 kips

  Loaded AHSM: Wxx (CG) = 24,204 k-ft^2 (Mxx = $9.02x10^6$ lb-in-sec^2)

  Loaded AHSM: Wyy (CG) = 13,712 k-ft^2 (Myy = $5.11x10^6$ lb-in- sec^2)

  Loaded AHSM: Wzz (CG) = 16,556 k-ft^2 (Mzz = $6.17x10^6$ lb-in-sec^2)

Weight of end shield wall = 197.4 kips

Shield wall thickness = 3 ft

End shield wall Wxx = 11,949 k-ft^2

End shield wall Wyy = 5,778 k-ft^2

End shield wall Wzz = 6,467 k-ft^2

- Lowest frequencies of the loaded module

  $f_{longitudinal}$ = 32.35 hz

  $f_{transverse}$ = 37.69 hz

  $f_{vertical}$ = 48.47 hz

- HSM damping

  ξ = 7%

The bases of the modules are modeled with horizontal rigid beams located at an elevation consistent with the surface of the pad (Z = 1.5 ft).

Each module is connected to the pad by three-dimensional rigid springs at six points. The configuration of the springs does not prevent the pad from bending and are configured to minimize any stiffening effects on the concrete pad. The vertical springs force the six points of vertical connection to remain on a plane; however, the pad inside the area defined by those six vertical connection points is able to experience bending deformations.

The HSMs located at the ends of each loading campaign have an end shield wall attached to them. These end shield walls are added to the respective HSM model as a lump weight and weight moment of inertia connected to the center of gravity of the HSM by a rigid beam.

The SASSI [7-63] SSI models of the storage pad for each loading configuration are shown in Figure 7-33, Figure 7-34, and Figure 7-35 for the 22, 42 and 92 loading configurations, respectively.

The concrete pad is analyzed as surface founded at the bottom of the excavation depth using corresponding surface input motions compatible with the strain compatible soil profiles. The SASSI [7-63] computer program is used for SSI analyses.

7.6.4.4 SSI Results

As shown in Table 7-29, are the 27 SSI analyses performed for three different configurations of storage units on the pads, for three input earthquakes, and for three sets of soil properties.

7.6.4.4.1 Maximum Accelerations and Envelope Response Spectra

The maximum calculated acceleration at the center of gravity of the casks for each of the 27 cases evaluated are presented in Table 7-34.

As shown in these tables, the maximum accelerations at the CG of the modules are:

[ ]

The envelopes of the acceleration response spectra at the base and CG of the HSMs are shown in Figure 7-36 through Figure 7-38, and Figure 7-39 through Figure 7-41, respectively. These spectra are the envelope of the spectra for all modules, all loading cases, all soil properties, and all input earthquakes.

7.6.4.4.2 Sliding and Rocking Stability Evaluations

The potential for sliding of the HSMs is evaluated in this section. For each SSI response time history earthquake, each soil case, each loading configuration, and at each time step the following expression is calculated:

$\mu_e(t) = [(a_x(t)^2 + a_y(t)^2)^{1/2}]/(1-a_z(t))$

Where:

$\mu_e(t)$ is the coefficient of friction needed to prevent sliding at each time step

$a_x(t)$ is the acceleration at the CG of the module in the X direction at time t

$a_y(t)$ is the acceleration at the CG of the module in the Y direction at time t

$a_z(t)$ is the acceleration at the CG of the module in the Z direction at time t

The coefficient of friction μ between the bottom of the module and the concrete pad is 0.6 [7-29]. Thus, if the maximum value of $\mu_e(t)$ is lower than 0.6, then no sliding occurs.

Figure 7-42, Figure 7-43, and Figure 7-44 show the controlling results for the 22, 42 and 92 loading configurations, respectively. These plots represent the maximum value for all the time steps of the time history. These results show that the end module has the potential for sliding for the UB soil case for the Coyote Lake and Norcia earthquakes. The higher friction demand is for the Norcia earthquake for the first loading (22 modules on the pad). The sliding distance for this case is calculated using the conservative approach given in [7-44].

Effective coefficient of friction μ_e

$\mu_e = \mu\ [1-0.4A_z/g]$

Where μ is the coefficient of friction = 0.6, and

A_z is the vertical peak input acceleration: $A_z/g = 0.35$ (the CG value was conservatively used).

$\mu_e = 0.6\ [1-0.4 \times 0.35] = 0.516$

Sliding coefficient c_s:

$c_s = 2\mu_e g = 2 \times 0.516 \times 386.4 = 398.77$

$c_s/g = 1.032$

Best estimate sliding distance δ_s

$\delta_s = c_s/(2\pi f_{es})^{1/2}$

f_{es} is the lowest frequency at which the horizontal 10% damped spectral acceleration SA_{vh} equals c_s, where

$SA_{vh} = [SA_{h1}^2 + 0.16SA_{h2}^2]^{1/2}$

in which SA_{h1} and SA_{h2} are the 10% damped spectral accelerations for each of the two orthogonal horizontal components, where SA_{h1} is the larger of the two spectral accelerations.

Conservatively, the 7% damped horizontal spectra for the critical module (UB soil, Norcia earthquake, 22-loading configuration, end module) are used. Two calculations were made: one with the spectra at the base of the module, and the other with the spectra at the CG of the module.

For the case of using the spectra at the base,

[ ]

7.6.4.4.3 Rocking Evaluation

The potential of each module to rock and uplift during an earthquake is evaluated in this section. For each earthquake, soil case, loading and at each time step the rocking potential around the YY axis is evaluated.

For the case of modules without a shield wall, the following expression is calculated at each time step:

Overturning moment $M_o(t) = a_x(t) \times H_{cg\text{-}HSM}$

Restoring moment $M_r(t) = (1 - a_z(t)) \times R$

Overturning potential $O_p(t) = M_r(t) / M_o(t)$

$a_x(t)$ is the horizontal acceleration in the X direction at time t

$a_z(t)$ is the vertical acceleration at time t

$H_{cg\text{-}HSM}$ is the HSM CG height = 10.11 ft

R is half of the width of the module = 4.21 ft

For the case of modules with a shield wall, the following expressions are calculated at each time step:

When the acceleration $a_x(t)$ is in the direction toward the module side without the shield wall:

Overturning moment $M_o(t) = a_x(t) \times (H_{cg\text{-}HSM} \times W_{HSM} + H_{cg\text{-}wall} \times W_{wall})$

Restoring moment $M_r(t) = (1\text{-}a_z(t)) \times (W_{HSM} \times R + W_{wall} \times (2R + 1.5))$

When the acceleration $a_x(t)$ is in the direction toward the module side with the shield wall (assuming that the shield wall is rigidly connected to the module):

Overturning moment $M_o(t) = a_x(t) \times (H_{cg\text{-}HSM} \times W_{HSM} + H_{cg\text{-}wall} \times W_{wall})$

Restoring moment $M_r(t) = (1\text{-}a_z(t)) \times (W_{HSM} \times (R + 3) + W_{wall} \times 1.5)$

Overturning potential $O_p(t) = M_r(t) / M_o(t)$

$H_{cg\text{-}wall}$ is the wall CG height = 9.25 ft

W_{HSM} is the HSM weight = 434.3 kips

W_{wall} is the wall weight = 197.4 kips

Thus, if the maximum $O_p(t)$ is lower than 1 then no uplift will occur.

Figure 7-45, Figure 7-46, and Figure 7-47 show plots of enveloping maximum rocking overturning potential of each HSM, for the 22, 42 and 92 loading configurations, respectively, for all soil cases and for all three earthquakes. It is seen that the Coyote Lake earthquake controls for the three loading configurations. The maximum $O_p(t)$ value for all time steps is plotted in these figures.

These results show that the highest potential for rocking occurs for the UB soil case, 22 HSMs loading configuration, and for the Coyote Lake. Therefore, the rocking angle and the uplift height are calculated for the controlling HSM using the conservative approach given in [7-44].

Horizontal spectral acceleration capacity SAH_{CAP}:

$SAH_{CAP} = 2g(f_I(\theta) - 1)/(F_H\ F_V\ \theta)$

$f_I(\theta) = \cos\theta + a \times \sin\theta$

$a = R / H_{cg\text{-}HSM} = 4.21/10.11 = 0.4164$

The static instability angle α is defined in [7-44] as:

$\alpha = \tan^{-1}(a) = 22.6$ degrees

F_H = 1 (since the lateral mass is equal to the vertical mass)

$F_V = [1 + ((a/F_H)*(SAV/SAH))^2]^{1/2}$

θ is the rotation angle.

SAV/SAH is the ratio of vertical to horizontal spectral accelerations determined at the effective rocking frequency f_e and effective damping β_e.

$f_e = (1/2\pi) \times [(2 (f_I(\theta) -1) g / (C_I \theta^2 H_{cg\text{-}HSM})]^2$

$\beta_e = \gamma / [4\pi^2 + \gamma^2]^{1/2}$

$C_I = I_B / M H^2_{cg\text{-}HSM}$

$\gamma = -2 LN(C_R)$

$C_R = [1 – (2 a^2 / C_I)]$

I_B is the mass moment of inertia of the module about the rotation edge.

$I_B = I_{CG} + M H^2_{cg\text{-}HSM}$ = 5,109,998.76 + 1,123.96 x 121.32^2 = 21,653,122.4 lb-in-sec^2

M is the module mass = 1,123.96 lb-sec^2/in

This is an iterative process until the horizontal spectral demand SAH_{DEM} equals the SAH_{CAP} for a rotation angle (θ), an effective rocking frequency (f_e), and an effective damping(β_e).

The maximum uplift height is:

$H_U = 2 R \sin\theta$

Table 7-35 lists the values of the parameters for the calculation of the rotational angle and the uplift height. From Table 7-35, the maximum rotation angle is calculated as: θ = 0.0008 radians = 0.046 degrees. This is much smaller than the instability angle: α = 22.6 degrees required to overturn the HSM. The maximum uplift is calculated as: H_U = 0.0808 inches.

Thus, it is concluded that the rocking angle and uplift are very small.

7.6.4.4.4 Results and Conclusions

The AHSM was selected for the SSI analyses of the NUHOMS® storage pad. The AHSM envelopes all other HSMs because it bounds the weight and CG height of all the other HSM types planned to be loaded at the WCS CISF.

From the SSI evaluation of 27 analysis cases it was determined that the enveloping maximum accelerations at the HSMs center of gravity are as follows:

[ ]

Based on a coefficient of friction, μ, of 0.6 between the bottom of the HSM and the concrete pad documented in Section 8.2.2.2 (A)(ii) of [7-29], the calculated maximum sliding that may occur is 0.188 in. The maximum HSM tipping rotation is calculated to be 0.046 degrees, which corresponds to 0.08 in. of HSM uplift. Both the calculated sliding distance and rotation angle are considered negligible.

7.6.5 NUHOMS® NITS Storage Pad Design

The WCS CISF storage pad for the NUHOMS® HSMs is a commercial grade reinforced concrete surface structure that is classified as not important to safety (NITS). The storage pad consists of a cast-in-place, 36 in. thick reinforced concrete basemat structure.

The storage pad is designed for normal operating loads, natural phenomena loads, and severe environmental loads. The storage pad is constructed using 4,000 psi 28 day compressive strength concrete. Reinforcing consists of #11 ASTM A 706 or ASTM A 615, Grade 60 steel rebar of 60,000 psi yield strength meeting the caveats in ACI 349, Section 21.2.5, spaced at 10 inches each way each face.

The NUHOMS® storage pad design is shown in Figure 7-53. A soil structure interaction analysis and elastic settlement analysis is performed as part of calculations AREVATN001-CALC-002 [7-66] and AREVATN001-CALC-001[7-67].

7.6.5.1 Design Inputs

Material Properties

[ ]

Soil Properties

[ ]

Design Loads

Dead Load - The design dead load consists of the weight of the reinforced concrete pad.

Live Load - Live loads include the weight of loaded HSMs, and operational loads (handling equipment and occupancy load).

- Weight of bounding AHSM loaded with heaviest DSC, increased by 5%, $W_{AHSM+DSC}$ = 449.8 kip (Ref. [7-29], Table R.3-1)
- Weight of End Shield Wall, increased by 5% = 197.4 kips
- Height of HSM_{AHSM} = 222 in (Ref. [7-29], Section R.1.5)
- Height of CG of HSM, including DSC, CG_{AHSM} = 121.3 in (Ref. [7-29], Section R.1.5)
- Footprint dimensions of HSM_{AHSM} = 101 in x 235 in (Ref. [7-29], Section R.1.5)
- 300 Ton installation capacity crane: total loaded weight = 1010 kips

Snow Load - The ground snow load of 10 psf, per Figure 7-1, ASCE 7- 05 [7-34], at the WCS CISF is enveloped by the live load.

Thermal Load - The maximum thermal load corresponds to the short term blocked vent condition. Thus, the thermal load is inconsequential insofar as the pad's structural integrity is concerned; the development of significant thermal stresses in the pad for a short term event are inhibited due to the low thermal conductivity of the concrete and the large thermal mass of the pad. Therefore, thermal loads are considered negligible.

Flood Load - Flood load is not part of the analysis because the Storage Pad is located above the flood elevation. A flood plain study was performed for the site in Reference [7-50] which shows that the Storage Pad is above the 100-year, 500-year, and probable maximum precipitation (PMP) flood levels.

Rain Load - The rain load due to ponding is negligible for the Storage Pad as the approach slabs are sloped to carry all rain water away from the HSMs.

Wind Load - Design basis wind pressure (W) and design basis tornado wind pressure (W_t) are governed by the seismic loads. By inspection the tornado wind load governs the regular wind load.

Per Reference [7-35], the postulated maximum tornado wind speed is 230 mph for Region I, which is conservative because Andrews, Texas is in Region II. The corresponding wind pressure is calculated using the methods of ASCE 7-10, [7-64]. The equivalent velocity pressure is $0.00256*230^2$=135.4 psf. This wind load is applied to the front face of the HSM array since a side load will be resisted by all of the HSMs in a given row. This equates to a force: 135.4 psf * 8'-5" (width) * 20'-7" (height) * 1.3 = 30,494 lbs, where 1.3 is a shape factor per ASCE 7-10.

The maximum seismic acceleration in the front-to-back (i.e., longitudinal) direction of the HSM resulting from the SSI analyses documented in Section 7.6.4 is 0.416g. Considering the weight of the HSM of 449.8 kips (see Live Load section above), the calculated longitudinal seismic load is: 0.416 * 449,800 lbs = 187,117 lbs. This is significantly higher than the maximum tornado wind loading of 30,494 lbs. Therefore, seismic governs.

Seismic Inertia Load - The 10,000-year return period earthquake response spectra were developed as part of the site-specific seismic hazard evaluation in Reference [7-33]. These are SSE equivalent ground motions. The strain-compatible soil properties and ground motion time histories documented in [7-33] were used as input to the SSI analyses.

As discussed in Section 7.6.4, a total of 27 SSI analyses are performed accounting for variations in input ground motions (3 sets of time histories), soil properties (3 sets of soil properties), and storage pad loading sequence configurations (two partial loadings and a fully loaded pad). The results of all 27 SSI analyses are enveloped to provide the enveloping maximum accelerations at the HSMs center of gravity (CG) used for pad design. The enveloping maximum bounding acceleration values at the CG of the loaded HSMs used for the design of the storage pad are:

Tornado-Missile Impact Load - The NUHOMS® HSMs are evaluated for tornado missile impact as documented in the applicable UFSAR (e.g., Reference [7-29] for the HSM Models 80 and 102). Tornado-missile impact directly to the storage pad is not considered here because such an extreme condition would result in localized damage to the storage pad, but not result in a loss of stability of the storage pad. In the case of such an accident, the storage pad would need to be evaluated and repaired as needed. This is consistent with Table 3-3, NUREG-1536 [7-42], which states for the tornado load case that

> "[t]he load combination (capacity/demand >1.00 for all sections) shall be satisfied without missile loadings. Missile loadings are additive (concurrent) to the loads caused by wind pressure and other loads; however, local damage may be permitted at the point of impact if there is no loss of intended function of any structure important to safety."

7.6.5.2 Design Basis

The design of the WCS CISF NITS storage pad is in accordance with the provisions of ACI 349-06 [7-31] and NUREG-1536 [7-42].

7.6.5.3 Load Combinations

In accordance with Section 5.4.3.4, NUREG-1567 [7-28], load combinations for reinforced concrete structures including Independent Spent Fuel Storage Installations (ISFSIs) shall meet the requirements of Table 3-3, NUREG-1536 [7-42], and ACI 349 [7-31]. Load combinations from these two sources are presented only for the applicable loads described in Section 7.6.5.1. Non applicable loads (e.g., piping, pipe break, soil, etc.) or loads not considered per the above discussion (thermal, snow, rain, wind and flooding) are not included. Only the seismic load is considered. The ACI 318-08 [7-39] load combinations are enveloped by ACI 349-06 [7-31] load combinations.

ACI 349-06 Load Combinations

$U = 1.4D$ (Ref. [7-31], Eq. 9-1)

$U = 1.2D + 1.6L$ (Ref. [7-31], Eq. 9-2)

$U = 1.2D + 0.8L$ (Ref. [7-31], Eq. 9-3)

$U = D + 0.8L + E_{SS}$ (Ref. [7-31], Eq. 9-6)

$U = D + 0.8L$ (Ref. [7-31], Eq. 9-8)

*Note: All dead loads are considered at 0.9 where the dead load reduces the effects of other loads. Similarly, live loads are taken as zero where the live load reduces the effects of other loads.

**The soil model is included in the analysis provided by AREVATN001-CALC-001 [7-67], thus, differential displacement of the ISFSI pad will be captured in the various load combinations. Therefore, no additional effects need to be added to the dead load.

NUREG-1536 Load Combinations

$U = 1.4D + 1.7L$ (Ref. [7-42], Table 3-3)

$U = D + L + E_{SS}$ (Ref. [7-42], Table 3-3)

*Note: All dead loads are reduced by 5% where dead load reduces the effect of other loads.

Governing Load Combinations

Governing load combinations are compiled based on the code required load combinations, considerations for reduced dead and live load effects, and directions of seismic excitation. The governing load combinations evaluated in the design of the storage pad are:

$U \geq 1.4D + 1.7L$

$U \geq D + L \pm E_{SS}$

7.6.5.4 Analysis Methodology

Equivalent static analyses of the storage pad are performed using finite element models developed using the ANSYS program [7-65]. The analysis methodology is based on elastic small displacement theory except for the presence of contact elements between the bottom of the pad and the top of its supporting soil. This feature allows the pad to lift off the soil should the physics of the problem require that to occur.

The analyses consider the sequence of HSM installation on the storage pad. Thus, five separate finite element models are developed, which consider four partially loaded configurations and a fully load pad configuration. The five analysis models are listed in Table 7-36.

The five models consist of four partially loaded storage pad models with two, four, eleven, and twenty one rows of back-to-back HSMs, and a model of the fully loaded storage pad. The model configurations were selected to provide bounding internal forces and moments resulting from the applicable loads presented in Section 7.6.5.3. Table 7-36 summarizes the five finite element models. Figure 7-48 shows the finite element model for the fully loaded pad configuration consisting of a 2 x 46 array of AHSMs. The model includes the soil supporting the storage pad (elements in red), the storage pad (elements in light blue), and the HSMs (elements in dark blue). All the models are similar except for the number of HSMs modeled on the storage pad.

The SSI analysis discussed in Section 7.6.4 determined the bounding maximum accelerations at the CG of the HSMs. The bounding accelerations correspond to the Upper Bound soil property case, 2x11 HSM array loading configuration, and the Coyote Lake and Norcia earthquake seismic inputs. These controlling maximum accelerations and enveloping values used in the structural evaluation of the storage pad are shown in Table 7-37.

The maximum accelerations in the two horizontal directions and the vertical direction applied at the CG of each HSM are used as the seismic accelerations to compute the internal stresses due to seismic loads. These internal stresses are then integrated to determine the internal forces and moments in the storage pad. These forces and moments are used to size the reinforcement and evaluate concrete stresses in accordance with ACI 349-06.

Concrete Pad Modeling

The pad is modeled using ANSYS SOLID45 8-node brick elements. No special features of the element are invoked. Thus the element uses its full integration scheme. In order to develop accurate internal forces and moments, four elements are used through the thickness of the pad. The mesh of the pad around the HSM is designed to accommodate the configuration of the HSMs. The concrete is designated Material Type 1 and is assumed to be homogenous with Young's modulus equal to 57,000 $\sqrt{f'c}$ psi.

The dimensions of the NUHOMS® storage pad model are: 480'-0" long x 50'-0" wide x 3'-0" thick. The loaded footprint is 465'-2" (length) and 39"-2" (width). Thus the ISFSI pad length includes an extra 7 feet on either end along the length of the pad and 5 feet on either side of the pad in the transverse direction, as described in the SSI analysis in Section 7.6.4. The pad dimensions are rounded up to 480 feet x 50 feet for analysis purposes.

The pad is to be constructed with 4,000 psi compressive strength concrete, elastic Young's modulus, E = 57,000 $\sqrt{4000}$ =3,605 ksi, and a Poisson's ratio of 0.17. These concrete properties are consistent with the SSI analysis. The concrete unit weight is taken at 135 pcf. This value was chosen to satisfy the ACI 349-06 requirement that stipulates the use of 90% of the dead weight if it assists in the load combination (Section 9.2.3 of [7-31]). The lighter dead weight of the concrete requires the pad to flex more than it otherwise would in order to resist the effect of overturning by the application of the horizontal seismic load at the CG of the HSMs. The concrete pad elements are the only part of the model with a weight density.

A gap of 0.2 ft is modeled between the concrete storage pad and the adjacent soil along the perimeter. This gap ensures that the soil does not artificially constrain bending of the concrete pad.

Soil Modeling

The soil is modeled using nine material properties divided into nine layers of elements, which are modeled using the ANSYS SOLID45 8-node brick elements. As with the use of this element for the pad, no special features of this element were invoked. The thickness, depth and material properties of each soil layer in the ANSYS model are consistent with the values provided in [7-32]. Figure 7-49 shows the soil layers and the material properties of each layer used in the ANSYS model.

In conjunction with depth, the soil model is also required to extend beyond the edges of the concrete pad footprint a distance that will mitigate any boundary condition effects that could affect the pad results. Therefore, the soil extends 1.5 times the soil depth or (100* 1.5=) 150 ft beyond the edge of the pad in all horizontal directions. This meets the requirement of St. Venant's Principle, which requires an extension of at least 1.0 times the soil depth. Figure 7-50 shows the soil model with the concrete pad elements removed. Figure 7-50 show the various soil materials using different colors for the elements in each layer corresponding to those shown in Figure 7-49.

The soil material properties used are the static properties, equal to or lower than the dynamic soil properties and, therefore, conservative for use in an equivalent static analysis.

The soil properties used in the equivalent static analysis are given in Appendix D of [7-32] and are listed in Table 7-38.

Contact Elements

The pad rests on the soil through the use of target/contact elements placed at the interface between the pad and the soil elements.

The contact elements are generated using the ANSYS "Contact Wizard" that uses surface to surface contact elements. The ANSYS software requires that the contact elements be specified between two surfaces, a "target" surface and a "contact" surface, which are defined as two different element types. The bottom surface of the pad is designated the "target" surface, Element Type #6, TARGE170, and the top surface of the soil is designated the "contact" surface, Element Type #7, CONTA173. These elements transmit compression and shear loads from one surface to the other. No tensile forces are transmitted through this interface. These elements are, therefore, non-linear elements.

These elements are actually surfaces that overlay the structural elements and they can be thought of as permitting the interfacing characteristics desired, i.e., permitting compressive and shear forces between the surfaces when penetration is attempted, and permitting separation between the surfaces with no forces present when gaps are present. An alignment of the meshes of the two surfaces such that the nodes are coincident is not necessary. ANSYS handles all the necessary geometric details to create the compression and shear only elements. The element stiffness and convergence parameters are computed from the geometry and material properties of the underlying elements.

The CONTA173 elements utilize KEYOPT (12) = 1 which translates into a "rough" contact surface between the bottom of the pad and the soil. This is considered conservative because by fixing the pad the internal forces in the pad can be maximized.

AHSM

The ANSYS models used for the structural analysis consider that the storage pad is loaded with AHSMs. The AHSM bounds the weight and CG of the other HSM types planned to be used at the WCS CISF. The AHSM is also the HSM with the smallest footprint. Thus, use of the AHSM provides for a bounding storage pad design. The weights used in the ANSYS models are increased by 5% to 449.8 kips ((334.3 kips (HSM) + 110) * 1.05 kips (DSC)) for the loaded AHSM and 197.4 kips for the end shield wall.

For purposes of the analysis the AHSMs are modeled as block assemblies using SOLID45 elements that are attached directly to the surface of the concrete pad. The top elevation of the block assembly representing the HSM corresponds to the CGs of the AHSM. The HSMs are modeled to the height of the CG above the pad surface, which is 121.3 in. In this modeling approach the function of the block assemblies representing the HSMs is to transmit the seismic inertial loads and HSM weight to the pad. The loads applied to the pseudo HSM CG are transferred to the base through another contact element application with a "pilot node" option. The node representing the HSM CG is paired with the rest of the nodes at the same elevation of the HSM. The node at the CG is set as the pilot node. The weight and the seismic loads are applied at this pilot node at each pseudo HSM block assembly. Thus, the pilot node becomes the master node and the rest of the paired nodes become slaves. The applied forces are distributed to the slave nodes following a rigid-body principle. The HSM distributes the force onto the pad by the theory of elasticity. The definition and application of the loads are described below. The modeling approach described above maximizes the moments delivered to the storage pad due to the horizontal seismic load. Figure 7-51 shows the pseudo HSM block assemblies.

The HSMs are modeled with Element Type #2. Element Type #2 is the ANSYS SOLID45 8-node brick element. No special features of this element are invoked. Thus, the element uses its full integration scheme, and its extra displacement shapes are included. Since each HSM a separate unit, a 2-in. gap is modeled between the side walls and rear walls of the HSM block assemblies. This is shown in Figure 7-52.

Consistent with Table 8.1-3, [7-29], the Young's Modulus for the pseudo HSM material is based on a 28-day concrete compressive strength of 5,000 psi, which correlates to a modulus of elasticity of 4,000 ksi. Additionally, the Poisson's ratio is set to 0.2 for the HSM material.

Boundary Conditions

The only boundary conditions in the models are on the soil mass. The nodes of the soil elements are constrained normal to the bottom and normal to the sides on all sides of the soil. The sides of the soil mass are far enough away (1.5 * soil depth) from the pad that boundary conditions do not significantly affect the response of the pad.

7.6.5.5 Analysis Results

The five ANSYS analysis models discussed in Section 7.6.5.4 are analyzed for the load combinations discussed in Section 7.6.5.3. Since these are static analyses the seismic load combination includes additional cases to consider sign reversal of the applied maximum seismic accelerations resulting from the SSI analysis described in Section 7.6.4, and shown in Table 7-37.

The stresses output by the SOLID45 elements are post-processed to calculate the maximum internal moments and shear forces. Table 7-39 summarizes the results for each of the five loading configuration analysis models. The enveloped max/min values of the moments and shear forces obtained from all five models used for the design of the pad are summarized in Table 7-40.

Acceptance Criteria

Shear:

$\phi V_n \geq V_u$, Section 11.1.1 of ACI 349 [7-31]

$\phi = 0.75$ for Shear, Section 9.3.2.3 of ACI 349 [7-31]

Bending:

$\phi M_n \geq M_u$

$\phi = 0.9$ for Bending, Section 9.3.2.1 of ACI 349 [7-31]

Reinforcement:

Minimum Reinforcement $= A_{s,\min} = \frac{3\sqrt{f'c}}{fy} b_w * d$, Eq. 10-3 ACI 349 [7-31]

But Not Less than, $\frac{200 * b_w * d}{f_y}$, Section 10.5.1 of ACI 349 [7-31]

Sizing of Reinforcement/ ACI Code Requirements

The reinforcement is evaluated for the ACI 349-06 Code requirements and consists of #11 bars at 9 inches on center top and bottom, each way, with mechanical lap splices.

The main reinforcement in X direction is calculated as:

$d_{slab1} = 36"\text{-}3" - 1.41" \div 2 = 32.3"$ Effective depth

$M_u = 271{,}989 lbf - in$ Design moment from Table 7-40

$A_{11} = 1.56 in^2$ Cross section of #11

$f_c' = 4000 psi$ Compressive strength of concrete

$F_y = 60 ksi$ Tensile strength of rebar

$R_t = \frac{M_u}{0.9 \times 1in \times d_{slab1}^2} = 290 psi$ Flexural resistance factor

$\rho = 0.005 + \frac{290-287}{314-287} \times (0.0055 - 0.005) = 0.0051$ Reinforcement ratio

$A_s = \rho \times 12in \times d_{slab1} = 1.98 in^2$ Steel required per 12" wide.

Therefore, provide # 11 rebar @ 9" o.c. = 2.1 in^2. per 12 inch strip OK

The main reinforcement in Y direction is calculated as:

$d_{slab2} = 36\text{-}3"\text{-}1.41 - 1.41 \div 2 = 30.89"$ Effective depth

$M_u = 195{,}189 lbf - in$ Design moment from Table 7-40

$R_t = \frac{M_u}{0.9 \times 1in \times d_{slab2}^2} = 227 psi$ Flexural resistance factor

$\rho = 0.0035 + \frac{227-204}{232-204} \times (0.004 - 0.0035) = 0.0039$ Reinforcement ratio

$A_s = \rho \times 12in \times d_{slab2} = 1.45 in^2$ Steel required per 12" wide.

Therefore, provide # 11 rebar @ 9" o.c. = 2.1 in^2. per 12 inch strip OK

The shear capacity of the pad per ACI 349 is:

$0.75 \times 2 \times \sqrt{4000}psi \times d_{slab1} = 3{,}064 lbf/in$
Shear capacity of 1" wide pad in X direction

$0.75 \times 2 \times \sqrt{4000}psi \times d_{slab2} = 2{,}930 lbf/in$
Shear capacity of 1" wide pad in Y direction

The maximum enveloping shear demand force at a distance "d" away from the edge of the HSM array is 2929.8 lbf/in and 2929.6 lbf/in the X and Y directions, respectively. Therefore, the maximum interaction ratio for shear is as follows:

In X direction: 2929.8/3064=0.96 < 1.0

In Y direction: 2929.6/2930=0.99 < 1.0

Thus, no shear reinforcement is required.

Construction Joint Assessment

The pad will be constructed in multiple sections which will require construction joints. The reinforcement sized for the internal forces and moments will continuously run through the construction joints into the following section of concrete. This reinforcement is evaluated to determine if additional shear reinforcement is required at each construction joint.

Take the maximum shear load to equal the shear capacity of concrete pad, 2,930 lbf/in,

F_z = 2,930 lb/in.

Over 9 inches F_z = 2,930 lb/in * 9 in = 26,370 lb per 9 inches

Using the methodology shown in Section 11.7 of ACI 349-06, the required shear transfer reinforcement area, A_{vf}, is defined by:

$$A_{vf} = \frac{V_n}{\phi f_y * \mu}$$

Where:

V_n = 26,370 lb per 9 inches

Φ =0.75 for shear

f_y = 60,000 psi

μ =1.0 (ACI 349-06, Section 11.7.4.3, concrete placed against hardened concrete with surface intentionally roughened as specified in ACI 349-06, Section 11.7.9)

$$A_{vf} = \frac{26,370lb}{0.75*60,000psi*1.0} = 0.59in^2$$

Area of Steel provided = 2 # 11@9” o.c.= 2x1.41 in^2 = 2.82 in^2 > 0.59 in^2, OK

No additional shear reinforcement is necessary across the construction joints.

Skin Reinforcement Assessment

In order to better control cracking of the concrete at the perimeter edges, additional reinforcement, known as “skin reinforcement” is computed in accordance with Section 10.6.4 of [7-31].

The spacing of reinforcement closest to the tension face shall not exceed the following equation:

$$s = 15*\left(\frac{40000}{f_s}\right) - 2.5*c_c < 12*\frac{40000}{f_s}$$ Eq. 10-4 [7-31]

Where:

s = vertical spacing of skin reinforcement

$f_s = 0.4*f_y = 0.4 * 60,000$ psi = 24,000 psi

c_c = 2” = least distance from surface of reinforcement to the tension face

$$s = 15*\left(\frac{40000}{24000}\right) - 2.5*2" = 20"$$

$$12*\left(\frac{40000}{24000}\right) = 20"$$

20” = 20” OK

Since the slab is 36 in. thick, more than one row of skin reinforcement will be necessary to maintain a spacing of 20 in. Use two layers of skin reinforcement spaced at 10 in.

Punching Shear Evaluation

The controlling load case for punching shear occurs during HSM installation with the loaded crane located on the pad. For purposes of this evaluation, a 300 ton crane capacity is assumed and a conservative total weight of 1010 kips is used with a square outrigger pad of 24in. x 24 in.

The punching shear capacity of the pad is checked under the scenario that the crane is on the verge of tipping over. The entire weight of the machine, counter weight and its maximum payload are supported by one outrigger leg. This is an extreme loading case for evaluation of the pad.

The effective depth of the pad is 36”-3”-1.41”/2=31.3”, in which 3 in. is the concrete cover and 1.41 in. is the diameter of #11 rebar. The perimeter of the punching shear area is 4 x (32.3”+ 24”) = 225.2”. The punching shear area is 225.2” x 32.3” = 7,273.96 in^2.

The factored punching shear capacity per ACI 349-06 is 0.75 x 4x $(4000psi)^{1/2}$ x 7,273.96 in^2= 1,380,137 lbf or 1,380 kips. The factor of safety is 1,380/1010 = 1.37. Therefore, the pad is adequate for punching shear.

Bearing Pressure

The bearing stress demand is calculated for the following load combinations:

Case 1: DL+LL

Case 2: DL+LL+ Seismic

The entire weight of the pad installed with 92 fully loaded HSMs is considered in the evaluations. The maximum seismic accelerations of 0.548g lateral and 0.433g vertical is used for the seismic load combination. The resulting bearing stress demand is 2.273 ksf and 4.238 ksf for load combinations Case 1 and Case 2, respectively.

Attachment G of [7-32] computes an allowable bearing capacity for the CISF pads as 12,633 psf. Using the length and width factors in [7-67] will increase the bearing capacity. Therefore using 12,633 psf is conservative. The factors of safety are 5.5 and 3 for Case 1 and Case 2, respectively.

Elastic Settlement

7.6.6 Transport Cask Stability

During cask receipt operations, the Cask Handling Building (CHB) crane will remove the transport casks from the conveyances (railcar, heavy haul, etc.) and stage the transport casks, vertically, on the CHB floor. A vertical cask transporter (VCT) will drive up to the transport cask, engage for lifting, and raise the cask for movement to the Canister Transfer System (CTS). The transport cask is then staged in the CTS for transferring the contents into the storage overpack.

During the operations process described above, the transport casks will be standing vertically, unrestrained, for some time. An evaluation has been performed to determine if during a seismic event there is any potential for tip-over of the transport casks. As noted in Section 7.5.3.2.1, administrative controls will be used to mitigate certain impacts of design-basis tornado loading. The transportation cask will not be moved into the building to begin the railcar unloading process unless current and forecasted weather indicates safe condition and forecast, as described in proposed Technical Specification 5.4 [7-78].

7.6.6.1 Design Basis

The objective of the evaluation is to follow the guidelines in 10CFR72 and calculate the factors of safety (FS) for three different NAC transport casks (STC, UMS, and MAGNATRAN) to withstand a design basis seismic event at the WCS CISF site located at Andrews County, Texas. The maximum design basis seismic event is 0.261g [7-33].

7.6.6.2 Design Input

WCS-12-05-100-001, Rev. 0 "Site-Specific Seismic Hazard Evaluation and Development of Seismic Design Ground Motions" [7-33].

7.6.6.3 Assumptions

- For casks that are identical in exterior dimensions but configured with different types of fuels, evaluation of the configuration with the highest location of Center of Gravity (CG) is the most conservative to withstand the seismic tip-over event.

  Basis: The primary overturning moment is the product of (height of CG measured from the base corner) × (horizontal seismic force measured in fraction of gravity). Therefore, the higher the CG position, the greater the overturning moment.

- The pivot point of the tip-over event is the extreme outer corner of the cask bottom support plate.

  Basis: By kinematics, the pivot point and the Center of gravity form a vertical line at the threshold of instability of the cask during a tip-over event.

- The natural frequencies of the STC, UMS, MAGNATRAN transport casks are greater than 33Hz. Therefore, there is no amplification of the seismic force in any direction.

  Basis: By engineering judgement and past analysis records.

7.6.6.4 Methodology

The maximum horizontal acceleration at the surface of the concrete pad due to an earthquake is evaluated. As required by 10 CFR 72.102 [7-74], the design minimum earthquake ground acceleration is 0.261g (Reference [7-33], page 60). This stability evaluation will show that the NAC STC, NAC-UMS, and MAGNATRAN transport cask systems at the WCS CISF are stable during the 0.261g design earthquake horizontal acceleration. The vertical acceleration is defined as 2/3 of the horizontal acceleration in accordance with ASCE 4-86 [7-75].

This evaluation determines the effects of ground accelerations (horizontal components a_x, a_z and vertical component a_y) on the Transport cask for tip-over. The peak ground acceleration is associated with a safe shutdown earthquake. For this evaluation, the maximum overturning moment is compared to the restoring moment required to keep the cask in a stable upright position (i.e., cask will not tip over due to the earthquake). The maximum ground accelerations and overturning/restoring forces and moment are calculated for both empty and fully loaded cask configurations.

In the event of earthquake, there exists a base shear force or overturning force due to the horizontal ground acceleration and a restoring force due to the net force of vertical ground acceleration and gravity. This ground motion tends to rotate the cask about the bottom corner at the point of rotation (at the chamfer). The horizontal moment arm is from the CG toward the outer radius of the cask. The vertical moment arm is from the CG to the bottom of the cask. If the overturning moment is greater than the restoring moment, the cask may tip over. Using the geometry of the cask design, the maximum horizontal and vertical ground accelerations that the cask can safely withstand without becoming unstable are identified.

The two orthogonal horizontal acceleration components (a_x and a_z) are combined for maximum horizontal acceleration magnitude. The result is applied simultaneously with the vertical component to statically evaluate the overturning force and moment. Upward ground acceleration reduces the vertical force that restores the cask to its undisturbed vertical position. Based upon the requirements presented in NUREG-0800 [7-43], the static analysis method is considered applicable if the natural frequency of the structure is greater than 33 cps (Hz). The natural frequency of the STC, UMS, MAGNATRAN transport cask are greater than 33Hz. During the design basis earthquake event, a factor of safety of greater than 1 against tip over of the cask must be maintained.

7.6.6.5 Evaluation

To maintain the metal transport cask in equilibrium, the restoring moment, M_R must be greater than, or equal to, the overturning moment, M_O. The combination of horizontal and vertical acceleration components is based on the 100-40-40 approach of ASCE 4-86 [7-75], which considers that when the maximum response from one component occurs, the response from the other two components statistically are at 40% of their respective maximum value. Normally, the maximum vertical component of acceleration can be obtained by scaling the maximum ground acceleration by two-thirds. However, the maximum vertical acceleration is very conservatively considered to be the same as the design basis ground acceleration.

Let:

a = maximum design basis earthquake ground acceleration in the horizontal direction

a_x = horizontal acceleration component in X-direction

a_z = horizontal acceleration component in Z-direction

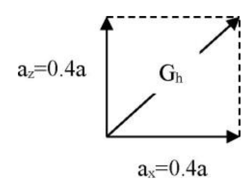
a_y = vertical acceleration component in Y-direction

G_H = Vector sum of two horizontal acceleration components

G_V = Vertical acceleration component

Two cases are analyzed:

Case 1) The vertical acceleration, a_y, is at its peak:

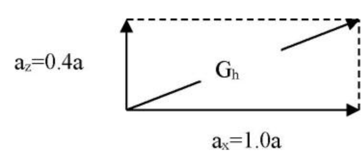


$$\left(a_y = 1.0a,\ a_x = 0.4a,\ \text{and}\ a_z = 0.4a\right)$$

$$G_H = \sqrt{a_x^2 + a_z^2} = \sqrt{(0.4a)^2 + (0.4a)^2} = 0.566a$$

$$G_v = 1.0a_y = 1.0a$$

Case 2) One horizontal acceleration, a_x, is at its peak:



$$\left(a_x = a,\ a_y = 0.4a,\ \text{and}\ a_z, = 0.4a\right)$$

$$G_H = \sqrt{a_x^2 + a_z^2} = \sqrt{(1.0a)^2 + (0.4a)^2} = 1.077a$$

$$G_v = a_y = 0.4a$$

For the cask to resist overturning, the restoring moment (M_R) about the point of rotation must be greater than the overturning moment (M_o).

$M_R \geq M_O$ or $F_r b \geq F_o d$; therefore, $(W \times 1 - W \times G_V) \times b \geq (W \times G_H) \times d$

(Eq 7.6.6.5-1)

d = vertical distance measured from the base of the cask to the center of gravity

b = horizontal distance measured from the point of rotation to the C.G.

W = the weight of the metal cask

F_o = overturning force

F_r = restoring force

Substituting for G_V and G_H into Equation 7.6.6.5-1 gives:

Case 1 (primary vertical)	Case 2 (primary horizontal)
$(1 - a)\frac{b}{d} \geq 0.566a$	$(1 - 0.4a)\frac{b}{d} \geq 1.077a$
$a \leq \dfrac{\frac{b}{d}}{0.566 + \frac{b}{d}}$	$a \leq \dfrac{\frac{b}{d}}{1.077 + 0.4 \times \frac{b}{d}}$

These equations are solved for each of the transport cask designs, in both loaded and empty configurations, and summarized in Table 7-44.

For the loaded transport casks, the minimum factor of safety to withstand a tip-over accident under Case 1 seismic load scenario is 1.55 for UMS loaded transport cask. The minimum factor of safety to withstand a tip-over accident under Case 2 seismic load scenario is 1.19 for UMS loaded transport cask. Each of the NAC transport casks, loaded or empty, meet the acceptance criteria of a FS greater than 1.

7.7 References

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7-24 NAC International Report 630075-R-06, Rev. 3, Appendix D, Kuosheng Hydraulic Gantry Crane NUREG-0554/ASME NOG-1 Conformance Matrix.

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Table 7-1
WCS CISF Structures and QA Classification

Structure	QA Classification
Canisters, Storage Overpacks (VCCs and HSMs), Transfer Casks	Important-to-Safety
Cask Handling Building	Important-to-Safety
Cask Handling Building Overhead Cranes	Important-to-Safety
Overhead Crane Bridge Trucks and Trolley Seismic Clips	Important-to-Safety
Crane Runway Support Beams	Important-to-Safety
Canister Transfer System	Important-to-Safety
Storage pads, NUHOMS® Systems	Not important to safety
Storage pads, VCCs	Important-to-Safety
NUHOMS® Transfer Equipment (Except Transfer Cask)	Not important to safety
Vertical Cask Transporter	Important-to-Safety

Table 7-2
Structural Evaluations for the Storage Systems at the WCS CISF

<table>
<tr><th>Cask System</th><th>Canister</th><th>Overpack</th><th>Appendix</th></tr>
<tr><td rowspan="4">NUHOMS®-MP187 Cask System</td><td>FO-DSC</td><td rowspan="4">HSM (Model 80)</td><td rowspan="4">Appendix A.7</td></tr>
<tr><td>FC-DSC</td></tr>
<tr><td>FF-DSC</td></tr>
<tr><td>GTCC Canister</td></tr>
<tr><td>Standardized Advanced NUHOMS® System</td><td>NUHOMS® 24PT1</td><td>AHSM</td><td>Appendix B.7</td></tr>
<tr><td rowspan="2">Standardized NUHOMS® System</td><td>NUHOMS® 61BT</td><td rowspan="2">HSM Model 102</td><td>Appendix C.7</td></tr>
<tr><td>NUHOMS® 61BTH Type 1</td><td>Appendix D.7</td></tr>
<tr><td rowspan="5">NAC-MPC</td><td>Yankee Class</td><td rowspan="5">VCC</td><td rowspan="5">Appendix E.7</td></tr>
<tr><td>Connecticut Yankee</td></tr>
<tr><td>LACBWR</td></tr>
<tr><td>GTCC-Canister-CY</td></tr>
<tr><td>GTCC-Canister-YR</td></tr>
<tr><td rowspan="2">NAC-UMS</td><td>Classes 1 through 5</td><td rowspan="2">VCC</td><td rowspan="2">Appendix F.7</td></tr>
<tr><td>GTCC-Canister-MY</td></tr>
<tr><td rowspan="2">MAGNASTOR</td><td>TSC1 through TSC4</td><td rowspan="2">CC1 through CC4</td><td rowspan="2">Appendix G.7</td></tr>
<tr><td>GTCC-Canister-ZN</td></tr>
</table>

Proprietary Information on Pages 7-136 and 7-137
Withheld Pursuant to 10 CFR 2.390

Table 7-5
Component Speed

Component	Max Speed	Function Description
Crane propel	90 cm/minute	Travel from loading zone to VCC
Crane lift	30 cm/minute	Lift transfer cask to top of VCC
Side shifter propel	10 cm/minute	Align transfer cask to adapter on VCC
Chain hoist lift	46 cm/minute	Lower canister into VCC

Table 7-6
Stress Ratios for Gantry Crane Members

Component	Maximum Stress Ratios (Usage Factors)‡
Lifting Booms	0.45
Lift Beams	0.65
Trolley Beam	0.80
Horizontal Struts	0.82

‡ Usage factor ratio is calculated stress divided by ASME NOG-1 allowable stress

Table 7-7
Factors of Safety for Main Components for Transfer Cask Lift

Component	Maximum Factor of Safety‡
Lift Links	4.54
Lift Link Pins	4.17
Slings	3.57
Shackles	3.14
TFR Lift Plates	5.56

‡ Factor of Safety is the ASME NOG-1 allowable stress divided by calculated stress

Table 7-8
Load Testing

Component	Min. Test Load	Reference
Gantry Lift Boom, each	124.7 MT	110% rated load, ASME B30.1, 1-6.4.2
Assembled Gantry Crane	100 MT	ASME NOG-1, para. 7422
Assembled Gantry Crane	125 MT	ASME NOG-1, para. 7423(a)(b)
Boom Wedge Locks	125 MT	ASME NOG-1, para. 7423 (b)(4)
Chain Hoist	125 MT	ASME B30.16, para. 16-2.2.2(b)
Chain Hoist Hook	181.4 MT	ASME B30.10, table 10-1.7-1
Lifting Links, each	100 MT	ASME B30.26, para 26-4.4.2
Transfer Cask Slings	113.4 MT	ASME B30.9, para. 9-6.6.2(a)
Transfer Cask Shackle, each	100 MT	ASME B30.26, para 26-1.4.2(a)
Transfer Cask Lift Plate	152 MT	ANSI N14.6, para 7.3.1(a), spc. lift device
Canister Lift Adapter	150 MT	ANSI N14.6, para 7.3.1(a), spc. lift device

Table 7-9
Safety Device Testing

Feature/Component	Testing*
Boom wedge locks	Hold load at 125% MCL
Wedge lock engagement	Engage with reduced oil pressure
Control stop button	All functions stop upon actuation
Gantry crane propel braking	Motion stops with lever in neutral
Lifting braking	Motion stops with lever in neutral
Chain hoist two-block limit switch	Motion stops
Side shifter propel	Motion stops with lever in neutral

* See operations and O&M manuals for component testing frequency

Table 7-10
Testing Requirements

Critical Component	Charpy	MTR	MT or PT
Trolley Beam	X	X	X
Lift Beams	X	X	X
Struts	X	X	X
Cross Bracing	X	X	No welds
Boom Sections	X	X	X
Base Enclosure	X	X	X
Lifting Links	X	X	No welds
Chain Hoist Hook	Not required	X	X

Table 7-11
Enveloping Element Forces (kip/in) and Moments (kip-in/in) for Cask Configuration 1

**** MAXIMUM AND MINIMUM SUMMARY OF ABOVE ENVELOPE RESULTS ****

RESULT	MAXIMUM	LOAD	JOINT	MINIMUM	LOAD	JOINT
NXX	0.973309E+02	133	5668	-0.971351E+02	126	5225
NYY	0.175945E+03	131	1389	-0.176289E+03	129	1389
NXY	0.710638E+02	131	126	-0.710638E+02	127	1146
MXX	0.496207E+02	131	403	-0.158170E+03	109	837
MYY	0.651214E+02	132	323	-0.130053E+03	104	299
MXY	0.221102E+02	104	3355	-0.232088E+02	201	2977
VXX	0.571444E+01	109	4966	-0.571444E+01	105	6316
VYY	0.621464E+01	104	2997	-0.621597E+01	105	3402

Table 7-12
Enveloping Element Forces (kip/in) and Moments (kip-in/in) for Cask Configuration 2

**** MAXIMUM AND MINIMUM SUMMARY OF ABOVE ENVELOPE RESULTS ****

RESULT	MAXIMUM	LOAD	JOINT	MINIMUM	LOAD	JOINT
NXX	0.569772E+02	132	5225	-0.568082E+02	126	5225
NYY	0.885718E+02	130	1398	-0.887461E+02	128	1398
NXY	0.371079E+02	128	126	-0.371079E+02	132	1146
MXX	0.556533E+02	108	323	-0.108215E+03	108	869
MYY	0.800629E+02	108	323	-0.146712E+03	105	617
MXY	0.351331E+02	105	2635	-0.351331E+02	109	8485
VXX	0.462325E+01	104	8899	-0.462324E+01	108	2149
VYY	0.445764E+01	104	2997	-0.430292E+01	104	3078

Table 7-13
Enveloping Element Forces (kip/in) and Moments (kip-in/in) for Cask Configuration 3

**** MAXIMUM AND MINIMUM SUMMARY OF ABOVE ENVELOPE RESULTS ****

RESULT	MAXIMUM	LOAD	JOINT	MINIMUM	LOAD	JOINT
NXX	0.765872E+02	128	5675	-0.763796E+02	126	5225
NYY	0.125460E+03	130	1398	-0.125541E+03	132	9954
NXY	0.519504E+02	128	126	-0.519640E+02	132	1146
MXX	0.659693E+02	131	991	-0.139056E+03	108	869
MYY	0.930660E+02	104	943	-0.125794E+03	108	989
MXY	0.413002E+02	104	2743	-0.420798E+02	108	8593
VXX	0.602652E+01	108	9007	-0.594009E+01	104	2257
VYY	0.573442E+01	108	7497	-0.557302E+01	108	7686

Table 7-14
Enveloping Element Forces (kip/in) and Moments (kip-in/in) for Cask Configuration 4

**** MAXIMUM AND MINIMUM SUMMARY OF ABOVE ENVELOPE RESULTS ****

RESULT	MAXIMUM	LOAD	JOINT	MINIMUM	LOAD	JOINT
NXX	0.907013E+02	128	5675	-0.905094E+02	126	5225
NYY	0.153049E+03	130	1398	-0.153281E+03	132	9954
NXY	0.619094E+02	126	1146	-0.619172E+02	130	126
MXX	0.654932E+02	132	1003	-0.151329E+03	109	837
MYY	0.972217E+02	108	905	-0.138299E+03	108	1001
MXY	0.436717E+02	105	2851	-0.439850E+02	109	8701
VXX	0.678284E+01	108	9115	-0.670758E+01	104	2365
VYY	0.608036E+01	108	7497	-0.672943E+01	108	7794

Table 7-15
Load Combination 104 Resultant Force For Width Cut, Cask Configuration 4 (kip & kip-in)

```
==========================================================================
  LOADING - 104
==========================================================================


    LOCATION OF CENTROID (REFER TO NOTE ABOVE) =    0.9900000E+02


         IN-PLANE NORMAL FORCE,       P =   -0.3362797E+03

         IN-PLANE SHEAR FORCE
            (PARALLEL TO CUT),        V =   -0.6475717E+03

         OUT-OF-PLANE (TRANSVERSE)
            SHEAR FORCE,             FZ =    0.1912850E+03

         BENDING MOMENT (MOMENT
            VECTOR PARALLEL TO CUT), MB =    0.7248867E+04

         TWISTING MOMENT (MOMENT
            VECTOR NORMAL TO CUT),   MT =   -0.1093596E+05

         IN-PLANE ROTATIONAL
            DEFORMATION MOMENT,      MZ =   -0.1293207E+05
```

Table 7-16
Load Combination 105 Resultant Force For Length Cut, Cask Configuration 2 (kip & kip-in)

```
================================================================================
  LOADING - 105
================================================================================


    LOCATION OF CENTROID (REFER TO NOTE ABOVE) =    0.9529411E+02


         IN-PLANE NORMAL FORCE,       P =    0.2532034E+01

         IN-PLANE SHEAR FORCE
            (PARALLEL TO CUT),        V =    0.4587067E+02

         OUT-OF-PLANE (TRANSVERSE)
            SHEAR FORCE,             FZ =    0.1734929E+03

         BENDING MOMENT (MOMENT
            VECTOR PARALLEL TO CUT), MB =    0.6583913E+04

         TWISTING MOMENT (MOMENT
            VECTOR NORMAL TO CUT),   MT =    0.3900859E+04

         IN-PLANE ROTATIONAL
            DEFORMATION MOMENT,      MZ =    0.9978431E+03
```

Table 7-17
Load Combination 301 Enveloping Reactions Cask Configuration 4 (kip & kip-in)

```
**** Summary of Global Reaction Envelopes ****

=================================================
  Type          Value        Load     Joint
=================================================

Force X  Min  -0.774047E-01  301      611
         Max   0.774047E-01  301      661
Force Y  Min   0.000000E+00  301      126
         Max   0.000000E+00  301      126
Force Z  Min  -0.189993E+00  301      126
         Max   0.189993E+00  301      1146
Moment X Min   0.000000E+00  301      126
         Max   0.000000E+00  301      126
Moment Y Min   0.000000E+00  301      126
         Max   0.000000E+00  301      126
Moment Z Min   0.000000E+00  301      126
         Max   0.000000E+00  301      126
=================================================
```

Table 7-18
Load Combination 302 To 309 Enveloping Reactions Cask Configuration 1
(kip & kip-in)

```
**** Summary of Global Reaction Envelopes ****

==================================================
  Type          Value        Load     Joint
==================================================


Force X  Min   -0.278213E+04  303      611
         Max    0.278213E+04  307      611
Force Y  Min    0.000000E+00  302      126
         Max    0.000000E+00  302      126
Force Z  Min   -0.278292E+04  306      126
         Max    0.278292E+04  307      126
Moment X Min    0.000000E+00  302      126
         Max    0.000000E+00  302      126
Moment Y Min    0.000000E+00  302      126
         Max    0.000000E+00  302      126
Moment Z Min    0.000000E+00  302      126
         Max    0.000000E+00  302      126
==================================================
```

Table 7-19
Load Combination 301 Maximum Displacements Cask Configuration 1 (in)

```
****SUMMARY OF MAXIMUM GLOBAL DISPLACEMENTS****
        INDEPENDENT IN EACH COORDINATE


=============================================
* RESULT *    MAXIMUM     LOAD     JOINT    *
*========*==================================*
* X-DISP * -0.233258E-02  301      225      *
* Y-DISP * -0.393650E+00  301      627      *
* Z-DISP *  0.851354E-03  301      403      *
=============================================
```

Table 7-20
Load Combination 302 to 309 Maximum Displacements Cask Configuration 1 (in)

```
****SUMMARY OF MAXIMUM GLOBAL DISPLACEMENTS****
        INDEPENDENT IN EACH COORDINATE


=============================================
* RESULT *    MAXIMUM     LOAD     JOINT    *
*========*==================================*
* X-DISP * -0.368355E+00  308      175      *
* Y-DISP * -0.534379E+00  309      525      *
* Z-DISP * -0.263145E+00  308      102      *
=============================================
```

Proprietary Information on Pages 7-154 and 7-155
Withheld Pursuant to 10 CFR 2.390

Table 7-23
SSI Analysis Cases

Case Number	Time History	Soil Case	Cask Configuration
1	Coyote Lake	LB	1
2	Coyote Lake	BE	1
3	Coyote Lake	UB	1
4	Norcia	LB	1
5	Norcia	BE	1
6	Norcia	UB	1
7	N. Palm Springs	LB	1
8	N. Palm Springs	BE	1
9	N. Palm Springs	UB	1
10	Coyote Lake	LB	2
11	Coyote Lake	BE	2
12	Coyote Lake	UB	2
13	Norcia	LB	2
14	Norcia	BE	2
15	Norcia	UB	2
16	N. Palm Springs	LB	2
17	N. Palm Springs	BE	2
18	N. Palm Springs	UB	2
19	Coyote Lake	LB	3
20	Coyote Lake	BE	3
21	Coyote Lake	UB	3
22	Norcia	LB	3
23	Norcia	BE	3
24	Norcia	UB	3
25	N. Palm Springs	LB	3
26	N. Palm Springs	BE	3
27	N. Palm Springs	UB	3
28	Coyote Lake	LB	4
29	Coyote Lake	BE	4
30	Coyote Lake	UB	4
31	Norcia	LB	4
32	Norcia	BE	4
33	Norcia	UB	4
34	N. Palm Springs	LB	4
35	N. Palm Springs	BE	4
36	N. Palm Springs	UB	4

Table 7-24
Description of Confinement Boundaries

System	Appendix Location
NUHOMS® MP187 Cask System	Section A.11.1
Standardized Advanced NUHOMS® System	Section B.11.1
Standardized NUHOMS®-61 BT System	Section C.11.1
Standardized NUHOMS®-61 BTH Type 1 System	Section D.11.1
Yankee-MPC	Section E.11.1.1
CY-MPC	Section E.11.1.1
MPC-LACBWR	Section E.11.2.1
NAC-UMS	Section F.11.1.1
NAC-MAGNASTOR	Section G.11.1.1

Table 7-25
Cask Handling Building SSCs and QA Classification

SSC	QA Classification
Building Structural steel	Important-to-Safety
Overhead Crane Support Beams	Important-to-Safety
Concrete Foundations and Slab on Grade	Important-to-Safety
Overhead Crane Bridge Trucks and Trolley Seismic Clips	Important-to-Safety
Overhead Cranes	Important-to-Safety
Building Classing	Not Important-to-Safety
Electrical Systems	Not Important-to-Safety
Mechanical and HVAC Systems	Not Important-to-Safety
Fire Protection System	Not Important-to-Safety

Table 7-26
Deleted

Table 7-27
Deleted

Table 7-28
Deleted

Table 7-29
Analyzed Cases

Case	Earthquake	Number of Modules on the Pad	Soil Properties
1	Coyote Lake	22	Best Estimate
2			Lower Bound
3			Upper Bound
4		42	Best Estimate
5			Lower Bound
6			Upper Bound
7		92	Best Estimate
8			Lower Bound
9			Upper Bound
10	Norcia	22	Best Estimate
11			Lower Bound
12			Upper Bound
13		42	Best Estimate
14			Lower Bound
15			Upper Bound
16		92	Best Estimate
17			Lower Bound
18			Upper Bound
19	Palm Springs	22	Best Estimate
20			Lower Bound
21			Upper Bound
22		42	Best Estimate
23			Lower Bound
24			Upper Bound
25		92	Best Estimate
26			Lower Bound
27			Upper Bound

Proprietary Information on Pages 7-161 through 7-166
Withheld Pursuant to 10 CFR 2.390

Table 7-33
"Maximum" Passing Frequencies due to Soil and Pad Modeling

Soil Case	f = Vs/(5xh_{soil}) [hz]	f = Vs/(5xh_{pad}) [hz]
BE	32.81	34.48
LB	25.10	25.82
UB	42.77	46.04

Proprietary Information on Pages 7-168 and 7-169
Withheld Pursuant to 10 CFR 2.390

Table 7-36
ANSYS Finite Element Models for Storage Pad Structural Evaluation

Model Identification	Model Description
HSMFUL	Fully Loaded Pad (2x46=92 AHSM)
HSM2CSK	Two Rows Back-to-Back HSMs (2x2=4 AHSM)
HSM4CSK	Four Rows Back-to-Back HSMs (2x4=8 AHSM)
HSMQUA	Eleven Rows Back-to-Back HSMs (2x11=22 AHSM)
HSMHAL	Twenty One Rows Back-to-Back HSMs (2x21=42 AHSM)

Proprietary Information on Pages 7-171 and 7-172
Withheld Pursuant to 10 CFR 2.390

Table 7-39
Design Force/Moment Values for Evaluation
Maxima and Minima (lbf and in-lbf) Per Inch Width
(2 Sheets)

		HSMFUL	HSM2CSK	HSM4CSK	HSMQUA	HSMHAL
Case 2 1.4D + 1.7L	Max. M_y	271,989	185,724	216,831	244,876	247,620
	Min. M_y	-20,411	-48,442	-56,174	-65,136	-66,652
	Max. F_{xz}	6,869	6,307	7,194	8,401	8,570
	Min. F_{xz}	-6,998	-4,999	-5,967	-6,820	-6,985
	Max. M_x	17,132	7,424	10,987	16,408	16,959
	Min. M_x	-195,189	-139,985	-167,158	-190,050	-194,786
	Max. F_{yz}	4,284	3,214	3,866	4,416	4,513
	Min. F_{yz}	-4,284	-3,214	-3,866	-4,416	-4,513
Case 3 D+SSE (+ + +)	Max. M_y	206,301	167,333	187,423	207,351	211,014
	Min. M_y	-15,521	-41,809	-47,905	-53,844	-56,450
	Max. F_{xz}	5,168	5,370	6,000	6,856	7,097
	Min. F_{xz}	-6,402	-4,373	-5,257	-6,100	-6,369
	Max. M_x	35,284	32,603	41,685	52,932	59,818
	Min. M_x	-164,488	-123,929	-147,154	-164,838	-173,207
	Max. F_{yz}	3,602	2,480	3,027	3,490	3,631
	Min. F_{yz}	-3,709	-2,710	-3,279	-3,717	-3,906
Case 4 D+SSE (- + +)	Max. M_y		185,253	210,381	242,114	256,650
	Min. M_y		-41,548	-48,765	-57,214	-60,403
	Max. F_{xz}		5,575	6,373	7,560	7,979
	Min. F_{xz}		-4,140	-4,909	-5,501	-5,639
	Max. M_x		23,072	34,672	47,915	56,668
	Min. M_x		-124,703	-150,698	-172,116	-181,051
	Max. F_{yz}		2,535	3,018	3,445	3,588
	Min. F_{yz}		-2,878	-3,494	-4,010	-4,207
Case 5 D+SSE (- - -)	Max. M_y	119,814	93,068	105,767	124,539	134,175
	Min. M_y	-25,809	-38,508	-43,905	-41,127	-48,483
	Max. F_{xz}	4,987	3,752	3,700	4,821	5,304
	Min. F_{xz}	-2,216	-1,848	-2,147	-2,324	-2,312
	Max. M_x	43,210	40,665	41,840	51,185	58,993
	Min. M_x	-76,875	-57,509	-66,509	-71,495	-70,442
	Max. F_{yz}	2,211	2,382	2,675	3,179	3,642
	Min. F_{yz}	-1,617	-1,528	-1,962	-2,702	-3,241

Table 7-39
Design Force/Moment Values for Evaluation
Maxima and Minima (lbf and in-lbf) Per Inch Width
(2 Sheets)

		HSMFUL	HSM2CSK	HSM4CSK	HSMQUA	HSMHAL
Case 6 D+SSE (+ - +)	Max. M_y		167,333	187,422	207,350	211,015
	Min. M_y		-41,809	-47,905	-53,844	-56,450
	Max. F_{xz}		5,370	6,000	6,856	7,097
	Min. F_{xz}		-4,373	-5,257	-6,100	-6,369
	Max. M_x		40,150	44,883	57,582	67,381
	Min. M_x		-122,477	-148,134	-170,698	-175,946
	Max. F_{yz}		2,710	3,279	3,717	3,906
	Min. F_{yz}		-2,480	-3,027	-3,490	-3,631
Case 7 D+SSE Rows 1, 46 Out of Phase	Max. M_y	188,227				
	Min. M_y	-82,892				
	Max. F_{xz}	6,421				
	Min. F_{xz}	-4,636				
	Max. M_x	26,789				
	Min. M_x	-143,269				
	Max. F_{yz}	3,032				
	Min. F_{yz}	-3,192				

Table 7-40
Enveloping Design Forces and Moments (lbf and in-lbf) Per Inch Width

Component	Design Values
Max. M_y	271,989
Max. M_x	-195,189
Max. F_{yz} *	4,512.9
Max. F_{xz} *	8,570

According to ACI 349, the design shear force is to be taken at 'd' away from the edge of the HSM module, where 'd" is the effective depth of the concrete pad.

