Safety Analysis Report (SAR), Chapter 3, "Principal Design Criteria"

RAI NP-3-7:

Clarify the basis or scope supporting classification of the Canister Transfer System (CTS) and Vertical Cask Transporter (VCT) as important to safety (ITS) Category B systems in WCS CISF SAR Table 3-5, "Quality Assurance Classification of Structures, Systems, and Components as Utilized at the WCS CISF."

NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components Accordance to Importance to Safety," defines ITS Category B as structures, systems and components (SSCs) whose failure or malfunction could indirectly result in a condition adversely affecting public health and safety. Thus, the failure of a Category B item, in conjunction with the failure of an additional item, could result in an unsafe condition. NUREG/CR-6407 defines ITS Category A as SSCs whose failure or malfunction could directly result in a condition adversely affecting public health and safety. Thus, the failure of a single item could cause loss of primary containment leading to release of radioactive material, loss of shielding, or unsafe geometry compromising criticality control.

The CTS and VCT handling systems each contain components, such as certain structural members and special lifting devices, whose failure could cause canisters loaded with fuel to drop under conditions (i.e., drop heights and overpack configurations) that have not been evaluated to show that primary containment and a safe geometry would be maintained. Therefore, to clarify the classification and scope, either provide an evaluation showing a single component failure within the CTS or VCT handling systems would not directly result in a condition adversely affecting public health and safety to justify classification of the overall systems as ITS Category B or designate portions of the CTS and VCT handling systems as ITS Category A.

This information is needed to determine compliance with 10 CFR 72.122(a).

Response to RAI NP-3-7:

The CTS is designed as a single-failure-proof (SFP) system for MAGNASTOR Transfer Cask (MTC) and canister handling. Section 7.5.1.5 of the WCS CISF Safety Analysis Report (SAR) describes the safety features for the CTS and gives the basis for categorizing the CTS as an SFP system. NUREG-0612 Section 5.1.6(3)(b) and ANSI N14.6 Section 7.1 recognize that SFP criteria can be met with increased stress design factors, and dual load paths are not necessarily required. As the entire CTS, including all components within a single load path, is designed as SFP in accordance with NUREG-0612 and ANSI N14.6 requirements, failure or malfunction of a single SSC that would result in a condition adversely affecting public health and safety could not reasonably be expected to occur. As such, the CTS has an overall classification as Category B.

As described in Section 7.5.2, failure modes for VCT operations associated with the handling of the loaded vertical concrete casks (VCCs) are bounded by existing drop analyses and the VCT can therefore be considered having an overall classification as Category B. For the instance of the VCT upending the transport cask and removing it or placing it onto the railcar, the VCT in this operation is designed to be SFP.

The license submittal outlines maintenance and testing requirements for the indicated SSCs and, as such, will ensure continuing compliance with their respective designations. The operational and continuing compliance requirements will also be proceduralized in accordance with the Heavy Loads Program, which is described in new SAR Section 4.7.5. With respect to initial construction and fabrication, the initial acceptance and load testing requirements validate the load bearing SSCs.

Impact:

SAR Section 4.7.5 and Table 4-3 have been added as described in the response.

SAR Chapter 5, "Operational Systems & Procedures"

RAI NP-5-1:

Describe how the air-powered chain hoist used as part of the Canister Transfer System (CTS) satisfies the single-failure-proof criteria of NUREG-0612. The response should specify the degree of conformance with ASME NUM-1, "Rules for Construction of Cranes, Monorails, and Hoists (with Bridge or Trolley or Hoist of the Underhung Type)," criteria for Type IA or IB hoists, and, if compared to the Type IB criteria, justify the lack of redundant torque transfer mechanisms between the braking device and the chain considering the effects of fatigue and wear over the course of the facility's operations.

WCS CISF SAR Section 5.2.1.3.2, Safety Features, states:

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

As described in WCS CISF SAR Section 7.5.1, "Canister Transfer System," the CTS includes an air-powered chain hoist for transfer of NAC fuel canisters from the transportation to the storage casks. The chain hoist is described as having a single disc brake of 200% design capacity and inherent air-motor braking acting through the gear train, but the NUREG-0612 criteria specify redundant holding brakes acting via redundant gear trains. Therefore, the described design does not appear to fully satisfy the single-failure-proof criteria of NUREG-0612.

This information is needed in order to confirm compliance with 10 CFR 72.24(c)(4).

Response to RAI NP-5-1:

The air-powered chain hoist is designed in accordance with ASME B30.16 and implemented with increased safety factors per ASME NUM-1 for a type 1B hoist to provide enhanced safety as required by NUREG-0612, including several safety features not typically found on commercially available hoists. NUM-1 crane standards incorporate design requirements specific to the concerns of "two blocking" or "load hang-up", and ensure that the cranes are designed either to withstand all such incidents without damage or loss of load, or to make the likelihood of their occurrence extremely small.

The system has a design rated load of 110 tons, which is two times larger than the maximum critical load (MCL) of 55 tons. Since the system is designed for a safety factor of 5 times the rated load, the overall factor of safety to the MCL load is 10 to 1.

