Enclosure 4 to E-55865

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1.2.2 Principal Design Criteria

The WCS CISF principal design criteria are based on the site characteristics, the design criteria associated with the cask systems listed in Table 1-1 that have been previously approved by the NRC, and specific criteria required for the WCS CISF design.

The cask systems listed in Table 1-1 meet the WCS CISF design criteria. Table 1-2 provides a summary of the WCS CISF principal design criteria.

1.2.3 Facility Descriptions

The major facilities at the WCS CISF are the Cask Handling Building and the storage area. The Cask Handling Building is approximately *175* feet long by *193* feet wide by *72* feet high. The building is a two-bay steel structure designed to support two commercial overhead cranes used to move transportation casks from the rail car to the transport vehicle. One bay of the building will house the Canister Transfer System described in Section 1.3.1.2 and the other bay will be available for direct transfer of transportation casks from the rail car to the transport vehicle. A 2,400 square foot area of the building is set aside for cask storage. The building plan view is shown in Figure 1-7. Figure 1-8 is a section through the building showing the overhead crane location. Air monitors and dosimeters are located in the building for monitoring purposes. The building is not designed or intended to provide confinement or shielding for SNF or GTCC materials. The building is classified as ITS - Category *B*. The purpose of the Cask Handling Building is to receive and prepare for storage shipments of dual-purpose canister systems. It will also receive GTCC waste canisters for storage at the site. It is also designed to process canisters stored at the site for off-site shipment. The Cask Handling Building is designed to handle canisterized material and does not have the capability to handle bare fuel.

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As Low As Reasonably Achievable (ALARA) principles are incorporated, to the maximum extent practical, throughout the facility design to reduce radiation exposure to facility personnel. Cranes/lifting devices for transferring the NUHOMS® transportation/transfer casks from the transportation skid to the transfer trailer/skid are designed to minimize the need for facility personnel to be near the loaded cask. This equipment is NITS as the lift heights of the loaded casks are maintained below 80 inches at all times after removal of the impact limiters. The analysis of bounding drop scenarios shows that a NUHOMS® transportation/transfer cask will maintain structural integrity of the DSC confinement boundary and maintain basket geometry from an 80 inch (from the bottom of the cask to the “ground”) drop. The ITS canister transfer system for the vertical transfer of canisters is remotely operated and the transfer equipment used to make the transfer to the storage overpacks is substantially identical to that used to transfer the canister into dry storage at the reactor facilities where the material was initially stored.

1.4 Analysis of Operations

This section provides a summary of the analyses performed for normal operations, off-normal and accident conditions.

1.4.1 Normal Operations – Dose Assessment

ALARA practices and dose reduction techniques are incorporated into the design of the WCS CISF. The receipt and transfer operations incorporate the ALARA principles and operational experience gained from the operations of these NRC licensed cask systems. The calculated operational exposures are very conservative, as the assumed dose rates on and around the transport/transfer casks are assumed to be for design basis transportation sources and the assumed dose rates on and around the storage overpacks are based on design basis source terms in the existing storage FSARs. These storage source terms, in most cases, are much higher than what can be accommodated by the transportation cask and therefore significant decay is required prior to shipment to the WCS CISF.

The maximum calculated occupational exposure for normal transfer operations is 232 person-rem when the 5,000 MTHM and GTCC waste canisters are placed into storage. Chapter 9 and its associated appendices provide a detailed evaluation of occupational exposures.

1.4.2 Normal Operations – Establishment of the Controlled Area (Site) Boundary

An analysis was performed to identify the location of the controlled area boundary to ensure compliance with 10 CFR 72.104 (a) (dose rate ≤ 25 mrem/yr). As noted above, the dose rates assumed on the surface of the storage overpacks are based on the design basis source terms in the licensed storage systems at the reactor sites.

The annual expected yearly dose at the nearest site boundary for the fully loaded (5,000 MTHM plus GTCC waste canisters) WCS CISF is *7.52*E-5 person-rem, including direct radiation (including skyshine) and contributions due to inhalation, submersion and ingestion from non-leak-tight containers. Chapters 9 and 11 and their associated appendices provide a detailed evaluation of site boundary exposures.

1.4.3 Accident Analysis

1.4.3.1 Safety Analysis Process

Chapter 12 and design specific appendices provide analysis for the off-normal and accident conditions for the approved storage systems. Chapter 12 defines the design basis events for each authorized cask system. The WCS CISF Technical Specifications [1-4] complete the design safety basis by defining the operational controls and limits placed on WCS CISF operations and lists the necessary administrative controls or programs established for the site. Chapter 14 provides the basis for the Technical Specifications.

All Indicated Changes are in response to RAI P-9-5

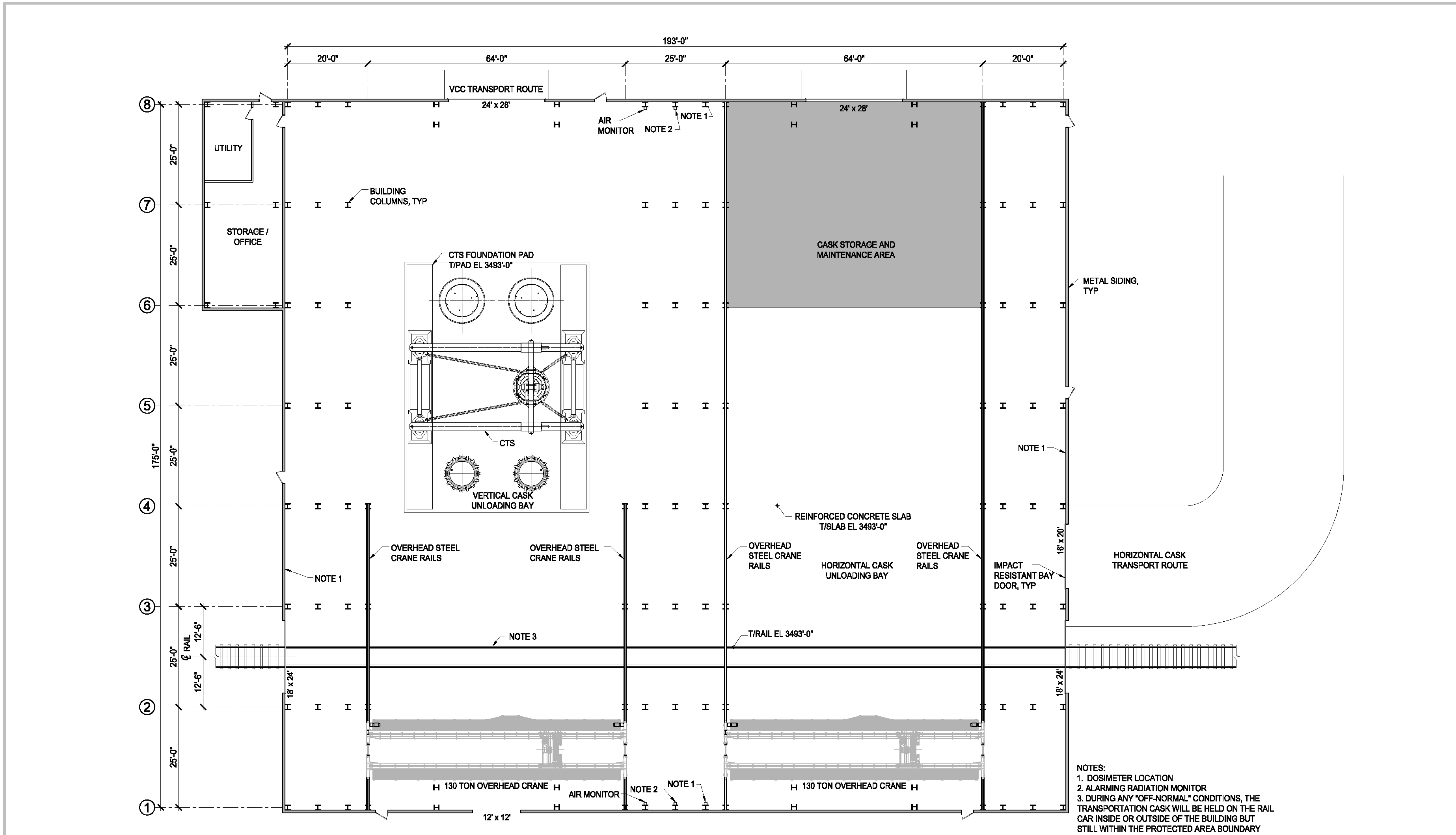

Figure 1-7
Cask Handling Building Plan

All Indicated Changes are in response to RAI NP-7-12

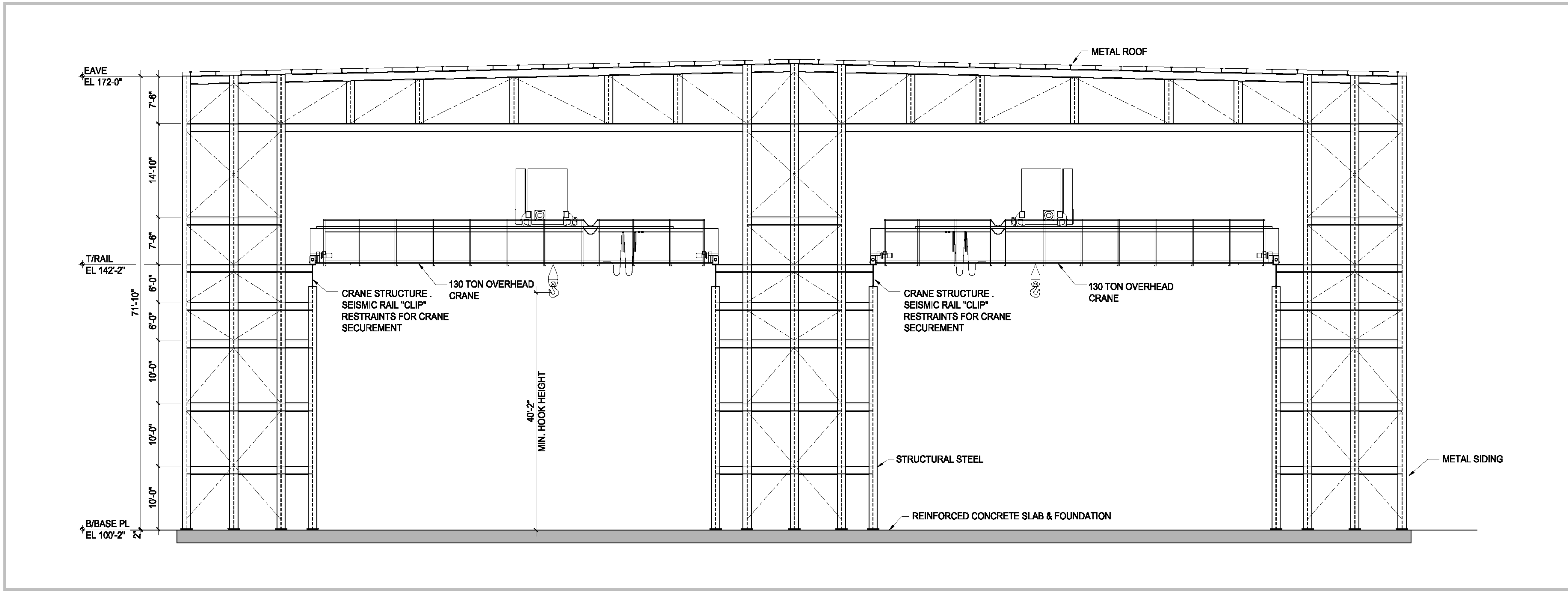

Figure 1-8
Cask Handling Building Section View

3.2.3.10.3 Procedure Used to Lump Masses

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

3.2.3.10.4 Methods Used to Couple Soil with Seismic-System Structures

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

3.2.3.10.5 Methods Used to Account for Torsional Effects

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

3.2.3.10.6 Methods for Seismic Analysis of Dams

There are no dams onsite or in the immediate area.

3.2.3.10.7 Methods to Determine Overturning Moments

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

3.2.3.10.8 Analysis Procedure for Damping

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

3.2.3.10.9 Seismic Analysis of Overhead Cranes

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

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

3.2.3.10.10 Seismic Analysis of Specific Safety Features

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

All Indicated Changes are in response to RAI NP-7-1

3.2.8.1 NUHOMS® and Vertical Cask Systems

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

3.2.8.2 Cask Storage Pad Load Combinations

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

3.2.8.3 Canister Transfer System

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

3.2.8.4 Cask Handling Building Load Combinations

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

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3.2.8.5 Cask Handling Building Foundation

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

3.2.8.6 Cask Handling Building Cranes

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

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

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

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

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

3.4.1 Cask Handling Building Quality Classification

The purpose of the CHB and associated lifting equipment is to receive, inspect and prepare for storage, shipments of canisterized SNF and GTCC waste canisters and to provide for cask and rail car light maintenance. The CTS and associated lifting hardware used for stack up and transfer operations for the NAC canisters is located inside the building. The NUHOMS® MP197HB and MP187 Casks Lift Beam Assembly *is* NITS because the NUHOMS® cask and canister are not lifted above the Technical Specifications [3-1] height limits. The building structure (structural steel and column foundations) is classified as ITS, Category *B* to meet the requirements of 10 CFR 72.122(b)(2)(ii) [3-23] and to prevent massive building collapse onto cask systems and related ITS SSCs. The overhead crane bridge *overhead cranes, runway beams, integral crane structure consisting of the bridge rails, bridge girders, and trucks, as well as the trolley structure and the various drive components* are ITS. The balance of the facility is also NITS as the fuel remains sealed from the environment inside the confinement boundary provided by the canister for all operations and the overpacks provide protection from natural phenomena and postulated off-normal and accident events.

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

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

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

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

3-26 *Not Used*.

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

3-28 *Not Used*.