Table 7-41
Cask Handling Building Primary Framing Member Sizes

Structural Element	Member Size Class
Main Building Columns	W14
Crane Columns	W14
Wind Columns	W14
Wind Column Vertical Truss Web Members	2L8x8
North-South Struts	W14, W18
East-West Struts	W12, W16
East-West Vertical Braces	HSS8.625 (round)
North-South Vertical Braces	HSS9.625, HSS5.5 (round)
Intermediate Level Horizontal Braces	WT
Primary Roof Truss Chords	W14
Secondary Roof Truss Chords	W14
Primary Roof Truss Web Diagonal Members	2L5x5
Secondary Roof Truss Web Diagonal Members	2L8x6
Interior Roof Truss Web Vertical Members	2L3.5x3.5
Exterior Roof Truss Web Vertical Members	W8
Primary Roof Horizontal Braces	HSS7x7 (square)
Secondary Roof Horizontal Braces	WT

Table 7-42
Cask Handling Building Evaluation of Soil and Structural Dominant Frequencies

Mode	Frequency of Rigid Mass on Soil Spring, f_{soil} (Hz)	CHB Fixed-Base Dominant Frequency, f_{CHB} (Hz)	Ratio f_{soil}/f_{CHB}
Horizontal, E-W (X)	16.1	3.02	5.32
Horizontal, N-S (Z)	16.1	3.47	4.63
Vertical (Y)	20.8	12.68	1.64
Rocking in E-W direction (about Z)	10.6	3.02	3.51
Rocking in N-S direction (about X)	6.9	3.47	1.98
Torsion	8.4	3.76	2.22

Table 7-43
Maximum Demand/Capacity Ratios (DCRs)

Element	Load Combination				
	Gravity	Seismic	Tornado Wind Pressure[1]	Tornado Missile Impact with Tornado Wind Pressure[2]	Governing DCR[6]
Main Column	0.17	0.27	0.21	0.65	0.65
Zipper Column[3]	0.08	0.10	0.15	0.16	0.16
Crane Column	0.30	0.28	0.11	0.65	0.65
Wind Column	0.12	0.12	0.13	0.70	0.70
Sacrificial Strut[3]	0.23	0.37	0.15	0.66	0.66
Non-Sacrificial Strut[4]	0.23	0.37	0.15	0.70	0.70
Crane Girder[5]	0.19	0.29	0.05	0.11	0.29
Roof truss bottom chord	0.12	0.16	0.38	0.62	0.62
Roof truss top chord	0.15	0.22	0.33	0.65	0.65
Roof truss web member	0.62	0.57	0.61	0.68	0.68
Sacrificial N-S Vertical Bracing[3]	0.21	0.12	0.12	0.61	0.61
Sacrificial E-W Vertical Bracing[3]	0.32	0.34	0.28	0.83	0.83
Sacrificial Crane Vertical Bracing[3]	0.32	0.25	0.12	0.19	0.32

1. The Tornado Wind Pressure DCRs do not reflect tornado missile impact; i.e., automobile. Columns are generally sized for missile impact.
2. Not all possible missile impact locations have been considered in this preliminary analysis. DCRs reflected are based on representative sampling of primary member and framing system impact locations. During detailed design, the governing DCR may increase (see Note 6).
3. Sacrificial members hit directly or in close proximity to a tornado missile are allowed to fail. These member DCRs are reflective of an indirect missile strike.
4. Non-Sacrificial members are designed to withstand a missile impact. These DCRs are indicative of a member that is directly impacted by a tornado missile. Unless noted otherwise, all members are non-sacrificial.
5. The DCRs for the crane girder do not consider all crane position loading scenarios and fatigue to be addressed in detailed design. These considerations may result in an increase in DCR (see Note 6).
6. During detailed design, the maximum member DCR shall not exceed 0.90.

Table 7-44
Evaluation Results with Factors of Safety for Transportation Cask Stability

Transport Cask Type	Minimum Earthquake Level to cause a Tipover (g)		Factor of Safety	
	Case 1	Case 2	Case 1	Case 2
STC, empty	0.442	0.357	1.69	1.37
UMS, empty	0.412	0.321	1.58	1.23
MAGNATRAN, empty	0.428	0.340	1.64	1.30
STC, loaded	0.436	0.350	1.67	1.34
UMS, loaded	0.403	0.311	1.55	1.19
MAGNATRAN, loaded	0.420	0.330	1.61	1.26

Proprietary Information on Pages 7-180 through 7-187
Withheld Pursuant to 10 CFR 2.390

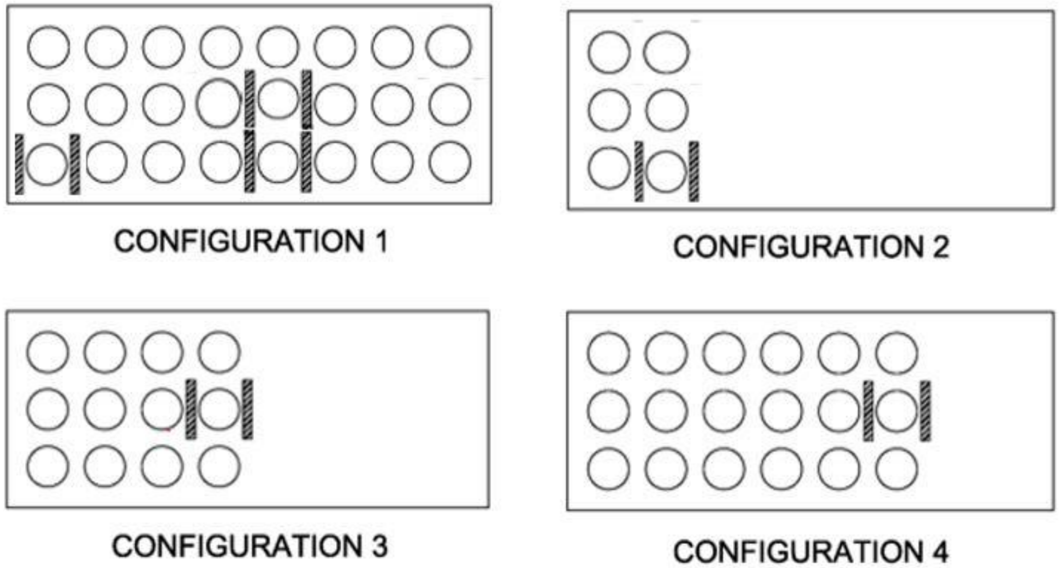

Figure 7-9
Cask Layout Design Configurations and VCT Locations

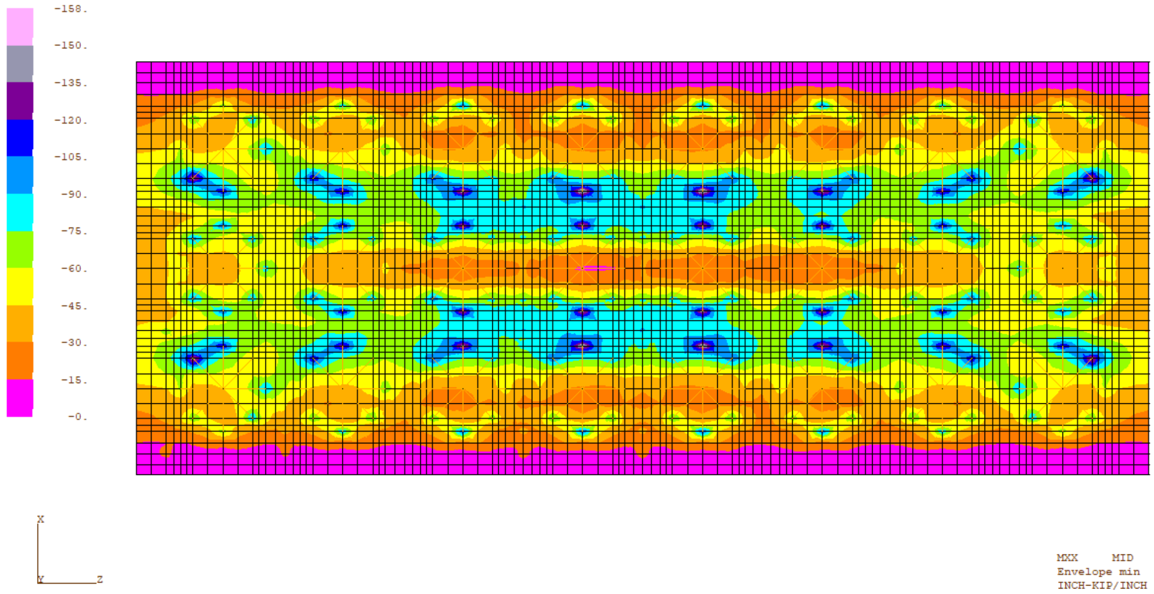

Figure 7-10
Enveloping Negative Moment Resultants (kip-in/in) About Global Z-Axis
(local MXX) - Configuration 1

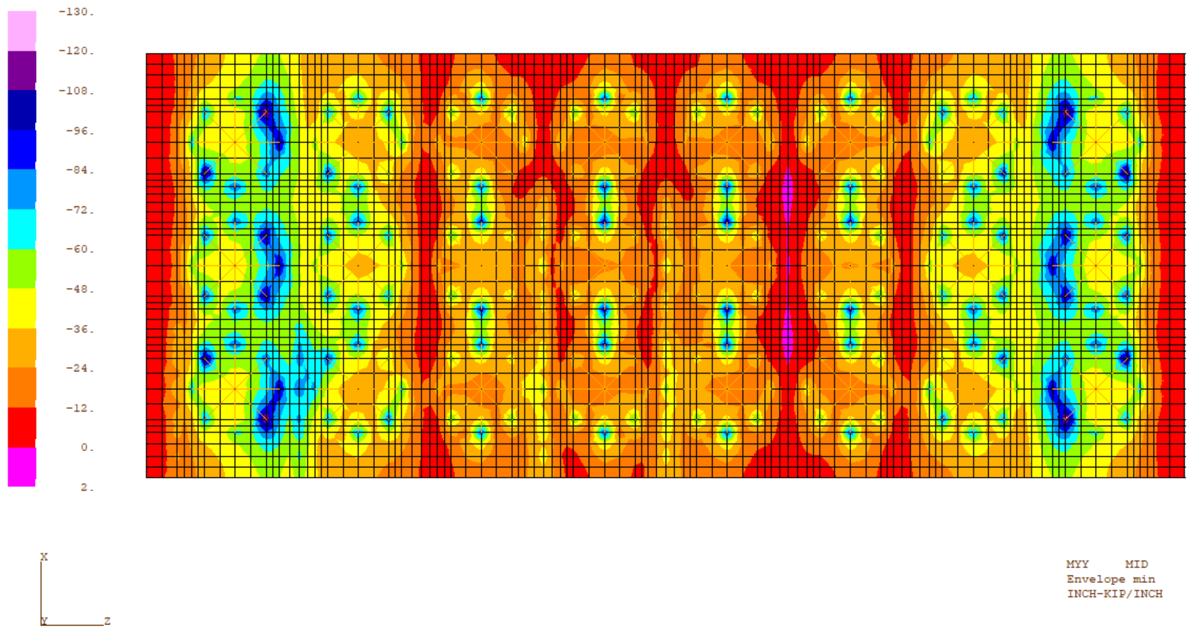

Figure 7-11
Enveloping Negative Moment Resultants (kip-in/in) About Global X-Axis (local M_{YY}) - Configuration 1

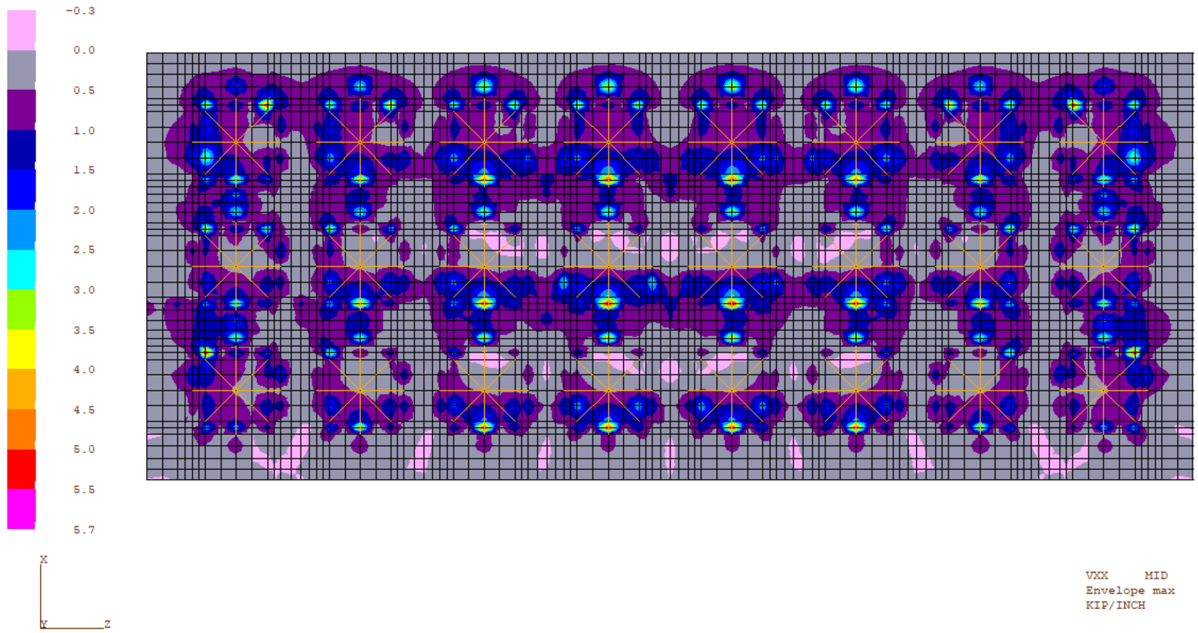

Figure 7-12
Enveloping Element Shear (kip/in) In The Global Y-Direction On The X-Face (local V_{XX}) - Configuration 1

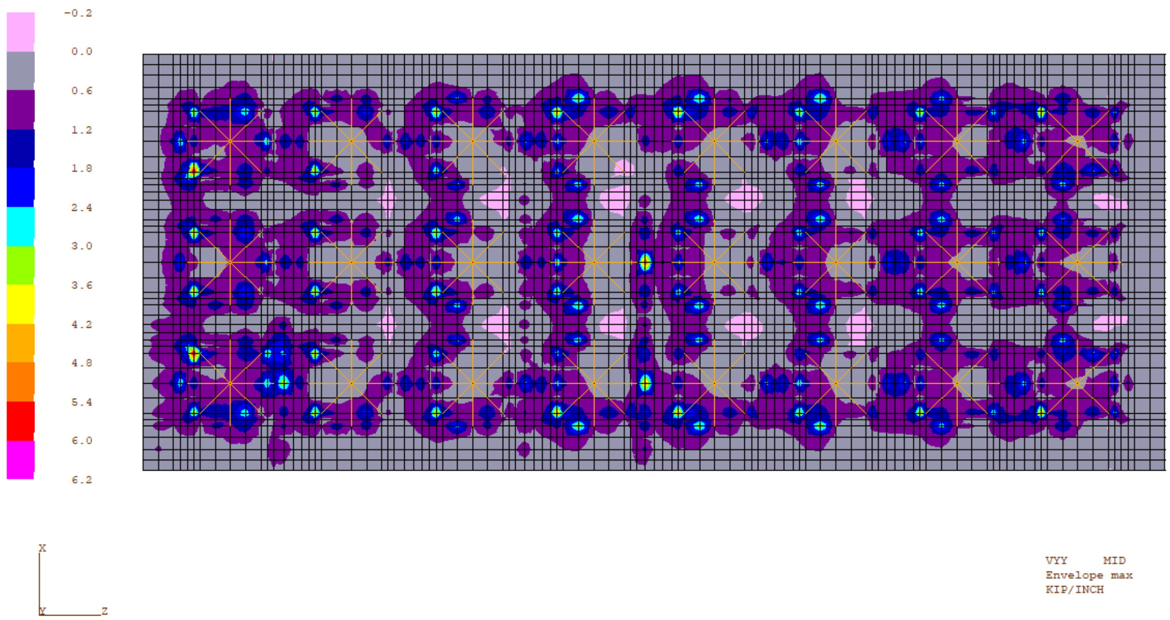

Figure 7-13
Enveloping Element Shear (kip/in) In The Global Y-Direction On The Z-Face (local V_{YY}) - Configuration 1

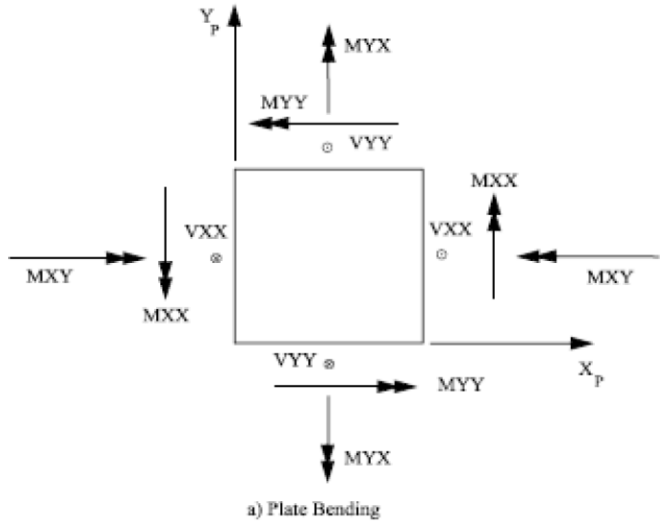

Figure 7-14
GTSTRUDL Plate Bending Element Sign Convention

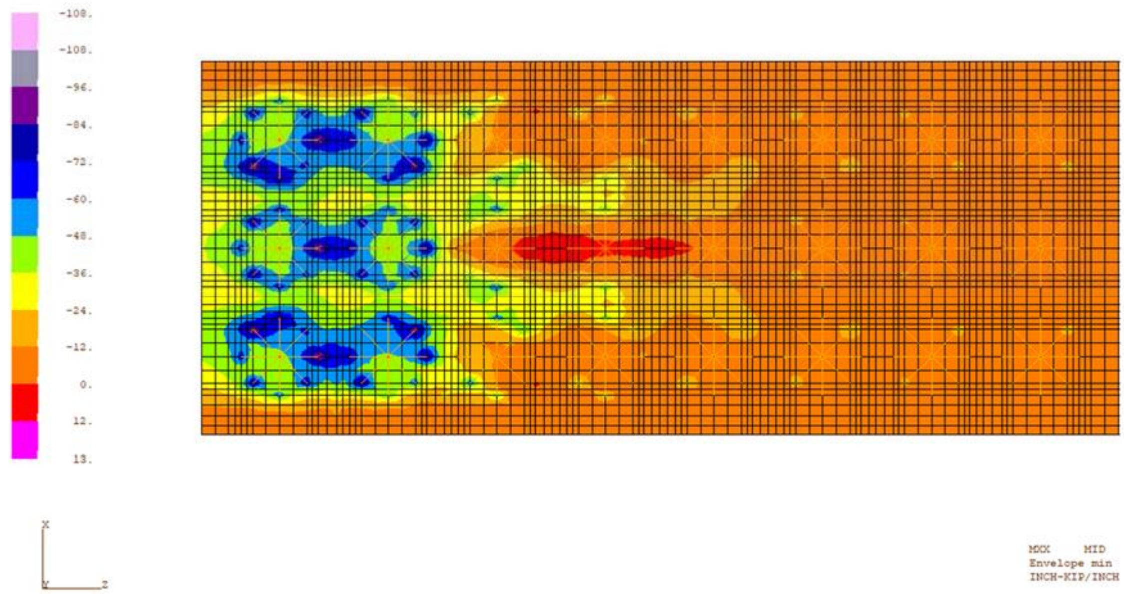

Figure 7-15
Enveloping Negative Moment Resultants (kip-in/in) About Global Z-Axis (local MXX) - Configuration 2

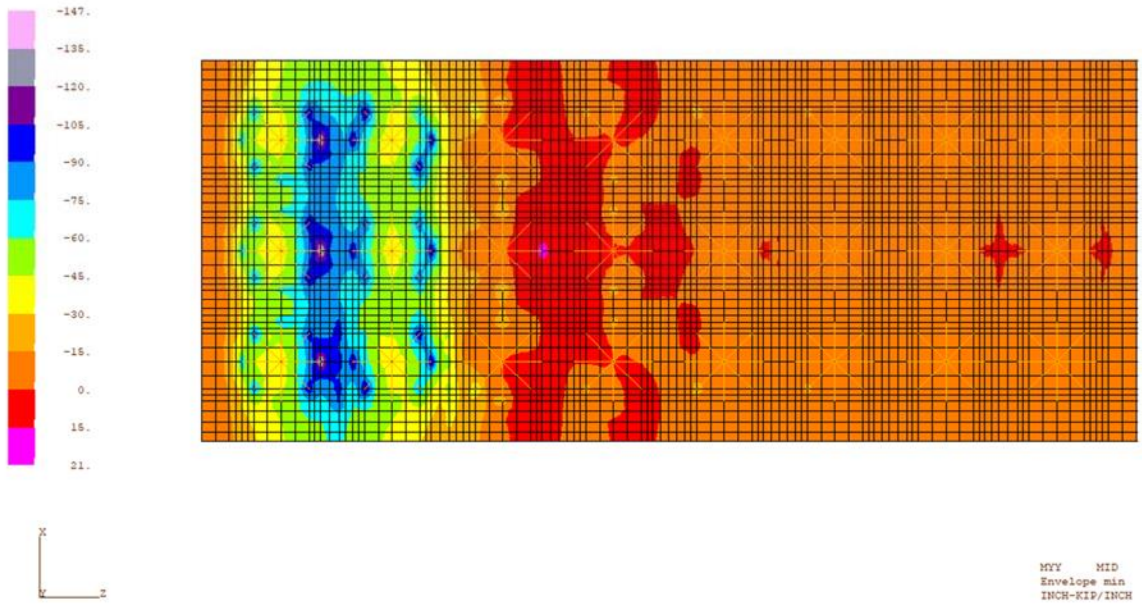

Figure 7-16
Enveloping Negative Moment Resultants (kip-in/in) About Global X-Axis (local M_{YY}) - Configuration 2

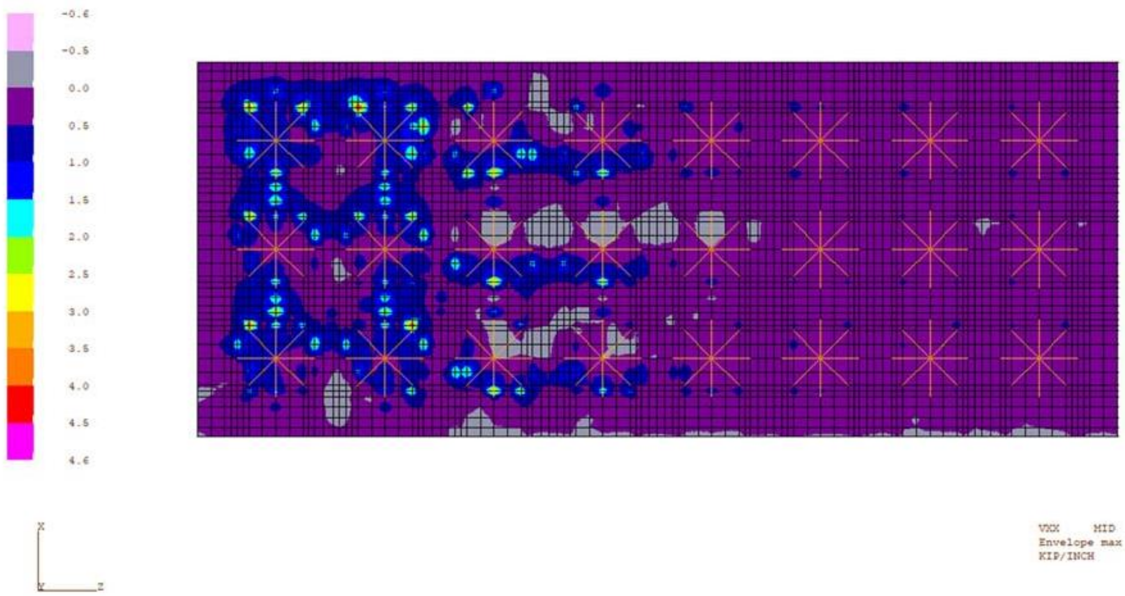

Figure 7-17
Enveloping Element Shear (kip/in) In The Global Y-Direction On The X-Face (local Vxx) - Configuration 2

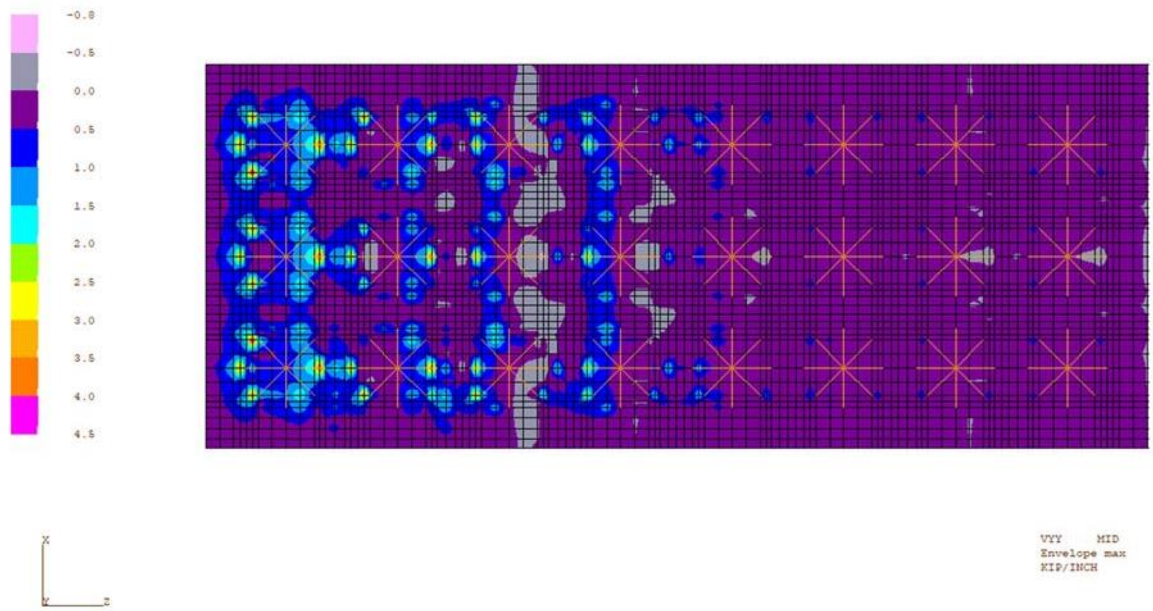

Figure 7-18
Enveloping Element Shear (kip/in) In The Global Y-Direction On The Z-Face (local V_{YY}) - Configuration 2

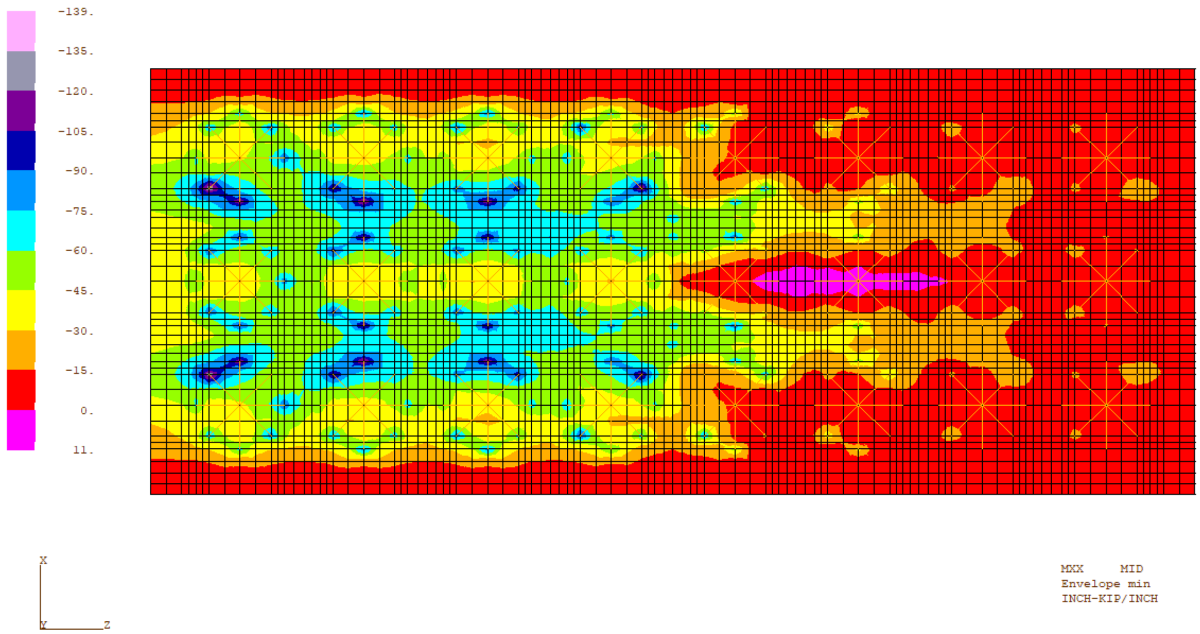

Figure 7-19
Enveloping Negative Moment Resultants (kip-in/in) About Global Z-Axis (local MXX) - Configuration 3

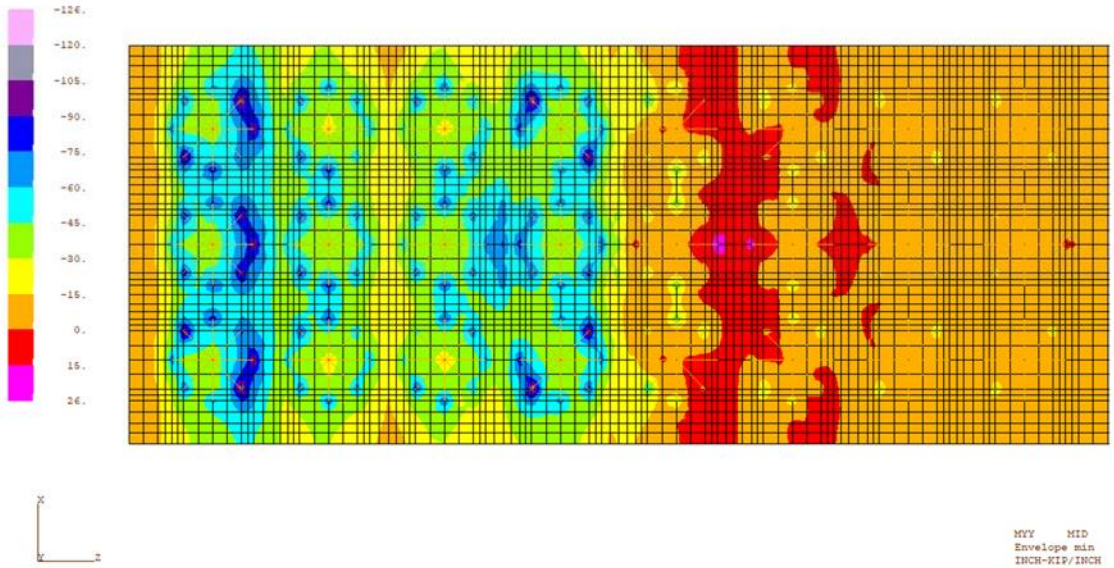

Figure 7-20
Enveloping Negative Moment Resultants (kip-in/in) About Global X-Axis (local M_{YY}) - Configuration 3

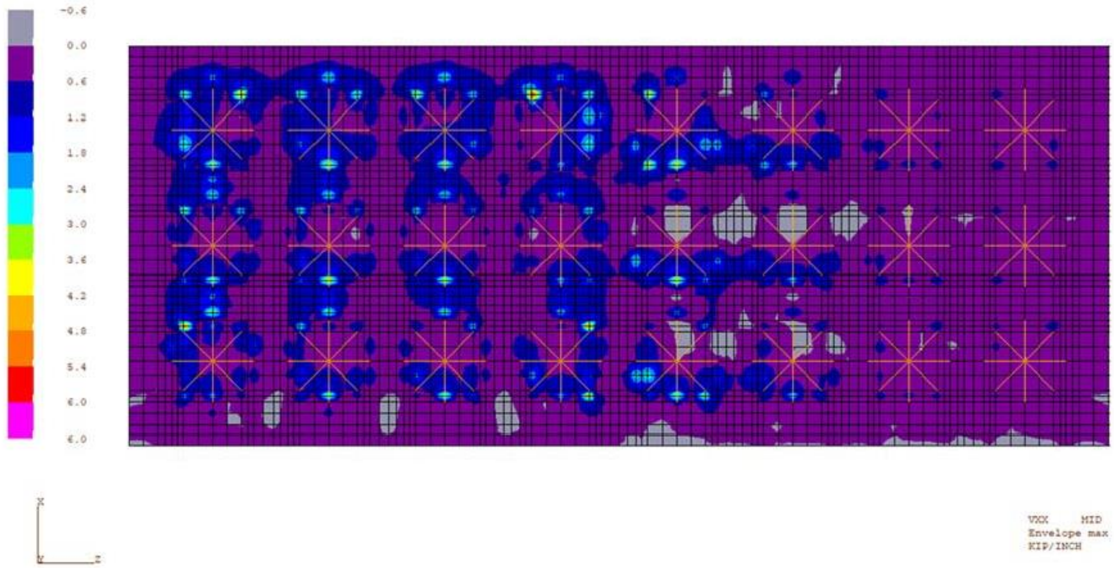

Figure 7-21
Enveloping Element Shear (kip/in) In The Global Y-Direction On The X-Face (local V_{XX}) - Configuration 3

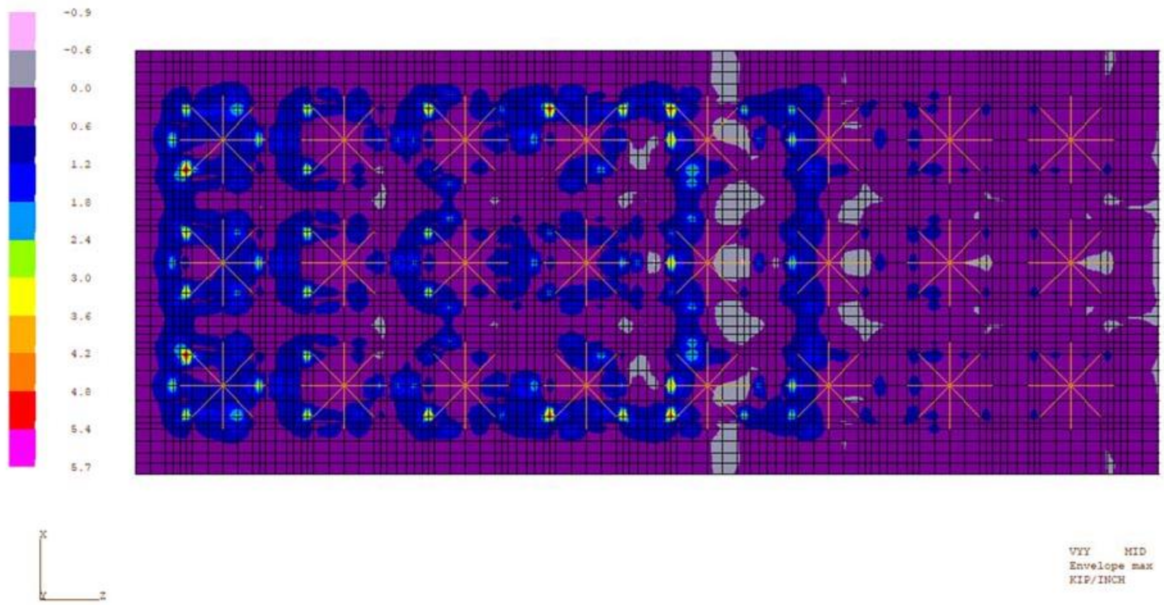

Figure 7-22
Enveloping Element Shear (kip/in) In The Global Y-Direction On The Z-Face (local V_{YY}) - Configuration 3

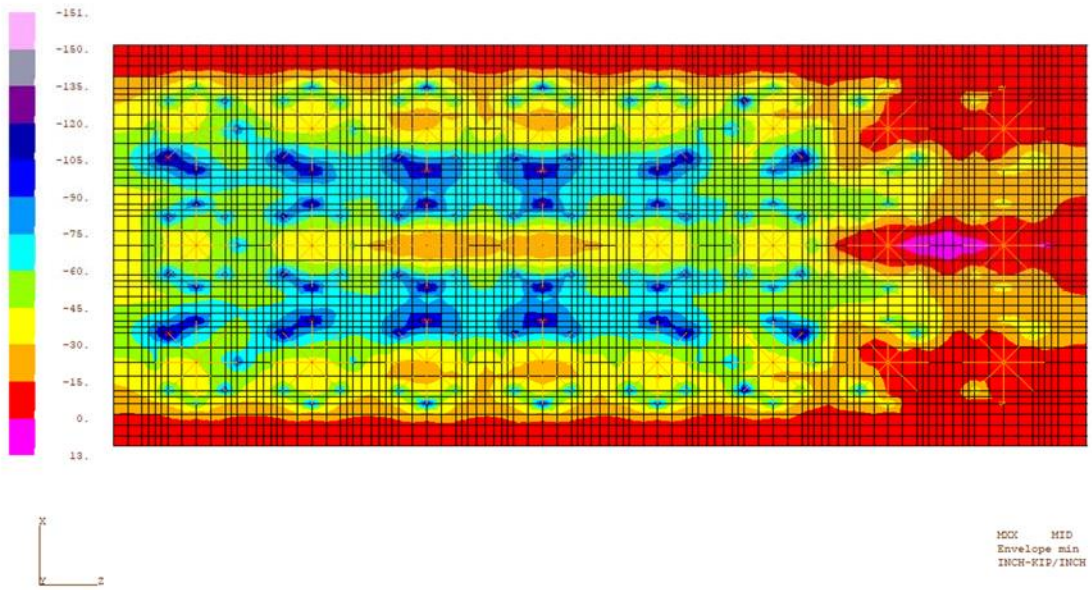

Figure 7-23
Enveloping Negative Moment Resultants (kip-in/in) About Global Z-Axis (local MXX) - Configuration 4

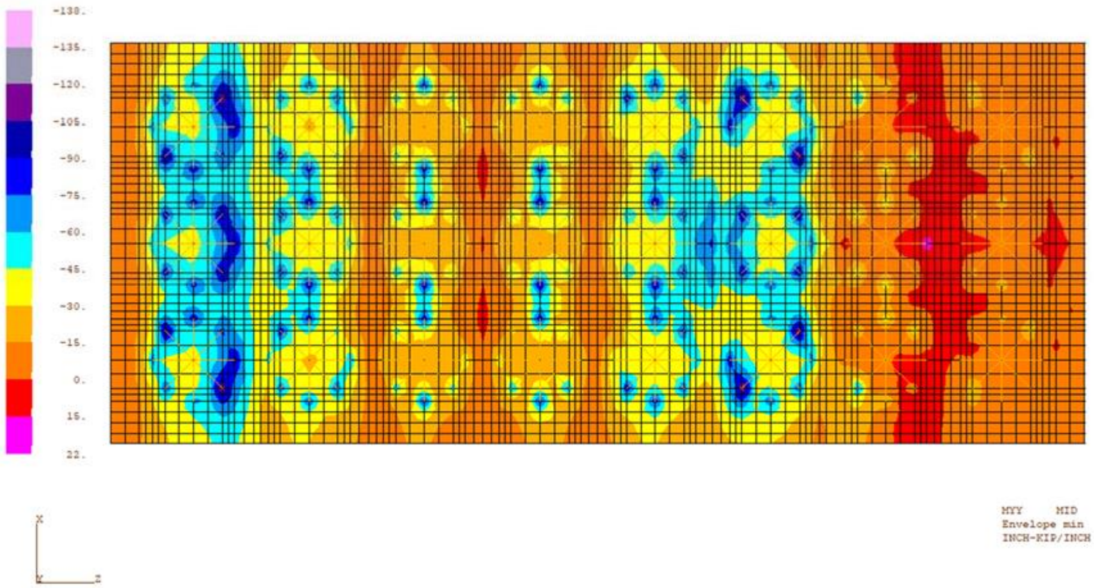

Figure 7-24
Enveloping Negative Moment Resultants (kip-in/in) About Global X-Axis (local M_{YY}) - Configuration 4

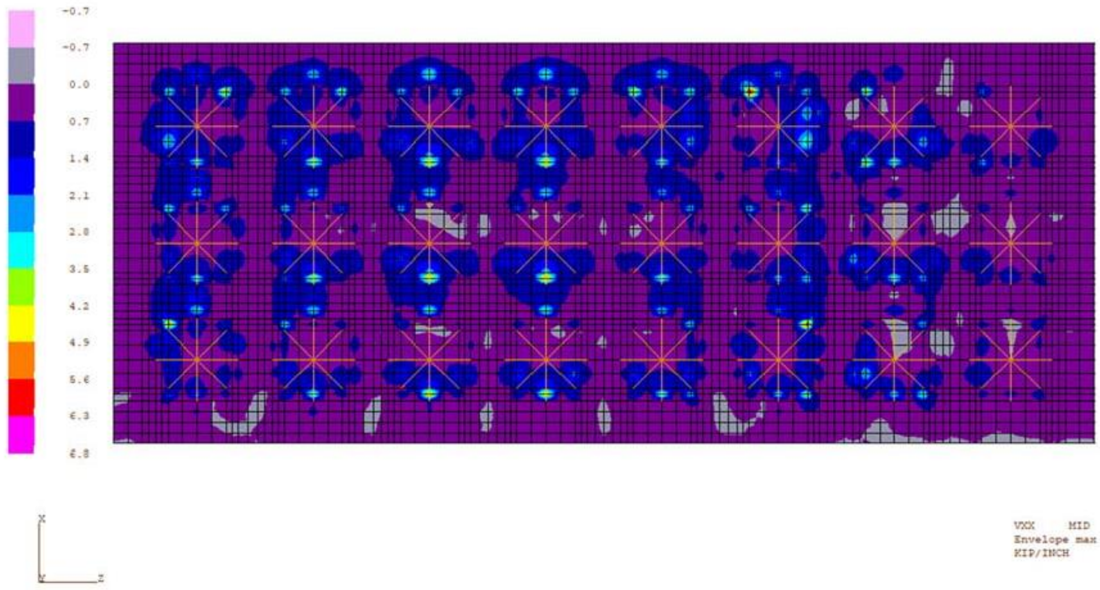

Figure 7-25
Enveloping Element Shear (kip/in) In The Global Y-Direction On The X-Face (local V_{XX}) - Configuration 4

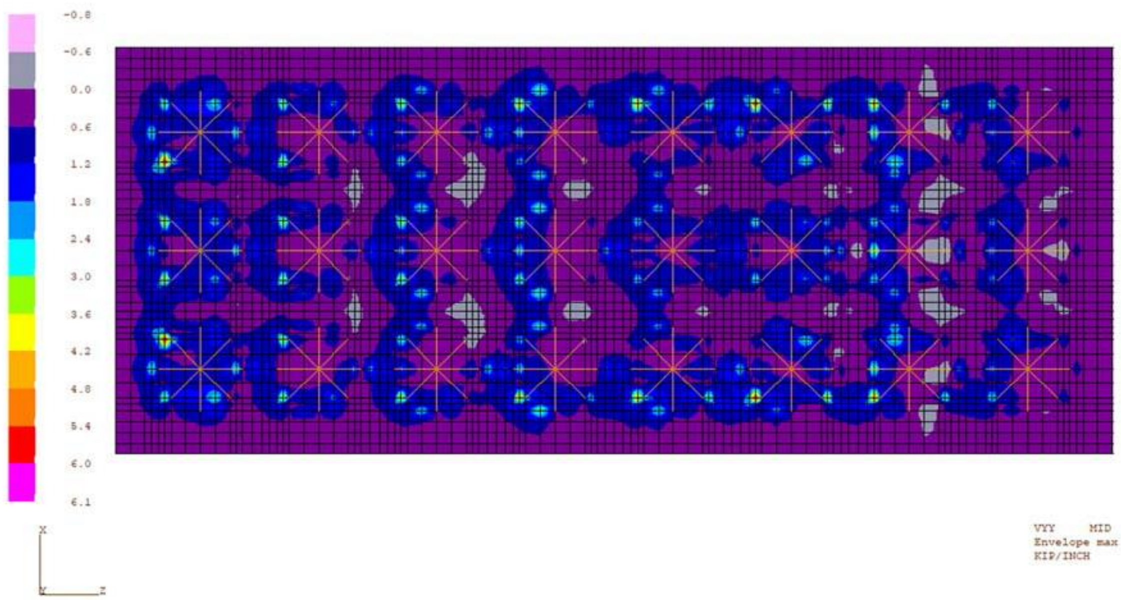

Figure 7-26
Enveloping Element Shear (kip/in) In The Global Y-Direction On The Z-Face
(local V_{YY}) - Configuration 4

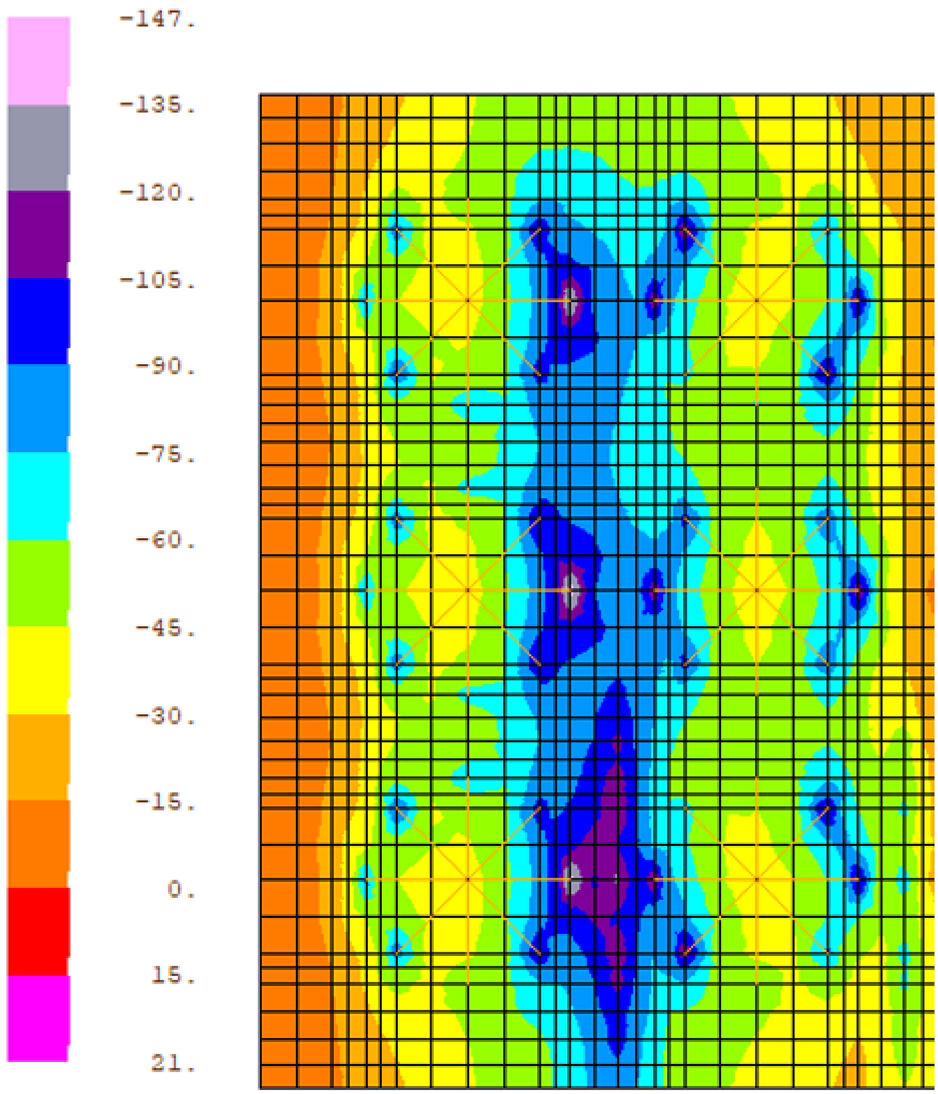

Figure 7-27
Excerpt Of Load Configuration 2 Enveloping Negative Moment Resultants (kip-in/in) About Global X-Axis (Local M_{YY}) Showing Effect Of VCT Loading

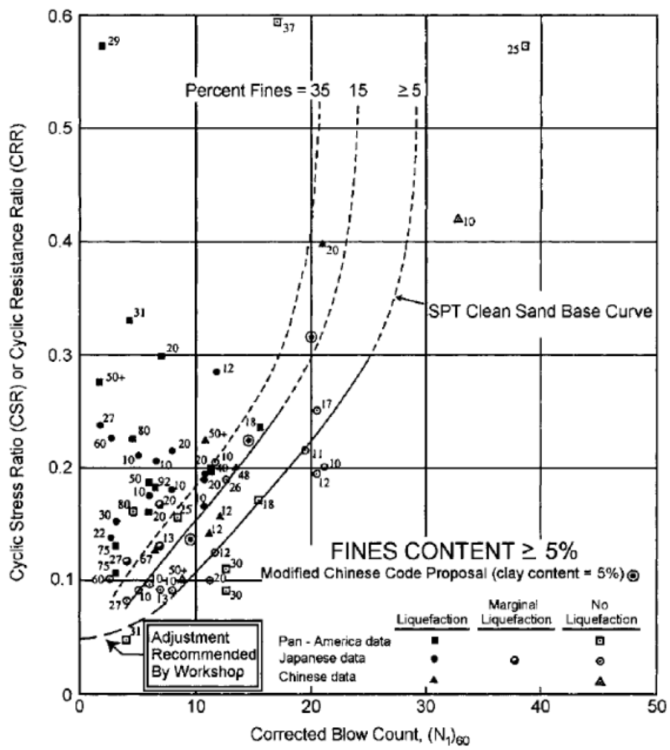

Figure 7-28
SPT-based liquefaction curves for M = 7.5 earthquakes)

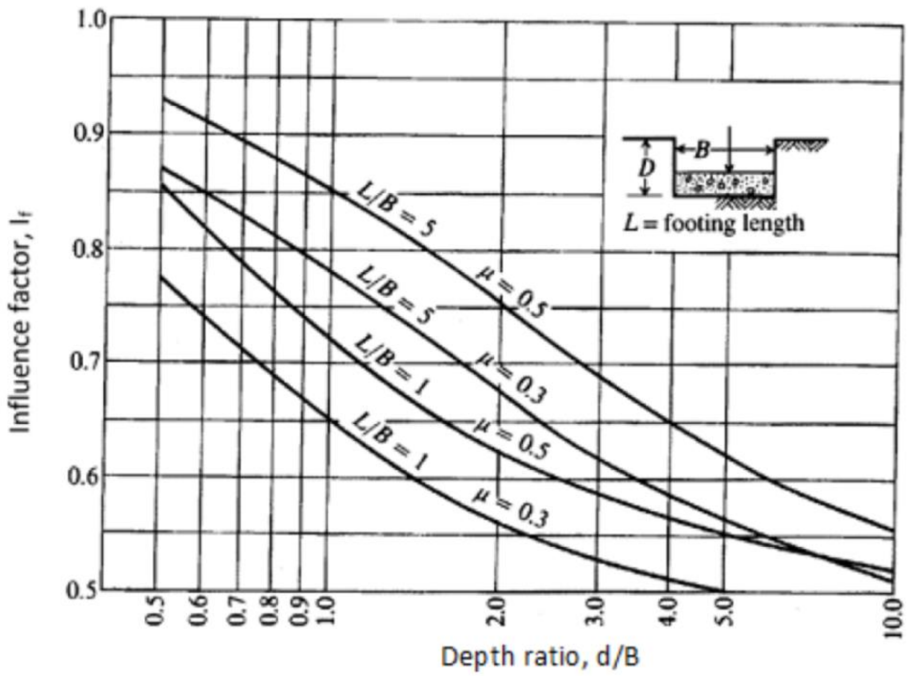

Figure 7-29
Footing Depth to Influence Factor

Years BP (millions)	ERA	PERIOD	FORMATION	THICKNESS	USCS	LITHOLOGY
	CENOZOIC	QUATERNARY	COVER SANDS	1'-10'	SP	SAND, FINE GRAINED, WELL SORTED, **UNCONSOLIDATED**, LOOSE, ORANGE TO TAN, **DRY**
0.01			CALICHE	4'-28'	NA	CALICHE WITH SAND MATRIX, **CONSOLIDATED**, FIRM TO MODERATELY HARD, WHITE TO TAN, **DRY**
			BLACKWATER DRAW	14'-38'	SP/SC/SM	SAND, W/SILT & CLAY, FINE GRAINED, WELL SORTED, **UNCONSOLIDATED**, ORANGE TO TAN, **DRY**
2.6		TERTIARY	CALICHE	19'-28'	NA	CALCAREOUS SAND, **CONSOLIDATED**-VERY HARD, LIGHT GRAY TO WHITE, **DRY**
			OGALLALA	35'-51'	SW/GW	SAND WITH GRAVEL GRADING DOWNWARD TO A GRAVEL WITH SAND, UPPER SAND IS WELL GRADE, **UNCONSOLIDATED**, TAN, **DRY**, LOWER GRAVEL WITH SAND MATRIX, POORLY SORTED, WELL TO POORLY CEMENTED, SUBANGULAR TO SUB ROUNDED, **DRY** IN THE SOUTHERN PORTION OF CISF SITE, 1-5 FEET OF GROUNDWATER PRESENT IN THE NORTHERN PORTION OF THE CISF SITE
			ERODED OR NOT DEPOSITED			
66	MESOZOIC	CRETACEOUS				
145		JURASSIC				
201		TRIASSIC	DOCKUM/ COOPER CANYON	~1400'/~500'	CL-CH	CLAY, CLAYSTONE, PLASTIC, STIFF, **CONSOLIDATED** MAROON TO RED, **DRY**

Figure 7-30
Soil Characterization at Depth

Initial Loading			Second Loading			Full		
1	2	end walls	1	2	end walls	1	2	end walls
3	4		3	4		3	4	
5	6		5	6		5	6	
7	8		7	8		7	8	
9	10		9	10		9	10	
11	12	1st Loading	11	12	1st Loading	11	12	1st Loading
13	14		13	14		13	14	
15	16		15	16		15	16	
17	18		17	18		17	18	
19	20		19	20		19	20	
21	22	end walls	21	22	end walls	21	22	end walls
			23	24	end walls	23	24	end walls
			25	26		25	26	
			27	28		27	28	
			29	30		29	30	
			31	32	2nd Loading	31	32	2nd Loading
			33	34		33	34	
			35	36		35	36	
			37	38		37	38	
			39	40		39	40	
			41	42	end walls	41	42	end walls
						43	44	end walls
						45	46	
						47	48	
						49	50	
						51	52	
						53	54	
						55	56	
						57	58	3rd Loading
						59	60	
						61	62	
						63	64	
						65	66	
						67	68	
						69	70	
						71	72	
						73	74	
						75	76	
						77	78	
						79	80	
						81	82	
						83	84	
						85	86	
						87	88	
						89	90	
						91	92	end walls

Figure 7-31
WCS CISF Storage Pad Analyzed Loading Configurations

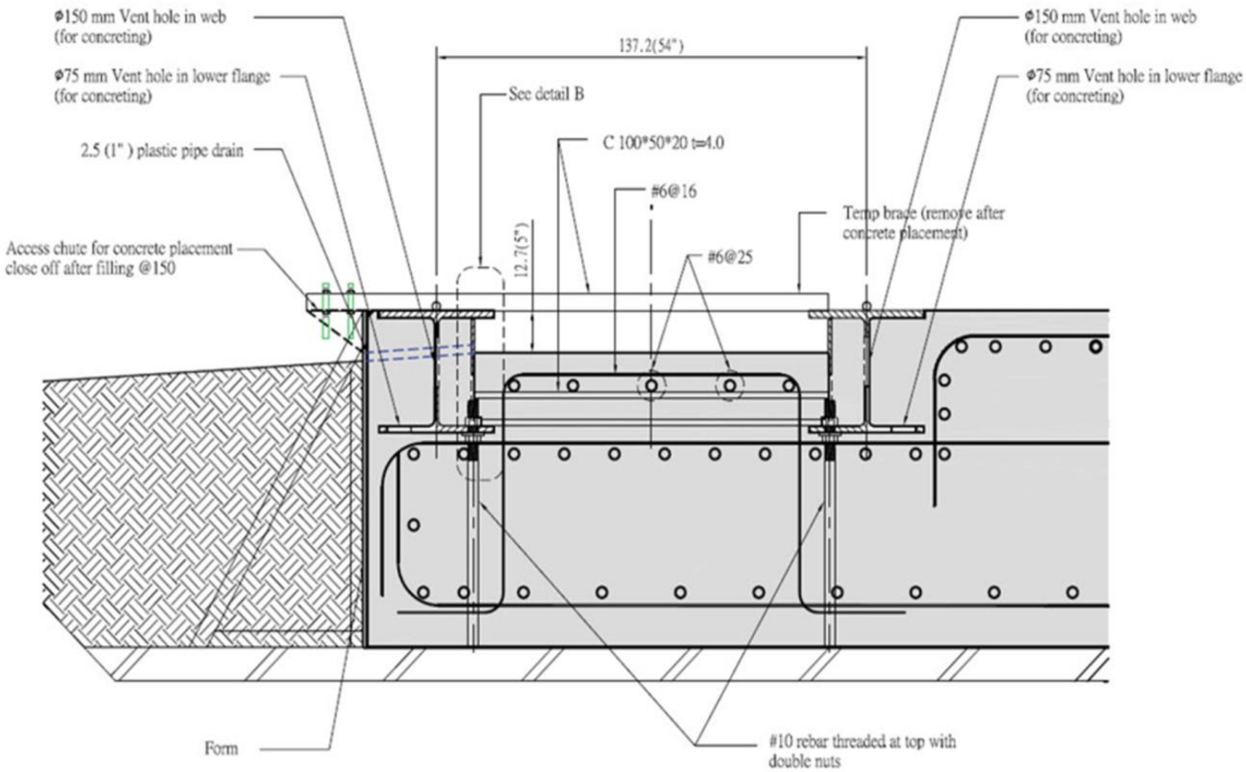

Figure 7-32
Typical Crane rail Installation Detail for the CTS

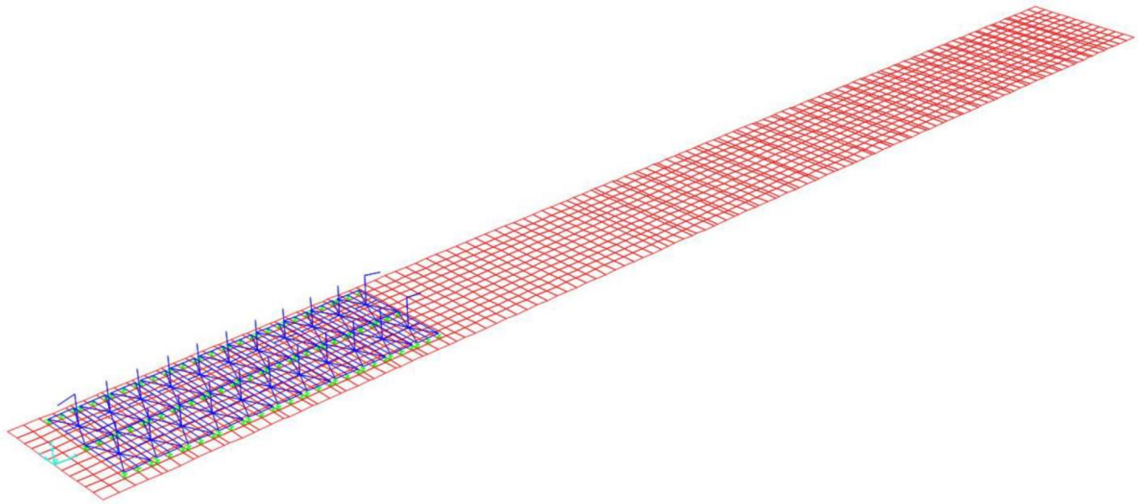

Figure 7-33
SASSI Model of Storage Pad with 22 HSMs Loaded

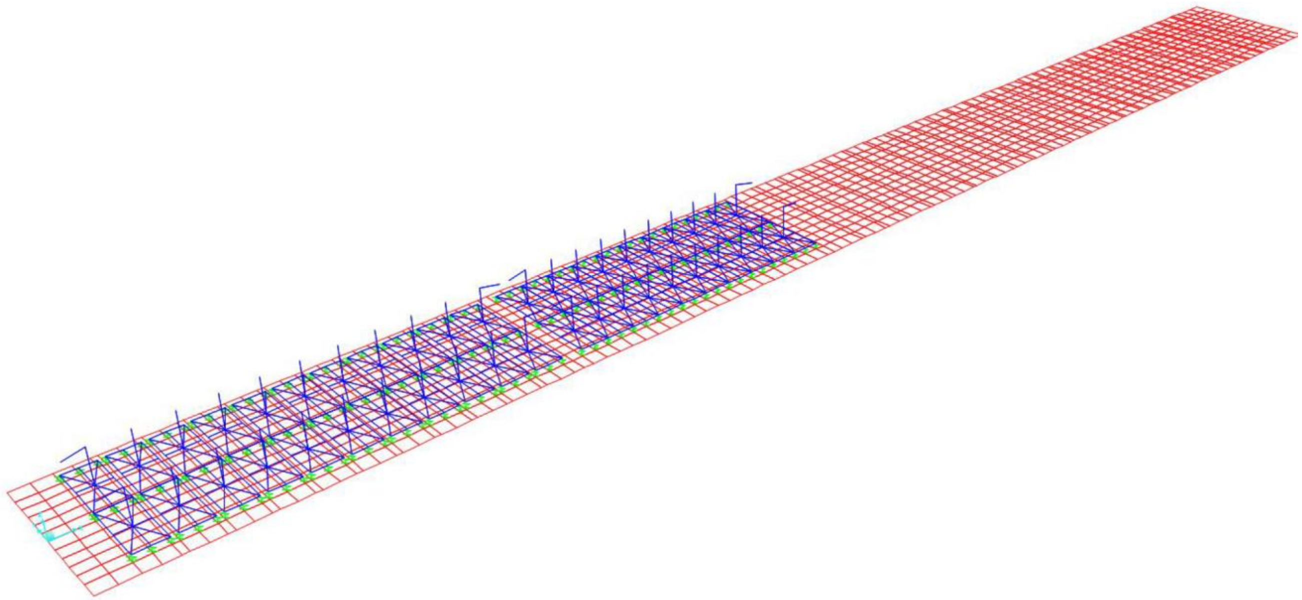

Figure 7-34
SASSI Model of Storage Pad with 42 HSMs Loaded

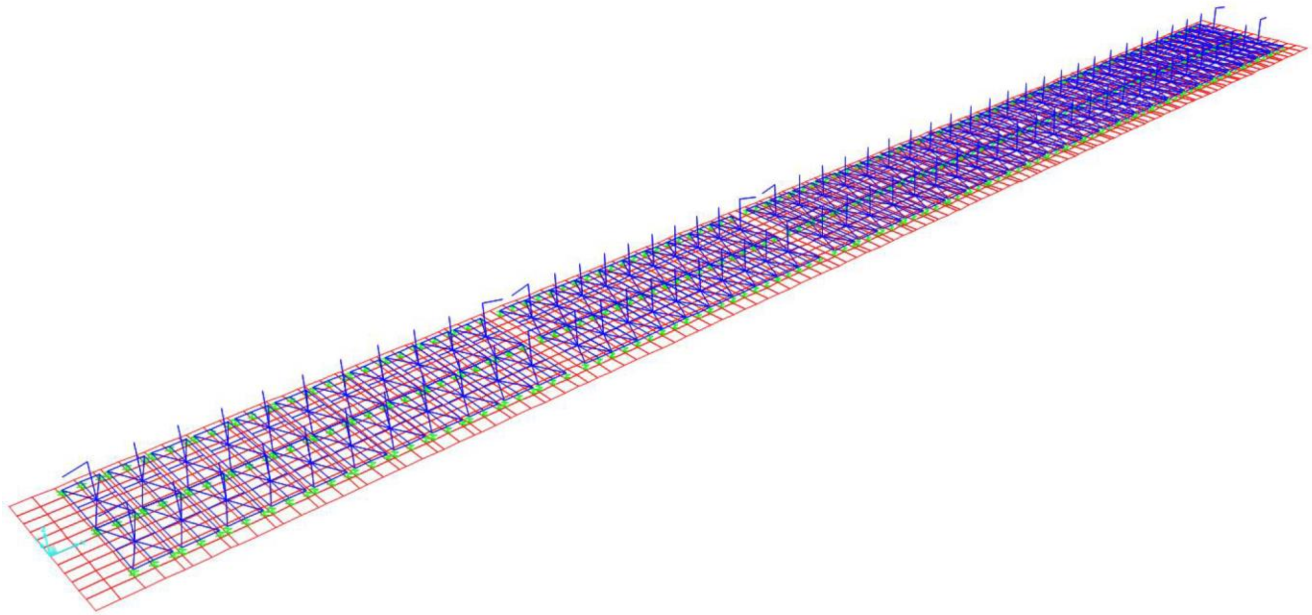

Figure 7-35
SASSI Model of Storage Pad with 92 HSMs Loaded

Proprietary Information on Pages 7-215 through 7-220
Withheld Pursuant to 10 CFR 2.390

