

CHAPTER 5
OPERATION SYSTEMS & PROCEDURES

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5. OPERATION SYSTEMS & PROCEDURES

5.1 Operation Description

This chapter addresses operations at the Waste Control Specialists LLC (WCS) Consolidated Interim Storage Facility (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.

WCS 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, WCS 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. WCS 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 rail cars are picked up at the WCS spur using the WCS-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 placed under the CTS using the VCT. 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), upended 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 moved and down ended onto the transporter with the VCT, 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 WCS'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, 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): WCS' locomotive, overhead bridge crane, 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.

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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 VCT is attached to the transportation cask and the cask is lifted into the vertical position.

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 C steel structure designed to support two commercial 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 VCT moves into position straddling the rail car and the transportation cask. The VCT uprights the transportation cask. The transportation cask is moved clear of the rail car, placed in 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 NITS 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 fully meets 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, WCS calibrated Perkin & Elmer[®] Liquid Scintillation Counters, and WCS 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 WCS 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 WCS calibrated Canberra[®] gas flow proportional gross alpha/beta counters, WCS calibrated Perkin & Elmer[®] Liquid Scintillation Counters, and WCS 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 Proposed SNM-1050, WCS *Consolidated* Interim Storage Facility Technical Specifications, Amendment 0.
- 5-2 “Post Transport Package Evaluation,” QP-10.02, Revision 1.
- 5-3 *WCS CISF Security Plan, Revision 0.*
- 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		
	<i>GTCC Canister</i>		
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		
	<i>GTCC-Canister-CY</i>		
	<i>GTCC-Canister-YR</i>		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.5
	<i>GTCC-Canister-MY</i>		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.5
	<i>GTCC-Canister-ZN</i>		

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 WCS waste management and disposal facilities at the WCS 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 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 WCS operating experience handling various transportation casks that are routinely loaded in spent fuel pools and subsequently received at the WCS 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 WCS 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
INSTALLATION DESIGN AND STRUCTURAL EVALUATION**

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

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 SAR Chapter, and associated Appendices. No new analyses are required for the NAC storage systems. 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 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 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 and storage pads for the vertical systems 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.

7.5 Cask Handling Building

The Cask Handling Building (CHB) is a two-bay ITS - Category C steel structure. The CHB is 140 feet by 130 feet and approximately 70 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 for NUHOMS[®] systems, 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 NITS bridge crane as all lifts are 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 Vertical Cask Transporter (VCT) is used to move the NAC transportation casks from the rail car 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.

For WCS, 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 facility 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.

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-I-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).

Incorporation of the CTS into the Cask Handling Building will require a locally thicker pad design. In the typical installation detail (Figure 7-32), the rail system is installed in an ISFSI pad. As can be seen in the detail below, 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.

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*

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*.

Proprietary Information on Pages 7-17 through 7-19
Withheld Pursuant to 10 CFR 2.390



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.

Reeving System

Drum Support

Head and Load Blocks

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

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



Control Stations

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.

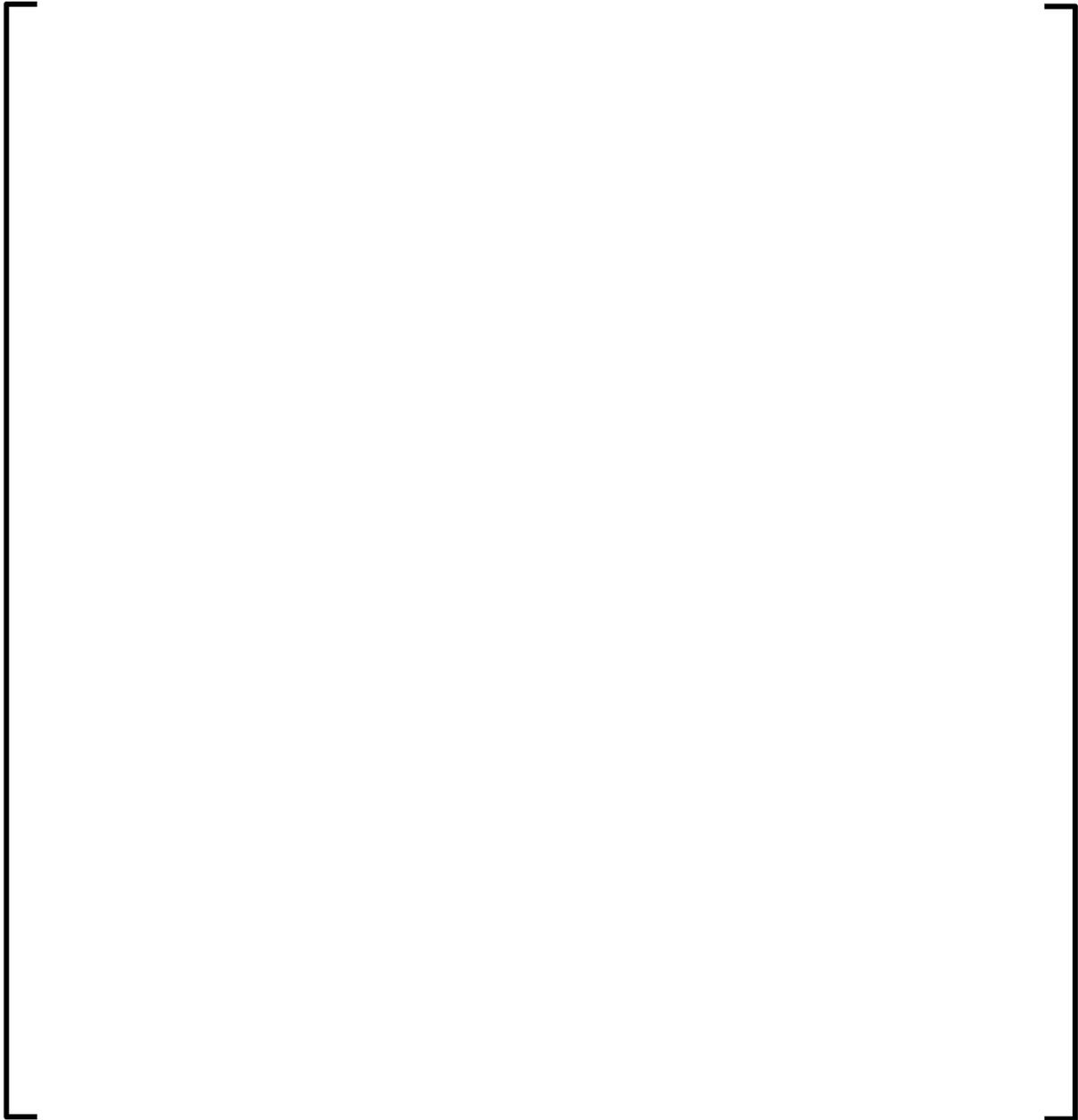
Operation and Maintenance manuals include a full explanation of the crane handling system, its controls, and the limitations for the system, and includes the requirements for installation, testing, preparation for operation and maintenance.

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 WCS CISF 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.

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 WCS CISF 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 WCS CISF 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 WCS CISF 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.).

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. Removing the transportation cask from the railcar within the Cask Handling Building 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 for the WCS CISF Cask Handling Building (CHB). The CHB is designed to meet the requirements of 10 CFR 72.122(b)(2)(ii). The CHB is a two bay commercially designed and fabricated steel frame structure with metal siding designed to support two commercial overhead cranes used to move transportation casks from the rail car to the transfer vehicle. The CHB is ITS - Category C. 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. The overhead cranes are NITS as all lifts are limited to a maximum height of 80 inches.

7.5.3.1 Descriptions of Systems, Structures and Components

To facilitate rail car unloading activities for NUHOMS[®] systems, 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 vertical systems will utilize the overhead bridge cranes to remove impact limiters and personnel barriers, and the VCT is used to move the NAC transportation casks from the rail car to the CTS.

The overhead bridge cranes are classified as Not-Important-to-Safety and are designed in accordance with ANSI B30.2, "Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)." 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 Analysis

The CHB structure is designed to withstand snow, rain, and wind loads in accordance with the International Building Code. Administrative controls will be used to preclude the presence of loaded storage, transportation, or transfer casks inside the CHB during a tornado watch or other inclement weather watches with the potential to lead to winds in excess of those addressed by International Building Code (IBC), thereby eliminating the potential for structural members or the overhead bridge crane from collapsing onto transportation or storage cask systems due to these weather events.

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*
- *H lateral soil pressure load*
- *T_o Thermal load*
- *W Wind load*
- *F' Flood load*
- *E' Design Basis Earthquake seismic load*

Load Definitions

- **Dead Load** – 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. The effects of differential settlement are considered when determining dead loads. In addition, a minimum uniform load allowance of 20 lb/ft² is applied to roof 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** – 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, 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.
 - **Rain, Snow and Ice** – Described in Chapter 3, the design live load due to rain, snow, and ice is 10 lb/ft² which is the ground snow load. Determination of roof snow and ice loads is in accordance with the requirements of American Society of Civil Engineers (ASCE) Standard 7-05 [7-34].

- **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 mode casks are also considered, along with sufficient allowance for any impact resulting from placing the moving loads 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.
- **Crane and Hoist Loads** – Design loads for the transfer facility permanently installed cranes and hoists envelop the fully-rated capacity of the equipment, including allowances for impact loads and test load requirements. The rated capacity of each of the two overhead bridge cranes in the transfer facility is 130 tons. Crane test loads are considered in the design at 125% of the rated capacity of the cranes, increased by an additional 15% to account for impact. Minimum lateral design loads on crane runway supports are 20% of the sum of the rated hoist capacity, plus the weight of the crane trolley to account for the effects of the moving trolley. The lateral load on crane supports is determined by applying the load at the top of the rail in either direction, and distributing it according to the relative stiffness of the end supports. Minimum longitudinal design loads on supports for each crane rail are 10% of the maximum crane wheel load. Seismic effects considered on fully loaded cranes and hoists are also included as described in Section 7.5.3.7.
- **Floor Live Loads** – A floor live load of 300 lb/ft² is applied in areas of heavy operation in the CHB.
- **Hydrostatic Fluid Pressure Loads** – Are due to fluids held in internal building compartments, such as tanks. There are no reinforced concrete tanks in the transfer facility. All tanks located in the transfer facility 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)** – Consist of thermally induced forces and moments resulting from operation and environmental conditions affecting the dry storage components and transfer facility building structure. Thermal loads are based on the most critical transient or steady-state condition. Thermal expansion loads due to axial restraint, as well as loads resulting from thermal gradients, are considered. The ambient temperature values during normal operating conditions identified in Chapter 3 are used for structural analysis and design.
- **Wind Loads (W)** – Are those pressure loads generated by the design wind. These loads do not incorporate any loads associated with tornados. The basic wind speed used to determine design wind loads on the CHB walls and roof areas is 90 mph.

Wind loads are determined in accordance with the requirements of ASCE Standard 7-05 [7-34], Section 6. The velocity pressures (q_z) for the transfer facility main wind-force resisting structures and the dry storage systems determined in accordance with ASCE Standard 7-05, Equation 6-15. Design basis wind pressures for each component are computed using the methodology of Section 6.4 either Method 1 (Simplified Method) or Method 2 (Analytical Method) of ASCE Standard 7-05 for the configuration and dimensions of each component.

$$q_z = 0.00256K_zK_{zt}K_dV^2I = 27.9 \text{ lb/ft}^2$$

where:

K_z = normal wind velocity pressure exposure coefficient for different heights above ground, from Table 6-3 of ASCE Standard 7-05, Exposure Category C, since the WCS CISF site is flat, $h = 70$ feet above ground and exposure C, gives $K_z = 1.17$

K_{zt} = topographic factor from section 6.5.7.1, ASCE Standard 7-05, $K_{zt} = 1.0$

K_d = wind direction factor, from Section 6.5.4.4 ASCE Standard 7-05, $K_d = 1.0$

I = importance factor for normal wind load determination of 1.15 for important-to-safety SSC (Category IV) as defined in ASCE Standard 7-05 Table 6-1

V = basic wind speed = 90 mph, ASCE Standard 7-05 Figure 6-1

- **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 by the IBC. The Maximum Considered Earthquake Ground Motion was used to develop the Design Earthquake Ground Motion for which the CHB structure will be proportioned to resist. The building is classified within IBC as Seismic Design Category C. This classification is based on the Design Earthquake Ground Motion and the Occupancy Category of the building. The Occupancy Category of the building has been assigned as IV (Building determined to be an essential facility). The Design spectral response acceleration (short periods) is established at 0.21g and the design spectral response acceleration (1-second period) is established at 0.05g. These 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.

7.5.3.2.1 Reinforced Concrete Load Combinations

Concrete sections for the CHB foundation and slab will be designed in accordance with ultimate strength design methods as specified in ACI 318 [7-39]. Design of ITS embedded plates and concrete anchors are in accordance with the requirements of ACI 318, Appendix D.

Load combinations used for the design of reinforced concrete components of the WCS CISF CHB will follow those specified in IBC Section 1605.

7.5.3.2.2 Structural Steel Loading Combinations

Steel sections for the CHB structure will be designed in accordance with AISC 360 [7-62]. Load combinations used for the design of structural steel components of the WCS CISF CHB will follow those specified in IBC Section 1605.

7.5.3.3 Reinforced Concrete Structural Analysis and Design

The Cask Handling Building reinforced concrete foundations are analyzed and designed to resist the loads and loading combinations specified in Section 7.5.3.2. A computer model will be generated and used to analyze the CHB for appropriate loading conditions. Construction of the reinforced concrete components will be in accordance with ACI 318-08 [7-39].

The Cask Transfer System (CTS) is a standalone hydraulic gantry system that will be housed in the CHB. The CTS is independent of the CHB structural system. The CHB slab-on-grade and foundations will be designed to accommodate the CTS mat foundation that is isolated from the building foundation. The CTS and its foundation will be designed to meet the requirements of the CTS as described in Section 7.5.1.

7.5.3.4 Structural Steel Design

Structural steel beams are provided in the CHB along the crane runways to support the rails for two 130-ton capacity overhead bridge cranes. The steel crane runway support beams are classified as category C Important to Radiological Safety since they provide support for the overhead cranes during a seismic event and prevent the cranes falling onto the transportation cask stations. The steel crane runway support beams are supported on steel columns that are tied to the main structural steel columns of the CHB on one end and steel brackets that protrude from the main structural steel columns of the CHB at the other end. In order to provide lateral support for the steel crane runway support beams, tie members are provided between the steel beams and the CHB frame to resist lateral forces on the steel beams due to crane trolley movement and seismic thrust loads. The steel crane runway support beams are shown in plan on Figure 1-7 and in elevation on Figure 1-8.

The CHB steel crane runway support beams are constructed using ASTM A992 and A36 mild carbon steel rolled shapes and/or plate sections. Standard carbon steel crane rails are connected by bolts to the top flanges of the steel crane runway support beams. All bolts used for primary structural connections are either A325 or A490. Welding electrodes are compatible with the joined materials.

7.5.3.5 *Not Used*

7.5.3.6 *Not Used*

7.5.3.7 Structural Analysis and Design

CHB structural steel components are analyzed and designed to resist the specified loading combinations. Static analysis methods are used 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.

The steel crane runway support beams are included in the structural system analysis model. Beams are analyzed and designed for worst-case crane wheel loads, assuming both of the overhead bridge cranes are fully loaded to their rated capacity. Loadings on the beams from the cranes are appropriately increased for impact effects as described in Section 7.5.3.2 for live crane and hoist loads. Both cranes are assumed to be fully loaded during a seismic event, the full weights of the cranes are considered in contributing mass during seismic events, and the full weight of the suspended load on each crane is considered for vertical participation during seismic events. To account for the pendulum effect of the flexible cabling that supports the suspended load on each crane, lateral seismic load contributions from the 130-ton suspended loads are considered to be similar to lateral effects due to trolley movement. That is, 20% of the suspended load is applied horizontally in the direction perpendicular to

the steel crane runway support beams and 10% of the suspended load is applied horizontally along the longitudinal axis of the steel crane runway support beams.

The positions of the cranes are varied along the crane runways to determine the worst case for maximum stresses on the steel crane runway support beams. To determine worst-case loadings on the beams, crane lifting trolleys are positioned to one side of each crane with the two cranes adjacent to each other. In addition, the worst-case location of the overhead bridge cranes is determined for the overall structure design.

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 for NUHOMS[®]). 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 and elastic settlement analysis is performed as part of Calculation NAC004-CALC-02 [7-48].

7.6.1.1 Design Inputs



Proprietary Information on Pages 7-41 through 7-44
Withheld Pursuant to 10 CFR 2.390

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.

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

$$U = 1.4D \quad (\text{Ref. [7-31], Eq. 9-1})$$

$$U = 1.2D + 1.6L \quad (\text{Ref. [7-31], Eq. 9-2})$$

$$U = 1.2D + 0.8L \quad (\text{Ref. [7-31], Eq. 9-3})$$

$$U = 1.2D + 1.6(L + E_O) \quad (\text{Ref. [7-31], Eq. 9-4})$$

$$U = 1.2D + 1.6(L + W) \quad (\text{Ref. [7-31], Eq. 9-5})$$

$$U = D + 0.8L + E_{SS} \quad (\text{Ref. [7-31], Eq. 9-6})$$

$$U = D + 0.8L + W_t \quad (\text{Ref. [7-31], Eq. 9-7})$$

$$U = D + 0.8L \quad (\text{Ref. [7-31], Eq. 9-8})$$

$$U = D + 0.8L + E_{SS} \quad (\text{Ref. [7-31], Eq. 9-9})$$

*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.

NUREG-1536 Load Combinations

$$U = 1.4D + 1.7L \quad (\text{Ref. [7-42], Table 3-3})$$

$$U = 1.05D + 1.275L \quad (\text{Ref. [7-42], Table 3-3})$$

$$U = 1.05D + 1.275(L + W) \quad U = D + L + E_{SS} \quad (\text{Ref. [7-42], Table 3-3})$$

$$U = D + L + W_t \quad (\text{Ref. [7-42], Table 3-3})$$

*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 (Nonlinear Soil Springs). Rigid members are used to locate the cask center of gravity in the model. 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. GTSTRUDL input files can be provided for each of the analyzed configurations.

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, $G_e = 0.4E_c = 0.4 \cdot 3,605 \text{ ksi} = 1,442 \text{ ksi}$ (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.

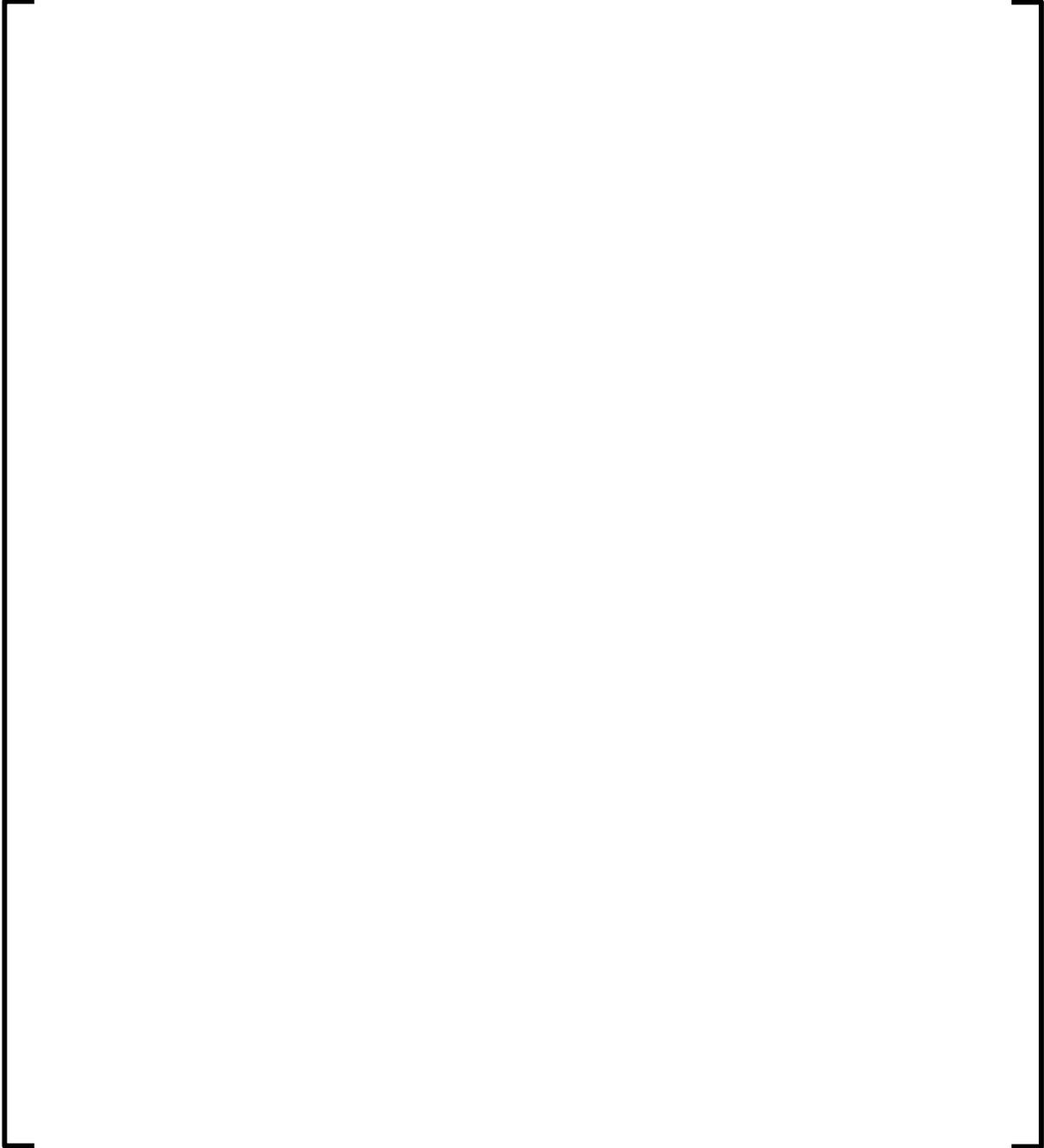
Effective elastic modulus, $E_{e,eff} = 1,803 \text{ ksi}$

Effective shear modulus, $G_{e,eff} = 721 \text{ ksi}$

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...” The GTSTRUDL command uses the user-input soil stiffness of 150 psi/in (Ref. [7-32], Section 4.3.2) combined with the tributary area from each node’s connecting element(s) to compute a spring stiffness in force per unit length.

7.6.1.6 Analysis



Proprietary Information on Pages 7-51 through 7-64
Withheld Pursuant to 10 CFR 2.390

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]. Therefore, the NAC storage pad for Andrews, TX is qualified and acceptable. 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 1.32 in (considering a safety factor of two). Furthermore, the concrete pad could slide up to 1.06 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



Proprietary Information on Pages 7-66 through 7-73
Withheld Pursuant to 10 CFR 2.390



7.6.2.6 Results and Conclusions

Based on the evaluation presented, it is concluded that overall the soils below the storage pad are not susceptible to liquefaction.

Based on analysis, the estimated settlement at the center of the storage pad (assuming the pad to be flexible for settlement purposes) for a uniform bearing pressure of 3,000 psf is on the order of 0.15 to 0.3 inch, with a differential settlement (between the corner and center of the concrete pad) on the order of 1/4 inch or less.

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



Proprietary Information on Pages 7-75 through 7-77
Withheld Pursuant to 10 CFR 2.390

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 $E = 57,000 \times (4,000)^{1/2} = 3.605 \times 10^6$ 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: W_{xx} (CG) = 24,204 k-ft² (M_{xx} = 9.02x10⁶ lb-in-sec²)

Loaded AHSM: W_{yy} (CG) = 13,712 k-ft² (M_{yy} = 5.11x10⁶ lb-in-sec²)

Loaded AHSM: W_{zz} (CG) = 16,556 k-ft² (M_{zz} = 6.17x10⁶ lb-in-sec²)

Weight of end shield wall = 197.4 kips

Shield wall thickness = 3 ft

End shield wall W_{xx} = 11,949 k-ft²

End shield wall W_{yy} = 5,778 k-ft²

End shield wall W_{zz} = 6,467 k-ft²

- *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:

$$\text{Overturning moment } M_o(t) = a_x(t) \times H_{cg-HSM}$$

$$\text{Restoring moment } M_r(t) = (1 - a_z(t)) \times R$$

$$\text{Overturning potential } O_p(t) = M_r(t) / M_o(t)$$

$a_x(t)$ is the horizontal acceleration in the X direction at time t

$a_z(t)$ is the vertical acceleration at time t

H_{cg-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:

$$\text{Overturning moment } M_o(t) = a_x(t) \times (H_{cg-HSM} \times W_{HSM} + H_{cg-wall} \times W_{wall})$$

$$\text{Restoring moment } M_r(t) = (1 - a_z(t)) \times (W_{HSM} \times R + W_{wall} \times (2R + 1.5))$$

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):

$$\text{Overturning moment } M_o(t) = a_x(t) \times (H_{cg-HSM} \times W_{HSM} + H_{cg-wall} \times W_{wall})$$

$$\text{Restoring moment } M_r(t) = (1 - a_z(t)) \times (W_{HSM} \times (R + 3) + W_{wall} \times 1.5)$$

$$\text{Overturning potential } O_p(t) = M_r(t) / M_o(t)$$

$H_{cg-wall}$ 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} :

$$SAH_{CAP} = 2g(f_I(\theta) - 1)/(F_H F_V \theta)$$

$$f_I(\theta) = \cos \theta + a \times \sin \theta$$

$$a = R / H_{cg-HSM} = 4.21/10.11 = 0.4164$$

The static instability angle α is defined in [7-44] as:

$$\alpha = \tan^{-1}(a) = 22.6 \text{ degrees}$$

$F_H = 1$ (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 .

$$f_e = (1/2\pi) \times [(2 (f_I(\theta) - 1) g / (C_I \theta^2 H_{cg-HSM}))^2]$$

$$\beta_e = \gamma / [4\pi^2 + \gamma^2]^{1/2}$$

$$C_I = I_B / M H_{cg-HSM}^2$$

$$\gamma = -2 \text{LN}(C_R)$$

$$C_R = [1 - (2 \alpha^2 / C_I)]$$

I_B is the mass moment of inertia of the module about the rotation edge.

$$I_B = I_{CG} + M H_{cg-HSM}^2 = 5,109,998.76 + 1,123.96 \times 121.32^2 = 21,653,122.4 \text{ lb-in-sec}^2$$

M is the module mass = 1,123.96 lb-sec²/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: $\theta = 0.0008$ radians = 0.046 degrees. This is much smaller than the instability angle: $\alpha = 22.6$ 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%,
 $W_{AHSM+DSC} = 449.8 \text{ kip}$ (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, $CG_{AHSM} = 121.3 \text{ in}$
(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: $135.4 \text{ psf} * 8'-5'' \text{ (width)} * 20'-7'' \text{ (height)} * 1.3 = 30,494$ 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: $0.416 * 449,800 \text{ lbs} = 187,117$ 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

$$U = 1.4D \quad (\text{Ref. [7-31], Eq. 9-1})$$

$$U = 1.2D + 1.6L \quad (\text{Ref. [7-31], Eq. 9-2})$$

$$U = 1.2D + 0.8L \quad (\text{Ref. [7-31], Eq. 9-3})$$

$$U = D + 0.8L + E_{SS} \quad (\text{Ref. [7-31], Eq. 9-6})$$

$$U = D + 0.8L \quad (\text{Ref. [7-31], Eq. 9-8})$$

*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.