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

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

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

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

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

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

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

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

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

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

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Notes:

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

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

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

4.7.1.3 Confinement Features

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

4.7.1.4 Function

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

4.7.1.5 Components

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

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

4.7.1.6 Design Bases and Safety Assurance

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

4.7.2 Overhead Bridge Cranes

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

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

4.7.4.1 Vertical Cask Transporter

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

4.7.4.2 Plans and Sections

The VCT is shown in Figure 4-4.

4.7.4.3 Function

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

4.7.4.4 Components

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

4.7.4.5 Design Bases and Safety Assurance

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

4.7.5 CISF Heavy Loads Program

4.7.5.1 Purpose

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

4.7.5.2 Definitions

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

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

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

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

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

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

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

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

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

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

   1. *Cranes: meeting the requirements of NUREG-0554.*

   2. *Special lifting devices: meeting the requirements of ANSI N14.6 (Section 7 Titled – "Special Lifting devices for Critical Loads").*

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

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

   1. *Cranes: meeting the requirements of NUREG-0554.*

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

All Indicated Changes are in response to RAI NP-3-7

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

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

4.7.5.3 Responsibilities

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

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

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

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

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

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

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

3. *Request assistance from Engineering as necessary.*

4. *Follow all invoked Heavy Load Lift procedures.*

D. *Operations:*

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

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

4.7.5.4 Main Body

A. *Personnel Qualification and Certification*

All Indicated Changes are in response to RAI NP-3-7

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

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

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

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

B. *Handling Equipment Certification*

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

All Indicated Changes are in response to RAI NP-3-7

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

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

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

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

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

A. *Handling Equipment Inspection*

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

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

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

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

All Indicated Changes are in response to RAI NP-3-7

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

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

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

B. *Handling Equipment Maintenance*

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

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

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

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

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

C. *Safe Loads Path*

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

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

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

All Indicated Changes are in response to RAI NP-3-7

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

D. Material Properties

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

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

4.7.5.5 Documentation

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

A. Certificates of Load Testing

B. Handling equipment operational test and inspection records

C. Maintenance records

D. Crane operator qualification records

E. Crane operator medical evaluations

All Indicated Changes are in response to RAI NP-3-7

4.7.5.6 Standards

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

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

C. ANSI/ASME B30.9, "Slings"

D. ANSI/ASME B30.10, "Hook"

E. ANSI/ASME B30.16, "Overhead Hoists"

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

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

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

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

Table 4-3
Heavy Load Handling Equipment Certification

HANDLING EQUIPMENT TYPE	***ANSI/ASME STANDARD***
Overhead Cranes	*B30.2*
Mobile Cranes	*B30.5*
Slings and Rigging	*B30.9*
Hooks	*B30.10*
Overhead Hoists	*B30.16*
Below-the-Hook Lifting Devices	*B30.20*
Special Lifting Devices	*N14.6*

All Indicated Changes are in response to RAI NP-3-7

5.1.2 Operations Between the Originating Sites and the WCS CISF

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

5.1.3 Operations at the WCS CISF

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

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

5.1.3.1 Receiving and Dispatch Operations for All Cask/Canister Systems

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

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

All Indicated Changes are in response to RAI P-5-3

7.4 Reinforced Concrete Structures – Important To Safety

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

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

7.5 Cask Handling Building

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

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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 bridge crane *with* lifts limited to a maximum height of 80 inches. The vertical systems will utilize the overhead bridge cranes to remove impact limiters and personnel barriers, and the Vertical Cask Transporter (VCT) is used to move the NAC transportation casks from the rail car to the Cask Transfer System (CTS).

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

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

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

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

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

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

RAIs NP-7-1 and NP-7-12

7.5.3.1 *Descriptions of Systems, Structures, and Components*

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

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7.5.3.1.1 Description of CHB Steel Building

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

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

The design of sacrificial members and their connections does not require the members to remain attached to the structure after impact (i.e., the sacrificial members may themselves become airborne). This is permitted because the safety-related fuel bearing SSCs inside the building have been designed to resist the full spectrum of Regulatory Guide 1.76 tornado missiles representing the range of potential missiles on the plant site. The sacrificial members are considered rigid building debris components as defined in the missile criteria in Regulatory Guide 1.76 [7-35]. Chapter 12 of the appendices (A.12, B.12, etc.) demonstrate that each cask system component is designed and conservatively evaluated for the most severe tornado and missiles anywhere within the United States (Region I as defined in NRC Regulatory Guide 1.76 [7-35]), therefore, the impact of the sacrificial members on the cask systems is bounded.

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

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

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

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

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

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

7.5.3.1.2 Description of CHB Foundation

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

All Indicated Changes are in response to RAI NP-7-12

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

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7.5.3.1.3 *Description of CHB Overhead Cranes*

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.

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

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

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

7.5.3.2 Design Criteria

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

- *ANSI/AISC N690-18, Specification for Safety-Related Steel Structures for Nuclear Facilities. Applicable to definition of steel design load combinations and steel member and connection design requirements. ANSI/AISC 360-16, Specification for Structural Steel Buildings, is the baseline document modified in part by ANSI/AISC N690-18 for application to nuclear facilities.*
- *ANSI/AISC 341-16, Seismic Provisions for Structural Steel Buildings. Applicable to definition of seismic design and detailing requirements for the CHB structural steel seismic lateral force resisting system.*
- *ACI 349-13, Code Requirements for Nuclear Safety-Related Concrete Structures. Applicable to definition of concrete design load combinations and design of reinforced concrete structures and anchorages.*
- *ASCE 43-05, Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities. Applicable to evaluation of seismic demand and capacity of the CHB structures.*
- *ASCE/SEI 4-16, Seismic Analysis of Safety-Related Nuclear Structures. Applicable to seismic analysis procedures for the Cask Handling Building and its foundations.*
- *ASCE/SEI 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures. Applicable to development of normal operating wind loads, snow and rain loads, and overhead crane operating loads.*
- *ASCE/SEI 7-05, Minimum Design Loads for Buildings and Other Structures. Applicable to transforming tornado wind speed into pressures applicable to the CHB, in accordance with NUREG-0800 Section 3.3.2, Tornado Loads.*
- *ASME NOG-1-2015, Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder). Applicable to analysis and design of the two 130-ton overhead cranes supported by the CHB.*
- *CMAA-70 2015, Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes. Applicable to design of the CHB crane runway system.*

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7.5.3.2.1 Load Definitions

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

Administrative Controls will be used to mitigate certain impacts of design-basis tornado loading. The transportation cask will not be moved into the building to begin the railcar unloading process unless current and forecasted weather for the approaching eight (8) hours indicate safe weather conditions. Eight hours is the estimated time to move any of the casks from the railcar to a stable configuration within the CHB in which the crane is no longer overhead or adjacent. For the NUHOMS® systems, eight hours bounds the approximate time (6.4 hours for MP187 casks, 4.3 hours for MP197HB casks) from entry of the cask railcar into the CHB, to the point where the cask has been placed on the transfer skid and the overhead crane can be relocated to the south end of the CHB. For the NAC systems, eight hours bounds the approximate time (5.5 hours for NAC-STC casks, 6.5 hours for NAC-UTC casks, and 8 hours for NAC-MAGNATRAN casks) from entry of the cask railcar into the CHB, to placement of the canister on the Canister Transfer Facility pad, at which point the overhead crane will no longer be overhead or adjacent to the cask on the railcar. Estimated time to perform cask receipt and transfer activities are provided as occupancy times in the occupational collective dose tables in each cask model's respective Appendix, refer to Tables A.9-2, B.9-2, C.9-2, D.9-2, E.9-1, F.9-1, and G.9-1. Administrative controls will restrict the movement of the overhead crane such that it will remain in the south-most bay of the CHB once railcar unloading has been completed. Administrative controls will prohibit additional non-empty casks on railcars inside the CHB, and thus adjacent to the crane, until the previous cask has been removed from the CHB and the next unloading evolution can proceed, weather conditions permitting. Similarly, for railcar loading operations following retrieval of a loaded canister, the loading process will not be permitted to proceed unless current and forecasted weather for the approaching eight hours indicate safe weather conditions. These actions eliminate the potential for collapse of overhead cranes onto canisters during receipt, transfer, and retrieval operations (with storage operations occurring outside the CHB).

A safe condition and forecast is considered to be the absence of: Tornado and Severe Thunderstorm Watches, Tornado and Severe Thunderstorm Warnings, and predicted wind speeds that would qualify for a Severe Thunderstorm Watch (58 mph or greater). Weather forecasts will be accessed from the NOAA Weather Forecast Office prior to each railcar loading/unloading. The nearest NOAA Weather Forecast Office to the CISF is the Midland/Odessa Office. Administrative controls triggered by the presence of Tornado and Severe Thunderstorm Watches, Tornado and Severe Thunderstorm Warnings, and predicted wind speeds that would qualify for a Severe Thunderstorm Watch ensure avoidance of atmospheric conditions which are favorable for the development of severe thunderstorms capable of producing tornados within the following eight hours.

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

Loads

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

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

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Load Definitions

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

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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.

- **Floor Live Loads** – A floor live load of 300 lb/ft^2 is applied in areas of heavy *equipment* operation in the CHB. *Live load for stairs, walkways, and platforms is 100 lb/ft^2.*

- ***Crane and Hoist Loads (C)*** *– Design loads for the CHB permanently installed cranes and hoists envelop the full rated capacity of the cranes, including allowances for impact loads and test load requirements. The rated capacity of each of the two overhead bridge cranes in the CHB is 130 tons. Crane test loads are considered in the design at 125% of the rated capacity of the cranes, increased by an additional 5% in accordance with ASME NOG-1-2015 Section 7423. Forces induced by crane movement are calculated in accordance with ASCE 7-16, as follows:*
  - *Vertical impact: 25% of maximum wheel loads (including lifted load and crane self-weight).*
  - *Lateral side thrust: 20% of the sum of the rated hoist capacity, plus the weight of the crane trolley and hoist.*
  - *Longitudinal traction: 10% of maximum wheel loads (including lifted load and crane self-weight).*

- ***Snow Load (S)*** *– As described in Chapter 3, the design live load due to rain, snow, and ice is 10 lb/ft^2, which is the ground snow load. Determination of roof snow and ice loads is in accordance with the requirements of ASCE 7-16.*

- **Hydrostatic Fluid Pressure Loads** – Are due to fluids held in internal building compartments, such as tanks. There are no reinforced concrete tanks in the *CHB*. All tanks located in the *CHB* are designed in accordance with mechanical equipment design criteria.

- **Soil Load (H)** – Based on the density of the soil and includes the effects of groundwater, see attachment E of the WCS CISF SAR Chapter 2. Since the WCS CISF site is a dry, relatively flat site and the CHB is a slab-on-grade structure, no groundwater or soil pressure loads are exerted on building structures. Therefore, determination of lateral soil pressure loads is not necessary for structural analysis or design.

All Indicated Changes are in response to RAI NP-7-12

- ***Thermal Load (T_o)*** *– Consists of thermally induced forces and moments resulting from operation and environmental conditions affecting the CHB. The design temperature changes (ΔT) used for structural analysis and design of the CHB are the differences between expected construction temperatures and winter or summer operating temperatures, assuming the building is unheated and without air conditioning. The temperatures considered for these ΔT calculations are based on data for Midland, Texas in Technical Report No. 65, Expansion Joints in Buildings, which include a 66°F mean temperature during construction, a summer operating temperature of 100°F (exceeded, on average, only 1% of the time between June and September), and a winter operating temperature of 19°F (exceeded, on average, 99% of the time between December and February). This results in a positive ΔT of 34°F and a negative ΔT of 47°F for consideration in the CHB analysis. In accordance with NUREG-1536 and ANSI/ANS 57.9, thermal loads are not combined with tornado or seismic loads given that the CHB thermal loading is self-limiting and will be relieved during response of the structure to these extreme loading conditions.*

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- ***Wind Loads (W)*** *– Are those pressure loads generated by the design (or "normal") wind. The basic wind speed used to determine design wind loads on the CHB walls and roof is 116 miles per hour. Design wind loads are determined in accordance with the requirements of ASCE 7-16 [7-69], which consider ultimate strength level (limit state) wind speeds rather than service level wind speeds. The resulting pressures are intended for use with unity (1.0) LRFD wind load factors in the steel and concrete design load combinations. Wind loading conditions applicable to the CHB Main Wind Force Resisting System are determined in accordance with the Directional Procedure given in ASCE 7-16, Chapter 27 Part 1. Internal pressure coefficients are based upon an enclosed structure, given use of rated doors and operational protocols to shut all CHB doors during inclement weather. Design velocity pressures (q_z) are determined using ASCE 7-16 Equation 26.10-1:*

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

where:

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

K_{zt} = topographic factor, taken as 1.0

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

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

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

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

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

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

7.5.3.2.2 <u>Structural Steel Load Combinations</u>

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

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

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

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

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

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

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

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1. $1.4D + C + T_o$
2. $1.2D + 1.6L + 1.4C + 0.5S + 1.2T_o$
3. $1.2D + 0.8L + 1.4C + 1.6S + 1.2T_o$
4. $1.2D + W + 0.8L + C + 0.5S + T_o$
5. $D + 0.8L + C + E$
6. $D + 0.8L + W_t$
7. $0.9D + C + W$
8. $0.9D + C + E$
9. $0.9D + W_t$

7.5.3.2.3 Reinforced Concrete Load Combinations

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

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

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

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

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

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

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

1. $1.4D + T_o$

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

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

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

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

6. $0.9D + C + W$

7. $0.9D + C + E$

8. $0.9D + W_t$

7.5.3.2.4 Overhead Crane Load Combinations

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

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7.5.3.3 CHB Steel Building Structural Analysis

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

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

7.5.3.3.1 CHB Steel Building Structural Analysis Model

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

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

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

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

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

7.5.3.3.2 <u>Static Analysis</u>

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

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

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7.5.3.3.3 Seismic Analysis

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

Evaluation of Soil Structure Interaction Effects

Per ASCE 43-05 Section 3.1 and ASCE 4-16 Section 5.1(a), soil-structure interaction (SSI) effects must be considered. To evaluate the significance of SSI effects for the CHB, an assessment of site soil properties and dominant structural frequencies is performed in accordance with ASCE 4-16 Section 5.1.1. This evaluation entails calculation of soil frequencies based on a single degree-of-freedom system consisting of the lateral, vertical, torsional, or rocking soil spring and the relevant mass or mass moment of inertia for the overall CHB. The mass of the embedded CHB foundation is neglected in this calculation. Equivalent soil spring stiffness terms are calculated in accordance with ASCE 4-16 Table 5-2, using strain-compatible shear modulus determined from the site PSHA at the elevation of foundation bearing (9 feet below grade). A minimum strain-compatible shear wave velocity at the depth of foundation bearing equal to 1,500 ft/second is assumed. Equivalent rectangular foundation dimensions are calculated on the basis of the combined contact areas of the three primary strip mat foundations as preliminarily sized. As shown in Table 7-42, all soil/structure frequency ratios exceed 2, in which case the CHB seismic analysis is permitted by ASCE 4-16 to be performed assuming fixed-base supports. The minimum ratio shown in Table 7-42 (2.1) pertains to the vertical response. The response frequency considered for this ratio is not associated with a dominant mode involving overall structural response. The mode involves the response of the loaded crane runway girder and has a small overall mass participation of approximately 10% in the vertical direction. There are also other modes involving vertical response of the crane system with similar frequencies and mass participation ratios.

