



FINAL SAFETY EVALUATION REPORT

FOR THE

WCS CONSOLIDATED INTERIM STORAGE FACILITY

INDEPENDENT SPENT FUEL STORAGE INSTALLATION

SPECIFIC MATERIALS LICENSE NO. SNM-2515

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ACRONYMS AND ABBREVIATIONS

ACI	American Concrete Institute
ADAMS	Agencywide Documents Access and Management System
AHSM	Advanced Horizontal Storage Module
AISC	American Institute of Steel Construction
ALARA	as-low-as-reasonably achievable
amsl	Above mean sea level
AMP	Aging management programs
AMR	Aging management review
ANS	American Nuclear Society
ANSI	American National Standard Institute
ARCs	antecedent moisture or runoff conditions
ASCE	American Society of Civil Engineers
ASLB	Atomic Safety and Licensing Board
ASM	Additional Security Measures
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
AWS	American Welding Society
B&PV	Boiler and Pressure Vessel
BE	Best Estimate
bgs	below ground surface
BTP	Branch Technical Position
BWR	Boiling Water Reactor
C	Celsius
CAC	Cost Activity Code
CAS	Central Alarm Station
CBR	California Bearing Ratio
CEUS-SSC	Central and Eastern United States Seismic Source Characterization
CEO	Chief Executive Officer
CG	Center of Gravity
CHB	Cask Handling Building
CISCC	Chloride-Induced Stress Corrosion Cracking
CISF	Consolidated Interim Storage Facility
CN	Curve Number
CoC	Certificate of Compliance
CTS	Canister Transfer System
CY	Connecticut Yankee
D&D	Decontamination and Decommissioning
DCE	Decommissioning Cost Estimate
DCR	Demand/Capacity Ratios
DE	Design Earthquake
DOE	Department of Energy
DP	Decommissioning Plan
DRS	Design Response Spectrum
DSC	Dry Shielded Canisters
EPRI	Electric Power Research Institute
EPID	Enterprise Project Identifier

ACRONYMS AND ABBREVIATIONS

EOC	Emergency Operations Center
ER	Environmental Report
ERO	Emergency Response Organization
F	Fahrenheit
FC	Fuel control
FHWA	Federal Highway Administration
FSAR	Final safety analysis report
FF	Failed Fuel
FO	Fuel Only
GISF	Generic Interim Storage Facility
GTCC	greater-than-Class C
GMM	Ground-motion attenuation model
HEC-HMS	Hydrologic Engineering Center Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Center River Analysis System
HSM	Horizontal Storage Modules
IC	Incident Commander
ISFSI	Independent Spent Fuel Storage Installation
ISG	Interim Staff Guidance
ISP	Interim Storage Partners
ITS	important-to-safety
ITS-B	ITS Category B
ITS-C	ITS Category C
JFLCO	J. F. Lehman & Company
kg	kilogram
kN	kilonewtons
LB	Lower bound
LACBWR	LaCrosse Boiling Water Reactor
LCO	Limiting conditions for operation
LLEA	Local law enforcement agency
LES	Louisiana Energy Services
LLC	Limited liability company
LLRW	low-level radioactive waste
LWR	Light Water Reactor
MAPS	Managing Aging Processes in Storage
MOX	Mixed-Oxide
mrem	Millirem
MRS	Monitored Retrievable Storage
MT	Metric tons
MTU	Metric tons uranium
NAC	NAC International
NASA	National Aeronautics and Space Administration
NCHRP	National Cooperative Highway Research Program
NCT	Normal conditions of transport
NDT	Nondestructive Testing
NEF	National Enrichment Facility
NOAA	National Oceanic and Atmospheric Administration
NQA	Nuclear Quality Assurance
NSHMP	National Seismic Hazard Mapping Project