NUREG-1536 Load Combinations

$$U = 1.4D + 1.7L \quad (\text{Ref. [7-42], Table 3-3})$$

$$U = 1.05D + 1.275L \quad (\text{Ref. [7-42], Table 3-3})$$

$$U = D + L + E_{SS} \quad (\text{Ref. [7-42], Table 3-3})$$

*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 peak 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 C 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 ($1.5 * \text{soil depth}$) 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:

$$\phi V_n \geq V_u, \text{ Section 11.1.1 of ACI 349 [7-31]}$$

$$\phi = 0.75 \text{ for Shear, Section 9.3.2.3 of ACI 349 [7-31]}$$

Bending:

$$\phi M_n \geq M_u$$

$$\phi = 0.9 \text{ for Bending, Section 9.3.2.1 of ACI 349 [7-31]}$$

Reinforcement:

$$\text{Minimum Reinforcement} = A_{s,\min} = \frac{3\sqrt{f'_c}}{f_y} b_w * d, \text{ Eq. 10-3 ACI 349 [7-31]}$$

$$\text{But Not Less than, } \frac{200 * b_w * d}{f_y}, \text{ Section 10.5.1 of ACI 349 [7-31]}$$

Sizing of Reinforcement/ ACI Code Requirements

The reinforcement is evaluated for the ACI 349-06 Code requirements and consists of #11 bars at 10 inches on center top and bottom, each way, with mechanical splices specified as 11L Bar Locks. As an alternative, lap splices may be used in lieu of mechanical splices. The mechanical coupler is the more critical case because it reduces the effective depth of the section.

The main reinforcement in X direction is calculated as:

$$d_{slab1} = 36'' - 3'' - 3.1'' \div 2 = 31.45'' \quad \text{Effective depth}$$

$$M_u = 234,235 \text{ lbf} - \text{in} \quad \text{Design moment from Table 7-40}$$

$$A_{11} = 1.56 \text{ in}^2 \quad \text{Cross section of \#11}$$

$$f'_c = 4000 \text{ psi} \quad \text{Compressive strength of concrete}$$

$$F_y = 60 \text{ ksi} \quad \text{Tensile strength of rebar}$$

$$R_t = \frac{M_u}{0.9 \times 1 \text{ in} \times d_{\text{slab1}}^2} = 263 \text{ psi} \quad \text{Flexural resistance factor}$$

$$\rho = 0.0045 + \frac{263-259}{287-259} \times 0.0005 = 0.0046 \quad \text{Reinforcement ratio}$$

$$A_s = \rho \times 10 \text{ in} \times d_{\text{slab1}} = 1.45 \text{ in}^2 \quad \text{Steel required per 10" wide.}$$

Therefore, provide # 11 rebar @ 10" o.c. = 1.56 in². OK

The main reinforcement in Y direction is calculated as:

$$d_{\text{slab2}} = 36-3"3.1 - 1.41 \div 2 = 29.2" \quad \text{Effective depth}$$

$$M_u = 186,555 \text{ lbf} - \text{in} \quad \text{Design moment from Table 7-40}$$

$$R_t = \frac{M_u}{0.9 \times 1 \text{ in} \times d_{\text{slab2}}^2} = 243 \text{ psi} \quad \text{Flexural resistance factor}$$

$$\rho = 0.004 + \frac{259-243}{259-232} \times 0.0005 = 0.0043 \quad \text{Reinforcement ratio}$$

$$A_s = \rho \times 10 \text{ in} \times d_{\text{slab2}} = 1.26 \text{ in}^2 \quad \text{Steel required per 10" wide.}$$

Therefore, provide # 11 rebar @ 10" o.c. = 1.56 in². OK

The shear capacity of the pad per ACI 349 is:

$$0.75 \times 2 \times \sqrt{4000} \text{ psi} \times d_{\text{slab1}} = 2984 \text{ lbf/in}$$

Shear capacity of 1" wide pad in X direction

$$0.75 \times 2 \times \sqrt{4000} \text{ psi} \times d_{\text{slab2}} = 2770 \text{ lbf/in}$$

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 2769.8 lbf/in and 2760.9 lbf/in the X and Y directions, respectively. Therefore, the maximum interaction ratio for shear is as follows:

$$\text{In X direction: } 2769.8/2984=92.8\%$$

$$\text{In Y direction: } 2760.9/2770=99.7\%$$

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, 2770 lbf/in,

$$F_z = 2,770 \text{ lb/in.}$$

Over 10 inches $F_z = 2,770 \text{ lb/in} * 10 \text{ in} = 27,700 \text{ lb per 10 inches}$

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:

$$V_n = 27,700 \text{ lb per 10 inches}$$

$$\Phi = 0.75 \text{ for shear}$$

$$f_y = 60,000 \text{ psi}$$

$\mu = 1.0$ (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)

$$A_{vf} = \frac{27,700 \text{ lb}}{0.75 * 60,000 \text{ psi} * 1.0} = 0.62 \text{ in}^2$$

$$\text{Area of Steel provided} = 2 \# 11 @ 10'' \text{ o.c.} = 2 * 1.41 \text{ in}^2 = 2.82 \text{ in}^2 > 0.62 \text{ in}^2, \text{ OK}$$

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:

$$s = 15 * \left(\frac{40000}{f_s} \right) - 2.5 * c_c < 12 * \frac{40000}{f_s} \quad \text{Eq. 10-4 [7-31]}$$

Where:

s = vertical spacing of skin reinforcement

$$f_s = 0.4 * f_y = 0.4 * 60,000 \text{ psi} = 24,000 \text{ psi}$$

$c_c = 2''$ = least distance from surface of reinforcement to the tension face

$$s = 15 * \left(\frac{40000}{24000} \right) - 2.5 * 2'' = 20''$$

$$12 * \left(\frac{40000}{24000} \right) = 20''$$

$$20'' = 20'' \quad \text{OK}$$

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 $36'' - 3'' - 3.1''/2 = 31.45''$, in which 3 in. is the concrete cover and 3.1 in. is the diameter of the coupler. The perimeter of the punching shear area is $4 \times (31.45'' + 24'') = 221.8''$. The punching shear area is $221.8'' \times 31.45'' = 6975.68 \text{ in}^2$.

The factored punching shear capacity per ACI 349-06 is $0.75 \times 4 \times (4000 \text{ psi})^{1/2} \times 6975.68 \text{ in}^2 = 1,323,542 \text{ lbf}$ or 1324 kips. The factor of safety is $1324/1010 = 1.31$. 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.

The ultimate bearing capacity is calculated using the Meyerhof's equations for vertical loading and inclined loading in Table 4-1 and Table 4-3 of [7-54] in consideration of Case 1 and Case 2 load combinations, respectively. The ultimate capacity for vertical loading is calculated as 64.45 ksf. The ultimate capacity for seismic loading is 12.105 ksf. Therefore, the factors of safety are 28.3 and 2.8 for Case 1 and Case 2, respectively.

Elastic Settlement

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7.7 References

- 7-1 “Post Transport Package Evaluation,” QP-10.02, Revision 1.
- 7-2 US Nuclear Regulatory Commission NUREG-0554, “Single-Failure-Proof Cranes for Nuclear Power Plants,” May 1979.
- 7-3 US Nuclear Regulatory Commission NUREG-0612, “Control of Heavy Loads at Nuclear Power Plants,” July 1980.
- 7-4 ASME NOG-1-2010, “Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder),” The American Society of Mechanical Engineers, 2010.
- 7-5 US Nuclear Regulatory Commission Regulatory Issue Summary 2005-25, Supplement 1, “Clarification of NRC Guidelines for Control of Heavy Loads,” May 2007.
- 7-6 US Nuclear Regulatory Commission Regulatory Guide 1.29, “Seismic Design Classification,” Revision 4, March 2007.
- 7-7 American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators, latest Edition at time of PO issuance.
- 7-8 American Welding Society D1.1, Structural Welding Code – Steel, 1996.
- 7-9 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.
- 7-10 Crane Manufacturers Association of America (CMAA) Specification #70, 2004.
- 7-11 American Society of Mechanical Engineers NQA-1, “Quality Assurance Requirements for Nuclear Facility Applications,” 1994 Edition.
- 7-12 NAC Equipment Specification Sheet, ESS-032, “*Kuosheng ISFSI Gantry Crane* Lift Booms and Trolley Beam *Side Shift Assemblies*.”
- 7-13 American Society of Mechanical Engineers B30.16-2012, “Overhead Hoists (Underhung)”.
- 7-14 American Society of Mechanical Engineers NUM-1, “Rules for Construction of Cranes, Monorails, and Hoists (with Bridge or Trolley or Hoist of the Underhung Type).”
- 7-15 *Deleted.*
- 7-16 American Society of Mechanical Engineers B30.10-2009, “Hooks.”
- 7-17 Calculation 630075-2004, rev 13, Gantry Crane Structural Evaluation, NAC International.
- 7-18 Calculation 630075-2006, rev 4, Adapter Plate and Clevis Plate Structural Evaluation, NAC International.
- 7-19 Calculation 630075-2015, rev 7, Structural Evaluation of Miscellaneous Gantry Crane Components, NAC International.

- 7-20 Calculation 630075-2016, rev 3, Structural Evaluation of Gantry Base, NAC International.
- 7-21 NAC International Report 630075-R-06, Rev. 3, Appendix A, Independent Assessment of Lift Systems Hydraulic Gantry Crane System for Compliance with the Criteria of NUREG-0612 & -0554 Providing Single-Failure-Proof Handling of Spent Fuel Casks.
- 7-22 NAC International Report 630075-R-06, Rev. 3, Appendix B, Failure Modes and Effects Analysis.
- 7-23 NAC International Report 630075-R-06, Rev. 3, Appendix C, Crane Operations Descriptions.
- 7-24 NAC International Report 630075-R-06, Rev. 3, Appendix D, Kuosheng Hydraulic Gantry Crane NUREG-0554/ASME NOG-1 Conformance Matrix.
- 7-25 NAC International Report 630075-R-06, Rev. 3, Appendix E, Kuosheng Chain Hoist ASME NUM-1 Compliance Matrix.
- 7-26 Calculation NAC004-CALC-04, Rev. 1, "Soil Structure Interaction Analysis of Independent Spent Fuel Storage Installation (ISFSI) Concrete Pad at Andrews, TX."
- 7-27 Jacks, Industrial Rollers, Air Casters, and Hydraulic Gantries (ASME B30.1-2009).
- 7-28 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.
- 7-29 AREVA TN Document NUH-003, Revision 14, "Updated Final Safety Analysis Report for the Standardized NUHOMS[®] Horizontal Modular Storage System for Irradiated Nuclear Fuel." (Basis for NRC CoC 72-1004).
- 7-30 Drawing NAC004-C-001, Rev. 0, "ISFSI Pad Licensing Design General Arrangement & Geotechnical."
- 7-31 ACI 349-06, "Code Requirements for Nuclear Safety-Related Concrete Structures and Commentary."
- 7-32 Geoservices, LLC, Project No. 31-151247, "Report of Geotechnical Exploration: Consolidated Interim Storage Facility (CISF) Andrews, Texas," August 20, 2015.
- 7-33 *WCS-12-05-100-001, Rev 0, "Site-Specific Seismic Hazard Evaluation and Development of Seismic Design Ground Motions."*
- 7-34 ASCE 7-05, "Minimum Design Loads for Buildings and Other Structures."
- 7-35 Reg Guide 1.76, "Design-Basis Tornado And Tornado Missiles For Nuclear Power Plants," Revision 1, March 2007.
- 7-36 GTSTRUDL Computer Program User Manual, Intergraph, Version 32.0.
- 7-37 Drawing NAC004-C-002, Rev. 0, "ISFSI Pad Licensing Design Structural Concrete Plan, Sections, and Details."
- 7-38 Regulatory Guide 1.61, Rev. 1, "Damping Values for Seismic Design of Nuclear Power Plants."

- 7-39 ACI 318-08, "Building Code Requirements for Structural Concrete and Commentary."
- 7-40 MAGNASTOR FSAR, Rev. 7, "MAGNASTOR Final Safety Analysis Report," July 2015.
- 7-41 Data Package LSI-ZS-VCT-2012, Rev. 1, "Lift Systems, Inc. Vertical Cask Transporter, Part Number CT201072."
- 7-42 NUREG-1536, Revision 1, "Standard Review Plan for Spent Fuel Dry Cask Storage Systems at a General License Facility," U.S. 200 Regulatory Commission, Office of Nuclear Material Safety and Safeguards.
- 7-43 NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," March 2007.
- 7-44 ASCE/SEI 43-05, "Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities."
- 7-45 IBC 2009, "International Building Code."
- 7-46 NAC-UMS FSAR, Rev. 10, "Final Safety Analysis Report for the UMS Universal Storage System," October 2012.
- 7-47 NAC-MPC FSAR, Rev. 10, "Final Safety Analysis Report for the NAC Multi-Purpose Cask," January 2014.
- 7-48 Calculation NAC004-CALC-02, Rev. 0, "Liquefaction Potential and Elastic Settlement Evaluation for Independent Spent Fuel Storage Installation (ISFSI) Concrete Pad at WCS Site in Andrews, TX."
- 7-49 Shin, M., et al., "Twisting Moments in Two-Way Slabs," Concrete International, July 2009.
- 7-50 Haas, F. H., "Flood Plain Study," prepared for Waste Control Specialists, LLC, Andrews, Texas, March 2006.
- 7-51 Regulatory Guide 1.92, Rev. 2, "Combining Modal Responses and Spatial Components in Seismic Response analysis."
- 7-52 Nuclear Regulatory Commission (2003), Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites, Regulatory Guide 1.198.
- 7-53 Youd, T.L. et. al. (2001), Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils, Journal of Geotechnical and Geoenvironmental Engineering, October 2001, pp. 817-833.
- 7-54 Bowles, Joseph E. (1996), Foundation Analysis and Design, Fifth Edition, McGraw-Hill, New York.
- 7-55 Mathcad Computer Program, PTC Inc., Version 15.
- 7-56 Excel Computer Program, Microsoft Inc., Version 15.0.4771.1004.
- 7-57 SC-SASSI Manual, Version 2.1.7, SC Solutions, Inc., November 6, 2015.

- 7-58 Nuclear Energy Institute (NEI), “Consistent Site-Response/Soil-Structure Interaction Analysis and Evaluation,” June 2009.
- 7-59 *Deleted.*
- 7-60 *Deleted.*
- 7-61 *ANSI/AISC N690-06, “Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures in Nuclear Facilities.”*
- 7-62 *ANSI/AISC 360-05, “Specification for Structural Steel Buildings.”*
- 7-63 *APA Consulting Computer Code SASSI, Version 1.0.*
- 7-64 *ASCE 7-10, “Minimum Design Loads for Buildings and Other Structures.”*
- 7-65 *ANSYS Computer Code and User’s Manual, Version 16.0.*
- 7-66 *Calculation AREVATN001-CALC-002, Rev. 0 “Soil Structure Interaction Analysis of TN Independent Spent Fuel Storage Installation (ISFSI) Concrete Pad at Andrews, TX.”*
- 7-67 *Calculation AREVATN001-CALC-001, Rev. 1 “ISFSI Pad Design for WCS at Andrews, Texas.”*

Table 7-1
WCS CISF Structures and QA Classification

Structure	QA Classification
<i>Canisters, Storage Overpacks (VCCs and HSMs), Transfer Casks</i>	Important-to-Safety
<i>Cask Handling Building</i>	<i>Important-to-Safety</i>
<i>Cask Handling Building Overhead Cranes</i>	Not 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**

Cask System	Canister	Overpack	Appendix
NUHOMS [®] -MP187 Cask System	FO-DSC	HSM (Model 80)	Appendix A.7
	FC-DSC		
	FF-DSC		
	<i>GTCC Canister</i>		
Standardized Advanced NUHOMS [®] System	NUHOMS [®] 24PT1	AHSM	Appendix B.7
Standardized NUHOMS [®] System	NUHOMS [®] 61BT	HSM Model 102	Appendix C.7
	NUHOMS [®] 61BTH Type 1		Appendix D.7
NAC-MPC	Yankee Class	VCC	Appendix E.7
	Connecticut Yankee		
	LACBWR		
	<i>GTCC-Canister-CY</i>		
	<i>GTCC-Canister-YR</i>		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.7
	<i>GTCC-Canister-MY</i>		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.7
	<i>GTCC-Canister-ZN</i>		

Proprietary Information on Pages 7-107 through 7-108
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 *	0.886027E+02	133	5668	* -0.882248E+02	127	5668	*
* NYX *	0.160126E+03	131	1389	* -0.160117E+03	129	1389	*
* NXY *	0.645948E+02	131	126	* -0.645948E+02	127	1146	*
* MXX *	0.581259E+02	131	403	* -0.997999E+02	132	869	*
* MYX *	0.515278E+02	132	323	* -0.912022E+02	108	869	*
* MXY *	0.158822E+02	133	6612	* -0.158822E+02	132	6981	*
* VXX *	0.482835E+01	128	3445	* -0.482834E+01	132	7495	*
* VYX *	0.485770E+01	128	2997	* -0.485770E+01	129	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 *	0.519769E+02	132	5225	* -0.516184E+02	126	5225	*
* NYY *	0.804491E+02	130	1398	* -0.804603E+02	128	1398	*
* NXY *	0.336569E+02	126	1146	* -0.336569E+02	130	126	*
* MXX *	0.524997E+02	134	819	* -0.813840E+02	108	869	*
* MYX *	0.511820E+02	104	931	* -0.966439E+02	105	617	*
* MXY *	0.216265E+02	105	2635	* -0.216265E+02	109	8485	*
* VXX *	0.403804E+01	104	3445	* -0.403803E+01	108	7495	*
* VYX *	0.398227E+01	104	2997	* -0.365465E+01	109	5337	*

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 *	0.697765E+02	132	5225	* -0.693990E+02	126	5225	*
* NYY *	0.114004E+03	130	1398	* -0.113953E+03	127	1398	*
* NXY *	0.471218E+02	128	126	* -0.471218E+02	132	1146	*
* MXX *	0.534518E+02	134	819	* -0.917819E+02	132	869	*
* MYX *	0.639595E+02	131	991	* -0.854730E+02	108	869	*
* MXY *	0.234838E+02	104	2743	* -0.234838E+02	108	8593	*
* VXX *	0.443911E+01	104	3445	* -0.443911E+01	108	7495	*
* VYY *	0.444899E+01	104	2997	* -0.384120E+01	129	8586	*

**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 *	0.826192E+02	132	5225	* -0.822430E+02	126	5225	*
* NYY *	0.139142E+03	130	1398	* -0.139099E+03	127	1398	*
* NXY *	0.561974E+02	126	1146	* -0.561974E+02	130	126	*
* MXX *	0.556960E+02	130	359	* -0.973071E+02	132	869	*
* MYY *	0.622557E+02	131	1003	* -0.894480E+02	108	869	*
* MXY *	0.244392E+02	105	2851	* -0.244392E+02	109	8701	*
* VXX *	0.470246E+01	104	3445	* -0.470245E+01	108	7495	*
* VYY *	0.471676E+01	128	2997	* -0.423826E+01	105	3294	*

Table 7-15
Load Combination 108 Resultant Force For Width Cut, Cask Configuration
2 (kip & kip-in)

LOADING - 108		
LOCATION OF CENTROID (REFER TO NOTE ABOVE) = 0.9900000E+02		
IN-PLANE NORMAL FORCE,	P =	0.1542928E+02
IN-PLANE SHEAR FORCE (PARALLEL TO CUT),	V =	0.6118734E+03
OUT-OF-PLANE (TRANSVERSE) SHEAR FORCE,	FZ =	0.1948777E+03
BENDING MOMENT (MOMENT VECTOR PARALLEL TO CUT),	MB =	0.4643966E+04
TWISTING MOMENT (MOMENT VECTOR NORMAL TO CUT),	MT =	0.8634955E+03
IN-PLANE ROTATIONAL DEFORMATION MOMENT,	MZ =	-0.2557984E+05

Table 7-16
Load Combination 105 Resultant Force For Length Cut, Cask Configuration
3 (kip & kip-in)

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=====
LOADING - 105
=====
```

LOCATION OF CENTROID (REFER TO NOTE ABOVE) = 0.9529411E+02

IN-PLANE NORMAL FORCE,	P =	-0.6539403E+02
IN-PLANE SHEAR FORCE (PARALLEL TO CUT),	V =	0.3542167E+03
OUT-OF-PLANE (TRANSVERSE) SHEAR FORCE,	FZ =	0.2026964E+03
BENDING MOMENT (MOMENT VECTOR PARALLEL TO CUT),	MB =	0.3908143E+04
TWISTING MOMENT (MOMENT VECTOR NORMAL TO CUT),	MT =	0.1125222E+04
IN-PLANE ROTATIONAL DEFORMATION MOMENT,	MZ =	0.9938373E+03

Table 7-17
Load Combination 301 Enveloping Reactions Cask Configuration 1 (kip & kip-in)

**** Summary of Global Reaction Envelopes ****

Type	Value	Load	Joint
Force X Min	-0.645959E-08	301	611
Force X Max	0.654836E-08	301	661
Force Y Min	0.000000E+00	301	126
Force Y Max	0.000000E+00	301	126
Force Z Min	-0.159837E-07	301	126
Force Z Max	0.159541E-07	301	1146
Moment X Min	0.000000E+00	301	126
Moment X Max	0.000000E+00	301	126
Moment Y Min	0.000000E+00	301	126
Moment Y Max	0.000000E+00	301	126
Moment Z Min	0.000000E+00	301	126
Moment Z 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	-0.252924E+04	303	611
Force X Max	0.252924E+04	307	611
Force Y Min	0.000000E+00	302	126
Force Y Max	0.000000E+00	302	126
Force Z Min	-0.252999E+04	306	126
Force Z Max	0.252999E+04	307	126
Moment X Min	0.000000E+00	302	126
Moment X Max	0.000000E+00	302	126
Moment Y Min	0.000000E+00	302	126
Moment Y Max	0.000000E+00	302	126
Moment Z Min	0.000000E+00	302	126
Moment Z Max	0.000000E+00	302	126

Table 7-19
Load Combination 301 Maximum Displacements Cask Configuration 3 (in)

****SUMMARY OF MAXIMUM GLOBAL DISPLACEMENTS****
INDEPENDENT IN EACH COORDINATE