7.5.3.3.4 Tornado Missile Impact Analysis

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

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

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

7.5.3.4 CHB Steel Building Design

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

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

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

7.5.3.4.1 Member Design

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

$$R_u \leq \phi R_n$$

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

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

STAAD Code Checking

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

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

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

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

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

7.5.3.4.2 <u>Connection Design</u>

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

- *All bolts are high strength bolts installed with full pretension.*
- *Bolts and welds do not share the same force component in any connection.*
- *Bolts are installed in standard holes or in short slots perpendicular to the applied load.*
- *The available shear strength of bolted joints is calculated as that for bearing-type joints in accordance with ANSI/AISC 360-16 Chapter J.*
- *Faying surfaces are prepared to satisfy slip-critical connection requirements in ANSI/AISC 360-16 and are prepared to have a Class A slip coefficient or higher.*
- *The required strength of OCBF vertical brace connections is determined using the overstrength seismic loads, in accordance with AISC 341-16 Section F1.6a. This requirement is met by designing for $F_\mu = 1.0$ seismic demands, in accordance with ASCE 43-05.*
- *All OCBF welded connections are detailed and installed in accordance with the applicable requirements of AWS D1.1 and D1.8 as required.*
- *Column base connections and splices are designed for the required axial, shear, and flexural forces defined in ANSI/AISC 341-16 Sections D2.5 and D2.6.*
- *The available strengths of concrete and reinforcing steel utilized in column base anchorage to the foundation are determined in accordance with ACI 349-13.*

7.5.3.5 Reinforced Concrete Structural Analysis and Design

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

Material properties considered in foundation analysis and design, including specified strengths for structural concrete, reinforcing steel, anchor rods, and steel plate (utilized for baseplate shear lugs) are summarized in Table 15-2. Soil properties considered in foundation design are those specified in the project geotechnical report (SAR Attachment E). This includes an allowable bearing pressure of 3000 lb/ft^2 and a subgrade modulus of 150 lb/in^3. As stated in the geotechnical report, the allowable bearing pressure is permitted to be increased to 4000 lb/ft^2 (33% increase) for load combinations that include transient loads (such as wind, seismic, and tornado loads). The unit weight of structural fill considered in foundation stability calculations is assumed to be 110 lb/ft^3.

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

7.5.3.6 Overhead Crane Analysis and Design

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

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

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

7.5.3.7 Summary of Maximum Design Capacity Ratios

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

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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 AREVATN00l-CALC-002, Rev. 0 "Soil Structure Interaction Analysis of TN Independent Spent Fuel Storage Installation (ISFSI) Concrete Pad at Andrews, TX."

7-67 Calculation AREVATN00l-CALC-001, Rev. 1 "ISFSI Pad Design for WCS at Andrews, Texas."

7-68 ACI 349-13, "Code Requirements for Nuclear Safety-Related Concrete Structures and 731Commentary."

7-69 ASCE 7-16, "Minimum Design Loads for Buildings and Other Structures."

7-70 ASME NOG-1-2015, "Rules for Construction of Overhead Gantry Cranes (Top Running Bridge, Multiple Girder)," The American Society of Mechanical Engineers, 2015.

7-71 ASCE/SEI 4-16, "Seismic Analysis of Safety-Related Nuclear Structures," American Society of Civil Engineers, 2016.

RAI NP-7-12

Table 7-41
Cask Handling Building Primary Framing Member Sizes

Structural Element	***Member Size Class***
Main Building Columns	*W14*
Crane Columns	*W14*
Wind Columns	*W14*
Wind Column Vertical Truss Web Members	*2L8x8*
North-South Struts	*W14, W18*
East-West Struts	*W12, W16*
East-West Vertical Braces	*HSS8.625 (round)*
North-South Vertical Braces	*HSS9.625, HSS5.5 (round)*
Intermediate Level Horizontal Braces	*WT*
Primary Roof Truss Chords	*W14*
Secondary Roof Truss Chords	*W14*
Primary Roof Truss Web Diagonal Members	*2L5x5*
Secondary Roof Truss Web Diagonal Members	*2L8x6*
Interior Roof Truss Web Vertical Members	*2L3.5x3.5*
Exterior Roof Truss Web Vertical Members	*W8*
Primary Roof Horizontal Braces	*HSS7x7 (square)*
Secondary Roof Horizontal Braces	*WT*

Table 7-42
Cask Handling Building Evaluation of Soil and Structural Dominant Frequencies

Mode	***Soil Frequency, f_{soil} (Hz)***	***CHB Fixed-Base Dominant Frequency, f_{CHB} (Hz)***	***Ratio f_{soil}/f_{CHB}***
Horizontal, E-W (X)	*18.7*	*3.5*	*5.3*
Horizontal, N-S (Z)	*18.1*	*4.0*	*4.5*
Vertical (Y)	*20.8*	*10.1*	*2.1*
Rocking in E-W direction (about Z)	*14.7*	*4.6*	*3.2*
Rocking in N-S direction (about X)	*24.4*	*4.0*	*6.1*
Torsion	*25.2*	*5.0*	*5.0*

Table 7-43
Maximum Design Capacity Ratios (DCRs)

Element	***Load Combination***				
	Gravity	***Seismic***	***Tornado Wind Pressure[1]***	***Tornado Missile Impact with Tornado Wind Pressure[2]***	***Governing DCR[6]***
Main Column	*0.17*	*0.27*	*0.21*	*0.65*	*0.65*
Zipper Column[3]	*0.08*	*0.10*	*0.15*	*0.16*	*0.16*
Crane Column	*0.30*	*0.28*	*0.11*	*0.65*	*0.65*
Wind Column	*0.12*	*0.12*	*0.13*	*0.70*	*0.70*
Sacrificial Strut[3]	*0.23*	*0.37*	*0.15*	*0.66*	*0.66*
Non-Sacrificial Strut[4]	*0.23*	*0.37*	*0.15*	*0.70*	*0.70*
Crane Girder[5]	*0.19*	*0.29*	*0.05*	*0.11*	*0.29*
Roof truss bottom chord	*0.12*	*0.16*	*0.38*	*0.62*	*0.62*
Roof truss top chord	*0.15*	*0.22*	*0.33*	*0.65*	*0.65*
Roof truss web member	*0.62*	*0.57*	*0.61*	*0.68*	*0.68*
Sacrificial N-S Vertical Bracing[3]	*0.21*	*0.12*	*0.12*	*0.61*	*0.61*
Sacrificial E-W Vertical Bracing[3]	*0.32*	*0.34*	*0.28*	*0.83*	*0.83*
Sacrificial Crane Vertical Bracing[3]	*0.32*	*0.25*	*0.12*	*0.19*	*0.32*

1. *The Tornado Wind Pressure DCRs do not reflect tornado missile impact; i.e., automobile. Columns are generally sized for missile impact.*
2. *Not all possible missile impact locations have been considered in this preliminary analysis. DCRs reflected are based on representative sampling of primary member and framing system impact locations. During detailed design, the governing DCR may increase (see Note 6).*
3. *Sacrificial members hit directly or in close proximity to a tornado missile are allowed to fail. These member DCRs are reflective of an indirect missile strike.*
4. *Non-Sacrificial members are designed to withstand a missile impact. These DCRs are indicative of a member that is directly impacted by a tornado missile. Unless noted otherwise, all members are non-sacrificial.*
5. *The DCRs for the crane girder do not consider all crane position loading scenarios and fatigue to be addressed in detailed design. These considerations may result in an increase in DCR (see Note 6).*
6. *During detailed design, the maximum member DCR shall not exceed 0.90.*