ACRONYMS AND ABBREVIATIONS

NWS	National Weather Service
NM	New Mexico
NGA-West2	Next Generation Attenuation—West2
NRC	Nuclear Regulatory Commission
NITS	not important to safety
NWS	National Weather Service
OAG	Ogallala-Antlers-Gatuña
OCA	Owner-controlled area
OCSI	Orano CSI LLC
OCUSA	Orano USA
OUSA	Orano USA LLC
OSL	Optically stimulated luminescence
pa	pascals
PA	Protected area
PGA	peak ground acceleration
pci	per cubic inch
PFS	Private Fuel Storage
psf	Per square foot
psi	pound per square inch
PSHA	probabilistic seismic hazard analysis
PMF	probable maximum flood
PMP	probable maximum precipitation
PSP	Physical security plan
PWR	pressurized-water reactor
QA	Quality Assurance
QAP	Quality Assurance Program
QAPDM	Quality Assurance Program Description Manual
RG	Regulatory Guide
RAI	request for additional information
RCRA	Resource Conservation and Recovery Act
ref-cm	Reference cubic centimeters
RSI	Request for supplemental information
RSO	Radiation Safety Officer
SAR	safety analysis report
SEI	Structural Engineering Institute
SER	safety evaluation report
SFP	Single-failure-proof
SFST	Spent Fuel Storage Transportation
SNF	Spent Nuclear Fuel
SLES	Safeguards LAN/Electronic Safe
SNM	Special Nuclear Material
SPM	Services Program Manual
SPT	standard penetration resistance test
SR	Surveillance Requirement
SSC	systems, structures, and components
SSI	soil-structure interaction
SSHAC	Seismic Hazard Analysis Committee
STC	Storage Transport Cask

ACRONYMS AND ABBREVIATIONS

TETN	Texas Engineering Technical Note
TLAA	Time-limited aging analyses
TN	Transnuclear
TX	Texas
tnris.org	Texas Natural Resources Information System
TS	technical specifications
TSC	transportable storage canister
TXN	Texas & New Mexico Railway
TWDB	Texas Water Development Board
UB	Upper bound
10 CFR	Title 10 of the <i>Code of Federal Regulations</i>
UHS	uniform hazard spectrum
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VCC	Vertical concrete cask
VCT	Vertical Cask Transporter
WCS	Waste Control Specialists, LLC
VT	visual testing
WRCC	Western Regional Climate Center
YR	Yankee Rowe
ZPA	Zero period acceleration
ZN	Zion

EXECUTIVE SUMMARY

By letter dated April 28, 2016, Waste Control Specialists LLC, submitted a license application to the U.S. Nuclear Regulatory Commission (NRC) to construct and operate a consolidated interim storage facility (CISF), which the applicant referred to as the WCS CISF, for spent nuclear fuel (SNF) and Greater-Than-Class C (GTCC) waste in Andrews County, Texas. The application specified a possession limit for spent nuclear fuel (SNF) of 5,000 metric tons total of uranium and mixed oxide, and a possession limit of 231.3 metric tons (510,000 pounds) for GTCC waste. The application requested a license term of 40 years.

On April 18, 2017, Waste Control Specialists LLC requested that the NRC temporarily suspend all safety and environmental review activities. On June 8, 2018, as supplemented on July 19, 2018, Interim Storage Partners LLC (ISP), a joint venture of Waste Control Specialists LLC and Orano CIS, LLC, (a subsidiary of Orano USA), requested that the NRC resume all safety and environmental review activities associated with the proposed WCS CISF.

The applicant prepared the application consistent with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste." The applicant also relied on information provided in Regulatory Guide (RG) 3.50, "Standard Format and Content for a Specific License Application for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Facility," to prepare a draft license." The application consists of the following documents:

1. A **License Application**, in which the applicant describes itself and provides some general and financial information, as required by 10 CFR 72.22;
2. A **Safety Analysis Report (SAR)**, in which the applicant describes its plans for designing, constructing, operating, maintaining, and decommissioning the proposed WCS CISF, as required by 10 CFR 72.24. The applicant prepared the SAR using Regulatory Guide 3.48, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)," Revision 1, dated August 1989, and NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities, Final Report," dated March 2000, and the Interim Staff Guidance used by the Spent Fuel Project Office;
3. An **Emergency Plan**, in which the applicant describes its plan for resolving any emergencies that happen during the WCS CISF's operation, as required by 10 CFR 72.32;
4. An **Environmental Report**, in which the applicant provides information, as required by 10 CFR 72.34, that the staff uses for its environmental review, conducted in parallel with preparation of the staff's safety evaluation report (SER). The staff published a Draft Environmental Impact Statement (EIS) in May 2020 and issued a Final EIS in July 2021; and
5. A **Physical Security Plan**, in which the applicant describes its plans for ensuring that the WCS CISF and nuclear material are appropriately protected. This document contains nonpublic safeguards information. It includes the Security Training and Qualification Plan and Safeguards Contingency Plan, as required by 10 CFR 72.180 and

72.184. The staff performs this review in parallel with the safety evaluation and documents the review in a separate security evaluation.