```
=====
* RESULT *   MAXIMUM   LOAD   JOINT   *
*-----*-----*-----*-----*
* X-DISP * -0.121221E-02  301    213    *
* Y-DISP * -0.938189E-01  301    621    *
* Z-DISP * -0.160898E-02  301    613    *
=====
```

Table 7-20
Load Combination 302 to 309 Maximum Displacements Cask Configuration
2 (in)

****SUMMARY OF MAXIMUM GLOBAL DISPLACEMENTS****
INDEPENDENT IN EACH COORDINATE

* RESULT *	MAXIMUM	LOAD	JOINT	*
* X-DISP *	-0.121571E+00	306	127	*
* Y-DISP *	-0.125408E+00	308	563	*
* Z-DISP *	-0.100084E+00	308	101	*

Proprietary Information on Pages 7-125 through 7-126
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
<i>NUHOMS[®] MP187 Cask System</i>	<i>Section A.11.1</i>
<i>Advanced Standardized NUHOMS[®] System</i>	<i>Section B.11.1</i>
<i>Standardized NUHOMS[®]-61 BT System</i>	<i>Section C.11.1</i>
<i>Standardized NUHOMS[®]-61 BTH Type 1 System</i>	<i>Section D.11.1</i>
<i>Yankee-MPC</i>	<i>Section E.11.1.1</i>
<i>CY-MPC</i>	<i>Section E.11.1.1</i>
<i>MPC-LACBWR</i>	<i>Section E.11.2.1</i>
<i>NAC-UMS</i>	<i>Section F.11.1.1</i>
<i>NAC-MAGNASTOR</i>	<i>Section G.11.1.1</i>

Table 7-25
Cask Handling Building SSCs and QA Classification

<i>SSC</i>	<i>QA Classification</i>
<i>Building Structural steel</i>	<i>Important-to-Safety</i>
<i>Overhead Crane Support Beams</i>	<i>Important-to-Safety</i>
<i>Concrete Foundations and Slab on Grade</i>	<i>Important-to-Safety</i>
<i>Overhead Crane Bridge Trucks and Trolley Seismic Clips</i>	<i>Important-to-Safety</i>
<i>Overhead Cranes</i>	<i>Not Important-to-Safety</i>
<i>Building Classing</i>	<i>Not Important-to-Safety</i>
<i>Electrical Systems</i>	<i>Not Important-to-Safety</i>
<i>Mechanical and HVAC Systems</i>	<i>Not Important-to-Safety</i>
<i>Fire Protection System</i>	<i>Not Important-to-Safety</i>

***Table 7-26
Deleted***

***Table 7-27
Deleted***

***Table 7-28
Deleted***

**Table 7-29
Analyzed Cases**

<i>Case</i>	<i>Earthquake</i>	<i>Number of Modules on the Pad</i>	<i>Soil Properties</i>
1	<i>Coyote Lake</i>	22	<i>Best Estimate</i>
2			<i>Lower Bound</i>
3			<i>Upper Bound</i>
4		42	<i>Best Estimate</i>
5			<i>Lower Bound</i>
6			<i>Upper Bound</i>
7		92	<i>Best Estimate</i>
8			<i>Lower Bound</i>
9			<i>Upper Bound</i>
10	<i>Norcia</i>	22	<i>Best Estimate</i>
11			<i>Lower Bound</i>
12			<i>Upper Bound</i>
13		42	<i>Best Estimate</i>
14			<i>Lower Bound</i>
15			<i>Upper Bound</i>
16		92	<i>Best Estimate</i>
17			<i>Lower Bound</i>
18			<i>Upper Bound</i>
19	<i>Palm Springs</i>	22	<i>Best Estimate</i>
20			<i>Lower Bound</i>
21			<i>Upper Bound</i>
22		42	<i>Best Estimate</i>
23			<i>Lower Bound</i>
24			<i>Upper Bound</i>
25		92	<i>Best Estimate</i>
26			<i>Lower Bound</i>
27			<i>Upper Bound</i>

Proprietary Information on Pages 7-132 through 7-137
Withheld Pursuant to 10 CFR 2.390

Table 7-33
“Maximum” Passing Frequencies due to Soil and Pad Modeling

<i>Soil Case</i>	<i>$f = Vs/(5xh_{soil})$ [hz]</i>	<i>$f = Vs/(5xh_{pad})$ [hz]</i>
<i>BE</i>	<i>32.81</i>	<i>34.48</i>
<i>LB</i>	<i>25.10</i>	<i>25.82</i>
<i>UB</i>	<i>42.77</i>	<i>46.04</i>

Proprietary Information on Pages 7-139 through 7-140
Withheld Pursuant to 10 CFR 2.390

Table 7-36
ANSYS Finite Element Models for Storage Pad Structural Evaluation

<i>Model Identification</i>	<i>Model Description</i>
<i>HSMFUL</i>	<i>Fully Loaded Pad (2x46=92 AHSM)</i>
<i>HSM2CSK</i>	<i>Two Rows Back-to-Back HSMs (2x2=4 AHSM)</i>
<i>HSM4CSK</i>	<i>Four Rows Back-to-Back HSMs (2x4=8 AHSM)</i>
<i>HSMQUA</i>	<i>Eleven Rows Back-to-Back HSMs (2x11=22 AHSM)</i>
<i>HSMHAL</i>	<i>Twenty One Rows Back-to-Back HSMs (2x21=42 AHSM)</i>

Proprietary Information on Pages 7-142 through 7-143
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	<i>Max. M_y</i>	234,235	161,267	187,440	215,014	219,311
	<i>Min. M_y</i>	-21,732	-38,812	-45,974	-54,473	-56,694
	<i>Max. F_{xz}</i>	6,570	5,847	6,593	7,975	8,240
	<i>Min. F_{xz}</i>	-6,739	-4,681	-5,572	-6,502	-6,724
	<i>Max. M_x</i>	15,906	4,907	8,698	14,456	15,413
	<i>Min. M_x</i>	-186,555	-129,217	-154,110	-179,726	-186,018
	<i>Max. F_{yz}</i>	3,971	2,895	3,490	4,113	4,262
	<i>Min. F_{yz}</i>	-3,971	-2,895	-3,490	-4,113	-4,262
	<i>Design^(*) F_{xz}</i>	2632.8	2693.1	2764.2	2674.1	2766.8
	<i>Design^(*) F_{yz}</i>	2653.4	2711.3	2531.9	2705.1	2626.5
Case 3	<i>Max. M_y</i>	198,194	156,482	175,601	197,601	203,317
	<i>Min. M_y</i>	-16,444	-33,554	-38,897	-45,133	-47,847
	<i>Max. F_{xz}</i>	4,878	4,980	5,483	6,476	6,776
	<i>Min. F_{xz}</i>	-6,440	-4,091	-4,907	-5,796	-6,100
	<i>Max. M_x</i>	31,939	29,944	38,148	48,429	54,682
	<i>Min. M_x</i>	-158,963	-113,135	-133,856	-153,307	-162,745
	<i>Max. F_{yz}</i>	3,370	2,255	2,743	3,223	3,383
	<i>Min. F_{yz}</i>	-3,543	-2,446	-2,961	-3,450	-3,667
	<i>Design^(*) F_{xz}</i>	2655.0	2732.0	2741.8	2758.4	2667.4
	<i>Design^(*) F_{yz}</i>	1929.3	2088.9	2742.8	2124.6	2702.1
Case 4	<i>Max. M_y</i>	111,550	159,455	182,299	215,455	231,521
	<i>Min. M_y</i>	-26,583	-33,538	-39,997	-48,287	-52,183
	<i>Max. F_{xz}</i>	5,132	5,221	5,886	7,213	7,717
	<i>Min. F_{xz}</i>	-2,026	-3,821	-4,514	-5,154	-5,312
	<i>Max. M_x</i>	48,169	22,033	31,418	43,624	51,765
	<i>Min. M_x</i>	-70,744	-114,418	-137,809	-160,922	-171,569
	<i>Max. F_{yz}</i>	2,088	2,274	2,714	3,205	3,394
	<i>Min. F_{yz}</i>	-1,437	-2,632	-3,193	-3,761	-4,005

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
	<i>Design^(*)</i> <i>F_{xz}</i>	2769.8	2755.1	2764.3	2764.8	2763.7
	<i>Design^(*)</i> <i>F_{yz}</i>	2088.3	2274.2	2714.2	2363.5	2715.8
Case 5	<i>Max. M_y</i>	175,331	82,868	94,618	114,252	124,927
	<i>Min. M_y</i>	-86,111	-36,105	-40,937	-37,709	-44,050
	<i>Max. F_{xz}</i>	6,563	3,707	3,604	4,765	5,291
	<i>Min. F_{xz}</i>	-4,732	-1,696	-1,966	-2,161	-2,147
	<i>Max. M_x</i>	25,949	38,929	40,148	48,063	55,045
	<i>Min. M_x</i>	-145,478	-52,751	-60,789	-66,352	-65,557
	<i>Max. F_{yz}</i>	2,756	2,287	2,565	3,022	3,349
	<i>Min. F_{yz}</i>	-2,943	-1,370	-1,778	-2,452	-2,932
	<i>Design^(*)</i> <i>F_{xz}</i>	2767.4	2768.6	2731.8	2750.0	2763.8
	<i>Design^(*)</i> <i>F_{yz}</i>	2756.0	2286.8	2564.6	2760.9	2609.1
Case 6	<i>Max. M_y</i>	/	156,481	175,600	197,601	203,318
	<i>Min. M_y</i>		-33,554	-38,897	-45,133	-47,847
	<i>Max. F_{xz}</i>		4,980	5,483	6,476	6,776
	<i>Min. F_{xz}</i>		-4,091	-4,907	-5,796	-6,100
	<i>Max. M_x</i>		38,661	42,708	54,310	63,487
	<i>Min. M_x</i>		-113,684	-136,935	-160,351	-166,453
	<i>Max. F_{yz}</i>		2,446	2,961	3,450	3,667
	<i>Min. F_{yz}</i>		-2,255	-2,743	-3,223	-3,383
	<i>Design^(*)</i> <i>F_{xz}</i>		2732.0	2741.8	2758.3	2667.5
	<i>Design^(*)</i> <i>F_{yz}</i>		2446.1	2491.8	2705.2	2650.0

(*): 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 7-40
Enveloping Design Forces and Moments (lbf and in-lbf) Per Inch Width

Component	Design Values
M_y	234,235
M_x	-186,555
$F_{yz}^{(*)}$	2,760.9
$F_{xz}^{(*)}$	2,769.8

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.

Proprietary Information on Pages 7-147 through 7-154
Withheld Pursuant to 10 CFR 2.390

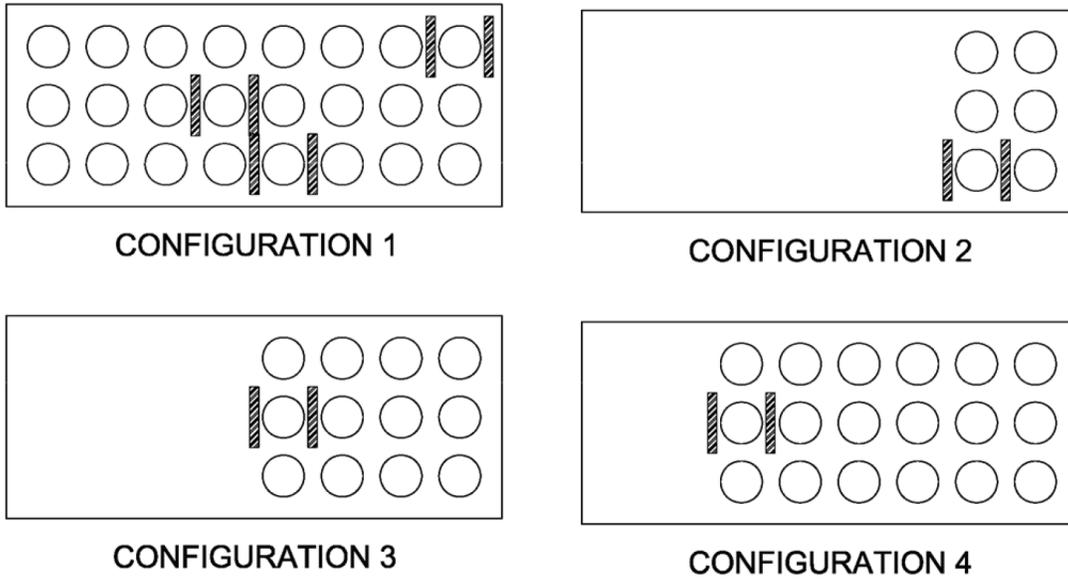


Figure 7-9
Cask Layout Design Configurations and VCT Locations

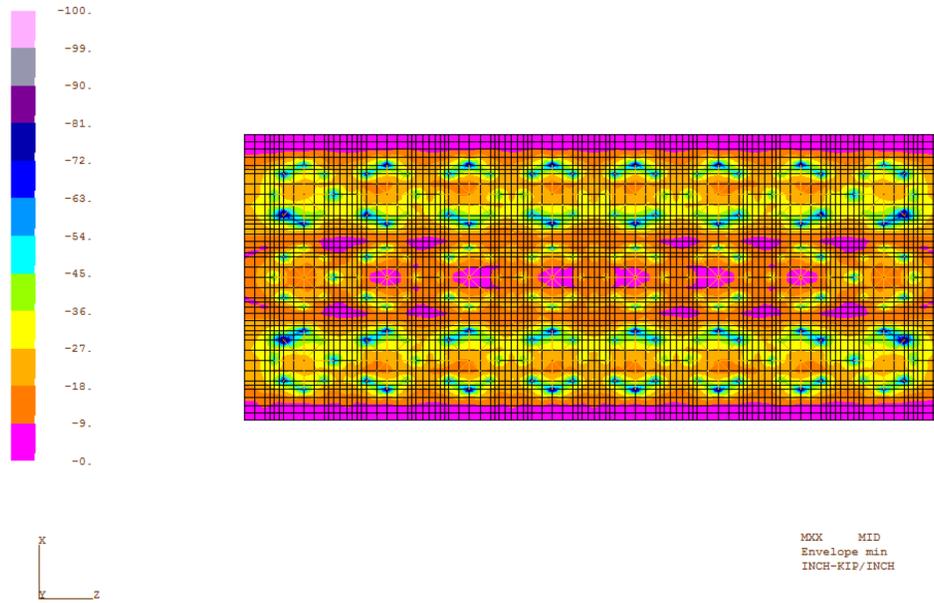


Figure 7-10
Enveloping Negative Moment Resultants (kip-in/in) About Global Z-Axis
(local M_{XX}) - Configuration 1

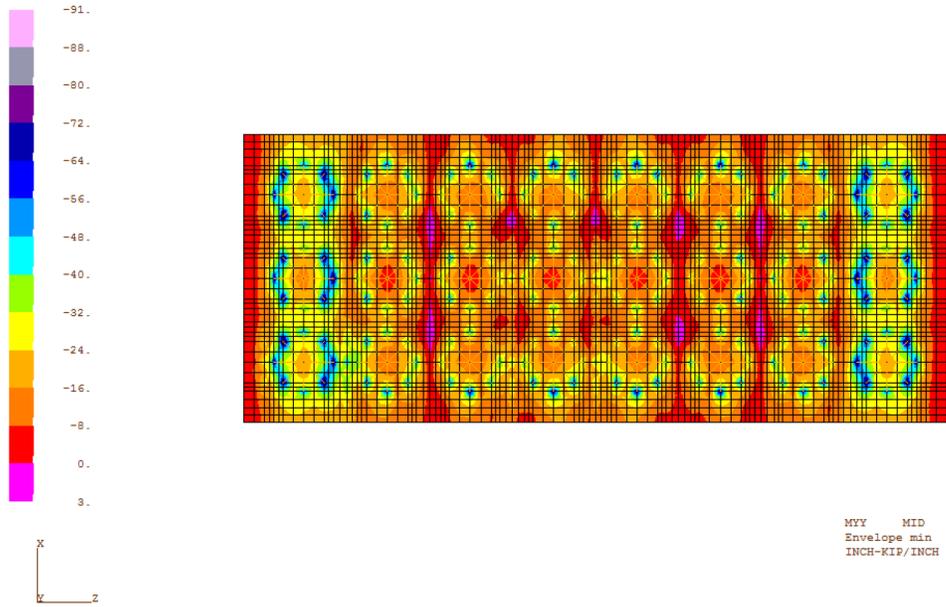


Figure 7-11
Enveloping Negative Moment Resultants (kip-in/in) About Global X-Axis
(local M_{YY}) - Configuration 1

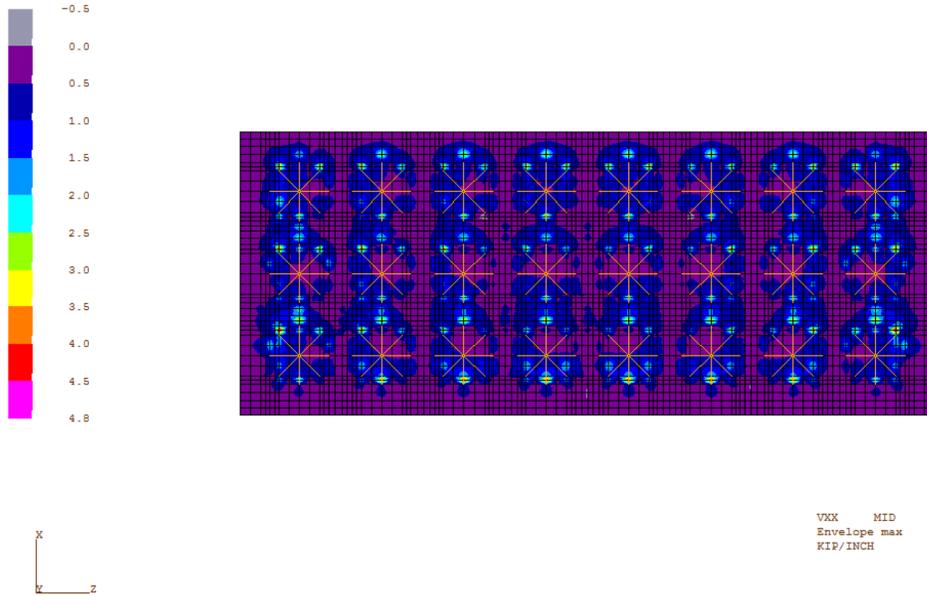


Figure 7-12
Enveloping Element Shear (kip/in) In The Global Y-Direction On The X-Face (local V_{XX}) - Configuration 1

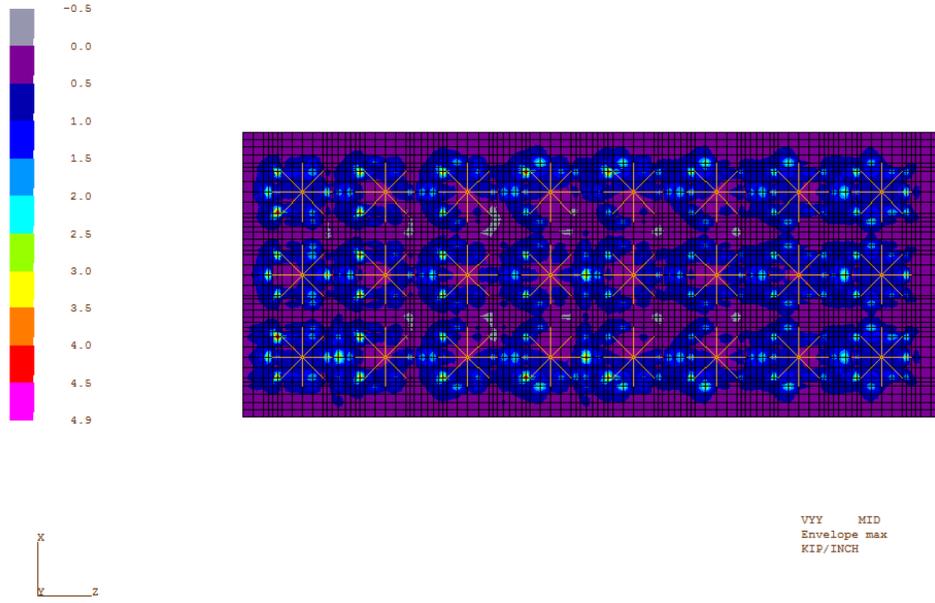


Figure 7-13
Enveloping Element Shear (kip/in) In The Global Y-Direction On The Z-Face (local V_{YY}) - Configuration 1

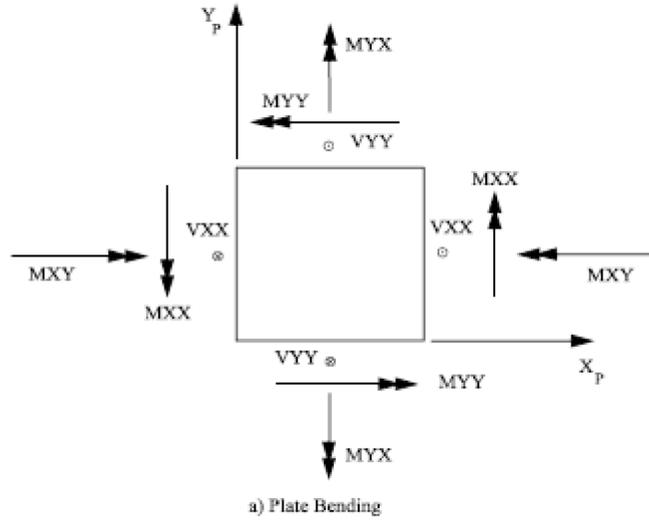


Figure 7-14
GTSTRUDL Plate Bending Element Sign Convention

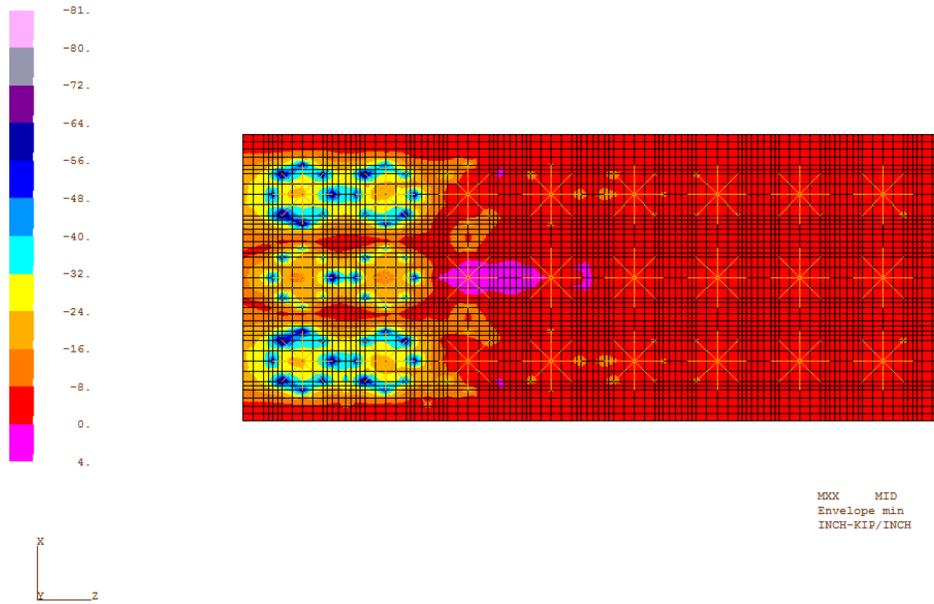


Figure 7-15
Enveloping Negative Moment Resultants (kip-in/in) About Global Z-Axis
(local M_{xx}) - Configuration 2

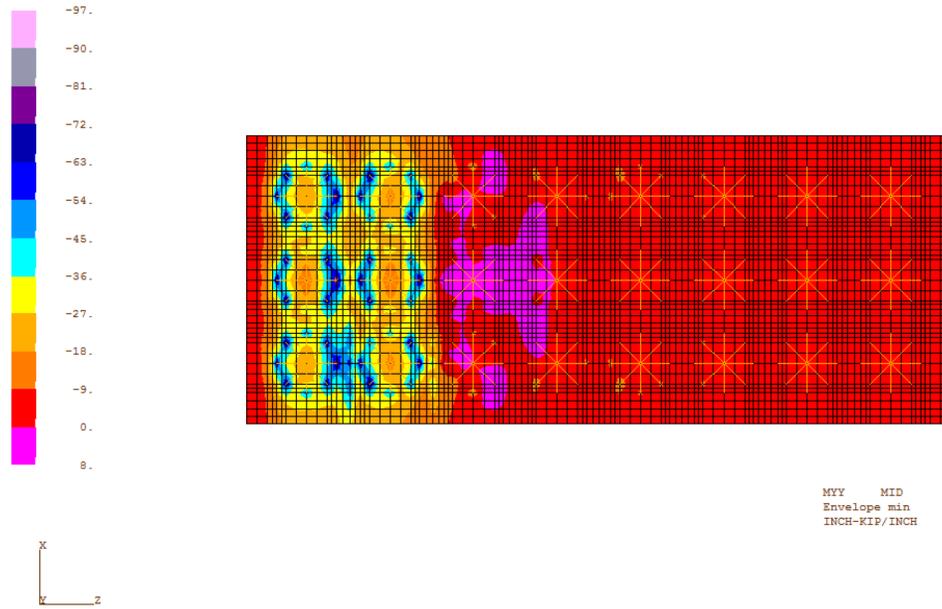


Figure 7-16
Enveloping Negative Moment Resultants (kip-in/in) About Global X-Axis
(local M_{YY}) - Configuration 2

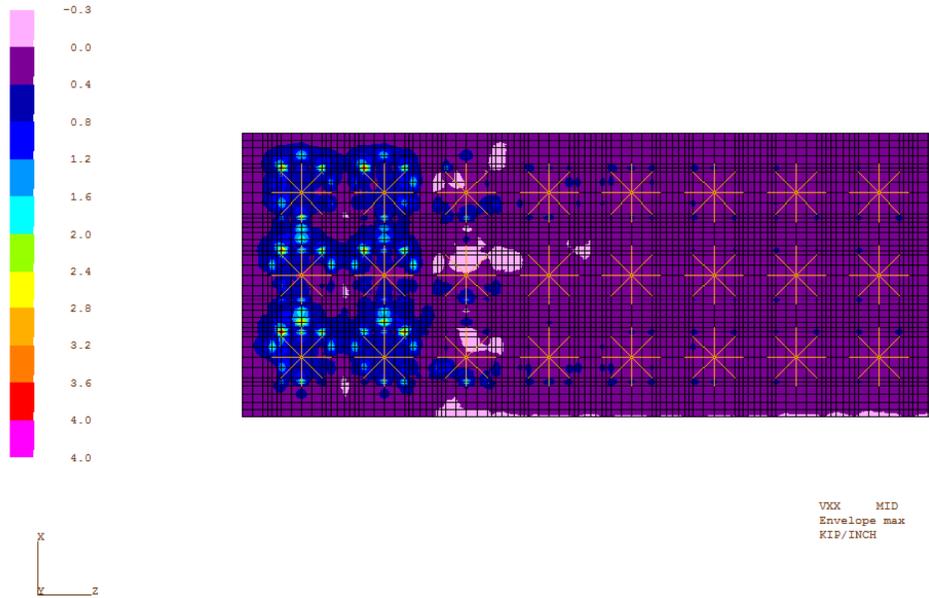


Figure 7-17
Enveloping Element Shear (kip/in) In The Global Y-Direction On The X-Face (local V_{XX}) - Configuration 2

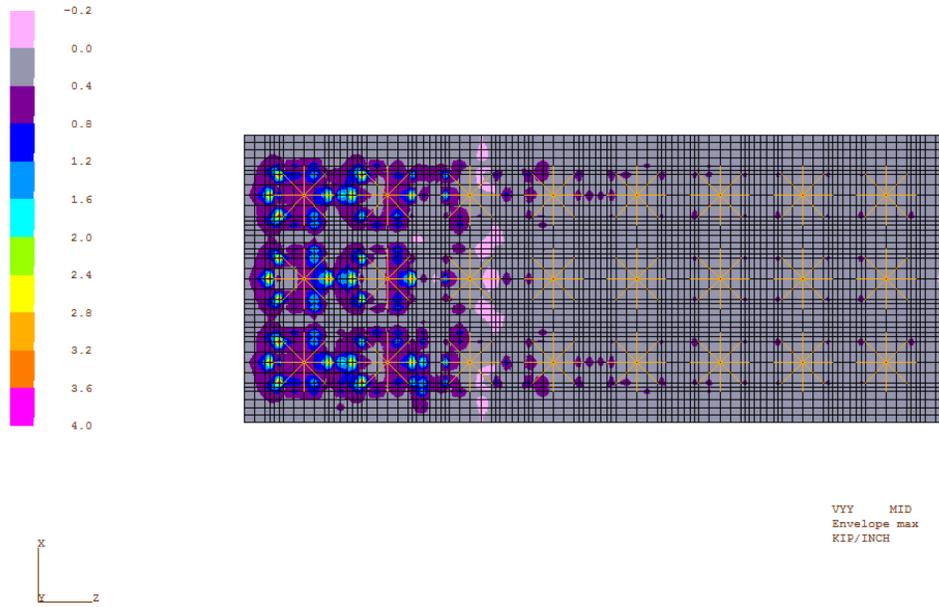


Figure 7-18
Enveloping Element Shear (kip/in) In The Global Y-Direction On The Z-
Face (local V_{YY}) - Configuration 2

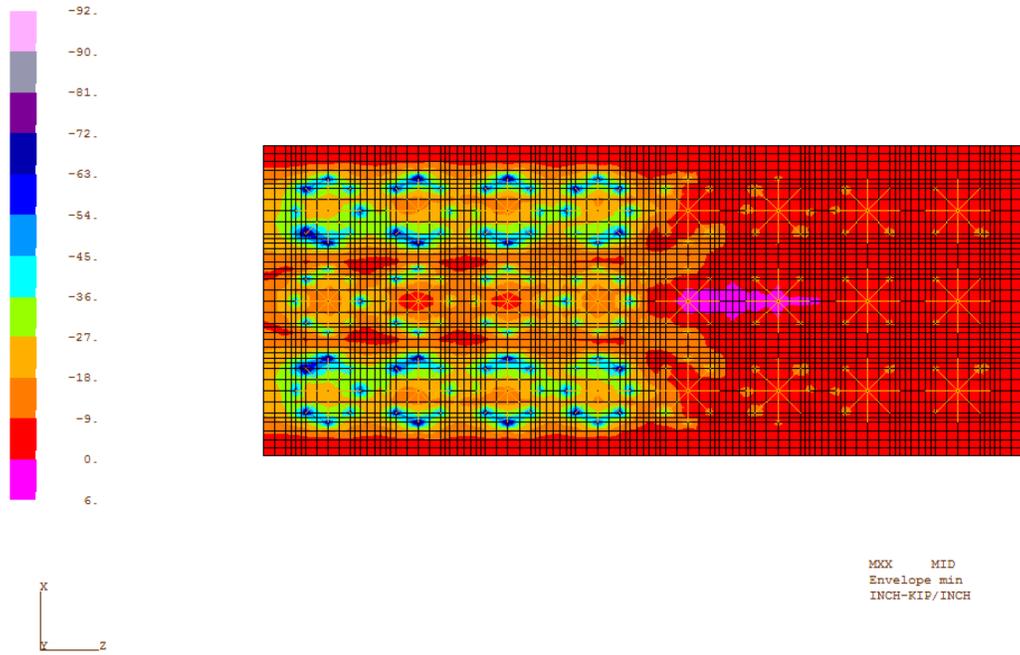


Figure 7-19
Enveloping Negative Moment Resultants (kip-in/in) About Global Z-Axis
(local M_{xx}) - Configuration 3

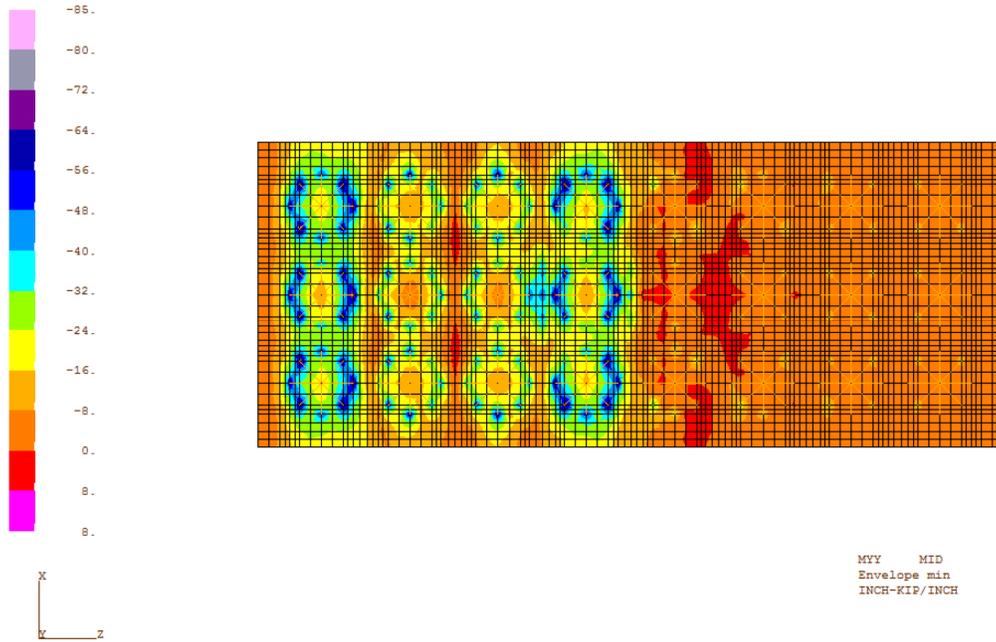


Figure 7-20
Enveloping Negative Moment Resultants (kip-in/in) About Global X-Axis
(local M_{YY}) - Configuration 3

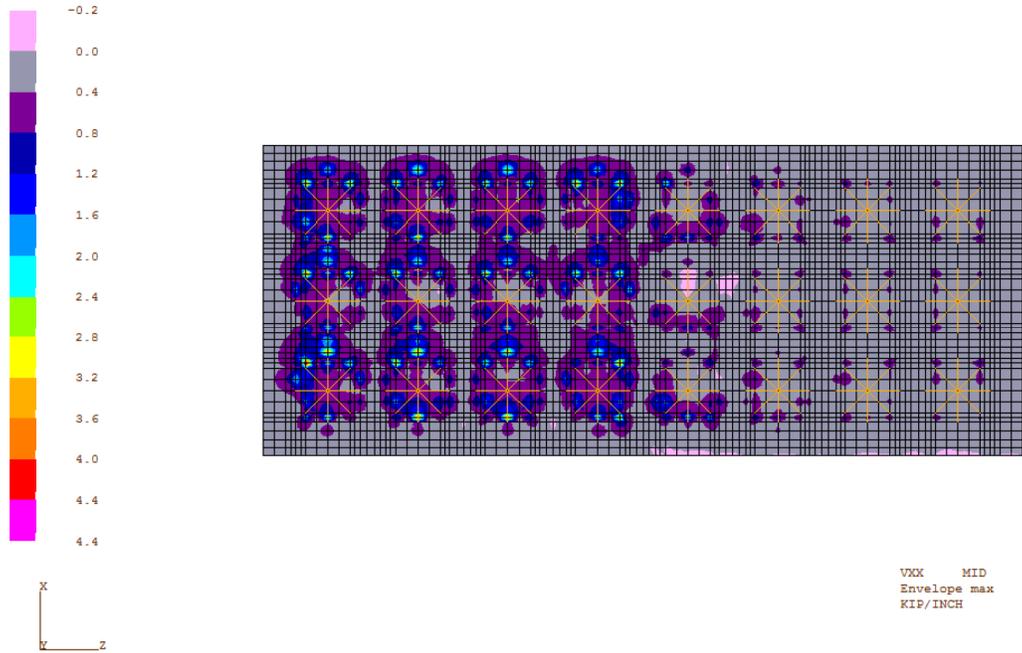


Figure 7-21
Enveloping Element Shear (kip/in) In The Global Y-Direction On The X-Face (local V_{XX}) - Configuration 3

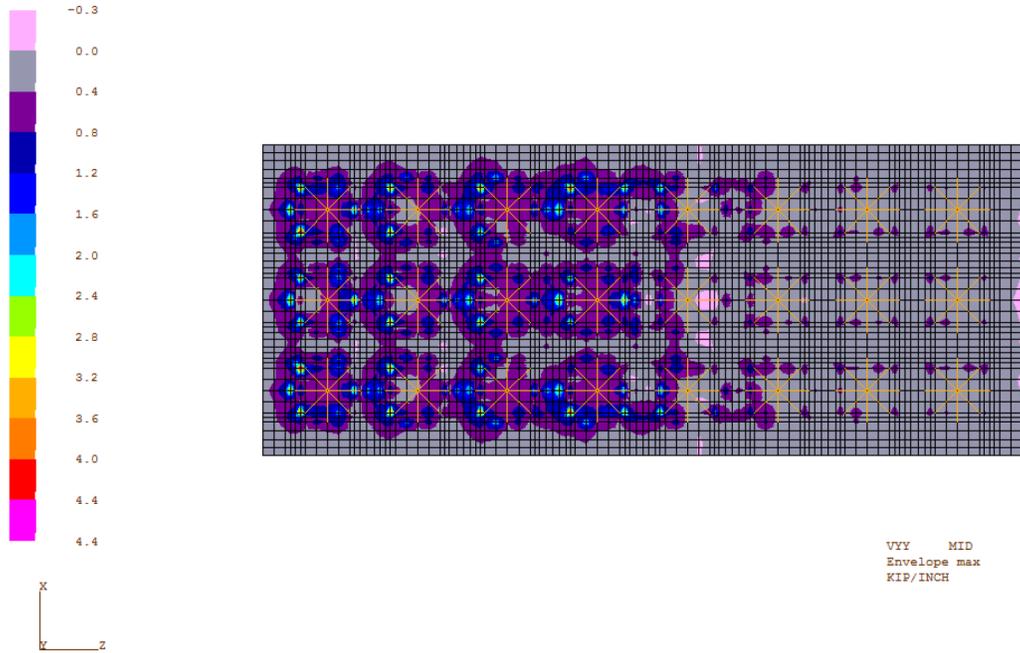


Figure 7-22
Enveloping Element Shear (kip/in) In The Global Y-Direction On The Z-Face (local V_{YY}) - Configuration 3

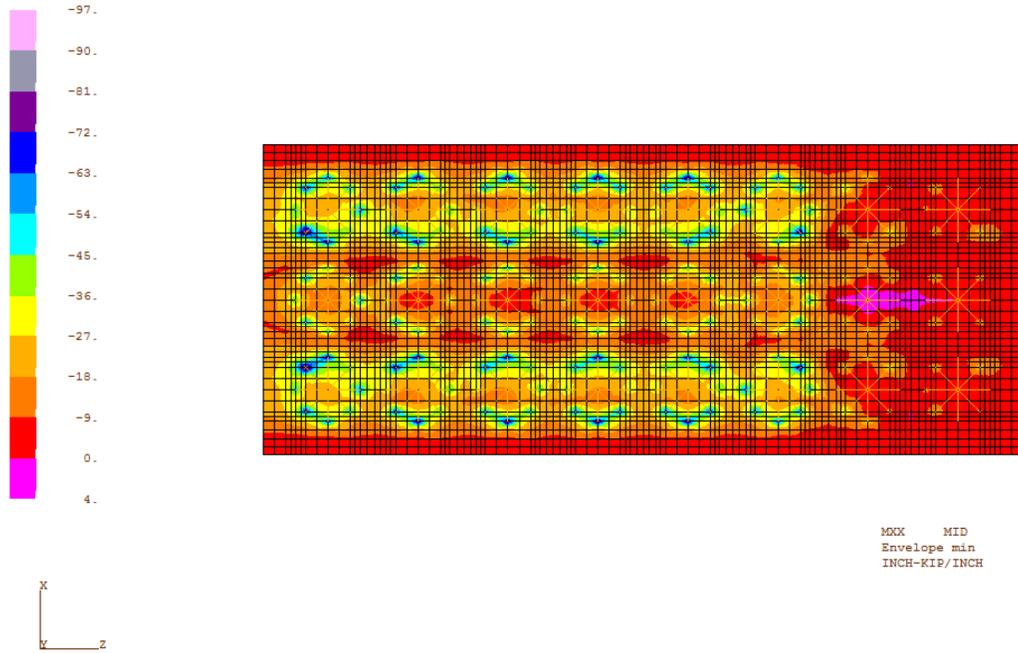


Figure 7-23
Enveloping Negative Moment Resultants (kip-in/in) About Global Z-Axis
(local M_{xx}) - Configuration 4

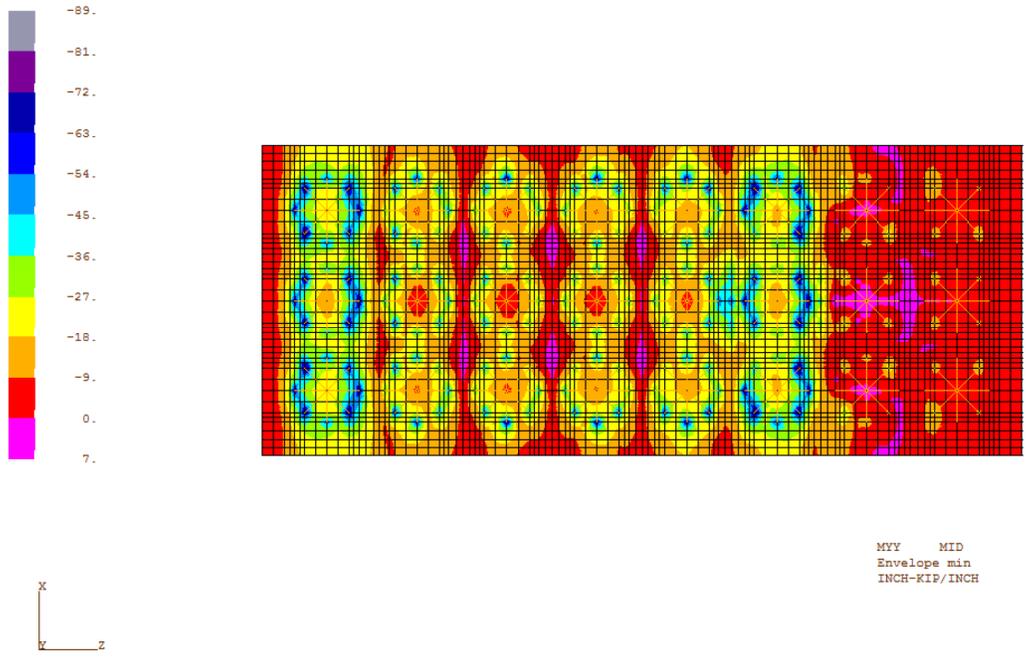


Figure 7-24
Enveloping Negative Moment Resultants (kip-in/in) About Global X-Axis
(local M_{YY}) - Configuration 4

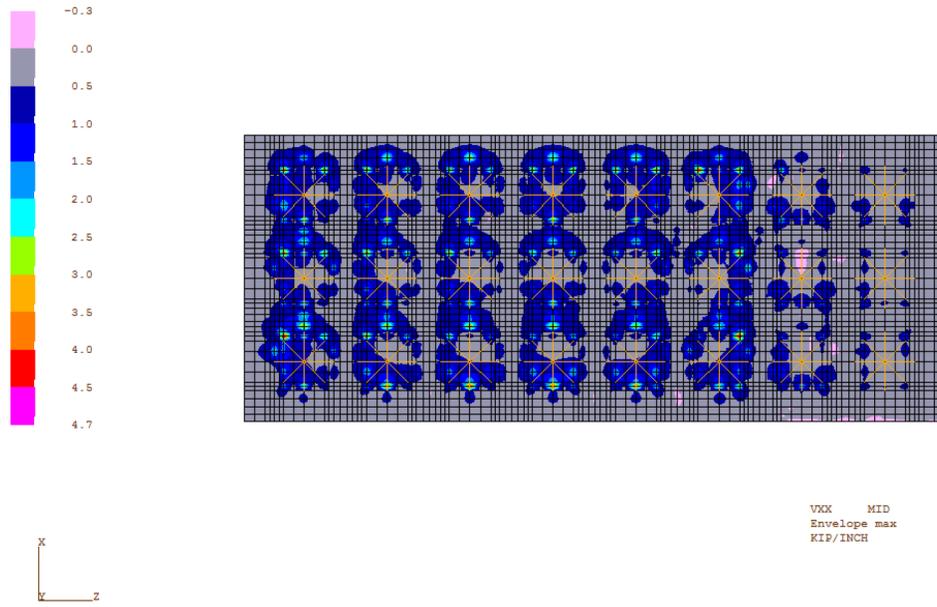


Figure 7-25
Enveloping Element Shear (kip/in) In The Global Y-Direction On The X-Face (local V_{XX}) - Configuration 4

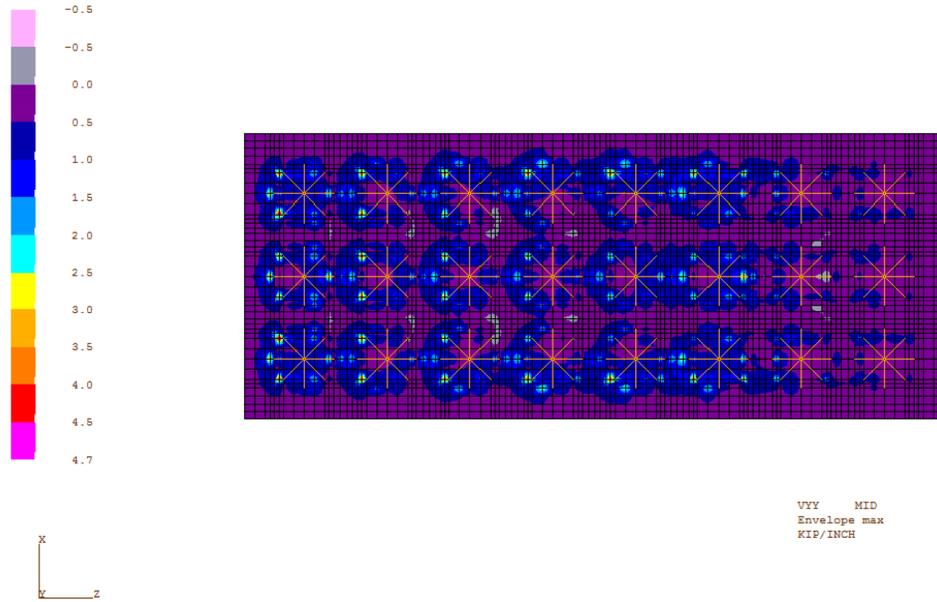


Figure 7-26
Enveloping Element Shear (kip/in) In The Global Y-Direction On The Z-Face (local V_{YY}) - Configuration 4

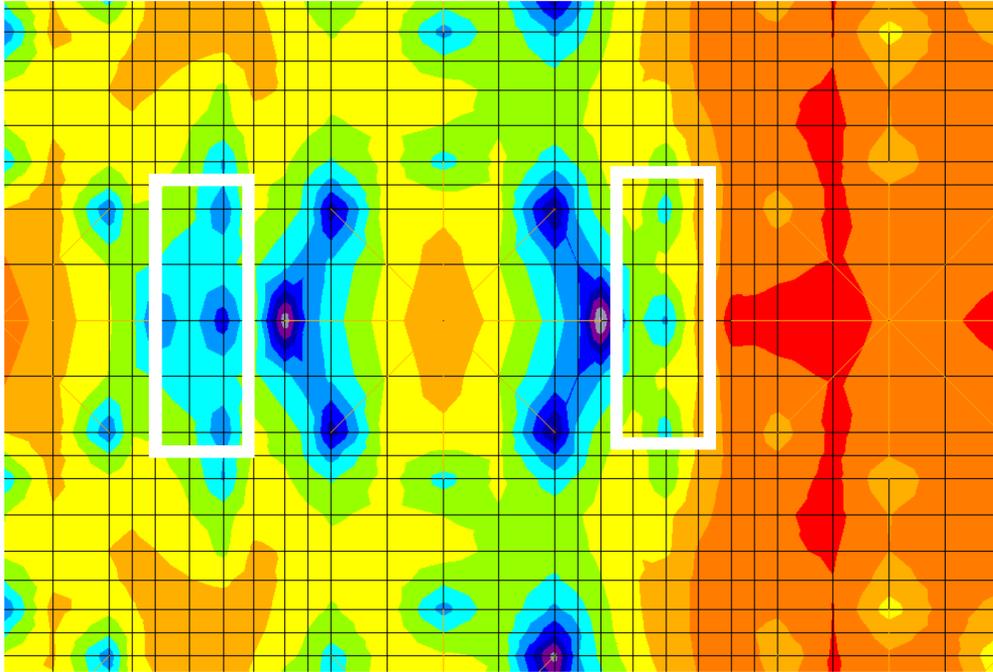


Figure 7-27
Excerpt Of Load Configuration 3 Enveloping Negative Moment Resultants
About Global X-Axis (Local M_{YY}) Showing Effect Of VCT Loading

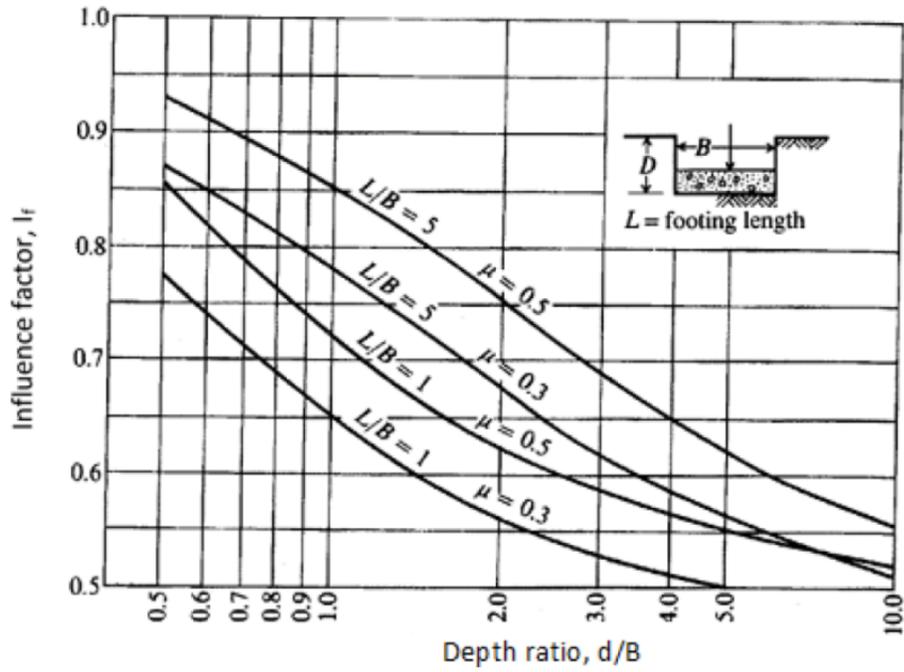


Figure 7-29
Footing Depth to Influence Factor

Proprietary Information on This Page
Withheld Pursuant to 10 CFR 2.390

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

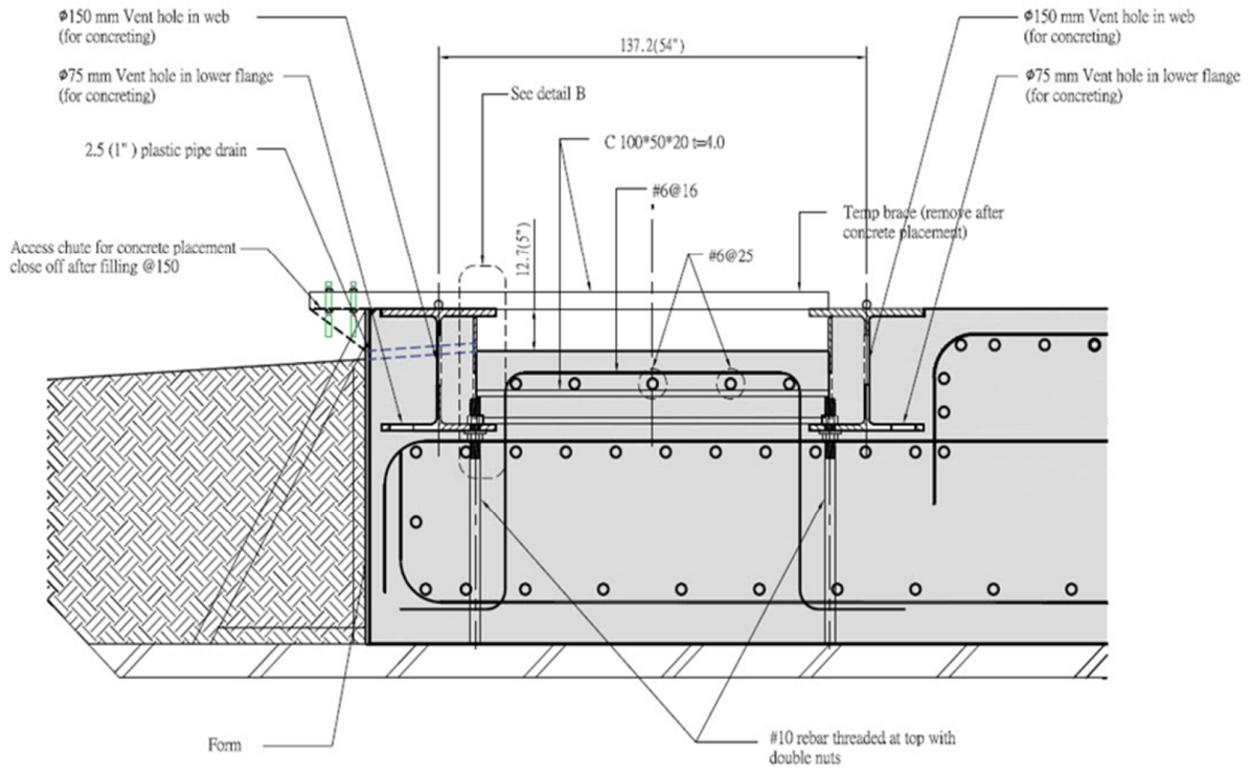


Figure 7-32
Typical Crane rail Installation Detail for the CTS

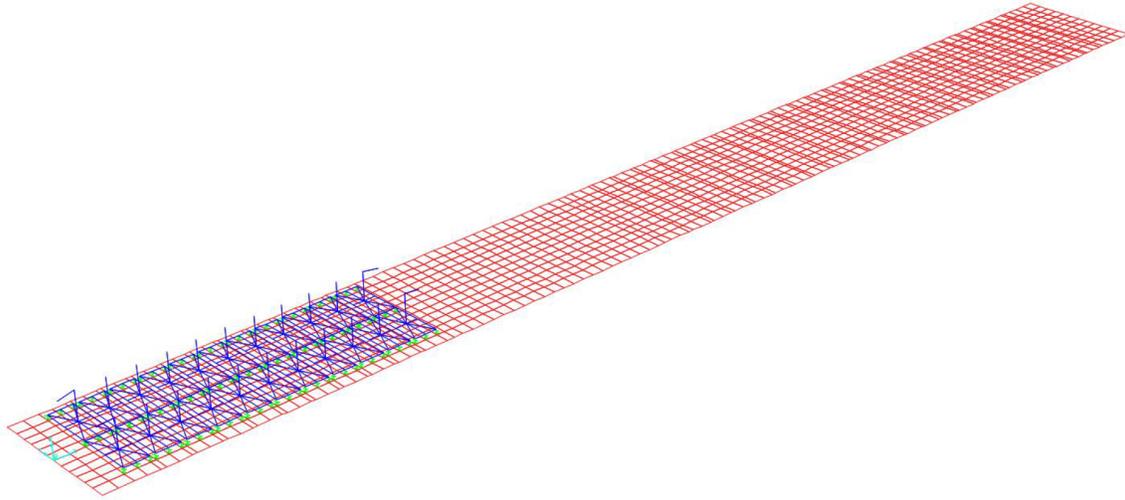


Figure 7-33
SASSI Model of Storage Pad with 22 HSMs Loaded

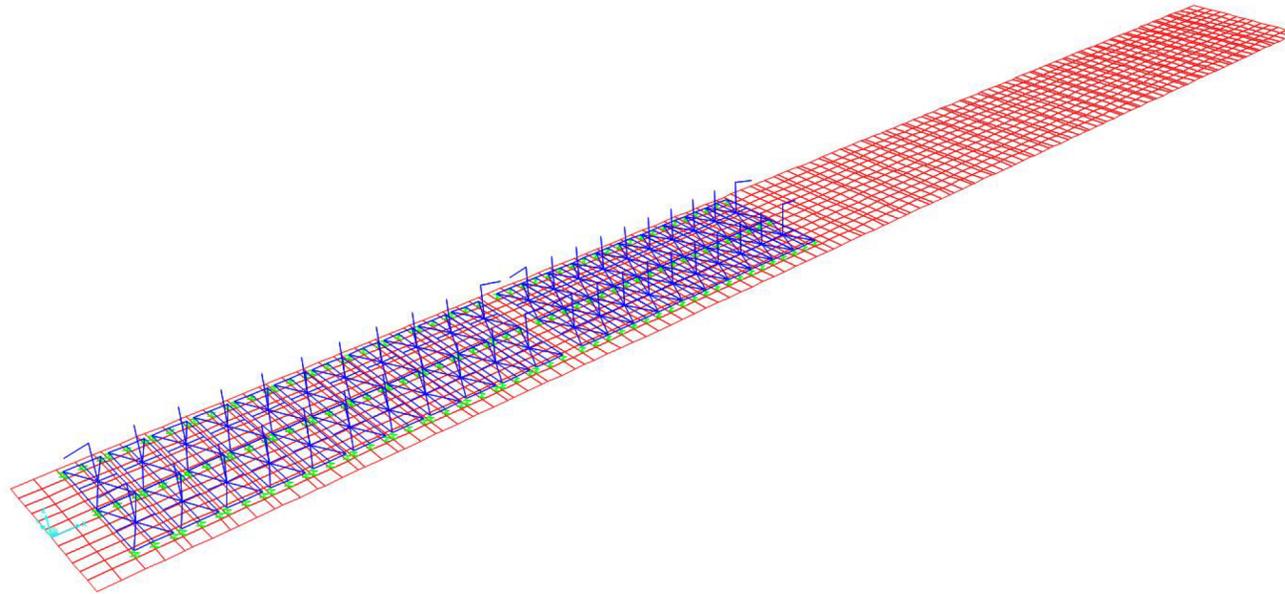


Figure 7-34
SASSI Model of Storage Pad with 42 HSMs Loaded

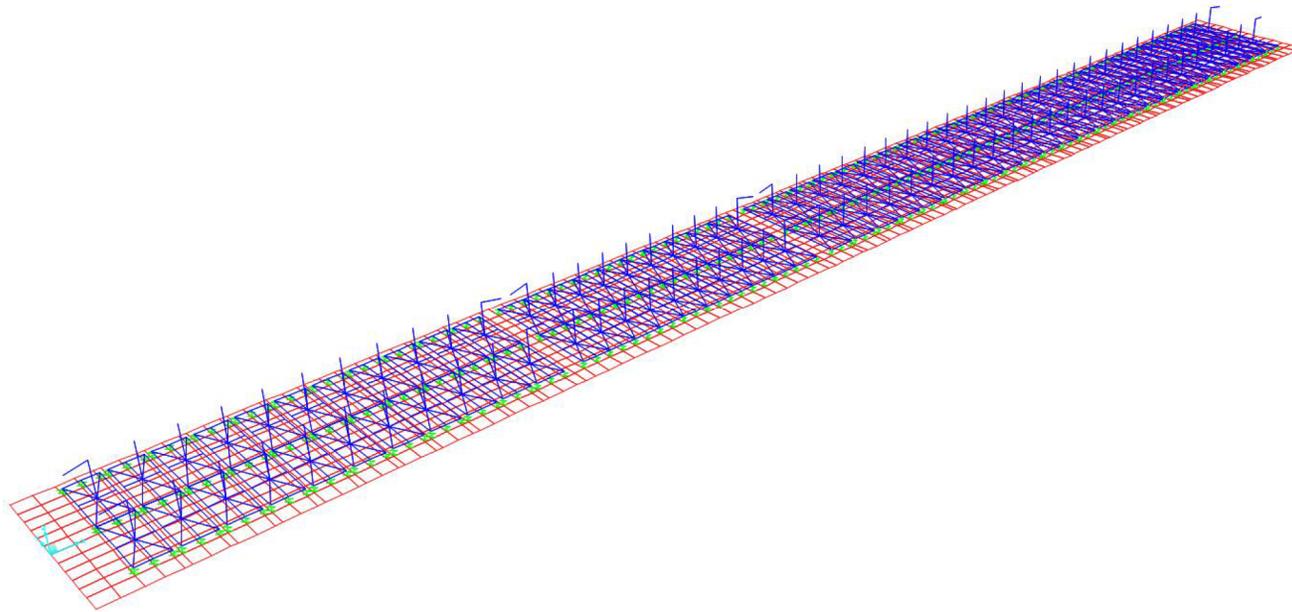