The chain hoist meets the ASME NUM-1, Type 1B critical load handling hoist standards.

i. Redundant braking comprised of:

- An air actuated disc type brake (primary), and
- Drive train braking (redundant)

With respect to redundant breaking and the complexity of the system, ASME NUM-1[1], Type 1B specifically applies to the chain hoist used for raising and lowering the loaded canister from the transportation cask to the storage overpack. Each chain hoist incorporates increased safety factors:

- Upon loss of air, the hoist brakes will engage preventing the load from moving
- Brakes designed for 2x Load
- Redundant braking provided by drive train braking limits lowering speed to half normal speed
- Hoist designed for 2x Load
- Hoist motor stall limit setting prevents overload due to block contact with body of hoist (2-block event)

From ASME NUM-1-2009:

> "Type 1 equipment: a crane monorail or hoist that is used to handle a critical load."
>
> "Type 1B equipment: a Type I crane, monorail, or hoist with enhanced safety features, including increased design factors and redundant components that minimize the potential for failure that would result in the loss of capability to stop and control the critical load."

ii. Controlled lowering speed of no greater than 9 inches per minute (field test results confirm 6 inches per minute lowering speed)

iii. Redundant two blocking protection via an upper limit switch (primary) and the air stall feature (redundant)

iv. Load test to 300% of the 55 ton MCL, which exceeds the ASME NUM-1 requirements. Please note that the 300% load test is the manufacturing verification load test for single-failure-proof components. Continuing Service testing is by inspection or 150% load testing.

v. Rigorous testing including:

   - Hoist speed and brake holding
   - Drive train braking (redundant brake)
   - Limit switch operation
   - Load hang up and two blocking protection (redundant with the limit switch) via air stall

vi. The Drive train is a standard design three-stage planetary gear box. Each gear box is rated at 5 times the load and provides reasonable protection against failure.

Annual complete hoist and drive train inspection to preclude any fatigue failure of hoist components, along with pre-use inspections prior to each use:

i. Usage of the chain hoist will be a small fraction of the usage considered “normal service” by ASME B30.16 from both load and frequency perspectives. “Normal Service” is defined as “uniform loads less than 65% of rated load for not more than 25% of the time”.

ii. Annual inspections include the manufacturers recommended inspections of all components, including fasteners, gears, shafts, bearings, sheaves, chain guides, springs, covers, load chain sheaves, motor components, brake components, load chain end anchors and the chain.

References:

1. ASME NUM-1-2009, Rules for Construction for Cranes, Monorails and Hoists

Impact:

No change as a result of this RAI.

SAR Chapter 7, "Installation Design and Structural Evaluation"

RAI NP-7-1:

Specify how the cask handling building (CHB) overhead crane design combines seismic loadings with normal loadings (e.g., CMAA #70, "Specifications for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Travelling Cranes," with discussion of how seismic loading is incorporated or an appropriate alternative standard such as the design criteria for a Type II crane as defined in ASME NOG-1), and justify the "not-important-to-safety" (NITS) classification of the crane structure exclusive of the seismic clips and runway beams.

The design measures necessary to ensure the crane structure itself can withstand design seismic loading must be specified to verify the crane structure would not fall and damage important-to-safety (ITS) equipment per 10 CFR 72.122(b). WCS CISF SAR Section 7.5.3.1 states the following regarding seismic design of the overhead bridge cranes:

> The overhead bridge cranes are classified as [NITS] and are designed in accordance with ANSI B30.2, "Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)." The overhead bridge cranes rails are attached to the CHB structure in a manner that provides adequate assurance that the rails will remain attached to the CHB structure during the above-described seismic event. Seismic clips are provided on the overhead crane bridge trucks and trolley to limit uplift during a seismic event, thereby eliminating the potential for the bridge or trolley to fall onto loaded casks inside the CHB.

Also, WCS CISF SAR Section 3.4.1 states:

> The 130-ton overhead crane and associated NUHOMS® MP197HB and MP187 Casks Lift Beam Assembly are 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 C 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 trucks and trolley seismic clips are ITS.

WCS CISF SAR Section 7.5.3.7, "Structural Analysis and Design," describes how the loadings on the crane runway beams were established, but not the loadings on the crane structure itself.

This information is needed to determine compliance with 10 CFR 72.122(b)(2)(ii).

Response to RAI NP-7-1:

This RAI makes the following requests related to CHB overhead crane design:

1. Justify the NITS classification of the CHB overhead cranes exclusive of the seismic clips and runway beams.

2. Specify the design measures that ensure the crane structure itself can withstand design seismic loading and will not fall and damage ITS equipment.

3. Specify how the overhead crane design combines seismic loadings with normal loadings, with discussion of how seismic loading is incorporated.