All Indicated Changes are in response to RAI NP-7-12

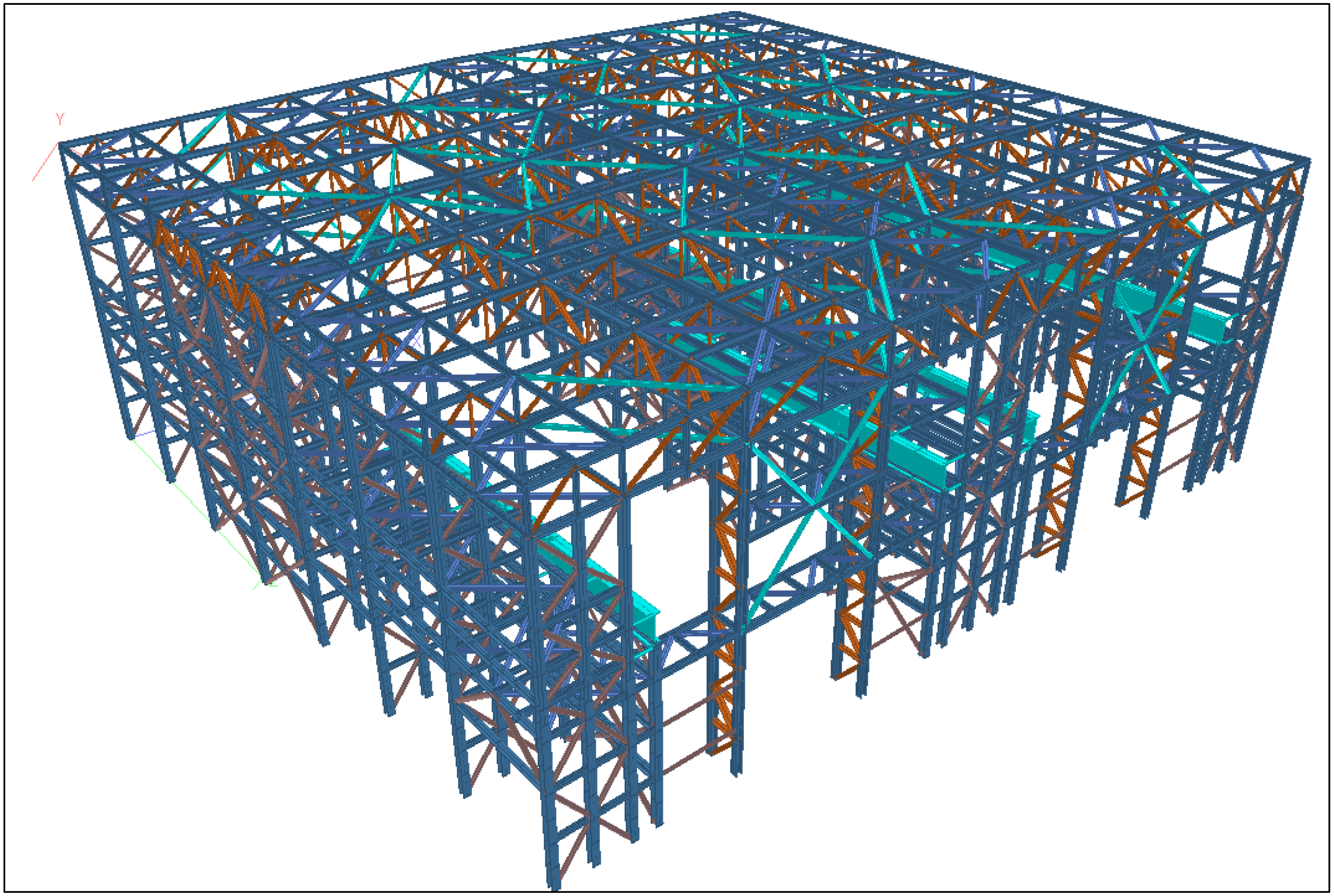

Figure 7-54
Isometric View of Cask Handling Building Structural Steel Framing

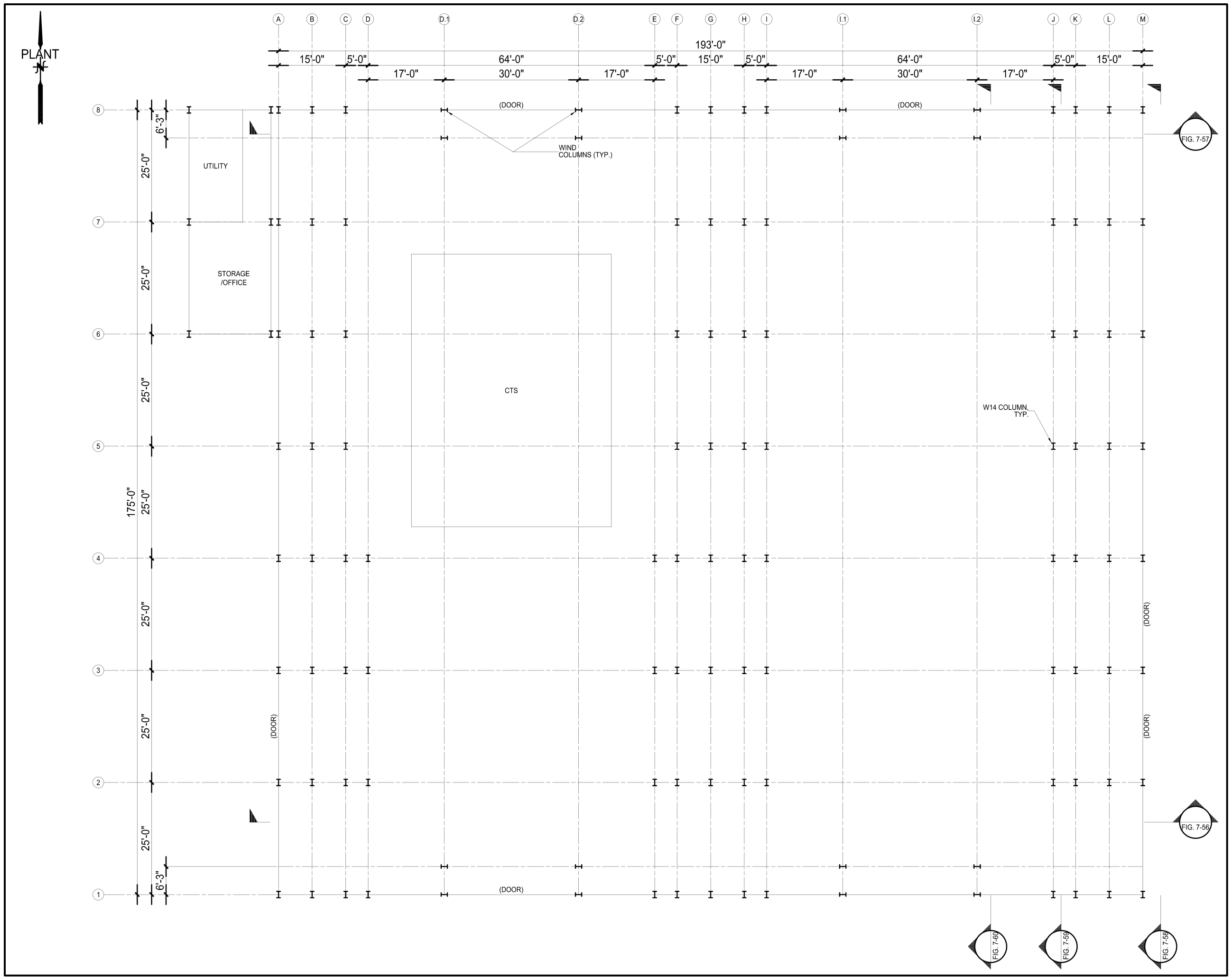

Figure 7-55
Plan View of Cask Handling Building Structural Steel Framing Arrangement, at Grade Level (Elevation 100'-0")

All Indicated Changes are in response to RAI NP-7-12

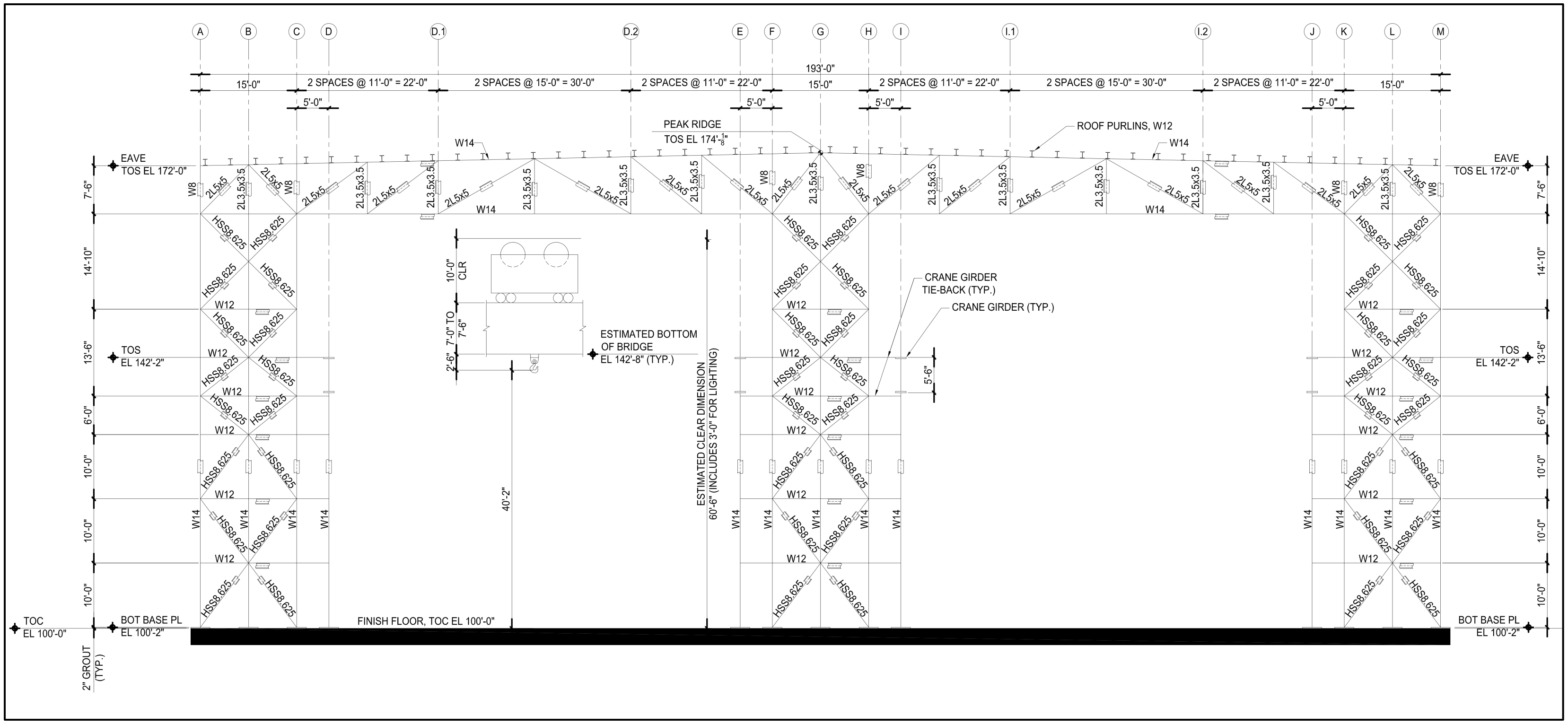

Figure 7-56
Cask Handling Building Structural Steel Framing Arrangement, Typical Interior Section (Looking North)

All Indicated Changes are in response to RAI NP-7-12

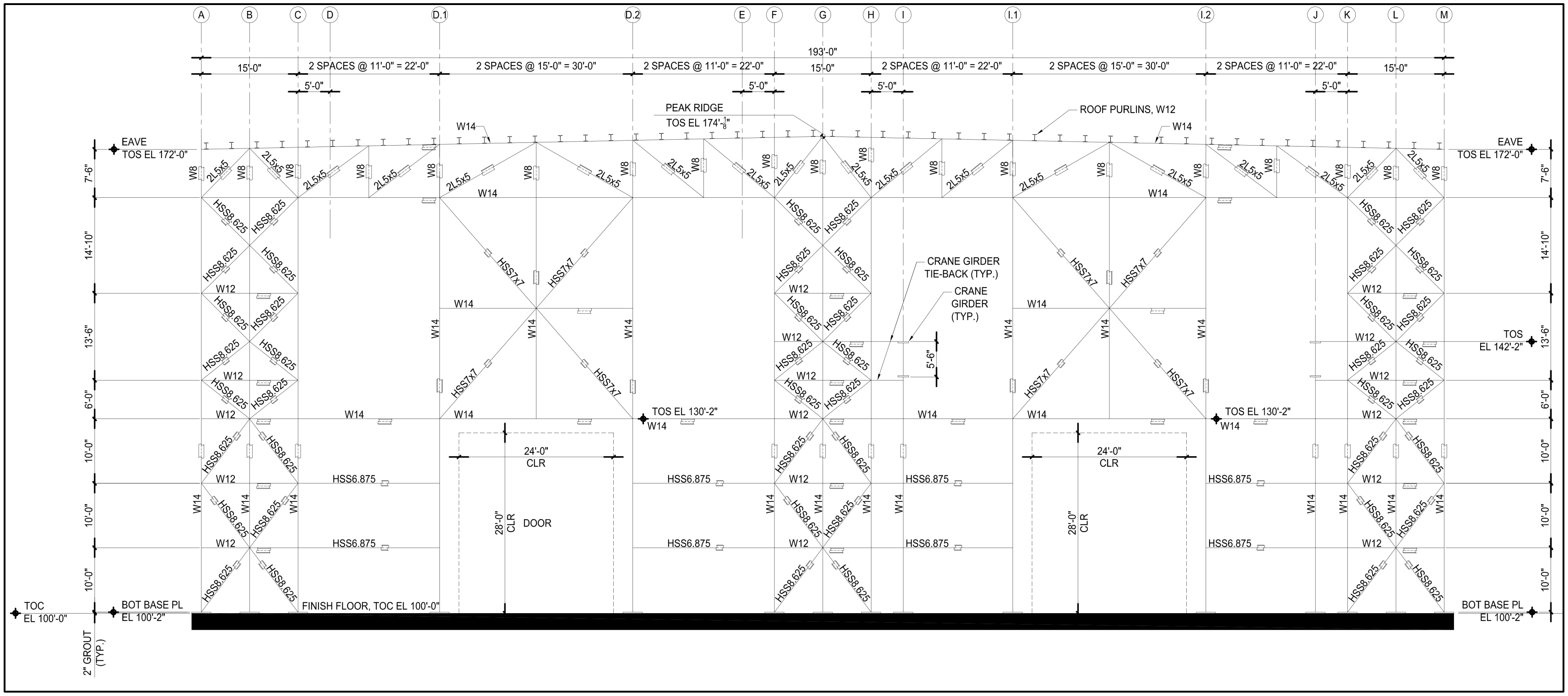

Figure 7-57
Cask Handling Building Structural Steel Framing Arrangement, Section at North Exterior Frame (Looking North)

All Indicated Changes are in response to RAI NP-7-12

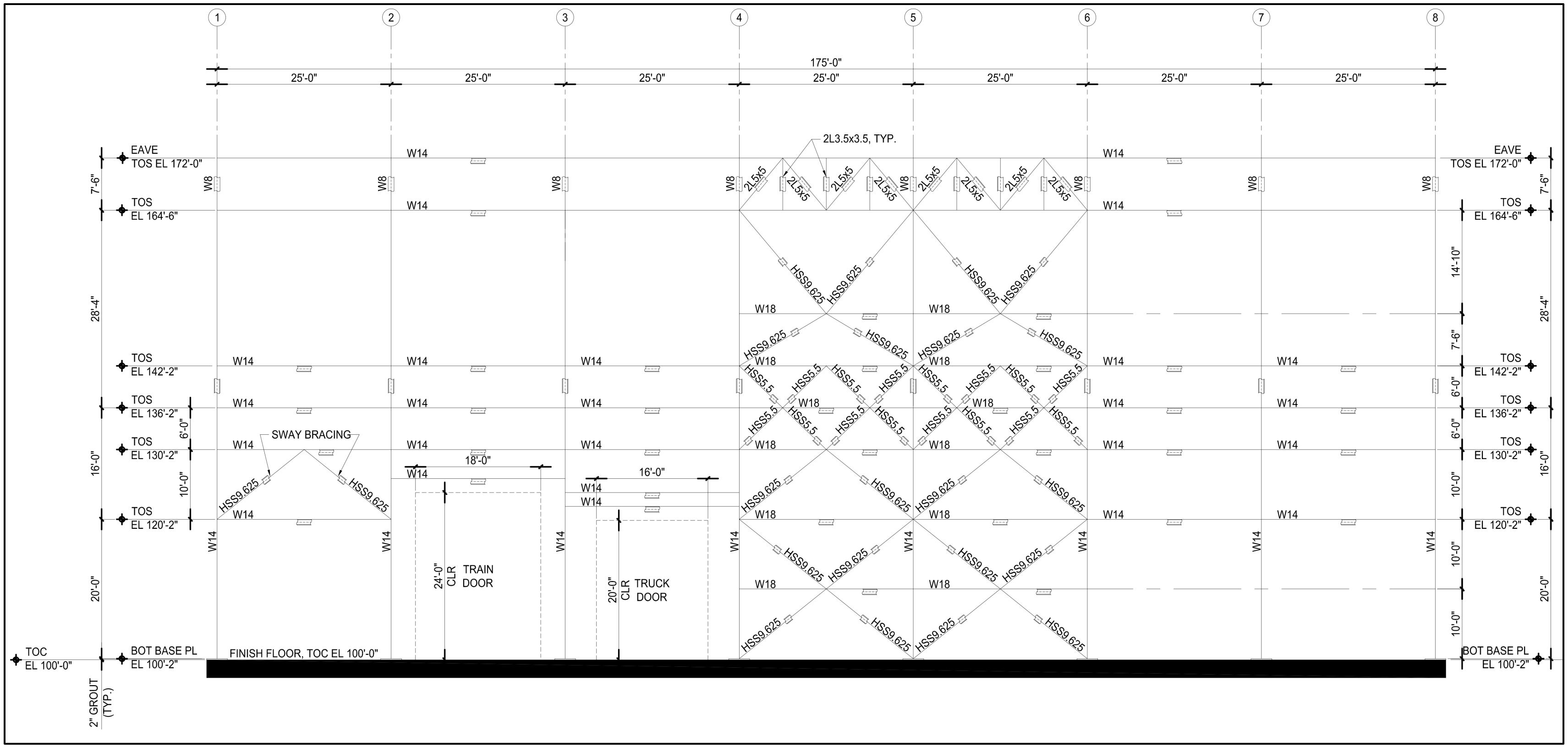

Figure 7-58

Cask Handling Building Structural Steel Framing Arrangement, Typical Section at Main Building Column Line (Looking West)