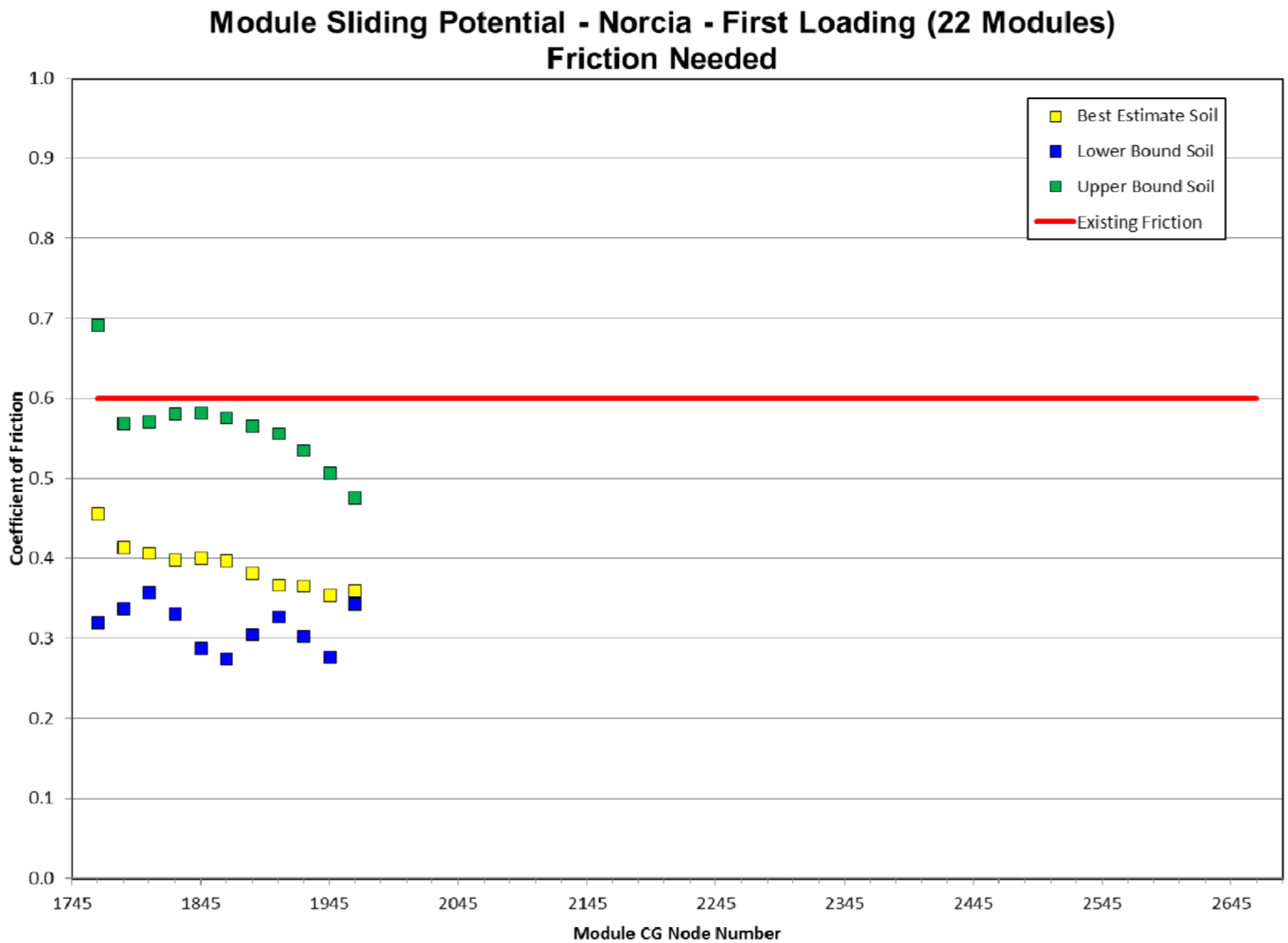

Figure 7-42
Sliding Potential – Norcia Earthquake Loading Configuration: 22 HSMs on the Pad

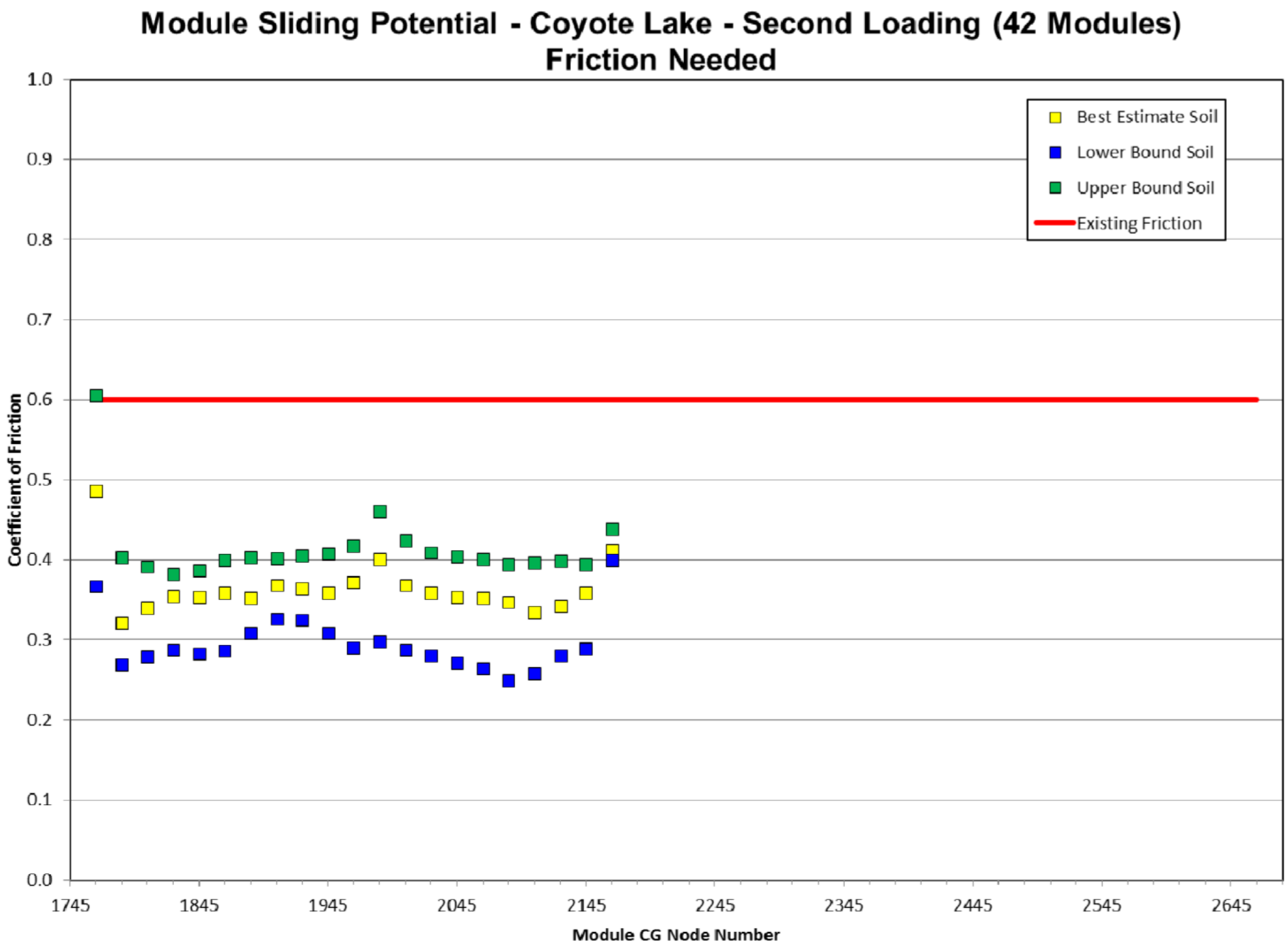

Figure 7-43
Sliding Potential – Coyote Lake Earthquake Loading Configuration: 42 HSMs on the Pad

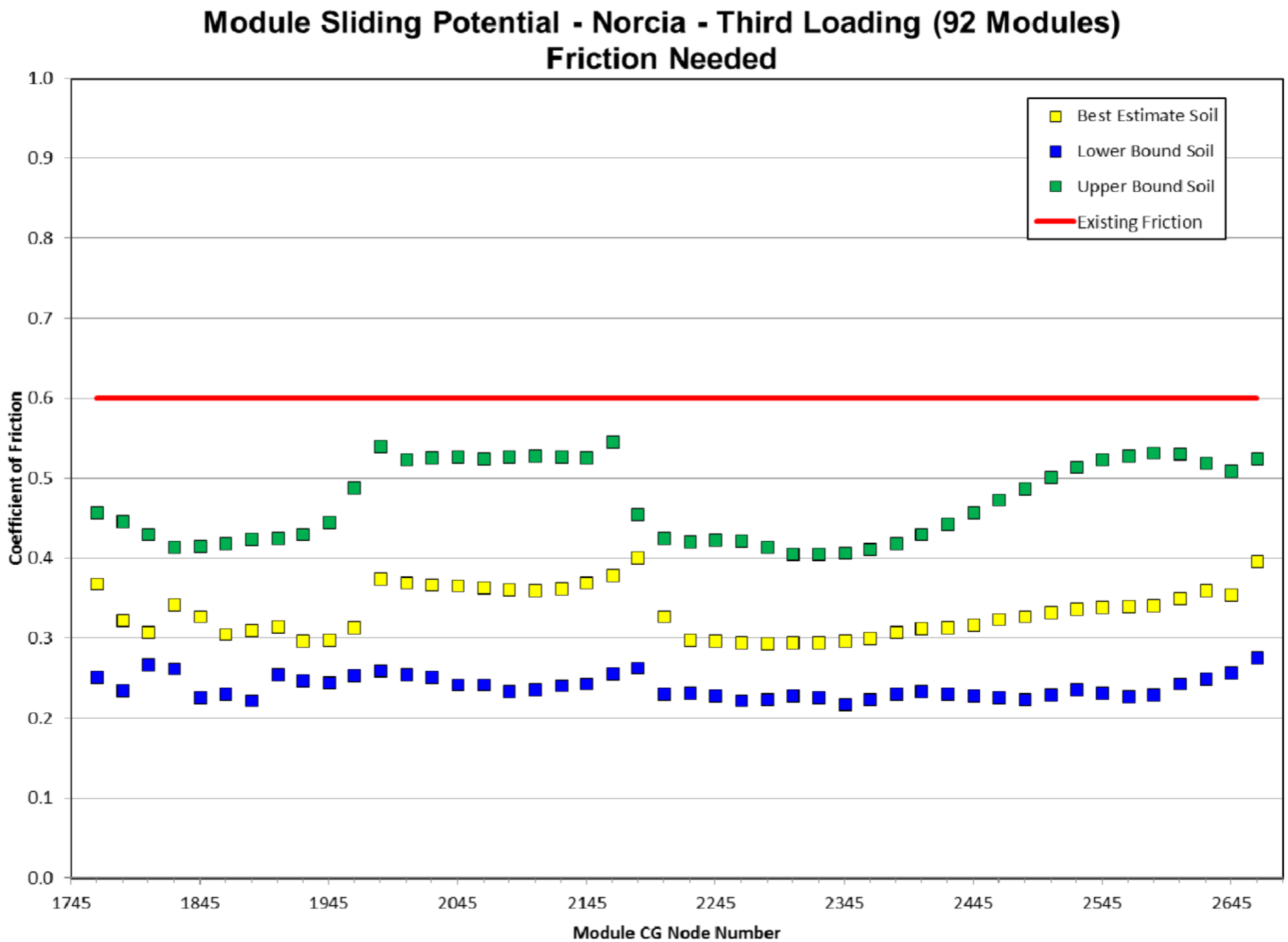

Figure 7-44
Sliding Potential – Norcia Earthquake Loading Configuration: 92 HSMs on the Pad

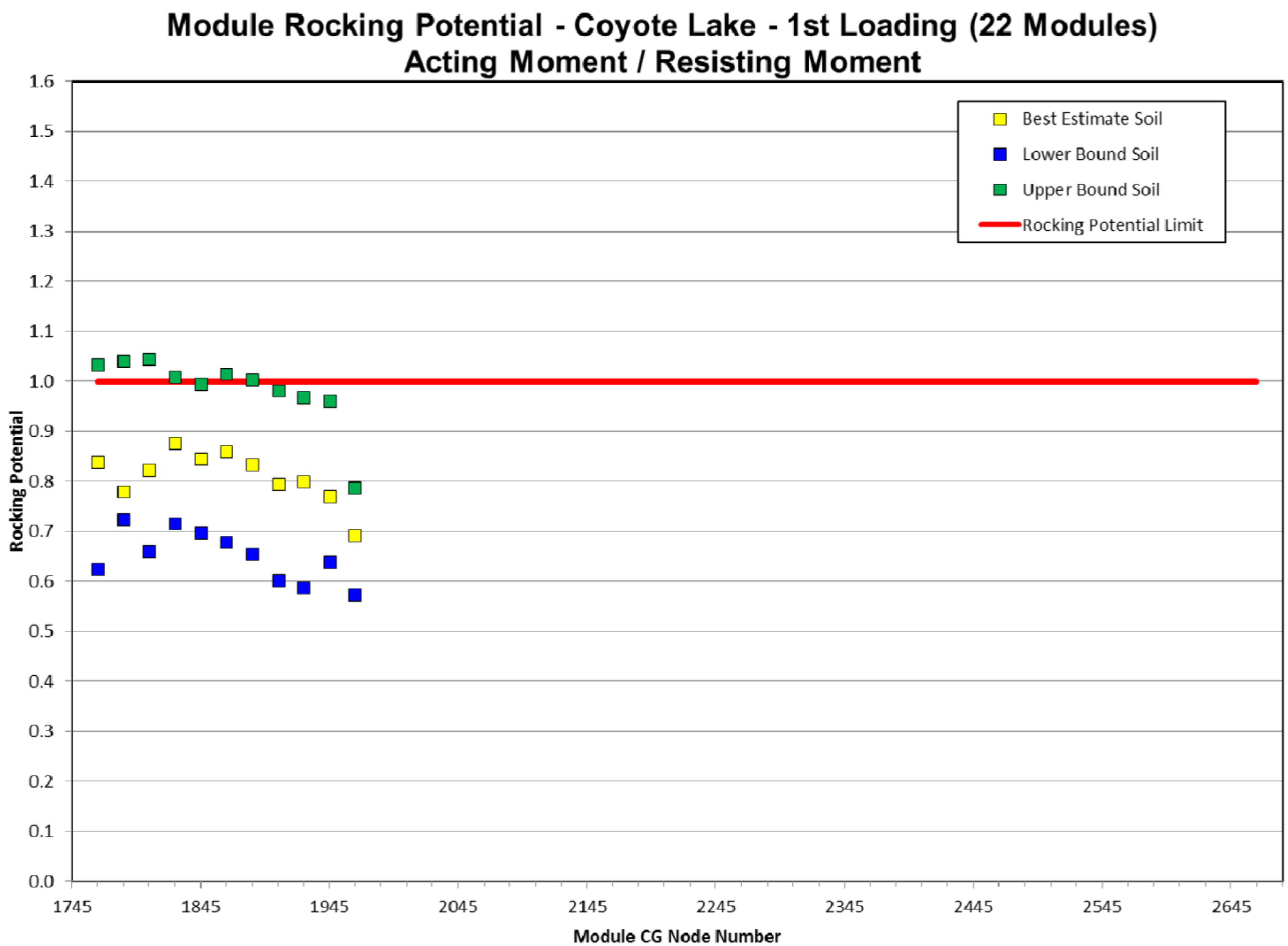

Figure 7-45
Rocking Potential – Coyote Lake Earthquake Loading Configuration: 22 HSMs on the Pad

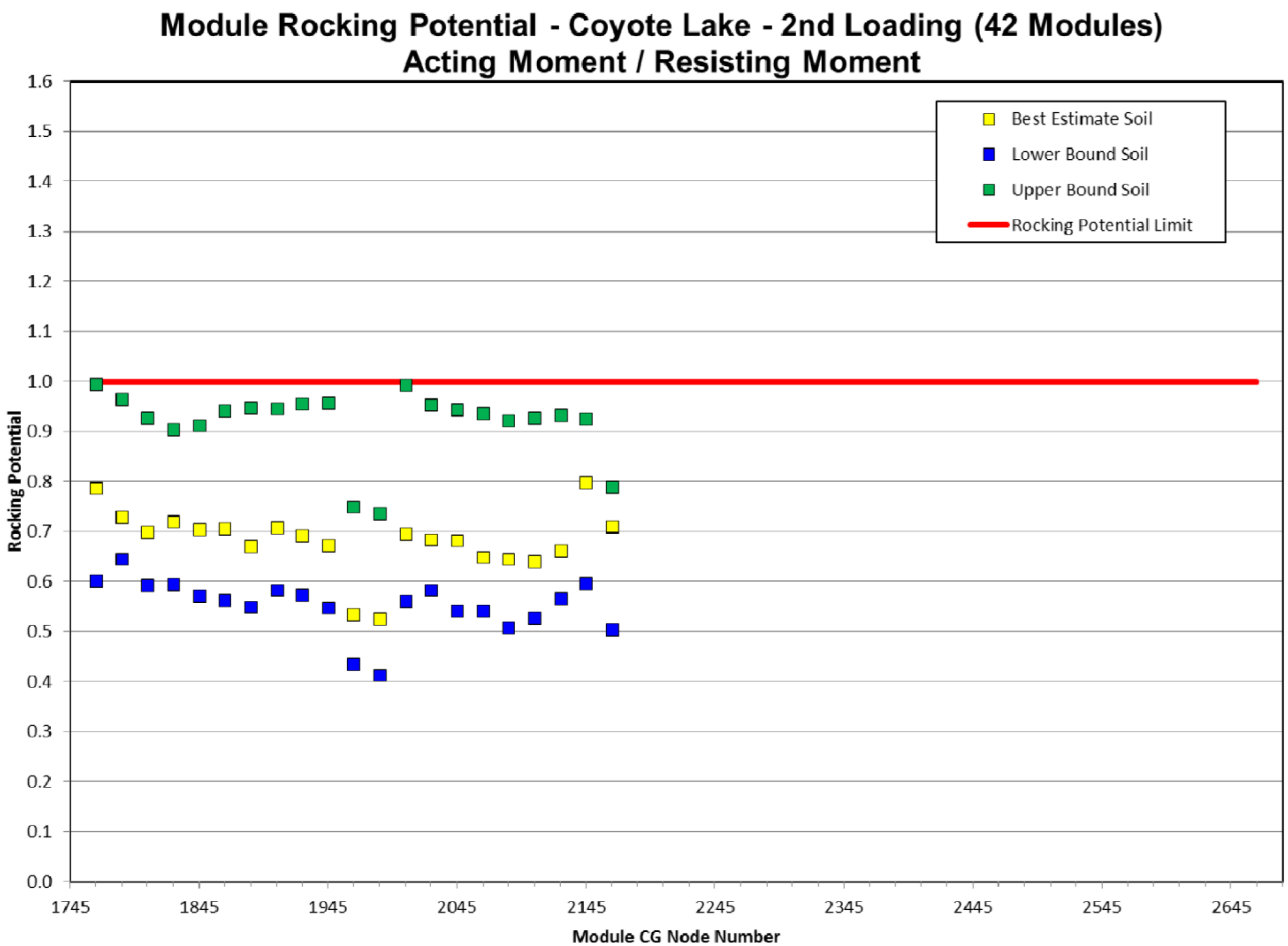

Figure 7-46
Rocking Potential – Coyote Lake Earthquake Loading Configuration: 42 HSMs on the Pad

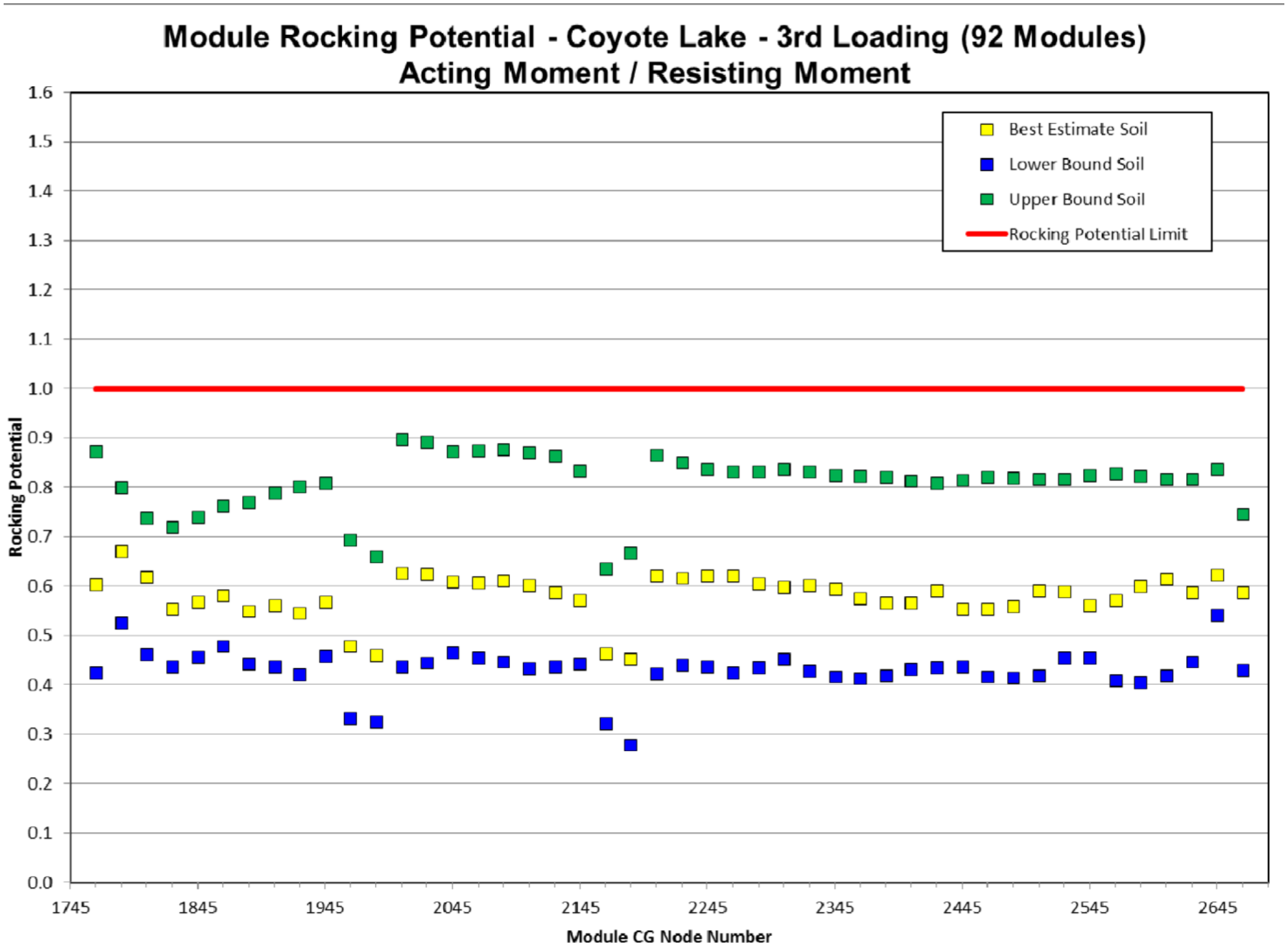

Figure 7-47
Rocking Potential – Coyote Lake Earthquake Loading Configuration: 92 HSMs on the Pad

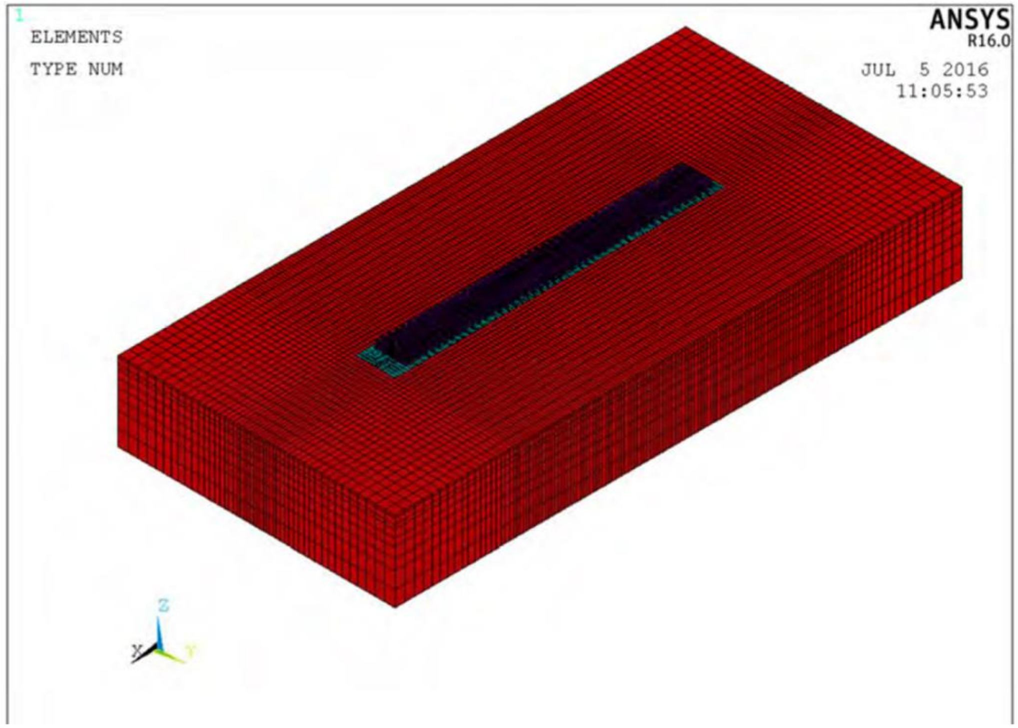

Figure 7-48
HSMFUL – ANSYS Model: Fully Loaded Pad Configuration– 2 x 46 AHSM Array

Young's Modulus E (psi)	Poisson's Ratio, υ			Material Name in ANSYS
6181	0.33	Layer 1	3ft	Material 4
8333	0.33	Layer 2	7ft	Material 5
8333	0.33	Layer 3	10ft	Material 6
248715	0.33	Layer 4	5ft	Material 7
383556	0.33	Layer 5	10ft	Material 8
557174	0.33	Layer 6	15ft	Material 9
374097	0.33	Layer 7	20ft	Material 10
374097	0.33	Layer 8	10ft	Material 11
860118	0.33	Layer 9	20ft	Material 12

Figure 7-49
Soil Properties

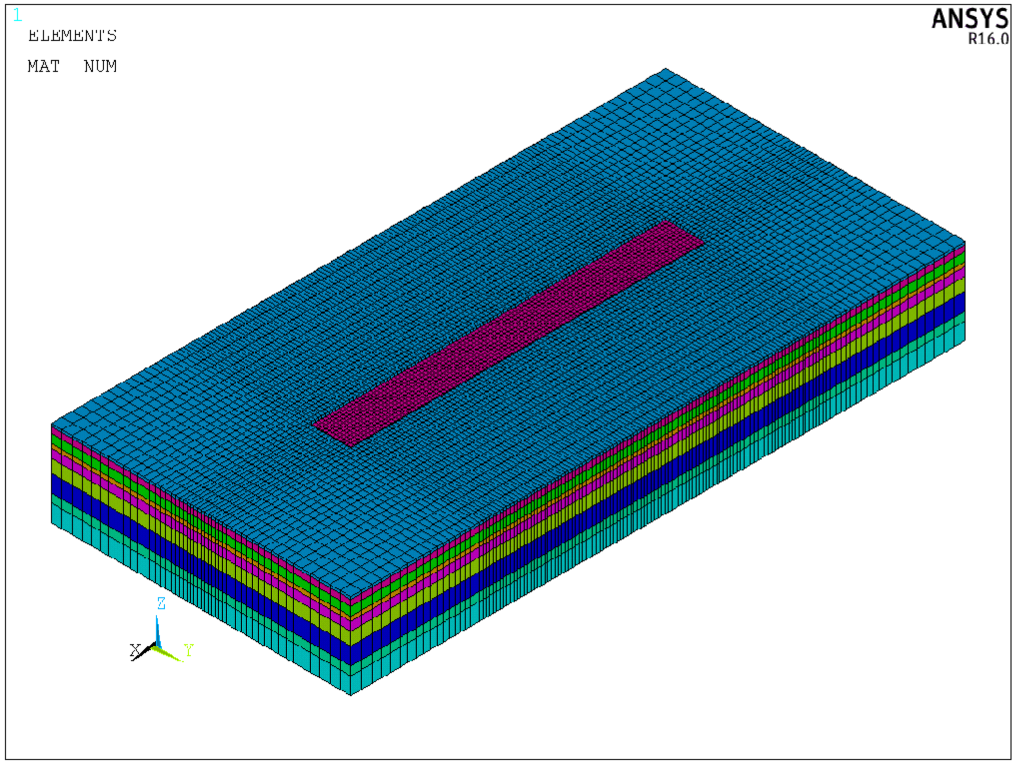

Figure 7-50
Overview of the Soil Layers in ANSYS Model

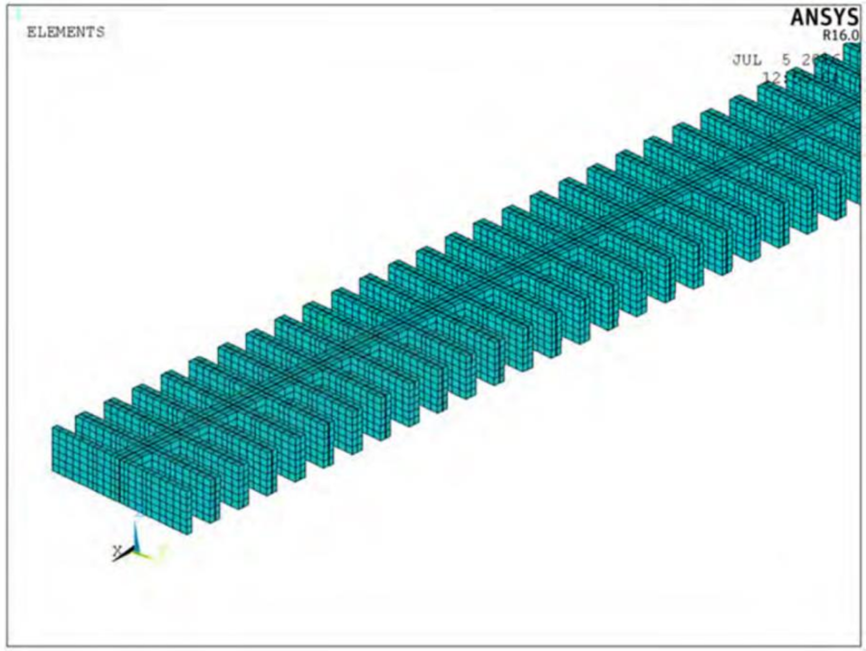

Figure 7-51
Overview of HSM Modeling

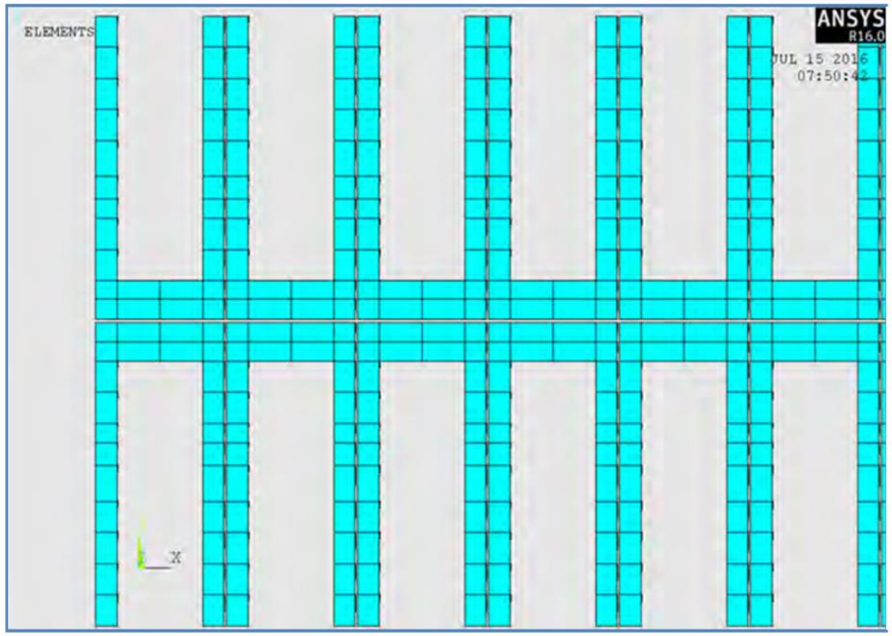

Figure 7-52
2-inch Gap between Modeled HSMs

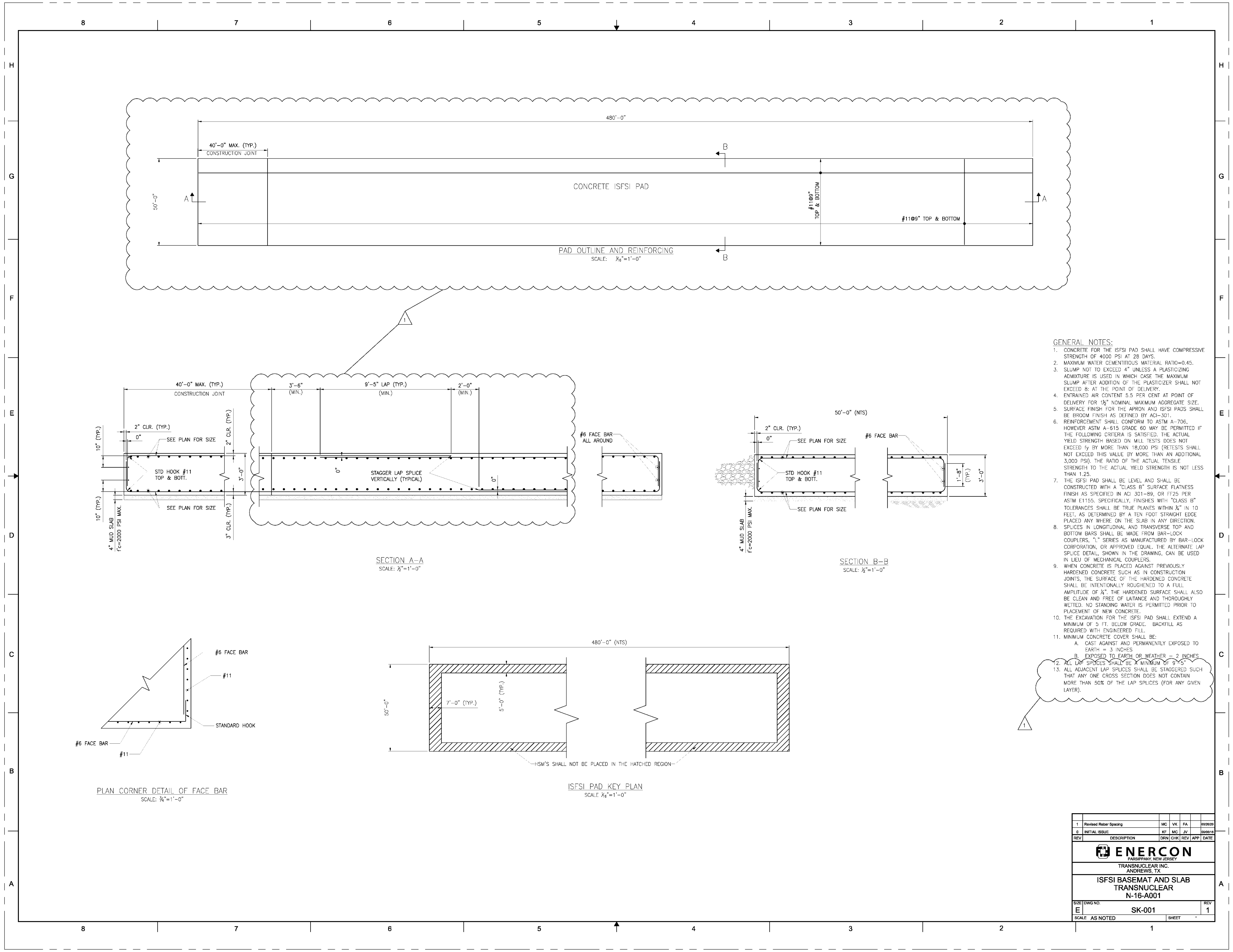

Figure 7-53
NUHOMS® NITS Pad Design

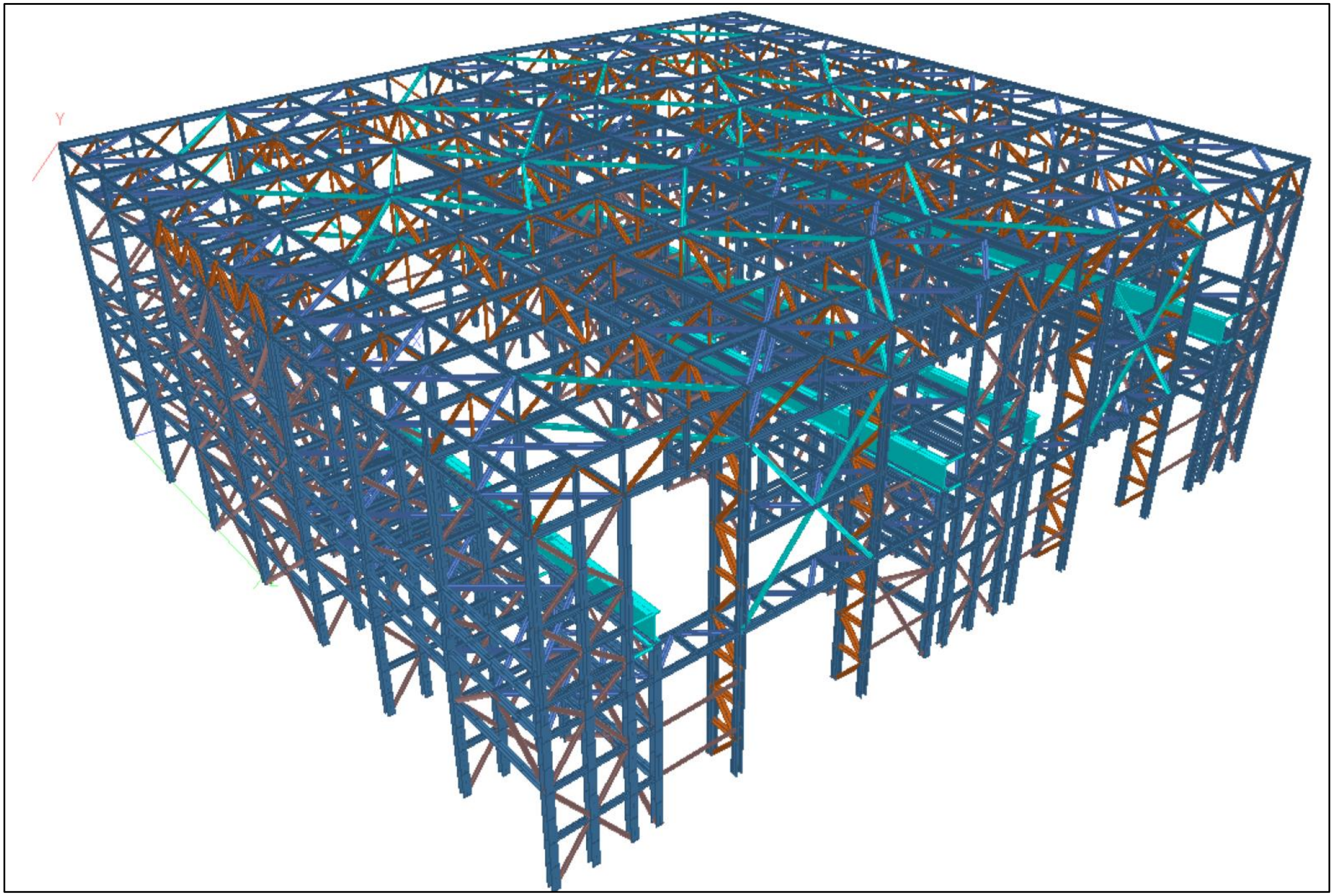

Figure 7-54
Isometric View of Cask Handling Building Structural Steel Framing

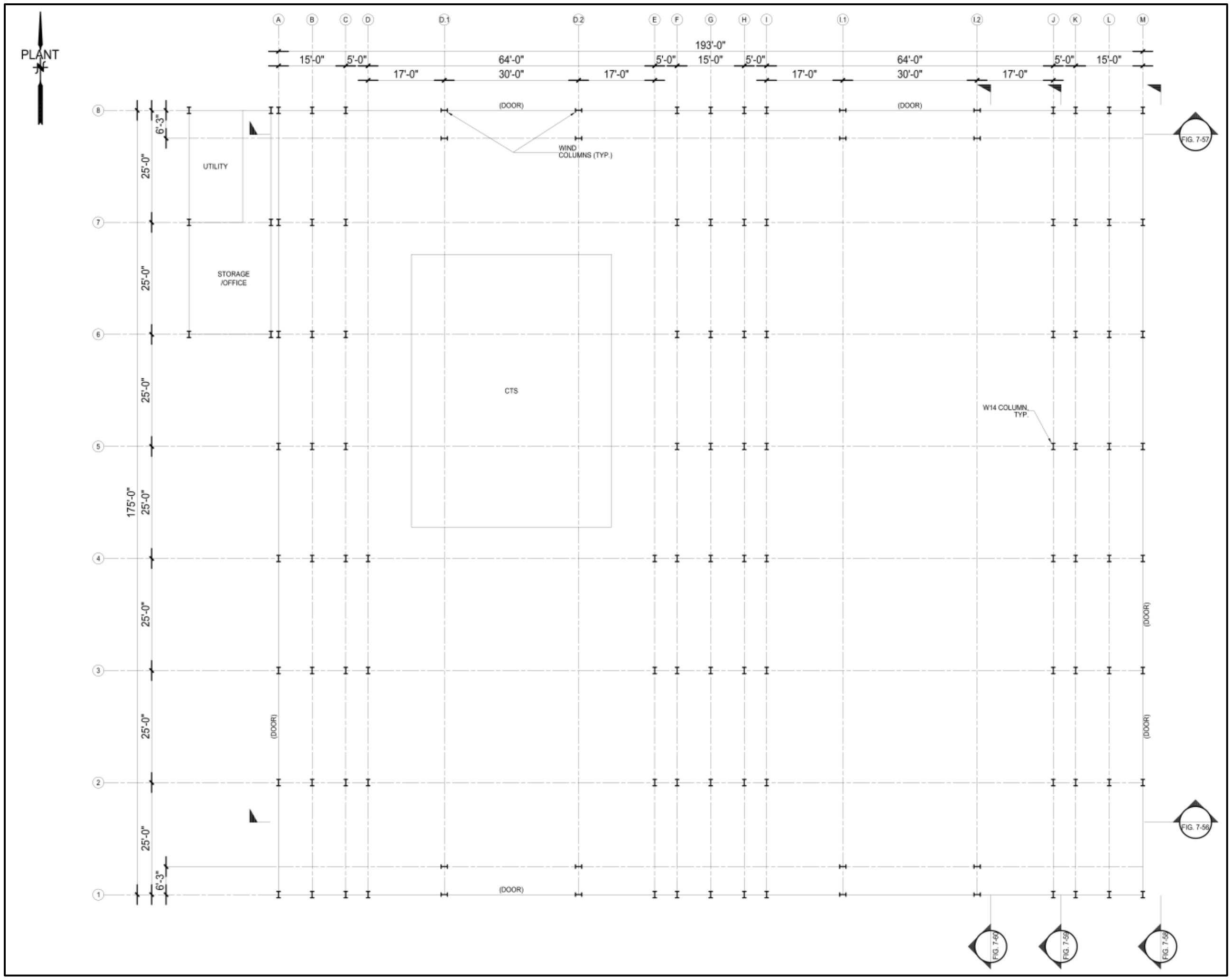

Figure 7-55
Plan View of Cask Handling Building Structural Steel Framing Arrangement, at Grade Level(Elevation 100’-0”)

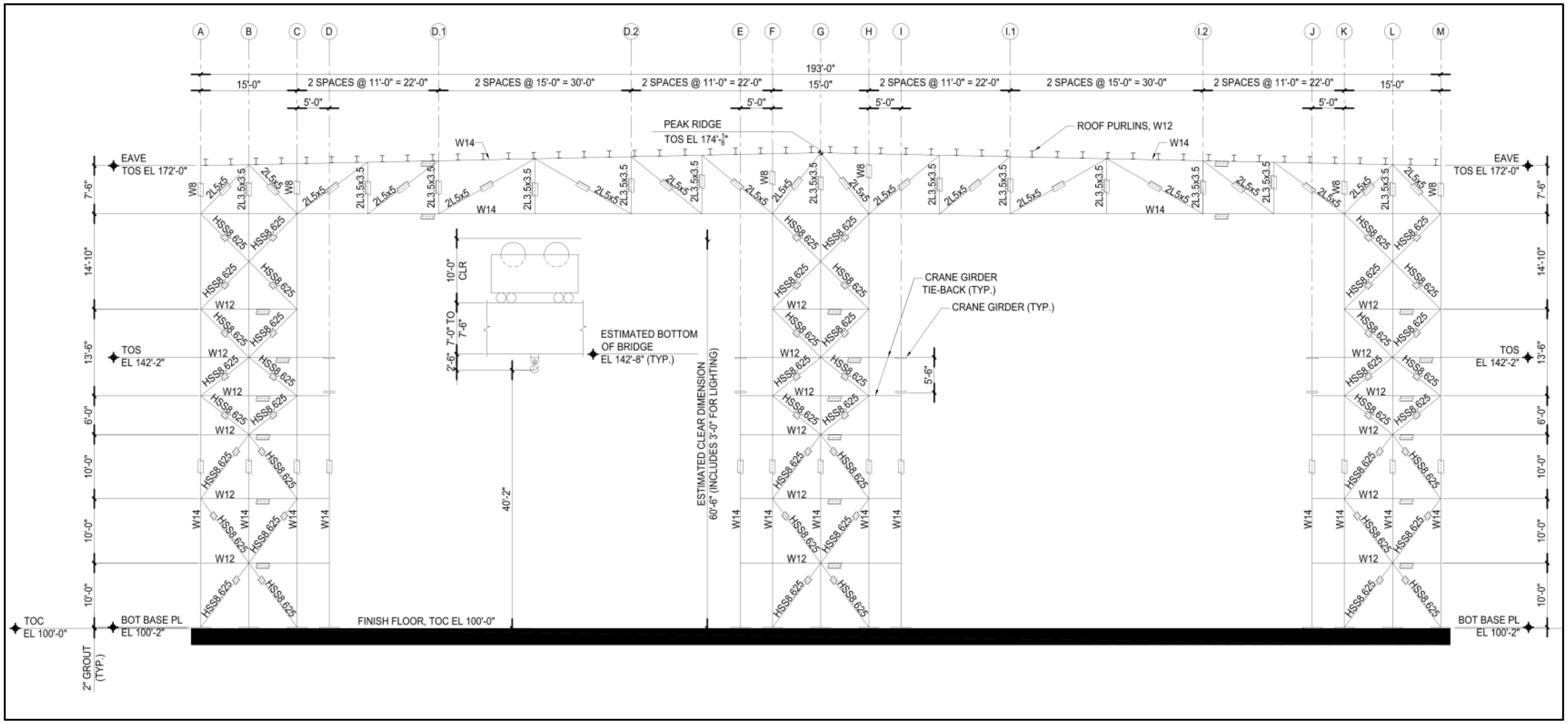

Figure 7-56
Cask Handling Building Structural Steel Framing Arrangement, Typical Interior Section (Looking North)

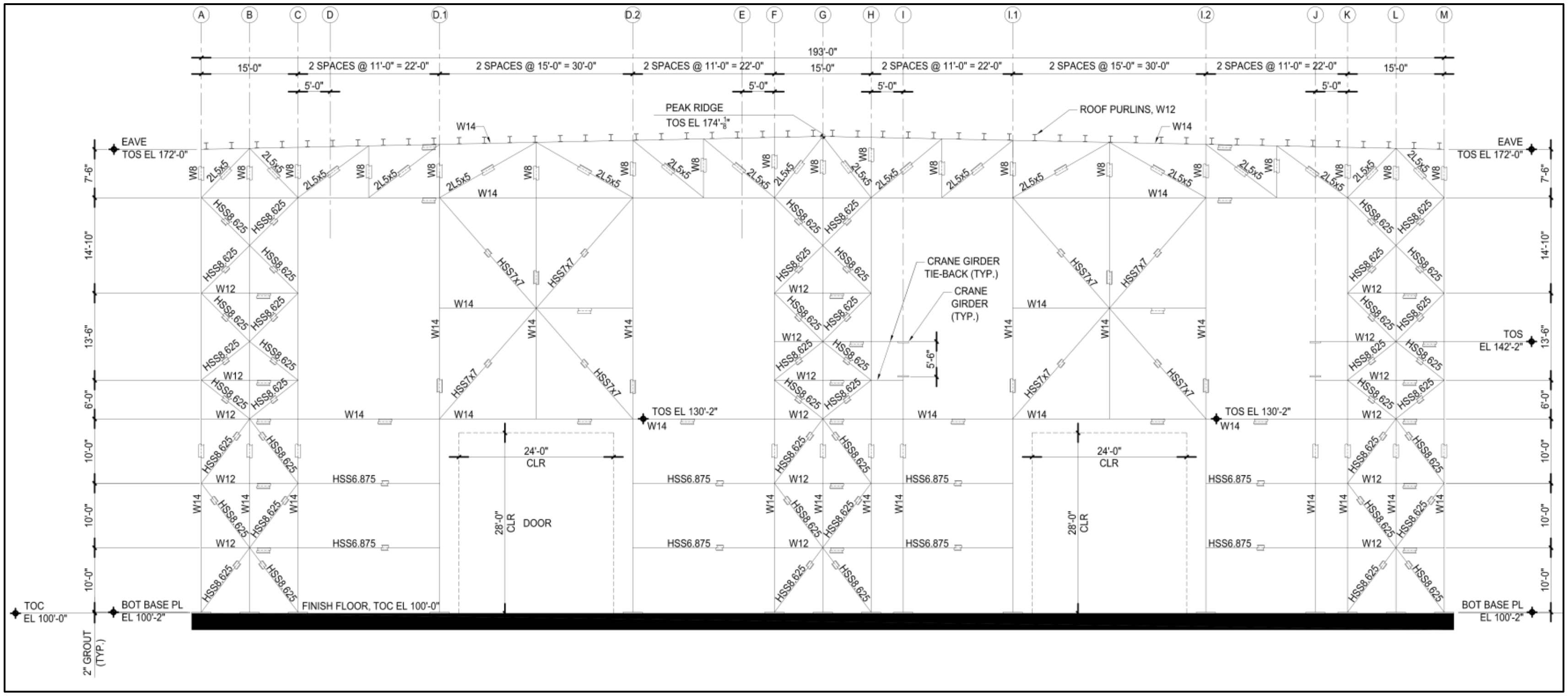

Figure 7-57
Cask Handling Building Structural Steel Framing Arrangement, Section at North Exterior Frame (Looking North)

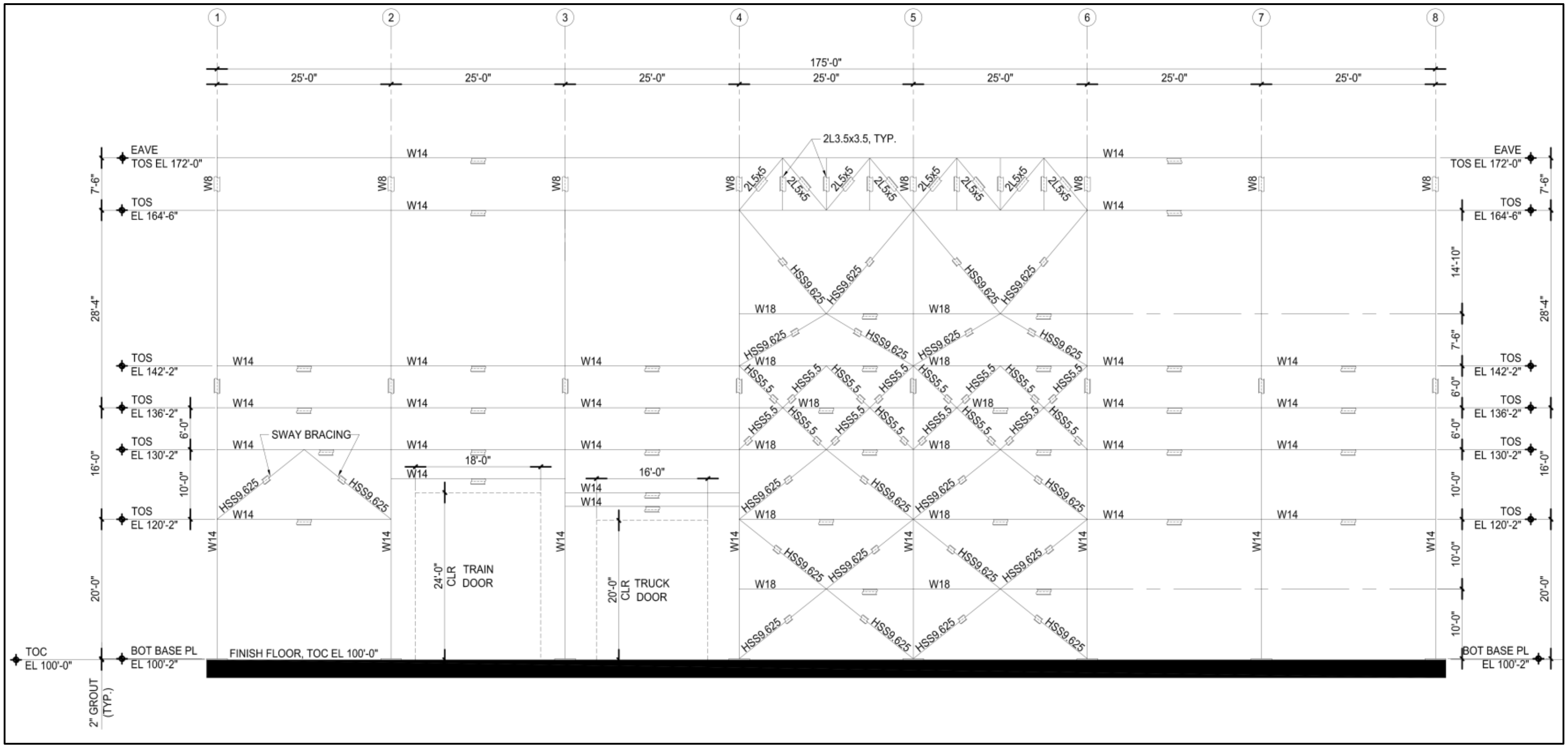

Figure 7-58
Cask Handling Building Structural Steel Framing Arrangement, Typical Section at Main Building Column Line (Looking West)

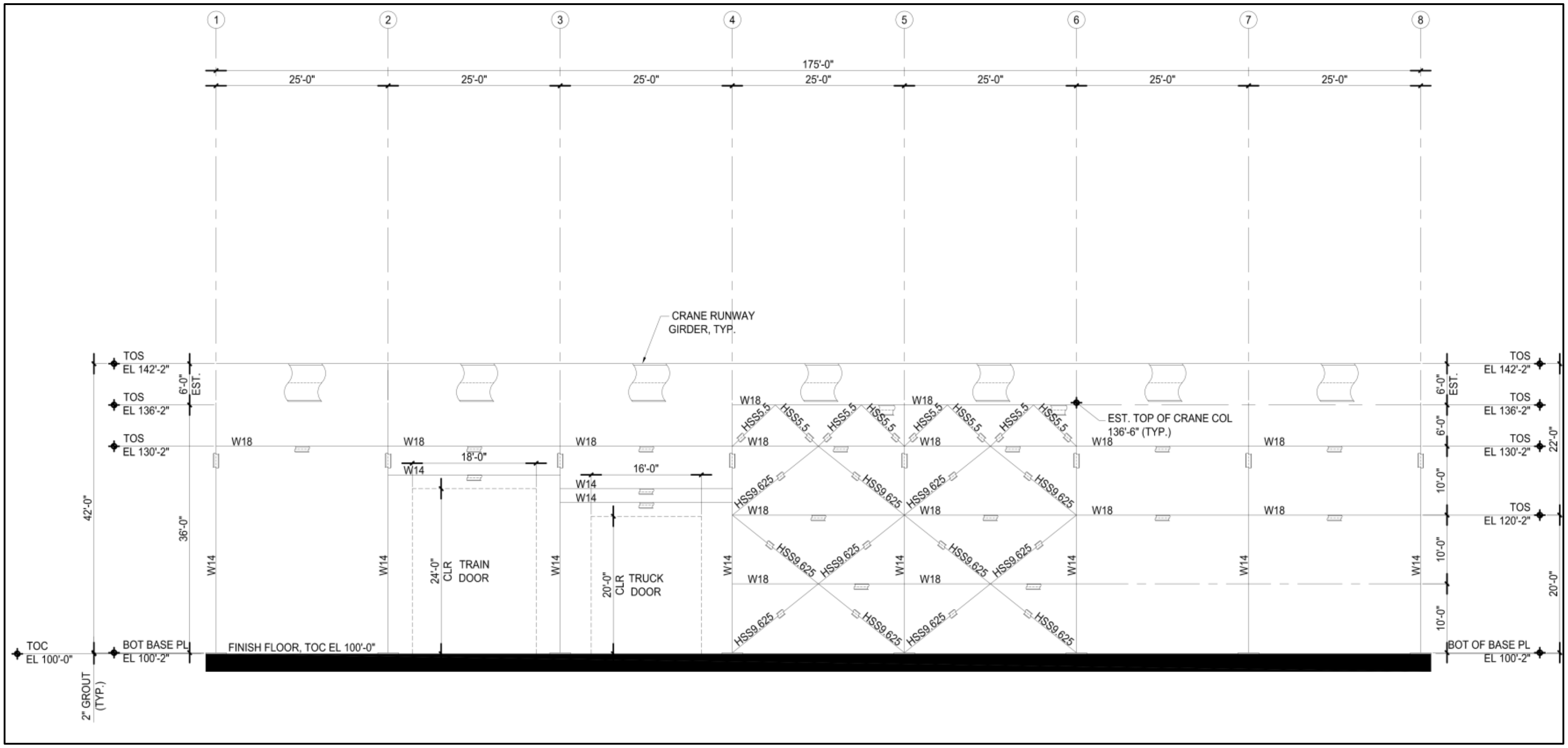

Figure 7-59
Cask Handling Building Structural Steel Framing Arrangement, Typical Section at Crane Column Line (Looking West)

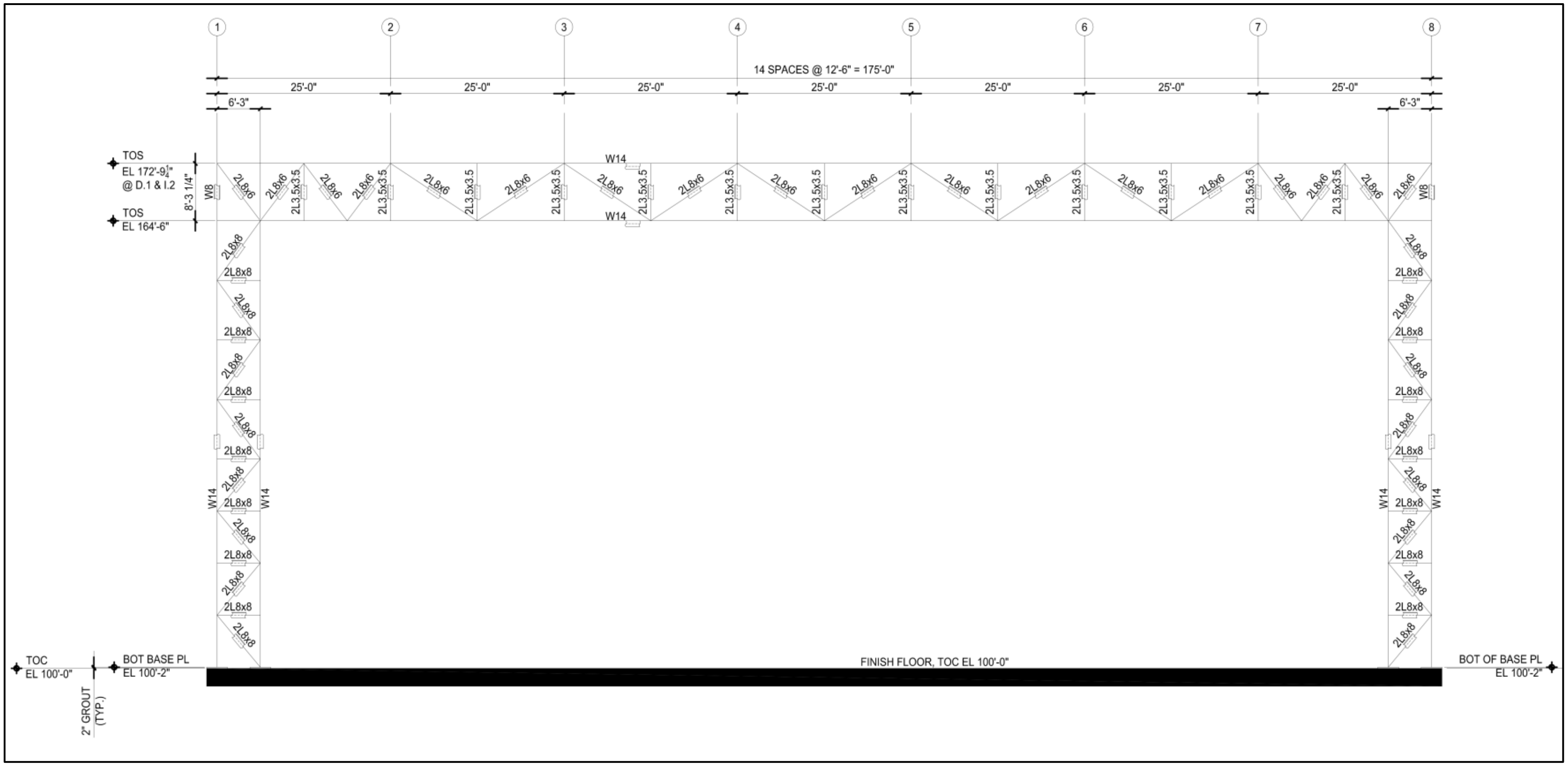

Figure 7-60
Cask Handling Building Structural Steel Framing Arrangement, Typical Section at Wind Column Line (Looking West)