These requests are addressed by the following:

1. ISP has redefined the CHB overhead cranes and runway beams as Quality Category B. Specifically, the CHB overhead cranes are equipped with ITS Category B seismic clips on the trolley and bridge to prevent separation of the trolley from the bridge girder and separation of the end trucks from the runway beam. The runway beams and their supporting structures are also ITS Category B to prevent failure or deformation. The integral crane structure consisting of the bridge rails, bridge girders, and trucks, as well as the trolley structure and the various drive components, are also ITS Category B to prevent failure or deformation. The ITS classification of these components, which serve the safety function of preventing collapse of crane structures onto canisters, provides reasonable assurance that collapse and resulting potential for loss or reduction of packaging effectiveness will not occur. For lifting, however, operational protocols limit overhead crane lifts to a height not exceeding the drop height that could cause loss or reduction of packaging effectiveness for the NUHOMS® casks even though for insurance reasons and to provide defense in depth, the overhead cranes are analyzed and designed as Type 1, single-failure-proof (SFP) cranes in accordance with American Society of Mechanical Engineers (ASME) NOG-1-2015, even though this does not form the licensing basis for these components.

2. The crane structures (bridge rails, bridge girders, trucks, etc.) do not have the potential for collapse onto canisters, e.g., during seismic loading as long as the ITS Category B seismic clips and runway support structure retain their safety function. The cranes are, however, analyzed and designed as Type 1, SFP cranes, in accordance with ASME NOG-1-2015, providing defense-in-depth as discussed above. In accordance with ASME NOG-1-2015, Section 4150, seismic demands on the overhead cranes are determined from modal response spectrum analysis of a three-dimensional mathematical model meeting all requirements of Section 4153, including requirements for model geometry, boundary conditions, and trolley and hook positions. WCS CISF Safety Analysis Report (SAR) Sections 7.5.3.2.4 and 7.5.3.6 have been added to reflect this discussion.

3. New WCS CISF SAR Sections 7.5.3.2.4 and 7.5.3.6 have been added to provide clarification that seismic demands on the CHB overhead cranes are analyzed in accordance with ASME NOG-1-2015 and ASCE 4-16 and to provide more details on incorporation of seismic loading.

SAR Sections 3.2.3.10.9, 3.2.8.4, 3.2.8.6, 3.4.1, 4.7.2, and 7.5.3.1.3, and Table 3-5, have further been revised to reflect the SFP design of the overhead crane in accordance with NOG-1-2015 and clarify the classification of the overhead crane bridge truck, trolley seismic clips, bridge rails, bridge girders, and trucks, as well as the trolley structure and crane runway support beams as ITS Category B structures, systems, and components (SSCs).

Impact:

SAR Sections 3.2.3.10.9, 3.2.8.4, 3.2.8.6, 3.4.1, 4.7.2, 7.5.3, 7.5.3.1.3, and 7.5.3.2.4 and Table 3-5, have been revised as described in the response. SAR Sections 7.5.3.2.4, and 7.5.3.6 have been added as described in the response.

RAI NP-7-12:

Provide a report for the design of the CHB that, at a minimum, includes the following: (1) the dimensions of all sections that have a structural role including locations, sizes, configuration, and spacing, (2) structural materials with defining standards or specifications, (3) location and specifications for assembly, and (4) fabrication codes and standards.

WCS CISF SAR Section 7.5.3.7, "Structural Analysis and Design," states that the CHB will be designed using static analysis methods for the determination of forces and moments on structural steel members from service loading conditions and dynamic methods for loading conditions involving seismic loads. The application, however, provides no additional information that would allow the staff to review the design of the CHB consistent with the guidance in Section 5.5.4 of NUREG-1567.

The report provided should include descriptions of the design method used, computer models used, and information on the application of the structural analysis methods used to determine the capacity of the CHB for service and natural phenomena loads. In addition, clarify if the modal response spectrum analysis will be the dynamic method used for the evaluation of seismic loads of the CHB.

This information is needed to determine compliance with 10 CFR 72.122(b)(2)(ii).

Response to RAI NP-7-12:

1. The dimensions (sizes, configuration, and spacing) of all sections with a structural role are provided in new Table 7-41 and new Figures 7-54 through 7-63 in the WCS CISF Safety Analysis Report (SAR), with a corresponding discussion added in Section 7.5.3.1.1.

2. Structural materials with defining standards and specifications are provided in new SAR Table 15-1.

3. Locations and specifications for assembly and connections are provided in new SAR Section 7.5.3.4.2.

4. Fabrication codes and standards are provided in new SAR Section 15.2.4.

Discussion of the design and analysis of the CHB is provided in SAR Section 7.5.3 and all subsections, which have been significantly expanded and restructured, and material and construction specifications and properties have been provided in new sections in SAR Chapter 15. ISP calculations providing the detailed analysis methodology and results will be enclosed with the final response for NRC information. SAR Sections 1.2.3, 7.4, and 7.5 and SAR Figures 1-7 and 1-8 have been revised in accordance with the expanded discussion in Section 7.5.3.

Impact:

SAR Sections 1.2.3, 7.4, 7.5, and 7.5.3 (including all subsections) have been revised, SAR Sections 15.1.5, 15.2.4, and 15.3.4, Tables 7-41, 7-42, 7-43, 15-1, and 15-2, and Figures 1-7, 1-8, and 7-54 through 7-63 have been added as described in the response.

Proprietary Information on Page 9 through Page 24
Withheld Pursuant to 10 CFR 2.390