This SER documents the staff's review and conclusions on the safety-related aspects of the license application. The staff conducted its technical review in accordance with the applicable NRC regulations in 10 CFR Part 20 "Standards for Protection Against Radiation" and Part 72. The staff reviewed the applicant's safety analysis report (SAR) following the guidance in NUREG-1567 (NRC 2000), applicable regulatory guides, and interim staff guidance.

Unless otherwise stated, this SER references information in SAR Revision 5, documents cited in or attached to the SAR, the applicant's responses to the staff's requests for additional information, and other relevant literatures.

As noted above, the license application requests to store SNF at the WCS CISF, an away-from-reactor independent spent fuel storage installation (ISFSI), for a license period of 40 years. At least 2 years before the end of this license term, the licensee may submit an application to renew the license. The proposed WCS CISF would provide an option for storing SNF from U.S. commercial nuclear power reactors. The WCS CISF would consist of dry cask storage systems stored on concrete pads, including up to 500 storage casks, onsite cask transporters, and transfer casks. The dry cask storage systems used at the proposed WCS CISF include the NUHOMS®-MP187 Cask System, Standardized Advanced NUHOMS System, Standardized NUHOMS System, NAC-MPC, NAC-UMS®, and NAC MAGNASTOR®. As discussed below, the NRC has previously issued certificates of compliance (CoCs) under 10 CFR Part 72, Subpart L, "Approval of Spent Fuel Storage Casks," for each of these systems except the NUHOMS MP187 Cask System, which the NRC previously licensed for use at the Rancho Seco ISFSI under 10 CFR Part 72, Subpart C, "Issuance and Conditions of License." As part of its application, ISP incorporated by reference final safety analysis reports corresponding to these six storage systems. The previously licensed systems include canisters that are suitable for both storage and transportation; however, the scope of this licensing action is limited to onsite SNF storage under 10 CFR Part 72. These systems provide structural protection and radiation shielding for canisters containing SNF and GTCC waste. The onsite handling of the cask systems would be accomplished using a cask handling building.

Description of the WCS CISF Site

The applicant proposes to locate the WCS CISF 1.5 miles north of the entrance to the WCS CISF site at 9998 Highway 176 West, which is approximately 32 miles west of Andrews, Texas, and 6 miles east of Eunice, New Mexico. The WCS CISF would be located on 320 acres of land within 14,000 acres of land owned by WCS, a portion of which WCS currently uses for disposal of hazardous waste regulated under the Resource Conservation and Recovery Act, low-level radioactive waste, and byproduct waste. There are no nearby lake systems or flowing or intermittent streams. The WCS CISF will include rail sidetracks that depart from the existing WCS CISF site rail loop and extend north and to the west into the protected area (PA) and one of which goes through the cask handling building.

Description of the WCS CISF Storage Systems

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

Safety of the WCS CISF

The staff determined that the proposed WCS CISF and the proposed cask designs are structurally sound and that the SNF and GTCC waste will remain safe within the canister during all phases of operation for normal, off-normal, and accident conditions. The analyses included natural and human-made phenomena, including an in-depth study of potential seismic activity at the WCS CISF. After reviewing the applicant's analyses, the staff concluded that the WCS CISF and the proposed cask designs are structurally safe and will meet all applicable regulatory requirements.

The staff has also determined that the applicant has shown that the SNF within the storage casks will remain subcritical (i.e., unable to sustain a nuclear chain reaction) during all phases of operation for both normal conditions and credible accident conditions. The applicant has provided radiation dose estimates for the surrounding public and the workers at the proposed WCS CISF. The cask systems are welded closed to prevent leakage of radioactive material. Additional shielding is provided by transportation, transfer, and storage casks during handling and storage.