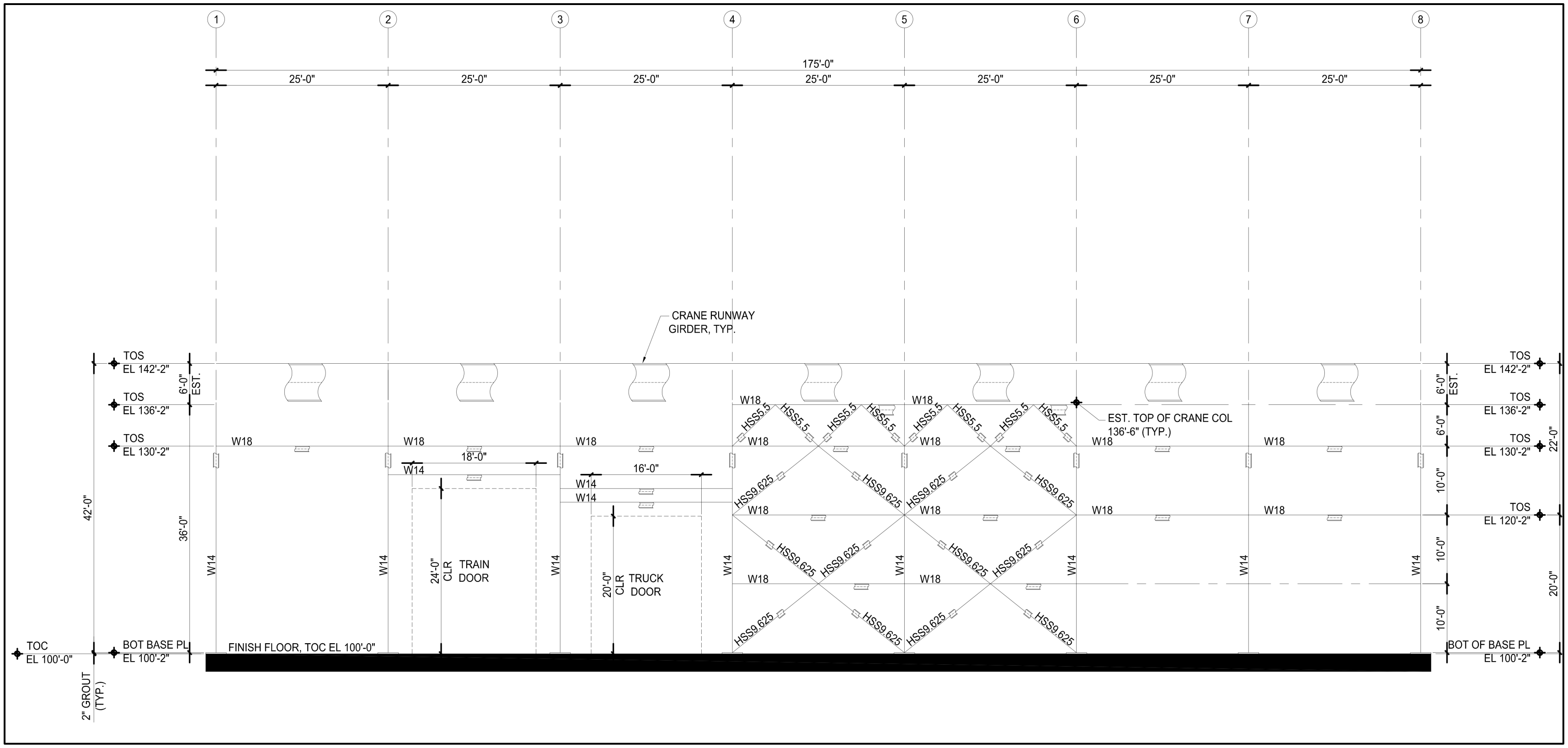

Figure 7-59
Cask Handling Building Structural Steel Framing Arrangement, Typical Section at Crane Column Line (Looking West)

All Indicated Changes are in response to RAI NP-7-12

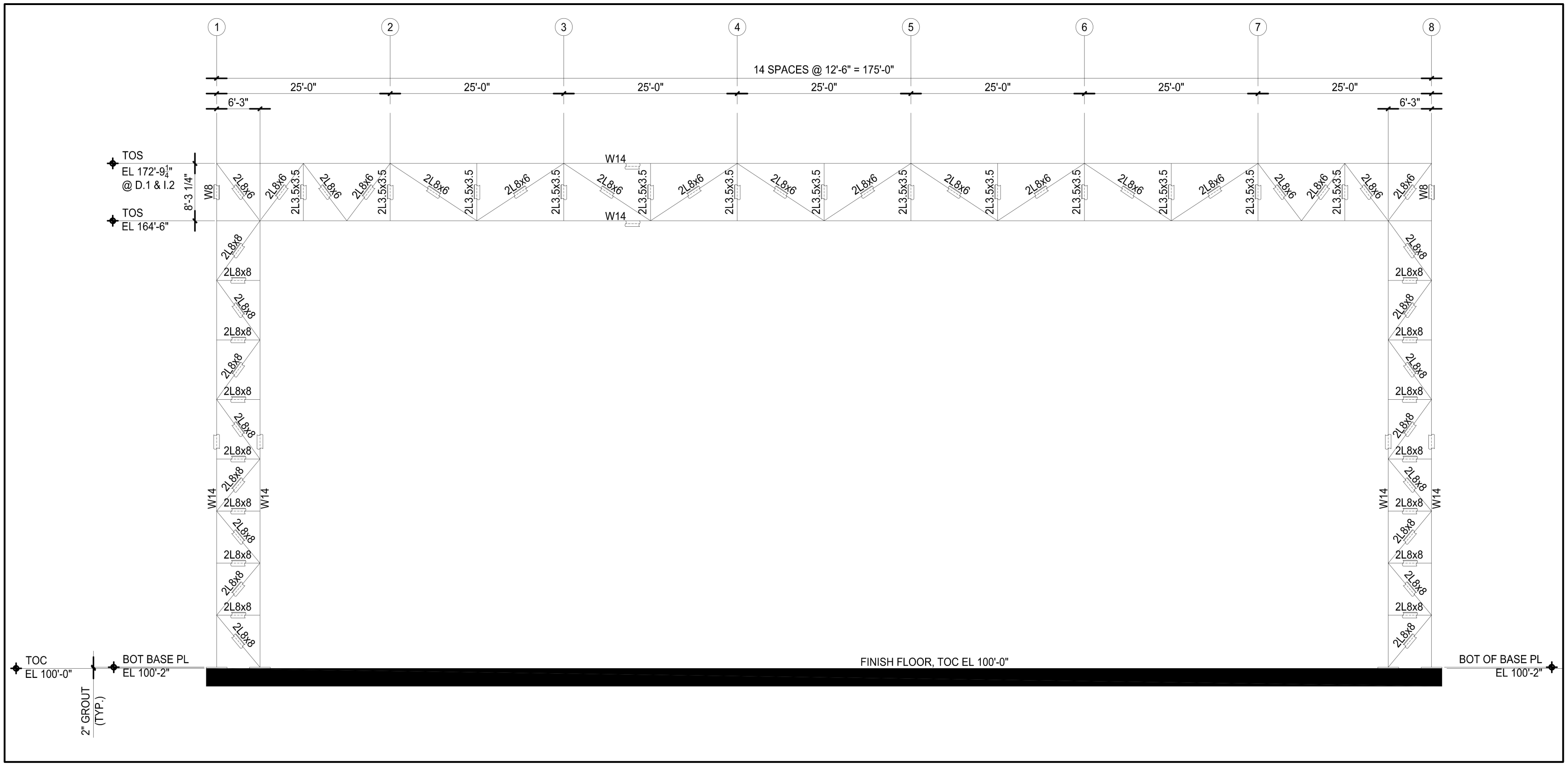

Figure 7-60
Cask Handling Building Structural Steel Framing Arrangement, Typical Section at Wind Column Line (Looking West)

All Indicated Changes are in response to RAI NP-7-12

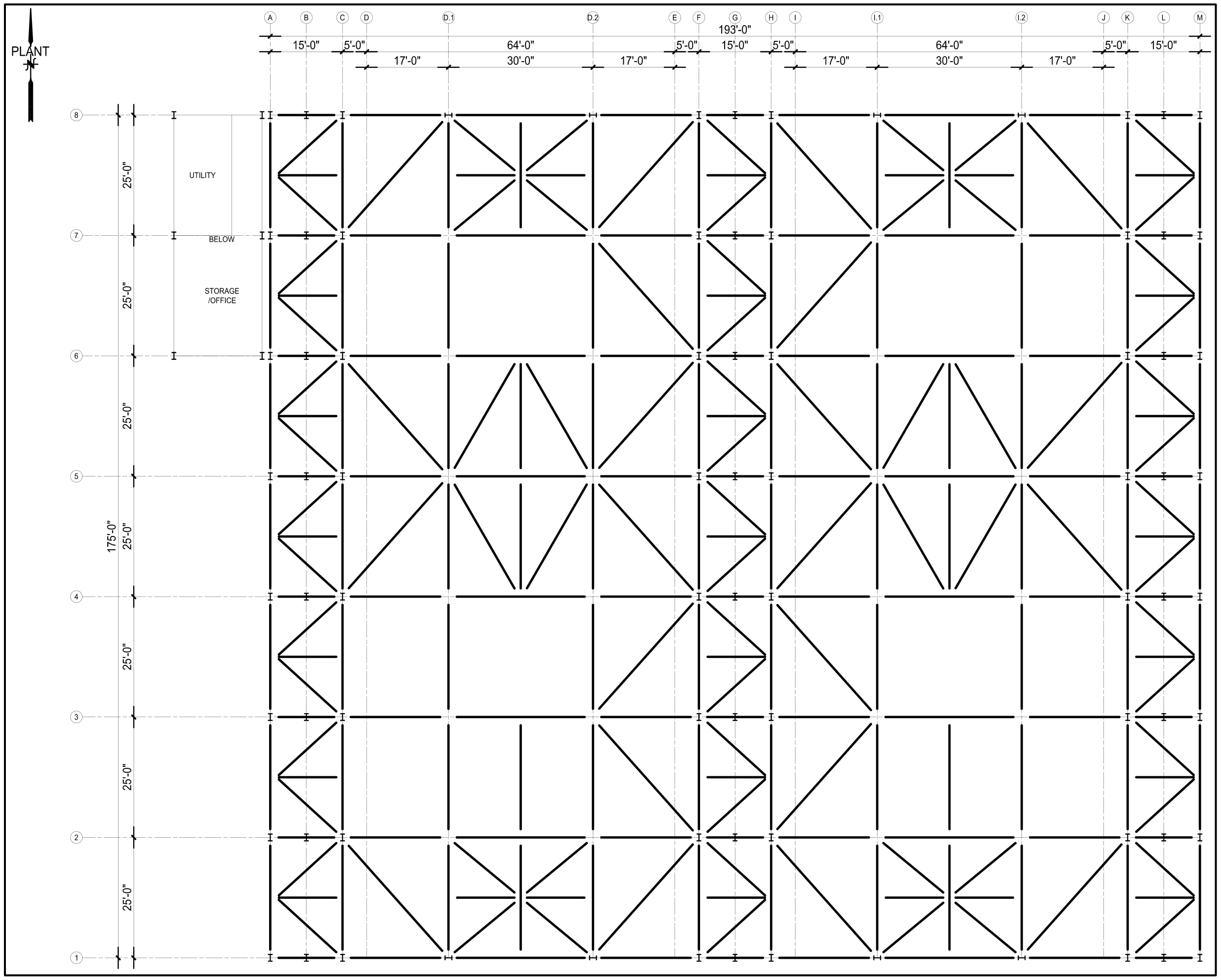

Figure 7-61
Cask Handling Building Structural Steel Framing Arrangement, Plan View at Roof Top Chord (Bottom Chord Similar)