Figure 7-35
SASSI Model of Storage Pad with 92 HSMs Loaded

Proprietary Information on Pages 7-182 through 7-187
Withheld Pursuant to 10 CFR 2.390

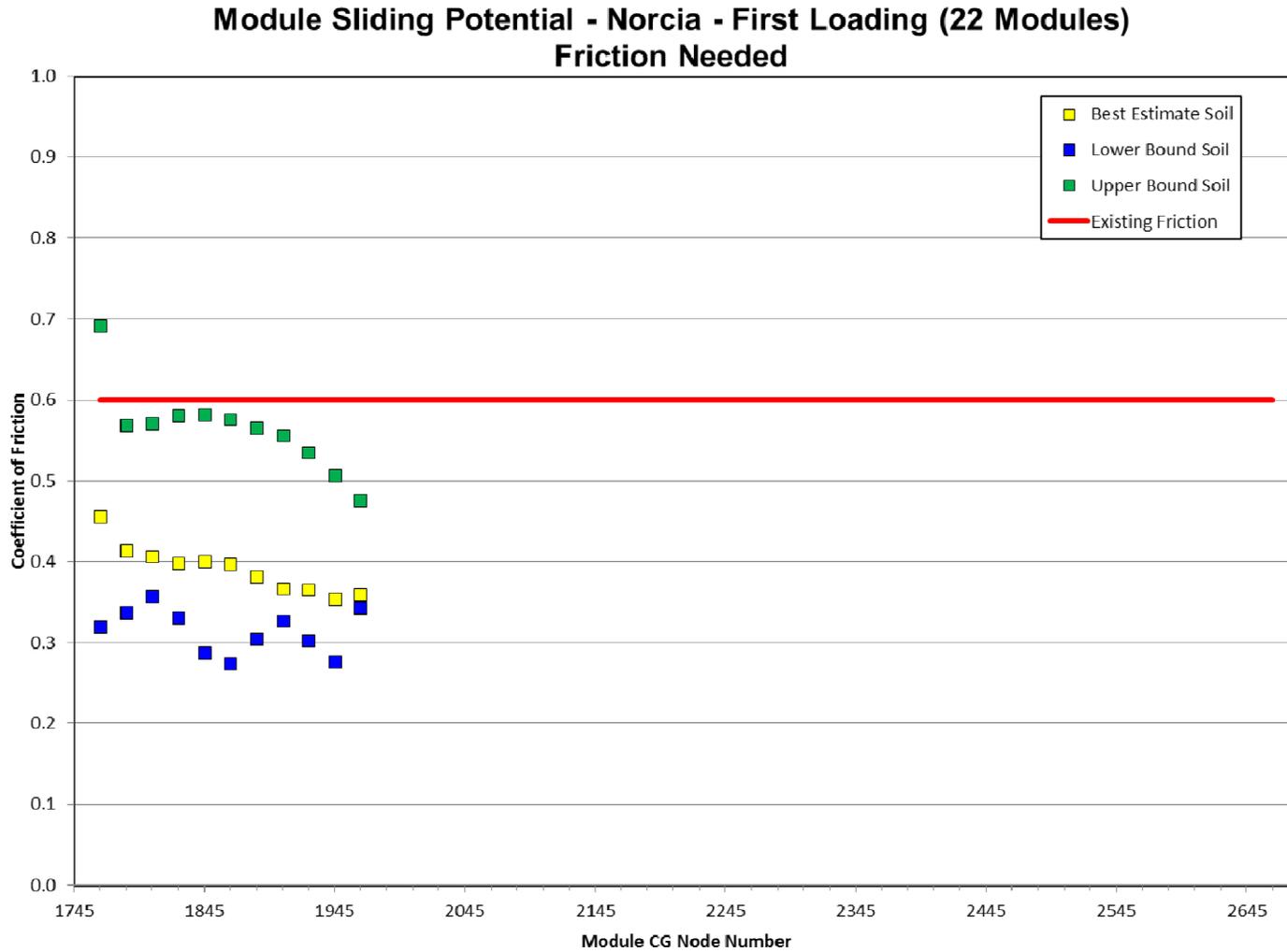


Figure 7-42
Sliding Potential – Norcia Earthquake Loading Configuration: 22 HSMs on the Pad

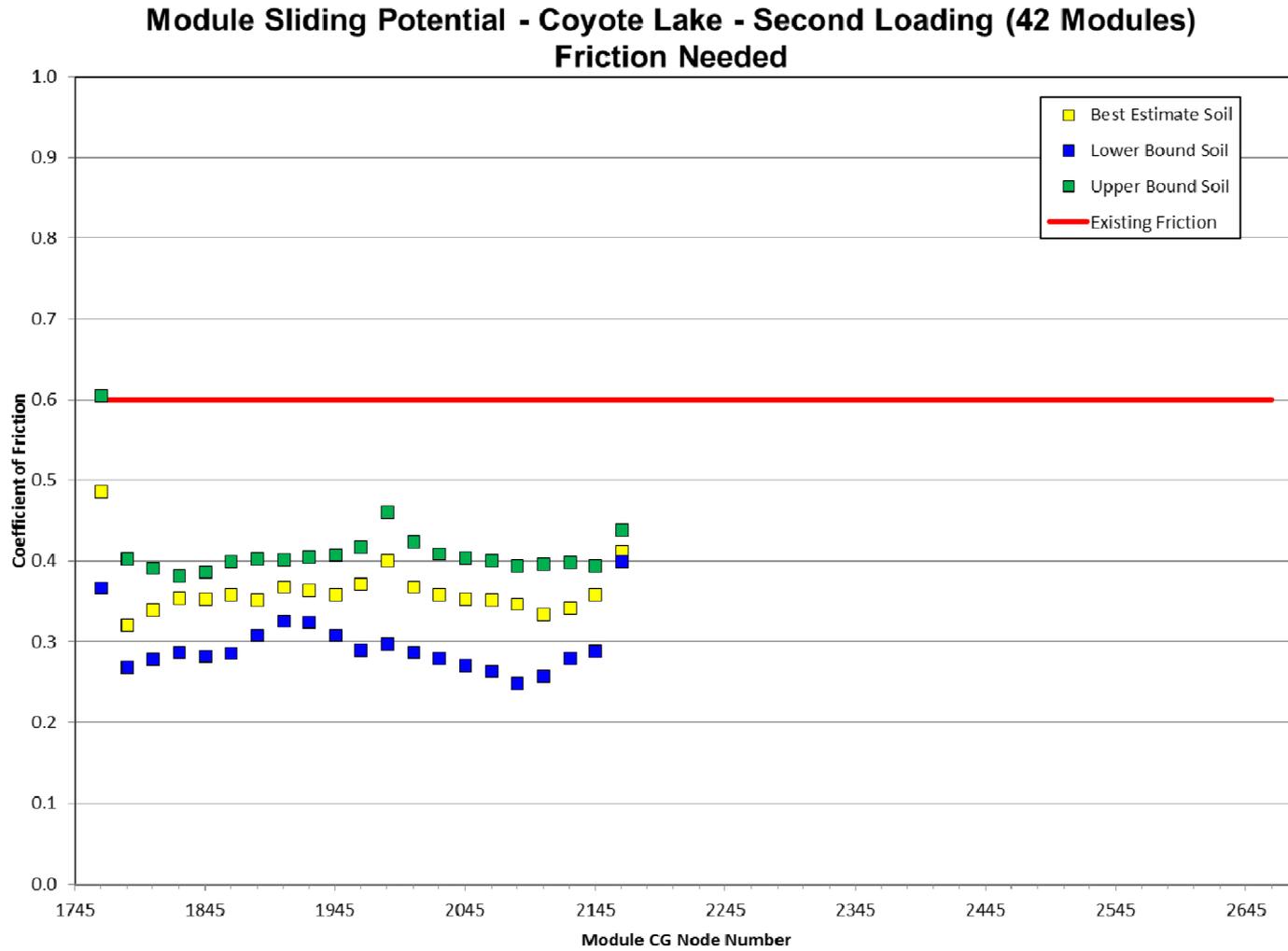


Figure 7-43
Sliding Potential – Coyote Lake Earthquake Loading Configuration: 42 HSMs on the Pad

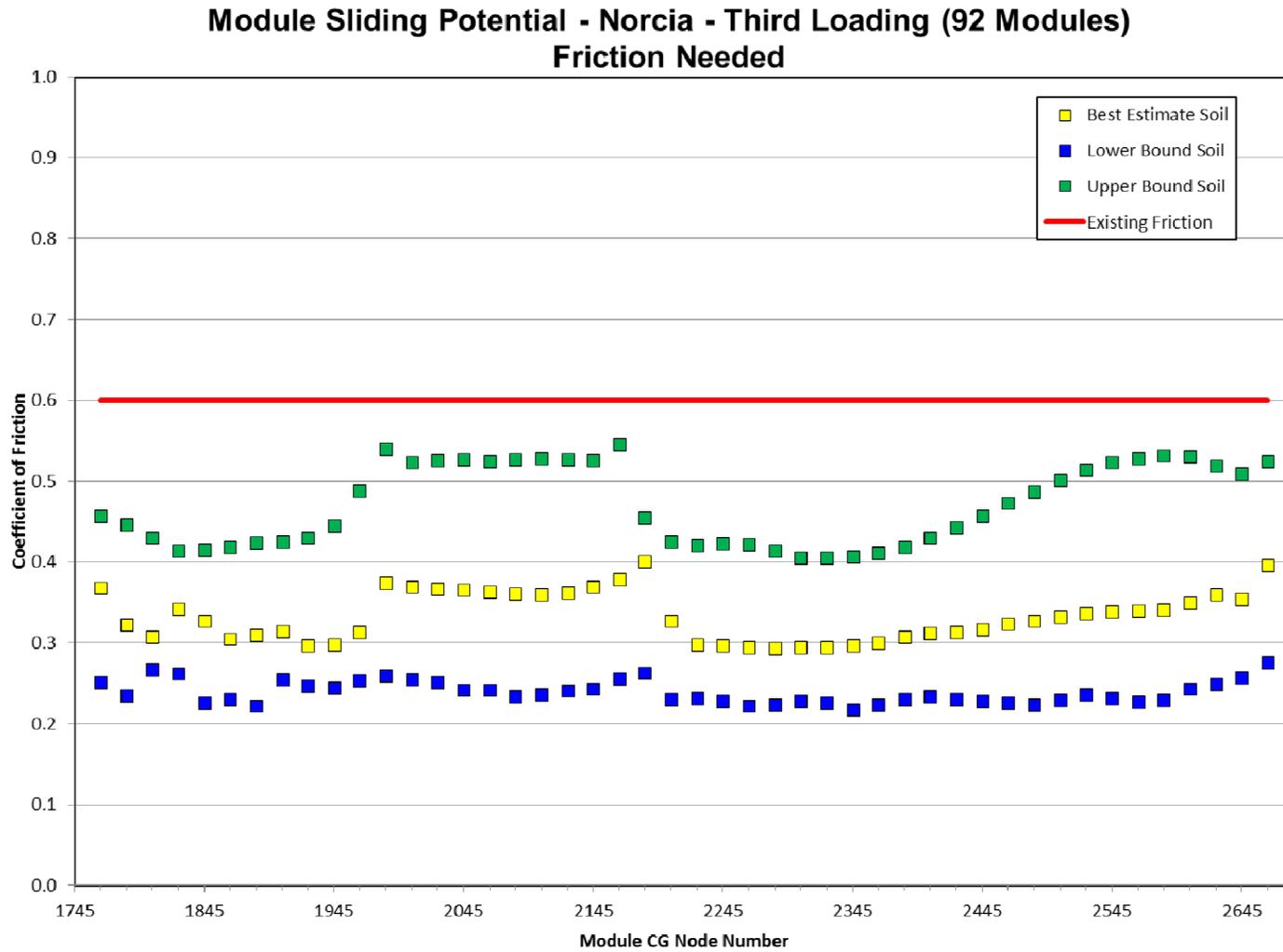


Figure 7-44
Sliding Potential – Norcia Earthquake Loading Configuration: 92 HSMs on the Pad

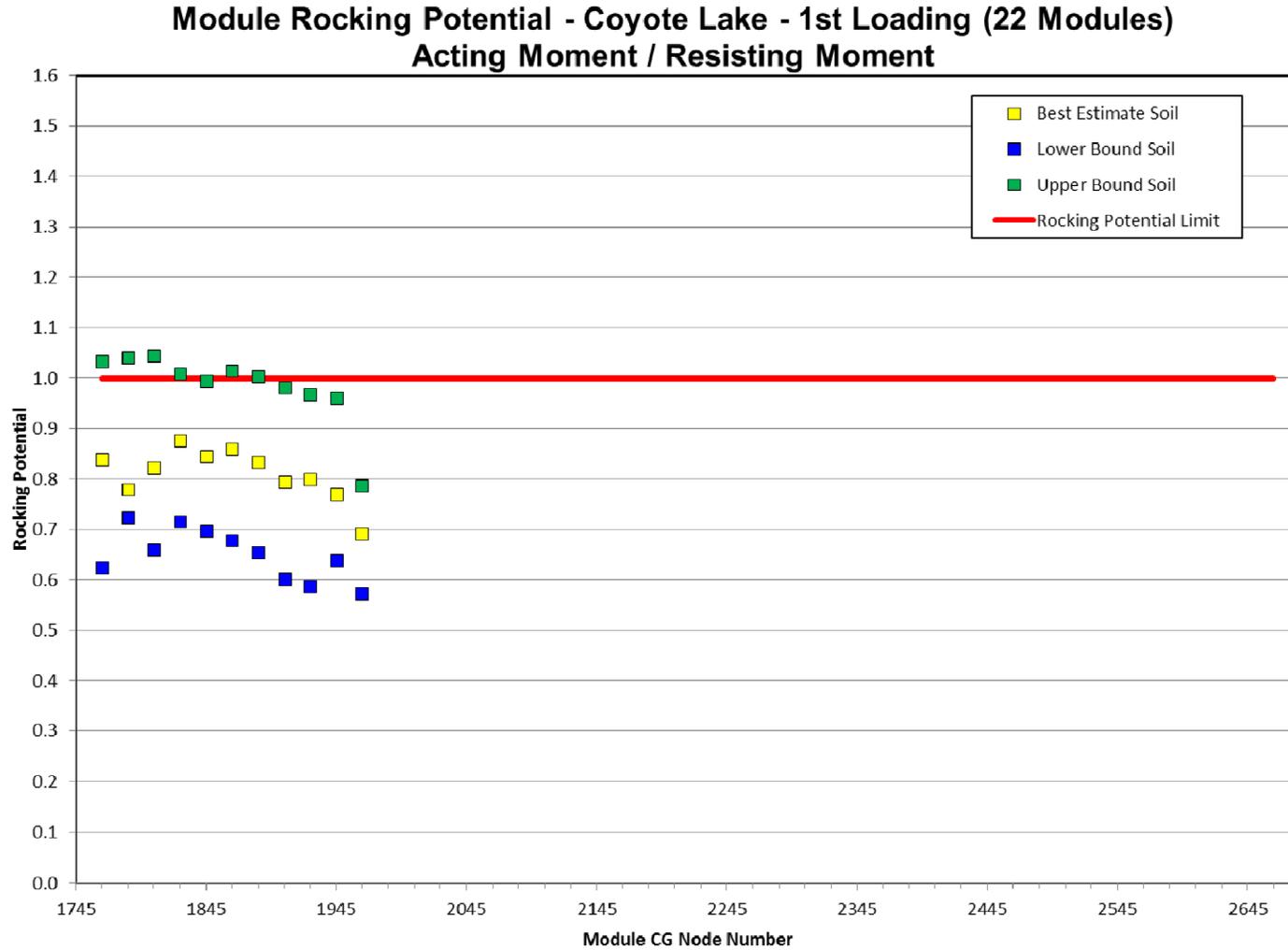


Figure 7-45
Rocking Potential – Coyote Lake Earthquake Loading Configuration: 22 HSMs on the Pad

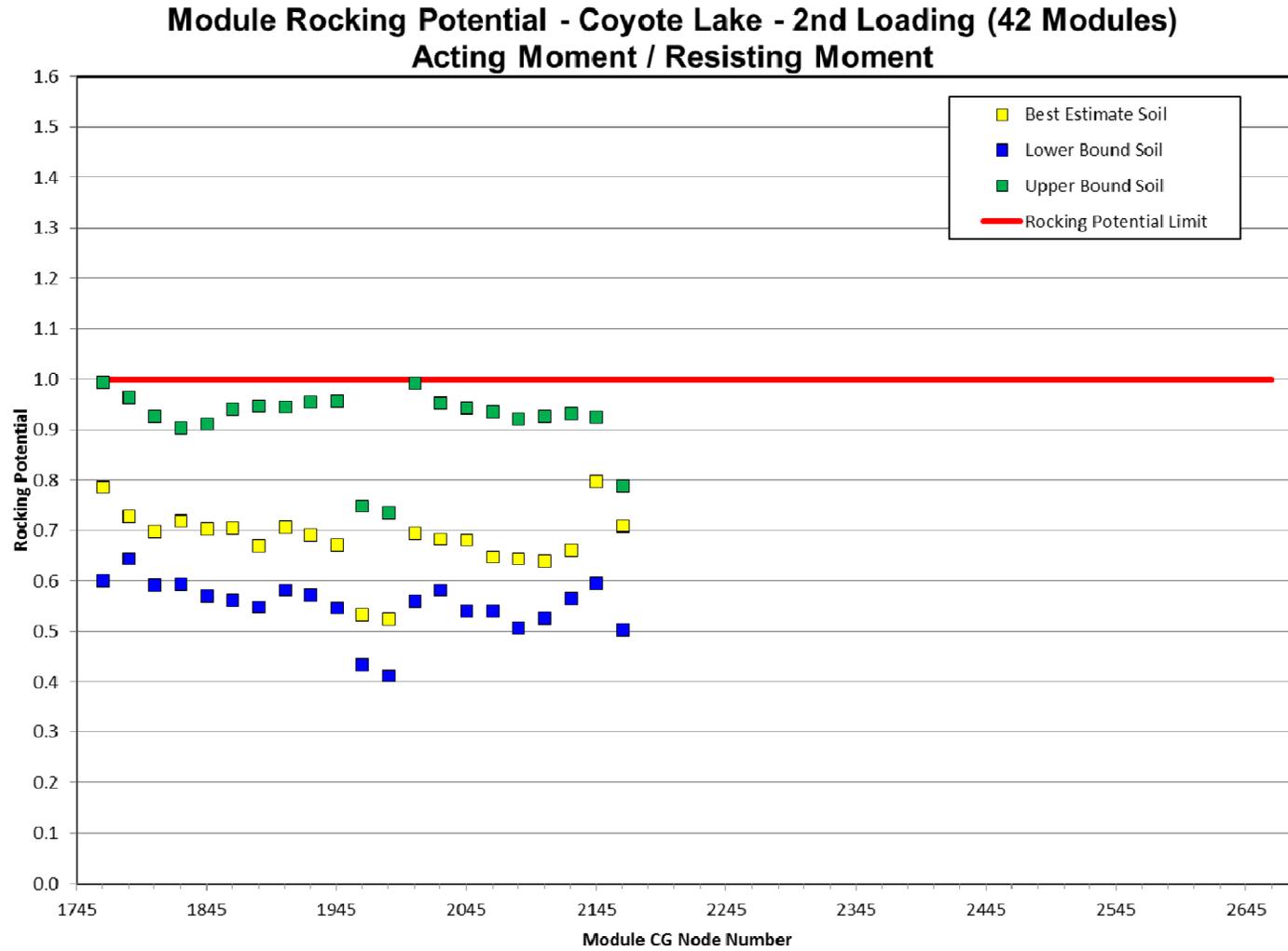


Figure 7-46
Rocking Potential – Coyote Lake Earthquake Loading Configuration: 42 HSMs on the Pad

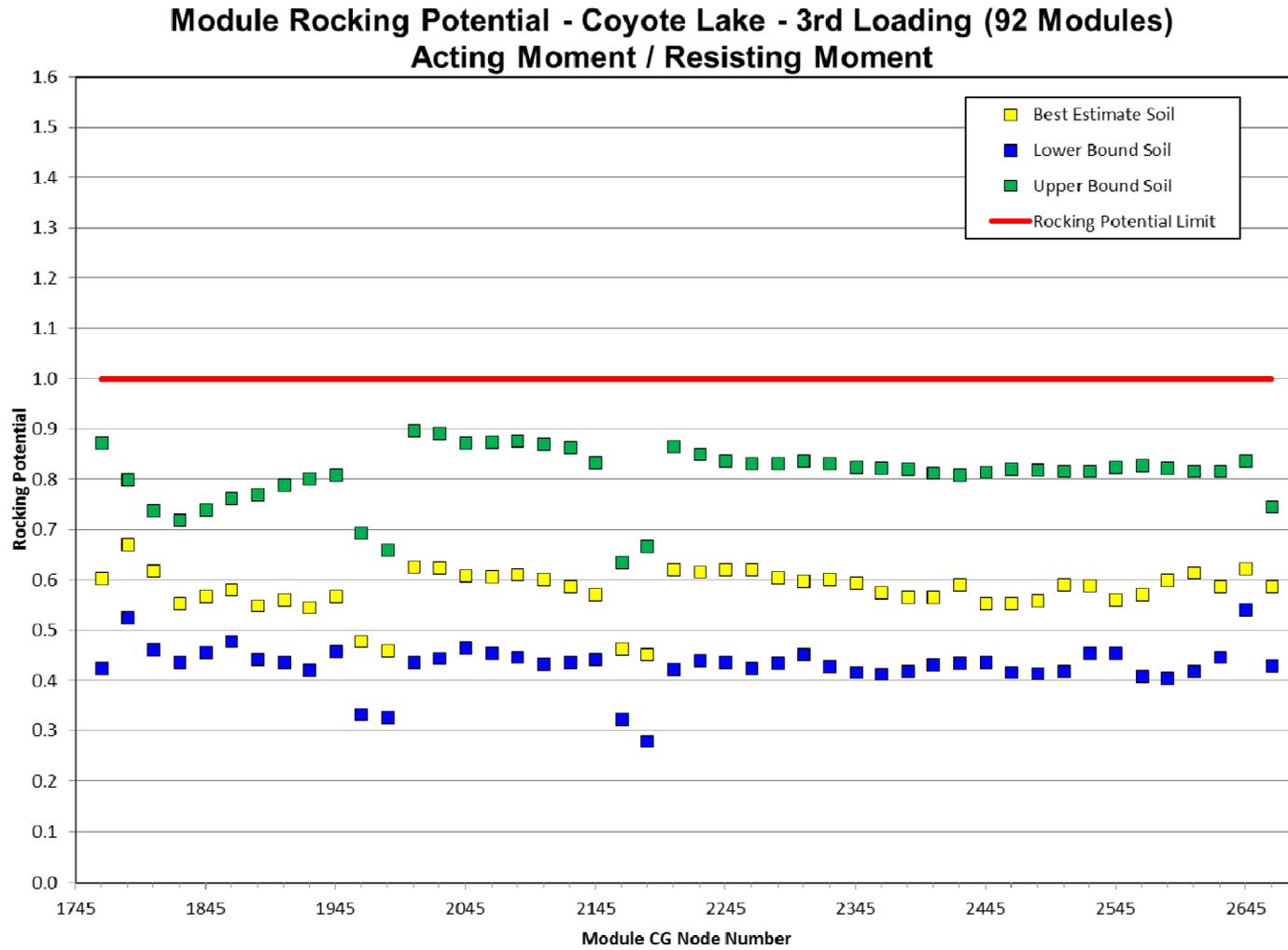


Figure 7-47
Rocking Potential – Coyote Lake Earthquake Loading Configuration: 92 HSMs on the Pad

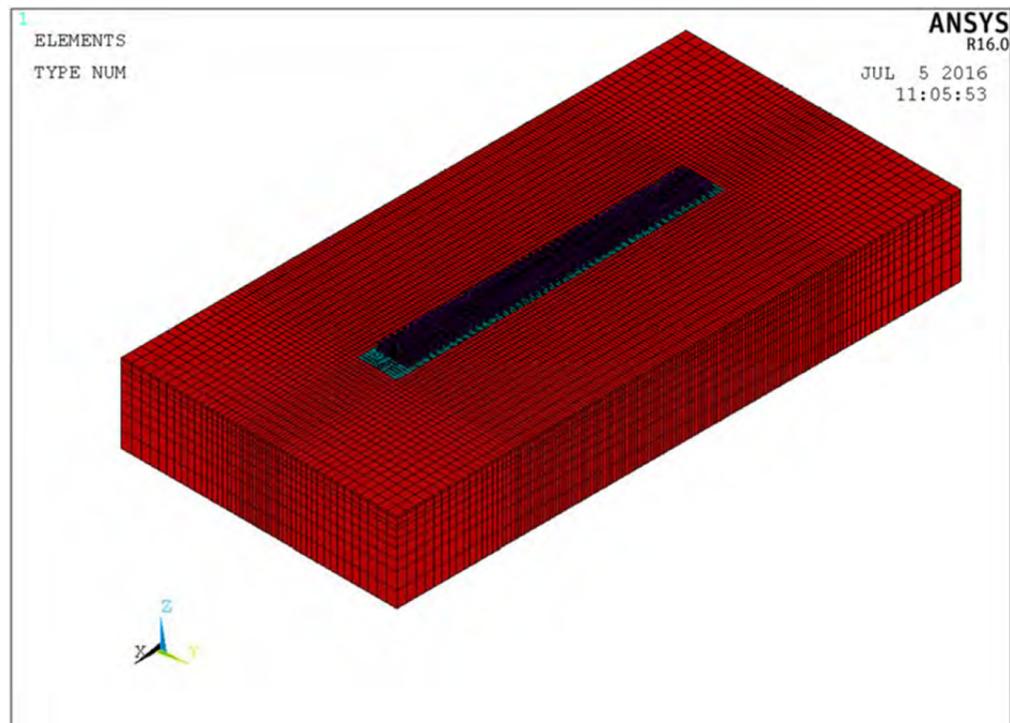


Figure 7-48
HSMFUL – ANSYS Model: Fully Loaded Pad Configuration– 2 x 46 AHSM Array

Young's Modulus E (psi)	Poisson's Ratio v	LAYER	Thickness	Material Name Used in ANSYS
9796	0.35	LAYER 1	3 ft	Material 4
9796	0.35	LAYER 2	7 ft	Material 5
28289	0.35	LAYER 3	5 ft	Material 6
32667	0.35	LAYER 4	10 ft	Material 7
32667	0.35	LAYER 5	10 ft	Material 8
95255	0.35	LAYER 6	12.5 ft	Material 9
95255	0.35	LAYER 7	12.5 ft	Material 10
72263	0.35	LAYER 8	20 ft	Material 11
72263	0.35	LAYER 9	20 ft	Material 12

Figure 7-49
Soil Properties

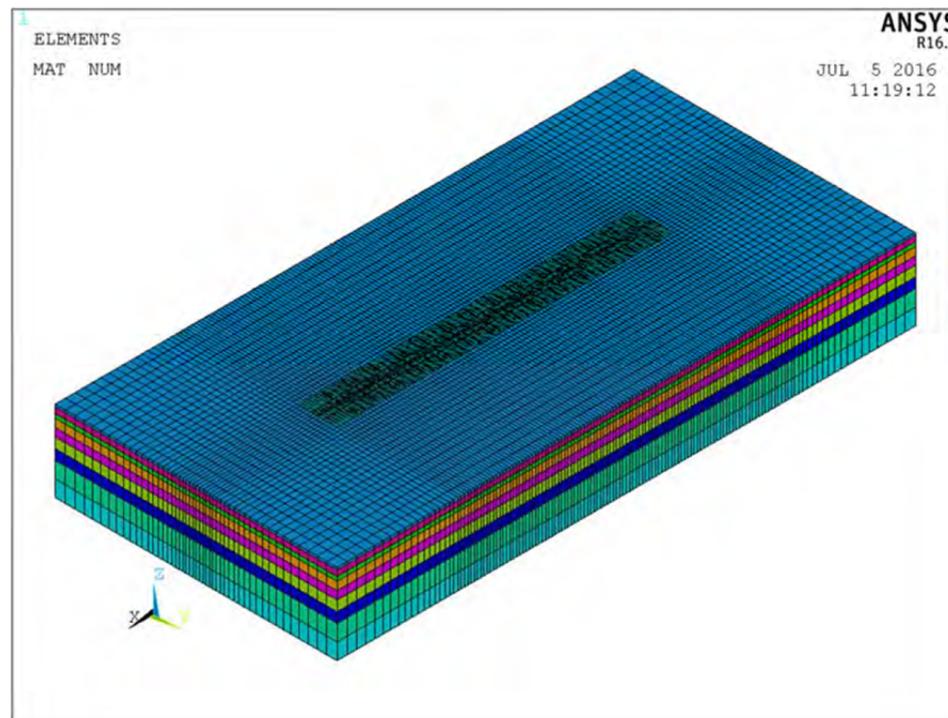
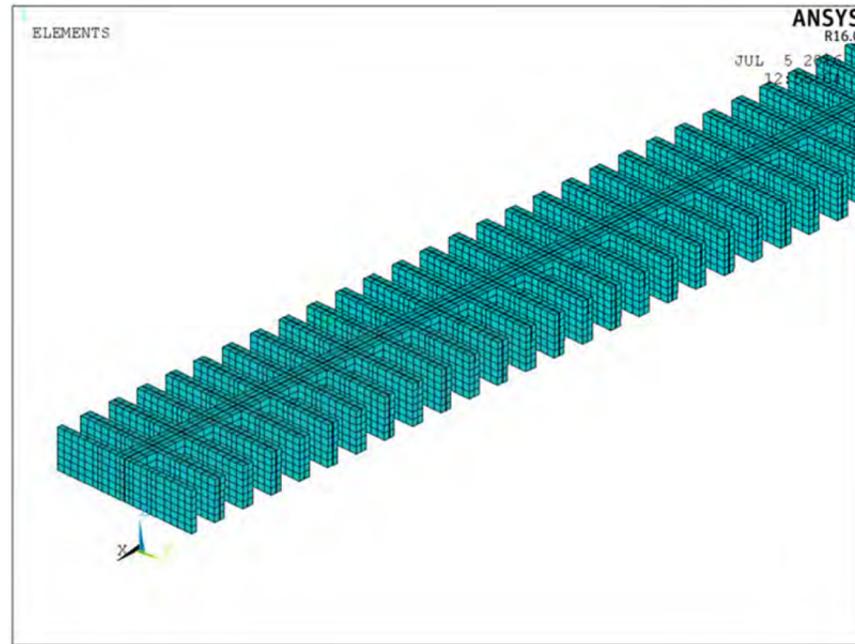


Figure 7-50
Overview of the Soil Layers in ANSYS Model



*Figure 7-51
Overview of HSM Modeling*

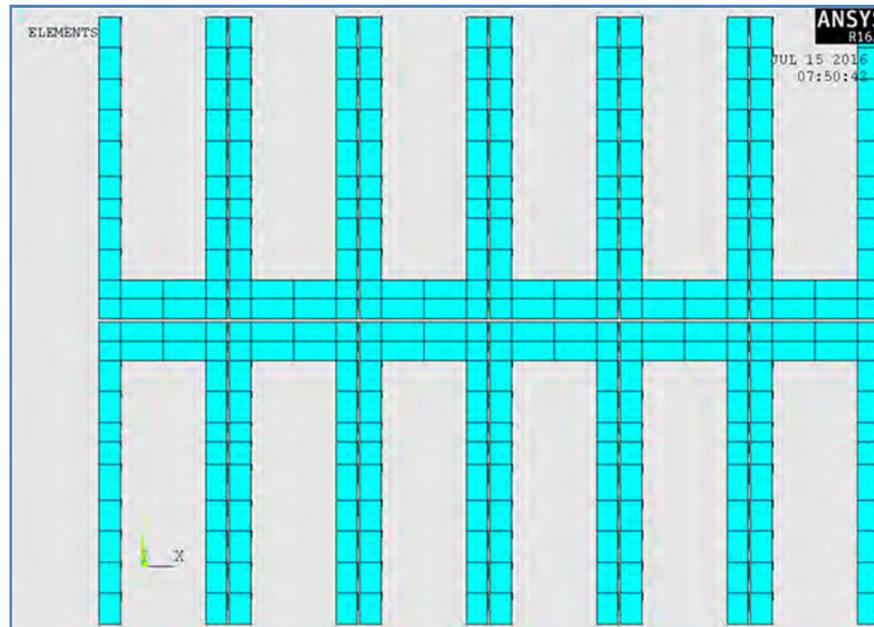


Figure 7-52
2-inch Gap between Modeled HSMs

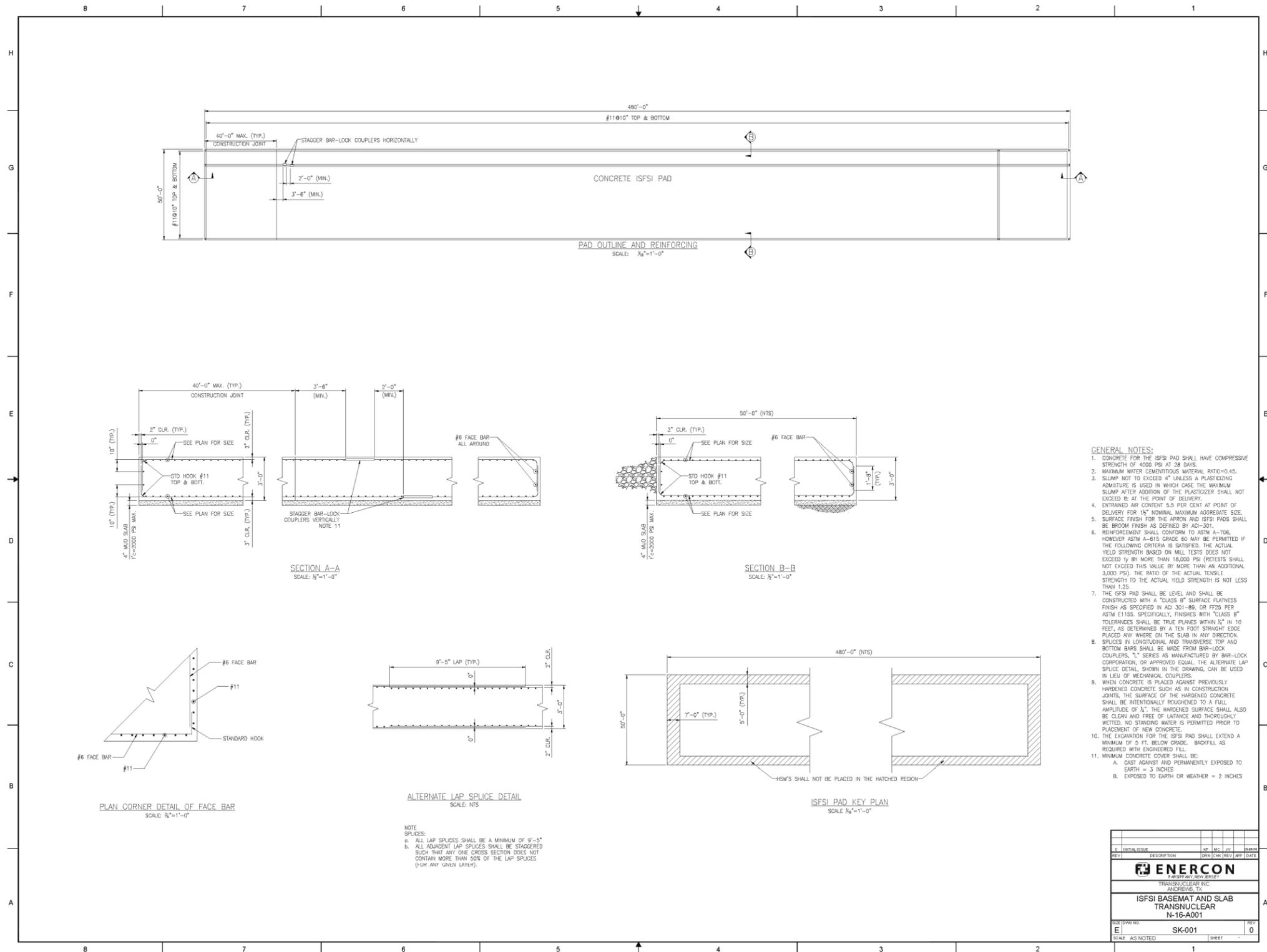


Figure 7-53
NUHOMS® NITS Pad Design

**CHAPTER 8
THERMAL EVALUATION**

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8. THERMAL EVALUATION

The purpose of this chapter is to demonstrate that the Waste Control Specialists, LLC (WCS) Consolidated Interim Storage *Facility* (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 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.

WCS 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 Storage 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 facility 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 facility. In order for a NAC-MAGNASTOR canister to be shipped to the WCS facility 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., $[752 - (718 F \times 0.65)] - 23.5°F = 262°F$). 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 facility 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. Advanced NUHOMS[®] Systems

According to NUREG-2174, a wind evaluation should be included for Advanced NUHOMS[®] Systems (AHSM) when there is not sufficient margin.

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 site 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 Proposed SNM-1050, WCS *Consolidated* Interim Storage Facility Technical Specifications, Amendment 0.
- 8-2 “Post Transport Package Evaluation,” QP-10.02, Revision 1.
- 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		
	<i>GTCC Canister</i>		
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		
	<i>GTCC-Canister-CY</i>		
	<i>GTCC-Canister-YR</i>		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.8
	<i>GTCC-Canister-MY</i>		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.8
	<i>GTCC-Canister-ZN</i>		

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

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

CHAPTER 9 RADIATION PROTECTION

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<i>Figure 9-4</i>	<i>Deleted</i>	<i>9-45</i>
<i>Figure 9-5</i>	<i>WCS CISF Receptors and Source of Radiation in the Region of Interest</i>	<i>9-46</i>
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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 Waste Control Specialists LLC (WCS) 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 (CISF).

9.1 Ensuring That Occupational Radiation Exposures Are ALARA

9.1.1 Policy Considerations

WCS 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 WCS personnel and existing WCS programs as well as the extensive experience of AREVA 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. WCS does this by implementing ALARA principles into the design, construction, and operation of the facility. WCS uses formal periodic reviews of the Radiation Protection Program to assure that objectives of the ALARA program are attained. WCS' radiation protection personnel also are responsible for maintaining occupational exposures as far below the specified regulatory limits as reasonably achievable.

WCS is committed to a strong ALARA program. The objectives of WCS' ALARA philosophy include protection of WCS personnel and protection of the public. Protection of WCS 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. WCS 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 WCS 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 WCS 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 and follow ALARA procedures.
- *Restricting* access to radiologically controlled areas.
- *Tracking* individual and collective doses to identify trends and 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.

WCS minimizes radiation dose to non-radiation workers by the following means:

- *WCS 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 WCS 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 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		
	<i>GTCC Canister</i>		
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		
	<i>GTCC-Canister-CY</i>		
	<i>GTCC-Canister-YR</i>		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.9
	<i>GTCC-Canister-MY</i>		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.9
	<i>GTCC-Canister-ZN</i>		

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 WCS personnel.

The storage cask temperature monitoring system and remote inspection of storage overpack vents for blockage 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 storage casks.

ALARA considerations have been incorporated into the WCS 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. WCS 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 NUHOMS[®] transportation casks and moves the casks from the railcar to the transfer trailer. It can also be used to lift impact limiters or other related equipment. The Vertical Cask Transporter (VCT) unloads the NAC system transportation casks from the railcar. 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 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		
	<i>GTCC Canister</i>		
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		
	<i>GTCC-Canister-CY</i>		
	<i>GTCC-Canister-YR</i>		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.9
	<i>GTCC-Canister-MY</i>		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.9
	<i>GTCC-Canister-ZN</i>		

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 cm² beta/gamma emitters and 220 dpm/100 cm² 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} std-cc/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, WCS will use the limits in their State radioactive material license RML R04100 which can be found in 30 TAC 336.364 Appendix G [9-19].

WCS will establish access controls to ensure that unauthorized access inside the OCA and the PA. 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.

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

The 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 WCS Radiation Protection Program. WCS 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, WCS 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 WCS 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.

NAC Systems

The WCS CISF is modeled explicitly. Shielding by NAC systems and AREVA TN 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 WCS 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, WCS 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 WCS 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

WCS 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 WCS. Additionally, 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 WCS. 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

WCS has evaluated the radiological impacts attributable to its present operations, those from the NEF, and radiation doses estimated for storing up to 40,000 MTHM of SNF at the CISF. While WCS 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. WCS estimated the cumulative radiation effective doses attributable to its 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, WCS 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 WCS airborne pathway (particulates and I29I) 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 WCS 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 I29I 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 WCS operations at the perimeter for 2015 ranged from background in the northeast quadrant to 0.06 mSv/yr (6.6 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.

Direct radiation doses from the WCS CISF were calculated by NAC International (2015). A graph of the dose rate as a function of distance from the center storage pads out to a distance of 1000 m was provided. This curve was extrapolated to further distances through log-transformed linear regression of the data. The regression equation was given by ($r^2 = 0.992$)

$$D(x) = \exp[-0.00999(x - 260) + 11.548]$$

where, x is the distance in meters from the center of the pad ($x \geq 260$) and $D(x)$ is the dose rate as a function of distance (mSv/yr (mrem/yr)). The attenuation factor from $x = 260$ m to $x = 1,900$ m was 4.1×10^{-9} [i.e., $D(1900 \text{ m})/D(260 \text{ m})$]. Thus, using the attenuation factor of 4.1×10^{-9} at 1.9 km results in a dose no greater than background at this or greater distances.

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.

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

Radiological instrument storage, calibration and maintenance will also be located in the Security and Administration Building, along with a low-radiation background counting room containing laboratory equipment for measuring radioactivity.