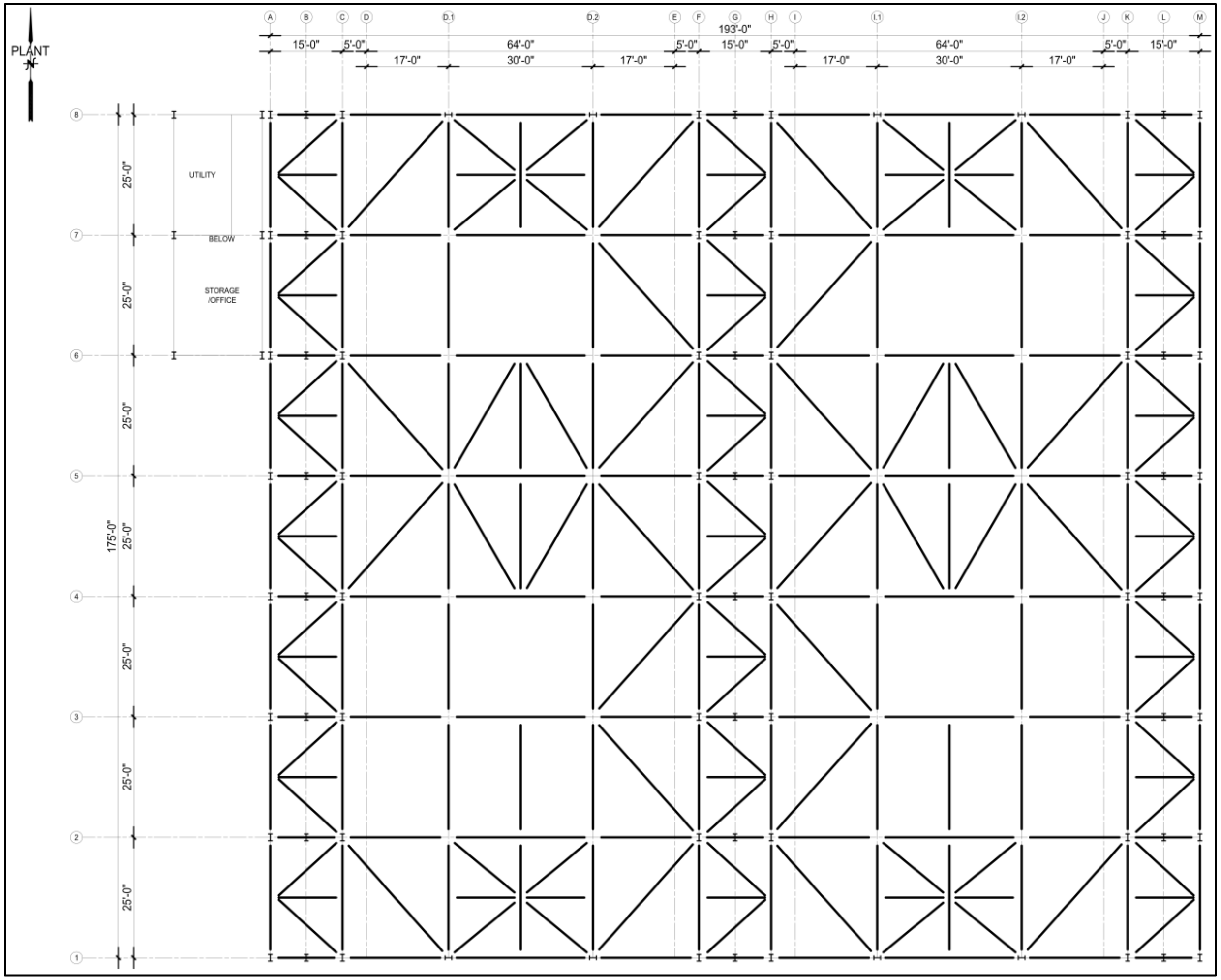

Figure 7-61
Cask Handling Building Structural Steel Framing Arrangement, Plan View at Roof Top Chord (Bottom Chord Similar)

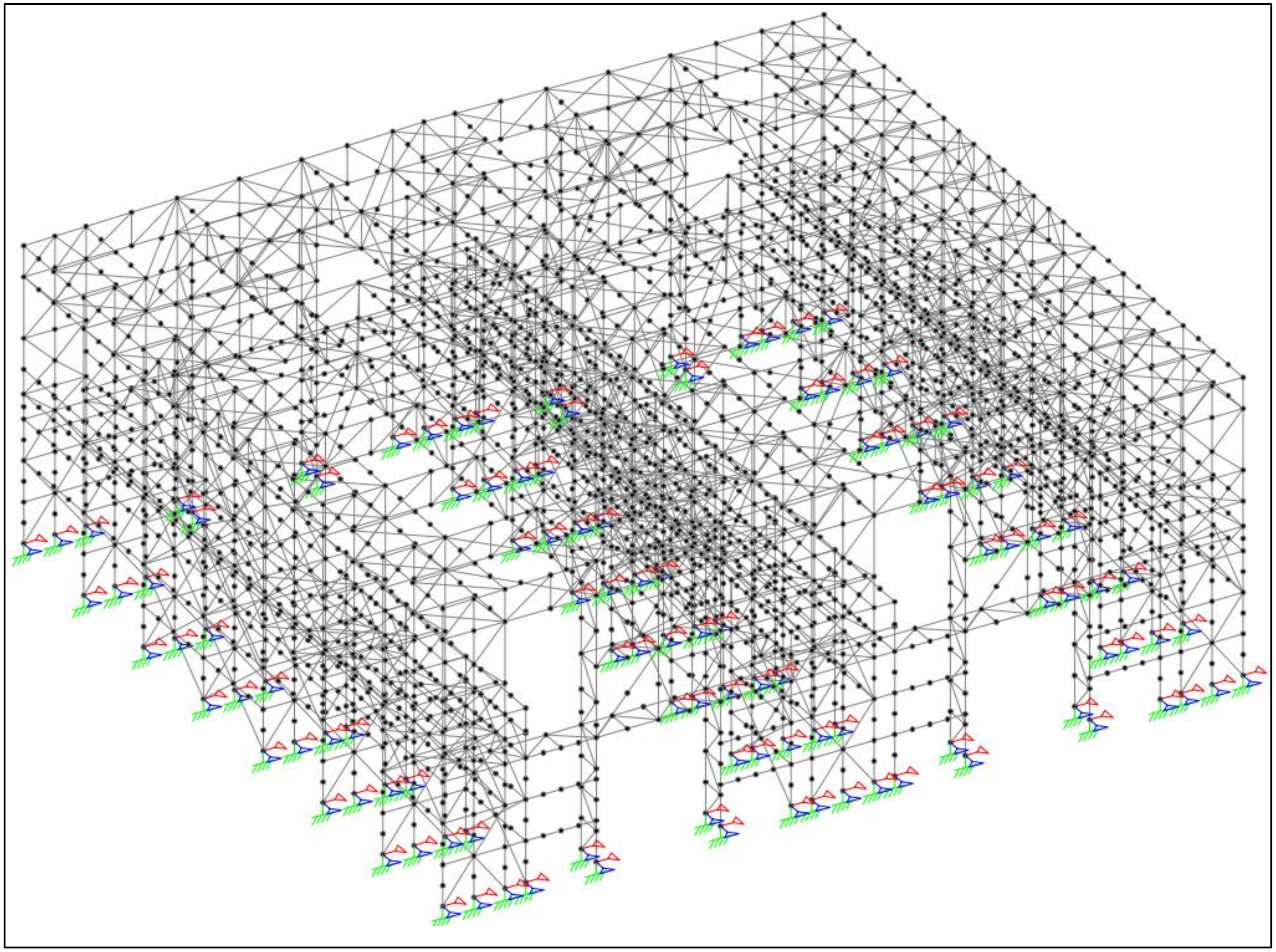

Figure 7-62
Cask Handling Building 3D STAAD.Pro Finite Element Model

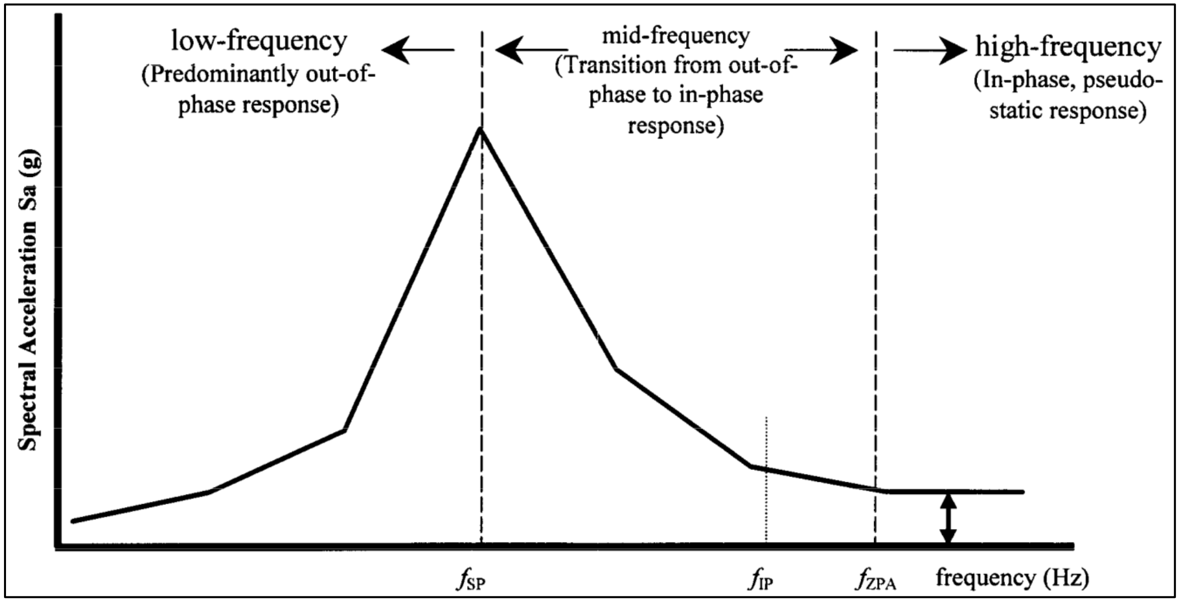

Figure 7-63
Generalized Acceleration Response Spectrum

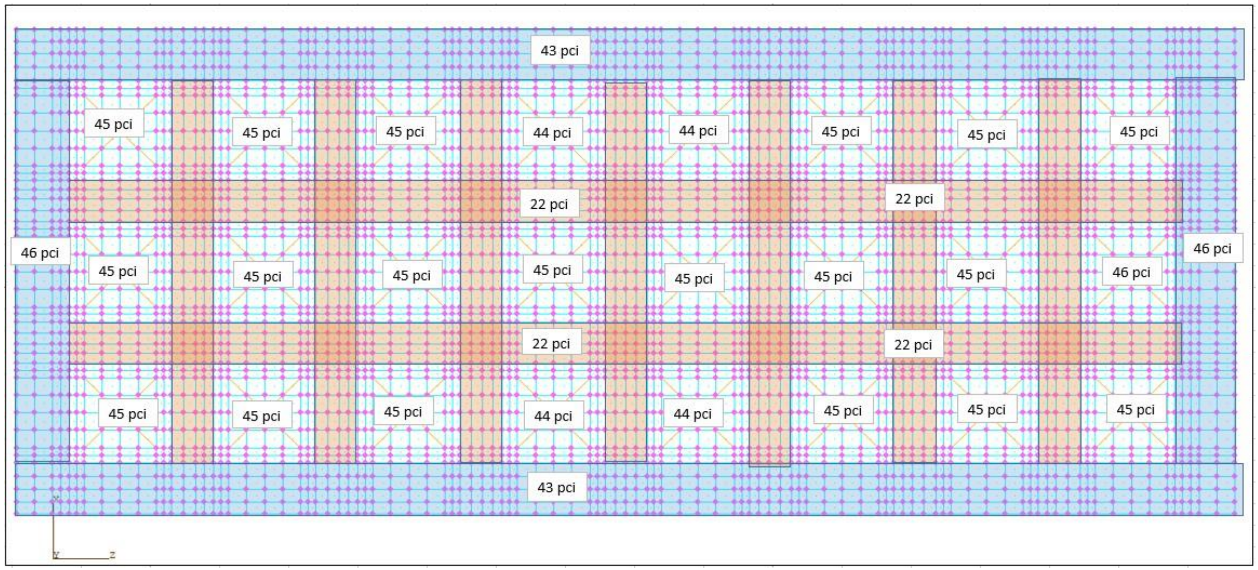

Figure 7-64
Storage Pad Cask Configuration 1 – Modulus of Sub-Grade Reactions for Soil Below the Different Sections of the Pad Used for Design Evaluation

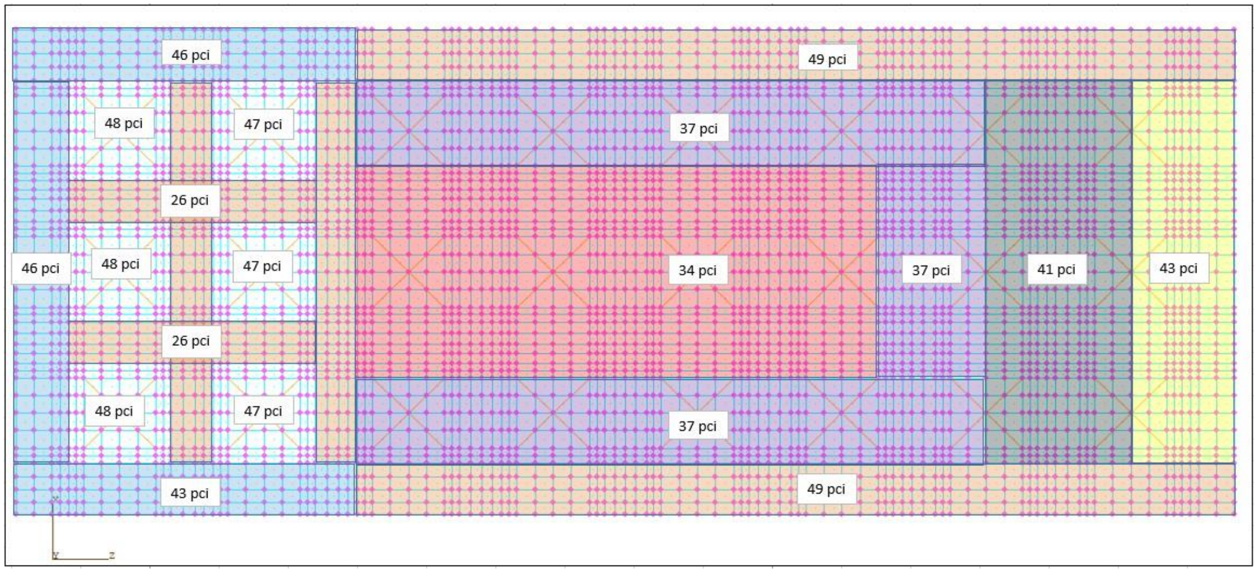

Figure 7-65
Storage Pad Cask Configuration 2 – Modulus of Sub-Grade Reactions for Soil Below the Different Sections of the Pad Used for Design Evaluation

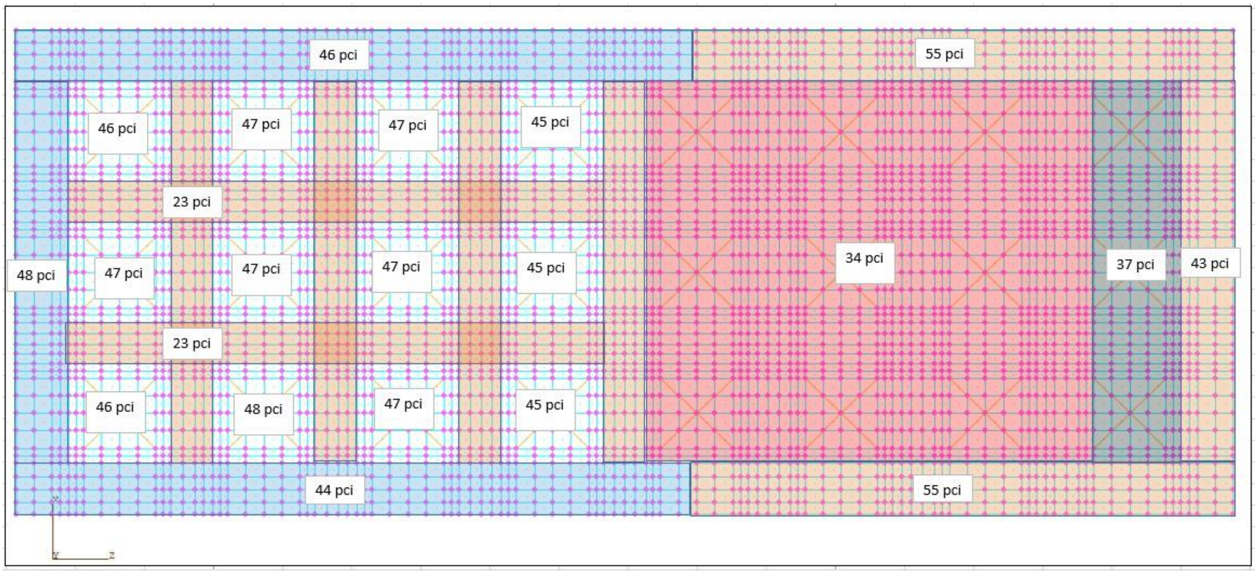

Figure 7-66
Storage Pad Cask Configuration 3 – Modulus of Sub-Grade Reactions for Soil Below the Different Sections of the Pad Used for Design Evaluation

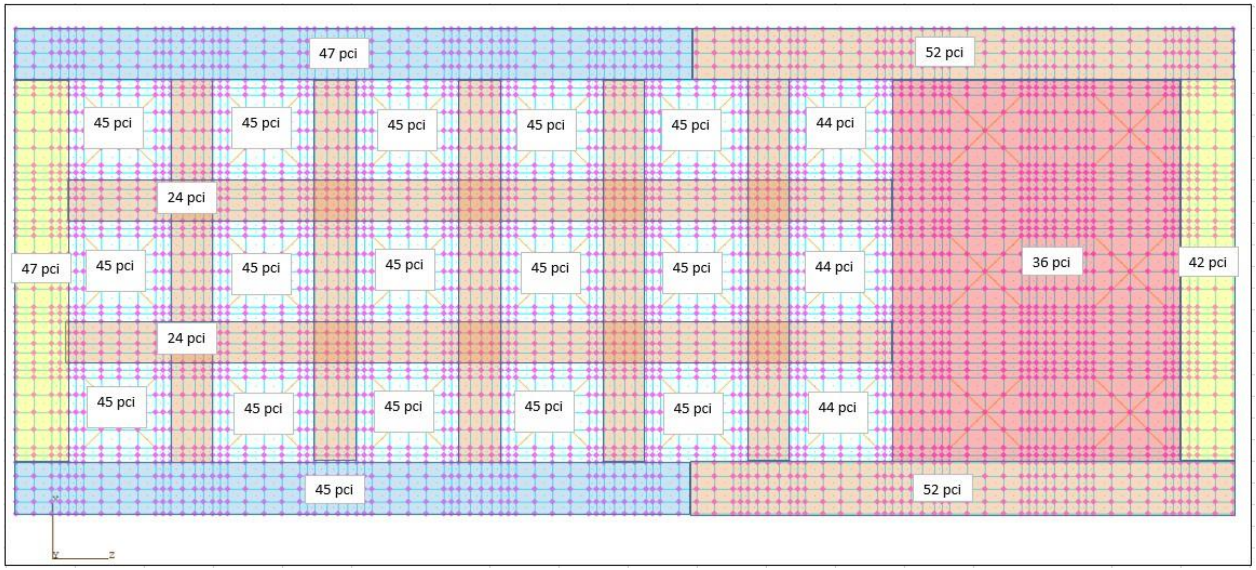

Figure 7-67
Storage Pad Cask Configuration 4 – Modulus of Sub-Grade Reactions for Soil Below the Different Sections of the Pad Used for Design Evaluation

CHAPTER 8
THERMAL EVALUATION

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8. THERMAL EVALUATION

The purpose of this chapter is to demonstrate that the Interim Storage Partners' (ISP's) WCS Consolidated Interim Storage Facility (WCS CISF) structures, systems, and components (SSCs) important-to-safety (ITS) and spent nuclear fuel (SNF) material temperatures remain within allowable values or criteria for normal, off-normal, and accident conditions. Canisters containing Greater Than Class C (GTCC) waste are bounded by the evaluations performed for canisters containing SNF, and, therefore, the SNF evaluations are also applicable to GTCC waste canisters.

The design of the WCS CISF is based on the use of cask systems that have been approved under 10 CFR 72. Chapter 3 identifies additional design criteria that cask systems must meet in order to be used at the WCS CISF. The design of the WCS CISF ensures that the receipt, handling, transfer, storage and monitoring of the vendor cask systems is in accordance with the safety analyses and limiting conditions for operation.

8.1 Thermal Design Criteria and Features

This section presents the thermal design criteria for the WCS CISF and summarizes thermal safety design and licensing bases applicable to authorized WCS CISF storage systems. WCS CISF design features and thermal safety evaluation assumptions are presented to demonstrate consistency with authorized storage system design and licensing bases.

8.1.1 Criteria

As specified in the Technical Specifications [8-1] only canisters that were loaded and stored in accordance with the listed Site Specific or General Licenses are acceptable for storage at the WCS CISF. Thermal assessments documented in this Chapter and associated Appendices verify that the WCS CISF characteristics and environmental conditions are bounded by the cask thermal analyses. Consistent with design and regulatory guidance, thermal safety is demonstrated for all WCS CISF cask systems to demonstrate SNF cladding integrity under all identified thermal loading conditions.

8.1.2 Features

WCS CISF storage systems are designed to ensure that the stored materials remain within thermal loading conditions under normal, off-normal and accident-level conditions during all operations, transfers and storage. SNF storage confinement features provide a passive cooling function for the cask systems by air convection.

8.2 Stored Material Specifications

SNF characteristics addressed in the individual canister/cask system thermal safety evaluations are provided in Appendices A.8, B.8, C.8, D.8, E.8, F.8 and G.8, depending on the canister/cask system. Storage of canisterized GTCC waste is addressed in Appendix H.

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. As stated in Section 7.2, 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 and will comply with WCS CISF License Conditions and Technical Specifications. In addition, a receipt inspection of the canisters is performed upon arrival at the WCS CISF, which includes a post transport evaluation in accordance with reference [8-2].

8.3 Thermal Assessment

Section 8.4 provides the reference to the appropriate Appendix for each authorized canister/cask system listed in the Technical Specifications [8-1] as acceptable for storage at the WCS CISF. Each Appendix then provides reference to the applicable design/licensing basis thermal analysis bounding the conditions of operations and storage at the WCS CISF.

ISP has considered the effects of other factors on the thermal assessment, such as cask spacing, elevation, and wind speed.

Effects from Cask Spacing

The proposed Technical Specifications for NAC vertical storage systems have minimum spacing requirements, which ensure that allowable thermal limits are not exceeded at the WCS CISF for those storage systems.

Elevation Effects

Elevation effects on the NUHOMS® Systems, have been previously evaluated in response to RAI 4-10 from NRC on the Amendment 10 application for the CoC 1004 license and have been reviewed by the staff. As shown in the response to RAI 4-10 [8-3], there is no effect on the NUHOMS® System up to an elevation of 5,000 ft. As noted in WCS SAR Chapter 2, the WCS CISF is at an elevation of about 3,500 ft. Since the elevation at the WCS CISF is lower than those previously evaluated for the NUHOMS® System, no further evaluation is performed.

NAC's storage systems are aboveground ventilated vertical cask designs, which are comparable in design to the aboveground ventilated vertical cask design evaluated in NUREG-2174, "Impacts of Variation in Environmental Conditions on the Thermal Performance of Dry Storge Casks." According to NUREG-2174, Section 4.8.4, Paragraph 3, "…the PCT increases by about 6 K (11°F) for every 500 m (1640.5 ft) of increased elevation". Since the WCS CISF is at an elevation of approximately 3500 ft. and based on the results shown in NUREG-2174, it is expected the PCT for an aboveground ventilated vertical cask would increase by approximately 23.5°F compared to sea level.

The evaluations using storage design basis heat loads for Yankee-MPC, CY-MPC, and MPC-LACBWR canisters demonstrate that at sea level the margin between the peak clad temperature (PCT) and the long-term allowable is approximately 81°F, 123°F, and 357°F, respectively. Therefore, the effect of elevation (i.e., 23.5°F increase) is within the margin for each canister type.

The evaluation using the storage design basis heat load for the NAC-UMS loaded with PWR fuel demonstrates that at sea level the margin between the PCT and the long-term allowable is approximately 104°F. Therefore, the effect of elevation (i.e., 23.5°F increase) is within the margin.

The evaluation using the storage design basis heat load for the NAC-MAGNASTOR loaded with PWR fuel demonstrates that at sea level the margin between the PCT and the long-term allowable is approximately 34°F. Therefore, the effect of elevation (i.e., 23.5°F increase) is within the margin. It is important to note that this margin is based on a significantly higher PWR storage heat load of 35.5 kW than would be allowed at the WCS CISF. In order for a NAC-MAGNASTOR canister to be shipped to the WCS CISF it must be below the maximum permissible heat load of the MAGNATRAN transportation cask, which is 23kW for PWR fuel. This is a design basis storage canister heat load reduction of approximately 35% prior to transportation. Applying this reduction to the design basis storage PCT would increase the margin to approximately 262°F (i.e., [752 - (718°F X 0.65)] – 23.5°F = 262°F). Therefore, the effect of elevation for a NAC-MAGNASTOR PWR canister that was previously in dry storage and subsequently shipped and placed back into storage at the WCS CISF is not significant.

The Effect of Low Speed Wind

1. Standardized NUHOMS® Systems

   According to NUREG-2174, wind does not have any significant effect on the thermal performance of Standardized NUHOMS® Systems. Therefore, no additional analyses are needed for low wind speed.

2. Standardized Advanced NUHOMS® Systems

   According to NUREG-2174, a wind evaluation should be included for Standardized Advanced NUHOMS® Systems (AHSM) when there is not sufficient margin.

   Standardized Advanced NUHOMS® System is considered for storage in Appendix B.8. The maximum fuel cladding temperature for thermal evaluations presented in Appendix B.8 has a significant margin to the fuel cladding temperature limit.

   The maximum fuel cladding temperature for normal storage operations is 618°F (Table 4.4-7 of CoC 1029 UFSAR). As noted in Section B.8.5.2, thermal evaluation for AHSM was based on a heat load of 24 kW compared to the maximum allowed heat load of 14.0 kW, providing sufficient margin. Therefore, no additional analyses are needed for low wind speed.

3. NAC Vertical Storage Systems

NAC's spent fuel storage cask designs are vertical-ventilated aboveground systems (i.e., the NAC-MPC, NAC-UMS, and NAC-MAGNASTOR systems). All of these systems have four air-inlet and four air-outlet vents. They are similar in design to the vertical-ventilated aboveground storage system evaluated for low wind speed in NUREG-2174. As concluded in the NUREG, the maximum fuel cladding temperature for the evaluated vertical-ventilated aboveground system with four air-inlet and four air-outlet vents was lower when subjected to a low wind speed scenario versus a no wind speed scenario. Therefore, the results and conclusions of the NUREG are applicable to NAC's storage systems and the effects of low wind speed on NAC's systems would result in lower maximum fuel cladding temperature. Therefore, no additional analyses are needed for low wind speed.

Based on the assessment of cask spacing, elevation and wind speed, no thermal analysis is required beyond that documented in the Appendices for each system identified in Section 8.4.

8.4 Thermal Analysis

Section 2.1 of the Technical Specifications [8-1] lists the SNF canisters authorized for storage at the WCS CISF. Table 8-1 provides the cross reference to the applicable appendix and section for each canister/storage overpack where the thermal evaluation is discussed. Table 8-2 compares the maximum ambient temperatures at the WCS CISF with the equivalent maximum ambient temperatures in Appendices A-G. Note that some ambient temperatures, where designated, are based on 3-day average high temperatures. Based on the Table 8-2 and the revised application, no new evaluations are performed for the various systems, because the existing analyses bound the ambient temperatures at the WCS CISF.

8.5 References

8-1 SNM-2515 Technical Specifications (See [Gen-1]).

8-2 "Post Transport Package Evaluation," QP-10.02, Revision 2.

8-3 Letter from Robert Grubb (TN) to NRC Document Control Desk, "Revision 1 to Transnuclear, Inc. (TN) Application for Amendment 10 to the Standardized NUHOMS® System (Docket No. 72-1004; TAC NO. L24052)," November 7, 2007 (E-25506) ML073180235.

Table 8-1
Thermal Evaluations for the Storage Systems at the WCS CISF

Cask System	Canister	Overpack	Appendix
NUHOMS®-MP187 Cask System	FO-DSC	HSM (Model 80)	Appendix A.8
	FC-DSC		
	FF-DSC		
	GTCC Canister		
Standardized Advanced NUHOMS® System	NUHOMS® 24PT1	AHSM	Appendix B.8
Standardized NUHOMS® System	NUHOMS® 61BT	HSM Model 102	Appendix C.8
	NUHOMS® 61BTH Type 1		Appendix D.8
NAC-MPC	Yankee Class	VCC	Appendix E.8
	Connecticut Yankee		
	LACBWR		
	GTCC-Canister-CY		
	GTCC-Canister-YR		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.8
	GTCC-Canister-MY		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.8
	GTCC-Canister-ZN		

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

CHAPTER 9
RADIATION PROTECTION

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9. RADIATION PROTECTION

This chapter addresses radiation protection and estimated radiation sources and exposures to operating personnel during normal operation and anticipated operational occurrences (including all types of radioactive material handling, transfer, processing, storage, and disposal; maintenance; routine operational surveillance; inservice inspection; and calibration).

This chapter also provides information on layout and equipment design, the planning and procedures programs, and the techniques and practices employed by Interim Storage Partners (ISP) in meeting as low as is reasonably achievable (ALARA) principles and standards of 10 CFR Part 20 for protection against radiation and the guidance given in relevant regulatory guides.

The occupational exposure and off-site dose rates are very conservative, as the dose rates on and around the transportation/transfer casks are based upon design basis transportation sources, and the dose rates on and around the storage overpacks are based upon design basis source terms in the existing storage Final Safety Analysis Reports (FSAR) [9-3, 9-4, 9-5, 9-9, 9-10, 9-11]. These storage source terms, in most cases, are much higher than what can be accommodated by the transportation casks and therefore, significant decay is required prior to shipment to the WCS Consolidated Interim Storage Facility (WCS CISF).

9.1 Ensuring That Occupational Radiation Exposures Are ALARA

9.1.1 Policy Considerations

ISP will implement a Radiation Protection Program at the WCS CISF consistent with the requirements of 10 CFR 72.126, 10 CFR 20.1101, and 10 CFR 19.12. The program will utilize the experience and expertise of ISP joint venture member Waste Control Specialists personnel and existing Waste Control Specialists programs as well as the extensive experience of TN Americas and NAC in designing and operating spent nuclear fuel (SNF) storage systems.

The Radiation Protection Program is designed to minimize exposure to radiation and to keep individual and collective exposures to personnel ALARA. ISP does this by implementing ALARA principles into the design, construction, and operation of the facility. ISP uses formal periodic reviews of the Radiation Protection Program to assure that objectives of the ALARA program are attained. ISP's radiation protection personnel also are responsible for maintaining occupational exposures as far below the specified regulatory limits as reasonably achievable.

ISP is committed to a strong ALARA program. The objectives of ISP's ALARA philosophy include protection of ISP personnel and protection of the public. Protection of ISP personnel includes surveillance and control of radiation exposure to ensure it remains within regulatory limits and to keep such exposures ALARA, both from an individual and collective dose perspective. Protection of the public health and safety is accomplished through surveillance and control of operations. ISP management is committed to compliance with regulatory requirements regarding personnel exposures and will establish and maintain a comprehensive program at the WCS CISF to keep individual and collective doses ALARA.

The Radiation Protection Program will ensure that WCS CISF personnel receive sufficient training and that ISP radiation protection personnel have the necessary authority, equipment, and supplies to ensure safe facility operation and to support radiation protection work. Periodic training and exercises will be conducted for site personnel regarding radiation protection principles and procedures, protective measures, and emergency responses, and to ensure an understanding of ALARA practices and dose reduction techniques. Revisions to relevant procedures and modifications to WCS CISF equipment and facilities will be made to support reducing exposures at a reasonable cost. Design, operation, and maintenance activities will be reviewed to ensure ALARA criteria are met.

The ISP ALARA program follows the requirements in 10 CFR Part 20, as well as relevant guidelines of Regulatory Guide 8.8 [9-16], Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations will be As Low As Is Reasonably Achievable, and Regulatory Guide 8.10 [9-17], Operating Philosophy for Maintaining Occupational and Public Radiation Exposures As Low As Is Reasonably Achievable.

The WCS CISF is designed and operated to provide radiation protection for workers in conformance with applicable regulatory criteria so that occupational radiation exposures are maintained ALARA.

Operation of the WCS CISF is in accordance with an ALARA policy that includes, as a minimum, the following criteria:

- Maintaining radiological releases and exposures to personnel below the applicable limits of 10 CFR Part 20.
- Ensuring that all exposures are kept ALARA, with technological, economic and social factors taken into consideration.
- Integrating appropriate radiation protection controls and ALARA program guidelines into all work activities, including those for design, operations, maintenance, and decommissioning.
- Ensuring that all personnel understand that no practice involving radiation exposure will be undertaken unless its use produces a net benefit and that all personnel shall follow ALARA procedures at all times.
- Restricting access to radiologically controlled areas.
- Tracking individual and collective doses to identify trends, causes, and take appropriate corrective actions for adverse trends.
- Conducting periodic training and exercises for management, radiation workers and other site personnel in radiation protection principles and procedures, individual and group protective measures, site procedures and emergency response.
- Integrating ALARA considerations into the WCS CISF design and procedure change activities, including appropriate experience gained during the loading and transfer operations at other ISFSIs relative to radiation control.

WCS CISF personnel including administration, security staff and railroad personnel involved in the delivery to and shipment from the WCS CISF of transport packages will be trained in accordance with 10 CFR Parts 19 and 20. These workers are considered “Radiation Workers” and the occupational radiation dose limits specified in 10 CFR Part 20 Subpart C apply. Individuals (visitors) not trained in accordance with 10 CFR Part 19 are considered members of the public and the dose limits specified in 10 CFR Part 20 Subpart D apply.

ISP minimizes radiation dose to non-radiation workers by the following means:

- ISP will control the number of non-radiation workers admitted to both the Owner Controlled Area (OCA) and to the WCS CISF.
- Commercial and industrial deliveries to ISP will be required to be accepted outside the OCA, for further transfer on site by radiation workers.
- Authorized visitors and other members of the public will be under escort while in the OCA and the WCS CISF.

- Visitors will receive orientation training on minimizing radiation exposure and emergency procedures.

9.1.2 Design Considerations

Consistent with 10 CFR 72.126(a), ALARA considerations have been incorporated into the WCS CISF design, including the layout of the WCS CISF and the SNF storage systems selected.

Only canisters that have been previously approved by the NRC to store and for transport spent nuclear fuel (SNF) and GTCC waste will be accepted at the WCS CISF. This includes commercial light water (pressurized water reactor and boiling water reactor) SNF. The controls for limiting the types and forms of SNF 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 for SNF are listed in Section 2.1 of the Technical Specifications [9-13].

The storage systems are designed to comply with 10 CFR Part 72 ALARA requirements. Details of the design considerations for each system are cross-referenced to the applicable FSAR in the table below:

Cask System	Canister	Overpack	Design Considerations
NUHOMS®-MP187 Cask System	FO-DSC	HSM (Model 80)	Section 7.1.2 of [9-3]
	FC-DSC		
	FF-DSC		
	GTCC Canister		
Standardized Advanced NUHOMS® System	NUHOMS® 24PT1	AHSM	Section 10.1.2 of [9-5]
Standardized NUHOMS® System	NUHOMS® 61BT	HSM Model 102	Section 7.1.2 of [9-4]
	NUHOMS® 61BTH Type 1		
NAC-MPC	Yankee Class	VCC	Appendix E.9
	Connecticut Yankee		
	LACBWR		
	GTCC-Canister-CY		
	GTCC-Canister-YR		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.9
	GTCC-Canister-MY		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.9
	GTCC-Canister-ZN		

The storage pads are sized to provide adequate spacing between storage casks or modules to permit workers to function efficiently during operations and maintenance. This helps minimize dose by limiting time spent by workers in the vicinity of storage casks.

The design of the storage systems includes a metal canister that is sealed by welding for SNF and GTCC waste confinement. This design precludes the release of radioactive effluents during normal operations, which fully satisfies the requirement of 10 CFR 72.126(d) to design the facility to provide means to limit the release of radioactive materials in effluents during normal operations to levels that are ALARA. This design also requires minimum maintenance and surveillance requirements by ISP personnel.

The VCC temperature monitoring system installed on the outlet vents enables data acquisition from remote readout of temperatures or inspection; this minimizes radiation dose to WCS CISF personnel by avoiding the need to perform daily walkdowns, or take measurements, or read instrumentation near the VCCs. The NUHOMS® storage overpack vents are covered by screens which prevent internal blockage of the vents. The back-to-back array allows visual inspection of screens for debris to be performed from low dose areas on the storage pad.

ALARA considerations have been incorporated into the WCS CISF design in accordance with 10 CFR 72.126(a) using guidance from Regulatory Guide 8.8, Regulatory Position 2 [9-16], as described below:

- Regulatory Position 2a on access control of radiation areas is satisfied by use of a security gate and a fence surrounding the WCS CISF Protected Area (PA) to prevent unauthorized access.
- Regulatory Position 2b on radiation shielding is satisfied by the shielding design for the transportation, storage, and transfer casks that minimizes personnel exposures during operations. The design of the storage cask air inlet and outlet ducts also prevents direct radiation streaming. The Security and Administration Building is located approximately 340 ft. (100 meters) from the nearest storage pad, and approximately 1130 ft. (345 meters) from the Cask Handling Building. Dose rates are sufficiently low at these distances such that shielding of the Security and Administration Building is unnecessary to assure dose rates are ALARA to personnel in the building.
- Regulatory Position 2c on process instrumentation and controls is satisfied since the cask temperature monitoring system will utilize a data acquisition system to record cask temperature instrumentation readings. This will avoid time spent by WCS CISF personnel near the storage casks to make daily cask vent blockage and temperature surveillances.

- Regulatory Position 2d on control of airborne contaminants and gaseous radiation sources is not applicable because gaseous releases are prevented by the sealed canister design. No surface contamination is expected on the outer surfaces of the canister since process controls are maintained during fuel loading at the originating site.
- Regulatory Position 2e on crud control is not applicable to the WCS CISF because the systems at the WCS CISF do not produce crud.
- Regulatory Position 2f on decontamination is satisfied because the internal surfaces of transfer and storage overpacks have surfaces that allow for decontamination by wiping. Surfaces of the floors also are painted in a manner that is easily decontaminated.
- Regulatory Position 2g on radiation monitoring systems is satisfied with the use of Area Radiation Monitors (ARM) and dosimetry area monitoring in the Cask Handling Building during transfer operations, and with Optical Stimulated Luminescence (OSL) dosimeters (or equivalent) along the perimeters of the PA and OCA to provide radiation dose monitoring. Continuous air monitors will be located in the Cask Handling Building.
- Regulatory Position 2h on resin treatment systems is not applicable to the WCS CISF because there will not be any radioactive systems containing resins and there will be no resin treatment at the WCS CISF.
- Applicable portions of Regulatory Position 2i concerning other ALARA features is satisfied because the WCS CISF provides a favorable working environment that promotes work efficiency (2i(13)). This includes adequate lighting in the Cask Handling Building and on the storage pads; adequate ventilation in the Cask Handling Building; adequate working space in the Cask Handling Building and at the storage pads; and accessibility to the transfer cask doors where operators need to perform tasks during canister transfer operations. Regulatory Position 2i(15) is satisfied because the emergency lighting system is adequate to permit prompt egress from any high radiation areas.

9.1.3 Operational Considerations

WCS CISF operational considerations to achieve ALARA conditions include:

- SNF and GTCC waste loading operations take place at the originating sites, not at the WCS CISF, and there is no other handling of SNF or GTCC waste outside of canisters at the WCS CISF.
- The WCS CISF will not process liquids or gases or contain, collect, store, or transport radioactive liquids. Any solid radioactive waste collected during canister transfer operations will be temporarily staged in a designated area in the Cask Handling Building until transferred to a licensed disposal facility as described in Section 6.4.
- Shielded transfer casks will be used to transfer canisters between a transportation cask and a storage cask.

- Dry runs and mock-ups will be used prior to canister transfer operations to train personnel on canister transfer procedures. ISP also will discuss methods to minimize exposures and will refine procedures to achieve minimum probable exposures.
- WCS CISF procedures and work practices will reflect relevant ALARA lessons learned from other ISFSIs that use dry cask storage.
- The overhead bridge cranes and the Canister Transfer System (CTS) are located in the Cask Handling Building. The overhead bridge crane handles the transportation casks and removes the casks from the railcar. It can also be used to lift impact limiters or other related equipment. The Vertical Cask Transporter (VCT) moves the uprighted NAC system transportation casks to the CTS. The CTS is designed to lift and transfer NAC system canisters from the transportation casks to the storage casks. Operation of these cranes during canister transfer operations is addressed in Chapter 5. A self-propelled VCT is used to move the NAC vertical concrete casks from the Cask Handling Building to the storage pads. A transfer trailer and transport truck move the NUHOMS® transfer cask to the storage overpacks. The transporters require minimum personnel and allow for quick and accurate placement of the canisters.
- Maintenance activities in the Cask Handling Building are performed when there are no transfer operations taking place to minimize dose.
- The storage casks and modules are spaced on the storage pads with sufficient distance from each other to facilitate placement operations and minimize the time spent by WCS CISF personnel near the loaded casks.

Regulatory Position 4 of Regulatory Guide 8.8 [9-16] regarding radiation protection facilities, instrumentation, and equipment is satisfied with the use of area radiation monitoring via dosimetry (OSL - beta/photon/neutron or equivalent) and alarming radiation monitors in the Cask Handling Building and dosimetry (OSL - beta/photon/neutron or equivalent) in the Restricted Area. The OCA boundary will be monitored with environmental dosimetry (OSL X-9 - beta/photon or equivalent) to ensure the dose to the public is maintained below 10 CFR Part 20 Subpart D standards. In addition, radiation protection personnel will use portable survey instruments (Ludlum Model 9, Model 78, Model 2360 and 12-4 or equivalent) and perform surveys during transportation cask receipt, inspection, and canister transfer operations, and the operating personnel will have personal dosimetry (Section 9.5.2). Although the likelihood of a canister leaking is very minimal, continuous air monitors will be located in the Cask Handling Building as a precaution to ensure no material has leaked during offloading operations. The access control point will be at the Security and Administration Building.

Airborne monitoring will be performed as needed with portable monitors. A low-radiation background counting room is included in the Security and Administration Building. Protective equipment, including anti-contamination clothing and respirators, will be available in the Cask Handling Building and controlled by radiation protection personnel.

Regulatory Guide 8.10 [9-17] considerations will be integrated into the WCS CISF operations as follows:

1. Management's commitment to keep occupational exposures ALARA is available to personnel in policy statements, instructions to personnel, and similar documents.

2. Adequate resources and funding are provided to meet implementation of ALARA policies and procedures.

3. The work environment encourages employees to raise ALARA concerns and receive timely feedback on submitted issues.

4. Facility personnel having responsibilities and implementing requirements for the Radiation Protection Program receive proper training in ALARA principles.

5. Sufficient authority to enforce safe facility operation, to approve radiation safety-related issues, and to communicate promptly to an appropriate level of management is provided to radiation protection personnel.

6. Occupational workers receive sufficient training on radiation protection.

7. Modifications to operating and maintenance procedures and to equipment and facilities are made where they will substantially reduce exposures at a reasonable cost.

Detailed operational considerations for each system are cross-referenced to the applicable FSAR in the table below:

Cask System	Canister	Overpack	Operational Considerations
NUHOMS®-MP187 Cask System	FO-DSC	HSM (Model 80)	Section 7.1.3 of [9-3]
	FC-DSC		
	FF-DSC		
	GTCC Canister		
Standardized Advanced NUHOMS® System	NUHOMS® 24PT1	AHSM	Section 10.1.3 of [9-5]
Standardized NUHOMS® System	NUHOMS® 61BT	HSM Model 102	Section 7.1.3 of [9-4]
	NUHOMS® 61BTH Type 1		
NAC-MPC	Yankee Class	VCC	Appendix E.9
	Connecticut Yankee		
	LACBWR		
	GTCC-Canister-CY		
	GTCC-Canister-YR		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.9
	GTCC-Canister-MY		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.9
	GTCC-Canister-ZN		

9.1.4 ISP ALARA Policy

The following sets forth ISP's policy on radiation protection principles and practices for maintaining occupational and public doses that are as low as reasonably achievable (ALARA) in the operation of its WCS Consolidated Interim Storage Facility (WCS CISF). This policy is based on three fundamental principles as described in International Commission on Radiological Protection (ICRP) Publication 103, "The 2007 Recommendations of the International Commission on Radiological Protection." Those principles are: (1) justification of exposure; (2) optimization of protection; and (3) limitation of individual dose. The policy also describes management's commitment to implement those principles.

Fundamental Principles of Radiation Protection and ALARA

The first principle, justification, states that "any decision that alters the radiation exposure situation should do more good than harm" (ICRP Publication 103). Decisions associated with justification do not simply take radiation doses into account, but should also encompass all of the possible benefits and detriments of the actions proposed. Thus, a decision may be justified by conclusions that the benefits of improved safety outweigh the detriment of occupational exposure and other detriments associated with taking the action.

The second principle, optimization, states that "the likelihood of incurring exposure, the number of people exposed, and the magnitude of their individual doses should be kept as low as reasonably achievable, taking into account economic and societal factors" (ICRP Publication 103). All exposures shall be kept ALARA, with technological, economic, and social factors considered. Once a particular exposure has been justified, it is necessary to take actions to reduce exposures to ALARA.

The third principle, limitation, states that "the total dose to any individual from regulated sources in planned exposure situations other than medical exposure of patients should not exceed the appropriate limits" (ICRP Publication 103). Individual dose limits shall be established that are appropriate for practices involving radiation exposure, and exposures to individuals shall not exceed these limits. Limits for occupational exposure are contained in 10 CFR 20.1201, "Occupational Dose Limits for Adults;" 10 CFR 20.1206, "Planned Special Exposures;" 10 CFR 20.1207, "Occupational Dose Limits for Minors;" and 10 CFR 20.1208, "Dose Equivalent to an Embryo/Fetus." Exceeding an occupational exposure limit is a significant violation and subject to enforcement.

Management Commitment

It will be a management priority that all personnel working with radioactive material be made aware of our commitment to the ALARA philosophy and that they be instructed in the procedures to be used to keep their exposures as low as possible. Supervisors and workers shall be appropriately instructed in the objectives and implementation of the ALARA program, with this information included in training modules.

It is management's direction that supervisors integrate appropriate radiation protection controls into all work activities. Management will make all reasonable modifications to procedures, equipment, and facilities to reduce exposures to ALARA.

Management has delegated authority to our RSO to ensure adherence to ALARA principles. The RSO shall emphasize the ALARA philosophy to all personnel working with radioactive material, and shall instruct workers to review current procedures and propose changes to reduce exposure levels. Management shall support the RSO in instances where this authority must be asserted. Strict compliance with all regulatory requirements and license conditions regarding procedures, radiation exposures, and releases of radioactive materials shall be met.

A comprehensive program shall be maintained, and periodically evaluated, to ensure that both individual and collective doses meet ALARA objectives and do not exceed acceptable levels.

9.2 Radiation Sources

The WCS CISF radiological shielding evaluation is based on the authorized cask system designs and their associated radiological source terms and dose evaluations. The source terms bound SNF and GTCC waste that will be stored at the WCS CISF.

9.2.1 Characterization of Sources

The source terms may be classified into three general categories:

- Gamma and neutron source terms from the fuel and GTCC waste
- External radioactive contamination on a canister
- Radioisotopes associated with releases from a canister

The characteristics of each of these radiation sources are discussed in the following sections.

9.2.1.1 Spent Nuclear Fuel and GTCC Waste

Details of the storage source terms for each system are cross-referenced to the applicable FSAR in the table below:

Cask System	Canister	Overpack	Source Terms
NUHOMS®-MP187 Cask System	FO-DSC	HSM (Model 80)	Section 7.2.1 of [9-3] for fuel and Section 7.2.1 of Appendix C of [9-3] for GTCC waste
	FC-DSC		
	FF-DSC		
	GTCC Canister		
Standardized Advanced NUHOMS® System	NUHOMS® 24PT1	AHSM	Section 5.2 of [9-5]
Standardized NUHOMS® System	NUHOMS® 61BT	HSM Model 102	Section K.5 of [9-4]
	NUHOMS® 61BTH Type 1		Section T.5 of [9-4]
NAC-MPC	Yankee Class	VCC	Appendix E.9 for fuel and Section 1.2.3.2 of [9-6] for GTCC waste
	Connecticut Yankee		
	LACBWR		
	GTCC-Canister-CY		
	GTCC-Canister-YR		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.9 for fuel and Section 1.3.1.1.2 of [9-7] for GTCC waste
	GTCC-Canister-MY		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.9 for fuel and Section 1.3.2 of [9-8] for GTCC waste
	GTCC-Canister-ZN		

Sources (surface dose rates) for the GTCC waste canisters are bounded by the design basis fuel and are therefore modeled as fuel canisters.

These storage source terms are used to compute the dose rates on the surfaces of the storage overpacks. Separate source terms are used to compute the dose rates on the surface of the transportation/transfer casks: see Chapter 5 of the MP187 SAR [9-2]; Chapter A.5 of the MP197HB SAR [9-1]; Chapter 5 of the NAC-STC SAR [9-6]; Chapter 5 of the UMS® Universal Transport Cask [9-7]; and Chapter 5 of the MAGNATRAN® SAR [9-8]. In general, the source terms in the associated storage FSARs are larger than the source terms in the transportation SARs, although in actuality the source terms in the transportation SARs must bound the WCS CISF as-loaded source terms because the fuel must be transported to the WCS CISF. For this reason, all reported WCS CISF dose rates are bounding because they are based on FSAR design basis storage source terms.

9.2.1.2 Radiation Sources for Site Dose Calculations

NUHOMS® HSM

For the NUHOMS® HSM portion of the site dose calculations, flux and dose rate information on the surfaces of the HSMs are used to generate surface sources. These surface sources are used as input to a site dose calculation in which the radiation interacts primarily with air. Average 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.

A surface source is modeled on each of the HSM array surfaces to reproduce the applicable HSM surface dose rate indicated in Table 9-1. Source particles are started using an outward cosine distribution and spectra applicable to each HSM system.

NAC VCC

This evaluation utilizes licensing basis surface currents imported from each system's 10 CFR Part 72 licensing basis evaluation. This evaluation considers all approved contents for each system, including undamaged and damaged fuel, and all non-fuel hardware. The contents are considered using the methods of previous licensing basis site boundary evaluations (e.g., a non-fuel hardware multiplication factor for the MAGNASTOR surface currents). For most systems, no additional source is required as the directly imported surface currents have considered bounding sources (e.g., no impact on site boundary dose rates for the loading of VCCs with damaged fuel). GTCC waste is not included in the 10 CFR Part 72 general licensing basis evaluations. Representative site specific data is imported for GTCC waste source data. All surface currents are applied in the MCNP VCC models as a surface source with cask specific directional and energy distributions. Radial and axial source distributions are assumed to be uniformly emitting.

Example surface currents used for the MAGNASTOR VCCs are provided in Table 9-2 and Table 9-3 for neutron and gamma sources, respectively.

9.2.1.3 External Radioactive Contamination

Canister removable contamination does not exceed 2,200 dpm/100 cm^2 beta/gamma emitters and 220 dpm/100 cm^2 alpha emitters as verified during loading and storage operations at the original canister loading site for the approved SNF systems that are listed in Section 2.1 of the Technical Specifications [9-13]. No radioactive contamination is expected on the internal or external surfaces of the storage overpacks.

Finally, one additional source of external radioactive contamination would be the surfaces of the transportation casks when they arrive at the WCS CISF. The contamination levels are governed by 10 CFR Part 71 regulations.

9.2.1.4 Fission Gases

All of the canisters authorized for storage at the WCS CISF except for the FO-, FC-, and FF-DSCs are leaktight per ANSI N14.5 (see Chapter 11 and associated appendices). The confinement boundary for these canisters is demonstrated to be leaktight during all normal, off-normal, and accident conditions. Therefore, estimating the maximum quantity of fission gas products for these canisters is not required per ISG-5 [9-12].

For the FO-, FC- and FF-DSCs, the fission gases are listed in Table A.11-1 of Appendix A.11.

9.2.2 Airborne Radioactive Material Sources

The potential for significant airborne radioactive contamination at the WCS CISF is small due to the inherent protection provided by the canisters. However, there are two possible sources of airborne radioactive materials: airborne dispersion of external non-fixed contamination on the individual canisters during normal operations and releases associated with a postulated confinement barrier breach.

9.2.2.1 Normal Operations

During transfer of the sealed canisters and subsequent storage in the applicable storage overpack, the only postulated mechanism for the release of airborne radioactive material is the dispersion of non-fixed surface contamination on the canister exterior. Because the contamination limits on the canisters are kept to a minimum (See section 9.2.1.3), there is no significant possibility of radionuclide release from the canister exterior surface during transfer or storage operations.

9.2.2.2 Accidents

As noted in Section 9.2.1.4, all of the canisters authorized for storage at the WCS CISF except for the FO-, FC-, and FF-DSCs are leaktight per ANSI N14.5. The confinement boundary for these canisters is demonstrated by testing to be leaktight during all normal, off-normal, and accident conditions. Therefore, evaluation of releases from inside the canisters, except for the FO-, FC-, and FF-DSCs, is not required per ISG-5 [9-12].

The 21 FO-, FC-, and FF-DSCs are fabricated and tested to a leakage rate of 10^{-5} ref-cm^3/sec; see Section 8.2.2 of [9-3]. The actinides and fission products for a B&W 15x15 fuel assembly are computed using SCALE6/ORIGEN-ARP. Two isotopic sets are considered, based on the design basis neutron and gamma sources. The design basis neutron source has a burnup of 38,268 MWd/MTHM, enrichment of 3.18% U-235, and was discharged in 1983. The design basis gamma source has a burnup of 34,143 MWd/MTHM, enrichment of 3.21% U-235, and was discharged in 1989. The two source terms considered are decayed until June 2020, which corresponds to the loading of Phase 1. The reported source term in Table A.11-1 of Appendix A.11 are the maximum values of the two isotopic sets considered.

9.3 Radiation Protection Design Features

9.3.1 Installation Design Features

A description of the WCS CISF layout and principle features is provided in Section 4.1. The WCS CISF layout and principle features were designed with consideration of the design features identified in Position 2 of Regulatory Guide 8.8, as addressed in Section 9.1.2. The WCS CISF has numerous design features that ensure that exposures are ALARA. These are discussed below.

First, the site is located far from population centers. The distance to the nearest town is approximately five miles. The town of Eunice, N.M., with a population of approximately 2,922, is located about five miles west of the WCS CISF. Hobbs, N.M., a community of about 34,122 people, is located approximately 20 miles north of the WCS CISF. The nearest residence is approximately 4 miles away in Lea County, N.M.

Second, the only sources of radiation at the WCS CISF are the sealed canisters containing SNF and GTCC waste. Canisters are sealed by welding, eliminating the potential for release. These canisters also are always shielded by casks during operations. As addressed in Section 6.1, solid waste would be packaged and temporarily stored in a designated radiologically controlled area until the waste is characterized and shipped to a licensed disposal facility.

Third, measures are taken at the originating sites to prevent loose surface contamination levels on the exterior of the canisters, as discussed in Section 9.2.2. Canisters are not transported to the WCS CISF unless contamination levels are within specified limits.

Fourth, only canisterized SNF and GTCC waste are authorized for storage at the WCS CISF. Canisters will not be opened, nor will SNF assemblies or GTCC waste be removed from the canisters at the WCS CISF. Additionally, the SNF will be stored dry inside the canisters, so that no radioactive liquid is available for release.

Fifth, the overpacks are heavily shielded to minimize external dose rates during operations and storage.

Sixth, the WCS CISF site layout provides substantial distance between the storage area and the OCA boundary, minimizing radiation exposures to individuals outside the OCA and assuring offsite dose rates are well below the 10 CFR 72.104 criteria. The closest distance from a storage pad to the OCA boundary is more than 4,300 ft.

Seventh, the Security and Administration Building is located at least 330 ft from the storage area. These distances provide separation of radioactive material handling and storage functions from other functions on the site.

Eighth, the location of the Cask Handling Building inside the PA minimizes the distance to the storage pads, provides for minimal other traffic on the route, and maintains substantial distance from the OCA boundary.

Finally, there are no radioactive liquid wastes associated with the WCS CISF.

The WCS CISF buildings are not designed for any special radiological considerations because there is no credible scenario for which a significant radioactive release could occur. The general area inside the PA fence is a restricted area, as defined by 10 CFR Part 20, and will be controlled in accordance with those requirements. Certain areas within the PA will be designated as Radiation Areas and High Radiation Areas, as necessary, and will be posted and controlled in accordance with applicable requirements of 10 CFR Part 20. The Cask Handling Building will be designated as a Radiation Area whenever loaded canisters are present, because the potential exists for dose rates to exceed 5 mrem/hr. Upon removal of the impact limiters from the transportation casks in the cask load/unload bay of the Cask Handling Building, the potential exists for dose rates in the vicinity of the top and/or bottom of the casks to exceed 100 mrem/hr in localized areas, and these localized areas will be posted as High Radiation Areas. Due to the administrative exclusion zones and exclusion of non-radiation workers, when the transportation casks have their impact limiters removed, dose rates outside the Cask Handling Building will be controlled and should remain below 100 mrem/hr and ALARA.

The Cask Handling Building houses the equipment used to handle the transition between transportation configurations under 10 CFR Part 71 and transfer operations under 10 CFR Part 72 for the canisters. The canisters are well shielded by the transportation casks and transfer casks during these operations. A thick steel plug is in place at the end of the canisters to minimize the dose rate at the cask top (and bottom for NUHOMS®) when the canisters are transferred from one overpack to another.

Table 9-4 provides the cross reference to the applicable appendix and section for each canister/storage overpack where the operational considerations for each system are discussed.

9.3.2 Access Control

The WCS CISF is designed to provide access control in accordance with 10 CFR Part 72 for both personnel radiological protection and facility physical protection (covered in the Security Plan). The PA is the area controlled for purposes of protecting individuals from exposure to radiation or radioactive materials and for providing facility physical security. The boundary of the PA is the security fence where the dose rate is less than 2 mrem/hr., in accordance with 10 CFR 20.1301. The controlled area is the area inside the site boundary (delineated by the OCA fence). The dose rate beyond the OCA fence is less than 25 mrem/yr. in accordance with 10 CFR 72.104. The access control boundaries for the controlled area and PA are established along the site fence lines (see Figure 1-2).

Access to the PA is controlled through a single access point in the Security and Administration Building (see Figure 1-2). Personal dosimetry is issued and controlled in this building to individuals entering the PA. Provisions exist in this building for donning and doffing personal protective equipment, such as anti-contamination clothing and/or respirators, which could be necessary in the event of contamination in the Cask Handling Building as a result of off-normal or accident conditions. Provisions for personnel decontamination are also contained in the Security and Administration Building. The PA also includes the storage area and Cask Handling Building. In accordance with the WCS CISF Radiation Protection Program During Operation (Section 9.5), radiation protection personnel will monitor radiation levels in the PA and establish access requirements as needed.

9.3.2.1 Controlled Area

Within the OCA, a restricted area is established to control access to radiation areas in order to maintain worker exposures ALARA.

The WCS CISF PA boundary will be posted as "restricted area, radioactive material area, dosimetry and RWP required for entry." The WCS CISF Cask Handling Building will be posted as a Radiation Area or High Radiation Area per 10 CFR Part 20 limits. In posting contamination areas, ISP will use the limits in Waste Control Specialists State radioactive material license RML R04100 which can be found in 30 TAC 336.364 Appendix G [9-19].

ISP will establish access controls to ensure that unauthorized access inside the OCA and the PA is prevented. These controls will be established for radiation protection, security, and safeguards purposes. The site layout, including a description of barriers and gates that will be used to preclude ready access into the OCA of the WCS CISF is provided in the Physical Security Plan.

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 within regulatory limits.

9.3.3 Shielding

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. 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, 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 Appendices A-9, B-9, C-9, D-9, E-9, F-9, and G-9 specifically Tables A.9-2,A.9-3, B.9-2, B.9-3, C.9-2, C.9-3, D.9-2, D.9-3, E.9-1, F.9-1, and G.9-1 for the respective configurations.

ISP 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, ISP will exclude workers from the Administrative Storage/Office Area and Cask Storage and Maintenance Area during offloading of canisters. See Figure 1-7.

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

WCS CISF personnel involved in canister handling activities will be trained in accordance with 10 CFR Parts 19 and 20. 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.

9.3.3.3 Storage Area Shielding

Table 9-4 provides the cross reference to the applicable appendix and section for each canister/storage overpack where the storage overpack shielding for each system is discussed. Any LLRW stored in the Cask Handling Building does not require any shielding.

9.3.4 Ventilation

Only NRC approved canisterized SNF and GTCC waste are acceptable for receipt and storage at the WCS CISF. Therefore, no safety related ventilation systems are required to support operations at the WCS CISF. 10 CFR 72.122(h)(3) states that ventilation systems and off-gas systems must be provided where necessary to ensure the confinement of airborne radioactive particulate materials during normal or off-normal conditions. Because there are no credible scenarios that would require installation of ventilation systems to protect against off-gas or particulate filtration, there are no special ventilation systems installed in the WCS CISF.

9.3.5 Area Radiation and Airborne Radioactivity Monitoring System

As discussed in Section 5.6, no sampling is required for airborne radioactivity for the safe operation of the WCS CISF.

10 CFR 72.122(h)(4) requires the capability for continuous monitoring of the storage system in a manner such that the licensee will be able to determine when corrective action needs to be taken to maintain safe storage conditions. This is not applicable to the WCS CISF because the canisters are sealed by welding and the canisters are placed in storage casks on storage pads, and there are no credible events that could result in releases of radioactive material from inside the canisters or unacceptable increases in direct radiation levels. Area radiation and airborne radioactivity monitors are therefore not needed at the storage pads. However, dosimeters (OSLs or equivalent) will be used to record dose rates in the PA and along the OCA boundary fence. The OSLs will primarily detect gamma radiation and have a lower limit of sensitivity of approximately 0.01 mrem. Dosimeters provide a passive means for continuous monitoring of radiation levels and provide a basis for assessing the potential impact on the environment.

Dosimeters will be located along the PA and OCA boundary fences. Each side of the boundary has one dosimeter. These dosimeters will be used to record dose rates along the boundary fence and to document that radiation levels at these boundaries are within regulatory limits. Dosimeters will also be placed on the outside of several buildings as follows: NW corner of the Security and Administration Building, NW corner of the Cask Handling Building, and at three locations along the East wall of the Security and Administration Building. Additionally, dosimeters will be located at strategic locations inside the Cask Handling Building where personnel will normally be working. These dosimeters will serve as a backup for monitoring personnel radiation exposure and maintaining this exposure ALARA. The dosimeters will be retrieved and processed quarterly.

Area radiation monitoring will be performed via the Radiation Protection Program. ISP will employ stationary continuous air monitors that will be installed at the Cask Handling Building, as described in Regulatory Guide 3.48, Section 7.3.4. These monitors will be used to assess the potential release of airborne radioactivity in off-normal events.