All Indicated Changes are in response to RAI NP-7-12

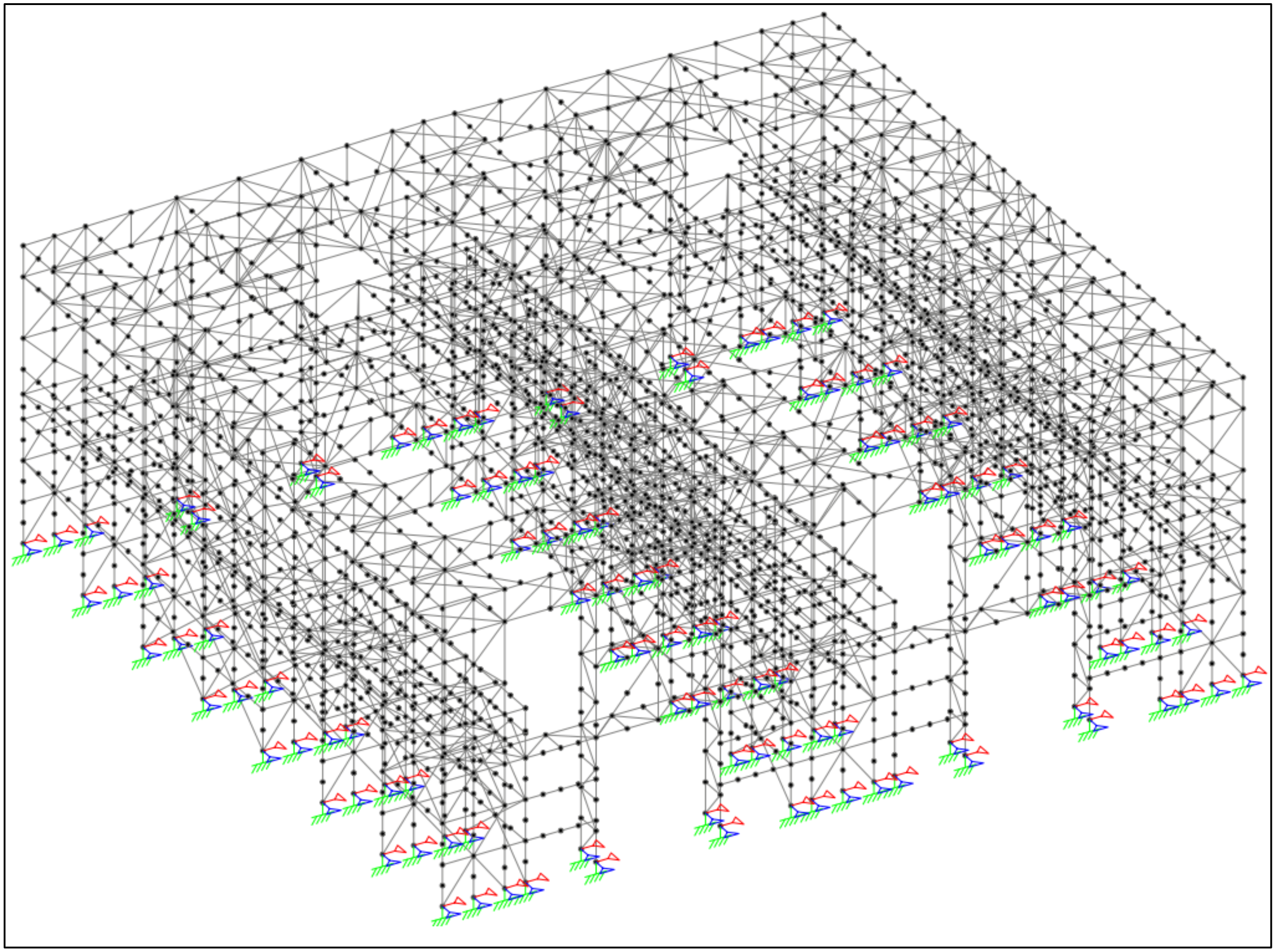

Figure 7-62
Cask Handling Building 3D STAAD.Pro Finite Element Model

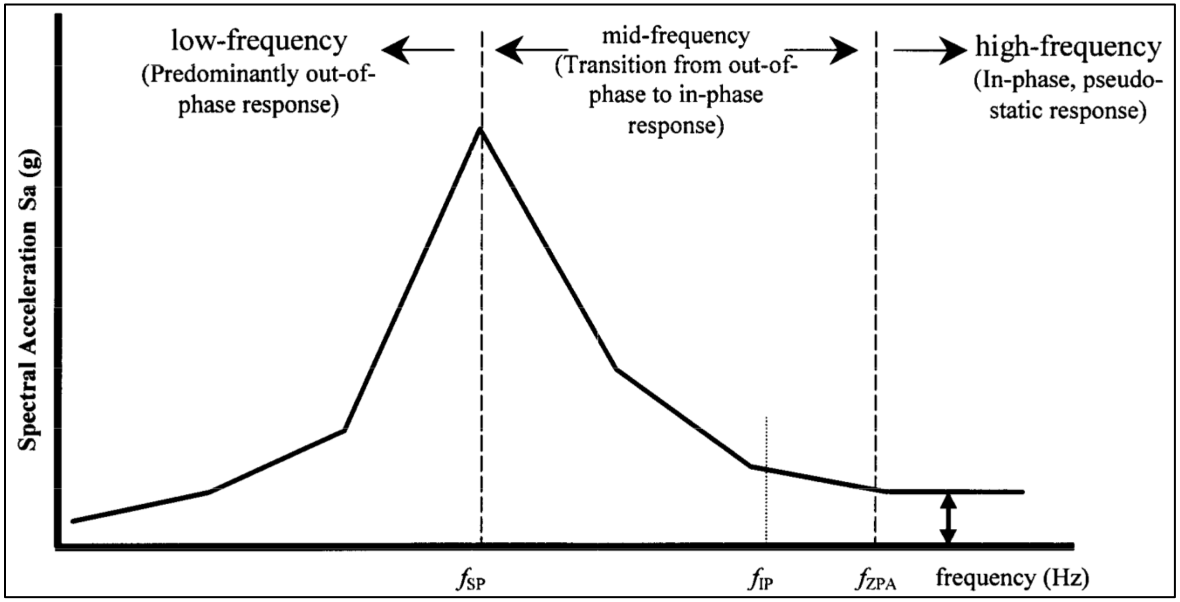

Figure 7-63
Generalized Acceleration Response Spectrum

9.4.3.3 Annual Dose Limits to an Individual

ISP has evaluated the radiological impacts attributable to Waste Control Specialists present operations, those from the NEF, and radiation doses estimated for storing up to 40,000 MTHM of SNF at the WCS CISF. While ISP is requesting authorization to only store 5,000 MTHM of SNF and related GTCC waste in its license application, it bounded the cumulative radiological impacts of storing up to 40,000 MTHM of SNF consistent with its plan to expand the WCS CISF in the future. ISP estimated the cumulative radiation effective doses attributable to Waste Control Specialists present operations, the NEF, and the WCS CISF to any real person that could be present at Sundance Services, Permian Basin Materials (Previously known as Wallach Concrete), and the nearest neighbor (Figure 9-5, WCS CISF Receptors and Source of Radiation in the Region of Interest). To assess the annual dose from the NEF, ISP relied on information provided in Section 4.2.12.2, *Operations*, of the NEF Environmental Report [9-18].

The maximum annual dose to any real individual who is located beyond the controlled area attributable to operations at the NEF was estimated at 0.026 mSv (2.6 mrem). The bounding annual dose equivalent reporting by NEF includes the direct radiation attributable to Uranium Byproduct Cylinder Pads estimated to occur over the lifespan of the NEF facility. The results of the annual radiation doses to any real person that could be present at Sundance Services, Permian Basin Materials (Previously known as Wallach Concrete), and the nearest neighbor location, respectively, are presented in Table 9-7. The RACER dose module was used to calculate the Waste Control Specialists airborne pathway (particulates and 129I) and direct radiation dose using available air and dosimeter data from 2015. The airborne pathway doses shown in Table 9-7, Estimated Cumulative Annual Dose Equivalent for All Sources of Radiation in the Region, represent the maximum net dose for the perimeter stations in the northwest quadrant. The net dose potentially attributable to Waste Control Specialists operations is estimated as the perimeter quadrant dose minus the background dose. The perimeter quadrant dose is based on data collected at the perimeter stations in the quadrant, and the background dose is based on data collected at the background sampling location (Station #9).

The airborne particulate and ^{129}I dose at the receptors would be less than the perimeter stations dose due to atmospheric dispersion. As such, the annual dose equivalent to the thyroid will be less than 0.75 mSv (75 mrem). Direct radiation doses are calculated in a similar manner. Net direct radiation from Waste Control Specialists operations at the perimeter for 2015 ranged from background in the northeast quadrant to *0.11* mSv/yr (*11* mrem/yr) in the southwest quadrant. Even though the dose from external radiation at the perimeter is less than the 0.25 mSv/yr (25 mrem/yr) limit, no receptor is present there. The doses were, therefore, reduced by attenuation to the applicable receptors as discussed below using the WCS CISF dose rate modeling.

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*Annual exposures at distances from the side of array of HSMs beyond 300 meters can be conservatively estimated using 1360*exp(-0.001273 *x) equation, where x is the distance from the origin of the CISF local frame of reference in feet. The origin of the local frame of reference is considered at 561994.08' Easting and 6877754.97' Northing when using the State Plane frame of reference. This equation can be also used to conservatively estimate the exposures for select locations where real individuals beyond the controlled area will be exposed to radiation from operations at the WCS CISF. Those locations are schematically shown on Figure 9-5. The bounding encompassing values for received annual exposures from the WCS CISF operations are summarized in Table 9-7.*

The results from this analysis demonstrate that the cumulative impacts from operations at these facilities located in the region where the WCS CISF will be located are less than the annual dose equivalent limit of 0.25 mSv (25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid, and 0.25 mSv (25 mrem) to any other critical organ, as specified in 10 CFR 72.104.

9.6 Doses to Off-Site Public

The maximum annual dose to the most exposed public individual due to operations at WCS CISF is limited to 25 mrem per 10 CFR 72.104.

9.6.1 Site Boundary Dose

The closest location of the site boundary is located at SPCS coordinate (558079.15, 6878157.94), or approximately 0.75 miles from the WCS CISF. The total dose rate at the site boundary is *8.58*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 *7.52*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 7.77E-3 mrem (see Appendix A.11, Confinement Evaluation). The total annual dose including leakage is significantly less than the 10 CFR 72.104 dose limit of 25 mrem to the whole body. Given that the annual dose contribution at the site boundary is less than 0.05 mrem/year, regardless of the contribution from any other radiation from uranium fuel cycle operations within the region, the 10 CFR 72.104 limits are met.

9.6.2 Effluent and Environmental Monitoring Program

This section describes the program for monitoring and estimating the release of radioactive materials processed and stored at the WCS CISF to the environment.

9.6.2.1 Gaseous Effluent Monitoring

As described in Section 6.1.1, there are no gaseous effluents to monitor for the WCS CISF.

9.6.2.2 Liquid Effluent Monitoring

As described in Section 6.1.2.1, there are no radioactive liquid effluents to monitor for the WCS CISF.

9.6.2.3 Solid Waste Monitoring

As described in Section 6.1.4, only one type of solid potentially radioactive waste is generated at the WCS CISF: waste from contamination surveillance, decontamination, and maintenance activities, consisting of paper or cloth swipes, paper towels, rubber gloves and boots. Solid radioactive wastes will be collected in containers and temporarily stored in the Cask Handling Building. Small volumes of solid radioactive wastes are anticipated. These low activity wastes will be disposed of at a Waste Control Specialists waste disposal facility in compliance with applicable federal and state regulations. Radiation protection personnel periodically monitor dose rates in the solid waste storage area using portable instrumentation for ALARA purposes as part of the facility Radiation Protection Program.

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9.6.2.4 Environmental Monitoring

ISP will establish a Radiological Environmental Monitoring Program (REMP) that will demonstrate compliance with 10 CFR 72.104. Details of this program are described in *Chapter 4 of the ISP Environmental Report and Figure 4.12-7 through Figure 4.12-12 show the locations being monitored under the current REMP program*.

In establishing the environmental monitoring program for SNF storage, ISP will build upon ISP joint venture member, Waste Control Specialists current monitoring program for ISP joint venture member, Waste Control Specialists *SP&D Facilities*. This program will include the following monitoring parameters: perimeter dosimetry (Landauer Inlight® Environmental X9 (beta/X/gamma) or equivalent), soil, and air locations. This program will be implemented by the radiation safety department in accordance with written procedures.

Waste Control Specialists uses the Luxel+ Ta (beta/photon/neutron) dosimeter for area monitoring under the radiation safety area monitoring program *(minimum of eight locations on the inner fence of the PA)* and the Landauer Inlight® Environmental X9 (beta/photon) dosimeter for perimeter environmental monitoring program *at the OCA boundary (for reference, see Figure 6.1-1 in Chapter 6 of the ISP Environmental Report). All dosimeters will be analyzed on a quarterly basis*. Environmental boundary air *and soil* monitoring (i.e., Low Volume air sampling and High Volume air sampling) will be performed at a minimum of two locations *on the north OCA boundary (for reference, see Figure 4.12-7 and Figure 4.12-9 in Chapter 4 of the ISP Environmental Report),* in addition to the locations currently performed under the REMP. Analyses will be for gross alpha/beta and gamma spectrometry and performed by a certified offsite laboratory *on a quarterly basis*. *Air samples will be collected monthly for each location and composited for a quarterly analysis. Soil samples will be collected and analyzed annually unless air samples indicate the need to take additional samples.*

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9.6.3 Maximum Off-Site Annual Dose

The nearest residence in Lea County, New Mexico is approximately 4 miles from the WCS CISF at SPCS coordinate (541732.42, 6873002.59). At this distance, the computed total dose rate is *5.00E-13* mrem/hr. With continuous occupancy of 8,760 hours per year, the total dose is *4.38E-09* mrem, which is essentially zero and less than the dose from natural background radiation.

9.6.4 Liquid Releases

As described in Section 6.1.2.1, there are no radioactive liquid radioactive wastes to monitor for the WCS CISF.

9.7 References

9-1 TN Document, NUH09.101 Rev. 17, "NUHOMS® -MP197 Transportation Package Safety Analysis Report." (Basis for NRC CoC 71-9302).

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

9-3 "Rancho Seco Independent Spent Fuel Storage Installation, Final Safety Analysis Report, Volume I, ISFSI System," NRC Docket No. 72-11, Revision 4.

9-4 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 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 *Not Used.*

9-16 NRC Regulatory Guide 8.8, Rev 3 "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations will be As Low As s Reasonably Achievable."

9-17 NRC Regulatory Guide 8.10, "Operating Philosophy for Maintaining Occupational and Public Radiation Exposures as Low as Reasonably Achievable."

9-18 NEF Environmental Report, Revision 4, April 2005.