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 and gamma radiations will be obtained from the personal dosimetry issued to each Radiation Worker (OSL or equivalent), with 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 WCS 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. WCS 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. WCS 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.

9.6 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 $4.90\text{E-}06$ 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 $4.29\text{E-}2$ 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 $7.77\text{E-}3$ 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 WCS 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

WCS will establish a Radiological Environmental Monitoring Program (REMP) that will demonstrate compliance with 10 CFR 72.104. Details of this program are described in Section 9.6.2.

In establishing the environmental monitoring program for SNF storage, WCS will build upon its current monitoring program for its existing 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.

WCS uses the Luxel+ Ta (beta/photon/neutron) dosimeter for area monitoring under the radiation safety area monitoring program and the Landauer Inlight® Environmental X9 (beta/photon) dosimeter for perimeter environmental monitoring program. Environmental boundary air monitoring (i.e., Low Volume air sampling and High Volume air sampling) will be performed at a minimum of two locations in addition to the locations currently performed under the REMP. Analyses will be for air particulate (gross alpha/beta and gamma spectrometry), H-3, and air cartridges (Kr-85, C-14, and I-129), and performed by a certified offsite laboratory.

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 4.83E-14 mrem/hr. With continuous occupancy of 8,760 hours per year, the total dose is 4.23E-10 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. WCS 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 site make transport of radioactive materials through an aquifer not credible. The WCS site 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 site is separated from that aquifer by the Dockum Formation, consisting of low permeability clays (1×10^{-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.

WCS will perform periodic surveys per WCS approved procedures for direct alpha/beta/gamma/neutron measurements and removable contamination swipes. The swipes will be processed on WCS calibrated gas flow proportional gross alpha/beta counters, WCS 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 AREVA TN Document, NUH09.101 Rev. 17, “NUHOMS[®]-MP197 Transportation Package Safety Analysis Report.” (Basis for NRC CoC 71-9302).
- 9-2 AREVA TN Document NUH-05-151 Rev. 17, “NUHOMS[®]-MP187 Multi-Purpose Transportation Package Safety Analysis Report.” (Basis for NRC CoC 71-9255).
- 9-3 “Rancho Seco Independent Spent Fuel Storage Installation, Final Safety Analysis Report, Volume I, ISFSI System,” NRC Docket No. 72-11, Revision 4.
- 9-4 AREVA TN Document NUH-003, Revision 14, “Updated Final Safety Analysis Report for the Standardized NUHOMS[®] Horizontal Modular Storage System for Irradiated Nuclear Fuel.” (Basis for NRC CoC 72-1004).
- 9-5 AREVA TN Document, ANUH-01.0150, Revision 6, “Updated Final Safety Analysis Report for the Standardized Advanced NUHOMS[®] Horizontal Modular Storage System for Irradiated Nuclear Fuel, NRC Docket No. 72-1029.
- 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 International, “NAC Multipurpose Cask Final Safety Analysis Report,” Revision 10, CoC 1025 Revision 6, USNRC Docket Number 72-1025.
- 9-10 NAC International, “Final Safety Analysis Report for the UMS Universal Storage System,” Revision 10, CoC 72-1015 Revision 5, USNRC Docket Number 72-1015.
- 9-11 NAC International, “MAGNASTOR[®] Final Safety Analysis Report,” Revision 6, CoC 1031 Revision 4, USNRC Docket Number 72-1031.
- 9-12 NRC Spent Fuel Project Office, Interim Staff Guidance, ISG-5, Rev. 1, “Confinement Evaluation.”
- 9-13 Proposed SNM-1050, WCS *Consolidated* Interim Storage Facility Technical Specifications, Amendment 0.
- 9-14 *Section 4.2.12.2, Operations, of the NEF Environmental Report, Revision 4, April 2005.*
- 9-15 *NAC International, 2015. Scoping Evaluation for WCS, Site Boundary Dose Rate Evaluation, Prepared by John Ritchie, August 28, 2015.*
- 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%	0.000E+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	1.100E-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	0.000E+00	0%	0.000E+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		
	<i>GTCC Canister</i>		
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		
	<i>GTCC-Canister-CY</i>		
	<i>GTCC-Canister-YR</i>		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.9
	<i>GTCC-Canister-MY</i>		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.9
	<i>GTCC-Canister-ZN</i>		

**Table 9-5
Dose Rates around the WCS CISF**

Detector	Coordinates (ft)		Dose Rate (mrem/hr)						
	Easting	Northing	Gamma	Neutron	(n,γ)	Total	σ	Direct	Skyshine
<i>General Area</i>									
D1	562321.81	6878484.76	4.64E-01	3.98E-02	1.85E-03	5.06E-01	1%	1.38E-01	3.68E-01
D2	562485.67	6878849.66	1.61E-01	1.36E-02	7.76E-04	1.76E-01	2%	3.76E-02	1.38E-01
D3	562649.54	6879214.55	5.17E-02	3.59E-03	2.67E-04	5.56E-02	4%	9.20E-03	4.64E-02
D4	562813.40	6879579.45	1.46E-02	1.09E-03	1.21E-04	1.58E-02	2%	2.61E-03	1.32E-02
D5	562989.56	6879971.71	4.65E-03	3.04E-04	4.64E-05	5.00E-03	5%	7.48E-04	4.25E-03
D6	563655.49	6879672.66	6.12E-03	4.44E-04	6.79E-05	6.63E-03	3%	9.24E-04	5.70E-03
D7	564066.00	6879488.31	5.42E-03	3.51E-04	5.31E-05	5.83E-03	2%	9.19E-04	4.91E-03
D8	564476.50	6879303.96	3.96E-03	2.10E-04	4.12E-05	4.21E-03	3%	6.97E-04	3.51E-03
D9	565142.44	6879004.91	1.22E-03	6.08E-05	1.82E-05	1.30E-03	2%	2.17E-04	1.08E-03
D10	564966.28	6878612.65	2.95E-03	2.02E-04	3.14E-05	3.19E-03	5%	4.76E-04	2.71E-03
D11	564802.42	6878247.75	6.14E-03	3.66E-04	4.77E-05	6.55E-03	4%	9.52E-04	5.60E-03
D12	564638.55	6877882.85	9.26E-03	6.49E-04	8.67E-05	1.00E-02	2%	1.45E-03	8.54E-03
D13	564474.69	6877517.96	1.07E-02	9.00E-04	9.19E-05	1.17E-02	2%	1.12E-03	1.06E-02
D14	563481.03	6877087.22	8.38E-02	6.73E-03	4.29E-04	9.09E-02	2%	7.90E-03	8.30E-02
D15	563070.52	6877271.57	2.49E-01	2.28E-02	1.34E-03	2.73E-01	1%	1.17E-02	2.62E-01
D16	562660.01	6877455.92	4.23E-01	4.00E-02	2.26E-03	4.65E-01	1%	2.67E-02	4.38E-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*

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

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)
<i>Sundance Services</i>	<i>WCS Operations</i>	$<6.3 \times 10^{-3}$ (<0.63) ^b	$<1 \times 10^{-7}$ ($<1 \times 10^{-5}$) ^c	$<6.3 \times 10^{-3}$ (<0.63)
	<i>WCS CISF</i>	N/A	5.7×10^{-5} (5.7×10^{-3}) ^d	5.7×10^{-5} (5.7×10^{-3})
	<i>NEF</i>	2.6×10^{-5} (2.6×10^{-3})	0.026 (2.6)	0.026 (2.6)
<i>Permian Basin Materials (Formerly Wallach Concrete)</i>	<i>WCS Operations</i>	$<6.3 \times 10^{-3}$ (<0.63) ^b	$<1 \times 10^{-7}$ ($<1 \times 10^{-5}$) ^c	$<6.3 \times 10^{-3}$ (<0.63)
	<i>WCS CISF</i>	N/A	2.3×10^{-6} (2.3×10^{-4}) ^d	2.3×10^{-6} (2.3×10^{-4})
	<i>NEF</i>	2.2×10^{-5} (2.2×10^{-3})	0.021 (2.1)	0.021 (2.1)
<i>Nearest Receptor</i>	<i>WCS Operations</i>	$<6.3 \times 10^{-3}$ (<0.63) ^b	$<1 \times 10^{-7}$ ($<1 \times 10^{-5}$) ^c	$<6.3 \times 10^{-3}$ (<0.63)
	<i>WCS CISF</i>	N/A	$<1 \times 10^{-6}$ ($<1 \times 10^{-4}$) ^d	$<1 \times 10^{-6}$ ($<1 \times 10^{-4}$)
	<i>NEF</i>	1.3×10^{-5} (1.3×10^{-3})	$<1 \times 10^{-6}$ ($<1 \times 10^{-4}$)	$<1.3 \times 10^{-5}$ ($<1.3 \times 10^{-3}$)
<i>NEF</i>	<i>WCS Operations</i>	$<6.3 \times 10^{-3}$ (<0.63) ^b	$<1 \times 10^{-7}$ ($<1 \times 10^{-5}$) ^c	$<6.3 \times 10^{-3}$ (<0.63)
	<i>CISF</i>	N/A	$<1 \times 10^{-6}$ ($<1 \times 10^{-4}$) ^d	$<1 \times 10^{-6}$ ($<1 \times 10^{-4}$)
	<i>NEF</i>	1.7×10^{-4} (1.7×10^{-2})	<0.2 (<20)	<0.2 (<20)
<i>Lea Co Landfill</i>	<i>WCS Operations</i>	$<6.3 \times 10^{-3}$ (<0.63) ^b	$<1 \times 10^{-7}$ ($<1 \times 10^{-5}$) ^c	$<6.3 \times 10^{-3}$ (<0.63)
	<i>CISF</i>	N/A	$<1 \times 10^{-6}$ ($<1 \times 10^{-4}$) ^d	$<1 \times 10^{-6}$ ($<1 \times 10^{-4}$)
	<i>NEF</i>	$<1.7 \times 10^{-4}$ ($<1.7 \times 10^{-2}$)	<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

^c Based on attenuation of gamma dose rate as a function of distance for the CISF, see footnote d

^d Based on extrapolation of the attenuation in gamma dose rate as a function of distance provided in NAC International (2015)

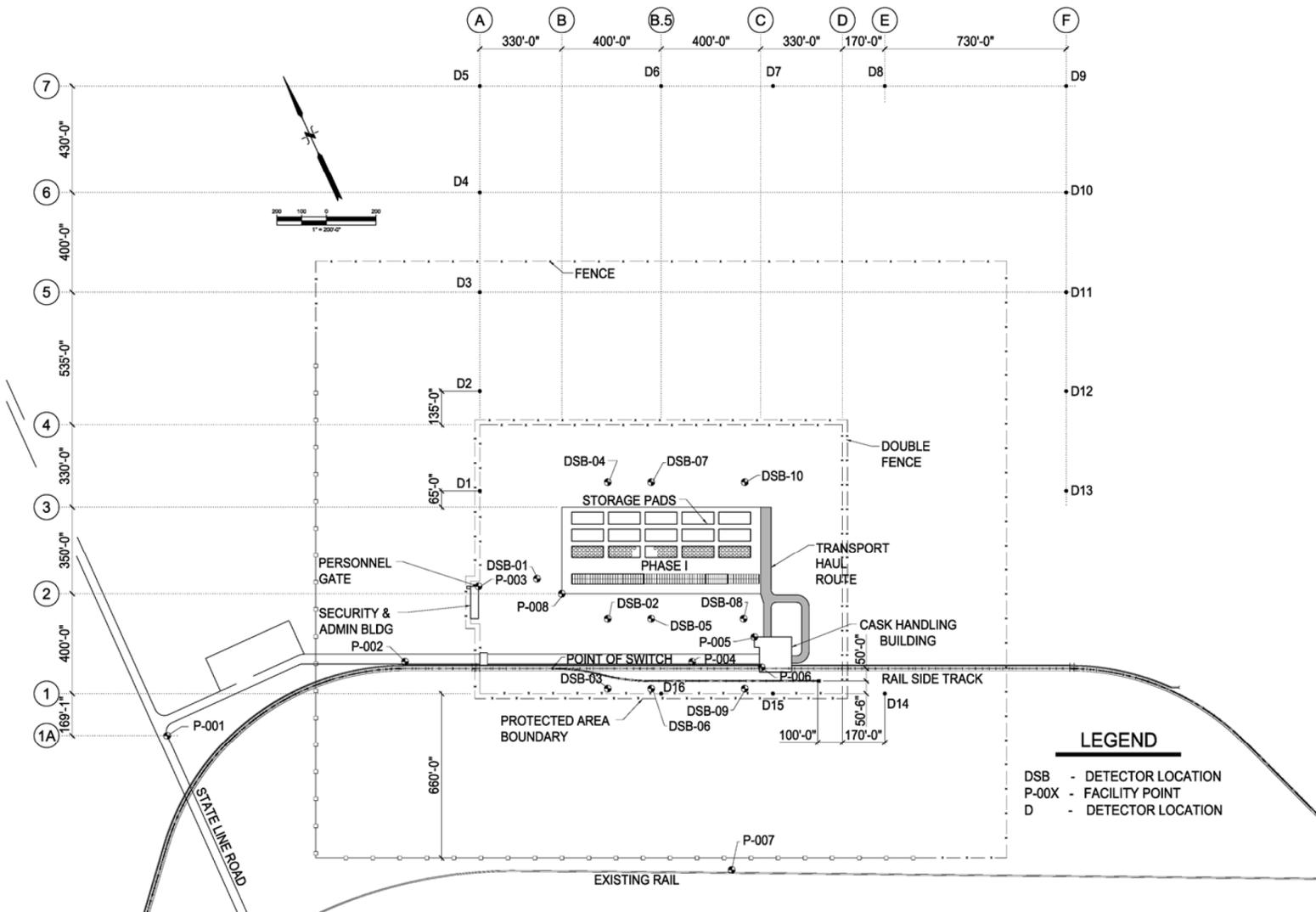


Figure 9-1
WCS CISF Conceptual Plan

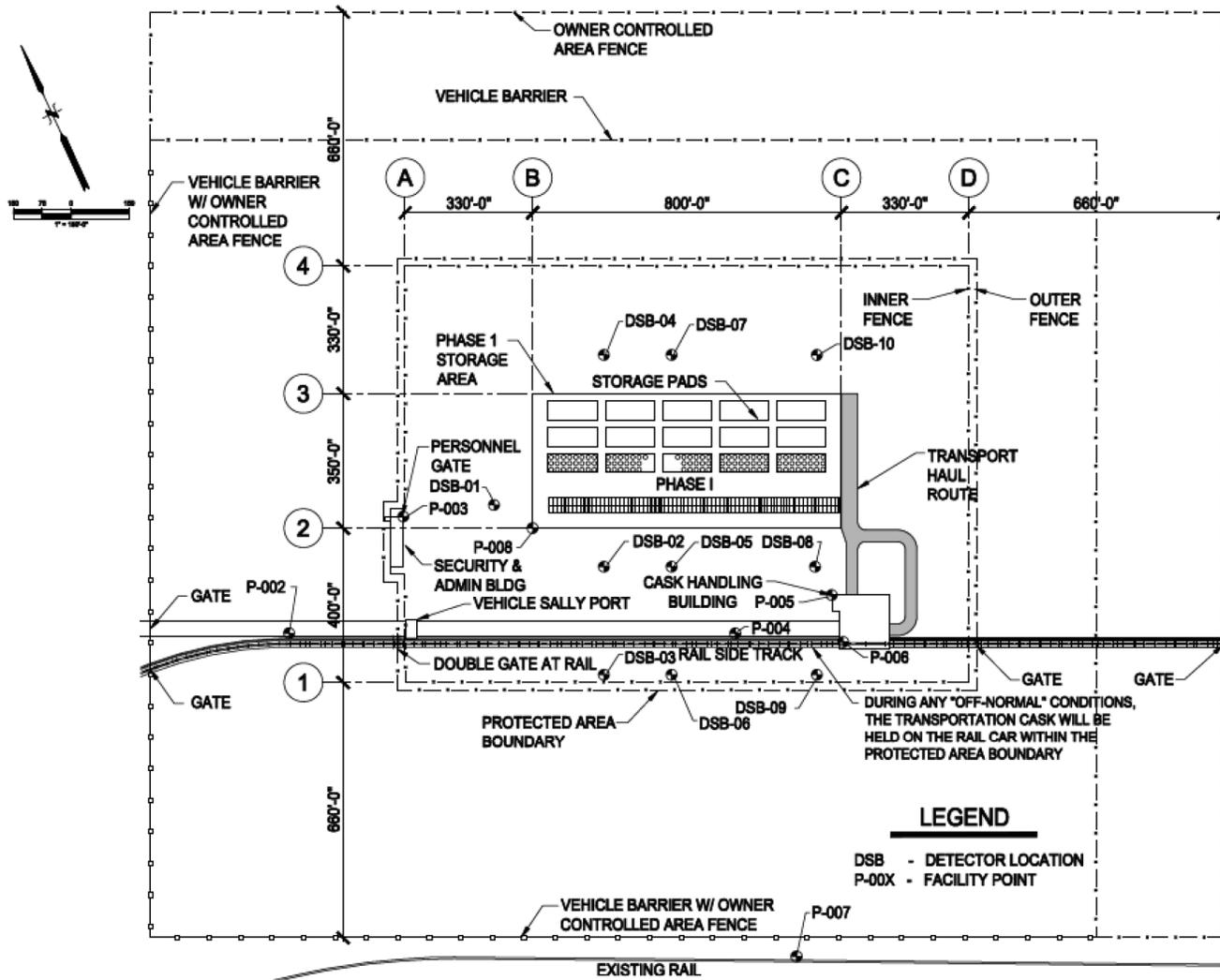


Figure 9-2
 WCS CISF Plan, Phase 1

Figure 9-3
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Figure 9-4
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Figure 9-5
WCS CISF Receptors and Source of Radiation in the Region of Interest

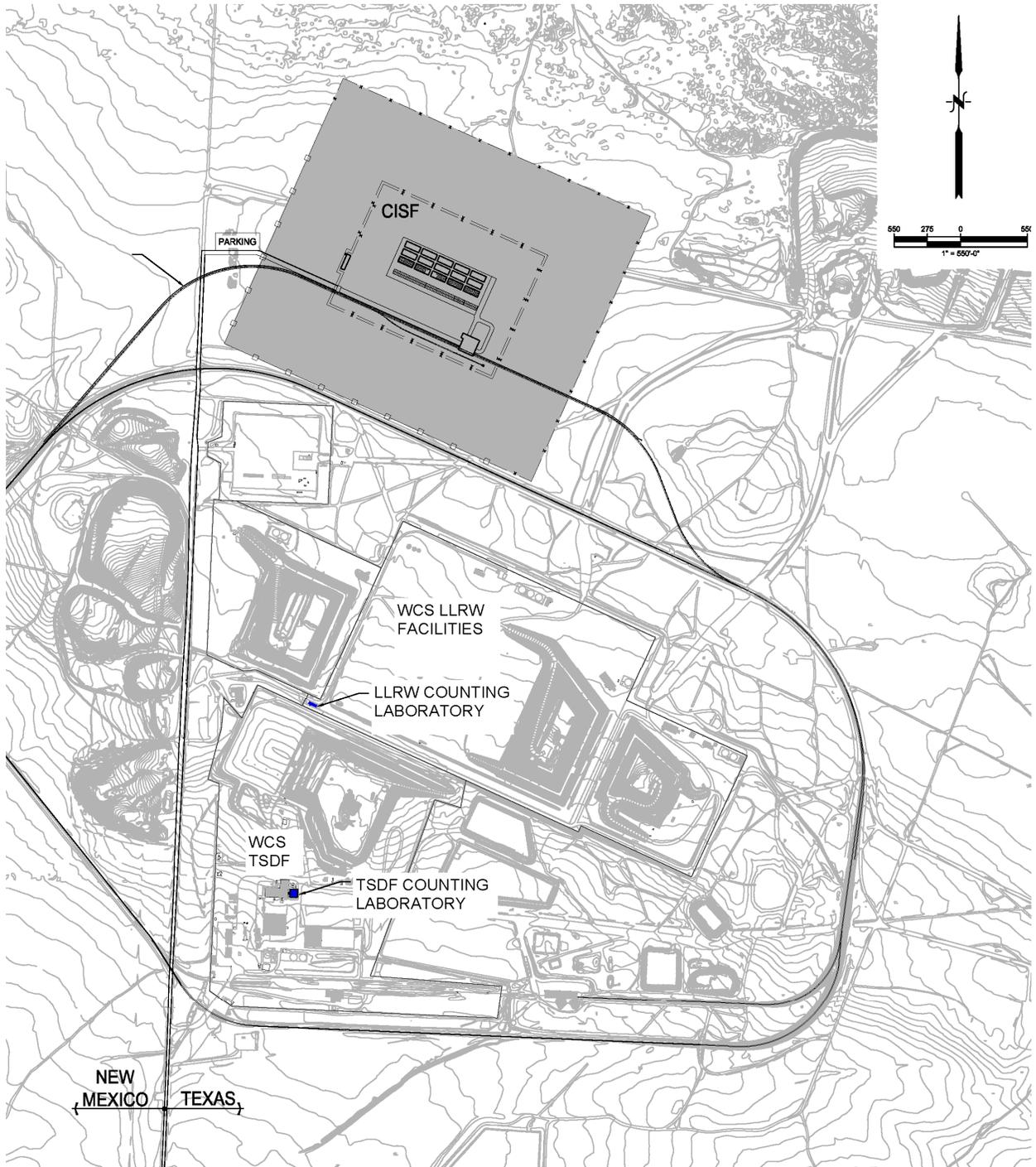
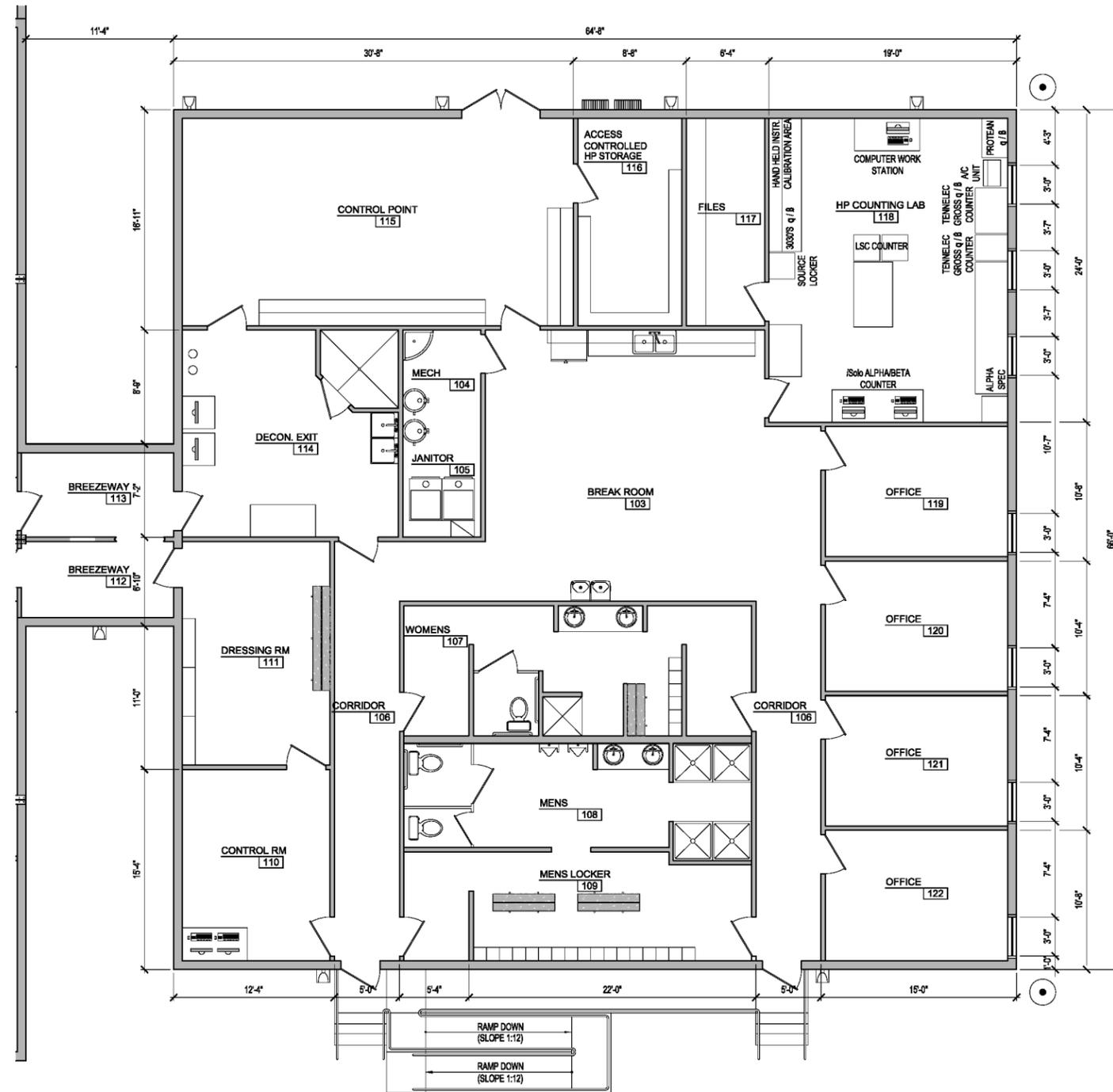
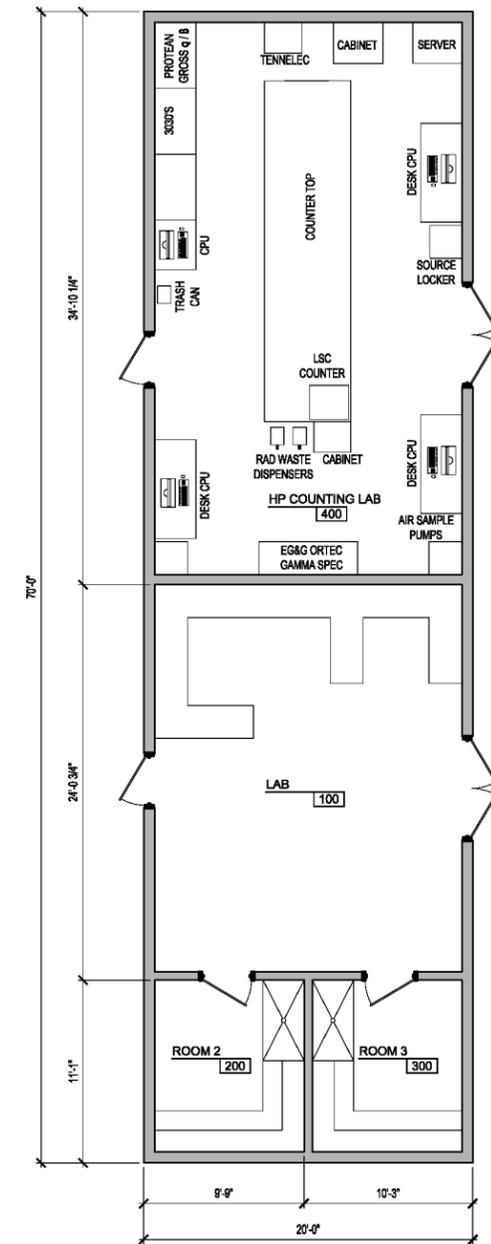


Figure 9-6
WCS Shared Laboratory Locations



TSDF Counting Laboratory Building



LLRW Counting Lab Building

Figure 9-7
Shared Laboratory Facilities

**CHAPTER 10
CRITICALITY EVALUATION**

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10. CRITICALITY EVALUATION

Storage and transportation cask systems received at the Waste Control Specialists, LLC (WCS) Consolidated Interim Storage Facility (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 site 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 Proposed SNM-1050, WCS *Consolidated* Interim Storage Facility Technical Specifications, Amendment 0. |

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 Waste Control Specialists, LLC (WCS) Consolidated Interim Storage Facility (CISF) are designed to ensure confinement of stored materials under normal, off-normal, and accident conditions during all operations, transfers, and storage. *In addition, the confinement boundary of each canister type authorized for storage at the WCS CISF is evaluated to demonstrate that loads during normal conditions of transport do not exceed ASME B&PV Subsection NB Article NB-3200 (Level A allowables) to ensure that the confinement boundary of the canisters is not adversely impacted during transport to the WCS CISF.* This chapter summarizes the system design features that ensure radiological releases are within limits and will remain As Low As Reasonably Achievable (ALARA), and that spent nuclear fuel (SNF) cladding and SNF assemblies are protected from degradation during storage.