The applicant has estimated that members of the public nearest to the proposed WCS CISF would receive radiation doses below NRC regulatory requirements, which for normal conditions of operation is 0.25 mSv/yr (25 mrem/year) and for credible accidents is 0.05 Sv/year (5 rem/year). The applicant also calculated radiation dose rates within the vicinity of individual casks to demonstrate that workers at the WCS CISF will not receive doses that exceed 0.05 Sv/year (5 rem/year), the NRC annual regulatory limit for workers at nuclear facilities. These radiation dose limits have been established by NRC to prevent any undue risk and to ensure the safety of all members of the public and workers at a nuclear facility. The applicant also described its radiation protection program, which employs an as low as is reasonably achievable (ALARA) radiation protection principle. Radiation doses received by the workers and dose rates within the vicinity of the storage pad will be monitored to verify that radiation dose limits are not exceeded. The staff reviewed the analyses provided by the applicant and concluded that the WCS CISF and the proposed cask designs are radiologically safe and will meet regulatory requirements.

As required by 10 CFR Part 72, the applicant demonstrated that all systems, structures, and components (SSCs) of the proposed WCS CISF that are important to safety would continue to perform their design functions during normal and off-normal conditions and during any credible accidents that could be postulated to occur. Based on its review and evaluation of the information provided, the staff concluded that the applicant has provided acceptable analyses of the design and performance of these structures, systems, and components important to safety under normal, off-normal, and accident conditions.

The staff further concluded that the applicant's analyses related to off-normal and accident events demonstrate that the WCS CISF will be sited, designed, constructed, and operated so that during all credible off-normal and accident events, public health and safety will be adequately protected.

The NUHOMS and NAC systems were evaluated against the parameters and conditions specific to the site and the SNF to be stored. Based on its review, the staff finds that the use of the NUHOMS and NAC systems as proposed for the WCS CISF is acceptable in accordance with the site-specific license provisions of 10 CFR Part 72, subject to the conditions of the license.

Other Requirements

To demonstrate its financial qualification, the applicant identified anticipated sources of funds for the WCS CISF. The NRC staff concludes that the applicant has provided reasonable assurance of its financial qualifications for construction, operation, and decommissioning of the WCS CISF.

The staff also found the applicant's emergency plan appropriately described WCS CISF's program for responding to onsite emergencies. It also described plans for seeking offsite assistance, if needed. Lastly, the staff found Revision 5 of the applicant's Physical Security Plan to be acceptable. However, the staff's security evaluation of the revised plan was transmitted as a separate safeguards document that is not available to the public.

References

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

10 CFR Part 20, "Standards for Protection Against Radiation."

AREVA Inc., "Updated Final Safety Analysis Report for the Standardized Advanced NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," ANUH-01.0150, Revision 6, August 2014 (proprietary). Transmittal dated July 13, 2016. Agencywide Documents Access and Management System (ADAMS) Accession No. ML16200A178.

AREVA Inc., "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," NUH-003, Revision 14, September 2014 (proprietary). Transmittal dated July 13, 2016. ADAMS Accession No. ML16218A396.

ISP, "Submittal of License Application Revision 2 and Request to Restart Review of Application for Approval of the WCS CISF, Docket 72-1050," June 8, 2018. ADAMS Accession No. ML18166A003.

ISP, "Supplement to Submittal of License Application Revision 2, and Request to Restart Review of Application for Approval of the WCS CISF," July 19, 2018. ADAMS Package Accession No. ML18206A595.

ISP, "License Application, Interim Storage Partners LLC," Revision 4, April 12, 2021. ADAMS Accession No. ML20237F470.

ISP, "Submission of Revision 5 of the Safety Analysis Report and Revision 4 of the License Application for the WCS CISF," Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML21105A766.

ISP, "WCS Consolidated Interim Spent Fuel Storage Facility Environmental Report," Revision 3, Docket No. 72-1050." ADAMS Accession No. ML20052E144.

ISP, "Revision 5 of the Physical Security Plan, Training and Qualification Plan, and Safeguards Contingency Plan with Updated Cover Sheets, Docket 72-1050 CAC/EPID 001028/L-2017-NEW-0002," transmittal letter dated September 19, 2020. ADAMS Accession No. ML20269A259.

NRC, Regulatory Guide 3.48, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)," Revision 1, August 1989. ADAMS Accession No. ML003739163.

NRC, Regulatory Guide 3.50, "Standard Format and Content for a License Application for An Independent Spent Fuel Storage Installation or a Monitored Retrievable Storage Facility," Revision 2, September 2014. ADAMS Accession No. ML14043A080.

NRC, NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities" March 2000. ADAMS Accession No. ML003686776.

NRC, NUREG-2239, "Environmental Impact Statement for Interim Storage Partners LLC's License Application for a Consolidated Interim Storage Facility for Spent Nuclear Fuel in Andrews County, Texas," May 2020. ADAMS Accession No. ML20122A220.