Similarly, ISP will employ stationary Area Radiation Monitors (ARMs) at the Cask Handling Building, as described in Regulatory Guide 3.48, Section 7.3.4. These monitors also will provide warning to personnel involved in the canister transfer operation of abnormal radiation levels. Because of the measures taken at the originating sites to minimize loose surface contamination levels on the exterior of the canisters during fuel loading operations, as discussed in Section 9.2.2, it is unlikely that canister transfer operations would generate significant levels of airborne contaminants. Airborne radioactivity concentrations will be detected by continuous air monitors located in the Cask Handling Building and air sampling conducted during canister offloading operations within the Cask Handling Building. There are no liquid or gaseous effluent releases from the WCS CISF. These requirements satisfy 10 CFR 72.126(b) and (c).

The types, capabilities, and parameters of fixed ARMs and continuous air monitors are described in the applicable ANSI N13.1, “Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities” and ANSI/ANS-HPSSC-6.8.1, “Location and Design Criteria for Area Radiation Monitoring Systems for Light Water Reactors.”

9.3.5.1 Area Radiation Monitoring System

Section 4.3.14 describes the radiation monitoring systems to be employed at the WCS CISF.

9.3.5.2 Radioactive Airborne Effluent Monitoring System

Since there is no significant possibility of radionuclide release from the canisters during transfer or storage operations, an airborne effluent monitoring system is not required for the safe operation of the WCS CISF. However, during receipt and transfer operations, portable airborne monitoring systems may be used in accordance with the Radiation Protection Program.

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 WCS 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.

ARM and dosimeter locations in the Cask Handling Building are shown in Figure 1-7. The ARMs in the Cask Handling Building have audible alarms to warn operating personnel of abnormal radiation levels.

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.

No credit is taken for the presence of any landscape features or site buildings, which would provide additional shielding. In addition to the HSMs, a number of vertical casks are adjacent to the HSM, as indicated in Figure 9-2. No credit is taken for any blocking provided by the vertical casks.

MCNP5 v1.40 is used in the analysis and all cross-sections utilized are provided with the computer program. All gamma cross-sections are from the ENDF/B-VI data set. The neutron cross sections are also from the ENDF/B-VI data set with the exception of iron (in the concrete) and gadolinium. Neutron cross-sections utilized are provided in Table 9-8.

NAC Systems

The WCS CISF is modeled explicitly. Shielding by NAC systems and NUHOMS® HSMs is included in the model. Dose rates are calculated using point detectors and superimposed mesh tallies. For the location specific dose rates, point detectors were used. Neutron, gamma, and neutron-induced gammas (N-Gamma) are accounted for in the shielding evaluation. Neutron induced gammas generated within the cask shielding are included in the imported gamma surface currents. N-Gamma cases and results for the VCCs only include gammas induced from neutron interactions in air surrounding the cask systems.

9.4.1.1 Dose Rate Results

Dose rates are computed at various locations around the WCS CISF using point detectors, as indicated on Figure 9-1 and Figure 9-2. Dose rates are computed for gamma radiation, neutron radiation and secondary gamma radiation created when neutrons are absorbed in air, soil or concrete. Fluxes are converted to dose rates using ANSI/ANS-6.1.1-1977 flux to dose rate conversion factors.

The total dose rate is computed as the sum of the gamma, neutron, and secondary gamma components. The gamma and neutron dose rate is approximately 90% and 10% of the total dose rate, respectively. The 1-sigma MCNP statistical uncertainty is also provided for the total dose rate. All reported dose rate results are well-converged. Coordinates of the detectors are given in the State Plane Coordinate System (SPCS).

Dose rate results for the general area around the WCS CISF are summarized in Table 9-5. Dose rate results for the locations around the facility and PA of the WCS CISF are summarized in Table 9-6. Coordinates of the detectors are given in the SPCS.

9.4.1.2 Direct Dose Rate

The point detector output provides both the total and uncollided dose rate. The uncollided dose rate is representative of the “direct” component of the dose rate. The direct dose rate is provided in Table 9-5 and Table 9-6 in the “Direct” column.

9.4.1.3 Air Scattered Dose Rate

The air scattered or skyshine dose rate is provided in Table 9-5 and Table 9-6 in the "Skyshine" column and is estimated by subtracting the direct dose rate from the total dose rate. It may be observed that the direct dose rate is dominant close to the storage overpacks (< 20 m) but skyshine becomes dominant farther from the storage overpacks (> 20 m).

9.4.2 Doses to Workers

Section 2.1 of the Technical Specifications [9-13] lists the NRC approved canisters authorized for storage of SNF at the WCS CISF. Table 9-4 provides the cross reference to the applicable appendix and section for each canister/storage overpack where the Occupational Exposure for each system is discussed. The NUHOMS® systems do not require workers to approach the modules to perform surveillance of maintenance activities, therefore the only occupational exposure associated with the NUHOMS® systems is placing the canisters into storage and retrieving them again for off-site shipment. For the vertical systems the applicable appendices listed in Table 9-4 provide occupational exposures due to surveillance activities required for the VCCs.

The total number and types of canisters being stored in Phase 1 are shown in Table 9-4. Table 9-4 points to Appendices A-G that in turn reference specific sections of the appropriate FSARs from the different vendors where the receipt and transfer doses for handling individual cask systems are described. These doses are bounding for the storage operations.

In order to maintain radiation doses within ALARA constraints, unrestricted access to the WCS CISF radiologically controlled area(s) (RCAs) within the PA boundary (see Figure 1-2) will only be allowed for Radiation Workers. Non-Radiation Workers (including employees who are not Radiation Workers) will only have limited access within an RCA and be escorted by a Radiation Worker (using a 1-to-5 Radiation Worker to Non-Radiation Worker ratio).

Construction workers will be considered Non-Radiation Workers and the radiation dose limits in 10 CFR 20 Subpart D will apply to them. Should all of Phase 1 construction not be completed upon the receipt of the first canister for storage, then construction areas will be established outside RCAs to maintain dose rates to construction workers below 2 mrem/hr. Laydown and material and equipment storage areas will be located in consideration of area dose rates to maintain worker doses ALARA.

RCAs located within the WCS CISF will be established around ongoing cask handling in the Cask Handling Building and transfer operations along the transport haul route, and for loaded storage overpacks in the storage area.

9.4.3 Dose Contributions to the Annual Doses for the Proposed WCS CISF

9.4.3.1 Contributions to the Annual Doses for the Proposed WCS CISF

Pursuant to 10 CFR 72.104, *Criteria for Radioactive Materials in Effluents and Direct Radiation from an ISFSI or MRS,* licensees are required to constrain the concentrations of radioactive materials in effluents and direct radiation from an ISFSI or MRS such that, during normal operations and anticipated occurrences, the annual dose equivalent to any real individual who is located beyond the OCA does not exceed 0.25 mSv (25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid, and 0.25 mSv (25 mrem) to any other critical organ. Similar standards are included in 40 CFR 191.03. These dose constraints not only apply to releases of radioactive materials and direct radiation from an ISFSI or MRS, but also to releases of radiation from uranium fuel cycle operations in the region. Accordingly, ISP must ensure that the annual dose to any real individual who is located outside the OCA boundary does not exceed the specified annual dose equivalent limit for releases of radioactive materials and direct radiation, not only from the WCS CISF, but also from all other operations at the Waste Control Specialists site and those attributable to the National Enrichment Facility (NEF) located near Eunice, New Mexico, and operated by URENCO USA (see Figure 9-5).

9.4.3.2 Annual Dose to the Members of the Public Working Around the WCS CISF

ISP joint venture member Waste Control Specialists has established a comprehensive Environmental Monitoring Program to assess the radiological impacts to human health and the environment attributable to operations at its Treatment, Storage and Disposal Facility, and its disposal operations for 11.e.(2) byproduct materials, as well as for Class A, B, C, and LLRW. The Environmental Monitoring Program was established to demonstrate compliance with applicable radiation protection standards attributable to all operations at the Waste Control Specialists site. ISP joint venture member, Waste Control Specialists, under the oversight of ISP will integrate the WCS CISF into its Environmental Monitoring Program. Radiological dose assessments are conducted using data collected as part of the Environmental Monitoring Program using the RACER (Risk Analysis, Communication, Evaluation, and Reduction) Data Analysis Tool (DAT) online application (www.raceratwcs.com). RACER provides a framework for managing and analyzing environmental monitoring data related to Waste Control Specialists. In addition to evaluating temporal and spatial trends in data, RACER allows measurement data to be combined with exposure parameters and dose coefficients to estimate dose. A report has been developed within the RACER application to specifically estimate annual dose to a hypothetical member of the public based on radionuclide measurements made in air and soil, as well as results from deployed environmental dosimeters.

9.4.3.3 Annual Dose Limits to an Individual

ISP has evaluated the radiological impacts attributable to Waste Control Specialists present operations, those from the NEF, and radiation doses estimated for storing up to 40,000 MTHM of SNF at the WCS CISF. While ISP is requesting authorization to only store 5,000 MTHM of SNF and related GTCC waste in its license application, it bounded the cumulative radiological impacts of storing up to 40,000 MTHM of SNF consistent with its plan to expand the WCS CISF in the future. ISP estimated the cumulative radiation effective doses attributable to Waste Control Specialists present operations, the NEF, and the WCS CISF to any real person that could be present at Sundance Services, Permian Basin Materials (Previously known as Wallach Concrete), and the nearest neighbor (Figure 9-5, WCS CISF Receptors and Source of Radiation in the Region of Interest). To assess the annual dose from the NEF, ISP relied on information provided in Section 4.2.12.2, *Operations*, of the NEF Environmental Report [9-18].

The maximum annual dose to any real individual who is located beyond the controlled area attributable to operations at the NEF was estimated at 0.026 mSv (2.6 mrem). The bounding annual dose equivalent reporting by NEF includes the direct radiation attributable to Uranium Byproduct Cylinder Pads estimated to occur over the lifespan of the NEF facility. The results of the annual radiation doses to any real person that could be present at Sundance Services, Permian Basin Materials (Previously known as Wallach Concrete), and the nearest neighbor location, respectively, are presented in Table 9-7. The RACER dose module was used to calculate the Waste Control Specialists airborne pathway (particulates and 129I) and direct radiation dose using available air and dosimeter data from 2015. The airborne pathway doses shown in Table 9-7, Estimated Cumulative Annual Dose Equivalent for All Sources of Radiation in the Region, represent the maximum net dose for the perimeter stations in the northwest quadrant. The net dose potentially attributable to Waste Control Specialists operations is estimated as the perimeter quadrant dose minus the background dose. The perimeter quadrant dose is based on data collected at the perimeter stations in the quadrant, and the background dose is based on data collected at the background sampling location (Station #9).

The airborne particulate and ^{129}I dose at the receptors would be less than the perimeter stations dose due to atmospheric dispersion. As such, the annual dose equivalent to the thyroid will be less than 0.75 mSv (75 mrem). Direct radiation doses are calculated in a similar manner. Net direct radiation from Waste Control Specialists operations at the perimeter for 2015 ranged from background in the northeast quadrant to 0.11 mSv/yr (11 mrem/yr) in the southwest quadrant. Even though the dose from external radiation at the perimeter is less than the 0.25 mSv/yr (25 mrem/yr) limit, no receptor is present there. The doses were, therefore, reduced by attenuation to the applicable receptors as discussed below using the WCS CISF dose rate modeling.

Annual exposures at distances from the side of array of HSMs beyond 300 meters can be conservatively estimated using 1360*exp(-0.001273 *x) equation, where x is the distance from the origin of the CISF local frame of reference in feet. The origin of the local frame of reference is considered at 561994.08' Easting and 6877754.97' Northing when using the State Plane frame of reference. This equation can be also used to conservatively estimate the exposures for select locations where real individuals beyond the controlled area will be exposed to radiation from operations at the WCS CISF. Those locations are schematically shown on Figure 9-5. The bounding encompassing values for received annual exposures from the WCS CISF operations are summarized in Table 9-7.

The results from this analysis demonstrate that the cumulative impacts from operations at these facilities located in the region where the WCS CISF will be located are less than the annual dose equivalent limit of 0.25 mSv (25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid, and 0.25 mSv (25 mrem) to any other critical organ, as specified in 10 CFR 72.104.

9.5 Radiation Protection Program During Operation

The major radiation protection functions of the Radiation Protection Program during operations of the Cask Handling Building are described in this section. The WCS CISF Radiation Protection Program is planned and organized in accordance with the criteria of NRC Regulatory Guides 8.8 and 8.10, and NUREG-0761.

9.5.1 Organization and Functions

The corporate structure of the applicant for the WCS CISF is addressed in Section 13.1.

The organizational structure of the WCS CISF, including the setting of the Radiation Safety Officer, is addressed in Section 13.1.1.2 and depicted in Figure 13-1.

The Personnel Functions, Responsibilities, and Authorities of those with responsibilities in the Radiation Protection Program are addressed in Section 13.1.2.2.

The Qualification requirements of those with responsibilities in the Radiation Protection Program are addressed in Section 13.1.3.1.

The WCS CISF training program is addressed in Section 13.3. It includes both technical and radiological training topics for the WCS CISF. Additionally, the Radiological Training Program topics are covered below in Section 9.5.4.

9.5.2 Equipment, Instrumentation and Facilities

A sufficient inventory and variety of operable and calibrated portable and fixed radiological instrumentation will be maintained to allow for effective measurement and control of radiation exposure and radioactive material and to provide back-up capability for inoperable equipment. Equipment will be able to assess sources of gamma, neutron, beta, and alpha radiation, including the capability to measure the range of dose rates and radioactivity concentrations expected. Radiation protection procedures will govern instrument calibration, instrument inventory and control, and instrument operation.

Facility requirements to support the WCS CISF radiation protection functions are shared between the WCS CISF and ISP joint venture member Waste Control Specialists and are as follows.

- Instrument calibration area LLRW
- Personnel change rooms, including lockers
- Access control stations for entrance to and exit from radiation areas and, if needed, temporary contamination control areas
- Office space to accommodate Radiation Protection staff
- 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 with detection capabilities ≤ 1.5 cpm.
- Hand and foot contamination monitors stationed at building exits to prevent the spread of contamination
- Portable monitoring equipment to augment fixed detector systems with detection capabilities as follows; 0.1 mR/hr to 999.9 mR/hr and/or 0.1 R/hr to 999.9 R/hr for GM detectors, 0.2 – 50,000 mR/hr with selectable range scales from x1 - x10k for Ion Chambers, 0 - 10,000 mrem/hr for Moderated Neutron Detectors with Gamma rejection up to 10R/hr.
- 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.

Radiological instrument storage and maintenance will also be located in the Security and Administration Building, along with a low-radiation background count room containing calibrated laboratory equipment for measuring radioactivity. Count room instrumentation will be calibrated onsite using NIST traceable sources per the manufacturer's specifications. Portable monitoring instrumentation will be calibrated at an offsite vendor with the proper calibration qualifications to perform such calibrations per the manufacturer's specifications to NIST traceable standards applicable to the nuclides of interest at the WCS CISF.

Access to the PA is controlled through a single access point in the Security and Administration Building (see Figure 1-2, the WCS CISF Site Boundary Layout). Personal dosimetry is issued and controlled in this building to individuals entering the PA. External radiation dose monitoring will be accomplished through the use of dosimeters (OSLs or equivalent) and self-reading dosimeters (SRDs) or digital alarming dosimeters (DADs). All operating personnel inside the Cask Handling Building and on the storage pads will utilize alarming dosimeters during the canister transfer process to warn of excessively high direct radiation and provide further assurance that occupation exposures will not exceed the limits of 10 CFR Part 20. The official dose of record of external dose to beta, gamma, and neutron radiation will be obtained from the personal dosimetry issued to each Radiation Worker (OSL or equivalent), with calibrated SRDs or DADs used as a means for tracking dose between dosimetry processing periods and as a backup to the dosimeters.

The Radiation Protection Program addresses the use of respiratory protection equipment, self-reading dosimetry, dose tracking and methods for data analysis and interpretation. Provisions exist in the Security and Administration Building for donning and doffing personal protective equipment, which could be necessary in the event of contamination in the Cask Handling Building.

Contamination of equipment or personnel is not expected to occur under normal conditions of operation. In accordance with the ISP policy of preventing generation of liquid radioactive waste, any necessary decontamination of equipment and personnel will be conducted using methods that produce only solid radioactive waste. Decontamination methods would typically include wiping the contaminated item with rags or paper wipes.

During routine storage operations at the WCS CISF, the only radiological instrumentation in use in the storage area will be the dosimeters, as described in Section 9.3.5. Routine radiological surveys will use instruments that are controlled by the Radiation Protection Program and governed by existing procedures. Portable instrumentation is calibrated at an approved certified offsite vendor. Procedures for radiological instrumentation will be established and applied to instruments used at the WCS CISF.

9.5.3 Procedures

Radiation protection procedures will govern all radiological work at the WCS CISF. Implementation of the procedures ensures that occupational doses are below the limits required by 10 CFR 20.1201. Although area radiation monitors are not installed throughout the PA, measures are in place to ensure that personnel in the PA do not exceed dose limits. As discussed in Section 9.5.2, personnel will use dosimetry and access to the PA is managed through controlled access points. Periodic radiation surveys will be conducted of areas inside the PA to determine radiation levels and prepare maps. Radiation work permits (RWPs) will be completed by qualified radiation protection personnel prior to any entry and will identify normal and unusual radiation readings. ISP will utilize its computer based Exposure Monitoring Reporting System to maintain access to the radiological areas, training for radiation workers (radiation training, respirator training, medical evaluation approval dates, etc.), current up-to-date accumulated dose rates for each radiation worker and internal monitoring data. Workers will be required to read, understand and sign that they are aware of the conditions or unknowns for each entry within the computer based system. Personnel will be required to have a qualified radiation protection technician with them at all times while in the areas. Radiation Protection Technician training will be performed per the DOE core and site training requirements and will include responses to unusual readings and off-scale conditions.

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

- Take contamination swipes of potentially contaminated areas (transportation casks)
- Perform radiation surveys to define and maintain acceptable radiation dose rates in the radiation areas
- Post areas based on surveys
- Provide radiation work permits and perform pre-operational briefings
- Ensure appropriate job classifications include 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
- Maintain records of the Radiation Protection Program, including audit and other reviews of program content and implementation, radiation surveys, instrument calibrations, individual monitoring results, and records required for decommissioning

- Perform, monitor and record environmental monitoring of boundaries.

9.5.4 Radiological Worker Training

Radiation workers at the WCS CISF will receive Radiation Worker training under the Radiation Safety Program. Rad Worker Training includes the following topics:

- Technical Topics
  - Sources of radiation (natural and man-made),
  - Basic atomic and nuclear physics,
  - Types of radiation and their characteristics (alpha, beta, gamma, x-ray, neutron),
  - Radiation units,
  - Biological effects,
  - Risks of occupational exposure (NRC Regulatory Guide 8.29),
  - Radiation measurement and survey instruments,
  - External dosimetry (TLD, OSL, SRD, extremity),
  - Time, distance, and shielding,
  - Internal dosimetry methods (whole-body counting, urinalysis, and fecal analysis), contamination control (sources of contamination, protective clothing/PPE, controlled areas and exiting, and personnel surveys),
  - Personnel and equipment decontamination,
  - Airborne radioactivity,
  - Respiratory protection and coordination with industrial/chemical hazards,
  - Prenatal radiation exposure (NRC Regulatory Guide 8.13),
  - First aid considerations,
  - Radiological waste reduction,
  - Introduction to mock-up training.
- Administrative Topics
  - ISP radiation safety policy,
  - Role of the RSO and RST,
  - Authority of radiation safety personnel,
  - ALARA philosophy and practices,
  - Regulatory and administrative limits; minimizing exposure,
  - Federal and State Regulations and License provisions for the protection of personnel from radiation and radioactive material,

- Radiological postings,
- Radiological surveys (purposes, methods),
- Control and removal of contaminated equipment,
- Introduction to WCS CISF operational procedures (additional, separate training is required for procedural qualification),
- Introduction to ISP quality assurance (additional, separate training is required for procedural qualification),
- Investigation and reporting of abnormal exposures,
- Obtaining exposure records,
- Responsibilities of individuals,
- Radiological emergencies,
- Respiratory protection program,
- Radiation work permits (RWPs).

The training session is followed by a written test, which must be passed at the 80% level of competency before unescorted access is allowed into a Restricted Area.

The RSO/Director of Health and Radiation Safety may authorize individuals with documented radiation safety training and experience from other sites or utilities, such as the DOE, to challenge any training requirement and demonstrate the requisite level of knowledge in radiation safety by:

- Successfully passing a written exam that includes basic radiation safety training principles and facility/WCS CISF specific information; and
- Successful discussion and performance of practical factors.

9.6 Doses to Off-Site Public

The maximum annual dose to the most exposed public individual due to operations at WCS CISF is limited to 25 mrem per 10 CFR 72.104.

9.6.1 Site Boundary Dose

The closest location of the site boundary is located at SPCS coordinate (558079.15, 6878157.94), or approximately 0.75 miles from the WCS CISF. The total dose rate at the site boundary is 8.58E-06 mrem/hr, which is less than naturally occurring background radiation. The annual dose to an individual living at the site boundary (8760 hours) due to the fully loaded facility is 7.52E-2 mrem, or essentially zero. Note that the annual dose 100 m from the WCS CISF due to postulated leakage of the FO-, FC-, and FF-canisters is 7.77E-3 mrem (see Appendix A.11, Confinement Evaluation). The total annual dose including leakage is significantly less than the 10 CFR 72.104 dose limit of 25 mrem to the whole body. Given that the annual dose contribution at the site boundary is less than 0.05 mrem/year, regardless of the contribution from any other radiation from uranium fuel cycle operations within the region, the 10 CFR 72.104 limits are met.

9.6.2 Effluent and Environmental Monitoring Program

This section describes the program for monitoring and estimating the release of radioactive materials processed and stored at the WCS CISF to the environment.

9.6.2.1 Gaseous Effluent Monitoring

As described in Section 6.1.1, there are no gaseous effluents to monitor for the WCS CISF.

9.6.2.2 Liquid Effluent Monitoring

As described in Section 6.1.2.1, there are no radioactive liquid effluents to monitor for the WCS CISF.

9.6.2.3 Solid Waste Monitoring

As described in Section 6.1.4, only one type of solid potentially radioactive waste is generated at the WCS CISF: waste from contamination surveillance, decontamination, and maintenance activities, consisting of paper or cloth swipes, paper towels, rubber gloves and boots. Solid radioactive wastes will be collected in containers and temporarily stored in the Cask Handling Building. Small volumes of solid radioactive wastes are anticipated. These low activity wastes will be disposed of at a Waste Control Specialists waste disposal facility in compliance with applicable federal and state regulations. Radiation protection personnel periodically monitor dose rates in the solid waste storage area using portable instrumentation for ALARA purposes as part of the facility Radiation Protection Program.

9.6.2.4 Environmental Monitoring

ISP will establish a Radiological Environmental Monitoring Program (REMP) that will demonstrate compliance with 10 CFR 72.104. Details of this program are described in Chapter 4 of the ISP Environmental Report and Figure 4.12-7 through Figure 4.12-12 show the locations being monitored under the current REMP program.

In establishing the environmental monitoring program for SNF storage, ISP will build upon ISP joint venture member, Waste Control Specialists current monitoring program for ISP joint venture member, Waste Control Specialists SP&D Facilities. This program will include the following monitoring parameters: perimeter dosimetry (Landauer Inlight® Environmental X9 (beta/X/gamma) or equivalent), soil, and air locations. This program will be implemented by the radiation safety department in accordance with written procedures.

Waste Control Specialists uses the Luxel+ Ta (beta/photon/neutron) dosimeter for area monitoring under the radiation safety area monitoring program (minimum of eight locations on the inner fence of the PA) and the Landauer Inlight® Environmental X9 (beta/photon) dosimeter for perimeter environmental monitoring program at the OCA boundary (for reference, see Figure 6.1-1 in Chapter 6 of the ISP Environmental Report). All dosimeters will be analyzed on a quarterly basis. Environmental boundary air and soil monitoring (i.e., Low Volume air sampling and High Volume air sampling) will be performed at a minimum of two locations on the north OCA boundary (for reference, see Figure 4.12-7 and Figure 4.12-9 in Chapter 4 of the ISP Environmental Report), in addition to the locations currently performed under the REMP. Analyses will be for gross alpha/beta and gamma spectrometry and performed by a certified offsite laboratory on a quarterly basis. Air samples will be collected monthly for each location and composited for a quarterly analysis. Soil samples will be collected and analyzed annually unless air samples indicate the need to take additional samples.

9.6.3 Maximum Off-Site Annual Dose

The nearest residence in Lea County, New Mexico is approximately 4 miles from the WCS CISF at SPCS coordinate (541732.42, 6873002.59). At this distance, the computed total dose rate is 5.00E-13 mrem/hr. With continuous occupancy of 8,760 hours per year, the total dose is 4.38E-09 mrem, which is essentially zero and less than the dose from natural background radiation.

9.6.4 Liquid Releases

As described in Section 6.1.2.1, there are no radioactive liquid radioactive wastes to monitor for the WCS CISF.

9.6.5 Features to Prevent Transport of Radioactive Material to the Environment

The WCS CISF plans to accept only welded canisters with confinement intact. ISP plans to confirm integrity of confinement upon receipt. The REMP ensures the detection of potential contamination that may be present at the WCS CISF.

The features of the WCS CISF make transport of radioactive materials through an aquifer not credible. The WCS CISF is located in the arid Permian Basin with little precipitation, and the nearest aquifer is located at a depth of 800 to 1,000 feet (243 to 305, meters) below ground surface. The WCS CISF is separated from that aquifer by the Dockum Formation, consisting of low permeability clays ($1X10^{-9}$cm/s).

The first potential water bearing zone is a dry transmissive unit and does not provide a transport mechanism. Monitor wells near the proposed WCS CISF are installed in the uppermost transmissive zone and have been dry since installation in 2005 or 2008.

The WCS CISF is required to be designed to facilitate decontamination of structures and equipment, minimize the quantity of radioactive wastes and contaminated equipment, and facilitate the removal of radioactive wastes and contaminated materials at the time it is permanently decommissioned pursuant to 10 CFR 72.130, Criteria of Decommissioning.

ISP will perform periodic surveys per ISP approved procedures for direct alpha/beta/gamma/neutron measurements and removable contamination swipes. The swipes will be processed on calibrated gas flow proportional gross alpha/beta counters, calibrated Liquid Scintillation Counters, and calibrated Gamma Spectroscopy counters to provide an early indication of any radioactive material that may be present. Air and soil samples will be collected under the REMP and shipped to an offsite certified laboratory for analysis.

9.7 References

9-1 TN Document, NUH09.101 Rev. 17, "NUHOMS® -MP197 Transportation Package Safety Analysis Report." (Basis for NRC CoC 71-9302).

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

9-3 RS ISFSI FSAR, Volume I (See [Gen-2]).

9-4 Standardized NUHOMS® System UFSAR (See [Gen-4]).

9-5 Standardized Advanced NUHOMS® System UFSAR (See [Gen-3]).

9-6 NAC International, "NAC-STC, NAC Storage Transport Cask Safety Analysis Report," Revision 17, CoC 9235 Revision 13, USNRC Docket Number 71-9235.

9-7 NAC International, "Safety Analysis Report for the UMS® Universal Transport Cask," Revision 2, CoC 9270 Revision 4, USNRC Docket Number 71-9270.

9-8 NAC International, "Safety Analysis Report for the MAGNATRAN Transport Cask," Revisions 12A, 14A, and 15A, USNRC Docket Number 71-9356.

9-9 NAC-MPC UFSAR (See [Gen-5]).

9-10 NAC-UMS UFSAR (See [Gen-6]).

9-11 MAGNASTOR UFSAR (See [Gen-7]).

9-12 NRC Spent Fuel Project Office, Interim Staff Guidance, ISG-5, Rev. 1, "Confinement Evaluation."

9-13 SNM-2515 Technical Specifications (See [Gen-1]).

9-14 Section 4.2.12.2, *Operations,* of the NEF Environmental Report, Revision 4, April 2005.

9-15 Not Used.

9-16 NRC Regulatory Guide 8.8, Rev 3 "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations will be As Low As s Reasonably Achievable."

9-17 NRC Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational and Public Radiation Exposures as Low as Reasonably Achievable."

9-18 NEF Environmental Report, Revision 4, April 2005.

9-19 Texas Administrative Code Title 30, Part 1, Chapter 334, Subchapter G, "Target Concentration Criteria."

Table 9-1
HSM Storage Systems at the WCS CISF

Exterior HSM Surfaces	HSM Model 80 (Table 7-1 of [9-3])		HSM Model 102 (Increased from Table T.5-2 of [9-4])		AHSM (Table 5.1-2 of [9-5])	
	Gammas(1)	Neutrons(1)	Gammas(1)	Neutrons(1)	Gammas(1)	Neutrons(1)
Front	10.7	0.45	18.38	0.76	1.89	0.04
Roof	35.9	0.07	28.77	0.91	0.03	0.00086
Side	0.99	0.006	2.43	0.10	0.26	0.01

(1) All dose rates in mrem/hr

Table 9-2
MAGNASTOR – Neutron Surface Currents at the WCS CISF

Group	E Lower [MeV]	E Upper [MeV]	Surface Current [/sec]			
			Radial		Top Axial	
1	1.360E+01	1.460E+01	0.000E+00	0%	0.000E+00	0%
2	1.250E+01	1.360E+01	0.000E+00	0%	0.000E+00	0%
3	1.125E+01	1.250E+01	0.000E+00	0%	0.000E+00	0%
4	1.000E+01	1.125E+01	0.000E+00	0%	0 .000E+00	0%
5	8.250E+00	1.000E+01	2.111E+03	49%	9.967E+02	100%
6	7.000E+00	8.250E+00	7.666E+03	29%	0.00OE+00	0%
7	6.070E+00	7.000E+00	1.334E+04	19%	0.000E+00	0%
8	4.720E+00	6.070E+00	2.976E+04	12%	6.406E+03	70%
9	3.680E+00	4.720E+00	3.763E+04	9%	1.968E+04	49%
10	2.870E+00	3.680E+00	4.850E+04	9%	2.239E+03	72%
11	1.740E+00	2.870E+00	4.529E+05	3%	4.769E+04	25%
12	6.400E-01	1.740E+00	4.831E+05	4%	2.760E+05	11%
13	3.900E-01	6.400E-01	4.481E+05	6%	2.406E+05	9%
14	1.100E-01	3.900E-01	1.384E+06	4%	6.962E+05	6%
15	6.740E-02	1.l00E-01	4.978E+05	5%	3.419E+05	8%
16	2.480E-02	6.740E-02	7.262E+05	4%	6.312E+05	6%
17	9.120E-03	2.480E-02	9.012E+05	4%	6.912E+05	6%
18	2.950E-03	9.120E-03	5.889E+05	4%	8.188E+05	5%
19	9.610E-04	2.950E-03	5.707E+05	5%	8.312E+05	5%
20	3.540E-04	9.610E-04	5.274E+05	6%	8.665E+05	5%
21	1.660E-04	3.540E-04	3.920E+05	7%	7.001E+05	5%
22	4.810E-05	1.660E-04	5.619E+05	5%	1.067E+06	4%
23	1.600E-05	4.810E-05	4.688E+05	5%	1.142E+06	4%
24	4.000E-06	1.600E-05	5.921E+05	6%	1.376E+06	4%
25	1.500E-06	4.000E-06	3.751E+05	7%	9.272E+05	5%
26	5.500E-07	1.500E-06	3.900E+05	8%	1.002E+06	5%
27	7.090E-08	5.500E-07	5.234E+06	1%	4.387E+06	2%
28	1.000E-11	7.090E-08	1.295E+07	1%	7.236E+06	2%
29	0.000E+00	1.000E-11	0.000E+00	0%	0.000E+00	0%
Total	--	--	2.768E+07	1%	2.331E+07	2%

Table 9-3
MAGNASTOR – Gamma Surface Currents at the WCS CISF

Group	E Lower [MeV]	E Upper [MeV]	Surface Current [/sec]			
			Radial		Top Axial	
1	1.20E+01	1.40E+01	0.00OE+00	0%	0.00OE+00	0%
2	1.00E+01	1.20E+01	5.619E+04	38%	3.280E+03	52%
3	8.00E+00	1.00E+01	1.421E+06	9%	1.778E+05	12%
4	6.50E+00	8.00E+00	1.196E+07	3%	1.289E+06	5%
5	5.00E+00	6.50E+00	1.181E+07	3%	7.945E+05	6%
6	4.00E+00	5.00E+00	1.288E+07	3%	8.856E+05	6%
7	3.00E+00	4.00E+00	1.773E+07	18%	1.125E+06	5%
8	2.50E+00	3.00E+00	1.413E+07	25%	4.934E+05	6%
9	2.00E+00	2.50E+00	4.897E+08	11%	3.386E+06	47%
10	1.66E+00	2.00E+00	3.454E+08	10%	3.371E+06	42%
11	1.44E+00	1.66E+00	3.242E+08	7%	3.760E+06	45%
12	1.22E+00	1.44E+00	8.864E+08	4%	5.968E+07	6%
13	1.00E+00	1.22E+00	1.247E+09	3%	1.389E+08	6%
14	8.00E-01	1.00E+00	1.569E+09	5%	2.879E+08	6%
15	6.00E-01	8.00E-01	2.228E+09	4%	7.754E+08	14%
16	4 .00E-01	6.00E-01	3.570E+09	3%	2 .048E+09	6%
17	3.00E-01	4.00E-01	2.401E+09	4%	1.969E+09	7%
18	2.00E-01	3.00E-01	3.088E+09	4%	2.497E+09	3%
19	1.00E-01	2.00E-01	6.673E+09	6%	3.654E+09	2%
20	5.00E-02	1.00E-01	3.061E+09	6%	1.996E+09	2%
21	2.00E-02	5.00E-02	6.157E+07	14%	5.504E+07	4%
22	1.00E-02	2.00E-02	7.970E+05	76%	4 .914E+05	33%
23	0.00E+00	1.00E-02	8.176E+05	29%	9.911E+04	80%
Total	--	--	2.602E+10	2%	1.350E+10	3%

Table 9-4
Shielding Evaluations for the Storage Systems at the WCS CISF

Cask System	Canister	Overpack	Appendix
NUHOMS®-MP187 Cask System	FO-DSC	HSM (Model 80)	Appendix A.9
	FC-DSC		
	FF-DSC		
	GTCC Canister		
Standardized Advanced NUHOMS® System	NUHOMS® 24PT1	AHSM	Appendix B.9
Standardized NUHOMS® System	NUHOMS® 61BT	HSM Model 102	Appendix C.9
	NUHOMS® 61BTH Type 1		Appendix D.9
NAC-MPC	Yankee Class	VCC	Appendix E.9
	Connecticut Yankee		
	LACBWR		
	GTCC-Canister-CY		
	GTCC-Canister-YR		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.9
	GTCC-Canister-MY		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.9
	GTCC-Canister-ZN		

Table 9-5
Dose Rates around the WCS CISF

	Coordinates (ft)		Dose Rate (mrem/hr)						
Detector	**Easting**	**Northing**	**Gamma**	**Neutron**	**(n,γ)**	**Total**	**σ**	**Direct**	**Skyshine**
General Area									
D1	562321.81	6878484.76	5.29E-01	4.53E-02	2.11E-03	5.76E-01	1%	1.57E-01	4.20E-01
D2	562485.67	6878849.66	2.02E-01	1.70E-02	9.69E-04	2.20E-01	2%	4.70E-02	1.73E-01
D3	562649.54	6879214.55	7.14E-02	4.95E-03	3.69E-04	7.67E-02	4%	1.27E-02	6.40E-02
D4	562813.40	6879579.45	2.18E-02	1.63E-03	1.80E-04	2.36E-02	2%	3.89E-03	1.97E-02
D5	562989.56	6879971.71	7.40E-03	4.84E-04	7.38E-05	7.95E-03	5%	1.19E-03	6.76E-03
D6	563655.49	6879672.66	9.60E-03	6.97E-04	1.07E-04	1.04E-02	3%	1.45E-03	8.96E-03
D7	564066.00	6879488.31	8.57E-03	5.55E-04	8.38E-05	9.21E-03	2%	1.45E-03	7.76E-03
D8	564476.50	6879303.96	6.26E-03	3.31E-04	6.51E-05	6.65E-03	3%	1.10E-03	5.55E-03
D9	565142.44	6879004.91	2.08E-03	1.04E-04	3.12E-05	2.22E-03	2%	3.71E-04	1.85E-03
D10	564966.28	6878612.65	4.79E-03	3.28E-04	5.09E-05	5.16E-03	5%	7.71E-04	4.39E-03
D11	564802.42	6878247.75	9.57E-03	5.71E-04	7.44E-05	1.02E-02	4%	1.49E-03	8.73E-03
D12	564638.55	6877882.85	1.36E-02	9.54E-04	1.27E-04	1.47E-02	2%	2.13E-03	1.26E-02
D13	564474.69	6877517.96	1.51E-02	1.27E-03	1.30E-04	1.65E-02	2%	1.58E-03	1.49E-02
D14	563481.03	6877087.22	9.80E-02	7.87E-03	5.02E-04	1.06E-01	2%	9.24E-03	9.72E-02
D15	563070.52	6877271.57	2.72E-01	2.49E-02	1.46E-03	2.98E-01	1%	1.27E-02	2.85E-01
D16	562660.01	6877455.92	4.52E-01	4.28E-02	2.42E-03	4.97E-01	1%	2.86E-02	4.69E-01

1. Detector locations shown on Figure 9-1.
2. Total = Direct + Skyshine.

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	4.50E-03	3.24E-04	6.23E-05	4.89E-03	3%	7.03E-04	4.19E-03
P-002 (Rail line)	561762.03	6877972.59	1.12E-01	8.03E-03	6.32E-04	1.20E-01	3%	2.10E-02	9.93E-02
P-003 (Security and Admin. Building)	562193.28	6878120.44	6.79E-01	5.26E-02	2.50E-03	7.34E-01	1%	2.14E-01	5.21E-01
P-004 (Rail line)	562816.16	6877498.49	6.75E-01	5.99E-02	3.44E-03	7.38E-01	1%	5.16E-02	6.87E-01
P-005 (CHB)	563088.75	6877495.24	7.26E-01	6.75E-02	3.43E-03	7.97E-01	1%	6.38E-02	7.33E-01
P-006 (CHB)	563039.04	6877384.55	4.42E-01	4.29E-02	2.17E-03	4.87E-01	1%	2.73E-02	4.60E-01
P-007 (Existing rail line)	562618.87	6876671.78	3.01E-02	2.66E-03	2.46E-04	3.30E-02	2%	1.26E-03	3.18E-02
P-008 (Corner of Storage Area)	562452.84	6877970.98	2.66	2.04E-01	1.15E-02	2.88	1%	1.03	1.85
Locations around the Protected Area									
DSB-01	562386.26	6878066.83	2.68	1.59E-01	7.27E-03	2.85	2%	1.24	1.60
DSB-02	562580.56	6877804.00	1.64	1.71E-01	9.80E-03	1.83	1%	2.82E-01	1.54
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	4.54	2.82E-01	1.05E-02	4.84	1%	2.25	2.59
DSB-05	562740.16	6877732.33	1.77	1.70E-01	1.06E-02	1.95	1%	3.22E-01	1.63
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	5.06	2.82E-01	1.19E-02	5.35	1%	2.45	2.90
DSB-08	563083.74	6877578.04	1.13	1.11E-01	5.56E-03	1.25	2%	1.60E-01	1.09
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	2.95	1.77E-01	7.12E-03	3.14	1%	1.27	1.87

1. Detector locations shown on Figure 9-2.
2. Total = Direct + Skyshine.

Table 9-7
Estimated Cumulative Annual Dose Equivalent for All Sources of Radiation in the Region

Receptor	Source[a]	Airborne Pathway mSv (mrem)	Direct Radiation mSv (mrem)	Annual Dose Equivalent mSv (mrem)
Sundance Services	Waste Control Specialists Operations	$<6.3x10^{-3}$ (<0.63)[b]	$<1x10^{-7}$ ($<1x10^{-5}$)	$<6.3x10^{-3}$ (<0.63)
	WCS CISF	N/A	$<4.5x10^{-3}$ $<4.5x10^{-1}$	$<4.5x10^{-3}$ $<4.5x10^{-1}$
	NEF	$2.6x10^{-5}$ ($2.6x10^{-3}$)	0.026 (2.6)	0.026 (2.6)
Permian Basin Materials (Formerly Wallach Concrete)	Waste Control Specialists Operations	$<6.3x10^{-3}$ (<0.63)[b]	$<1x10^{-7}$ ($<1x10^{-5}$)	$<6.3x10^{-3}$ (<0.63)
	WCS CISF	N/A	$<1.2x10^{-3}$ $<1.2x10^{-1}$	$<1.2x10^{-3}$ $<1.2x10^{-1}$
	NEF	$2.2x10^{-5}$ ($2.2x10^{-3}$)	0.021 (2.1)	0.021 (2.1)
Nearest Receptor	Waste Control Specialists Operations	$<6.3x10^{-3}$ (<0.63)[b]	$<1x10^{-7}$ ($<1x10^{-5}$)	$<6.3x10^{-3}$ (<0.63)
	WCS CISF	N/A	$<4.5x10^{-11}$ $<4.5x10^{-9}$	$<4.5x10^{-11}$ $<4.5x10^{-9}$
	NEF	$1.3x10^{-5}$ ($1.3x10^{-3}$)	$<1x10^{-6}$ ($<1x10^{-4}$)	$<1.3x10^{-5}$ ($<1.3x10^{-3}$)
NEF	Waste Control Specialists Operations	$<6.3x10^{-3}$ (<0.63)[b]	$<1x10^{-7}$ ($<1x10^{-5}$)	$<6.3x10^{-3}$ (<0.63)
	CISF	N/A	$<6.0x10^{-4}$ $<6.0x10^{-2}$	$<6.0x10^{-4}$ $<6.0x10^{-2}$
	NEF	$1.7x10^{-4}$ ($1.7x10^{-2}$)	<0.2 (<20)	<0.2 (<20)
Lea Co Landfill	Waste Control Specialists Operations	$<6.3x10^{-3}$ (<0.63)[b]	$<1x10^{-7}$ ($<1x10^{-5}$)	$<6.3x10^{-3}$ (<0.63)
	CISF	N/A	$<1.5x10^{-4}$ $<1.5x10^{-2}$	$<1.5x10^{-4}$ $<1.5x10^{-2}$
	NEF	$<1.7x10^{-4}$ ($<1.7x10^{-2}$)	<0.2 (<20)	<0.2 (<20)

[a] Uranium fuel cycle facilities in the region

[b] Based on net dose for perimeter stations in northwest quadrant

Table 9-8
MCNP Neutron Cross-Sections, NUHOMS® Systems

Isotope	Cross-Section Library Source
1001.62c	ENDF/B-VI
5010.66c	ENDF/B-VI
5011.66c	ENDF/B-VI
7014.62c	ENDF/B-VI
8016.62c	ENDF/B-VI
11023.62c	ENDF/B-VI
13027.62c	ENDF/B-VI
14000.60c	ENDF/B-VI
19000.62c	ENDF/B-VI
20000.62c	ENDF/B-VI
22000.62c	ENDF/B-VI
26056.62c (soil)	ENDF/B-VI
26000.55c (concrete)	LANL/T
64000.35c	LLNL

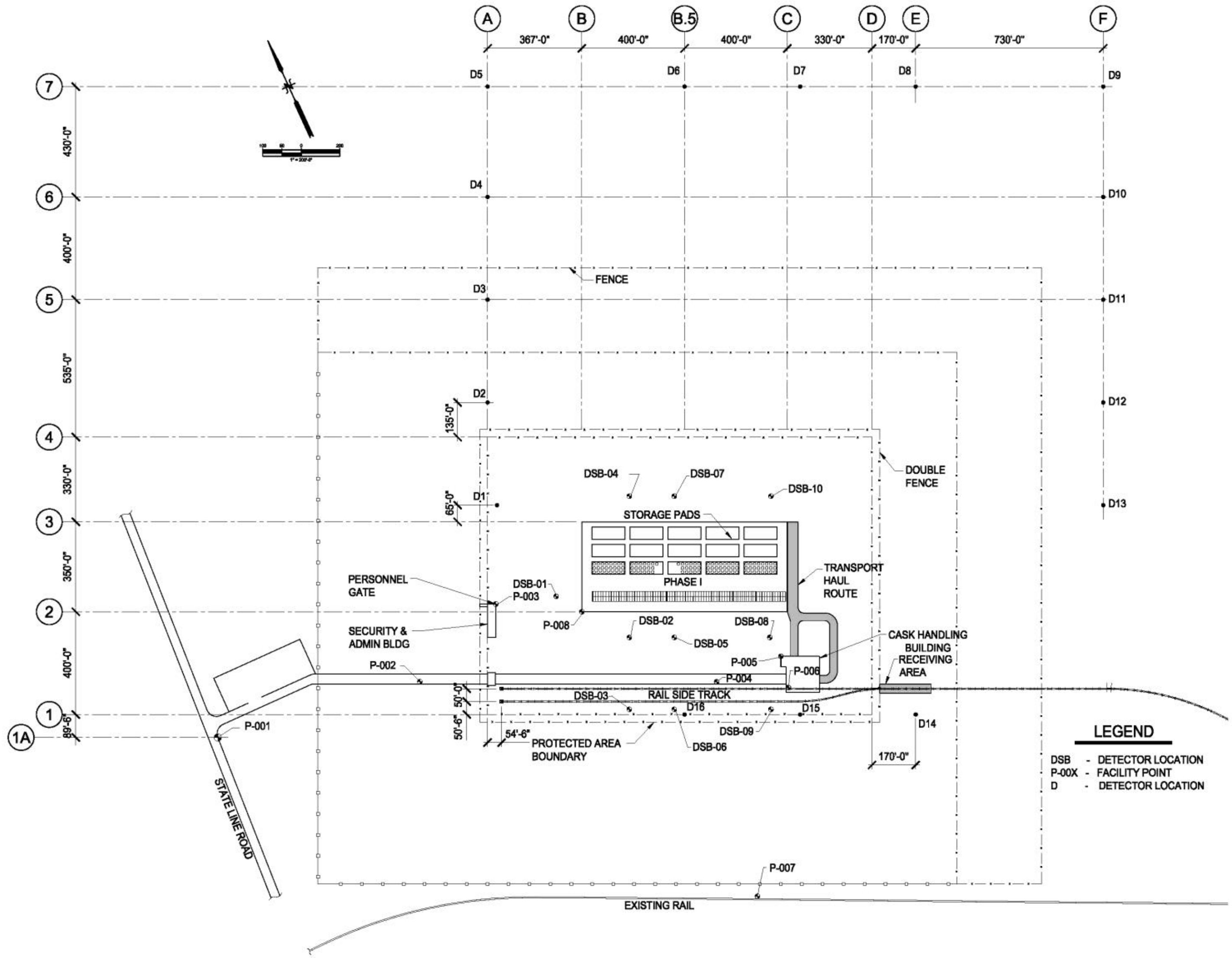

Figure 9-1
WCS CISF Conceptual Plan

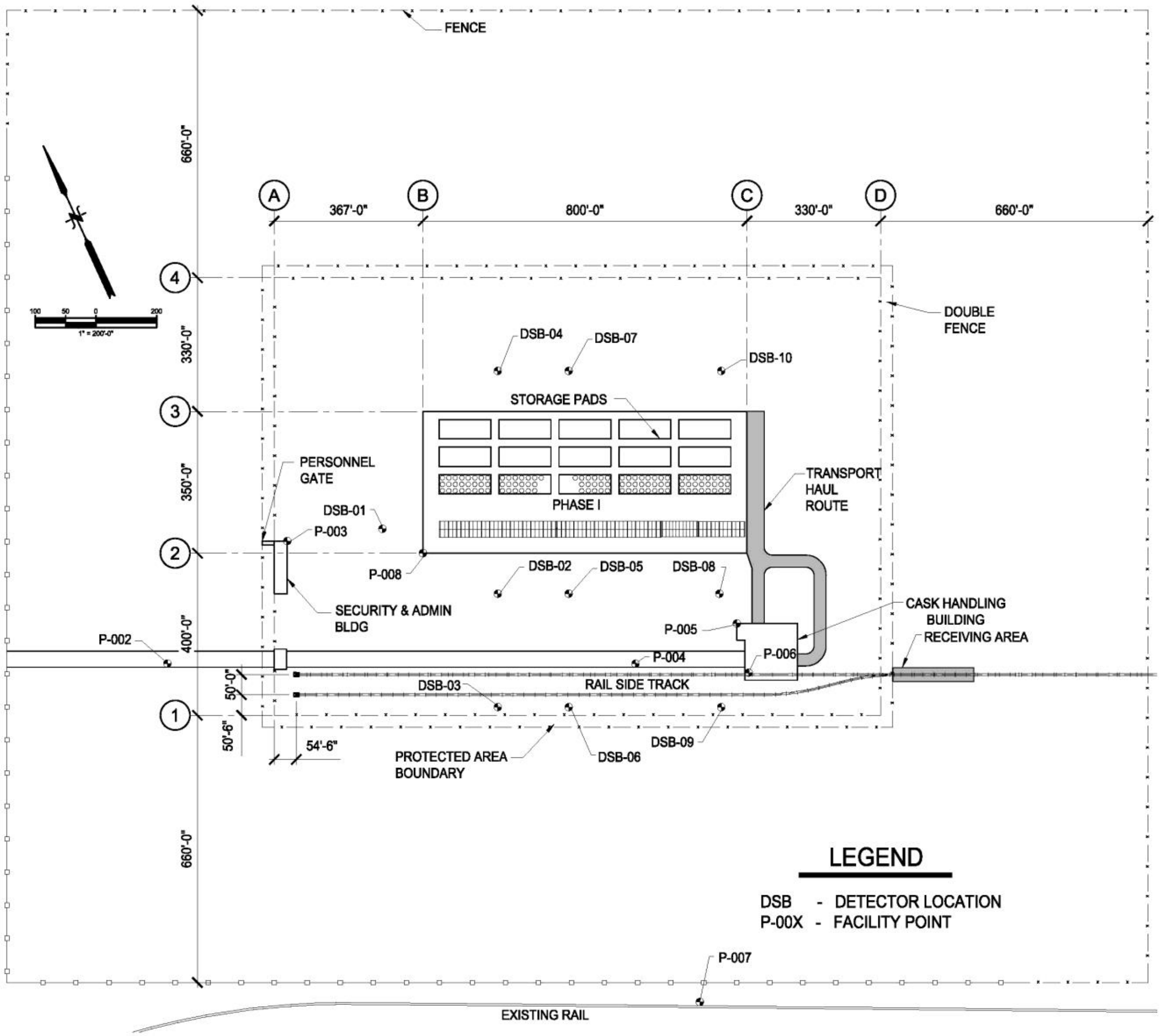

Figure 9-2
WCS CISF Plan, Phase 1

Figure 9-3
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Figure 9-4
Deleted

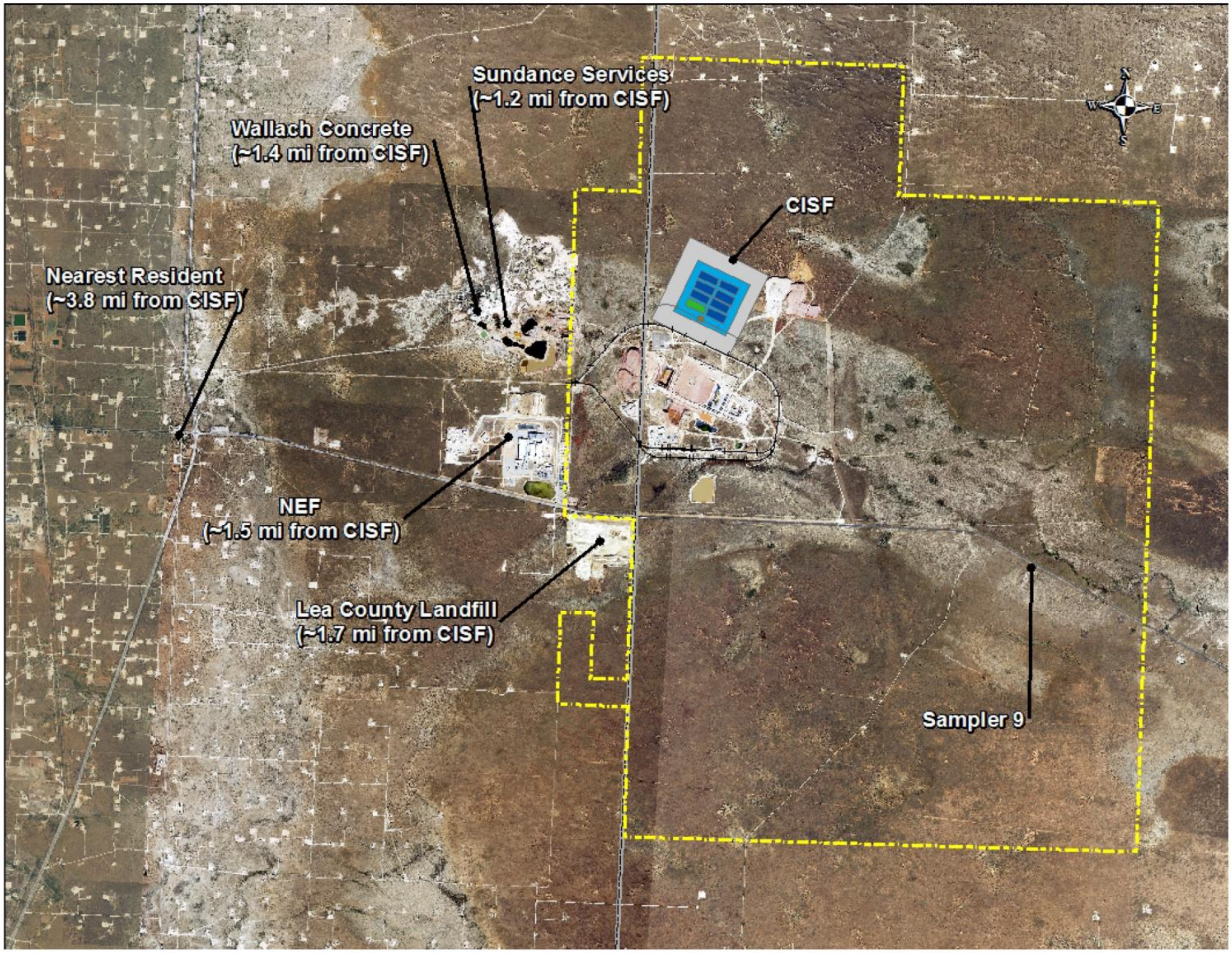


Figure 9-5
WCS CISF Receptors and Source of Radiation in the Region of Interest

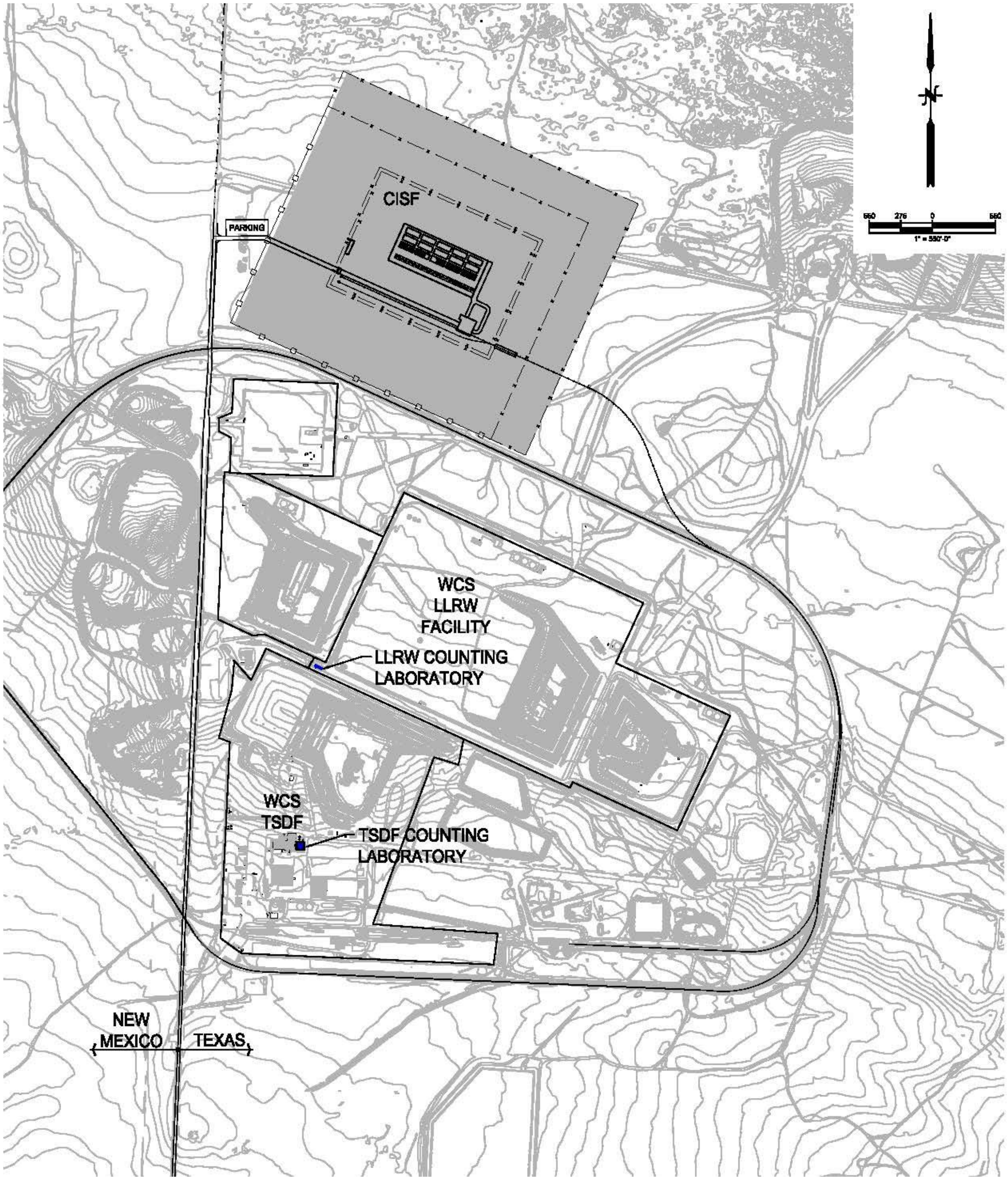
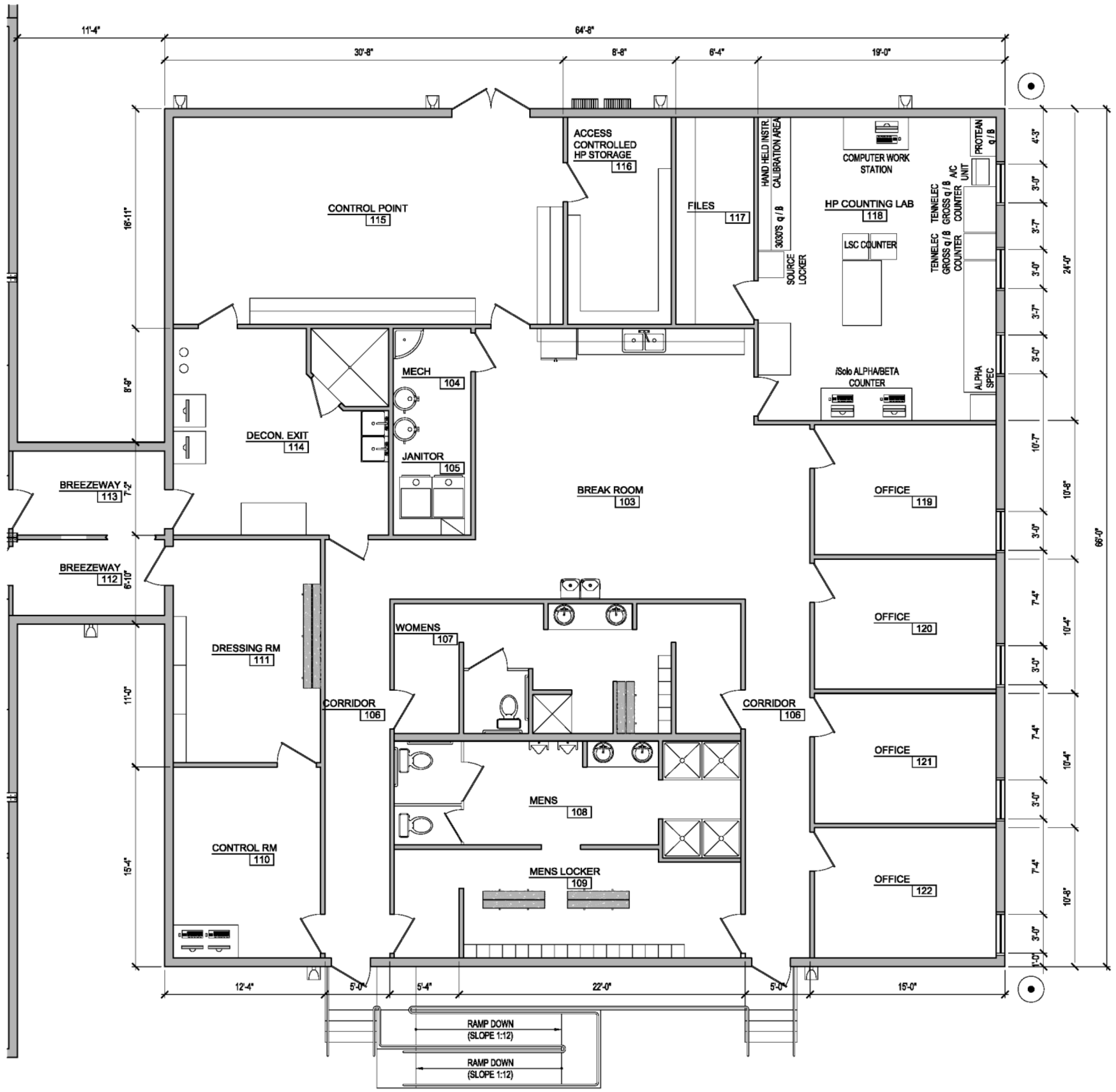


Figure 9-6
ISP and Waste Control Specialists Shared Laboratory Locations



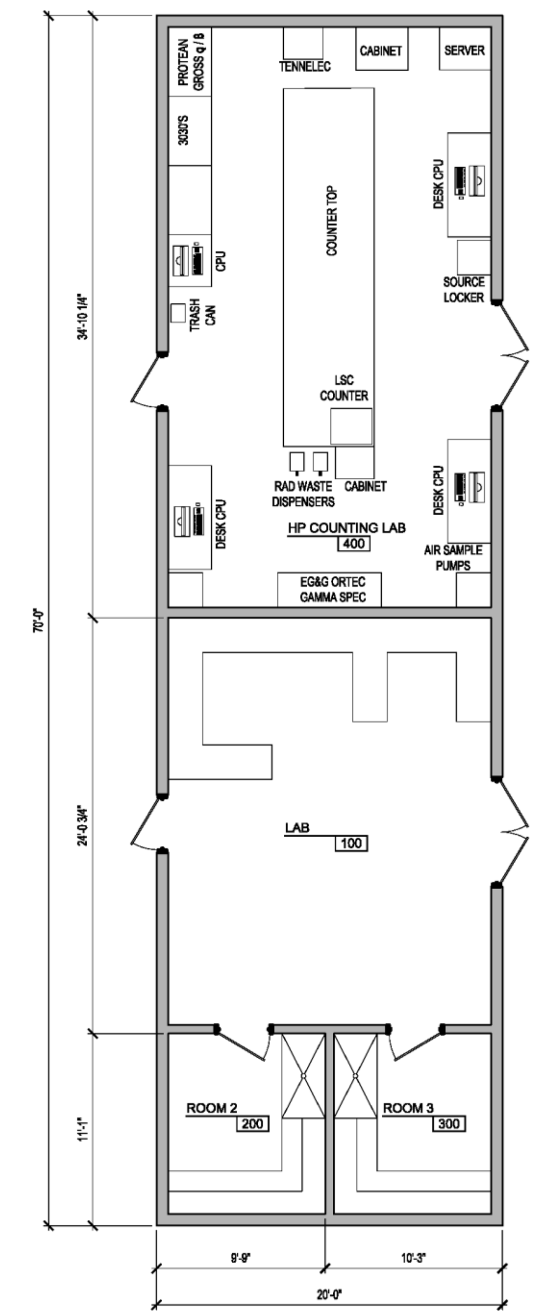


Figure 9-7
Shared Laboratory Facilities

9.8 Supplemental Data

The following Instrumentation Specifications are enclosed as noted below:

1. Mirion Technologies Series 5 XLB Automatic Low Background Alpha/Beta Counting System
2. Ludlum Measurements, Inc., Model 9-3 Ion Chamber
3. Ludlum Measurements, Inc., Model 12-4 Neutron Dose Ratemeter
4. Ludlum Measurements, Inc., Model 78 Stretch Scope Exposure Ratemeter
5. Ludlum Measurements, Inc., Model 79 Carbon Fiber Stretch Scope

Model 9-3
Ion Chamber Survey Meter

Ludlum Measurements, Inc.