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} std-cm³/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} std-cm³/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 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 addition, the License Condition 20 requires that the CoC 1004 aging management program (AMP) be incorporated in this WCS CISF license for the NUHOMS[®] Systems upon approval by the NRC. Similarly, License Condition 20 requires that as the AMPs for the NAC International systems are approved by the NRC, these also are incorporated into this WCS CISF license. The AMPs are applied based on the age of the canister when it was originally loaded under the applicable Site Specific or General License at the site of origin.

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

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

11.6 References

- 11-1 Proposed SNM-1050, WCS *Consolidated* Interim Storage Facility Technical Specifications, Amendment 0. |
- 11-2 “Post Transport Package Evaluation,” QP-10.02, Revision 1. |

**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		
	<i>GTCC Canister⁽¹⁾</i>		
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		
	<i>GTCC-Canister-CY⁽¹⁾</i>		
	<i>GTCC-Canister-YR⁽¹⁾</i>		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.11
	<i>GTCC-Canister-MY⁽¹⁾</i>		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.11
	<i>GTCC-Canister-ZN⁽¹⁾</i>		

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

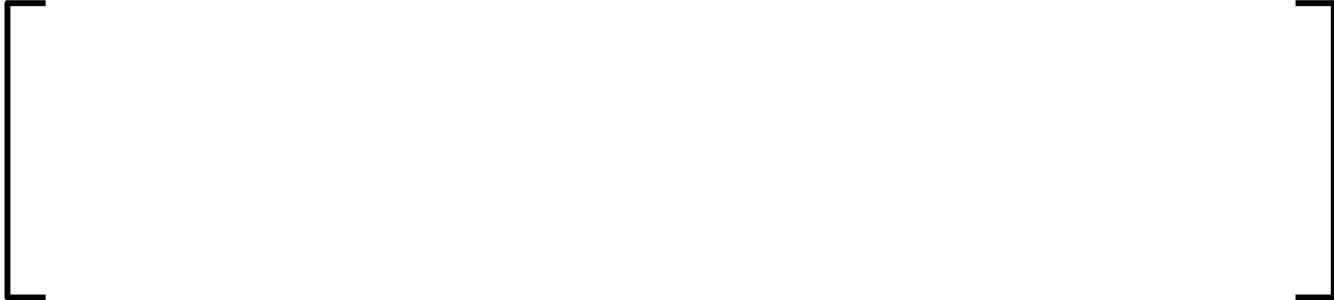
- *Adiabatic Heat Up/Blockage of Air Inlets/Outlets (Also see Section 12.2.3)*
- Drop Accidents
- Earthquakes
- Lightning
- Fire/Explosion
- Flood
- Tornado Wind and Missiles
- Tip Over/ Overturning

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



12.2.1.1 Cause of Fire



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

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 WCS is a uranium enrichment facility, URENCO, and the distance is approximately 7,277 feet from the interior fence of the CISF to the closest building. The process used is a physical rather than a chemical process, and no chemical reactions are initiated although process hazards include possible chemical reactions in some accident scenarios. Some chemical reactions that may take place at URENCO are controlled by utility systems that decontaminate equipment and remove contaminants from effluent streams and lubricating oil [12-4]. Process Hazards identified by URENCO include radioactivity and toxicity of UF₆ 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 (5th percentile). Figure 3.7-1 of the URENCO ISA shows corresponding doses as a function of distance from the criticality site, and since the WCS CISF is over 2,000 meters from the URENCO facility, the results indicate that the consequences of a postulated criticality event upon members of the public at or beyond the site boundary would be considerably below the threshold for an intermediate consequence event, as defined by 10 CFR 70.61 [12-4].

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

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

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

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

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

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

12.2.3 Adiabatic Heat Up/Blockage of Air Inlets/Outlets

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

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

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

- a. Section 5.4.1.1 of NUREG -1567 – “For a site-specific ISFSI, the application may involve use of a cask certified under 10 CFR 72, Subpart L, including the SAR for the certified cask system by reference. Additional information relating to the cask should also be provided, including the applicant’s evaluations that establish that site parameter limits are within the bounds of those established as limiting conditions as set forth in the Certificate of Compliance.”*
- b. Section 6.5.1.2 of NUREG -1567 – “The reviewer should evaluate the thermal performance of the cask in accordance with Chapter 4 of NUREG-1536.” (Section 4.5.4.5 of NUREG-1536 addresses adiabatic heatup.)*
- c. Section 6.5.1.1 of NUREG -1567 – “The reviewer should verify that technical specifications relating to heat removal capability have been included in the technical specification chapter of the SAR.”*

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

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

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

12.3 References

- 12-1 NRC Regulatory Guide 3.48, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)," Rev. 1.
- 12-2 American National Standards Institute, American Nuclear Society, ANSI/ANS 57.9 1984, Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type).
- 12-3 Proposed SNM-1050, WCS *Consolidated* Interim Storage Facility Technical Specifications, Amendment 0.
- 12-4 *Louisiana Energy Services, "Integrated Safety Analysis Summary," Revision 4, 2005.*
- 12-5 *NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," Revision 0, U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, March 2000.*
- 12-6 *NUREG-1536, "Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility," Revision 1, U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, July 2010.*

**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	HSM (Model 80)	Appendix A.12
	FC-DSC		
	FF-DSC		
	<i>GTCC Canister</i>		
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	VCC	Appendix E.12
	Connecticut Yankee		
	LACBWR		
	<i>GTCC-Canister-CY</i>		
NAC-UMS	Classes 1 through 5	VCC	Appendix F.12
	<i>GTCC-Canister-MY</i>		
MAGNASTOR	TSC1 through TSC4	CC1 through CC4	Appendix G.12
	<i>GTCC-Canister-ZN</i>		

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 Waste Control Specialists LLC (WCS) Consolidated Interim Storage Facility (CISF). Included are descriptions of organizational structure, personnel responsibilities and qualifications, interface with contractors and other outside organizations.

WCS has provided in the CISF application the following plans as required by 10 CFR Part 72:

- *The Quality Assurance Plan, “Quality Assurance Program for Consolidated Interim Spent Fuel Storage Facility and Packaging and Transport of Radioactive Materials,” QAPD-400, Revision 2 (WCS SAR Chapter 13 Section 13.8, Reference 13-2).*
- *The Emergency Response Plan, WCS ERP-100, Draft Consolidated Emergency Response Plan, 3-15-2017.*
- *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, WCS’ Radiation Safety Plan and Environmental Monitoring Program are described in Chapter 9 of the WCS 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 was managed by Waste Control Specialists LLC with support from AREVA Inc. (AREVA) and NAC International. Final responsibility for construction, preoperational testing, startup and operation of the WCS CISF remains with WCS. Therefore, *WCS’* organization and its interfaces with outside support organizations are described herein.

13.1 Organizational Structure

Contran is a holding company that owns stakes of varying sizes in subsidiaries, including the largest, Valhi, Inc. (a publicly traded company about 93% controlled by Contran). Primarily through Valhi, the company has stakes in diversified operations in chemicals; waste management (Waste Control Specialists); computer support systems, precision ball bearing slides and security products.

Valhi, operating through subsidiaries, includes companies manufacturing ergonomic computer support systems and office security products, titanium metal products for the aerospace and other markets and Waste Control Specialists - operator of hazardous-waste treatment facilities in Texas.

Waste Control Specialists LLC (WCS) operates West Texas facilities for the processing, treatment, storage and disposal of a range of low-level radioactive, hazardous, toxic and other wastes. The West Texas site includes a Resource Conservation and Recovery Act (RCRA) Subtitle C landfill for the disposal of hazardous and low-activity radiological wastes, a byproduct disposal facility and an LLRW disposal facility licensed to accept waste from nuclear power plants and federal generators such as the Department of Energy (DOE). WCS is one of only three private companies in the United States licensed to dispose of LLRW waste.

The WCS organization at the time of filing of the license application consists of WCS corporate personnel, WCS CISF personnel, as well as contracted support for engineering, design and operations, public affairs and other necessary expertise.

WCS established contracted support in several functional work areas to manage and accomplish needed tasks to prepare this license application and associated reports. WCS will name additional position titles and hire 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*, WCS *expects to* enter into a contract(s) with the DOE 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 will be the sole customer 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, where ever SNF is mentioned, this included both SNF and GTCC wastes.) DOE will obtain adequate funding for this contract from the Nuclear Waste Fund, as authorized by Congress. This funding will demonstrate the necessary financial capabilities for construction, operation, and decommissioning of the WCS CISF.

13.1.1 Corporate Organization

The WCS Chief Executive Officer (CEO)/President, is the executive in charge of WCS, managing all WCS 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 WCS CEO/President establishes the basic policies of the WCS QA Program. The WCS CEO/President is the highest level of management responsible for the WCS policies, goals, and objectives. Those reporting to the WCS CEO/President who have quality affecting responsibilities are the Vice President (VP) Licensing & *Corporate Compliance*, Senior (Sr.) VP/General Manager (Sr. VP/GM) and Director of Quality Assurance (DQA).

The VP Licensing & *Corporate Compliance* is responsible for the facility's license and has the authority and reporting responsibility as Responsible Officer associated with 10 CFR Part 21.

The Sr. VP/GM is responsible for the overall operation and administration of the facility.

13.1.1.1 Corporate Functions, Responsibilities, and Authorities