All Indicated Changes are in response to RAI P-9-5

Table 9-5
Dose Rates around the WCS CISF

	Coordinates (ft)		Dose Rate (mrem/hr)						
Detector	**Easting**	**Northing**	**Gamma**	**Neutron**	**(n,γ)**	**Total**	**σ**	**Direct**	**Skyshine**
General Area									
D1	562321.81	6878484.76	*5.29E-01*	*4.53E-02*	*2.11E-03*	*5.76E-01*	*1%*	*1.57E-01*	*4.20E-01*
D2	562485.67	6878849.66	*2.02E-01*	*1.70E-02*	*9.69E-04*	*2.20E-01*	*2%*	*4.70E-02*	*1.73E-01*
D3	562649.54	6879214.55	*7.14E-02*	*4.95E-03*	*3.69E-04*	*7.67E-02*	*4%*	*1.27E-02*	*6.40E-02*
D4	562813.40	6879579.45	*2.18E-02*	*1.63E-03*	*1.80E-04*	*2.36E-02*	*2%*	*3.89E-03*	*1.97E-02*
D5	562989.56	6879971.71	*7.40E-03*	*4.84E-04*	*7.38E-05*	*7.95E-03*	*5%*	*1.19E-03*	*6.76E-03*
D6	563655.49	6879672.66	*9.60E-03*	*6.97E-04*	*1.07E-04*	*1.04E-02*	*3%*	*1.45E-03*	*8.96E-03*
D7	564066.00	6879488.31	*8.57E-03*	*5.55E-04*	*8.38E-05*	*9.21E-03*	*2%*	*1.45E-03*	*7.76E-03*
D8	564476.50	6879303.96	*6.26E-03*	*3.31E-04*	*6.51E-05*	*6.65E-03*	*3%*	*1.10E-03*	*5.55E-03*
D9	565142.44	6879004.91	*2.08E-03*	*1.04E-04*	*3.12E-05*	*2.22E-03*	*2%*	*3.71E-04*	*1.85E-03*
D10	564966.28	6878612.65	*4.79E-03*	*3.28E-04*	*5.09E-05*	*5.16E-03*	*5%*	*7.71E-04*	*4.39E-03*
D11	564802.42	6878247.75	*9.57E-03*	*5.71E-04*	*7.44E-05*	*1.02E-02*	*4%*	*1.49E-03*	*8.73E-03*
D12	564638.55	6877882.85	*1.36E-02*	*9.54E-04*	*1.27E-04*	*1.47E-02*	*2%*	*2.13E-03*	*1.26E-02*
D13	564474.69	6877517.96	*1.51E-02*	*1.27E-03*	*1.30E-04*	*1.65E-02*	*2%*	*1.58E-03*	*1.49E-02*
D14	563481.03	6877087.22	*9.80E-02*	*7.87E-03*	*5.02E-04*	*1.06E-01*	*2%*	*9.24E-03*	*9.72E-02*
D15	563070.52	6877271.57	*2.72E-01*	*2.49E-02*	*1.46E-03*	*2.98E-01*	*1%*	*1.27E-02*	*2.85E-01*
D16	562660.01	6877455.92	*4.52E-01*	*4.28E-02*	*2.42E-03*	*4.97E-01*	*1%*	*2.86E-02*	*4.69E-01*

1. Detector locations shown on Figure 9-1.
2. Total = Direct + Skyshine.

All Indicated Changes are in response to RAI P-9-5

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

	Coordinates (ft)		Dose Rate (mrem/hr)						
Detector	**Easting**	**Northing**	**Gamma**	**Neutron**	**(n,γ)**	**Total**	**σ**	**Direct**	**Skyshine**
Locations around Facility									
P-001 (Site turn off)	560770.85	6878102.44	*4.50E-03*	*3.24E-04*	*6.23E-05*	*4.89E-03*	*3%*	*7.03E-04*	*4.19E-03*
P-002 (Rail line)	561762.03	6877972.59	*1.12E-01*	*8.03E-03*	*6.32E-04*	*1.20E-01*	*3%*	*2.10E-02*	*9.93E-02*
P-003 (Security and Admin. Building)	562193.28	6878120.44	*6.79E-01*	*5.26E-02*	*2.50E-03*	*7.34E-01*	*1%*	*2.14E-01*	*5.21E-01*
P-004 (Rail line)	562816.16	6877498.49	*6.75E-01*	*5.99E-02*	*3.44E-03*	*7.38E-01*	*1%*	*5.16E-02*	*6.87E-01*
P-005 (CHB)	563088.75	6877495.24	*7.26E-01*	*6.75E-02*	*3.43E-03*	*7.97E-01*	*1%*	*6.38E-02*	*7.33E-01*
P-006 (CHB)	563039.04	6877384.55	*4.42E-01*	*4.29E-02*	*2.17E-03*	*4.87E-01*	*1%*	*2.73E-02*	*4.60E-01*
P-007 (Existing rail line)	562618.87	6876671.78	*3.01E-02*	*2.66E-03*	*2.46E-04*	*3.30E-02*	*2%*	*1.26E-03*	*3.18E-02*
P-008 (Corner of Storage Area)	562452.84	6877970.98	*2.66*	*2.04E-01*	*1.15E-02*	*2.88*	*1%*	*1.03*	*1.85*
Locations around the Protected Area									
DSB-01	562386.26	6878066.83	*2.68*	*1.59E-01*	*7.27E-03*	*2.85*	*2%*	*1.24*	*1.60*
DSB-02	562580.56	6877804.00	*1.64*	*1.71E-01*	*9.80E-03*	*1.83*	*1%*	*2.82E-01*	*1.54*
DSB-03	562465.86	6877548.58	*3.82E-01*	*4.27E-02*	*2.08E-03*	*4.27E-01*	*2%*	*2.51E-02*	*4.02E-01*
DSB-04	562805.88	6878305.73	*4.54*	*2.82E-01*	*1.05E-02*	*4.84*	*1%*	*2.25*	*2.59*
DSB-05	562740.16	6877732.33	*1.77*	*1.70E-01*	*1.06E-02*	*1.95*	*1%*	*3.22E-01*	*1.63*
DSB-06	562625.45	6877476.91	*4.46E-01*	*4.22E-02*	*2.34E-03*	*4.91E-01*	*3%*	*2.71E-02*	*4.64E-01*
DSB-07	562965.47	6878234.06	*5.06*	*2.82E-01*	*1.19E-02*	*5.35*	*1%*	*2.45*	*2.90*
DSB-08	563083.74	6877578.04	*1.13*	*1.11E-01*	*5.56E-03*	*1.25*	*2%*	*1.60E-01*	*1.09*
DSB-09	562969.03	6877322.61	*3.14E-01*	*2.85E-02*	*1.57E-03*	*3.44E-01*	*2%*	*1.71E-02*	*3.27E-01*
DSB-10	563309.05	6878079.77	*2.95*	*1.77E-01*	*7.12E-03*	*3.14*	*1%*	*1.27*	*1.87*

All Indicated Changes are in response to RAI P-9-5

Table 9-7
Estimated Cumulative Annual Dose Equivalent for All Sources of Radiation in the Region

Receptor	Source[a]	Airborne Pathway mSv (mrem)	Direct Radiation mSv (mrem)	Annual Dose Equivalent mSv (mrem)
Sundance Services	Waste Control Specialists Operations	<6.3x10^{-3} (<0.63)[b]	<1x10^{-7} (<1x10^{-5})	<6.3x10^{-3} (<0.63)
	WCS CISF	N/A	*<4.5x10^{-3}* *<4.5x10^{-1}*	*<4.5x10^{-3}* *<4.5x10^{-1}*
	NEF	2.6x10^{-5} (2.6x10^{-3})	0.026 (2.6)	0.026 (2.6)
Permian Basin Materials (Formerly Wallach Concrete)	Waste Control Specialists Operations	<6.3x10^{-3} (<0.63)[b]	<1x10^{-7} (<1x10^{-5})	<6.3x10^{-3} (<0.63)
	WCS CISF	N/A	*<1.2x10^{-3}* *<1.2x10^{-1}*	*<1.2x10^{-3}* *<1.2x10^{-1}*
	NEF	2.2x10^{-5} (2.2x10^{-3})	0.021 (2.1)	0.021 (2.1)
Nearest Receptor	Waste Control Specialists Operations	<6.3x10^{-3} (<0.63)[b]	<1x10^{-7} (<1x10^{-5})	<6.3x10^{-3} (<0.63)
	WCS CISF	N/A	*<4.5x10^{-11}* *<4.5x10^{-9}*	*<4.5x10^{-11}* *<4.5x10^{-9}*
	NEF	1.3x10^{-5} (1.3x10^{-3})	<1x10^{-6} (<1x10^{-4})	<1.3x10^{-5} (<1.3x10^{-3})
NEF	Waste Control Specialists Operations	<6.3x10^{-3} (<0.63)[b]	<1x10^{-7} (<1x10^{-5})	<6.3x10^{-3} (<0.63)
	CISF	N/A	*<6.0x10^{-4}* *<6.0x10^{-2}*	*<6.0x10^{-4}* *<6.0x10^{-2}*
	NEF	1.7x10^{-4} (1.7x10^{-2})	<0.2 (<20)	<0.2 (<20)
Lea Co Landfill	Waste Control Specialists Operations	<6.3x10^{-3} (<0.63)[b]	<1x10^{-7} (<1x10^{-5})	<6.3x10^{-3} (<0.63)
	CISF	N/A	*<1.5x10^{-4}* *<1.5x10^{-2}*	*<1.5x10^{-4}* *<1.5x10^{-2}*
	NEF	<1.7x10^{-4} (<1.7x10^{-2})	<0.2 (<20)	<0.2 (<20)

All Indicated Changes are in response to RAI P-9-5

[a] Uranium fuel cycle facilities in the region
[b] Based on net dose for perimeter stations in northwest quadrant

Because only previously loaded canisters will be accepted at the WCS CISF the following topics identified in ISG-15 are remain unchanged from what has been previously reviewed and approved by the US NRC in the applications incorporated by reference listed in Section 1.6.

- Material Properties
- Weld Design and Inspection
- Galvanic and Corrosive Reactions
- Bolt Applications
- Protective Coatings and Surface Treatments
- Neutron Shielding Materials
- Materials for Criticality Control
- Seals
- Low Temperature Ductility of Ferritic Steels
- Fuel Cladding, including burnup and cladding temperature limits
- Prevention of Oxidation Damage During Loading of Fuel
- Flammable Gas Generation
- Canister Closure Weld testing and Inspection

15.1.5 Cask Handling Building

The materials used in the construction of the Cask Handling Building are given in Table 15-1.

15.2.2.2 AHSM

The reinforced concrete AHSM is designed to meet the requirements of ACI 349-97. Load combinations specified in ANSI 57.9-1984, Section 6.17.3.1 are used for combining normal operating, off-normal, and accident loads for the AHSM.

15.2.2.3 HSM Model 102

The HSM Model 102 reinforced concrete is designed to meet the requirements of ACI 349-85 and ACI 349-97 Editions, respectively. Load combinations specified in ANSI 57.9-1984, Section 6.17.3.1 are used for combining normal operating, off-normal, and accident loads for the HSM.

15.2.2.4 NAC-MPC VCC

The American Concrete Institute Specifications ACI 349 (1985) and ACI 318 (1995) govern the NAC-MPC system VCC design and construction, respectively.

15.2.2.5 NAC-UMS VCC

The American Concrete Institute Specifications ACI 349 (1985) and ACI 318 (1995) govern the NAC-UMS system VCC design and construction, respectively.

15.2.2.6 MAGNASTOR VCC

The American Concrete Institute Specifications ACI-349 (1985) and ACI-318 (1995) govern the MAGNASTOR system VCC design and construction, respectively.

15.2.3 Transfer Casks for Vertical Systems

The ANSI N14.6 (1993) and NUREG-0612 govern the NAC-MPC, NAC-UMS and MAGNASTOR system transfer cask designs, operations, fabrication, testing, inspection, and maintenance.

15.2.4 Cask Handling Building

Materials for Cask Handling Building steel structures will be constructed to ANSI/AISC 360-16. Materials for the Cask Building Overhead Cranes will adhere to NOG-1-2015 fracture toughness requirements. The reinforced concrete structures in the Cask Handling Building are designed to ACI 349-13 and constructed to ACI 318-08.

All Indicated Changes are in response to RAI NP-7-12

Coefficient of Thermal Expansion, α (x 10^{-6} in/in/°F)	5.9
Density (lbm/in^3)	0.29

15.3.4 Cask Handling Building

The Cask Handling Building is built with the use of reinforced concrete for foundation and slab, and structural steel members for above-ground structure.

The specifications and details that apply to these materials are given in Table 15-2.

Table 15-1
Material Specifications for Cask Handling Building Structures

Structural Element	***Applicable Material Specification***
Wide Flange Beams and Columns	*ASTM A992 Grade 50*
Channels	*ASTM A572 Grade 50*
Angles	*ASTM A572 Grade 50*
Plate	*ASTM A572 Grade 50*
Hollow Structural Shapes	*ASTM A1085*
Bolts for primary framing connections	*ASTM F3125 Grade A325*
Crane Rail	*ASTM A759*
Anchor Rods	*ASTM A193 Grade B7*
Concrete Reinforcing Steel	*ASTM A706 Grade 60*

Table 15-2
Material Properties for Cask Handling Building Structural Analysis and Design

Structural Element	Property	Value
Structural Steel Members and Plates	Elastic Modulus, E	29,000 ksi
	Poisson's Ratio, μ	0.30
	Coefficient of Thermal Expansion, α	6.5 x 10-6 in/(in°F)
	Unit Weight, γ	0.490 kip/ft^3
	Specified Yield Strength, F_y	50 ksi
Concrete Foundation and Slab	Specified Compressive Strength, f'_c	4500 psi
	Elastic Modulus, E	3820 ksi
	Poisson's Ratio, μ	0.17
	Coefficient of Thermal Expansion, α	5.5 x 10-6 in/(in°F)
	Unit Weight, γ	0.150 kip/ft^3
Concrete Reinforcing Steel	Specified Yield Strength, F_y	60 ksi
Anchor Rods	Specified Yield Strength, F_y	105 ksi
	Specified Tensile Strength, F_u	125 ksi
Structural Fill	Unit Weight, γ	0.110 kip/ft^3

All Indicated Changes are in response to RAI NP-7-12

A.11. CONFINEMENT EVALUATION

The design criteria for the NUHOMS® MP187 Cask System requires that the FO-, FC, FF- Dry Shielded Canisters (DSCs or canisters) and GTCC Canister are designed to ensure confinement of stored materials under normal, off-normal, and accident conditions during all operations, transfers, and storage. This chapter summarizes the system design features that ensure radiological releases are within limits and will remain As Low As Reasonably Achievable (ALARA), and that spent nuclear fuel (SNF) cladding and SNF assemblies are protected from degradation during storage.