NAC International, "NAC-MAGNASTOR Final Safety Analysis Report," Revision 7, July 2015 (proprietary). Transmittal August 3, 2016. ADAMS Accession No. ML16223A932.

NAC International, "NAC-MPC, NAC Multi-Purpose Cask, Final Safety Analysis Report," Revision 10, January 2014 (proprietary). Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A556.

NAC International, "NAC-UMS Universal MPC System Final Safety Analysis Report for the UMS Universal Storage System," Revision 10, October 2012 (redacted). Transmittal dated August 3, 2016. ADAMS Accession No. ML16245A212.

Sacramento Municipal Utility District, "Rancho Seco Independent Spent Fuel Storage Installation, Final Safety Analysis Report, Volume 1, ISFSI System," Revision 4, June 2010 (proprietary). Transmittal dated August 11, 2016. ADAMS Accession No. ML16236A115.

WCS, "License Application to Construct and Operate a Consolidated Interim Storage Facility for Spent Nuclear Fuel in Andrews County, Texas, Docket 72-1050," April 28, 2016. ADAMS Package Accession No. ML16133A070.

WCS, "Request That NRC Temporarily Suspend All Safety & Environmental Review Activities As Well As Public Participation Activities Associated With WCS' License Application For Period Commencing On 04/18/2017 & Continuing Until Completion Of Sale Of WCS To Energy Solutions," April 18, 2017. ADAMS Accession No ML17110A206.

WCS, ERP-100, "Consolidated Emergency Response Plan," February 8, 2019. ADAMS Accession No. ML19156A045.

1 GENERAL DESCRIPTION

By letter dated April 28, 2016, the U.S. Nuclear Regulatory Commission (NRC) received an application from Waste Control Specialists LLC (WCS), requesting a license to construct and operate a consolidated interim storage facility (CISF) for spent nuclear fuel (or spent fuel) and greater-than-Class C (GTCC) waste, primarily comprising spent uranium-based fuel along with a small quantity of mixed-oxide fuel, at the WCS site in Andrews County, TX, for a 40-year period. The NRC performed its acceptance review and accepted the WCS license application for technical review on January 26, 2017. On April 18, 2017, WCS requested that the NRC suspend review activities for the WCS CISF license application.

By letter dated June 8, 2018, Interim Storage Partners LLC (ISP or the applicant), a joint venture between WCS and Orano CIS, LLC (a subsidiary of Orano USA), requested that the NRC resume its review of the CISF license application under the applicant's new name, reflecting the organization of the joint venture. With this request, ISP submitted a revised license application, later updated on July 19, 2018, that included a revised environmental report and revised safety analysis report (SAR). ISP subsequently submitted updated revisions of the SAR on May 22, 2020, September 2, 2020, and April 12, 2021, and updated revisions of the license application on August 24, 2020, and April 12, 2021.

The proposed WCS CISF is an independent spent fuel storage installation (ISFSI) that uses dry cask storage technology. In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 72.42, "Duration of License; Renewal," the NRC would initially license the WCS CISF for 40 years. At least 2 years before the end of this license term, the licensee may submit an application to renew the license. ISP submitted the license application in accordance with the applicable requirements in 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste."

1.1 Scope of Review

The staff reviewed the ISP application for the WCS CISF in accordance with the applicable requirements in 10 CFR Part 72 and consistent with NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," issued March 2000, including Section 1.4, "Acceptance Criteria," and Section 1.5, "Review Procedures," and Regulatory Guide 3.48, Revision 1, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)."

1.2 Regulatory Requirements

The regulations in 10 CFR Part 72 establish the requirements, procedures, and criteria for the issuance of licenses to receive, transfer, and possess power reactor spent fuel, power-reactor-related GTCC waste, and other radioactive materials associated with spent fuel storage in an ISFSI and the terms and conditions under which the Commission will issue these licenses. The regulatory requirements relevant to the general description of the proposed WCS CISF are detailed in the following regulations:

- 10 CFR 72.22, "Contents of Application: General and Financial Information"
- 10 CFR 72.24, "Content of Application: Technical Information"

1.3 Staff Review and Analysis

Unless otherwise stated, the staff reviewed the information submitted by the applicant in Revision 4 of its license application, dated April 12, 2021, and SAR Revision 5, also submitted on April 12, 2021, as well as information submitted in response to staff requests for supplemental and additional information and information that the applicant incorporated by reference. The staff evaluated the applicant's description of the location, principal functions, design features, and construction and operation schedules for the ISP's WCS CISF in SAR Chapter 1, "Introduction and General Description of Installation." The staff visited the site on several occasions during its review to confirm the information presented in the application. Additionally, the staff also reviewed Chapter 1 of the license application, entitled, "General and Financial Information," and confirmed that the application contained the specific information about the applicant required by 10 CFR 72.22(a) through (d).