Features

- Five Range Ion Chamber
- 1000 mg/cm^2 Retractable Beta Shield
- Low Battery Warning
- High Background Zero Capability
- Audio Proportional to Reading
- Rugged Construction
- Adjustable Shoulder Strap Included

Model 9-3 Ion Chamber
(shoulder strap not shown)
Below: Retractable Beta Shield

Specifications
Part Number: 48-3633

DETECTOR

RANGE: typically 0.2–50000 mR/hr
LINEARITY: reading within 10% of true value
ENERGY RESPONSE: within 20% of true value from 40 keV to 2 MeV
RESPONSE TIME: approximately 5 seconds for 90% of final meter deflection on the x1 and x10 scales, and 2 seconds on the x100, x1k, and x10k scales
CHAMBER VOLUME: 220 cm^3 (13.4 in^3)
WINDOW: 7 mg/cm^2 metalized polyester; with slide open, allows gamma detection to 6 keV
WINDOW AREA: 40 cm^2 (6.2 in^2) (31.5 cm^2 [4.9 in^2] open with optional 79% open screen)
CHAMBER CONSTRUCTION: carbon coated acrylic
BETA SHIELD: retractable 1000 mg/cm^2 phenolic slide
SIDE WALL: 1000 mg/cm^2 aluminum and acrylic

INSTRUMENT CONTROLS

ZERO ADJUST: allows limited background subtract, and also used to compensate for electrometer drift
AUDIO: On/Off; when On, click rate relates to meter reading
BAT TEST: pushbutton used to check battery capacity
RESET: causes chamber discharge to re-establish a current reading
RANGE SELECTION: instrument Off, plus x10k, x1k, x100, x10, and x1
CALIBRATION CONTROLS: individual potentiometers for each range

METER

METER: 6.4 cm (2.5 in.) arc, 1 mA, pivot-and-jewel suspension
METER DIAL: 0–5 mR/hr, BAT TEST (others available)
AUDIO: built-in unimorph speaker with ON/OFF switch
POWER: 2 each "AA" cell batteries housed in a sealed externally-accessible compartment
BATTERY LIFE: x100 and higher ranges at full scale without display light, 1050 hours; at x 1 and x10 in low background without display light, 1500 hours
CONSTRUCTION: cast and drawn aluminum with beige powder coating
TEMPERATURE RANGE: -20 to 50 °C (-4 to 122 °F), temperature compensation maintains calibration within 15% of 25 °C reading
SIZE: 23.4 x 8.9 x 21.6 cm (9.2 x 3.5 x 8.5 in.) (H x W x L) including instrument handle
WEIGHT: 1.6 kg (3.6 lb) including batteries

Ludlum Measurements, Inc. P.O. Box 810, Sweetwater, Texas 79556
Web: http://www.ludlums.com **Tel**: 800-622-0828 / 325-235-5494 / **Fax**: 325-235-4672 / **Email**: sales@ludlums.com

Feb 2019

Model 12-4
Neutron Dose Ratemeter

Ludlum Measurements, Inc.

Features

- Moderated Neutron Detector
- Range: 0–100 mSv/h (0–10,000 mrem/hr)
- Gamma Rejection up to 0.1 Sv/h (10 R/hr)
- Rugged
- 4-Range Analog Meter
- Complete Turn-Key System

Specifications

Part Number: 48-1200

INDICATED USE: neutron dose rate
MEASUREMENT RANGE: 0–100 mSv/h (0–10,000 mrem/hr)
DETECTOR: ^{3}He proportional detector, 1.6 x 2.5 cm (0.6 x 1.0 in.) (D x L), surrounded by a 22.9 cm (9.0 in.) diameter cadmium loaded polyethylene sphere
SENSITIVITY: typically 10 cpm per µSv/h (100 cpm per mrem/hr) (bare AmBe neutrons)
LINEARITY: reading within 10% of actual value
ENERGY RESPONSE: provides an appropriate inverse RPG curve for neutrons from thermal through 7 MeV, provides response up to 12 MeV
GAMMA REJECTION: < 10 cpm through 0.1 Sv/hr (10 R/hr) (^{137}Cs gamma)
OPERATING VOLTAGE: approximately 1200 Vdc
THRESHOLD: -2 mV
WORKING ENVIRONMENT: splashproof shields for outdoor use
METER DIAL: 0–10 mrem/hr, 0–2.5 kV, BAT TEST (other dials available)
HIGH VOLTAGE: adjustable from 400–2500 V (can be read on meter)
DISCRIMINATOR: adjustable from 1–50 mV
CONTROLS:

1. Multipliers: x1, x10, x100, x1000
2. Response: toggle switch for FAST (4 seconds) or SLOW (22 seconds) from 10% to 90% of final reading
3. Reset: pushbutton to zero meter
4. HV Test: pushbutton to display the high voltage on the meter
5. Audio: built-in unimorph speaker (greater than 60 dB at 61 cm [2 ft]) with ON/OFF switch

CALIBRATION: accessible from front of instrument (protective cover provided)
POWER: 2 “D” cell batteries (housed in sealed compartment that is externally accessible)
BATTERY LIFE: typically 600 hours with alkaline batteries (battery condition can be checked on meter)
CONSTRUCTION: cast and drawn aluminum with beige powder coat finish
TEMPERATURE RANGE: -20 to 50 °C (-4 to 122 °F)
SIZE: 43.2 x 22.9 x 26.7 cm (17.0 x 9.0 x 10.5 in.) (H x W x L)
TOTAL WEIGHT: 8.3 kg (18.3 lb); with batteries

Options

Lighted Handle: (PN 4464-154) meter-illuminating self-contained handle with 3-position rocker switch (On, Off, OnCall)
Shoulder Harness (PN 4363-413) nylon strap with wide comfort pad help ease task of carrying heavier instruments
Carrying Case: (PN 2310377) rugged, foam-padded, padlockable transport and storage case with hinged lid & trunk stay
Portable Scaler Option: (PN 4464-114) adds scaler counting capability with digital readout to analog ratemeter
Headphones: headphones provide superior audio in noisy or crowded environments. Several models are available.

Ludlum Measurements, Inc. P.O. Box 810, Sweetwater, Texas 79556
Web: http://www.ludlums.com **Tel**: 800-622-0828 / 325-235-5494 / **Fax**: 325-235-4672 / **Email**: sales@ludlums.com

Nov 2017

Model 78
Stretch Scope Exposure Ratemeter

Ludlum Measurements, Inc.

Features

- 0.1 mR/hr to 1000 R/hr
- (Sv version also available)
- 1 m (42 in.) to 3.8 m (12.4 ft) Telescoping Stainless Pole
- Dual Analog/Digital Display
- Splashproof Buttons
- Energy Compensated GM Detectors

Introduction

The Model 78 Stretch Scope keeps the user a safe distance from high rad areas, and reaches areas difficult to access with other probes. The wide detection range is accomplished using dual energy-compensated GM detectors. The backlit digital LCD delivers precise 4-digit measurement values, which can be programmed to display units of R or Counts, and is accompanied by icons and messages for operational status of the instrument. Rate changes are conveniently viewed on the accompanying analog meter. Clip-on shoulder strap is included.

(shown with optional headset)

Specifications

Part Number: 48-2832

WORKING ENVIRONMENT: splashproof shields for outdoor use (environmental rating of IP52)
DETECTORS: 2 energy-compensated GM tubes
ENERGY RESPONSE: within 25% of true value from 60 keV–3 MeV
DISPLAY: 4-digit LCD display with 1.3 cm (0.5 in.) digits, and 6.4 cm (2.5 in.) analog meter
DISPLAY RANGE: 000.0-999.9 with indicators of mR/hr and R/hr (Sv display also available)
MEASURED RANGE: 0.1 to 999.9 mR/hr or 0.1 to 999.9 R/hr
BACKLIGHT/RESET: temporary action 2-position toggle switch to turn backlight on for preset amount of time, or zero meter and display
METER DIAL: 0–1k 4-decade logarithmic
RANGE SELECTION: 2-position toggle switch to select between mR/hr and R/hr
LINEARITY: reading within 10% of true value
AUDIO: built-in click-per-event audio with ON/OFF switch
RESPONSE: dependent on number of counts present: typical times FAST 4–25 seconds, or SLOW 4–60 seconds, from 10% to 90% of final reading
POWER: 2 “D” cell batteries (housed in sealed handle)
BATTERY LIFE: typically 250 hours with alkaline batteries (low battery indicated on display)
METER: 6.4 cm (2.5 in.) arc, 1 mA analog type
CONSTRUCTION: aluminum housing with beige powder coat paint, and polished stainless steel telescope
TEMPERATURE RANGE: -20 to 50 °C (-4 to 122 °F)
SIZE: 12.2 x 10.9 x 105.9 cm retracted; 377.2 cm fully extended (4.8 x 4.3 x 41.7 in. retracted; 148.5 in. fully extended) (H x W x L, fully extended L)
WEIGHT: 2.9 kg (6.4 lb), including batteries

Options:

Case: water, crush- and dust proof wheeled case with custom foam pads protect & transport instrument PN 4272-444
Headphone: dual volume controls, padded ear cups, adjustable head strap, 3 m (10 ft) cord PN 47-3708

Also Available

Model 78-1: same as above, but in Sv units (1 µSv/h to 10,000 mSv/h), Part No. 48-3743

Ludlum Measurements, Inc. P.O. Box 810, Sweetwater, Texas 79556
Web: http://www.ludlums.com **Tel**: 800-622-0828 / 325-235-5494 / **Fax**: 325-235-4672 / **Email**: sales@ludlums.com

Model 79
Carbon Fiber Stretch Scope

Features

- Light Weight - Approximately 1/3 the Weight of Comparable Instruments
- 1.1 m (45 in.) to 4.5 m (177 in.) Telescoping Carbon Fiber Pole
- 10 µSv/h–10 Sv/h (1 mR/hr–1000 R/hr)
- 1 µSv/h (0.1 mR/hr) Display Resolution
- Backlit Auto-Ranging LCD with Adjustable Viewing Angle
- Simple Green, Yellow, and Red Status Indicators
- 3-Button Intuitive Interface for Easy Operation
- USB Port and All-Digital Calibration

Introduction

The Model 79 Stretch Scope provides the operator with the ability to investigate areas of suspected gamma contamination while remaining at a greater distance from potentially high fields of radioactivity. The 4.5 m telescoping pole allows the attached detector to reach areas difficult to access with other types of instruments.

A large, easy-to-read LCD display rotates to maximize ease of viewing. Padded shoulder strap (included), warning tone, and easy, intuitive design are also featured. The unit's body is made of durable,high-impact, plastic with splash-resistant construction allowing outdoor use.

The Model 79 has three modes of operation - RATE, MAX, and COUNT. Measurements can be collected in two sets of units (primary and secondary) for RATE and MAX modes in cps, cpm, Sv/h, mrem/hr, and R/hr units. The user can choose by simply pressing the Units button. An internal switch is used to enable or disable the front-panel setup feature to protect desired settings from inadvertent modification. Setup is also available via software from Ludlum Measurements.

Specifications

Part Number: 48-3966 (*an adjustable shoulder strap is included*)

DETECTOR: Geiger-Mueller (GM)
ENERGY RESPONSE: Within 25% of true value from 60 keV to 3 MeV
LINEARITY: Reading within 10% of true value
LCD DISPLAY: 3 digit LCD with large 13.4 mm (0.53 in.) digits, (k)cps, (k)cpm, (k)Bq, (k)dpm, (µ)(m)R(/h), (µ)(m)Sv(/h), (µ)(m)rem(/h), low-battery indicator, MAX, ALARM, MUTE
DISPLAY RANGE: 0.0 cps to 99.9 kcps; 0.00 cpm to 999 kcpm; 0.00 Bq to 99.9 kBq; 0.00 dpm to 999 kdpm; 0.00 µR/h to 999 R/h; 0.00 µSv/h to 999 Sv/h; 0.00 µrem/h to 999 rem/h. Display range can be set to limit display to calibrated range
BACKLIGHT: Built-in ambient light sensor automatically activates low-power LED backlight, unless internal dipswitch is set to continuous-On (will reduce battery life). Alarm light intensity varies based on ambient light levels.
USER CONTROLS:

- ON/OFF/ACK - Press to turn ON; Tap to acknowledge alarms and silence alarm tone; Press to reset Sigma Audio alarm; Turn "click" audio On/Off; Turn Sigma Audio beep On/Off; Hold for OFF
- MODE - Alternates between NORMAL (count rate), MAX (captures peak rate), and COUNT (user-selectable preset count time from 0 to 10 minutes). Number of modes can be reduced in setup.
- UNITS - Changes the units between primary or secondary units

RESPONSE TIME: User-selectable from 1 to 60 seconds, or Auto-Response Rate FAST or SLOW
WARM-UP TIME: Less than 2 minutes
ALARMS: Count rate, exposure/dose, and scaler alarm setpoints adjustable over the display range
OVERLOAD: High count rate saturation protection prevents false display of lower count rates
ZERO PROTECTION: After a user-settable time interval (default 60 seconds) of no pulses from detector, the instrument will flash zero reading and the alarm audio will be triggered
DEAD TIME CORRECTION: Employs first and second order corrections for extended performance
AUDIO: greater than 75 dB at 0.6 (2 ft), approximately 4 kHz
POWER: two alkaline or two rechargeable "AAA" batteries
BATTERY LIFE: approximately 100 hours of operation, 24-hour low battery warning
CONSTRUCTION: display unit: high-impact plastic with separate battery compartment; telescoping pole: carbon fiber
TEMPERATURE RANGE: -20 to 50 °C (-5 to 122 °F), may be certified for operation from -40 to 65 °C (-40 to 150 °F)
SIZE: 20.3 x 8.1 x 114 cm retracted; 4.5 m fully extended (8.0 x 3.2 x 45 in. retracted; 177 in. fully extended) (H x W x L; extended L)
WEIGHT: 1.4 kg (3 lb), including batteries and shoulder strap

Options:

Stereo Audio Option: Part Number 4498-697
Lumic Calibration Software Kit: Part Number 4498-1020
Case: (right) water-, crush- and dust-proof case with custom foam pads to protect and transport instrument (Part Number 2312979)

Ludlum Measurements, Inc.

Ludlum Measurements, Inc. P.O. Box 810, Sweetwater, Texas 79556
Web: http://www.ludlums.com **Tel**: 800-622-0828 / 325-235-5494 / **Fax**: 325-235-4672 / **Email**: sales@ludlums.com

May 2019

MIRION TECHNOLOGIES

Series 5 XLB™

Automatic Low Background Alpha/Beta Counting System

KEY FEATURES

- Automatic single detector, ultra-low background counting system
- Enhanced low background capability
- Gas Stat digital gas conservation and monitoring system
- Fifty planchet sample changer with 100 sample capacity optional
- Molded low background passive shielding with interlocking design
- Reduced system footprint and integrated cart
- High performance dual anode 5.7 cm (2.25 in.) gas flow detector with ultra-thin gold sputtered window; single anode one inch detector option available
- Advanced electronic diagnostics continuously monitor operating conditions
- Universal auto-sensing power supply
- Coded positive sample carrier identification
- External or sample changer based bar code reader
- CE compliant

DESCRIPTION

Superior Counting Performance, Unparalleled System Features

The Series 5 XLB low background alpha/beta counter offers a completely integrated, computer controlled system for maximum flexibility.

The Series 5 platform is designed to count samples the way they are prepared in a laboratory. Sensible and smart, Series 5 counters provide integrated intelligence to satisfy the most demanding applications and routine analysis.

Enhanced Low Background and Productivity

Due to increasing environmental regulations to reach lower detection limits, sample count times have increased reducing the overall sample throughput in the laboratory. The Series 5 system incorporates enhanced technology to reduce system background and increase sample throughput. Using an improved guard detector, the system sensitivity for high energy, cosmic background is increased, enabling the anti-coincidence circuitry to detect and reject more spurious background events.

The beta background for the Series 5 counter has been reduced by as much as 35% over older systems. Beta backgrounds as low as 0.5 cpm can be achieved. This means that the Series 5 family of low background counters can count twice as many samples for a given detection limit as a counter with a beta background of 1.0 cpm – impressive performance from an impressive system.

Custom Molded Shield

Using a graded shielding system, the Series 5 system counts samples with more accuracy than any other low background counter.

The molded shield system provides 10 cm (4 in.) of custom molded lead surrounding the detector. The shield comprises interlocking modules which weigh no more than 27 kg (60 lb) each for safety and ease of assembly.

Time Proven Reliability

The sample changer of the Series 5 family is time and field proven. The highly reliable design of the automated sample changer transports and counts samples day after day providing worry free operation. When work counts and time is precious, count on a system to deliver results and reliability.

Ultra-Thin Detector Windows

The standard gas flow detector of the Series 5 family of systems incorporates a high performance pancake-style 5.7 cm (2.25 in.) detector. The entrance window of the detector is made with state-of-the-art technology and special materials to provide the highest counting efficiency and the lowest alpha background of any counter.

Positive Sample Identification and Bar Code – The Advantage

Today's changing requirements demand sample identification that is maintained through the counting data. Data defensibility is a priority. The Series 5 system incorporates a unique combination of carrier and sample identification systems to maintain chain-of-custody. Two methods of sample identification are linked to the final data report. The sample carrier is uniquely coded for routine analysis. The Series 5 counter can be configured with an automatic sample bar code reader. When present, the sample bar code is automatically captured by Apex-Alpha/Beta™ software and stored with the sample count data, forming the missing link in sample custody in the count room. Only Mirion sample carriers are washable for easy cleaning and decontamination.

Circuitry So Advanced, It Thinks for Itself

The electronics package of the Series 5 family of counting systems provides the most advanced control and monitoring system available to assure accurate results. The Series 5 incorporates hardware diagnostics which continuously monitor internal and external parameters including gas pressure and flow, system voltage, power distribution, and other system critical parameters. The user is alerted on the front panel if any of these parameters falls below normal operation thresholds.

Human Factor Engineering

Often computer controlled analytical equipment requires additional laboratory space for the computer system and peripherals. The Series 5 counter addresses that problem with an integrated mobile cart that provides all of the support necessary for the computer, monitor, keyboard, and pointing device. The optional S5-ACCKIT includes a monitor support shelf tray, printer support tray, and a gas tank bracket. The retractable printer shelf opens to hold printer and supplies. The Series 5 system is designed to be a completely integrated, self contained counting system with the industry's smallest footprint.

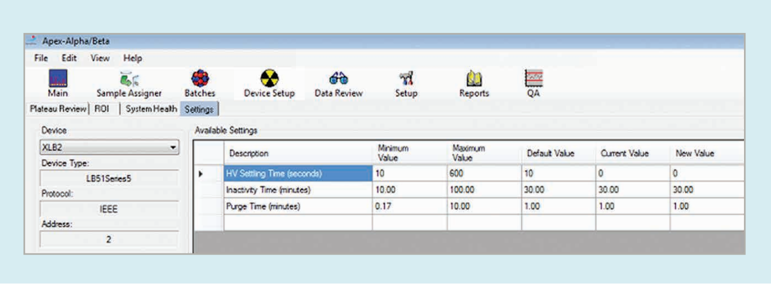
Gas Stat Gas Conservation System

Conventional low background counters have manual gas flow control and use the equivalent of a 1A gas cylinder on the average of once per six weeks. Changing gas supplies usually means re-verification of critical system calibrations which can be an unnecessary time consuming process. Not only time, but the impact on data quality can become significant issues when frequent re-calibrations must be performed, due to a change in gas quality.

The Series 5 system includes Gas Stat, the industry standard for gas management, which eliminates the high frequency of re-calibrations due to counting gas changes. Gas Stat is a microprocessor-controlled gas monitoring and control system that provides worry free operation by eliminating the need to adjust manual flow meters. The normal gas flow rate is set by the operator through software control, and flow rates are digitally displayed in real time on the computer screen.

The Series 5 hardware senses when the system is not counting samples, and automatically reduces the gas flow rate to a low quiescent flow to maintain detector gas quality. This prevents atmospheric impurities from diffusing into the detector and causing questionable results. When the user starts a count, Gas Stat automatically purges the detector and resets the flow rate to normal. Gas Stat uses a preset maximum flow rate for the detector purging; so, it is virtually impossible to cause window damage due to over pressurization.

Gas Stat effectively increases the useful life of the gas supply, thereby reducing the frequency of instrument re-verification, saving time and improving the quality of counting data.



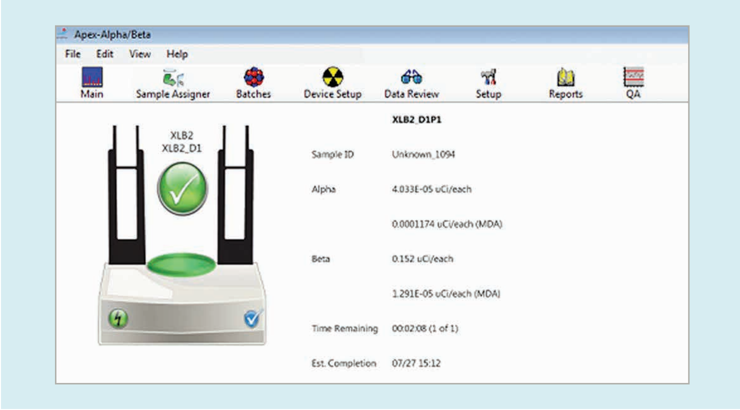
Software – Powerful and Flexible

The Series 5 counter has been designed to take full advantage of computer-based system integration. Series 5 XLB system can be operated with the legacy Eclipse™ software, or can use the state-of-the-art Apex-Alpha/Beta software to provide the optimum combination of power and ease of use for a low background system.

Apex-Alpha/Beta software includes a Microsoft SQL Server Express database for fast and efficient data storage. Custom reports can be easily developed for your application or presentation using an integrated reporting tool without the need for any third-party software. See the Apex-Alpha/Beta specification sheet for more detail on its advanced features.

Final activity results can be viewed on-screen for each sample as it is counted. An intuitive, symbolic icon tool bar provides access to functions at the push of a button.

No other counter can match the advanced automation capabilities and features of the Series 5 XLB counter and Apex-Alpha/Beta Software.



Software – Powerful and Flexible

SPECIFICATIONS

*All specifications are based on measurements performed at a Mirion manufacturing facility with 5.7 cm (2.25 in.) detector with ultra-thin window, unless noted otherwise.

To achieve lower Beta background, the Gamma detector can be replaced with a Lead Plug (7081577).

PERFORMANCE

Background:

	WARRANTY	
	Standard system or Gamma system with lead plug installed	Gamma system with NaI detector installed
Gross (alpha+beta)	≤0.80 cpm	≤1.1 cpm
Alpha	≤0.1 cpm	≤0.1 cpm
Beta	≤0.75 cpm	≤1.0 cpm

Efficiency:

- 4π efficiency measured with a NIST traceable standard point source 5.08 x 0.3 cm (2 in. x 1/8 in.) planchet in 0.3 cm (1/8 in.) insert.

	Warranty
Alpha (^{210}Po)	≥38%
Beta ($^{90}Sr/^{90}Y$)	≥45%

- Counting efficiency is dependent on operating voltage, source thickness and distance from detector. Backscattering of high energy emitters produces higher than expected efficiency.

Spillover:

- ≤1.0% ^{210}Po alpha into beta channel with the system adjusted for a ≤0.1% spillover of ^{90}Sr beta into the alpha channel.

Detector Plateau:

- Alpha (^{210}Po) – ≤2.5% slope/100 V: ≥800 V plateau.
- Beta (^{90}Sr) – ≤2.5% slope/100 V: ≥200 V plateau.

Sample Count Rate:

- 500000 cpm with ≤1.5% deadtime loss.

Counting Time Preset:

- Adjustable between 0.2 and 9999 minutes.

PHYSICAL

Sample Changer Capacity:

- Standard – 50 samples.
- Optional – 100 samples.

Weight:

- Net weight less cart – standard system 324 kg (716 lb).
- Net weight cart with casters 54 kg (120 lb).

Dimensions:

(Height x Width x Depth)

- Table Top Model – 37 x 58 x 76 cm (14.5 x 23 x 30 in.).
- With 50 Sample Capacity – 75 x 58 x 76 cm (29.5 x 23 x 30 in.).
- With 100 Sample Capacity – 124 x 58 x 76 cm (49 x 23 x 30 in.).
- Cart With Casters – 76 x 58 x 76 cm (30 x 23 x 30 in.).

POWER REQUIREMENTS

The Series 5 counter is equipped with a universal power supply and automatically adapts to voltage and frequency.

- 100–240 V ac at 50/60 Hz.
- 100 W maximum.

ENVIRONMENTAL

- Operating Temperature – 0 to 50 °C (32 to 122 °F).
- Operating Humidity – 0 to 80% relative, non-condensing.
- Meets the environmental conditions specified by EN 61010, Installation Category I, Pollution Degree 2.

ORDERING INFORMATION

5XLB Models:

These models include on-site installation and one year on-site warranty. Requires computer, monitor, printer and Apex-Alpha/Beta (S556C) Software.

- S5X2050 – Includes basic S5XLB counter, 2.25 in. detector, 50 sample towers, carrier plates, carrier inserts (5/16 & 1/8 deep), planchets and cart.
- S5X2100 – Includes basic S5XLB counter, 2.25 in. detector, 100 sample towers, carrier plates, carrier inserts (5/16 & 1/8 deep), planchets and cart.
- S5XG2050 – Includes S5XLB counter with gamma option, 2.25 in. gas flow detector, 2X2 NAI, 50 sample towers, carrier plates, carrier inserts (5/16 & 1/8 deep), planchets and cart.
- S5XG2100 – Includes S5XLB counter with gamma option, 2.25 in. gas flow detector, 2X2 NAI, 100 sample towers, carrier plates, carrier inserts (5/16 & 1/8 deep), planchets and cart.

Export 5XLB Models:

Models with “E” do not include on-site installation. Requires computer, monitor, printer and Apex-Alpha/Beta Software.

- S5X2050E – Includes basic S5XLB counter, 2.25 in. detector, 50 sample towers, carrier plates, carrier inserts (5/16 & 1/8 deep), planchets and cart.
- S5X2100E – Includes basic S5XLB counter, 2.25 in. detector, 100 sample towers, carrier plates, carrier inserts (5/16 & 1/8 deep), planchets and cart.
- S5XG2050E – Includes S5XLB counter with gamma option, 5.7 cm gas flow detector, 50.8 x 50.8 mm NAI, 50 sample towers, carrier plates, carrier inserts (7.9 & 3.2 mm deep), planchets and cart.
- SXG2100E – Includes S5XLB counter with gamma option, 5.7 in. gas flow detector, 50.8 x 50.8 mm NAI, 100 sample towers, carrier plates, carrier inserts (7.9 & 3.2 mm deep), planchets and cart.

MISCELLANEOUS

- AB-CPU7 – Windows 7 PC with LCD monitor.
- AB-CPU10 – Windows 10 PC with LCD monitor.
- S556C – Apex-Alpha/Beta Software.
- S550C – Eclipse Software (Existing Eclipse Users Only).
- LB-Integ – Integration of customer supplied computer.
- 488PCI – IEEE-488 Card and Cable (PCI Bus).
- 488USB – IEEE-488 Interface (USB).
- S5-ACCKIT – S5 Mobile Cart Accessory Kit including Monitor Tray, Printer Tray, and Gas Tank Bracket.
- XLB-GR – Single Stage Gas Regulator.

ACCESSORIES

- 6200-12 – Carrier Inserts 2 x 1/16 in.
- 6200-13 – Carrier Inserts 2 x 1/8 in.
- 6200-14 – Carrier Inserts 2 x 1/4 in.
- 6200-09 – Carrier Inserts 2 x 5/16 in.
- 6200-21 – Carrier Inserts 1 x 1/16 in.
- 6200-22 – Carrier Inserts 1 x 1/8 in.
- 6200-23 – Carrier Inserts 1 x 1/4 in.
- 6200-24 – Carrier Inserts 1 x 5/16 in.
- 6200-137 – Plastic Carrier Inserts 2 x 1/4 in.
- 6200-96 – Carrier Plates Coded 1–50
- 6200-97 – Carrier Plates Coded 51–100
- 6200-88 – Carrier Plates Coded 101–150
- 1750-06 – Group Plates A – E
- 1750-07 – Group Plates F – J
- 1400-156 – Uncoded Carrier Plates
- 1750-475 – End Carrier Plates
- 1750-23 – Carrier Plate Cassette
- 6200-476 – 60 mm Carrier Insert Disk
- 6200-477 – 60 mm Carrier Insert Ring

Replacement Detectors and Windows

- S5-F2 – 2.25 in. detector for XLB, S5E and Solo
- WIND280 – Replacement premium 2.25 in. ultra-thin window
- WIND280AL – Replacement standard 2.25 in. thin window

ISO 9001 SYSTEM CERTIFIED
MERIDEN CT
SMYRNA GA
OAK RIDGE TN
CONCORD ON

CANBERRA

CHAPTER 10
CRITICALITY EVALUATION

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10. CRITICALITY EVALUATION

Storage and transportation cask systems received at the Interim Storage Partners' (ISP's) WCS Consolidated Interim Storage Facility (WCS CISF) are designed to ensure that the stored materials remain subcritical under normal, off-normal and accident conditions during all WCS CISF operations, transfers and storage. This chapter presents criticality safety criteria and summarizes design features which ensure criticality safety at the WCS CISF. The design of the canisters is such that, under all credible conditions, the highest effective neutron multiplication factor (k_{eff}) remains less than 0.95.

10.1 Criticality Design Criteria and Features

This section presents the criticality design criteria for the WCS CISF and summarizes criticality safety design and licensing bases applicable to the authorized storage cask systems.

10.1.1 Criteria

As specified in the Technical Specifications [10-1] only canisters that were loaded and stored in accordance with the listed Site Specific or General Licenses are acceptable for storage at the WCS CISF. Criticality safety is demonstrated for all authorized storage systems in the original Site Specific and General License licensing documents. The criticality safety criterion is satisfied for all systems. Criticality safety evaluations further assume limiting spent nuclear fuel (SNF) characteristics, which are stipulated in the Technical Specifications associated with the applicable Site Specific or General Licenses. Criticality evaluations are not required for canisters loaded with Greater Than Class C (GTCC) waste because they contain less than 15 grams of fissile material.

10.1.2 Features

The storage systems are designed to ensure that the stored materials remain subcritical under normal, off-normal and accident-level conditions during all WCS CISF operations, transfers and storage. The primary cask criticality control design features are basket geometry and supplemental neutron absorber materials. Neutron reflector effects on cask and/or canister walls are also evaluated in the design and licensing basis calculations of final k_{eff}. Continued reliance on these design features is used following receipt of transportation casks at the WCS CISF, in order to ensure that the stored materials remain subcritical under normal, off-normal and accident-level conditions. These features will also remain functional for subsequent off-site transportation and SNF retrieval operations.

WCS CISF design and operational control features preclude events or conditions which may degrade canister/cask systems, including SNF, basket geometry and neutron absorber materials. The criticality control design feature integrity has been demonstrated for all systems received at the WCS CISF under all normal, off-normal and accident-level conditions. Therefore, criticality monitoring is not required.

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, and Appendices A.11, B.11, C.11, D.11, E.11, F.11 and G.11.

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 CISF are canister breach and severe flooding. As documented in Sections 2.4.2.2 and 3.2.2, the WCS CISF is not in a floodplain and is above the Probable Maximum Flood elevation and therefore will remain dry in the event of a flood. There are no other sources of standing water at the WCS CISF. Thus, there is no standing water to cause a criticality event.

10.2 Stored Material Specifications

SNF characteristics are addressed in the individual canister/cask system criticality safety evaluations, which are provided in Appendices A.10, B.10, C.10, D.10, E.10, F.10 and G.10, depending on the canister/cask system. Canisters 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. Objective evidence is provided through records review for each canister prior to transport, verifying that the canister was fabricated, loaded, stored and maintained in accordance with the Site Specific or General License requirements prior to shipment.

10.3 Criticality Assessment

No criticality safety analyses are performed beyond those presented in the applicable SARs for the canisters that are authorized for storage at the WCS CISF by the Technical Specifications [10-1] that were loaded and stored in accordance with the listed Site Specific or General Licenses.

Section 10.4 points to the appropriate Appendix for each authorized canister/cask system listed in the Technical Specifications [10-1] as acceptable for storage at the WCS CISF. Each Appendix then points to the applicable design/licensing basis criticality analysis bounding the conditions of operations and storage at the WCS CISF.

10.4 Criticality Analysis

Section 2.1 of the Technical Specifications [10-1] addresses the canisters contents authorized for SNF storage at the WCS CISF. Table 10-1 provides the cross reference to the applicable appendix and section for each canister/storage overpack where the criticality safety is discussed.

10.5 References

10-1 SNM-2515 Technical Specifications (See [Gen-1]).

Table 10-1
Criticality Evaluations of Storage Systems at the WCS CISF

Cask System	Canister	Overpack	Appendix
NUHOMS®-MP187 Cask System	FO-DSC	HSM (Model 80)	Appendix A.10
	FC-DSC		
	FF-DSC		
Standardized Advanced NUHOMS® System	NUHOMS® 24PT1	AHSM	Appendix B.10
Standardized NUHOMS® System	NUHOMS® 61BT	HSM Model 102	Appendix C.10
	NUHOMS® 61BTH Type 1		Appendix D.10
NAC-MPC	Yankee Class	VCC	Appendix E.10
	Connecticut Yankee	VCC	
	LACBWR	VCC	
NAC-UMS	Classes 1 through 5	VCC	Appendix F.10
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.10

CHAPTER 11
CONFINEMENT EVALUATION

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11. CONFINEMENT EVALUATION

Storage and transportation cask systems received at the Interim Storage Partners' (ISP's) WCS Consolidated Interim Storage Facility (WCS 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.

11.1 Confinement Design Characteristics

As specified in the Technical Specifications [11-1] only canisters that were loaded and stored in accordance with the listed Site Specific and General Licenses are acceptable for storage at the WCS CISF.

Table 11-1 provides the cross reference to the applicable appendix and section for each canister/storage overpack where the confinement is discussed. The confinement of GTCC waste is addressed in Sections H.3.3.1 and H.4.2.2.1.

In general, all of the canisters to be stored at the WCS CISF are designed to be leak tight under all normal, off-normal, and accident conditions. Therefore, the confinement of the SNF or GTCC waste is maintained under all conditions. The only exceptions to this are the FO-, FC-, FF- Dry Shielded Canisters (DSCs or canisters) that were leak tested to a leakage rate of 10^{-5} ref-cm^3/sec. The confinement evaluation for these canisters is presented in Appendix A.11.

11.2 Confinement Monitoring

No confinement monitoring is required for any of the canisters to be stored at the WCS CISF because all canisters include welded closures.

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} ref-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.

11.4 Confinement Analysis

The confinement analysis for each authorized storage system is provided in appendices for this chapter. Table 11-1 provides the cross reference to the applicable appendix and section for each canister/storage overpack where the confinement analysis is presented.

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 and will comply with WCS CISF License Conditions and Technical Specifications. In addition, a receipt inspection of the canisters is performed upon arrival at the WCS CISF, which includes a post transport package evaluation in accordance with reference [11-2].

In order to assure that only conforming canisters are shipped to the WCS CISF, Section 1.2.4 of the SAR and Condition 9 of the proposed Materials License for the WCS CISF describe in detail the canisters that are acceptable for storage at the CISF. SAR Section 1.2.4.2 Pre-Shipment Review of Canisters, describes the process that ISP will use to verify that every spent fuel canister received at the WCS CISF complies with the terms, conditions of use, and technical specifications of one of the six storage systems listed in Section 2.1 of the Technical Specifications, when stored in the canister's approved overpack. ISP will not provide its permission to shipper to release a canister for shipment to the CISF until it has been confirmed that the canister meets the requirements. In accordance with 10 CFR 73.37(b)(1)(ii), the shipper must "coordinate shipment itineraries to ensure that the receiver at the final delivery point is present to accept the shipment."

In the highly unlikely event that a non-conforming canister is found as part of receipt inspection, the canister will be placed in a safe condition and the issue will be entered into the ISP Corrective Action Program and the corrective action would be subject to a reportability determination in accordance with 10 CFR Part 21, 10 CFR 72.242, 10 CFR Part 71.95, 49 CFR Part 171.15, and other regulations that may apply. The ISP reportability determination procedure provides the regulatory requirements for reporting to the appropriate agency, including deadlines for such notifications. The non-conforming canister will need to be evaluated on a case by case basis and depending on the specific conditions of the canister. The canister will be immediately placed in a safe condition and, following the applicable evaluations, the appropriate licensing actions will be initiated to resolve the situation. The corrective actions will include, but not be limited to the following:

1. Notifying the NRC as required. Conferring with the NRC as needed.

2. Maintaining the canister inside the transportation cask in its transportation configuration until appropriate corrective actions are determined. The safety for temporary storage will be confirmed using Part 71 analysis as appropriate.

3. Developing an action plan with a timeframe which will include input from the NRC discussions.

4. Obtaining agency approvals as necessary.

5. Proceeding with corrective actions.

The timeline by which a canister will be returned to the place of origin, or other facility licensed to perform fuel loading procedures, will depend on the specific corrective actions required to address the condition identified by the corrective action evaluation performed. As discussed above, this event will be extremely rare and will not result in a number of canisters with this condition.

The design and licensing basis for all of the canisters acceptable for storage at the CISF is that confinement is maintained for all normal, off-normal, and accident conditions of storage at the originating site and during storage at the WCS CISF. In addition, the design and licensing basis for the WCS CISF demonstrates that the canisters maintain confinement for all normal conditions of transport in the transportation cask used to transport the canister to the CISF. Therefore, there is no credible scenario under which a canister will fail the post-transportation leakage test. The post-transportation leakage test is not part of the design or licensing basis for the continued integrity of the confinement boundary for the canisters, rather, as described in SAR Section 5.1.3.1, it is a prudent measure being taken to confirm that a canister remains able to perform its safety function and is, therefore, acceptable for storage at the WCS CISF.

In addition, License Condition 20 requires that as the license renewals are completed and approved by the NRC for the NAC International systems, 10 CFR 72.42 compliant aging management programs (AMPs) and time limited aging analyses (TLAAs) are also 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.

11.6 References

11-1 SNM-2515 Technical Specifications (See [Gen-1]).

11-2 "Post Transport Package Evaluation," QP-10.02, Revision 2.

Table 11-1
Confinement Evaluations for Authorized Storage Systems at the WCS CISF

Cask System	Canister	Overpack	Appendix
NUHOMS® MP187-Cask System	FO-DSC	HSM (Model 80)	Appendix A.11
	FC-DSC		
	FF-DSC		
	GTCC Canister(1)		
Standardized Advanced NUHOMS® System	NUHOMS® 24PT1	AHSM	Appendix B.11
Standardized NUHOMS® System	NUHOMS® 61BT	HSM Model 102	Appendix C.11
	NUHOMS® 61BTH Type 1		Appendix D.11
NAC-MPC	Yankee Class	VCC	Appendix E.11
	Connecticut Yankee		
	LACBWR		
	GTCC-Canister-CY(1)		
	GTCC-Canister-YR(1)		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.11
	GTCC-Canister-MY(1)		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.11
	GTCC-Canister-ZN(1)		

Note 1: The confinement of GTCC waste is addressed in Sections H.3.3.1 and H.4.2.2.1.

CHAPTER 12
ACCIDENT ANALYSIS

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12. ACCIDENT ANALYSIS

The purpose of this chapter is to present the engineering analyses performed to qualify the storage and transportation systems received at the Interim Storage Partners' (ISP's) WCS Consolidated Interim Storage Facility (WCS CISF) for off-normal operating conditions and for a range of credible and hypothetical accidents conditions. In accordance with NRC Regulatory Guide 3.48 [12-1], the design events identified by ANSI/ANS 57.9-1984, [12-2] form the basis for the accident analyses performed for the WCS CISF storage and transportation systems. Off-normal events are addressed in Section 12.1 and postulated accident events are addressed in Section 12.2. These events provide a means of establishing that the WCS CISF system designs satisfy the applicable operational and safety acceptance criteria.

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 is 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 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 (shown in Table 1-2)
- 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.

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 a 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

b. CTS Operations with a Loaded Transfer Cask

c. Loaded Storage Cask positioned in the VCT

For a hypothetical fire accident within the Cask Handling Building during operations of the CTS, the transport cask fire accident (10 CFR 71) bounds the VCT operations and the storage cask fire accident performance is demonstrated within the respective Appendix for the cask. With respect to the CTS and the function of positioning the loaded transfer cask within the CTS work envelope, a fire accident is evaluated considering only the contribution of the CTS as it will be operated independent of any other equipment.

12.2.1.1 Cause of Fire

While it is possible that the CTS could cause a fire while transferring a loaded transfer cask in the Cask Handling Building, this fire event is unlikely and would be confined and rapidly extinguished by the operations personnel performing the transfer or by the site fire crew. The CTS's primary power is electricity for the hydraulic pumps, etc. As a contingency, the CTS is equipped with an auxiliary power unit that is gas driven and is used to implement controlled recovery of the load in the event of a power failure. The CTS's maximum permissible quantity of flammable liquid is 50 gallons, which is the only flammable material in the vicinity of the CTS during transfer operations. Due to the CTS function requiring a level surface, the area will not be conducive to the accumulation of flammable liquids to prolong or intensify a fire event.

The flammable or combustible materials carried by other onsite vehicles or by other equipment used for CISF operations and maintenance, such as air compressors or electrical generators, is not considered to be within the proximity of the CTS.

With respect to hydraulic fluids, NAC refers to 49 CFR 173.120, Class 3 – Flammable and Combustible Liquids for the formal definition and considers the hydraulic fluid (synthetic HFD) as being a combustible liquid incapable of sustained burning.

Flammable liquids are defined as:

- A liquid having a flash point of ≤ 60.5º C (141º F)
- Any material in a liquid phase with a flash point ≤ 37.8º C (100º F) that is intentionally heated and offered for transport or transported at or above its flash point in bulk packaging.

Combustible liquids are a liquid that does not meet the definition of any other hazard class and has a flash point of > 60.5º C (141º F) and ≤ 93º C (200º F).

12.2.1.2 Detection of Fire

A fire in the vicinity of the CTS will be detected by observation of the fire or smoke.

12.2.1.3 Analysis of Fire

It is conservatively assumed that the CTS fire is 2-meter from the transfer cask surface, with a heat flux of 29.3 kW/m2 on the cask surface. A 3-D half symmetry finite element model is used to perform a transient analysis. The heat flux of 29.3 kW/me2 is applied from bottom of the TFR to 1 meter from bottom, then decrease to zero at 2 meter from bottom. The source of the fire is considered to be 50 gallon of gasoline and the fire is sustained for 3.5 minutes. The transient analysis considered 3.5 min of fire and 30 min. post-fire.

The analysis results indicate that the TFR surface temperature increased 51C. [

]

12.2.1.4 Corrective Actions

Immediately upon detection of the fire, appropriate actions would 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.

The neighboring facility to the west of the WCS CISF 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, Evaluations of Explosions Postulated to Occur at Nearby Facilities and on Transportation Routes near Nuclear Power Plants, Revision 2, was used to determine distances from nearby facilities or transportation routes beyond which any explosion that might occur is not likely to have an adverse effect on WCS CISF SSCs important to safety. The guidance in Regulatory Guide 1.91 is based on limiting the overpressure at SSCs to less than 1 psi from any explosion. The magnitude of explosions involving solid or liquid materials is calculated by converting the weight of potentially explosive materials to their TNT equivalence. Per Regulatory Guide 1.91, a more detailed review of transporting explosive materials on these transportation routes would not be required beyond demonstrating that the overpressures at the WCS CISF can be shown not to exceed 1 psi for any explosion. Using the methodology of Regulatory Guide 1.91, the nearest truck 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 Texas & New Mexico Railway at its closest point, is approximately 4.8 miles from the west OCA boundary of the WCS CISF. Using the methodology of Regulatory Guide 1.91, the maximum probable hazardous solid cargo for a single box car is 132,000 lbs, and detonation of this quantity of explosive could produce a 1 psi overpressure at a distance of approximately 2,300 ft (0.44 mile) from the detonation which does not approach the location of the WCS CISF. Considering for the possibility that multiple boxcars of explosive material are connected in a single train and multiple boxcars explode in the same event shows that ten completely full boxcars exploding in the same event produce 1 psi of overpressure at a distance of 5,000 feet from the detonation. This distance is much less than the distance to the WCS CISF. The weight of explosive material required to exceed 1 psi of overpressure at the WCS CISF makes the situation extremely unlikely under normal transportation conditions due to the configuration limitations (as the length of the train increases each successive rail car gets further away from the WCS CISF).

The Waste Control Specialists rail spur and loop exits the Texas & New Mexico Railway near Eunice, New Mexico as shown in updated SAR Figure 2-3. This spur continues east until it reaches the existing Waste Control Specialists facility where it forms a loop around the facility. The rail side track to the WCS CISF will begin by connecting to the northeast side of the existing loop and terminate inside the PA after going through the CHB. This rail line is completely controlled by ISP joint venture member Waste Control Specialists and limited to approved Waste Control Specialists waste shipments and transport casks. Railcars carrying contents with the potential to adversely affect the CISF will not be permitted on the Waste Control Specialists rail spur and loop. Fire and explosion precautions for the WCS CISF rail side track are discussed in Section 3.3.6 of the SAR.

The effects of explosions on the storage systems are discussed in the SAR Appendices, Sections A.12.2.5, B.12.2.5, C.12.2.5, D.12.2.5, E.12.1.2, E.12.2.2, F.12.1.2 and G.12.1.2, 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.

Permian Basin Materials, LLC (PBM) operates an aggregates quarry and concrete ready mix facility in New Mexico near the CISF. PBM shares a property boundary with Waste Control Specialists and this boundary is approximately 4,000 feet from the CISF Protected Area. Actual blasting activities are further away but distances vary depending on exact locations.

PBM does not hold permits or licenses with the U.S. Bureau of Alcohol Tobacco and Firearms (BATF) or any other state or federal agency authorizing storage of explosives on their property. Blasting activities are conducted by PBM's blasting contractor, ORICA USA, who delivers the blasting agents to the quarry by truck. The blasting agents are delivered, placed, and detonated all in the same day so that no explosives are stored at the quarry. The fact that delivery, placement, and blasting must occur on the same day limits the amount of explosives that can be delivered in one day. The blasting contractor has indicated that blasting at the quarry occurs approximately once a month and up to 11,000 lbs of explosives are used in a typical single day blasting event. Any unused explosives are removed from the PBM site at the end of each day [12-8].

There are several types of explosives used in the mining and quarry industry and the type of explosive used is generally determined by the regional geology. PBM's contractor has been using Ammonium Nitrate/ Fuel Oil (ANFO) as their blasting agent. ANFO has the added safety benefit in that it is shipped on the same truck as a binary explosive with the Ammonium Nitrate in a separate compartment from the Fuel Oil. The truck drives to each individually pre-drilled hole, where the specific weight of explosive is mixed and poured into the hole.

Trucks that deliver explosives to PBM are regulated by U.S. Department of Transportation regulations [12-10] that establish maximum gross vehicle weights at 80,000 lbs resulting in a maximum cargo weight of under 50,000 lbs. This is consistent with guidance from Regulatory Guide 1.91 [12-11] which recommends using 50,000 lbs of equivalent weight TNT for a postulated accident involving a truck on a highway.

Based on the typical blasting activities and regulations precluding storage of explosives, the guidance in Regulatory Guide 1.91 provides a reasonable evaluation of the hazard associated with the PBM quarry to the CISF. This evaluation establishes that an acceptable safe distance for an explosion involving 50,000 lbs of equivalent weight TNT is approximately 1,660 feet from the point of detonation which is well short of the CISF.

If future operations require the storage of explosives on site, such storage will be limited by BATF regulation 27 CFR 555.218, "Table of Distances for Storage of Explosive Materials (High)" [12-9]. This table establishes that the minimum safe distance from an unbarricaded stockpile of 300,000 lbs of high explosives to inhabited buildings shall be 2,275 feet. This safe distance is well below the 4,000 feet between the CISF PA and the PBM property line providing assurance that future operations at the quarry will not impact the CISF.

Immediately south of the proposed WCS CISF is the currently operating Waste Control Specialists commercial waste disposal facility. This site has 12 fixed fuel tanks (Table 2-20) ranging in size from under 300 gallons to 8,000 gallons in size containing either diesel fuel, gasoline, or propane. Three of the twelve tanks are collocated in a cluster. These three tanks are the MWTF Diesel Tank (red), the MWTF Diesel Tank (green), and the MWTF Gasoline Tank. These three tanks consist of a total of 8,500 gallons of diesel fuel and 5,000 gallons of gasoline.

Regulatory Guide 1.91 [12-11] was established to determine acceptable distances from explosions at which no significant damage would be expected. The guidance establishes the safe distance where the overpressure from the explosion is less than 1.0 psi.

Gasoline and diesel fuel are not explosive compounds and only have explosive potential if they are allowed to vaporize and mix with oxygen. Potential vaporization would only be the result of a tank leak or tank collapse allowing the liquid fuel to be released and then to vaporize.

Utilizing the guidance [12-11] for vapor cloud explosions, an evaluation of the collocated tanks [12-12] determines that the safe distance from the cluster of fuel tanks is 454 feet. This distance is significantly less than the 4,400 feet that exists between the cluster of tanks and the CISF Protected Area (PA) boundary.

In addition to the three collocated tanks, the evaluation [12-12] uses similar methodology to model the potential Vapor Cloud Explosion that could result from failure of the 5,000 gallon propane tank. The model shows that the safe distance from the propane tank is 1,010 feet. This distance is significantly less than the 4,340 feet that exists between the propane tank and the CISF PA boundary.

As indicated in Table 2-20, these evaluated cases bound all of the fixed diesel/gasoline tanks and the propane tanks at the existing Waste Control Specialists facility. In addition to the fixed tanks, Waste Control Specialists has three 475 gallon mobile diesel tanks used for fueling heavy equipment in the field. Applying the results from the evaluation of the larger collocated tanks [12-12], the Owner Controlled Area boundary provides 660 feet of standoff distance from the Protected Area of the CISF. This is more than adequate to provide safe distance from an accident involving the mobile diesel tanks.

Oil industry pipelines are located near the facility. A natural gas pipeline owned by Energy Transfer LP (previously owned by Sid Richardson Energy Services Company) runs parallel to Texas State Hwy 176 within an easement on Waste Control Specialists property. An evaluation assessing the hazards to the WCS CISF due to a pipeline leak and subsequent vapor cloud explosion following the guidance of Regulatory Guide 1.91 determined that the distance between the pipeline and the WCS CISF is sufficient to preclude any adverse impacts to the facility [12-7].

Directly adjacent to (within 30 feet) and parallel to the Energy Transfer LP natural gas pipeline is an additional buried 14 inch diameter pipeline which is in idle status. This pipeline is also owned by Energy Transfer LP and it has been idle since before 2004.

There is a 10-inch diameter buried CO_2 pipeline which runs along the western and southern boundary of New Mexico Section 32. This pipeline does not present a hazard to the WCS CISF based on the nature of the pipeline product and its distance from the WCS CISF, which is more than 8,000 feet at its closest point.

Love's Travel Stops & Country Stores has started construction on a travel stop in New Mexico at the southeast corner of the intersection of New Mexico Highway 18 and Hwy 176. The Travel Stop will store up to 40,000 gallons of diesel fuel, 28,000 gallons of gasoline, and up to 12,000 gallons of non-flammable Diesel Exhaust Fluid (DEF) in underground tanks. Emergency Response Guide 128 [12-4] recommends a 0.5 mile safe distance for ignitable liquid tank fires which is much less than the 3.5 mile distance from the Travel Stop to the closest point at the WCS CISF boundary.

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, ISP 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.

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 Technical Specifications (See [Gen-1])

12-4 Emergency Response Guide 128, Emergency Response Guidebook (2016), U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration.

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.

12-7 ISP Calculation "Hazard Analysis of Gas Pipeline for WCS CISF," WCS01-0211, Revision 0.

12-8 Permian Basin Materials. Personal communications between M. Ulibari, Permian Basin Materials, D. Maggard, ORICA USA, C. Patterson, ORICA USA, A. Melton, ORICA USA, and B. Mason, Waste Control Specialists LLC, April 2019.

12-9 27 CFR Part 555, Commerce in Explosives, U.S. Bureau of Alcohol Tobacco and Firearms (BATF), U.S. Department of Justice.

12-10 23 CFR Part 655, Traffic Operations, Federal Highway Administration, U.S. Department of Transportation

12-11 Regulatory Guide 1.91, "Evaluation of Explosions Postulated to Occur at Nearby Facilities and Transportation Routes Near Nuclear Power Plants," Revision 2, Nuclear Regulatory Commission.

12-12 ISP Calculation "Fuel Tank Evaluation," WCS01-0212, Revision 0.

Table 12-1
Off-Normal and Accident Evaluations for the Storage Systems at the WCS CISF

Cask System	Canister	Overpack	Appendix
NUHOMS®-MP187-Cask System	FO-DSC FC-DSC FF-DSC GTCC Canister	HSM (Model 80)	Appendix A.12
Standardized Advanced NUHOMS® System	NUHOMS® 24PT1	AHSM	Appendix B.12
Standardized NUHOMS® System	NUHOMS® 61BT	HSM Model 102	Appendix C.12
	NUHOMS® 61BTH Type 1		Appendix D.12
NAC-MPC	Yankee Class Connecticut Yankee LACBWR GTCC-Canister-CY GTCC-Canister-YR	VCC	Appendix E.12
NAC-UMS	Classes 1 through 5 GTCC-Canister-MY	VCC	Appendix F.12
MAGNASTOR	TSC1 through TSC4 GTCC-Canister-ZN	CC1 through CC4	Appendix G.12

CHAPTER 13
CONDUCT OF OPERATIONS

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13. CONDUCT OF OPERATIONS

This chapter discusses the organization for the design, fabrication, construction, testing, operation, modification and decommissioning of the Interim Storage Partners (ISP) WCS Consolidated Interim Storage Facility (WCS CISF). Included are descriptions of organizational structure, personnel responsibilities and qualifications, interface with contractors and other outside organizations.

ISP has provided in the CISF application the following plans as required by 10 CFR Part 72:

- The Quality Assurance Plan, "TN Americas LLC Quality Assurance Program Description Manual for 10 CFR Part 71, Subpart H and 10 CFR Part 72, Subpart G," current revision (Chapter 13 Section 13.8, Reference [13-2]).
- The Emergency Response Plan, WCS ERP-100, Draft Consolidated Emergency Response Plan, [13-4].
- The Physical Security Plan, Safeguards Contingency Plan, and Security Training and Qualification Plan, which were provided pursuant to 10 CFR 72.24(o), 72.180, and 72.184 separately as part of the license application.

In addition to the above, ISP's Radiation Safety Plan and Environmental Monitoring Program are described in Chapter 9 of the SAR and will be adopted or adapted to ensure the safe operation and maintenance of the WCS CISF under 10 CFR Part 72.

The development of the WCS CISF is managed by ISP with support from Waste Control Specialists LLC, TN Americas LLC and NAC International. Final responsibility for construction, preoperational testing, startup and operation of the WCS CISF remains with ISP. Therefore, ISP's organization and its interfaces with outside support organizations are described herein.

13.1 Organizational Structure

Orano CIS LLC and Orano USA LLC

Orano CIS LLC (OCIS) and Orano USA LLC (OUSA) are Limited Liability Companies formed in Delaware with principle offices in Washington, D.C. The sole purpose of OCIS is to be the 51 % parent of ISP. OCIS is owned 100% by OUSA. OUSA business includes decommissioning activities, support of the DOE Lab complex, transportation and logistics of materials supporting the nuclear fuel cycle, the supply of components and services related to the storage of used nuclear fuel, the sale of uranium conversion and enrichment services. TN Americas LLC is a subsidiary of OUSA that performs transportation and logistics of materials supporting the nuclear fuel cycle and the supply of components and services related to the Storage of Used Nuclear fuel. The parent of OUSA is Orano SA with principle offices in Paris, France.

Waste Control Specialists LLC

Waste Control Specialists LLC owns and operates West Texas facilities used in the processing, treatment, storage and disposal of a range of low-level radioactive, hazardous, toxic and other wastes. Waste Control Specialists has permits and licenses from the Texas Commission on Environmental Quality (TCEQ) and the U.S. Environmental Protection Agency (U.S. EPA) to accept hazardous and toxic wastes, LLRW and byproduct waste material governed by various laws and regulations, including the Atomic Energy Act (AEA), Resource Conservation and Recovery Act (RCRA) and the Toxic Substances Control Act (TSCA), for treatment, storage and/or disposal. Waste Control Specialists is currently the only facility in the U.S. that can accept Class A, B and C LLRW for disposal from generators across the U.S. Waste Control Specialists also provides waste management services to the commercial sector and Federal government waste generators.

J.F. Lehman & Company

J.F. Lehman (JFLCO) and its partners recently acquired 100% of Waste Control Specialists through a holding company, FERMI HOLDINGS. JFLCO is a private equity firm founded in 1992 that focuses exclusively on investing in companies in the defense, aerospace and maritime industries and companies using the technical capabilities that originate from these sectors. This investment strategy reflects the firm’s deep experience in and commitment to these sectors for more than two decades. The firm’s investment strategy is designed to leverage its specialized industry knowledge and operational skills to create significant value by helping acquired companies achieve their full potential.

JFLCO is headquartered in New York with additional offices in Washington, D.C. To date, the firm has acquired approximately 60 operating entities within 24 platform investments with an aggregate transaction value of approximately $3.1 billion.

Interim Storage Partners LLC

Interim Storage Partners LLC (ISP) is a Limited Liability Company formed in Delaware with principle office at Andrews, Texas. ISP is a joint venture of Orano CIS (51%) and Waste Control Specialists LLC (49%). The sole purpose of ISP is to license, design, construct and operate the CISF at the Waste Control Specialists site in Andrews, Texas.

The ISP organization at the time of filing of the license application revision consists of TN Americas LLC personnel, Waste Control Specialists corporate personnel, WCS CISF personnel, as well as contracted support for engineering, design and operations, public affairs and other necessary expertise.

ISP will name additional position titles and second additional employees as the project moves from the pre-licensing phase to the licensing and construction phase, and subsequently, into the operational phase.

Prior to commencing construction, operation, and receipt of licensed material at the WCS CISF, ISP expects to enter into a contract(s) with the DOE or other entities that may hold title to the spent fuel, that will provide the funding for facility construction, operation, and decommissioning, including any fees paid to hosting public entities. It is anticipated that the DOE or other SNF title holders will be the customers for the WCS CISF and will have title to the spent nuclear fuel (SNF) and Greater Than Class C (GTCC) waste stored at the facility. (Note, in the balance of this chapter, wherever SNF is mentioned, this includes both SNF and GTCC wastes.)

13.1.1 Corporate Organization

The ISP Chief Executive Officer (CEO)/President, is the executive in charge of ISP, managing all ISP functional areas to include those actions necessary to comply with the applicable requirements of 10 CFR Part 72 Subpart G and 10 CFR Part 71 Subpart H.

The ISP CEO/President establishes the basic policies of the QA Program. The ISP CEO/President is the highest level of management responsible for the ISP policies, goals, and objectives. Also the ISP CEO/President is responsible for Field Services & Operations and Fleet Asset Management functions associated with storage / transportation systems and other related activities subject to the requirements of the QA Program (QAP). Additionally, the ISP CEO/President has the authority and reporting responsibility as Responsible Officer associated with 10 CFR Part 21. Those reporting to the ISP CEO/President who have quality affecting responsibilities are the Chief Engineer CISF Licensing and Engineering and Director of Quality Assurance (DQA).

The Chief Engineer CISF Licensing and Engineering is responsible for the facility's license and the overall operation and administration of the facility.

13.1.1.1 Corporate Functions, Responsibilities, and Authorities

The ISP CEO/President establishes the basic policies of ISP. The ISP CEO/President is the highest level of management and holds the following responsibilities:

- developing ISP policies, goals, and objectives;
- performing the long-range planning necessary to ensure stable resources for the operation of the facility;
- ensuring appropriate financial stability is maintained on an operating basis;
- ensuring decommissioning is properly funded;
- ensuring decommissioning funding remains current by means of annual decommissioning funding reviews; and
- ensuring license standards for engineering and design, construction, QA, testing and operation are met through oversight by Corporate Staff, expert consultants reporting through to the Chief Engineer CISF Licensing and Engineering, and the WCS CISF QA personnel.

The Chief Engineer CISF Licensing and Engineering reports directly to the ISP CEO/President and is responsible for preparation and submittal of the WCS CISF License Application, including the Safety Analysis Report, Environmental Report and Emergency Response Plan; securing inside and/or outside expertise to assist in preparation of the License Application; and development of responses to address requests for additional information from the NRC (pre-licensing phase). Additionally, the Chief Engineer CISF Licensing and Engineering is responsible for all design control and configuration management activities associated with structures, systems and components considered important-to-safety (ITS).

The Chief Financial Officer reports directly to the ISP CEO/President and is responsible for managing budgets, payroll, cash flows, and financial security.

The VP Legal Services reports directly to the ISP CEO/President and serves as the liaison with the NRC and other organizations on all legal matters. The ISP CEO/President is responsible for ensuring that the project's legal activities are consistent with the policies established by the ISP CEO/President.

13.1.1.2 Applicant's Organization

Figure 13-1 illustrates the organizational structure of ISP. The Chief Engineer CISF Licensing and Engineering reports directly to the ISP CEO/President and is responsible for the overall operation and administration of the facility. The Chief Engineer CISF Licensing and Engineering is responsible for ensuring all activities are conducted within the limitations of the facility's license and in compliance with applicable federal and state regulations, has the responsibility of managing compliance with all WCS CISF licensing requirements, as well as responsibilities over WCS CISF engineering activities.

The DQA reports directly to the ISP CEO/President and has overall responsibility for the implementation of the QA Program. The DQA has the responsibility and authority for developing, maintaining and verifying proper implementation of the QA Program. This responsibility includes setting priorities, objectives and ensuring activities subject to the requirements of the QAPD are performed in accordance with the implementing procedures.

Additional responsibilities assigned to the DQA position include:

- administering the corrective action program;
- ensuring QA staff is appropriately qualified;
- conducting audits, surveillances and inspections to verify activities are conducted in accordance with QAPD requirements;
- initiating corrective action requests when conditions or significant conditions adverse to quality are identified by QA staff; and
- periodically reporting to the ISP CEO/President and the Chief Engineer CISF Licensing and Engineering on the status and effectiveness of the program.

The DQA and the QA organization have:

- sufficient authority and organizational freedom to identify quality problems, require corrective action be taken and verify corrective action effectiveness;
- sufficient independence from cost and schedule considerations;
- the authority to stop unsatisfactory work and prevent its further processing, installation, use or delivery; and
- sufficient expertise and training in the field of Nuclear QA enabling them to assess the quality functions in accordance with the applicable regulatory criteria, codes, and standards invoked by the QAP (records will be maintained to document qualifications of the QA personnel where required).