The WCS CEO/President establishes the basic policies of WCS. The WCS CEO/President is the highest level of management and holds the following responsibilities:

- Developing WCS 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
- Ensuring license standards for engineering and design, construction, QA, testing and operation are met through oversight by Corporate Staff, expert consultants reporting directly to the VP Licensing & *Corporate Compliance*, and the WCS CISF QA personnel.

The VP Licensing & *Corporate Compliance* reports directly to the WCS CEO/President and is responsible for preparation and submittal of the WCS 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 VP Licensing & *Corporate Compliance* has the authority and reporting responsibility as Responsible Officer associated with 10 CFR Part 21.

The Chief Financial Officer reports directly to the WCS CEO/President and is responsible for managing budgets, payroll, cash flows, and financial security.

The VP Legal Services reports directly to the WCS Sr. VP/GM and serves as the WCS/CISF liaison with the NRC and other organizations on all legal matters. The WCS CEO/President is responsible for ensuring that the project's legal activities are consistent with the policies established by the WCS CEO/President.

The Director of Engineering reports to the VP Operations and is responsible for all design control and configuration management activities associated with structures, systems and components considered important-to-safety (ITS).

The Director of Logistics and Transportation reports to the Sr. VP Planning and Business Development and 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)*.

13.1.1.2 Applicant's In-House Organization

Figure 13-1 illustrates the organizational structure of WCS. The Sr. VP/GM reports directly to the WCS CEO/President and is responsible for the overall operation and administration of the facility. The Sr. VP/GM 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.

The VP Operations reports to the Sr. VP/GM and is responsible for scheduling of project personnel, WCS CISF work activities, operations, maintenance, project management functions and reporting performance data to the Sr. VP/GM as well as responsibilities over WCS CISF engineering activities.

The DQA reports directly to the WCS 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
- Periodically reporting to the WCS CEO/President and the Sr. VP/GM 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
- 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 Radiation Safety Officer (RSO)/Director of Health and Radiation Safety is responsible for ensuring compliance to WCS' Radioactive Materials License(s) along with State and Federal regulations related to radiological safety and therefore reports to the Sr. VP/GM and has a direct line of communication to the WCS 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 Safety Manager reports to the RSO/Director of *Health and* Radiation Safety and is responsible for managing the Industrial Health and Safety program to protect employees and the company and maintain safe working conditions. The *Health and* Safety Manager ensures that all industrial safety programs meet compliance and reporting requirements of federal and state regulations, works with the Radiation Safety Department in promoting the nuclear culture throughout the WCS CISF, and coordinates compliance functions to ensure all safety issues are resolved and that all compliance matters are maintained as prescribed by OSHA.

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.

The Training Manager reports to the Sr. VP/GM and is responsible for staff training and improvement initiatives focused on improving performance across the WCS organization.

The Manager of Facility Compliance reports to the VP Licensing & *Corporate Compliance* and has the day-to-day responsibility of managing compliance with all WCS CISF licensing requirements.

13.1.1.3 Interrelationships with Contractors and Suppliers

As facility owner and licensee, WCS will retain ultimate responsibility for the safe operation of the facility and for compliance with all license conditions. AREVA is the prime contractor for the design, development, construction, operation, and maintenance of the WCS CISF. As the construction contractor for the WCS CISF, AREVA will provide an acceptable construction quality assurance program (CQAP) to WCS. WCS 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.).

WCS 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.
- 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.

WCS control of contractors and suppliers is established before award or purchase by use of WCS or sub-tier procurement documents, which specify applicable technical, regulatory, administrative, quality, and reporting requirements. WCS procurement documents require suppliers to pass on appropriate QA program requirements to sub-tier suppliers.

At the proper time, WCS operations management will hire or appoint an individual to fill the role of Construction Manager. During construction of the WCS CISF, the Construction Manager will oversee the installation in accordance with QA requirements. The Construction Manager will perform the oversight role on a daily basis. The Construction Manager will report to the Director of Engineering who in turn reports to the VP Operations. WCS 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 WCS 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 WCS Andrews County Site and corporate personnel, prime contractor AREVA, sub-contractors and licensing consultants. The staff that supports WCS 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.

AREVA will provide to WCS 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 WCS personnel prior to construction. The actual qualifications, training and experience of the WCS 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 WCS organization and the prime contractor 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.

WCS administrative staff common to the adjacent site facilities will be responsible for many of the administrative requirements of the WCS CISF, including the maintenance of records in accordance with conditions of the License. WCS 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 WCS staff members. Contractors may maintain their own personnel functions, services and records, periodically transferring custody of operating records to WCS as required.

13.1.2.1.1 Safety Review Committee

The WCS CISF Safety Review Committee is responsible for reviewing and advising the WCS 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 WCS CEO/President will designate, in writing, the members and alternates for this committee. The Sr. VP/GM 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
- 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 WCS 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 WCS CEO/President on matters related to the safe storage of SNF.
- Notify the WCS CEO/President of any safety significant disagreement between the Safety Review Committee and the Sr. VP/GM 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.
- Significant audit findings that affect the safe storage of SNF.

Reports or records of these reviews will be forwarded to the WCS 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 Sr. VP/GM reports directly to the WCS CEO/President and is responsible for the safe overall operation and administration of the facility. The Sr. VP/GM 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.

The VP Operations reports to the Sr. VP/GM and is responsible for scheduling of project personnel, WCS CISF work activities, operations, maintenance, project management functions and reporting performance data to the Sr. VP/GM as well as responsibilities over WCS CISF engineering activities.

The WCS CISF Director of Operations will report directly to the VP Operations, and will be 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 WCS CISF Director of Operations 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 WCS CISF Director of Operations will designate in writing personnel who are qualified to act as the WCS CISF Director of Operations during an absence.

The Director of Engineering reports to the VP Operations and is responsible for all design control and configuration management activities associated with structures, systems and components considered ITS.

The DQA has the responsibility and authority for developing, maintaining and verifying proper implementation of the QA Program. Each organization within WCS is responsible for implementation of the program for their respective scope of responsibility. The DQA reports to the WCS 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 WCS CEO/President.

The RSO/Director of Health and Radiation Safety is responsible for ensuring compliance to WCS' Radioactive Materials License(s) along with State and Federal regulations related to radiological safety and therefore reports to the Sr. VP/GM and has a direct line of communication to the WCS 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 ensuring implementation of the Radiation Safety Program at the WCS CISF. These duties 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 Sr. VP/GM. The Facility Security Officer/Security Manager and security staff personnel will be responsible for WCS CISF security during routine, emergency and contingency operations.

The Health and Safety Manager reports to the RSO/Director of Health and Radiation Safety and implements WCS CISF Health and Safety programs and procedures. This includes safety training and maintaining the performance of the facility's fire protection systems.

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 WCS CISF Director of Operations reports directly to the VP Operations. The WCS CISF Director of Operation'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 WCS CISF Director of Operations 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 WCS CISF Director of Operations 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 WCS CISF Director of Operations 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 WCS 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 WCS 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 WCS 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 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 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 Manager of Facility Compliance reports to the VP Licensing & *Corporate Compliance* and shall have, as a minimum, a Bachelor's degree (or equivalent) in an engineering, or scientific field and a minimum of five years of appropriate, responsible experience in implementing and supervising a nuclear licensing and regulatory compliance program.