As stated in Section 5.1.3.1, a post-transportation evacuated volume helium leak test will be conducted for each canister, as prudent measure, to confirm that a canister remains able to perform its safety function and is, therefore, acceptable for storage at the WCS CISF. Table A.11-9 identifies the accessible portions of the canister confinement boundary along with those portions that are inaccessible for the post-transportation leak test.

As documented in Section 8.2.2 of Appendix C of [A.11-1] the confinement evaluation for the FO-, FC- and FF- DSCs bound the GTCC canister; therefore, no additional discussion for the GTCC canister is required in this chapter.

All Indicated Changes are in response to RAI P-5-1

Table A.11-9
Canister Confinement Boundaries

Accessible Portions	***Inaccessible Portions***
NUHOMS®-MP187 Cask System Canisters FO-, FC-, FF-DSCs and GTCC Canister	
• *Shell* • *Shell long seam welds* • *Shell circumferential welds, if present*	• *Inner Bottom Cover Plate (IBCP)* • *IBCP to Shell weld* • *Siphon and Vent block (S&VB)* • *S&VB Cover Plates* • *Inner Top Cover Plate (ITCP)* • *ITCP to shell weld* • *S&VB Cover to S&VB welds* • *S&VB to Shell weld*

All Indicated Changes are in response to RAI P-5-1

B.11 CONFINEMENT EVALUATION

The design criteria for the Standardized Advanced NUHOMS® 24PT1 Dry Shielded Canister (DSC or canister) require that the canister is designed to maintain confinement of radioactive material under normal, off-normal, and accident conditions associated with spent nuclear fuel (SNF) handling, storage and off-site transportation.

As stated in Section 5.1.3.1, a post-transportation evacuated volume helium leak test will be conducted for each canister, as prudent measure, to confirm that a canister remains able to perform its safety function and is, therefore, acceptable for storage at the WCS CISF. Table B.11-1 identifies the accessible portions of the canister confinement boundary along with those portions that are inaccessible for the post-transportation leak test.

All Indicated Changes are in response to RAI P-5-1

Table B.11-1
Canister Confinement Boundaries

Accessible Portions	***Inaccessible Portions***
Advanced Standardized NUHOMS® System Canisters NUHOMS® 24PT1	
• *Shell* • *Shell long seam welds* • *Shell circumferential welds, if present*	• *Inner Bottom Cover Plate (IBCP)* • *IBCP to Shell weld* • *Siphon and Vent block (S&VB)* • *S&VB Cover Plates* • *Inner Top Cover Plate (ITCP)* • *ITCP to shell weld* • *S&VB Cover to S&VB welds* • *S&VB to Shell weld*

All Indicated Changes are in response to RAI P-5-1

C.11 CONFINEMENT EVALUATION

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

As stated in Section 5.1.3.1, a post-transportation evacuated volume helium leak test will be conducted for each canister, as prudent measure, to confirm that a canister remains able to perform its safety function and is, therefore, acceptable for storage at the WCS CISF. Table C.11-1 identifies the accessible portions of the canister confinement boundary along with those portions that are inaccessible for the post-transportation leak test.

All Indicated Changes are in response to RAI P-5-1

Table C.11-1
Canister Confinement Boundaries

Accessible Portions	***Inaccessible Portions***
Standardized NUHOMS® System Canisters *NUHOMS® 61BT*	
• *Shell* • *Shell long seam welds* • *Shell circumferential welds, if present*	• *Inner Bottom Cover Plate (IBCP)* • *IBCP to Shell weld* • *Siphon and Vent block (S&VB)* • *S&VB Cover Plates* • *Inner Top Cover Plate (ITCP)* • *ITCP to shell weld* • *S&VB Cover to S&VB welds* • *S&VB to Shell weld*

All Indicated Changes are in response to RAI P-5-1

D.11 CONFINEMENT EVALUATION

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

As stated in Section 5.1.3.1, a post-transportation evacuated volume helium leak test will be conducted for each canister, as prudent measure, to confirm that a canister remains able to perform its safety function and is, therefore, acceptable for storage at the WCS CISF. Table D.11-1 identifies the accessible portions of the canister confinement boundary along with those portions that are inaccessible for the post-transportation leak test.

All Indicated Changes are in response to RAI P-5-1

Table D.11-1
Canister Confinement Boundaries

Accessible Portions	***Inaccessible Portions***
Standardized NUHOMS® System Canisters NUHOMS® 61BTH Type 1	
• *Shell* • *Shell long seam welds* • *Shell circumferential welds, if present*	• *Inner Bottom Cover Plate (IBCP)* • *IBCP to Shell weld* • *Siphon and Vent block (S&VB)* • *S&VB Cover Plates* • *Inner Top Cover Plate (ITCP)* • *ITCP to shell weld* • *S&VB Cover to S&VB welds* • *S&VB to Shell weld*

All Indicated Changes are in response to RAI P-5-1

E.11 CONFINEMENT EVALUATION

The NAC-MPC storage system is provided in three configurations. The Yankee-MPC provides storage for up to 36 intact Yankee Class spent fuel assemblies and reconfigured fuel assemblies (RFA). The CY-MPC holds up to 26 Connecticut Yankee spent fuel assemblies, reconfigured fuel assemblies or damaged fuel cans. The MPC-LACBWR provides storage for up to 68 Dairyland Power Cooperative La Crosse Boiling Water Reactor spent fuel assemblies with 32 damaged fuel cans. These three configurations of the NAC-MPC have similar components and operating features, but have different physical dimensions, weights and storage capacities. Confinement features for the Yankee-MPC and CY-MPC systems are addressed in the main body of Chapter 7 of Reference E.11-1. Appendix 7.A of Reference E.11-1 has been added to address the MPC-LACBWR system. Figures illustrating the confinement boundary for the Yankee-MPC and CY-MPC are found in Figures 7.1-1 and 7.1-2 of Reference E.11-1. The Figure illustrating the confinement boundary for the MPC-LACBWR is found in Figure 7.A.1-1 of Reference E.11-1.

The codes and standards for the design, fabrication, and inspection of the canister and confinement boundary are detailed in Reference E.11-2. Specifically, Appendix B, Section B.3.3, "Codes and Standards", which states the ASME Boiler and Pressure Vessel Code (ASME Code), 1995 Edition with Addenda through 1995, is the governing Code for the NAC-MPC System canister except that Addenda through 1997, are applied for critical flaw evaluation of the canister closure weld and Section B.3.3.1, "Alternatives to the ASME Code," which lists the Code alternatives for the canister in Table B3-1. Included in this table is the leaktight criterion of ANSI N14.5 for the canister.

Appendix A, Section A 3.1, "NAC-MPC System Integrity," of Reference E.11-2, includes limiting condition for operation (LCO) 3.1.1 for canister maximum vacuum drying time, LCO 3.1.2 for canister vacuum drying pressure, and LCO 3.1.3 for canister helium backfill pressure. These LCOs create a dry, inert, leaktight atmosphere, which contributes to preventing the leakage of radioactive material.

The confinement features of the NAC-MPC system for Yankee Rowe, Connecticut Yankee and La Crosse are such that the potential for canister leakage is not credible. Similarly, the storage of reactor generated GTCC waste from Yankee Rowe and Connecticut Yankee within a welded closed GTCC-Canister-YR and GTCC-Canister-CY does not present the potential for a credible leakage path. In addition, GTCC waste is a non-gas generation media. Thus, there is no means of dispersal from the GTCC-Canister-YR and GTCC-Canister-CY.

As stated in Section 5.1.3.1, a post-transportation evacuated volume helium leak test will be conducted for each canister, as prudent measure, to confirm that a canister remains able to perform its safety function and is, therefore, acceptable for storage at the WCS CISF. Table E.11-1 identifies the accessible portions of the canister confinement boundary along with those portions that are inaccessible for the post-transportation leak test.

All Indicated Changes are in response to RAI P-5-1

Table E.11-1
Canister Confinement Boundaries

Accessible Portions	***Inaccessible Portions***
NAC-MPC Yankee Class and Connecticut Yankee Class and the GTCC-Canister-CY and GTCC-Canister-YR	
• *Shell* • *Bottom Plate* • *Shell long seam welds* • *Shell circumferential welds, if present* • *Shell to Bottom Plate weld*	• *Shield Lid* • *Port Covers* • *Shield Lid to Shell Welds* • *Shield Lid to Port Cover welds*
NAC-MPC LACBWR	
• *Shell* • *Bottom Plate* • *Shell long seam welds* • *Shell circumferential welds, if present* • *Shell to Bottom Plate weld* • *Closure Lid (portion inside closure ring)*	• *Closure lid under the closure ring* • *Closure lid to shell weld* • *Port Covers (inner set)* • *Closure lid to port cover weld (inner set)*

All Indicated Changes are in response to RAI P-5-1

F.11 CONFINEMENT EVALUATION

The NAC-UMS storage system is provided in two configurations, PWR – 3 different lengths and BWR – 2 different lengths. The NAC-UMS provides storage for up to 24 PWR spent fuel assemblies or up to 56 BWR spent fuel assemblies. These configurations of the NAC-UMS have similar components and operating features, but have different physical dimensions, weights and storage capacities.

Confinement features for the NAC-UMS system are addressed in the main body of Chapter 7 of the NAC-UMS FSAR, Reference F.11.2-1. Figures illustrating the confinement boundary for the NAC-UMS are found in Figures 7.1-1 and 7.1-2 or Reference F.11-1.

The codes and standards for the design, fabrication, and inspection of the canister and confinement boundary are detailed in Reference F.11-2. Specifically, Appendix B, Section B 3.3, "Codes and Standards," which states the ASME Code, 1995 Edition with Addenda through 1995, is the governing Code for the NAC-UMS canister and Section B 3.3.1, "Exception to Codes, Standards, and Criteria," which lists the Code exception for the canister in Table B3-1. Included in this table is the leaktight criterion of ANSI N14.5 for the canister.

Appendix A, Section A 3.1, "NAC-UMS System Integrity," of Reference F.11.2, includes limiting condition for operations (LCO) 3.1.1 for canister maximum vacuum drying time, LCO 3.1.2 for canister vacuum drying pressure, and LCO 3.1.3 for canister helium backfill pressure. These LCOs create a dry, inert, leaktight atmosphere, which contributes to preventing the leakage of radioactive material.

The confinement features of the NAC-UMS system for PWR fuel are such that the potential for canister leakage is not credible. Similarly, the storage of reactor generated GTCC waste from Maine Yankee within a welded closed GTCC-Canister-MY does not present the potential for a credible leakage path. In addition, GTCC waste is a non-gas generation media. Thus, there is no means of dispersal from the GTCC-Canister-MY.

As stated in Section 5.1.3.1, a post-transportation evacuated volume helium leak test will be conducted for each canister, as prudent measure, to confirm that a canister remains able to perform its safety function and is, therefore, acceptable for storage at the WCS CISF. Table F.11-1 identifies the accessible portions of the canister confinement boundary along with those portions that are inaccessible for the post-transportation leak test.

All Indicated Changes are in response to RAI P-5-1

Table F.11-1
Canister Confinement Boundaries

Accessible Portions	***Inaccessible Portions***
NAC-UMS Classes 1 through 5 and GTCC-Canister-MY	
• *Shell* • *Bottom Plate* • *Shell long seam welds* • *Shell circumferential welds, if present* • *Shell to Bottom Plate weld*	• *Shield Lid* • *Port Covers* • *Shield Lid to Shell welds* • *Shield Lid to Port Cover welds*

All Indicated Changes are in response to RAI P-5-1

G.11 CONFINEMENT EVALUATION

The MAGNASTOR TSC provides confinement for its radioactive contents in long-term storage. The confinement boundary provided by the TSC is closed by welding, creating a solid barrier to the release of contents in the design basis normal conditions and off-normal or accident events. The welds are visually inspected and nondestructively examined to verify integrity. The figure illustrating the confinement boundary for the NAC-MAGNASTOR is found in Figure 7.1-1 of Reference G.11-1.

The sealed TSC contains a pressurized inert gas (helium). The confinement boundary retains the helium and also prevents the entry of outside air into the TSC in long-term storage. The exclusion of air precludes fuel rod cladding oxidation failures during storage.

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

The codes and standards for the design, fabrication, and inspection of the canister and confinement boundary are detailed in Reference G.11-2. Specifically, Appendix A, Section 4.2, “Codes and Standards,” which states the ASME code, 2001 Edition with Addenda through 2003, Section III, Subsection NB, is the governing Code for the design, material procurement, fabrication, and testing of the canister and Section 4.2.1, “Alternatives to Codes, Standard, and Criteria,” which lists the approved alternatives to the ASME Code in Table 2.1-2 in the NAC MAGNASTOR Final Safety Analysis Report (FSAR). In addition, Section 4.1.4, “TSC Confinement Integrity,” which states the leaktight criterion for the canister in ANSI N14.5.

Appendix A, Section 3.1, “MAGNASTOR System Integrity,” of Reference G.11-2, includes limiting condition for operation (LCO) 3.1.1 for canister maximum vacuum drying time, canister vacuum drying pressure, and canister helium backfill density. These LCOs create a dry, inert, leaktight atmosphere, which contributes to preventing the leakage of radioactive material.

As stated in Section 5.1.3.1, a post-transportation evacuated volume helium leak test will be conducted for each canister, as prudent measure, to confirm that a canister remains able to perform its safety function and is, therefore, acceptable for storage at the WCS CISF. Table G.11-1 identifies the accessible portions of the canister confinement boundary along with those portions that are inaccessible for the post-transportation leak test.

All Indicated Changes are in response to RAI P-5-1

Table G.11-1
Canister Confinement Boundaries

Accessible Portions	***Inaccessible Portions***
NAC-MAGNASTOR TSC1 through TSC4 and GTCC-Canister-ZN	
• *Shell* • *Bottom Plate* • *Shell long seam welds* • *Shell circumferential welds, if present* • *Shell to Bottom Plate weld* • *Closure Lid (portion inside closure ring)*	• *Closure lid under the closure ring* • *Closure lid to shell weld* • *Port Covers (inner set)* • *Closure lid to port cover weld (inner set)*