The Director of Operations/Construction reports to the Chief Engineer CISF Licensing and Engineering and is responsible for scheduling of project personnel, WCS CISF work activities, operations, maintenance, project management functions and performance data.

The Radiation Safety Officer (RSO)/Director of Health and Radiation Safety is responsible for ensuring compliance to the Radioactive Materials License(s) along with State and Federal regulations related to radiological safety and reports to the Director of Operations/Construction and has a direct line of communication to the ISP CEO/President on matters regarding safety. The RSO/Director of Health and Radiation Safety is responsible for the Radiation Safety Program and (industrial) Health and Safety Program.

The RSO/Director of Health and Radiation Safety is also responsible for managing the Industrial Health and Safety program to protect employees and the company and maintain safe working conditions. This involves ensuring that all industrial safety programs meet compliance and reporting requirements specified in federal and state regulations, working with the Radiation Safety Department in promoting the nuclear culture throughout the WCS CISF, and coordinating compliance functions to ensure all safety issues are resolved and that all compliance matters are maintained as prescribed by OSHA.

The Training Manager reports to the Director of Operations/Construction and is responsible for staff training and improvement initiatives focused on improving performance across the ISP organization.

The Director of Contracts and Administrative Services reports to the VP of Legal Services and is responsible for records management and quality-related purchasing activities and is responsible for negotiating contracts and issuing procurement documents in support of engineering, fabrication, maintenance, testing and other activities associated with storage / transportation systems and other related activities subject to the requirements of the QAP.

13.1.1.3 Interrelationships with Contractors and Suppliers

As facility owner and licensee, ISP will retain ultimate responsibility for the safe operation of the facility and for compliance with all license conditions. TN Americas and Waste Control Specialists are the contractors for the design, development, construction, operation, and maintenance of the WCS CISF. As the construction contractor for the WCS CISF, TN Americas will provide an acceptable construction quality assurance program (CQAP) to ISP. ISP QA will perform surveillances and/or audits of CQAP required activities throughout construction to verify conformance to quality, technical and regulatory requirements (design bases, specifications, license conditions, etc.).

ISP contractors and suppliers of services or items classified as ITS and quality affecting activities, are pre-approved prior to award according to QA procedures. As required, audits and/or surveys are conducted to determine supplier approval. These audits/surveys are based on one or all of the following criteria:

- the suppliers' capability to comply with the requirements of 10 CFR Part 71 Subpart H, 10 CFR Part 72 Subpart G, and other regulations, codes or standards that are applicable to the scope of work to be performed;
- a review of previous records to establish the past performance history of the supplier; and
- a survey of the suppliers' facilities and review of the supplier's QA Program to assess the adequacy and verify implementation of quality controls consistent with the requirements being invoked.

ISP control of contractors and suppliers is established before award or purchase by use of ISP or sub-tier procurement documents, which specify applicable technical, regulatory, administrative, quality, and reporting requirements. ISP procurement documents require suppliers to pass on appropriate QA program requirements to sub-tier suppliers.

The Director of Operations/Construction fills the role of Construction Manager. During construction of the WCS CISF, the Construction Manager will oversee the installation in accordance with QA requirements. The Director of Operations/Construction will perform the oversight role on a daily basis. The Director of Operations/Construction will report to the Chief Engineer CISF Licensing and Engineering who in turn reports to the ISP CEO/President. ISP will: 1) perform independent audits of the WCS CISF operations contractor's QA Program (both the achievement of quality by the WCS CISF contractor management and the verification of quality by WCS CISF contractor QA personnel); 2) provide qualified on-site staff to manage and oversee WCS CISF contractor activities; 3) retain the responsibility to budget necessary and sufficient funds to safely operate and maintain the facility; and 4) retain the authority through the establishment of initial WCS CISF contract, provisions, and as necessary through revision of the contract, to correct any deficiencies in the operation of the facility relative to its design and licensing basis.

The on-site ISP organization will be modified as necessary to ensure an appropriate interface with the WCS CISF operating contractor organization to perform the management and oversight functions discussed above.

13.1.1.4 Applicant’s Technical Staff

The WCS CISF technical staff includes ISP joint venture member Waste Control Specialists’ Andrews County Site and corporate personnel, contractor TN Americas, sub-contractors and licensing consultants. The staff that supports ISP operations is described below. The functions, responsibilities and authorities of the WCS CISF operations personnel are described in Section 13.1.2.2. The qualifications of the technical staff meet or exceed the requirements specified in Section 13.1.3.

TN Americas will provide to ISP information regarding the storage systems and transportation casks necessary to support the licensing, design, construction, operation, and maintenance of the WCS CISF. Designs, calculations, and analyses performed by this vendor or any other vendors will be reviewed and approved by ISP personnel prior to construction. The actual qualifications, training and experience of the ISP and contractor staff providing oversight to the design, construction, and operation of the WCS CISF will be maintained on file to demonstrate compliance with the minimum requirements.

13.1.2 Operating Organization, Management, and Administrative Control System

The following sections describe the WCS CISF and contractor combined organization during the operational phase of the project.

13.1.2.1 On-Site Organization

This section describes the WCS CISF operations organization expected to be in place during receipt, long-term storage and eventual loading for off-site disposal of SNF. The WCS CISF operations organization will be staffed with technical personnel from the existing ISP joint venture member Waste Control Specialists organization and TN Americas to perform the functions of WCS CISF specialists and key management as described in Section 13.1.2.2. An estimated 20 full-time security guards will be required to staff the operating WCS CISF. The positions shown are functional and may not correspond to actual titles or positions. Lines of authority, responsibility, and communication will be established and defined for all WCS CISF organization and supporting positions. These relationships will be documented and updated as appropriate, in organization charts, functional descriptions of departmental responsibilities and relationships, and position descriptions for key personnel. This organization will ensure the continued safe operation of the WCS CISF during all normal, off-normal, and accident conditions.

Waste Control Specialists administrative staff common to the adjacent site facilities will be responsible for many of the administrative requirements of the WCS CISF, subject to ISP oversight including the maintenance of records in accordance with conditions of the License. Waste Control Specialists administrative staff will be responsible for the necessary personnel functions, ensuring that adequate business records and services are maintained, and appropriate applicable hiring standards are followed in the selection of staff members. Contractors may maintain their own personnel functions, services and records, periodically transferring custody of operating records to ISP as required.

13.1.2.1.1 Safety Review Committee

The WCS CISF Safety Review Committee is responsible for reviewing and advising the ISP CEO/President on matters relating to the safe storage of SNF.

The Safety Review Committee will be composed of a minimum of a Chairperson and four members. Alternates may be substituted for regular members. The ISP CEO/President will designate, in writing, the members and alternates for this committee. The Chief Engineer CISF Licensing and Engineering shall be the Chairperson of the Safety Review Committee.

The Safety Review Committee will collectively have experience and knowledge in the following areas:

- SNF Handling and Storage;
- Engineering;
- Radiation Safety; and
- Quality Assurance.

The Safety Review Committee will meet at least once prior to receipt of SNF for storage at the WCS CISF and at least once prior to transporting the SNF off-site. The Committee will also meet at least once annually and at any time deemed necessary by the ISP CEO/President. A quorum will consist of three regular members or duly appointed alternates. At least one member of the quorum will be the Chairperson or the Chairperson's designated alternate.

The Safety Review Committee will, as a minimum, perform the following functions:

- advise the ISP CEO/President on matters related to the safe storage of SNF; and
- notify the ISP CEO/President of any safety significant disagreement between the Safety Review Committee and the Chief Engineer CISF Licensing and Engineering within 24 hours.

The Safety Review Committee will be responsible for the review of:

- proposed changes to the WCS CISF Technical Specifications or the License;
- violations of codes, orders, license requirements, or internal procedures/instructions which are ITS storage of SNF;
- indications of unanticipated deficiencies in any aspect of design or operation of SSCs that could affect the safe storage of SNF;
- significant accidental, unplanned, or uncontrolled radioactive releases, including corrective action to prevent recurrence;
- significant operational abnormalities or deviations from normal and expected performance of equipment that affects the safe storage of SNF;
- the performance of the corrective action system;
- internal and external experience information related to the safe storage of SNF that may indicate areas for improving facility safety; and
- significant audit findings that affect the safe storage of SNF.

Reports or records of these reviews will be forwarded to the ISP CEO/President within 30 days following completion of the review.

13.1.2.2 Personnel Functions, Responsibilities, and Authorities

All WCS CISF personnel will perform their activities in accordance with the requirements of the WCS CISF license, Technical Specifications, QA Procedures, Security Plans and procedures, WCS CISF procedures, and applicable federal and state regulations.

The Chief Engineer CISF Licensing and Engineering reports directly to the ISP CEO/President and is responsible for the safe overall operation and administration of the facility. The Chief Engineer CISF Licensing and Engineering is responsible for ensuring all activities are conducted within the limitations of the facility's license and in compliance with applicable federal and state regulations as well as responsibilities over WCS CISF engineering activities and is responsible for all design control and configuration management activities associated with structures, systems and components considered ITS.

The Director of Operations/Construction reports to the Chief Engineer CISF Licensing and Engineering and is responsible for scheduling of project personnel, WCS CISF work activities, operations, maintenance, project management functions and reporting performance data to the Chief Engineer CISF Licensing and Engineering .

The Director of Operations/Construction is also responsible for the safe operation of the WCS CISF including maintenance of personnel training and qualifications in accordance with the WCS CISF Operations Training Program and operation of WCS CISF equipment that is ITS. The Director of Operations/Construction will be responsible for the day-to-day operation of the WCS CISF and will provide direction and guidance for the safe operation, maintenance, radiation safety, training and qualification of the WCS CISF and personnel. In order to ensure continuity of operation and organizational responsiveness to off-normal situations, a formal order of succession and delegation of authority will be established. The Director of Operations/Construction will designate in writing personnel who are qualified to act as the Director of Operations/Construction during an absence.

The DQA has the responsibility and authority for developing, maintaining and verifying proper implementation of the QA Program. Each organization within ISP is responsible for implementation of the program for their respective scope of responsibility. The DQA reports to the ISP CEO/President and has overall responsibility for the implementation of the QA Program. This responsibility includes setting priorities, objectives and ensuring activities subject to the requirements of the QAPD are performed in accordance with the implementing procedures. The DQA is independent of cost and schedule considerations and has direct access to the ISP CEO/President.

The RSO/Director of Health and Radiation Safety is responsible for ensuring compliance to ISP’s Radioactive Materials License(s) along with State and Federal regulations related to radiological safety and reports to the Director of Operations/Construction and has a direct line of communication to the ISP CEO/President on matters regarding safety. The RSO/Director of Health and Radiation Safety is responsible for the Radiation Safety Program and (industrial) Safety Program.

The Radiation Safety Supervisor reports to the RSO/Director of Health and Radiation Safety and is responsible for implementation of the Radiation Safety Program at the WCS CISF. This includes safety training and maintaining the performance of the facility's fire protection systems. Duties also include the training of personnel in the use of equipment, control of radiation exposure of personnel and continuous determination of the radiological status of the facility.

The Facility Security Officer/Security Manager reports to the Director of Operations/Construction. The Facility Security Officer/Security Manager and security staff personnel will be responsible for WCS CISF security during routine, emergency and contingency operations.

13.1.3 Personnel Qualification Requirement

The Operator Training Program will include requirements regarding the physical condition and general health of personnel certified for the operations of equipment and controls that are important to safety such that they may not cause operational errors that could endanger other in-facility personnel or the public health and safety. Any condition that might cause impaired judgement or motor coordination will be considered in the selection of personnel for activities that are important to safety. However, these conditions will not categorically disqualify a person, if appropriate provisions are made to accommodate such condition.

The minimum qualification requirements for the WCS CISF positions that are ITS during off-loading, transfer, storage, loading and other SNF handling operations at the WCS CISF are outlined below.

13.1.3.1 Minimum Qualification Requirements

The physical condition and general health of personnel certified for the operation of equipment and controls ITS shall not be a potential cause of operational errors that could endanger other in-plant personnel or the public health and safety.

Requirements for these positions include knowledge of SNF handling and storage equipment and processes, criticality safety control, industrial safety and Radiation Safety Program concepts as they apply to the overall safety of a nuclear facility, commensurate to work performed. All off-loading, transfer, loading and other SNF handling operations at the WCS CISF will either be performed by, or supervised by, WCS CISF personnel trained and qualified by the WCS CISF Operations Training Program.

During WCS CISF operations, operation of equipment and controls identified as ITS for the WCS CISF will be limited to personnel who are trained and qualified in accordance with the WCS CISF Operations Training Program, or personnel who are under the direct visual supervision of a person who is trained and qualified in accordance with the WCS CISF Operations Training Program.

The individual qualification requirements for staff provided below are for the minimum levels. However, actual functional resumes will be available once staff is selected during construction in advance of operation under the License.

The Director of Operations/Construction reports directly to the Chief Engineer CISF Licensing and Engineering. The Director of Operation/Construction's qualifications include knowledge of radioactive materials handling and storage equipment and processes, criticality safety control, industrial safety and radiation safety program concepts as they apply to the overall safety of a radioactive materials facility. The Director of Operations/Construction must have an Associate's Degree or equivalent from a two-year college or technical institute in an engineering or scientific field generally associated with nuclear power production, fuel storage or radiation safety; or sixty hours related study in the field of hazardous waste management, environmental science and/or radiation health and additionally shall have a minimum of 10 years of radioactive materials operations experience, of which a minimum of 5 years shall be experience in management of bulk radioactive materials handling operations or an equivalent combination of training, experience and education. The Director of Operations/Construction will be trained and qualified in accordance with the WCS CISF Operations Training Program training and qualification requirements.

The WCS CISF Operations Supervisors report to the Director of Operations/Construction and shall have a high school diploma or have successfully completed the GED test and 3-5 years of radioactive materials handling facility experience of which a minimum of 1 year shall be experience in supervising radioactive materials handling operations, or equivalent combination of education and experience. Consistent with the assigned duties, WCS CISF Operations Supervisors will be trained and qualified in accordance with the WCS CISF Operations Training Program training and qualification requirements. In addition, WCS CISF Operations Supervisors are trained in the operation of plant cranes and forklifts.

All personnel that operate cranes at the WCS CISF must be certified by the "National Commission for the Certification of Crane Operators" (NCCCO). These crane operators must be certified on each crane they operate and must be designated as a competent person. This certification must be renewed every five years. Fork Lift/Power Industrial Trucks Certification is made according to 29 CFR 1910.178 at the WCS CISF with a combination of: formal and practical instruction on operation of Fork Lifts; followed by demonstration of Job Performance Measures (JPMs) for "Safe Forklift Operation/ Powered Industrial Trucks" which must be completed and signed by the student operator and Instructor. Forklift Operation/ Powered Industrial Trucks Refresher Training must be completed every three years.

WCS CISF Operators report to WCS CISF Operations Supervisors and shall have a high school diploma or have successfully completed the GED test. WCS CISF Operators shall have 2 years of radioactive materials facility experience of which a minimum of 1 year shall be radioactive materials handling operations experience. Consistent with the assigned duties, WCS CISF Operators will be trained and qualified in accordance with the WCS CISF Operations Training Program training and qualification requirements and with any vendor training and qualification requirements for the operation of vendor-specific cask/canister handling equipment. In addition, WCS CISF Operators are trained in the operation of forklifts and plant cranes.

The WCS CISF Radiation Safety Supervisors (RSS) report to the RSO/Director of Health and Radiation Safety and shall have an Associate’s Degree in Health Physics/Radiation Safety Technology, or Bachelor’s degree in Health Physics / Physical Science, or a related technical field, or sixty (60) hours of related study and five (5) years of experience in the field of Health Physics or combination of education and experience at the discretion of the RSO/Director of Health and Radiation Safety.

The WCS CISF Radiation Safety Technicians (RST) report to WCS CISF Radiation Safety Supervisors and shall have an Associate’s Degree in Health Physics/Radiation Safety Technology, Physical Science, or a related technical field, or fifty (50) hours of related study and two (2) years of experience in Radiation Safety, Environmental Monitoring, Industrial/Occupational safety, Radiological Instrumentation or combination of education and experience at the discretion of the RSO/Director of Health and Radiation Safety. Qualifications include knowledge of radioactive materials handling and storage equipment and processes, industrial safety and radiation safety concepts as they apply to the overall safety of a radioactive materials facility.

The DQA reports to the ISP CEO/President and shall have at least a Bachelor's degree (or equivalent) in a scientific or engineering field and at least five years of responsible experience in the implementation of a QA program or equivalent combination of education, training and experience. The DQA shall also have at least two years of experience in a management role of a QA organization at a radioactive materials facility.

The Maintenance Manager reports to the Director of Operations/Construction and shall have, as a minimum, five years of experience in facility operations and maintenance. Qualified candidates will have an in-depth knowledge of various maintenance operations, utility infrastructure operations, as well as a degree of familiarity with building systems, instrumentation, and configurations.

WCS CISF Maintenance Technicians report to the Maintenance Manager and shall have, as a minimum, two years of experience in facility operations and maintenance. Qualified candidates will have a basic knowledge of various maintenance operations, utility infrastructure operations, as well as a degree of familiarity with building systems, instrumentation, and configurations. As consistent with assigned duties, WCS CISF Maintenance Technicians will be trained and qualified in accordance with the WCS CISF Operations Training. In addition, WCS CISF Maintenance Technicians are trained in the operation of forklifts and plant cranes and they should have a working knowledge of the plant drawing system and the vendor manual system.

Waste Acceptance Specialists report to the Director of Operations/Construction and shall have, as a minimum, a Bachelor's degree (or equivalent) in an engineering, physical science or environmental discipline or five (5) years of related waste management work experience; or an equivalent combination of training, experience and education.

The RSO/Director of Health and Radiation Safety reports to the Director of Operations/Construction and is responsible for ensuring compliance to the Radioactive Material License(s), along with State and Federal regulations related to radiological safety. The RSO/Director of Health and Radiation Safety has a direct line of communication with the ISP CEO/President.

Qualifications of the designated RSO include, as a minimum: a bachelor’s degree in a physical or biological science, industrial hygiene, health physics, radiation protection, or engineering from an accredited college or university, or national certification under a nationally recognized health physics authority, or an equivalent combination of experience and training in radioactive waste processing, or in radioactive waste disposal.

The Facility Security Officer/Security Manager reports to the Director of Operations/Construction and shall have a minimum of five years of experience in the responsible management of physical security similar to that required for the WCS CISF. Academic training may not be credited toward fulfilling this experience requirement. In accordance with 10 CFR 73.51(d)(5), members of the WCS CISF security organization will be trained, equipped, qualified and re-qualified to perform assigned job duties in accordance with appendix B to part 73, sections I.A. (1) (a) and (b), B(1)(a), and the applicable portions of II.

The Safeguards Information Coordinator (SGI-C) reports to the Facility Security Officer/Security Manager and shall have experience in safeguards programs and physical security.

Security Shift Supervisors report to the Facility Security Officer/Security Manager and shall have a high school diploma or equivalent and at least three years of applicable experience in physical security. Prior to appointment, the Shift Supervisor shall have satisfied WCS CISF security force training and qualification requirements. In accordance with 10 CFR 73.51(d)(5), members of the WCS CISF security organization will be trained, equipped, qualified and re-qualified to perform assigned job duties in accordance with appendix B to part 73, sections I.A. (1) (a) and (b), B(1)(a), and the applicable portions of II.

Security Officers/Guards report to the Security Shift Supervisors and shall have a high school diploma or GED and two years security experience required. In accordance with 10 CFR 73.51(d)(5), members of the security organization will be trained, equipped, qualified and re-qualified to perform assigned job duties in accordance with appendix B to part 73, sections I.A. (1) (a) and (b), B(2)(a), and the applicable portions of II.

13.1.3.2 Qualification of Personnel

The qualifications, training and experience of the WCS CISF operating contractor staff occupying the key positions described in Section 13.1.2.2 will be kept on file to demonstrate compliance with the minimum requirements set forth in Section 13.1.3.1.

13.1.4 Liaison With Outside Organizations

The WCS CISF will interface with a number of off-site organizations and agencies such as applicable DOE offices or projects as necessary to ensure the safe shipment of SNF to and from the WCS CISF.

WCS CISF Security will establish formal arrangements, via Memoranda of Understanding (MOU), that will be established with various government law enforcement and emergency response agencies relative to the construction and operation of the WCS CISF. Each MOU will define the anticipated response actions of that response force and how each agency will interact with Security and Emergency Staff. These arrangements will be available in the site-specific WCS CISF license application documentation.

13.2 Pre-Operational Testing and Operation

This section describes the WCS CISF Pre-operational and Operational Test program. Included is a description of the administrative procedures for conducting the program and a general program description.

The testing program consists of pre-operational testing, which occurs prior to SNF receipt, and operational or start-up testing, which occurs after SNF receipt. The objectives of both are to ensure that plant structures, systems and components (SSCs):

- Have been adequately designed and constructed;
- Meet regulatory and licensing requirements;
- Do not adversely affect worker safety or the health and safety of the public; and
- Can be operated in a dependable manner to perform their intended function.

Additionally, the testing programs ensure that operating and emergency procedures are correct and that personnel have acquired the correct level of technical expertise.

13.2.1 Administrative Procedures for Conducting Test Program

The system for preparing, reviewing, approving, and implementing testing procedures and instructions for WCS CISF operations will be in accordance with written procedures meeting QAP requirements. Any changes to, or deviations from, these procedures and instructions will be reviewed and approved in accordance with Technical Specifications requirements of the 10 CFR Part 72 license via a 72.48 review.

13.2.2 Test Program Description

The objectives of the pre-operational testing program are to ensure that the receiving, transfer and storage system performs its intended safety functions and meets the operating controls and limits proposed in the license Technical Specifications applicable to the WCS CISF and each storage system.

13.2.2.1 Pre-Operational Testing

Before the operation of the WCS CISF, the following systems will be tested to ensure they are functioning properly:

- Cask unloading equipment,
- Cask Handling Building overhead bridge cranes and interlocks,
- Cask transporter vehicles,
- Storage cask/module monitoring equipment,
- Area radiation monitoring equipment,

- Electrical systems (ensure that power is available for lighting, security systems, and general service receptacles)
  - Security systems (e.g., alarm, surveillance, etc.) equipment
  - Communications systems (ensure that all WCS CISF communication system and devices are properly connected into the Central Alarm Station and Secondary Alarm Station as applicable)
  - Fire protection equipment
  - Emergency operations center
  - Environmental monitoring
  - Potable water

To the extent practicable, functional tests of the WCS CISF operations, transfer operations, and overpack loading and retrieval will be performed to verify the storage system components (e.g., canisters, casks, transfer systems, etc.) can be operated safely and effectively. Pre-operational testing may be performed using the actual cask and dummy canister or a training cask and canister with test weights, as appropriate. The training cask and canister will be designed and fabricated to approximate the size, weight and behavior of the cask and canister system being exercised.

A dummy canister weighted to simulate actual canisters will be obtained for pre-operational testing mimicking each licensed system. A canister will be loaded into the transportation cask so receipt and transfer operations using actual equipment can be performed. The actual transfer casks/transfer equipment and storage overpacks will be used for this testing. Pre-Operations testing will include all steps to safely receive and place the canister/storage overpack on the storage pad in the Storage Area.

The facility constructor is responsible for completion of all as-built drawing verification, purging/flushing, cleaning, hydrostatic or pneumatic testing, system turnover and initial calibration of instrumentation, in accordance with design and installation specifications provided by the architect engineers and cask system vendors. The Director of Operations/Construction is responsible for coordination of the preoperational testing program.

The Pre-operational Test Plan, including test summaries for all systems, is made available to the NRC at least 90 days prior to the start of testing. Subsequent changes to the Pre-operational Test Plan are also made available to the NRC.

Pre-operational testing is performed for all SSCs ITS and associated interfaces, to ensure that all SSCs ITS are built and function as designed. Pre-operational tests (dry runs or cold tests) are also performed for all operations involving SNF (SNF), to demonstrate that operations are efficiently performed in a safe manner, and to provide verification that operating procedures are acceptable prior to receipt of SNF.

Pre-operational testing on SSCs ITS is completed prior to the on-site receipt of SNF. Systems that are not-important-to-safety (NITS) and which are not required prior to on-site receipt of SNF, pre-operational testing may be completed after SNF receipt (for example, building ventilation tests). Those systems are identified in the Pre-operational Test Plan.

For systems and components that are NITS, acceptance criteria are established only to ensure worker safety and the reliable and efficient operation of the system, and to demonstrate the performance of intended functions.

An operational readiness review will be conducted as part of the pre-operational test program, to verify that the WCS CISF is ready to receive and store SNF. The operational readiness review addresses the following areas at a minimum:

- Radiological controls
- Nuclear safety
- Operations training and procedures
- Construction
- Engineering/design control
- Fire protection
- Maintenance
- Quality assurance
- Emergency preparedness
- Safeguards and security.

Results of pre-operational tests are evaluated, and changes to SSCs and operating procedures are made as necessary. In accordance with 10 CFR 72.80(g), ISP will notify the NRC of its readiness to begin operations at least 90 days prior to the first storage of SNF or GTCC waste.

13.2.2.2 Operational Testing

Operational testing is performed for all SSCs ITS and associated interfaces. These tests ensure the SSCs function as designed when loaded with SNF, and that measured parameters are bounded by the safety analysis. Pre-operational tests demonstrate operations are efficiently performed in a safe manner and provide verification that operating procedures are acceptable prior to normal operations.

Operational testing associated with a particular cask system design is performed the first time the cask system is used at the WCS CISF. Testing is performed in accordance with the cask transportation CoC requirements, operations steps identified in Chapter 5 and associated appendices and the license Technical Specifications requirements.

After start-up testing is complete, inspections and tests of all SSCs ITS will continue on a routine basis to verify that SSCs continue to function as designed. This includes full load tests of the cranes that carry SNF casks and canisters.

13.2.3 Test Discussion

The purpose of the pre-operational tests is to ensure that a canister can be properly and safely retrieved from the transportation cask and placed into storage. Proper operation of the Cask Handling Building, and transfer vehicles/crawlers, as well as the associated handling equipment (e.g., lifting equipment) will provide such assurance.

Pre-operational test requirements will be specific. Detailed procedures will be developed and implemented by ISP personnel responsible for ensuring the test requirements are satisfied.

The expected results of the pre-operational tests are the successful completion of the following:

- Transferring the canister from the transportation overpack to the storage overpack,
- Moving the transfer cask loaded with a canister and test weights to the storage overpack or storage pad (depending on the system)
- Emplacing canisters in a storage overpack or moving the storage overpack to the storage pad, retrieval of the canister from storage and preparing it for transportation in the same cask that provided transportation to the WCS CISF.

The tests will be deemed successful if the expected results are achieved safely and without damage to any of the components or associated equipment.

Should any equipment or components require modification in order to achieve the expected results, it will be retested to affirm that the modification is sufficient. If any pre-operational test procedures are changed in order to achieve the expected results, the changes will be incorporated into the appropriate operating procedures.

13.2.4 Operating Startup Plan

An operating startup plan will be prepared to implement the procedures necessary for the initial receipt of spent fuel and GTCC waste at the WCS CISF site, and the subsequent transfer of the spent fuel and GTCC waste to storage. The startup plan will be submitted to the NRC at 90 days prior to the initial receipt and storage of spent fuel and GTCC waste at WCS CISF. The plan will identify specific operations unique to the initial handling of spent fuel and GTCC waste to be placed into storage. The operating startup plan will also include reviews and tests of the operating procedures, confirmation of radiation exposure times and received doses, direct measurement of radiation dose rates from transportation and transfer casks and storage systems, evaluation of shielding methods, verification of heat removing features in accordance with the technical specifications, and notification to the NRC of the first loaded cask placed in storage.

The operating startup plan will be implemented for the initial receipt and transfer of spent fuel and GTCC waste and placement into storage. Upon completion of the plan, the effectiveness of procedures, actions, and equipment will be evaluated and documented to improve operations for subsequent spent fuel shipments.

13.3 Training Program

The ISP Training Program shall be in accordance with SPM 2.1 [13-5].

13.3.1 Program Description

The objective of the ISP training program for the WCS CISF is to ensure a qualified work force for safe and efficient WCS CISF operations. The training program will be used to provide this training and indoctrination and will be revised, as appropriate, to include lessons learned from operating the facilities. All individuals working in the Cask Handling Building and in the Storage Area will receive radiation and safety training and those performing cask/canister handling operations will be provided additional training, as required.

The training programs, in concert with other management systems, ensure that qualified individuals will be available to perform planned and unplanned tasks while protecting the health and safety of facility personnel and the public. ISP will maintain additional training to support the Emergency Response Plan, Physical Security Plan, Safeguards Information Plan, QAPD, and administrative and safety requirements, as required.

13.3.1.1 General Employee Training

General Employee Training (GET) serves as orientation to the WCS CISF, work processes, regulatory environment and basic safety measures such as the ALARA concept. Among other things, GET covers:

- ISP – History and Summary of Capabilities
- ISP Mission, Vision and Core Values
- Introduction and Organization
- Qualification and Training Program Descriptions
- Permits and Licenses
- Hazardous Waste Regulations and Operations
- Safety Overview Training
- General Employee Radiological Training
- Computer Security
- Quality Assurance Program
- WCS CISF Security
- Stop Work Authority
- Emergency Equipment Legend and Site Overview Map

All ISP employees must complete GET training within 30 days of placement.

13.3.1.2 Radiation Worker Training

Radiation workers at the WCS CISF will receive Radiation Worker I or II training depending on their job function. Rad Worker I Training includes the following topics:

- Fundamentals of radioactive materials and radiation;
- Radiation versus contamination;
- Biological effects of radiation;
- Risks of occupational exposure;
- Exposure limits and minimizing exposure;
- Existing and potential areas of exposure and contamination;
- Personnel dosimetry (internal and external);
- Use of anti-contamination protective clothing (PCs);
- Contamination control;
- Methods of decontamination;
- Rights and responsibilities of radiation workers;
- Stop work authority;
- WCS CISF specific lessons learned as well as industry events;
- Federal and State Regulations and License provisions for the protection of personnel from radiation and radioactive material;
- Emergency response;
- Radiation exposure reports available to workers;
- Respiratory protection program;
- Use of radiation work permits (RWPs).

The training session is followed by a written test, which must be passed at the 80% level of competency before unescorted access is allowed into a Restricted Area.

The RSO may authorize individuals with documented radiation safety training and experience from other sites or utilities, such as the DOE, to challenge any training requirement and demonstrate the requisite level of knowledge in radiation safety by:

- Successfully passing a written exam that includes basic radiation safety training principles and facility/WCS CISF specific information; and
- Successful discussion and performance of practical factors.

Individuals unable to successfully pass the written exam or practical factors shall be required to complete the Radiation Worker II classroom instruction and testing.

Records of required training and satisfactory completion are maintained in each worker's file in the training department.

Hands-on training should be used for newly trained individuals without prior radiation work experience to ensure understanding and proficiency in applied radiation safety practices.

Each worker who is categorized as a Radiation Worker II will receive a minimum of 24 hours classroom training prior to initial assignment and 8 hours of refresher training annually. The purpose of the training is to teach proper methods for working with radiation and handling radioactive materials, to discuss the effects of radiation, to explain the risks of occupational exposure, and to identify the specific hazards associated with facility operations. The following topics will be covered, at a minimum:

- Technical Topics
  - Sources of radiation (natural and man-made),
  - Basic atomic and nuclear physics,
  - Types of radiation and their characteristics (alpha, beta, gamma, x-ray, neutron),
  - Radiation units,
  - Biological effects,
  - Risks of occupational exposure (NRC Regulatory Guide 8.29),
  - Radiation measurement and survey instruments,
  - External dosimetry (TLD, OSL, SRD, extremity),
  - Time, distance and shielding,
  - Internal dosimetry methods (whole-body counting, urinalysis and fecal analysis), contamination control (sources of contamination, protective clothing/PPE, controlled areas and exiting, and personnel surveys),
  - Personnel and equipment decontamination,
  - Airborne radioactivity,
  - Respiratory protection and coordination with industrial/chemical hazards,
  - Prenatal radiation exposure (NRC Regulatory Guide 8.13),
  - First aid considerations,
  - Radiological waste reduction,
  - Introduction to mock-up training.
- Administrative Topics
  - ISP radiation safety policy,

- Role of the RSO and RST,
- Authority of radiation safety personnel,
- ALARA philosophy and practices,
- Regulatory and administrative limits; minimizing exposure,
- Federal and State Regulations and License provisions for the protection of personnel from radiation and radioactive material,
- Radiological postings,
- Radiological surveys (purposes, methods),
- Control and removal of contaminated equipment,
- Introduction to WCS CISF operational procedures (additional, separate training is required for procedural qualification),
- Introduction to ISP quality assurance (additional, separate training is required for procedural qualification),
- Investigation and reporting of abnormal exposures,
- Obtaining exposure records,
- Responsibilities of individuals,
- Radiological emergencies,
- Respiratory protection program,
- Radiation work permits (RWPs).

The training session is followed by a written test, which must be passed at the 80% level of competency before unescorted access is allowed into a Restricted Area.

The RSO/Director of Health and Radiation Safety may authorize individuals with documented radiation safety training and experience from other sites or utilities, such the DOE, to challenge any training requirement and demonstrate the requisite level of knowledge in radiation safety by:

- Successfully passing a written exam that includes basic radiation safety training principles and facility/WCS CISF specific information; and
- Successful discussion and performance of practical factors.

13.3.1.3 Technical Training

Classroom and field training are provided by the responsible department when appropriate or necessary. On the Job Training (OJT) is provided within most disciplines. OJT consists of, but is not limited to, task training and evaluation, procedure training, and specific discipline-related training requirements.

Certified WCS CISF Operators will be responsible for cask/canister handling and transfer operations. These individuals will be certified by ISP management and meet the requirements of the WCS CISF Equipment Operator Training and Certification Program. This program meets the requirements of 10 CFR Part 72, Subpart I. They will also meet vendor training and qualification requirements for the operation of vendor-specific cask/canister handling equipment. The Certified WCS CISF Operators shall participate in initial and proficiency training programs.

Each individual will be given instructions regarding the hazards and safety precautions applicable to the type of work to be performed, general work place hazards, and the procedures for protecting themselves from injury. Only qualified individuals will operate equipment, machinery, and cranes.

In addition, WCS CISF Maintenance Technicians are trained in the operation of forklifts and plant cranes and they should have a working knowledge of the plant drawing system and the vendor manual system.

Technical Training is also used to develop the necessary manipulative skills to perform assigned work in a competent manner. Technical Training consists of the following segments.

- Initial Training
- On-the-Job Training and Qualifications
- Continuing Training
- Special Training.

13.3.1.3.1 Initial Training

Initial Training provides an understanding of the fundamentals, basic principles and procedures related to an employee's assigned work. This training may consist of, but is not limited to, live, taped and filmed lectures, self-guided study, demonstrations, laboratories, workshops and on-the-job training.

New employees or those transferred from other sections within the WCS CISF may be partially qualified due to previous training or experience. The extent of further training for these employees is determined by applicable regulations, performance in review sessions, comprehensive examinations or other techniques designed to identify the employee's level of ability.

Initial job training and qualification programs are developed for operations, maintenance and technical services classifications. Training for each program is grouped into logical blocks or modules and presented to accomplish specific behavioral objectives. Trainee progress is evaluated through written examinations, oral examinations or practical tests. Depending upon regulatory requirements, the individual's needs and plant operating conditions, allowances are made to suit specific situations.

WCS CISF specific technical training modules that may be included in initial training programs include:

- Operations Initial Training
  - WCS CISF fundamentals
  - General SNF handling systems
  - Specific SNF handling systems
  - Radiological safety
  - Equipment design and operating characteristics
  - On-site SNF cask transfer systems
  - Procedures.
- Mechanical Maintenance Initial Training
  - WCS CISF fundamentals
  - Fundamental shop skills
  - Facility and cask system familiarization.
- Instrumentation, Electrical and Performance Initial Training
  - WCS CISF fundamentals
  - Basic instrument and electrical
  - Basic performance
  - Facility and cask system familiarization.
- Radiation Safety Initial Training
  - WCS CISF fundamentals
  - Fundamental radiation safety
  - Facility and cask system familiarization.
- Engineer/Professional/Supervisory Training
  - WCS CISF fundamentals
  - Facility orientation
  - SNF handling and cask system training.
- Quality Assurance
  - Basic requirements
  - General criteria
  - Applicable codes, standards and implementing documents
  - Problem identification
- Dispute resolution.

13.3.1.3.2 On-the Job Training and Qualifications

On-the-Job Training (OJT) is a systematic method of providing the required job related skills and knowledge for a position. This training is conducted in the work environment. Tasks and related procedures for each technical area supplement and complement formal classroom, practical demonstrations/evaluations and/or mock-up training. The program objective is to ensure the trainee's ability to perform job tasks as described in task descriptions and Training and Qualification.

13.3.1.3.3 Continuing Training

Continuing Training maintains and improves job-related knowledge and skills, such as:

- Facility systems and component changes
- OJT/qualifications program changes
- Procedure and directive changes
- Operating experience program document review, including industry and in-house operating experiences
- Continuing training required by regulation (e.g., Emergency Preparedness)
- General employee, special administrative, vendor and/or advanced training topics supporting elective tasks
- Training to resolve deficiencies or to reinforce seldom-used knowledge and skills
- Pre-job instruction, mock-up training and structured walk-throughs
- Quality awareness.

Continuing Training and Requalification training may overlap to some degree in definition. Requalification or Retraining refers to specific training designed for proficiency maintenance. Continuing Training consists of formal and informal components performed as needed to maintain proficiency on the job. Each organization's continuing training program is developed with a systematic approach, using information from job performance and safe operation information as a basis for determining training content. Continuing Training may be offered, as needed, on any of the topics or programs listed above.

Once the objectives for Continuing Training have been established, training methods may vary. A selected method must provide clear evidence of objective accomplishment and consistency in delivery.

13.3.1.3.4 Special Training

Special Training involves those subjects of a unique nature (i.e., QA, Specific Equipment Operation, Emergency Response) required for a particular area of work. Special training is usually given to selected personnel based on specific needs not directly related to disciplinary lines.

13.3.1.4 Personnel Certification Requirements

Operation of equipment and controls ITS is performed by trained and certified personnel. Certification training includes at a minimum the following topics:

- Dry Fuel Storage Equipment Operator Certification (includes Cask Transporter Certifications)
- Forklift (powered industrial truck)
- Crane Operator Training
- Radiation Worker II Training
- Technical Training
- Specific On-the-Job Training.

Training is specific to the task to be performed, and personnel must pass specific written and practical tests to become certified to perform that task. Refresher training and testing are conducted periodically as required by codes and standards to maintain proficiency and adapt to changes in technology, methods or job responsibilities.

13.3.1.5 Training Program Evaluations

Training and qualification activities are monitored by the Training Department. QA audits the WCS CISF Training Program. In addition, affected departments, trainees and vendors may provide input concerning Training Program effectiveness. Methods utilized to obtain this information include surveys and questionnaires. Frequently conducted classes are routinely evaluated. Evaluation information may be collected through the following methods:

- Verification of program objectives as related to job duties for which intended
- Periodic working group program evaluations
- Testing to determine student accomplishment of objectives
- Student evaluation of instruction
- Supervisor's evaluation of trainee's performance after OJT
- Supervisor's evaluation of instruction.

Unacceptable individual performance is reported to appropriate management.

13.3.2 Retraining Program

Continuing Training and Requalification training may overlap to some degree in definition. Requalification and Retraining refer to specific training designed for proficiency maintenance. Continuing Training consists of formal and informal components performed as needed to maintain proficiency on the job. Each organization's continuing training program is developed with a systematic approach, using information from job performance and safe operation information as a basis for determining training content. Continuing Training may be offered, as needed, on any of the topics or programs listed below.

Continuing Training maintains and improves job-related knowledge and skills, such as:

- Facility systems and component changes
- OJT/qualifications program changes
- Procedure and directive changes
- Operating experience program document review, including industry and in-house operating experiences
- Continuing training required by regulation (e.g., Emergency Preparedness)
- General employee, special administrative, vendor and/or advanced training topics supporting elective tasks
- Training to resolve deficiencies or to reinforce seldom-used knowledge and skills
- Pre-job instruction, mock-up training and structured walk-throughs
- Quality awareness.

Once the objectives for Continuing Training have been established, training methods may vary. A selected method must provide clear evidence of objective accomplishment and consistency in delivery.

13.3.3 Administration and Records

Upon employment, assignment to the WCS CISF, or assignment to a new job at the WCS CISF, a training file is created or reviewed for each employee. Each record includes the job title of the employee and the type and amount of both introductory and continuing training that will be given to that employee. Also included in the file are records that document the training and certifications that have been completed. Training records on WCS CISF personnel are QA records and will be kept according to all applicable statutory and regulatory requirements and supplemental ISP records management policies and procedures.

13.4 Facility Operations

This section describes the WCS CISF programs for conducting normal facility operations. Included are descriptions of procedure and record management programs and the facility review and audit, facility modification management and employee concerns programs.

13.4.1 Facility Procedures

All WCS CISF operations ITS are conducted using detailed written and approved procedures. The development, review, approval, use, distribution and changes to all procedures are governed by facility administrative procedures, all of which will be made available to the NRC prior to their use. As noted throughout the Safety Analysis Report (SAR), procedures are used to ensure that activities are carried out in a safe manner. These activities typically include procedures for the following.

- All cask handling operations including receipt, on-site movement, transfer and storage operations
- Cask Handling Building workstations
- All facility operations
- Material control and accounting activities
- Emergency Response Plan implementation
- Security and Safeguards Plan implementation
- Design changes to the facility
- Maintenance of facility structures, systems and components (SSCs)
- Construction and testing of facility SSCs
- QA program implementation
- Training.

General Procedure categories are as follows.

- Administrative Procedures: Provide rules and instructions to provide all WCS CISF personnel with a clear understanding of operating philosophy and management policies.
- Radiation Safety Procedures: Implement the radiation control program to ensure exposures are kept as low as is reasonably achievable (ALARA). Included are procedures controlling the release of effluents. Chapter 9 provides a detailed description of the Radiation Safety Program and procedures.
- Operating Procedures: Provide instructions for all WCS CISF operations, including receiving, handling and storing of SNF, to ensure all operations are performed consistently, efficiently and safely. Special processes and SNF material control and accounting procedures are also governed by operating procedures.

- Maintenance Procedures: Provide instructions for performing preventive and corrective maintenance to ensure that maintenance is performed consistently, efficiently and safely.
- Inspection and Test Procedures: Ensure that all WCS CISF SSCs are tested on a routine basis to verify operability, to ensure that they continue to meet design requirements, and to ensure that they meet quality standards commensurate with their importance to safety.
- Quality Assurance Procedures: Ensure that all WCS CISF activities are performed in accordance with the WCS CISF QA program. Design Control is included under QA procedures.
- Security Procedures: Provide instructions for protecting the facility, personnel and safeguards information in accordance with regulatory requirements and guidance.

13.4.1.1 Preparation of Procedures

At ISP, Management is responsible for routinely evaluating work performed within their functional area of responsibility to identify quality affecting work activities and ensure QA work is controlled and accomplished in accordance with a procedure or work instruction as required.

The development of all procedures, including operating, abnormal, maintenance, instrument, periodic test, radioactive waste management, radiation safety and emergency preparedness, is performed by qualified members of the facility staff. Procedures addressing receipt and handling of incoming casks are provided by the vendors and integrated into facility procedures. All procedures are sufficiently detailed so that qualified individuals can perform the required functions without direct supervision.

Initial procedure drafts are reviewed by other qualified staff members and by vendor personnel as appropriate. Initial drafts also receive a cross-disciplinary review by the appropriate organizations including Radiation Safety and QA reviews. Reviewers, designated to approve procedures, determine the necessity for additional cross-disciplinary reviews. The WCS CISF Director of Operations/Construction or designee shall approve all ITS procedures and safety-affecting procedures. The DQA or designee shall approve all quality-affecting procedures.

Procedures control the issuance of documents (e.g., work procedures or work instructions) that prescribe requirements for activities affecting quality associated with items or services classified as ITS or quality affecting to ensure adequate review, approval, release, distribution and use of documents and their revisions. Documents that prescribe requirements ITS, or qualify affecting activities are reviewed and approved for technical adequacy and inclusion of appropriate quality requirements prior to approval and issuance. Procedures are reviewed and approved by members of ISP management with direct and oversight responsibilities for work prescribed by the work procedure or work instruction. Records of completed cross-disciplinary reviews shall be maintained for all changes to ITS procedures.

13.4.1.2 Changes to Procedures

Changes to work procedures or work instructions that prescribe requirements for ITS, or qualify affecting activities, are reviewed and approved by the same organizations that performed the initial review and approval or by qualified responsible organizations. Minor changes to procedures, such as inconsequential editorial corrections, shall not require that the revised documents receive the same review and approval as the original documents. To avoid a possible omission of a required review, the type of minor changes that do not require such a review and approval and the persons who can authorize such a decision shall be clearly delineated.

Changes to procedures shall be additionally processed as described below.

1. The preparer documents the proposed change as well as the reason for the change.

2. A safety evaluation performed by a qualified reviewer includes a screening and an unreviewed safety question evaluation, in accordance with 10 CFR 72.48. If the safety evaluation reveals that a license change is needed to implement the proposed changes, NRC approval is needed prior to implementation.

3. The procedure, with proposed changes, is reviewed and approved by a qualified reviewer.

4. The WCS CISF Director of Operations/Construction or designee also reviews the procedure change and is responsible for final approval, and for determining whether cross-disciplinary review is necessary and by which groups. The need for cross-disciplinary reviews shall be considered, as a minimum, for the following.

    - For proposed changes having a potential impact on radiation safety, a review shall be performed for radiation hazards. Changes shall be approved in writing by the RSO/Director of Health and Radiation Safety or designee.
    - A criticality safety review shall be performed for proposed changes having a potential impact on criticality safety. Changes shall be approved in writing by the RSO/Director of Health and Radiation Safety or designee.
    - A QA review shall be performed for proposed changes that directly involve QA. Changes shall be approved in writing by the DQA.
    - A material control review shall be performed for proposed changes potentially affecting material control and accountability.

5. Records of completed cross-disciplinary reviews shall be maintained for all changes to ITS procedures.

13.4.1.3 Distribution of Procedures

Upon issue of each new or revised procedure or work instruction all hard copy previous versions of the procedure or work instruction are retrieved from each applicable controlled document location and disposed of as the newly effective procedure or work instruction or their revisions are made available at these locations, as applicable. Non-confidential, non-safeguards documents are protected.

13.4.2 Facility Records

Records management is controlled in a systematic manner in order to provide identifiable and retrievable documentation.

The WCS CISF maintains a records storage system. Access to and use of the WCS CISF records storage facility is controlled. Documents in the records storage system shall be legible and identifiable as to subject. Original or reproduced copies of documents shall be stamped, initialed, signed or otherwise authenticated and dated by authorized personnel. Computer storage of data may be used.

In order to preclude deterioration of records in the records storage system, the following requirements apply.

- Records are not stored loosely, but firmly attached in binders or placed in folders or envelopes. Records are stored in steel file cabinets.
- Special processed records (e.g., radiographs, photographs, negatives, microfilm) which are light-sensitive, pressure-sensitive and/or temperature-sensitive, are packaged and stored as recommended by the manufacturers of those materials.
- Computer storage of records is performed in a manner to preclude inadvertent loss and to ensure accurate and timely retrieval of data.

The WCS CISF records storage system will provide for the accurate retrieval of information without undue delay. Written instructions regarding the storage of records in the records storage system include, but are not limited to, the following.

- A description of the WCS CISF records storage system location(s) and identification of the location(s) of the various record types within the WCS CISF records storage system
- The filing system to be used
- A method for verifying that records received are in agreement with any applicable transmittal documents and are in good condition. This is not required for documents generated within a section for use and storage in the same section's satellite files.
- A method for maintaining a record of the records received
- The criteria governing access to and control of the WCS CISF records storage system

- A method for maintaining control of and accountability for records removed from the WCS CISF records storage system
- A method for filing supplemental information and for disposing of superseded records.

A qualified fire protection engineer will evaluate record storage areas, including satellite files, to ensure that records are adequately protected from damage.

Records related to health and safety shall be maintained in accordance with the requirements of Title 10, Code of Federal Regulations, as described below. A WCS CISF administrative procedure shall provide a list of all applicable records and retention periods. The following records shall be retained for at least three years.

- Records of instrument calibrations
- Records of audits and inspections
- ALARA findings
- Changes to physical security records, in accordance with 10 CFR 72.180, 72.182 and 72.184.

Records of SNF inventory are retained for as long as the material is stored at the WCS CISF and for five years after the SNF is transferred out of the WCS CISF. These records are maintained in duplicate at separate locations in accordance with 10 CFR 72.72.

At a minimum, the following records are retained for the duration of the facility license.

- Records important to decommissioning
- Records of spills or other unusual occurrences involving the spread of contamination in and around the facility
- As-built drawings and modifications of structures and equipment in restricted areas where radioactive materials are used or stored, and of locations of possible inaccessible contamination
- A list of areas designated or formerly designated as restricted areas, or areas where a documented spill has occurred. This list is kept in a single document and updated at least every two years.
- Records of any changes to the WCS CISF, changes to procedures pursuant to 10 CFR 72.48, test records, the safety analysis report (SAR) and SAR updates
- Records of safety evaluations described in the WCS CISF license conditions
- Records of SNF shipment receipts, inventory, location, disposal and transfer
- Records of current SNF inventory based on a physical inspection that occurs at least once annually

- Records of written material control and inventory procedures
- Records of QA activities required by the QA program in accordance with 10 CFR 72.174
- Records of training, qualification and re-qualification as required by the WCS CISF license conditions for current and past WCS CISF staff
- Operating records, including maintenance and modifications
- Records of Facility Radiation Safety Review Committee activities
- Records of radiation exposure for all individuals entering radiation control areas
- Records of analyses required by the Radiological Environmental Monitoring Program that would permit accuracy evaluation of the analyses at a later date
- Records of plant radiation surveys
- Records of environmental surveys
- Physical security records in accordance with 10 CFR 72.180, 72.182, 72.184 and 73.70.

Retention periods are specified for other facility records as necessary to meet applicable regulatory requirements. Records with no specified retention periods are kept for the duration of the facility license. Retention times should be indicated within facility procedures as specified.

13.4.3 Facility Review and Audit Program

The Audit section of the QA Program establishes the measures for planned and documented audits to verify compliance and effectiveness with all aspects of the QA Program. Procedures shall ensure that audits are performed by appropriately trained personnel; properly planned and scheduled, audit results are documented, reported, and reviewed by appropriate levels of supervision and management; and responsible persons in the area audited take necessary action to correct reported deficiencies.

13.4.4 Modifications to Facilities and Equipment

13.4.4.1 Facility Initiated Modifications

To provide for the continued safe and reliable operation of the WCS CISF, measures are implemented to ensure that quality is not compromised by planned modifications involving ITS SSCs. The Chief Engineer CISF Licensing and Engineering is responsible for the design and implementation of SSC modifications and modifications that could impact SSCs. The design and implementation of modifications is performed in a manner to maintain quality commensurate with the remainder of the system being modified, or as dictated by applicable regulations.

In accordance with the QAPD [13-2] requirements, procedures shall be implemented to ensure that activities affecting quality are controlled in accordance with appropriate instructions, procedures and drawings necessary for complying with the applicable criteria of 10 CFR Part 72 Subpart G, 10 CFR Part 71 Subpart H for items and services classified as ITS. Instructions, procedures and drawings are developed, reviewed, approved, utilized and controlled in accordance with the requirements of approved procedures. These instructions, procedures and drawings include appropriate quantitative and qualitative acceptance criteria. Any changes to instructions, procedures and drawings, receive the same level of review and approval as originally required. Finally, compliance with these approved instructions, procedures and drawings is mandatory for all personnel performing activities subject to the requirements of the QAP.

Each change to the facility shall require a safety evaluation in accordance with 10 CFR 72.48. Each modification shall also be evaluated for required changes or additions to the facility's procedures, personnel training, testing program or regulatory documents.

Each modification is also evaluated and documented for radiation exposure, in keeping with the facility ALARA program, criticality, and worker safety requirements and/or restrictions. The evaluation of modifications may also include, but is not limited to, the review of:

- Modification cost
- Similar completed modifications
- QA aspects
- Potential operability or maintainability concerns
- Constructability concerns
- Post-modification testing requirements
- Environmental considerations
- Human factors

After completion of a modification to an SSC, ISP shall ensure all applicable testing has been completed for correct operation of the systems affected by the modification, and that documentation regarding the modification is completes in accordance with QAP requirements. All required records shall be available to facility staff and stored as required by the QAP.

13.4.4.2 Vendor-Initiated Modifications

Prior to receipt of any cask system for which the WCS CISF is licensed, ISP will follow the process described in Section 1.2.4.2.

13.4.5 Employee Concerns Program

ISP and its contractor(s) shall ensure establishment and maintenance of a safety-conscious work environment (SCWE) at the WCS CISF; where a SCWE is one in which employees feel free to raise concerns, both to their management and to the NRC, without fear of retaliation. ISP will institutionalize the program in a WCS CISF procedure or program level document, based on NRC guidance for "Establishing and Maintaining a Safety Conscious Work Environment" (NRC August 2005) in order to maintain a work environment in which safety issues are raised and solutions promptly identified. All WCS CISF personnel will receive formal training on the employee concerns program. SCWE Training will be derived from Principles for a Strong Nuclear Safety Culture (INPO November 2004) and Traits of a Healthy Nuclear Safety Culture (INPO 12-012, December 2012).

In addition to the Employee Concerns Program, the following actions will be taken:

- Copies of NRC Form 3, "Notice to Employees," will be posted in locations frequented by employees.
- Space will be made available on-site to NRC personnel with sufficient privacy that WCS CISF personnel may feel comfortable discussing safety or other concerns with NRC personnel.

13.5 Emergency Response Planning

A Consolidated Emergency Response Plan (CERP) has been prepared for the WCS CISF with an outline and content that complies with the requirements of 10 CFR 72.32(a). The CERP applies specifically to emergencies that could occur at the WCS CISF as well as the facilities operated by ISP joint venture member Waste Control Specialists.

All accidents and off-normal events evaluated in Chapter 12 of this SAR were considered in the planning basis for development of the CERP. The planning basis includes credible events as well as hypothetical accidents whose occurrence is not considered credible, so as not to limit the scope of Emergency Response Planning. Evaluation of the consequences of credible and hypothetical accidents postulated to occur at the WCS CISF determined that releases of radioactivity would not require response by an off-site organization to protect persons beyond the boundary of the WCS CISF owner-controlled area. There is a single emergency classification level for events at the WCS CISF, the Alert classification, which is based on the worst-case consequences of potential accidents which are postulated to occur at the WCS CISF.

Should an off-normal event or accident occur, the CERP requires personnel stationed at the WCS CISF to notify appropriate emergency response personnel and the Incident Commander (IC) or designee immediately. The emergency response personnel are then responsible for responding to the event in accordance with the CERP and notifying the appropriate authorities, as stated in the CERP. The emergency response personnel are also responsible for calling out trained personnel to assemble at the WCS CISF to mitigate the consequences of the emergency at the direction of the Incident Commander (IC), assess radiation and radioactivity levels in the vicinity of the WCS CISF, and return the WCS CISF to a safe and stable condition. The design of the WCS CISF provides for accessibility to equipment on-site and availability of off-site emergency facilities and services in accordance with 10 CFR 72.122(g). ISP/Waste Control Specialists have a central Emergency Operations Center (EOC) from which management and support personnel carry out coordinated emergency response activities. The EOC is the location having appropriate communications and informational materials to carry out the assigned emergency response mission. The primary EOC is the Executive Conference Room located in the southern section of the main administrative building within the boundaries of the existing facility. The secondary EOC is the Waste Control Specialists LLRW Administration Building, within the existing boundary controlled by Waste Control Specialists.

The CERP identifies Incident Commanders (ICs) who train to coordinate the response of the Emergency Response Organization (ERO) to an emergency event. These personnel may not always be present at the facility when an event occurs. One of the ICs designated in the CERP is always on-call. If the on-call IC is not at the facility, then he / she is available to those individuals present at the facility through communication device or other means. Depending upon the nature of the event, the on-call IC may designate certain duties to those present at the facility by phone or electronic communication. The IC assumes responsibilities for declaring an Alert, as appropriate, and activation of the ERO, as well as communicating with on-site emergency response personnel and apprising them of the situation at the WCS CISF. The CERP identifies responsibilities and staffing of the on-site ERO and for requesting off-site assistance. Members of the ERO will be trained on how to respond to various emergencies at the WCS CISF, as established in the CERP.

Off-site assistance may be requested as necessary from both the Andrews County Volunteer Fire Department, located 32 miles from the WCS CISF, and the Eunice, New Mexico Volunteer Fire Department, located 6 miles from the WCS CISF. Both departments have signed agreements to assist the ERO in the control of major emergencies and are both equipped to respond to structural fires, oil well fires and chemical tank explosions. The City of Andrews Police Department provides ambulance service for Andrews County and has agreed to provide emergency medical assistance and evacuation for the WCS CISF. Additional ambulance service is available through the Eunice Fire and Rescue Service, which has also agreed to provide emergency medical care to the facility. For off-site medical care, Carlsbad Medical Center, located in Carlsbad, New Mexico is the first choice for incidents involving radiologically contaminated individuals unless life-threatening injuries are present, in which case they would take precedence and treatment would be sought at Lea Regional Medical Center or Permian Regional Medical Center. Lea Regional Medical Center is located 25 miles to the northwest in Hobbs, New Mexico. The hospital is fully equipped to handle most types of emergencies and has a life flight helicopter available. The hospital has received training from the Waste Isolation Pilot Plants (WIPP) personnel on the handling of injury victims in the event of contamination with radioactive materials. Permian Regional Medical Center is located approximately 32 miles to the east in Andrews, Texas. The hospital is fully equipped to handle most types of emergencies. Waste Control Specialists also has agreements with the Andrews County Sherriff's Office and the Eunice Police Department to provide law enforcement services should they be needed at the facility. Other off-site assistance may be requested from industry or the NRC, as specified in the CERP.

The CERP was submitted to the following organizations for their review and comment in accordance with 10 CFR 72.32(a)(14):

- Andrews, Texas Police Department
- Andrews County Sherriff's Office
- Carlsbad Medical Center
- City of Andrews, Texas

- Eunice, New Mexico Fire and Rescue
- Eunice, New Mexico Police Department
- Lea Regional Medical Center
- Permian Regional Medical Center

The MOUs are included as Appendix D in the CERP.

The CERP does not cover actions to be taken for security related events at the WCS CISF. These actions will be governed by the WCS CISF Safeguards Contingency Plan.

13.6 Decommissioning Plan

13.6.1 WCS CISF Decommissioning Plan

Prior to the end of the WCS CISF life, canisters loaded with SNF will be transferred from storage casks into transportation casks and transported off-site. Since the canisters are designed to meet DOE guidance applicable to multi-purpose canisters for storage, transport and disposal of SNF, the SNF assemblies will remain sealed in the canisters such that decontamination of the canisters is not required. Following shipment of the canisters off-site and the decommissioning period begins, the WCS CISF will be decommissioned by characterization, identification, and removal of any residual radioactive material and performance of a final radiological status survey. Additional details on decommissioning are found in License Application Appendix B, “Preliminary Decommissioning Plan.”

13.6.2 Cost of Decommissioning

10 CFR 72.30(b) requires that the proposed decommissioning plan include a decommissioning cost estimate, a funding plan, and method of assuring the availability of decommissioning funds.

The cost of decommissioning the WCS CISF facilities, storage modules, and area is estimated to be approximately $12,650,000. A fully executed written contract between ISP and the US DOE or the SNF Title Holder(s), will be established prior to receipt of SNF at the WCS CISF. Pursuant to a contract with DOE, DOE shall take legal title of the SNF prior to receipt and shall also be responsible for all costs associated with the decommissioning of the WCS CISF allowing for its unrestricted release pursuant to 10 CFR Part 20 Subpart E at the time of license termination. If other SNF Title Holder(s), other than DOE, (Client(s)), enter into a contract with ISP for storage services, the contract shall allocate legal and financial liability among the licensee and the clients and shall include provisions requiring clients to provide periodically credit information, and, when necessary financial assurances to cover their obligations. Additional details and decommissioning cost estimate information is found in License Application Appendix D, “Decommissioning Funding Plan.”

13.6.3 Decommissioning Facilitation

The design features of the dry cask storage concept, to be utilized at the WCS CISF provide for the inherent ease and simplicity of decommissioning the facility in conformance with 10 CFR 72.130. Details on these design features and measures that will be taken to both minimize the potential for contamination and facilitate any decontamination efforts which may be required are found in License Application Appendix B, "Preliminary Decommissioning Plan."

13.6.4 Recordkeeping for Decommissioning

Records important to decommissioning, as required by 10 CFR 72.30(f), will be maintained until the WCS CISF is released for unrestricted use. See Section 13.4.2 for the type of records that will be maintained for the WCS CISF. These records will be maintained in a secure storage area.

13.7 Physical Security and Safeguards Contingency Plans

The purpose of the WCS CISF Security Program is to establish and maintain physical security capabilities for protecting SNF at the WCS CISF. This Program meets the requirements contained in 10 CFR Part 72, Subpart H, "Physical Protection," and applicable portions of 10 CFR Part 73.

The WCS CISF Security Program is described in the following WCS CISF documents:

- Physical Security Plan, to include physical protection designs,
- Security Training & Qualification (T&Q) Plan, and
- Safeguards Contingency Plan.

Physical Security Plan, Security Training & Qualification (T&Q) Plan and Safeguards Contingency Plan are designated as Safeguards Information and are protected from unauthorized disclosure in accordance with 10 CFR 73.22. These plans will be submitted for NRC review separately. A summary description of the WCS CISF physical protection measures that does not include safeguards information follows.

The Security Force controls access to the WCS CISF Restricted Area (RA). Access to the WCS CISF is limited to individuals who require access to perform work related activities. The WCS CISF Security Force maintains a list of approved individuals authorized unescorted access. Individuals granted access to the WCS CISF RA are badged to indicate whether access is granted with or without escort. Authorized individuals are required to display issued identification dedicated solely for access to the WCS CISF. An escort is not required for these individuals. All other personnel are considered visitors, and must sign in on a visitor log before entering the WCS CISF RA. The log documents the visitors name, date, time, purpose of visit, employment affiliation, citizenship and name of escort. Visitors are issued display badges that indicate an escort is required. Authorization for access to the WCS CISF is also contingent upon the individual's meeting WCS CISF prescribed radiation safety briefings or training. Personnel, hand-carried articles and vehicles that enter the WCS CISF RA are searched to detect the presence of firearms, explosive and incendiary devices.

The WCS CISF RA perimeter has an intrusion detection system to immediately detect unauthorized entry, including penetration by stealth. This system is protected against circumvention and tampering. Staffed alarm stations support the Security Program by monitoring perimeter alarms, coordinating security communications and performing closed circuit television surveillance and alarm assessment. Detailed descriptions and capabilities of the WCS CISF physical protection systems are contained in the WCS CISF Security Plan.

In accordance with 10 CFR 72.184, the WCS CISF Safeguards Contingency Plan addresses security responses to a spectrum of threats. For planning purposes, these threats include generic and postulated, site-specific contingencies, to include attempted radiological sabotage. Contingency event categories include: (1) Loss of Security Effectiveness, (2) Threats, and (3) Adversary Actions. The Safeguards Contingency Plan provides a Responsibility Matrix that details specific Security Force actions for neutralizing each contingency event. WCS CISF Security contingency planning involves detailed response procedures, and assistance from local law enforcement, when requested.

As stipulated in Appendix B to 10 CFR 73.55, provisions for training and qualifying Security Force members are contained in the WCS CISF Guard Training and Qualification (T&Q) Plan. The T&Q Plan identifies all crucial security tasks and the associated Security Force positions that must be trained and qualified in the respective crucial task. In addition to initial and recurring Security Force training requirements, the T&Q Plan also describes a screening program to determine if the Security Force member's background and physical/mental qualifications meet criteria defined in this plan.