The Director of Engineering reports directly to the VP Operations. The Director of Engineering qualifications include, as a minimum, a Bachelor's degree in engineering and 10 years of responsible nuclear facility experience providing engineering services and at least three (3) years supervising an engineering department. Relevant experience in a highly regulated industry is required. The Director of Engineering shall also be a Registered Professional Engineer in the state designated to host the WCS CISF.

The RSO/Director of Health and Radiation Safety reports to the Sr. VP and is responsible for ensuring compliance to WCS' 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 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 Health and Safety Manager reports to the RSO/Director of Health and Radiation Safety and shall have, as a minimum, a Bachelors degree in Industrial, Occupational or Radiation Safety or a minimum of 60 hours of related college level study and a minimum of 4 years of experience in the field of Industrial or Occupational Safety or equivalent combination of education, training and experience.

The Facility Security Officer/Security Manager reports to the Sr. VP/GM 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 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(I)(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 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 WCS 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 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 WCS 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
- 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 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), WCS 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 WCS 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 WCS

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.

13.3 Training Program

WCS will expand its existing Training Plan, TRN-1.1, to encompass training for the WCS CISF.

13.3.1 Program Description

The objective of the WCS 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. WCS 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 WCS facilities, work processes, regulatory environment and basic safety measures such as the ALARA concept. Among other things, GET covers:

- WCS – History and Summary of Capabilities
- WCS 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 WCS 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
 - WCS 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 operational procedures (additional, separate training is required for procedural qualification),
 - Introduction to WCS 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.

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 WCS 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 facility 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 facility, or assignment to a new job at the facility, 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 WCS 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 facility 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 WCS, 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 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 WCS 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 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 records storage system will provide for the accurate retrieval of information without undue delay. Written instructions regarding the storage of records in the WCS records storage system include, but are not limited to, the following.

- A description of the WCS records storage system location(s) and identification of the location(s) of the various record types within the WCS 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 records storage system
- A method for maintaining control of and accountability for records removed from the WCS 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 WCS QA Program establishes the measures for planned and documented audits to verify compliance and effectiveness with all aspects of the WCS 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 WCS Director of 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 WCS QAPD (Appendix C of the License Application) 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, WCS 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 complete 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, *WCS will follow the process described in Section 1.2.4.2.*

13.4.5 Employee Concerns Program

WCS and its prime 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. WCS 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. WCS 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 other WCS operated facilities*.

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). WCS has 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 LLRW Administration Building, *also within the existing facility boundary*.

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 WCS 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. WCS also has agreements with the Andrews County Sheriff'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 Sheriff'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 WCS and the US DOE will be established prior to receipt of SNF at the WCS CISF. Pursuant to this contract, 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. 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.

13.8 References

- 13-1 Regulatory Guide 1.8, “Qualification and Training of Personnel for Nuclear Power Plants,” Revision 3.
- 13-2 “Quality Assurance Program for Consolidated Interim Spent Fuel Storage Facility and the Packaging and Transport of Radioactive Materials,” QAPD-400, Revision 2.
- 13-3 Proposed SNM-1050, WCS *Consolidated* Interim Storage Facility Technical Specifications, Amendment 0.
- 13-4 *The Emergency Response Plan, WCS ERP-100, Consolidated Emergency Response Plan, 4-19-2016.*

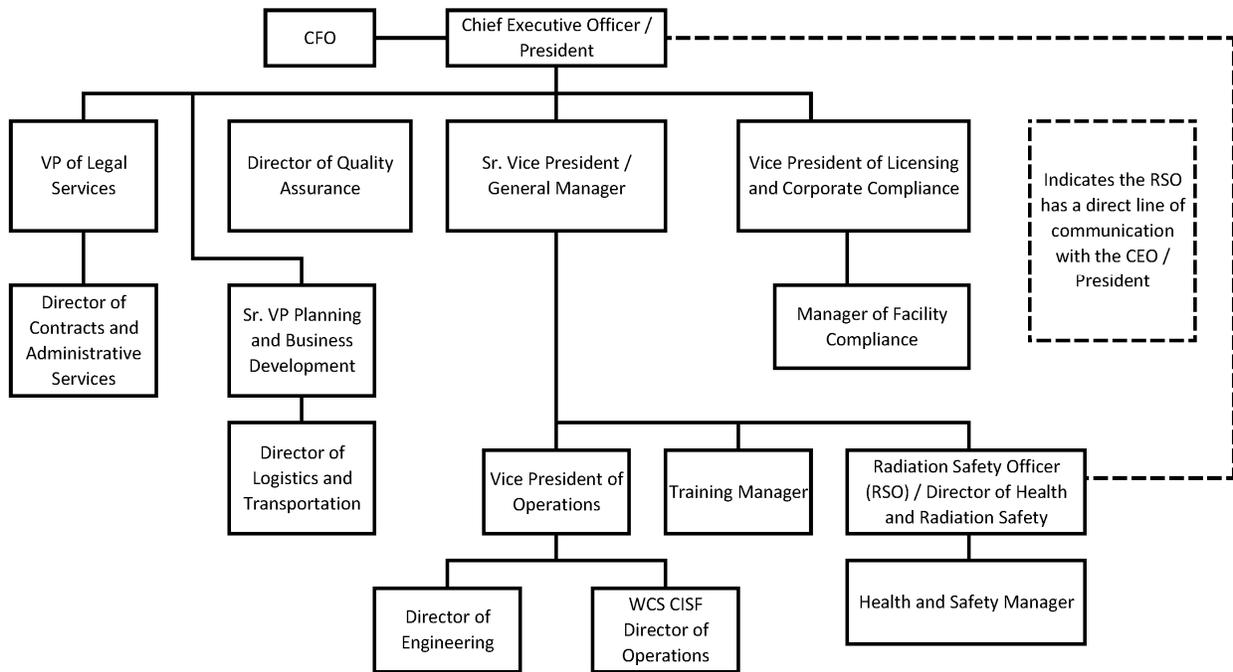


Figure 13-1
WCS Organization Chart

TECHNICAL SPECIFICATION BASES

TECHNICAL SPECIFICATION BASES**TABLE OF CONTENTS**

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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.

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.

BASES

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.

AND**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.

OR

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.

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.

BASES

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.

OR

A.2

The CANISTER shall be placed in a TRANSPORTATION CASK.

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.

AND

 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.

OR

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 MAGNASTOR 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.

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 MAGNASTOR 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.

BASES

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 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.

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) and Canister Transfer System and Vertical Cask Transporter (VCT) operational components at the Waste Control Specialists, LLC (WCS) Consolidated Interim Storage Facility (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

15.2 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.

15.3 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 ($\times 10^6$ psi):	3.605
Coefficient of Thermal Expansion, α ($\times 10^{-6}$ 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 ($\times 10^6$ psi):	29.88
Coefficient of Thermal Expansion, α ($\times 10^{-6}$ 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
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	Yield Strength (ksi):	50.0
	Modulus of Elasticity, E ($\times 10^6$ psi):	
	Coefficient of Thermal Expansion, α ($\times 10^{-6}$ in/in/ $^{\circ}$ F)	
	Density (lbm/in ³)	
15.3.2.2	<u>ASTM A514 - CTS Header Plate [15-4]</u>	
	Ultimate Strength (ksi):	110.0
	Yield Strength (ksi):	100.0
15.3.2.3	<u>ASTM A693/564, Type 630 - Lift Pin [15-3]</u>	
	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 ($\times 10^{-6}$ in/in/ $^{\circ}$ F)	5.9
	Density (lbm/in ³)	0.29
15.3.2.4	<u>ASTM A516, Gr 70 - Canister Adapter Plate [15-3]</u>	
	Ultimate Strength (ksi):	70.0
	Yield Strength (ksi):	38.0
	Modulus of Elasticity, E ($\times 10^6$ psi):	29.2
	Coefficient of Thermal Expansion, α ($\times 10^{-6}$ in/in/ $^{\circ}$ F)	6.4
	Density (lbm/in ³)	0.284
15.3.2.5	<u>ASTM A574, Gr 70 - Canister Adapter Plate Bolts [15-3]</u>	
	Ultimate Strength (ksi):	170.0
	Yield Strength (ksi):	135.0
15.3.2.6	<u>ASTM A325 - Bolts [15-1]</u>	
	Ultimate Strength (ksi):	120.0
	Yield Strength (ksi):	92.0
15.3.2.7	<u>ASTM A311, Class B - Pins [15-2]</u>	
	Ultimate Strength (ksi):	170.0
	Yield Strength (ksi):	135.0
15.3.2.8	<u>ASTM A572, Grade 50 [15-1]</u>	
	Ultimate Strength (ksi):	65.0

	Yield Strength (ksi):	50.0
15.3.2.9	<u>ASTM A36 [15-1]</u>	
	Ultimate Strength (ksi):	58.0
	Yield Strength (ksi):	36.0
15.3.2.10	<u>ASTM A490 [15-1]</u>	
	Ultimate Strength (ksi):	150.0
	Yield Strength (ksi):	130.0
15.3.3	<u>Vertical Cask Transporter</u>	
	<p>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.</p>	
15.3.3.1	<u>ASTM A572, Gr. 50 - VCT lift tower [15-3]</u>	
	Values at Temperature (100°F)	
	Ultimate Strength (ksi):	65.0
	Yield Strength (ksi):	50.0
	Modulus of Elasticity, E ($\times 10^6$ psi):	
	Coefficient of Thermal Expansion, α ($\times 10^{-6}$ in/in/°F)	
	Density (lbm/in ³)	
15.3.3.2	<u>ASTM A514 - VCT Header/Lift Link [15-4]</u>	
	Values at Temperature (100°F)	
	Ultimate Strength (ksi):	110.0
	Yield Strength (ksi):	100.0
15.3.3.3	<u>ASTM A693/564, Type 630 - Lift Pin [15-3]</u>	
	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 ($\times 10^{-6}$ in/in/ $^{\circ}$ F)	5.9
Density (lbm/in ³)	0.29

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. 7, 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.