Each commitment made in the Security, T&Q, and Contingency Plans is implemented by written procedures. The regulatory basis for implementing procedures is 10 CFR 73.55(b)(3)(ii). Implementing procedures, which are developed, approved and maintained by WCS CISF Security management, ensure accurate and organized day-to-day security operations.

13.8 References

13-1 Regulatory Guide 1.8, "Qualification and Training of Personnel for Nuclear Power Plants," Revision 3.

13-2 "TN Americas LLC Quality Assurance Program Description Manual for 10 CFR Part 71, Subpart H and 10 CFR Part 72, Subpart G," current revision

13-3 SNM-2515 Technical Specifications (See [Gen-1])

13-4 The Emergency Response Plan, WCS ERP-100, Consolidated Emergency Response Plan, 02-08-2019.

13-5 "Systematic Approach To Training," SMP 2.1, current Revision.

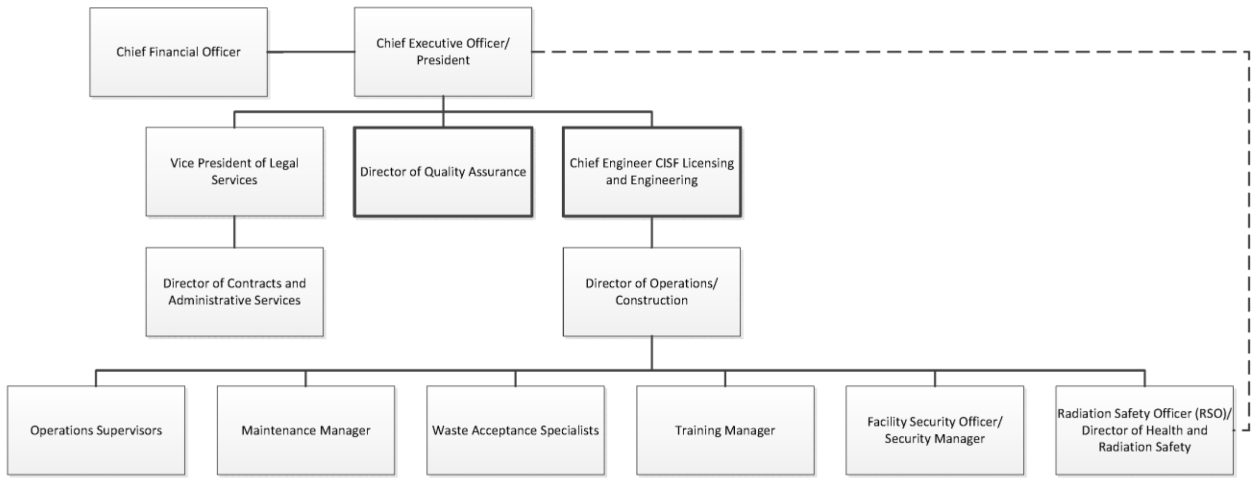

Figure 13-1
ISP Organization Chart

TECHNICAL SPECIFICATION BASES

TECHNICAL SPECIFICATION BASES

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B 2.0 SAFETY LIMITS (SLs)

BASES

BACKGROUND	The canister designs authorized for storage at the WCS CISF requires certain limits on spent fuel parameters, including fuel type, maximum allowable enrichment prior to irradiation, maximum burnup, and minimum acceptable cooling time prior to storage in the canister. Other important limitations are the radiological source terms from non-fuel assembly hardware and GTCC wastes. These limitations are included in the thermal, structural, radiological, and criticality evaluations performed for these canister designs.
APPLICABLE SAFETY ANALYSES	Various analyses have been performed that use these fuel parameters as assumptions. These assumptions are included in the thermal, criticality, structural, shielding and confinement analyses. Only canisters that have been previously approved by the NRC to store and transport commercial light water (PWR and BWR) spent nuclear fuel and GTCC waste will be received at the WCS CISF. Technical Specification 2.1 lists the authorized canisters for storage at the WCS CISF. Prior to acceptance of a canister at the WCS CISF a records review is required 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. This will assure that only canisters authorized for storage are stored at the WCS CISF.
FUNCTIONAL AND OPERATING LIMITS VIOLATIONS	If Functional and Operating Limits are violated, the limitations on the fuel assemblies in the DSC have not been met. Actions must be taken to place the affected fuel assemblies in a safe condition. However, it is acceptable for the affected fuel assemblies to remain in the DSC if that is determined to be a safe condition. Notification of the violation of a Functional and Operating Limit to the NRC is required within 24 hours. Written reporting of the violation must be accomplished within 60 days. This notification and written report are independent of any reports and notification that may be required by 10 CFR 72.75.
REFERENCES	1. SAR Chapters 3, 7, 8, 9 and 12.

B 3.0 LIMITING CONDITION FOR OPERATION (LCO) APPLICABILITY

BASES

LCOs	LCO 3.0.1, 3.0.2, 3.0.4 and 3.0.5 establish the general requirements applicable to all Specifications and apply at all times, unless otherwise stated.
LCO 3.0.1	LCO 3.0.1 establishes the Applicability statement within each individual Specification as the requirement for when the LCO is required to be met (i.e., when the canister is in the specified conditions of the Applicability statement of each Specification).

LCO 3.0.2

LCO 3.0.2 establishes that upon discovery of a failure to meet an LCO, the associated ACTIONS shall be met. The Completion Time of each Required Action for an ACTIONS Condition is applicable from the point in time that an ACTIONS Condition is entered. The Required Actions establish those remedial measures that must be taken within specified Completion Times when the requirements of an LCO are not met. This Specification establishes that:

a. Completion of the Required Actions within the specified Completion Times constitutes compliance with a Specification; and

b. Completion of the Required Actions is not required when an LCO is met within the specified Completion Time, unless otherwise specified.

There are two basic types of Required Actions. The first type of Required Action specifies a time limit in which the LCO must be met. This time limit is the Completion Time to restore a system or component or to restore variables to within specified limits. (Whether stated as a Required Action or not, correction of the entered Condition is an action that may always be considered upon entering ACTIONS). The second type of Required Action specifies the remedial measures that permit continued operation of the unit that is not further restricted by the Completion Time. In this case, compliance with the Required Actions provides an acceptable level of safety for continued operation.

Completing the Required Actions is not required when an LCO is met or is no longer applicable, unless otherwise stated in the individual Specifications.

BASES

LCO 3.0.2 (continued)

The Completion Times of the Required Actions are also applicable when a system or component is removed from service intentionally. The reasons for intentionally relying on the ACTIONS include, but are not limited to, performance of Surveillances, preventive maintenance, corrective maintenance, or investigation of operational problems. Entering ACTIONS for these reasons must be done in a manner that does not compromise safety. Intentional entry into ACTIONS should not be made for operational convenience.

Individual Specifications may specify a time limit for performing an SR when equipment is removed from service or bypassed for testing. In this case, the Completion Times of the Required Actions are applicable when this time limit expires if the equipment remains removed from service or bypassed.

When a change in specified Condition is required to comply with Required Actions, the equipment may enter a specified Condition in which another Specification becomes applicable. In this case, the Completion Times of the associated Required Actions would apply from the point in time that the new Specification becomes applicable and the ACTIONS Condition(s) are entered.

LCO 3.0.3

This specification is not applicable to the WCS CISF. The placeholder is retained for consistency with the power reactor technical specifications.

LCO 3.0.4

LCO 3.0.4 establishes limitations on changes in specified Conditions in the applicability when an LCO is not met. It precludes placing the WCS CISF in a specified Condition stated in that applicability (e.g., Applicability desired to be entered) when the following exist:

a. Conditions are such that the requirements of the LCO would not be met in the Applicability desired to be entered; and

b. Continued noncompliance with the LCO requirements, if the Applicability were entered, would result in the equipment being required to exit the Applicability desired, to be entered to comply with the Required Actions.

BASES

LCO 3.0.4 (continued)

Compliance with Required Actions that permit continued operation of the equipment for an unlimited period of time in specified Condition provides an acceptable level of safety for continued operation. Therefore, in such cases, entry into a specified Condition in the Applicability may be made in accordance with the provisions of the Required Actions. The provisions of this Specification should not be interpreted as endorsing the failure to exercise the good practice of restoring systems or components before entering an associated specified Condition in the Applicability.

The provisions of LCO 3.0.4 shall not prevent changes in specified Conditions in the Applicability that are required to comply with ACTIONS. In addition, the provisions of LCO 3.0.4 shall not prevent changes in specified Conditions in the Applicability that are related to the unloading of a canister.

Exceptions to LCO 3.0.4 are stated in the individual Specifications.

Exceptions may apply to all the ACTIONS or to a specific Required Action of a Specification.

Surveillances do not have to be performed on the associated equipment out of service (or on variables outside the specified limits), as permitted by SR 3.0.1. Therefore, changing specified Conditions while in an ACTIONS Condition, either in compliance with LCO 3.0.4, or where an exception to LCO 3.0.4 is stated, is not a violation of SR 3.0.1 or SR 3.0.4 for those Surveillances that do not have to be performed due to the associated out of service equipment.

LCO 3.0.5

LCO 3.0.5 establishes the allowance for restoring equipment to service under administrative controls when it has been removed from service or not in service in compliance with ACTIONS. The sole purpose of this Specification is to provide an exception to LCO 3.0.2 (e.g., to not comply with the applicable Required Action(s)) to allow the performance of required testing to demonstrate:

a. The equipment being returned to service meets the LCO; or

b. Other equipment meets the applicable LCOs.

BASES

LCO 3.0.5 (continued)

The administrative controls ensure the time the equipment is returned to service in conflict with the requirements of the ACTIONS is limited to the time absolutely necessary to perform the allowed required testing. This Specification does not provide time to perform any other preventive or corrective maintenance.

LCO 3.0.6	This specification is not applicable to the WCS CISF. The placeholder is retained for consistency with the power reactor technical specifications.
LCO 3.0.7	This specification is not applicable to the WCS CISF. The placeholder is retained for consistency with the power reactor technical specifications.

B 3.0 SURVEILLANCE REQUIREMENT (SR) APPLICABILITY

BASES

SRs

SR 3.0.1 through SR 3.0.4 establish the general requirements applicable to all Specifications in Sections 3.1, 3.2, 3.3, and 3.4 and apply at all times, unless otherwise stated.

SR 3.0.1

SR 3.0.1 establishes the requirement that SRs must be met during the specified Conditions in the Applicability for which the requirements of the LCO apply, unless otherwise specified in the individual SRs. This Specification is to ensure that Surveillances are performed to verify systems and components, and that variables are within specified limits. Failure to meet a Surveillance within the specified Frequency, in accordance with SR 3.0.2, constitutes a failure to meet an LCO.

Systems and components are assumed to meet the LCO when the associated SRs have been met. Nothing in this Specification, however, is to be construed as implying that systems or components meet the associated LCO when:

a. The systems or components are known to not meet the LCO, although still meeting the SRs; or

b. The requirements of the Surveillance(s) are known to be not met between required Surveillance performances.

Surveillances do not have to be performed when the equipment is in a specified Condition for which the requirements of the associated LCO are not applicable, unless otherwise specified.

Surveillances, including Surveillances invoked by Required Actions, do not have to be performed on equipment that has been determined to not meet the LCO because the ACTIONS define the remedial measures that apply. Surveillances have to be met and performed in accordance with SR 3.0.2, prior to returning equipment to service.

BASES

SR 3.0.1 (continued)

Upon completion of maintenance, appropriate post maintenance testing is required to declare equipment within its LCO. This includes ensuring applicable Surveillances are not failed and their most recent performance is in accordance with SR 3.0.2. Post-maintenance testing may not be possible in the current specified Conditions in the Applicability due to the necessary equipment parameters not having been established. In these situations, the equipment may be considered to meet the LCO provided testing has been satisfactorily completed to the extent possible and the equipment is not otherwise believed to be incapable of performing its function.

This will allow operation to proceed to a specified Condition where other necessary post maintenance tests can be completed.

SR 3.0.2

SR 3.0.2 establishes the requirements for meeting the specified Frequency for Surveillances and any Required Action with a Completion Time that requires the periodic performance of the Required Action on a "once per..." interval.

SR 3.0.2 permits a 25% extension of the interval specified in the Frequency. This extension facilitates Surveillance scheduling and considers plant operating conditions that may not be suitable for conducting the Surveillance (e.g., transient conditions or other ongoing Surveillance or maintenance activities).

The 25% extension does not significantly degrade the reliability that results from performing the Surveillance at its specified Frequency. This is based on the recognition that the most probable result of any particular Surveillance being performed is the verification of conformance with the SRs. The exceptions to SR 3.0.2 are those Surveillances for which the 25% extension of the interval specified in the Frequency does not apply. These exceptions are stated in the individual Specifications. The requirements of regulations take precedence over the TS. Therefore, when a test interval is specified in the regulations, the test interval cannot be extended by the TS, and the SR includes a Note in the Frequency stating, "SR 3.0.2 is not applicable.”

BASES

SR 3.0.2 (continued)

As stated in SR 3.0.2, the 25% extension also does not apply to the initial portion of a periodic Completion Time that requires performance on a "once per..." basis. The 25% extension applies to each performance after the initial performance. The initial performance of the Required Action, whether it is a particular Surveillance or some other remedial action, is considered a single action with a single Completion Time. One reason for not allowing the 25% extension to this Completion Time is that such an action usually verifies that no loss of function has occurred by checking the status of redundant or diverse components or accomplishes the function of the equipment in an alternative manner.

The provisions of SR 3.0.2 are not intended to be used repeatedly merely as an operational convenience to extend Surveillance intervals (other than those consistent with refueling intervals) or periodic Completion Time intervals beyond those specified.

SR 3.0.3

SR 3.0.3 establishes the flexibility to defer declaring affected equipment as not meeting the LCO or an affected variable outside the specified limits when a Surveillance has not been completed within the specified Frequency. A delay period of up to 24 hours or up to the limit of the specified Frequency, whichever is less, applies from the point in time that it is discovered that the Surveillance has not been performed in accordance with SR 3.0.2, and not at the time that the specified Frequency was not met.

This delay period provides adequate time to complete Surveillances that have been missed. This delay period permits the completion of a Surveillance before complying with Required Actions or other remedial measures that might preclude completion of the Surveillance. The basis for this delay period includes consideration of unit conditions, adequate planning, availability of personnel, the time required to perform the Surveillance, the safety significance of the delay in completing the required Surveillance, and the recognition that the most probable result of any particular Surveillance being performed is the verification of conformance with the requirements.

When a Surveillance with a Frequency based not on time intervals, but upon specified unit conditions or operational situations, is discovered not to have been performed when specified, SR 3.0.3 allows the full delay period of 24 hours to perform the Surveillance.

BASES

SR 3.0.3 (continued)

SR 3.0.3 also provides a time limit for completion of Surveillances that become applicable as a consequence of changes in the specified Conditions in the Applicability imposed by Required Actions.

Failure to comply with specified Frequencies for SRs is expected to be an infrequent occurrence. Use of the delay period established by SR 3.0.3 is a flexibility that is not intended to be used as an operational convenience to extend Surveillance intervals.

If a Surveillance is not completed within the allowed delay period, then the equipment is considered not in service or the variable is considered outside the specified limits and the Completion Times of the Required Actions for the applicable LCO Conditions begin immediately upon expiration of the delay period. If a Surveillance is failed within the delay period, then the equipment is not in service, or the variable is outside the specified limits and the Completion Times of the Required Actions for the applicable LCO Conditions begin immediately upon the failure of the Surveillance. Completion of the Surveillance within the delay period allowed by this Specification, or within the Completion Time of the ACTIONS, restores compliance with SR 3.0.1.

SR 3.0.4

SR 3.0.4 establishes the requirement that all applicable SRs must be met before entry into a specified Condition in the Applicability.

This Specification ensures that system and component requirements and variable limits are met before entry in the Applicability for which these systems and components ensure safe operation of the facility.

The provisions of this Specification should not be interpreted as endorsing the failure to exercise the good practice of restoring systems or components to an appropriate status before entering an associated specified Condition in the Applicability. However, in certain circumstances, failing to meet an SR will not result in SR 3.0.4 restricting a change in specified Condition. When a system, subsystem, division, component, device, or variable is outside its specified limits, the associated SR(s) are not required to be performed, per SR 3.0.1, which states that Surveillances do not have to be performed on such equipment. When equipment does not meet the LCO, SR 3.0.4 does not apply to the associated SR(s) since the requirement for the SR(s) to be performed is removed. Therefore, failing to perform the Surveillance(s) within the

BASES

SR 3.0.4 (continued)

specified Frequency does not result in an SR 3.0.4 restriction to changing specified Conditions of the Applicability. However, since the LCO is not met in this instance, LCO 3.0.4 will govern any restrictions that may (or may not) apply to specified Condition changes.

The provisions of SR 3.0.4 shall not prevent changes in specified Conditions in the Applicability that are required to comply with ACTIONS. In addition, the provisions of SR 3.0.4 shall not prevent changes in specified Conditions in the Applicability that are related to the off-site shipment of canisters.

The precise requirements for performance of SRs are specified such that exceptions to SR 3.0.4 are not necessary. The specific time frames and Conditions necessary for meeting the SRs are specified in the Frequency, in the Surveillance, or both. This allows performance of Surveillances when the prerequisite Condition(s) specified in a Surveillance procedure require entry into the specified Condition in the Applicability of the associated LCO prior to the performance or completion of a Surveillance. A Surveillance that could not be performed until after entering the LCO Applicability would have its Frequency specified such that it is not "due" until the specific Conditions needed are met. Alternatively, the Surveillance may be stated in the form of a Note as not required (to be met or performed) until a particular event, condition, or time has been reached. Further discussion of the specific formats of SR annotation is found in Technical Specifications Section 1.4, operation to proceed to a specified condition where other necessary post maintenance tests can be completed.

B.3.1 RADIATION PROTECTION

B.3.1.1 SHIPPING/TRANSFER CASK (STC) Exterior Surface Contamination

BASES

BACKGROUND	Since the STC may be subject to weeping, the exterior surface of the STC is checked. Contamination on these surfaces is removed to a level that is as low as reasonably achievable (ALARA) and below the LCO limits in order to minimize radioactive contamination to personnel and the environment.
APPLICABLE SAFETY ANALYSIS	This radiation protection measure assures that the surfaces of the STC has been decontaminated. This keeps the dose to occupational personnel ALARA.
LCO	The contamination limits on the exterior surface of the STC are based on the allowed removable external radioactive contamination specified for spent fuel shipping containers in 49 CFR 173.443 (as referenced in 10 CFR 71.87(i)). Consequently, these contamination levels are considered acceptable for exposure to the general environment. This level will also ensure that the contamination levels of the inner surfaces of the HSM and potential releases of radioactive material to the environment are minimized. The HSM will protect the CANISTER from direct exposure to the elements and will, therefore, limit potential releases of removable contamination. The probability of any removable contamination being entrapped in the HSM airflow path released outside the HSM is considered extremely small. The number and location of surface swipes used to determine compliance for this LCO for both the exterior surface of the STC is based on standard industry practice.

BASES

APPLICABILITY	Measurement and comparison of the removable contamination levels for both the STC is performed during LOADING OPERATIONS (NUHOMS® Systems).
ACTIONS	If the removable surface contamination is not within the LCO limits, action must be taken to decontaminate the STC, as appropriate, to bring the contamination level to within the limits. The Completion Time of 7 days and prior to TRANSFER OPERATIONS is appropriate given that sufficient time is required to prepare for and perform the decontamination once the limit has been determined to be exceeded.
SURVEILLANCE REQUIREMENTS	The measurement of the removable surface contamination on the STC is performed once, prior to TRANSFER OPERATIONS, to verify it is less than the established LCO limits. This Frequency is necessary in order to confirm that the loaded STC can be moved safely to the Storage Area without releasing loose contamination to the environment or causing excessive operational doses to personnel.
REFERENCES	None.

B.3.2 NAC-MPC SYSTEM Integrity

B.3.2.1 CANISTER Maximum Time in the TRANSFER CASK

BASES

BACKGROUND	During TRANSFER OPERATIONS or prior to TRANSPORT OPERATIONS, a loaded CANISTER is transferred from one VCC to another VCC (or a TRANSPORTATION CASK) using the TRANSFER CASK. The TRANSFER CASK is placed on the VCC (or a TRANSPORTATION CASK), the bottom doors are opened, the loaded CANISTER is lifted into the TRANSFER CASK cavity, the bottom shield doors are closed and the CANISTER is lowered until it rests on the bottom doors. Subsequently, the loaded TRANSFER CASK is placed on another VCC (or TRANSPORTATION CASK) and the procedure is reversed, lowering the loaded CANISTER into another VCC (or TRANSPORTATION CASK). The LCO limits the total time a CANISTER can be maintained in the TRANSFER CASK to 25 days (600 hrs).
APPLICABLE SAFETY ANALYSIS .	Limiting the total time that a loaded CANISTER backfilled with helium may be in the TRANSFER CASK, prior to placement in a VCC, or TRANSPORTATION CASK, precludes the inappropriate use of the TRANSFER CASK as a storage component. The thermal analyses in the NAC-MPC Final Safety Analysis Report show that the short-term temperature limits for the spent fuel cladding are not exceeded for an unlimited period of time (steady state analysis). The duration of 25 days (600 hrs) is defined based on a test time of 30 days for abnormal regimes as described in PNL-4835.

BASES

LCO	Limiting the length of time that the loaded CANISTER backfilled with helium is allowed to remain in the TRANSFER CASK ensures that the TRANSFER CASK is not inappropriately used as a storage component.
APPLICABILITY	The elapsed time restrictions on a loaded CANISTER in the TRANSFER CASK apply during TRANSFER OPERATIONS and prior to TRANSPORT OPERATIONS.
ACTIONS	A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each NAC-MPC system. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each NAC-MPC system not meeting the LCO. Subsequent NAC-MPC systems that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions. A.1 Complete CANISTER TRANSPORTATION CASK. B.1 Return CANISTER to TRANSPORTATION CASK or VCC.
SURVEILLANCE REQUIREMENTS .	SR 3.2.1.1 Verify CANISTER transfer complete.
REFERENCES	NAC-MPC FSAR Sections 4.4, 4.5, 4.A.3, 8.1, 8.2, 8.3, 8.A.1, 8.A.2 and 8.A.3.

B.3.2.2 VCC Heat Removal System

BASES

BACKGROUND	The VCC Heat Removal System is a passive, air-cooled convective heat transfer system, which ensures that heat from the CANISTER is transferred to the environment by the upward flow of air through the VCC. Relatively cool air is drawn into the annulus between the VCC and the CANISTER through the four air inlets at the bottom of the VCC. The CANISTER transfers its heat from the CANISTER surface to the air via natural convection. The buoyancy created by the heating of the air creates a chimney effect and the air flows back into the environment through the four air outlets at the top of the VCC.
APPLICABLE SAFETY ANALYSIS	The thermal analyses of the VCC take credit for the decay heat from the spent fuel assemblies being ultimately transferred to the ambient environment surrounding the VCC. Transfer of heat away from the fuel assemblies ensures that the fuel cladding and CANISTER component temperatures do not exceed applicable limits. Under normal storage conditions, the four air inlets and four air outlets are unobstructed and full air flow (i.e., maximum heat transfer for the given ambient temperature) occurs. Analyses have been performed for the complete obstruction of all of the air inlets and outlets. The complete blockage of all air inlets and outlets stops air cooling of the CANISTER. The CANISTER will continue to radiate heat to the relatively cooler inner shell of the VCC. With the loss of air cooling, the CANISTER component temperatures will increase toward their respective short-term temperature limits. The limiting component is the CANISTER basket support and heat transfer disks, which, by analysis, approach their temperature limits in 24 hours for Yankee-MPC and CY-MPC systems, if no action is taken to restore air flow to the heat removal system. The MPC-LACBWR analysis for all inlets and outlets blocked shows system temperatures remain below long-term limits for the 4.5 kW total heat load. Thermal performance of the MPC-LACBWR system is provided by radiation between the CANISTER and VCC, and air cooling convection heat transfer is not required to maintain system safety limits.

.

BASES

LCO

The VCC Heat Removal System must be verified to be OPERABLE for Yankee-MPC and CY-MPC systems to preserve the assumptions of the thermal analyses. Operability of the heat removal system ensures that the decay heat generated by the stored fuel assemblies is transferred to the environment at a sufficient rate to maintain fuel cladding and CANISTER component temperatures within design limits for the Yankee-MPC and CY-MPC systems.

APPLICABILITY

The LCO is applicable during STORAGE OPERATIONS. Once a VCC containing a CANISTER loaded with spent fuel has been placed in storage, the heat removal system must be OPERABLE to ensure adequate heat transfer of the decay heat away from the fuel assemblies for the Yankee-MPC and CY-MPC systems.

ACTIONS

A note has been added to ACTIONS that states for this LCO, separate Condition entry is allowed for each VCC. This is acceptable since the Required Actions for each Condition provide appropriate compensatory measures for each VCC not meeting the LCO. Subsequent VCCs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1

If the VCC heat removal system has been determined to be not OPERABLE, it must be restored to OPERABLE status within 8 hours. Eight hours is reasonable based on the accident analysis that shows that the limiting VCC component temperatures will not reach their temperature limits for 24 hours after a complete blockage of all inlets and outlets.

B.1

Until the completion of Required Action A.1, performance of SR 3.2.2.1 shall be performed on an increased Completion Time Frequency of 6 hours to document the OPERABLE status of the VCC heat removal system.

<u>AND</u>

B.2.1

If Required Action A.1 cannot be met, an engineering evaluation is performed to verify that the VCC heat removal system is OPERABLE. The Completion Time for this Required Action of 12 hours will ensure that the CANISTER remains in a safe, analyzed condition.

<u>OR</u>

BASES

ACTIONS (continued)	B.2.2 Place the affected NAC-MPC SYSTEM in a safe condition. The Completion Time for this Required Action of 12 hours will ensure that the NAC-MPC system is maintained in a safe condition.
SURVEILLANCE REQUIREMENTS	SR 3.2.2.1 The long-term integrity of the stored fuel is dependent on the ability of the VCC to reject heat from the CANISTER to the environment. Visual observation that all four air inlet and outlet screens are unobstructed and intact ensures that air flow past the CANISTER is occurring and heat transfer is taking place. Complete blockage of more than two air inlet or outlet screens or the equivalent effective screen area renders the heat removal system not OPERABLE and this LCO is not met. Partial blockage of less than two air inlet or outlet screens or the equivalent effective screen area does not result in the heat removal system being not OPERABLE. However, corrective actions should be taken promptly to remove the obstruction and restore full flow through the affected air inlet and outlet screens. Alternatively, based on the thermal analyses, if the air temperature rise is less than the limits stated in the SR, adequate air flow and, therefore, adequate heat transfer is occurring to provide assurance of long-term fuel cladding integrity. The reference ambient temperature used to perform this Surveillance shall be measured at the storage pad. The Frequency of 24 hours is reasonable based on the time necessary for VCC and CANISTER components to heat up to unacceptable temperatures assuming design basis heat loads, and allowing for corrective actions to take place upon discovery of the blockage of the air inlet and outlet screens.
REFERENCES	NAC-MPC FSAR Chapter 4, Appendix 4.A and Chapter 11, Section 11.1.1, Section 11.2.8 and Appendix 11.A.

B.3.3 NAC-UMS SYSTEM Integrity

B.3.3.1 CANISTER Maximum Time in the TRANSFER CASK

BASES

BACKGROUND	The cumulative time a loaded, helium backfilled CANISTER may remain in the TRANSFER CASK is limited to 600 hours. This limit ensures that the test duration of 30 days (720 hours) considered in PNL-4835 for zirconium alloy clad fuel for storage in air is not exceeded and ensures that the TRANSFER CASK is used as intended. The time limit is established to preclude long-term storage of a loaded CANISTER in the TRANSFER CASK. For heat loads less than or equal to 20kW (PWR) forced air cooling is not required. The maximum heat load allowed by NAC-UMS TRANSPORTATION CASK for the shipment of Maine Yankee fuel is 19.92 kW.
APPLICABLE SAFETY ANALYSIS	Analyses reported in the NAC-UMS Safety Analysis Report for heat loads of 20 kW or less (PWR), and with the CANISTER backfilled with helium, the analysis shows that the fuel cladding and CANISTER components reach a steady-state temperature below the short-term allowable temperatures. Therefore, the time in the TRANSFER CASK is limited to 600 hours. This limit ensures that the test duration of 30 days (720 hours) considered in PNL 4835 for zirconium alloy clad fuel for storage in air is not exceeded and ensures that the TRANSFER CASK is used as intended. Since the 600 hours is significantly less than the 720 hours considered in PNL-4835, operation in the TRANSFER CASK to this period is acceptable.

BASES

LCO	For PWR heat loads less than or equal to 20 kW, the thermal analysis shows that the presence of helium in the CANISTER is sufficient to maintain the fuel cladding and CANISTER component temperatures below the short term temperature limits. Therefore, forced air cooling is not required for these heat load conditions. Therefore, the CANISTER may remain in the TRANSFER CASK for up to 600 hours, where the time limit is based on the test duration of 30 days (720 hours) considered in PNL 4835 for zirconium alloy clad fuel for storage in air rather than on temperature limits.
APPLICABILITY	During TRANSFER OPERATIONS the TRANSFER CASK active cooling system must be in operation or the time limits specified must be adhered to. This LCO is applicable once a CANISTER is lifted off the VCC pedestal or the TRANSPORTATION CASK is no longer in the horizontal orientation.
ACTIONS	A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each NAC-UMS® system. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each NAC-UMS® system not meeting the LCO. Subsequent NAC-UMS® systems that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions. A note has been added to Condition A that reminds users that all time spent in Condition A is included in the 600-hour cumulative limit. If the LCO 3.3.1. 600-hour cumulative time limit is exceeded: A.1 The CANISTER shall be placed in a VCC. <u>OR</u> A.2 The CANISTER shall be placed in a TRANSPORTATION CASK.

BASES

SURVEILLANCE REQUIREMENTS	SR 3.3.1.1 The elapsed time from entry into the LCO conditions of Applicability until placement of the CANISTER in a VCC or TRANSPORTATION CASK shall be monitored.
.	
REFERENCES	NAC-UMS FSAR Sections 4.4, 8.1 and 8.2.

B.3.3.2 VCC Heat Removal System

BASES

BACKGROUND	The VCC Heat Removal System is a passive, air-cooled convective heat transfer system, which ensures that heat from the CANISTER is transferred to the environment by the upward flow of air through the VCC. Relatively cool air is drawn into the annulus between the VCC and the CANISTER through the four air inlets at the bottom of the VCC. The CANISTER transfers its heat from the CANISTER surface to the air via natural convection. The buoyancy created by the heating of the air creates a chimney effect and the air flows back into the environment through the four air outlets at the top of the VCC.
APPLICABLE SAFETY ANALYSIS	The thermal analyses of the VCC take credit for the decay heat from the spent fuel assemblies being ultimately transferred to the ambient environment surrounding the VCC. Transfer of heat away from the fuel assemblies ensures that the fuel cladding and CANISTER component temperatures do not exceed applicable limits. Under normal storage conditions, the four air inlets and four air outlets are unobstructed and full air flow (i.e., maximum heat transfer for the given ambient temperature) occurs. Analyses have been performed for the complete obstruction of all of the air inlets and outlets. The complete blockage of all air inlets and outlets stops air cooling of the CANISTER. The CANISTER will continue to radiate heat to the relatively cooler inner shell of the VCC. With the loss of air cooling, the CANISTER component temperatures will increase toward their respective short-term temperature limits. The limiting components are the CANISTER basket support and heat transfer disks, which, by analysis, approach their temperature limits in 24 hours, if no action is taken to restore air flow to the heat removal system. The maximum fuel clad temperatures remain below allowable accident limits for approximately six days (150 hours) with complete air flow blockage.
LCO	The VCC Heat Removal System must be verified to be OPERABLE to preserve the assumptions of the thermal analyses. Operability of the heat removal system ensures that the decay heat generated by the stored fuel assemblies is transferred to the environment at a sufficient rate to maintain fuel cladding and CANISTER component temperatures within design limits.

BASES

APPLICABILITY

The LCO is applicable during STORAGE OPERATIONS. Once a VCC containing a CANISTER loaded with spent fuel has been placed in storage, the heat removal system must be OPERABLE to ensure adequate heat transfer of the decay heat away from the fuel assemblies.

ACTIONS

A note has been added to ACTIONS that states for this LCO, separate Condition entry is allowed for each VCC. This is acceptable since the Required Actions for each Condition provide appropriate compensatory measures for each VCC not meeting the LCO. Subsequent VCCs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1

If the VCC heat removal system has been determined to not be OPERABLE, it must be restored to an analyzed safe status immediately, with adequate heat removal capability. Immediately, defined as the required action to be pursued without delay and in a controlled manner, provides a reasonable period of time (typically, one operating shift) to take action to remove the obstructions in the air flow path.

In order to meet A.1, adequate heat removal capability must be verified to exist, either by visual observation of at least two unobstructed air inlet and outlet screens or by physically clearing any blockage from two air inlet and outlet screens, to prevent exceeding the short-term temperature limits.

Thermal analysis of a fully blocked VCC shows that without adequate heat removal, the fuel cladding accident temperature limit could be exceeded over time. As a result, requiring immediate verification of adequate heat removal capability will ensure that the VCC and CANISTER components and the fuel cladding do not exceed their short-term temperature limits.

The thermal analysis also shows that complete blockage of two air inlet and outlet screens results in no potential for exceeding accident fuel cladding, VCC or CANISTER component temperature limits. As a result, verifying that there are at least two unobstructed air inlet and outlet screens will ensure that the accident temperature limits are not exceeded during the time that the remainder of the air inlet and outlet screens are returned to OPERABLE status.

<u>AND</u>

BASES

ACTIONS (continued)

A.2
As long as adequate heat removal capability has been verified to exist, restoring the VCC heat removal system to fully OPERABLE is not an immediate concern. Therefore, restoring it to OPERABLE within 25 days is a reasonable Completion Time.

B.1

If the Required Actions A.1 or A.2 cannot be met, an engineering evaluation is performed to verify that the VCC heat removal system is OPERABLE.

The Completion Time for this Required Action of 5 days will ensure that the CANISTER remains in a safe, analyzed condition.

<u>OR</u>

B.2
Place the affected NAC-UMS SYSTEM in a safe condition.

The Completion Time for this Required Action is 5 days. Requiring B.2 action completion within 5 days will ensure that the NAC-UMS SYSTEM is maintained in a safe condition.

SURVEILLANCE REQUIREMENTS

SR 3.3.2.1

The long-term integrity of the stored fuel is dependent on the ability of the VCC to reject heat from the CANISTER to the environment. Visual observation that all four air inlet and outlet screens are unobstructed and intact ensures that air flow past the CANISTER is occurring and heat transfer is taking place. Complete blockage of one or more air inlet or outlet screens renders the heat removal system inoperable and this LCO is not met. Partial blockage of one or more air inlet or outlet screens does not constitute inoperability of the heat removal system. However, corrective actions should be taken promptly to remove the obstruction and restore full flow through the affected air inlet and outlet screens. Alternatively, based on the analyses, if the air temperature rise is less than the limits stated in the SR, adequate air flow and, therefore, adequate heat transfer is occurring to provide assurance of long-term fuel cladding integrity. The reference ambient temperature used to perform this Surveillance shall be measured at the WCS CISF.

BASES

SURVEILLANCE REQUIREMENTS (continued)	SR 3.3.2.1 (continued) The Frequency of 24 hours is reasonable based on the time necessary for VCC and CANISTER components to heat up to unacceptable temperatures assuming design basis heat loads, and allowing for corrective actions to take place upon discovery of the blockage of the air inlet and outlet screens. SR 3.3.2.2 The initial confirmation of the OPERABILITY of the VCC is established based on air temperature measurements at the VCC outlets and the WCS CISF ambient, and verification that the air temperature rise is less than the limits stated in the SR. Following the initial confirmation, the continued OPERABILITY of the VCC shall be confirmed by one of the verification methods specified in SR 3.3.2.1. The specified Frequency of once between 5 and 30 days after beginning STORAGE OPERATIONS is reasonable and ensures that the VCC has reached thermal equilibrium and, therefore, the outlet air temperature measurements will reflect expected temperatures under normal operations. Completion of the measurements within 30 days of placement of the VCC into STORAGE OPERATIONS ensures that corrective actions can be taken to establish the OPERABLE status of the VCC within a reasonable period of time.
REFERENCES	NAC-UMS FSAR Chapter 4 and Chapter 11, Section 11.1.2 and Section 11.2.13.

B.3.4 MAGNASTOR SYSTEM Integrity

B.3.4.1 CANISTER Maximum Time in the TRANSFER CASK

BASES

BACKGROUND	When a MAGNASTOR CANISTER is lifted off a VCC pedestal or when the MAGNATRAN TRANSPORTATION CASK is no longer in the horizontal orientation, there are time limits with completing the transfer from a TRANSPORTATION CASK to a VCC and vice versa without the TRANSFER CASK active cooling system in operation.
APPLICABLE SAFETY ANALYSIS	To protect the fuel cladding from exceeding allowable temperature limits, the TRANSFER CASK active cooling system must be running or the transfer from a TRANSPORTATION CASK to a VCC and vice versa must be completed within a maximum timeframe.

BASES

LCO	A dry pressurized, helium filled and sealed CANISTER establishes the inert environment that will ensure the integrity of the fuel cladding and proper performance of the MAGNASTOR system thermal design, while precluding air in-leakage and out-leakage of radioactive materials. Table A provides the time limit for completing the first attempt at TRANSFER OPERATIONS. The heat load limit specified is the maximum heat load limit authorized in the MAGNATRAN TRANSPORTATION CASK. If the initial attempt at TRANSFER OPERATIONS is not completed in 41 hours, the TRANSFER CASK active cooling system must be placed in operation for a minimum of 24 hours to restore the CANISTER thermal condition to the initial thermal condition presented in the thermal transient analysis for the MAGNASTOR TRANSFER CASK. Once the CANISTER thermal condition is restored to the initial transient analysis condition, a subsequent transfer attempt can be performed. Per Table B, the time limit for subsequent attempts at TRANSFER OPERATIONS is 31 hours.
APPLICABILITY	During TRANSFER OPERATIONS the TRANSFER CASK active cooling system must be in operation or the time limits specified must be adhered to. This LCO is applicable once a CANISTER is lifted off the VCC pedestal or the TRANSPORTATION CASK is no longer in the horizontal orientation.

BASES

ACTIONS

A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each CANISTER. This is acceptable as the Required Actions for each Condition provide appropriate compensatory measures for each CANISTER not meeting the LCO. Subsequent CANISTERS that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1
If the TRANSFER OPERATIONS is not going to be completed in time, the CANISTER must be returned to the TRANSFER CASK immediately.

AND

A.2
The TRANSFER CASK active cooling system must be operational immediately.

AND

A.3
The TRANSFER CASK active cooling system must be operational for at least 24 hours before attempting a subsequent transfer attempt.

BASES

SURVEILLANCE REQUIREMENTS	SR 3.4.1.1 During TRANSFER OPERATIONS and prior to TRANSPORT OPERATIONS, the amount of time the CANISTER remains off a VCC pedestal or not in a MAGNATRAN TRANSPORTATION CASK that is not in the horizontal orientation must be continuously recorded. In addition, the amount of time the CANISTER has been in a TRANSFER CASK without the TRANSFER CASK active cooling system operational must be continuously recorded.
REFERENCES	MAGNASTOR FSAR Sections 4.4 and 9.1.

B.3.4.2 VCC Heat Removal System

BASES

BACKGROUND	The heat removal system for the VCC containing a loaded TSC is a passive, convective air-cooled heat transfer system that ensures that the decay heat emitted from the TSC is transferred to the environment by the upward flow of air through the VCC annulus. During STORAGE OPERATIONS, ambient air is drawn into the VCC annulus through the four air inlets located at the base of the VCC. The heat from the TSC surfaces is transferred to the air flow via natural circulation. The buoyancy of the heated air creates a chimney effect forcing the heated air upward and drawing additional ambient air into the annulus through the air inlets. The heated air flows back to the ambient environment through the four air outlets located in the VCC lid.
APPLICABLE SAFETY ANALYSIS	The thermal analyses of the MAGNASTOR SYSTEM take credit for the decay heat from the TSC contents being transferred to the ambient environment surrounding the VCC. Transfer of heat from the TSC contents ensures that the fuel cladding and TSC component temperatures do not exceed established limits. During normal STORAGE OPERATIONS, the four air inlets and four air outlets are unobstructed and full natural convection heat transfer occurs (i.e., maximum heat transfer for a given ambient temperature and decay heat load). Vent obstruction can be any type of accumulation within the vent that restricts airflow. Analyses have been performed for two scenarios corresponding to the complete obstruction of what is equivalent to two and four air inlets. Blockage of the equivalent area of two air inlets reduces the convective air flow through the VCC/TSC annulus and decreases the heat transfer from the TSC surfaces to the ambient environment. Under this off-normal event, no VCC or TSC components or fuel cladding exceed established short-term temperature limits, and the TSC internal pressure does not exceed the analyzed maximum pressure. The complete blockage of all four air inlets effectively stops the transfer of the decay heat from the TSC due to the elimination of the convective air flow. The TSC will continue to radiate heat to the liner of the VCC. Upon loss of air cooling, the MAGNASTOR SYSTEM component temperatures will increase toward their respective established accident temperature limits. The spent fuel cladding and fuel basket and VCC structural component temperatures do not reach their accident limits for a time period of approximately 72 hours. The internal pressure in the TSC cavity will not reach the analyzed maximum pressure condition for approximately 58 hours after a complete blockage condition occurs.

BASES

APPLICABLE SAFETY ANALYSIS (continued)	Therefore, following the identification of a reduction in the heat dissipation capabilities of the VCC by the temperature- monitoring program or the visual inspection of the air inlet and outlet screens, actions are to be taken immediately to restore at least partial convective airflow (i.e., a minimum area of what is equivalent of two air inlet and all four air outlets are unobstructed). Once partial airflow is established, the fuel cladding and the TSC and component temperatures will not exceed normal STORAGE OPERATIONS limits. Efforts to reestablish full OPERABLE status for the VCC can then be undertaken in a controlled manner. If necessary, the TSC may be transferred into the TRANSFER CASK to permit full access to the base of the VCC for repairs with minimal radiological effects.
LCO	The VCC heat removal system is to be verified to be OPERABLE to preserve the applicability of the design bases thermal analyses. The continued operability of the heat removal system ensures that the decay heat generated by the TSC contents is transferred to the ambient environment to maintain the fuel cladding and VCC and TSC temperatures within established limits.
APPLICABILITY	The LCO is applicable during STORAGE OPERATIONS. Once the VCC lid is installed following transfer of a loaded TSC, the heat removal system is required to be OPERABLE to ensure adequate heat transfer.
ACTIONS	A Note has been added to the Actions that states for this LCO, separate condition entry is allowed for each VCC. This is acceptable, as the Required Actions for each Condition provide appropriate compensatory measures for each VCC not meeting the LCO. Other VCCs that do not meet the LCO are addressed by independent Condition entry and application of the associated Required Actions. A.1 If the VCC heat removal system has been determined to be inoperable, full operability is to be restored, or at a minimum, adequate heat removal must be restored or verified to prevent exceeding fuel cladding and critical component temperatures for accident events. Adequate heat removal capability is ensured by having at least the equivalent area of two VCC air inlets and all four air outlets unobstructed, which is consistent with the analyzed off-normal event. Alternatively, adequate heat removal can be verified by measuring the exit air temperature from the four air outlets and determining the temperature rise over the WCS CISF ambient air temperature.

BASES

ACTIONS (continued)

This verification must be completed immediately where "immediately" is defined as "the required action should be pursued without delay in a controlled manner". Restoration of adequate heat removal must be completed within 58 hours of the last operability determination to ensure the TSC internal pressure limit is not exceeded per the analysis in MAGNASTOR FSAR Section 12.2.13.3, which is the most restrictive time limit.

Thermal analyses of a fully blocked VCC air inlet condition show that fuel cladding and critical basket material accident temperatures and internal pressure limits could be exceeded over time. As a result, requiring immediate verification, or restoration, of adequate heat removal capability will ensure that accident temperature and pressure limits are not exceeded. Once adequate heat removal has been reestablished or verified, the additional actions required to restore the VCC to OPERABLE status can be completed under A.2.

AND

A.2
In addition to Required Action A.1, efforts are required to be continued to restore the VCC heat removal system to OPERABLE.

As long as adequate heat removal capability has been verified to exist, restoring the VCC heat removal system to fully OPERABLE is not an immediate concern. Therefore, restoring it to OPERABLE within 30 days is a reasonable Completion Time.

SURVEILLANCE REQUIREMENTS

SR 3.4.2.1
The long-term integrity of the stored spent fuel is dependent on the continuing ability of the VCC to reject decay heat from the TSC to the ambient environment. Routine verification that the four air inlets and four air outlets are unobstructed and intact ensures that convective airflow through the VCC/TSC annulus is occurring and performing effective heat transfer. Alternatively, the Surveillance Requirement can be fulfilled by measuring the exit air temperature from the four air outlets and determining the temperature rise over the WCS CISF ambient air temperature. As long as the temperature increase of the convective airflow is less than the surveillance limits, adequate heat transfer is occurring to maintain VCC, TSC, and spent fuel cladding temperatures below long-term limits.

BASES

SURVEILLANCE REQUIREMENTS (Continued)	SR 3.4.2.1 (continued) If partial or complete blockage of the VCC air inlets occurs, the heat rejection system will be rendered inoperable and this LCO is not met. Immediate corrective actions are to be taken to remove the obstructions from at least two air inlets and all four air outlets, or equivalent area, to restore partial air flow, and additional corrective actions are to be taken to remove all air inlet and outlet obstructions and return the VCC to a fully OPERABLE status. The Frequency of 24 hours is reasonable based on the time necessary for the spent fuel cladding and VCC and TSC component temperatures to reach their short-term temperature limits and the internal pressure to increase to the accident condition pressure limit. The Frequency will allow appropriate corrective actions to be completed in a timely manner.
.	
REFERENCES	MAGNASTOR FSAR Section 4.4.

CHAPTER 15
MATERIALS EVALUATION

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15. MATERIALS EVALUATION

This chapter provides the detailed descriptions of the materials selected for use in the important-to-safety (ITS) storage pads for the NAC Vertical Concrete Casks (VCCs); Canister Transfer System; Vertical Cask Transporter (VCT) operational components; Cask Handling Building; and Special Lifting Devices for the NAC transportation casks at the Interim Storage Partners' (ISP's) WCS Consolidated Interim Storage Facility (WCS CISF). The significant physical and mechanical properties of materials used in these components are defined, and the material specifications, tests and acceptance conditions important to material use are identified in this chapter.

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 1.2.41 As demonstrated in Chapter 2, the WCS CISF is not located in coastal marine environment where the canisters would experience atmospheric chloride corrosion. However, when the Aging Management Program for a given 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 Management Program will be applied to the canister at the WCS CISF. (See License Condition 20 for Aging Management Program Commitments for the WCS CISF).

Because only previously loaded canisters will be accepted at the WCS CISF the following topics identified in ISG-15 are remain unchanged from what has been previously reviewed and approved by the US NRC in the applications incorporated by reference listed in Section 1.6.

- Material Properties
- Weld Design and Inspection
- Galvanic and Corrosive Reactions
- Bolt Applications
- Protective Coatings and Surface Treatments
- Neutron Shielding Materials
- Materials for Criticality Control
- Seals
- Low Temperature Ductility of Ferritic Steels
- Fuel Cladding, including burnup and cladding temperature limits
- Prevention of Oxidation Damage During Loading of Fuel
- Flammable Gas Generation
- Canister Closure Weld testing and Inspection

15.1.5 Cask Handling Building

The materials used in the construction of the Cask Handling Building are given in Table 15-1.

15.1.6 NAC Transportation Cask Special Lifting Devices

15.1.6.1 NAC-STC Special Lifting Device

The materials used in the construction of the NAC-STC Special Lifting Device are:

Lifting Plates	ASTM A240, UNS S31803
Lift Arm and Lift Pin	ASTM A693/564, Type 630

15.1.6.2 NAC-UMS Special Lifting Device

The materials used in the construction of the NAC-UMS Special Lifting Device are:

Lifting Plates	ASTM B209, 6061-T6
Lift Arm	ASME SA693, Type 630
Lift Pin	ASTM A304

15.1.6.3 MAGNATRAN Special Lifting Device

The materials used in the construction of the MAGNATRAN Special Lifting Device are:

Lifting Plates	ASTM A514
Lift Arm and Lift Pin	ASTM A693/564, Type 630

15.2 Applicable Codes and Standards

The principal codes and standards applied to the ITS components of the Canister Transfer System and VCT and the ITS storage pads are the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, the American Society for Testing and Materials (ASTM), and the American Concrete Institute (ACI). Materials meeting the requirements of these codes and/or standards conform to acceptable minimum thickness, chemical content and formulation specifications and are fabricated using controlled processes and procedures.

Base materials for the Canister Transfer System and the VCT will adhere, as applicable, to NOG-1 [15-1] and ANSI N14.6 [15-5] fracture toughness requirements.

The following sections list the applicable codes and standards applicable to the various canisters and storage overpacks authorized for storage at the WCS CISF.

15.2.1 Canisters

15.2.1.1 FO-, FC-, FF-DSCs

The DSCs are designed to meet the stress intensity allowables of the ASME Boiler and Pressure Vessel Code (1983) Section III, Division I, Subsections NB, NF, and NG for Class I components and supports, as applicable. ASME Code Service Levels A and B allowables are used for normal and off-normal operating conditions. Service Levels C and D allowables are used for accident conditions such as a postulated cask drop accident. Approved code alternatives are addressed in Section 4.3.4 of Appendix: Technical Specifications to SNM-2510.

15.2.1.2 NUHOMS®-24PT1 DSC

The DSC is designed fabricated and inspected to the maximum practical extent in accordance with ASME Boiler and Pressure Vessel Code Section III, Division 1, 1992 Edition with Addenda through 1994, including exceptions allowed by Code Case–595-1, Subsections NB, NF and NG for Class 1 components and supports. Code Alternatives are discussed in Section 4.3.4 of Appendix A: Technical Specifications for the Advanced NUHOMS® System to CoC No. 1029.

15.2.1.3 NUHOMS®-61BT DSC

The DSC is designed fabricated and inspected to the maximum practical extent in accordance with ASME Boiler and Pressure Vessel Code Section III, Division 1, 1998 Edition with Addenda through 2000, Subsections NB, NF and NG for Class 1 components and supports. Code Alternatives are discussed in Section 4.2.4 of Appendix A: Technical Specifications for the Standardized NUHOMS® Horizontal Modular Storage System to CoC No. 1004.

15.2.1.4 NUHOMS®-61BTH Type 1 DSC

The DSC is designed fabricated and inspected to the maximum practical extent in accordance with ASME Boiler and Pressure Vessel Code Section III, Division 1, 1998 Edition with 1999 Addenda, Subsections NB, NF and NG for Class 1 components and supports. Code Alternatives are discussed in Section 4.2.4 of Appendix A: Technical Specifications for the Standardized NUHOMS® Horizontal Modular Storage System to CoC No. 1004.

15.2.1.5 NAC-MPC Canister

The NAC-MPC canister and spent fuel basket are designed fabricated and inspected to the maximum practical extent in accordance with ASME Boiler and Pressure Vessel Code Section III, Subsection NB and NG, 1995 Edition with Addenda through 1995, respectively. Table B3-1 of the NAC-MPC CoC No. 1025 lists approved alternatives to the ASME Code for the design, procurement, fabrication, inspection and testing of NAC-MPC system canisters and spent fuel baskets.

15.2.1.6 NAC-UMS Canister

The NAC-UMS canister and spent fuel basket are designed fabricated and inspected to the maximum practical extent in accordance with ASME Boiler and Pressure Vessel Code Section III, Subsection NB and NG, 1995 Edition with Addenda through 1995, respectively. Table B3-1 of the NAC-MPC CoC No. 1015 lists approved alternatives to the ASME Code for the design, procurement, fabrication, inspection and testing of NAC-UMS system canisters and spent fuel baskets.

15.2.1.7 MAGNASTOR Canister

The MAGNASTOR canister and spent fuel basket are designed fabricated and inspected to the maximum practical extent in accordance with ASME Boiler and Pressure Vessel Code Section III, Subsection NB and NG, 2001 Edition with Addenda through 2003, respectively. Table 2.1-2 of the MAGNASTOR FSAR lists approved alternatives to the ASME Code for the design, procurement, fabrication, inspection and testing of MAGNASTOR system canisters and spent fuel baskets CoC No. 1031.

15.2.2 Storage Overpacks

15.2.2.1 HSM Model 80

The reinforced concrete HSMs are designed to meet the requirements of ACI 349-85. The load combinations specified in ANSI 57.9-1984, Section 6.17.3.1 are used for combining normal operating, off-normal, and accident loads for the HSM. Approved code alternatives are addressed in Section 4.3.4 of Appendix: Technical Specifications to SNM-2510.

15.2.2.2 AHSM

The reinforced concrete AHSM is designed to meet the requirements of ACI 349-97. Load combinations specified in ANSI 57.9-1984, Section 6.17.3.1 are used for combining normal operating, off-normal, and accident loads for the AHSM.

15.2.2.3 HSM Model 102

The HSM Model 102 reinforced concrete is designed to meet the requirements of ACI 349-85 and ACI 349-97 Editions, respectively. Load combinations specified in ANSI 57.9-1984, Section 6.17.3.1 are used for combining normal operating, off-normal, and accident loads for the HSM.

15.2.2.4 NAC-MPC VCC

The American Concrete Institute Specifications ACI 349 (1985) and ACI 318 (1995) govern the NAC-MPC system VCC design and construction, respectively.

15.2.2.5 NAC-UMS VCC

The American Concrete Institute Specifications ACI 349 (1985) and ACI 318 (1995) govern the NAC-UMS system VCC design and construction, respectively.

15.2.2.6 MAGNASTOR VCC

The American Concrete Institute Specifications ACI-349 (1985) and ACI-318 (1995) govern the MAGNASTOR system VCC design and construction, respectively.

15.2.3 Transfer Casks for Vertical Systems

The ANSI N14.6 (1993) and NUREG-0612 govern the NAC-MPC, NAC-UMS and MAGNASTOR system transfer cask designs, operations, fabrication, testing, inspection, and maintenance.

15.2.4 Cask Handling Building

Materials for Cask Handling Building steel structures will be constructed to ANSI/AISC 360-16. Materials for the Cask Building Overhead Cranes will adhere to NOG-1-2015 fracture toughness requirements. The reinforced concrete structures in the Cask Handling Building are designed to ACI 349-13 and constructed to ACI 318-08.

15.2.5 NAC Transportation Cask Special Lifting Devices

The ANSI N14.6 (1993) and NUREG-0612 govern the NAC Transportation Cask Special Lifting Device designs, operations, fabrication, testing, inspection, and maintenance.

15.3 Material Properties

The mechanical properties of steels used in the fabrication of the ITS storage pad and Cask Transfer System and VCT components are presented in the following sections.

15.3.1 ITS Storage Pads

The ITS storage pad construction is built with the use of concrete and reinforcing bar. The following specifications and details apply to these materials.

15.3.1.1 ASTM C150 Type II Portland Cement

Values at Temperature (100°F)	
Compressive strength "specified" (psi):	4000
Modulus of Elasticity, E (× 10^6 psi):	3.605
Coefficient of Thermal Expansion, α (×10^{-6} in/in/°F):	5.5
Density "specified" (lb/ft^3)	150

15.3.1.2 ASTM A615/A615M, Grade 60 Carbon Steel Reinforcing Bar

Values at Temperature (100°F)	
Ultimate Strength (ksi):	90.0
Yield Strength (ksi):	60.0
Modulus of Elasticity, E (× 10^6 psi):	29.88
Coefficient of Thermal Expansion, α (x 10^{-6} in/in/°F)	6.1
Density (lbm/in^3)	0.284

15.3.2 Canister Transfer System

The Canister Transfer System consists of four synchronized vertical hydraulic booms and moves on steel rails the entire length of the Canister Transfer System Operations Area. This area includes loading/unloading areas at each end for transfer cask change-out, lid storage and transfer adapter storage. Between the tops of the vertical hydraulic booms, across the width of the operations zone, are two lift beams. Connecting the lift beams, in the longitudinal direction is a trolley beam that allows transverse motion. Lifting links are positioned in fixed locations on the trolley beam and are interchangeable for different transfer cask types. Loads are lifted by energizing the vertical hydraulic booms, in a synchronized motion, to raise and lower the top framework of the Canister Transfer System. The following materials are identified in the analysis of the Canister Transfer System.

15.3.2.1 ASTM A572, Gr. 50 - CTS lift tower [15-3]

Ultimate Strength (ksi):	65.0

Yield Strength (ksi):	50.0
Modulus of Elasticity, E (× 10^6 psi):	29.3
Coefficient of Thermal Expansion, α (x 10^{-6} in/in/°F)	6.5
Density (lbm/in^3)	0.284

15.3.2.2 ASTM A514 - CTS Header Plate [15-4]

Ultimate Strength (ksi):	110.0
Yield Strength (ksi):	100.0

15.3.2.3 ASTM A693/564, Type 630 - Lift Pin [15-3]

Ultimate Strength (ksi):	135.0
Yield Strength (ksi):	105.0
Modulus of Elasticity, E (× 10^6 psi)	28.5
Coefficient of Thermal Expansion, α (x 10^{-6} in/in/°F)	5.9
Density (lbm/in^3)	0.29

15.3.2.4 ASTM A516, Gr 70 - Canister Adapter Plate [15-3]

Ultimate Strength (ksi):	70.0
Yield Strength (ksi):	38.0
Modulus of Elasticity, E (× 10^6 psi):	29.2
Coefficient of Thermal Expansion, α (x 10^{-6} in/in/°F)	6.4
Density (lbm/in^3)	0.284

15.3.2.5 ASTM A574 - Canister Adapter Plate Bolts

The material properties for ASTM A574 are provided in Table 15-3.

15.3.2.6 ASTM A325 – Bolts [15-1]

Ultimate Strength (ksi):	120.0
Yield Strength (ksi):	92.0

15.3.2.7 ASTM A311, Class B – Pins [15-2]

Ultimate Strength (ksi):	170.0
Yield Strength (ksi):	135.0

15.3.2.8 ASTM A572, Grade 50 [15-3]

Ultimate Strength (ksi):	65.0
Yield Strength (ksi):	50.0

15.3.2.9 ASTM A36 [15-3]

Ultimate Strength (ksi): 58.0

Yield Strength (ksi): 36.0

15.3.2.10 ASTM A490 [15-1]

Ultimate Strength (ksi): 150.0

Yield Strength (ksi): 130.0

15.3.3 Vertical Cask Transporter

The VCT consists of two synchronized vertical hydraulic booms and is driven on steel tracks. The range of operations is areas between the Canister Transfer System and the Storage Area. Between the tops of the vertical hydraulic booms, across the width of the VCT is the lift beam, from which the lift links are hung. Lifting links are positioned in fixed locations on the beam and are interchangeable for different transportation cask and storage cask types. Loads are lifted by energizing the vertical hydraulic booms, in a synchronized motion, to raise and lower the lift beam of the VCT. The following materials are identified in the analysis of the VCT.

15.3.3.1 ASTM A572, Gr. 50 - VCT lift tower [15-3]

Values at Temperature (100°F)

Ultimate Strength (ksi): 65.0

Yield Strength (ksi): 50.0

Modulus of Elasticity, E ($\times 10^6$ psi): 29.3

Coefficient of Thermal Expansion, α (x 10^{-6} in/in/°F) 6.5

Density (lbm/in^3) 0.284

15.3.3.2 ASTM A514 - VCT Header/Lift Link [15-4]

Values at Temperature (100°F)

Ultimate Strength (ksi): 110.0

Yield Strength (ksi): 100.0

15.3.3.3 ASTM A693/564, Type 630 - Lift Pin [15-3]

Values at Temperature (70°F)

Ultimate Strength (ksi): 135.0

Yield Strength (ksi): 105.0

Modulus of Elasticity, E ($\times 10^6$ psi): 28.5

Coefficient of Thermal Expansion, α (x 10^{-6} in/in/°F) 5.9

Density (lbm/in^3)	0.29

15.3.4 Cask Handling Building

The Cask Handling Building is built with the use of reinforced concrete for foundation and slab, and structural steel members for above-ground structure.

The specifications and details that apply to these materials are given in Table 15-2.

15.3.5 NAC Transportation Cask Special Lifting Devices

15.3.5.1 ASTM A304

Values at Temperature	70°F
Ultimate Strength (ksi):	75.0
Yield Strength (ksi):	30.0
Modulus of Elasticity, E (× 10^6 psi):	28.3

15.3.5.2 ASTM A693/564, Type 630

Values at Temperature	70°F
Ultimate Strength (ksi):	135.0
Yield Strength (ksi):	105.0
Modulus of Elasticity, E (× 10^6 psi):	28.5

15.3.5.3 ASTM B209/B210, 6061-T6 & T-651

Values at Temperature	70°F
Ultimate Strength (ksi):	42.0
Yield Strength (ksi):	35.0
Modulus of Elasticity, E (× 10^6 psi):	10.0

15.3.5.4 ASTM A514

Values at Temperature	100°F
Ultimate Strength (ksi):	110.0
Yield Strength (ksi):	100.0
Modulus of Elasticity, E (× 10^6 psi):	29.3

15.4 References

15-1 ASME NOG-1-2010, "Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)," The American Society of Mechanical Engineers, 2010.

15-2 ASTM A311/A311M – 04 (Reapproved 2010), "Standard Specification for Cold-Drawn, Stress-Relieved Carbon Steel Bars Subject to Mechanical Property Requirements," ASTM International, West Conshohocken, Pennsylvania.

15-3 "Structural and Thermal Material Properties – MAGNASTOR/MAGNATRAN Cask System," NAC Calculation 71160-2101 Rev. 9, NAC International, Atlanta, Georgia.

15-4 ASTM A514/A514M – 05 (Reapproved 2009) "Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding," West Conshohocken, PA, 2009.

15-5 ANSI N14.6-1993 American National Standard for Radioactive Materials – "Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More," 1993.

15-6 ASME Boiler and Pressure Vessel Code, Section II, Material Specifications, Part D – Properties, 2001 Edition.

Table 15-1
Material Specifications for Cask Handling Building Structures

Structural Element	Applicable Material Specification
Wide Flange Beams and Columns	ASTM A992 Grade 50
Channels	ASTM A572 Grade 50
Angles	ASTM A572 Grade 50
Plate	ASTM A572 Grade 50
Hollow Structural Shapes	ASTM A1085
Bolts for primary framing connections	ASTM F3125 Grade A325
Crane Rail	ASTM A759
Anchor Rods	ASTM A193 Grade B7
Concrete Reinforcing Steel	ASTM A706 Grade 60

Table 15-2
Material Properties for Cask Handling Building Structural Analysis and Design

Structural Element	Property	Value
Structural Steel Members and Plates	Elastic Modulus, E	29,000 ksi
	Poisson's Ratio, μ	0.30
	Coefficient of Thermal Expansion, α	6.5 x 10-6 in/(in°F)
	Unit Weight, γ	0.490 kip/ft^3
	Specified Yield Strength, F_y	50 ksi
Concrete Foundation and Slab	Specified Compressive Strength, f'_c	4500 psi
	Elastic Modulus, E	3820 ksi
	Poisson's Ratio, μ	0.17
	Coefficient of Thermal Expansion, α	5.5 x 10-6 in/(in°F)
	Unit Weight, γ	0.150 kip/ft^3
Concrete Reinforcing Steel	Specified Yield Strength, F_y	60 ksi
Anchor Rods	Specified Yield Strength, F_y	105 ksi
	Specified Tensile Strength, F_u	125 ksi
Structural Fill	Unit Weight, γ	0.110 kip/ft^3

Table 15-3
Material Properties for ASTM A574

Temp (°F)	Yield Strength[1] (ksi)	Ultimate Strength[2] (ksi)
100	135	170
300	126	170

Notes:

1. The yield strength is taken from Reference [15-6] Table Y-1, pages 536-538.
2. The ultimate strength is taken from Reference [15-6] Table U, pages 428-429.