1.3.1 General Description of Installation and General Systems Description

The staff reviewed SAR Section 1.1, "Introduction," and Section 1.2, "General Description of Installation," which provided an overview of the proposed WCS CISF. The applicant described the location of the proposed ISP CISF in Andrews County, TX, the materials to be stored at this facility, the spent fuel storage systems to be used, and its storage system principal design criteria. In addition, in SAR Table 1-1, "Storage Systems at the WCS CISF," the applicant listed 11 storage and transportation systems it proposed to use, and in SAR Section 1.6, "Material Incorporated by Reference," the applicant identified 11 final SARs corresponding to these systems that the NRC had previously approved and that the applicant incorporated by reference into the SAR. The systems incorporated by reference use different canisters for spent fuel and GTCC and employ six overpack designs. Table 1-1 of this safety evaluation report summarizes these systems.

Table 1-1. Storage Systems at the WCS CISF

Storage System	NRC Docket No.	License Type	Canister Types	Transportation System	SAR Appendix
NUHOMS®-MP187 Cask System	72-11 (SNM-2510)	Site Specific	FO, FC, FF-DSC	MP187 71-9255	Appendix A
			GTCC Canister		Appendix H
Standardized Advanced NUHOMS System	72-1029	General	NUHOMS 24PT1		Appendix B
Standardized NUHOMS System	72-1004	General	NUHOMS 61BT	MP197 71-9302	Appendix C
			NUHOMS 61BTH Type 1		Appendix D
NAC-MPC	71-9235 72-1025	General	Yankee Class	NAC STC 71-9235	Appendix E
			Connecticut Yankee		
			LACBWR		
			GTCC-Canister-CY		Appendix H
			GTCC-Canister-YR		

Storage System	NRC Docket No.	License Type	Canister Types	Transportation System	SAR Appendix
NAC-UMS®	71-9270 72-1015	General	Classes 1–5	NAC UMS 71-9270	Appendix F
			GTCC-Canister-MY		Appendix H
MAGNASTOR®	72-1031	General	TSC1–TSC4	MAGNATRAN® 71-9356	Appendix G
			GTCC-Canister-ZN		Appendix H

The applicant stated that all transfer and handling activities will be in dry mode, and the WCS CISF design does not employ a spent fuel pool or other bare fuel handling capability.

The staff reviewed SAR Section 1.2, which states that no gaseous, liquid, or solid radioactive waste treatment systems are associated with the proposed WCS CISF. In Attachment A of Revision 4 of the license application, submitted on April 12, 2021, the applicant proposed License Conditions 8A and 8B to possess 5,000 metric tons of uranium or mixed oxides in the form of intact spent fuel assemblies, damaged fuel assemblies, failed fuel assemblies, and fuel debris, and 231.3 metric tons (510,000 pounds) of GTCC waste. This quantity of waste would be stored in approximately 470 storage overpacks. The applicant described the major structures and components at the WCS CISF, including, for example, the cask handling building and storage area, and explained how spent fuel and GTCC waste would be received, offloaded, and stored.

The staff reviewed the facility layout provided in multiple drawings, including SAR Figure 1-1, “WCS CISF Location”; SAR Figure 1-2, “WCS CISF Site Boundary Layout”; SAR Figure 1-3, “WCS CISF Site Overview”; SAR Figure 1-6, “WCS CISF Storage Pad Layout”; and SAR Figure 1-7, “Cask Handling Building Plan.” In SAR Figure 1-8, “Cask Handling Building Section View,” the applicant provided information on the location of the overhead cranes. In SAR Figure 1-9, “Security and Administration Building,” the applicant showed the layout of the building containing the central alarm station and health physics spaces and the main points of personnel ingress and egress.

The staff reviewed SAR Section 1.3, “General Description of Systems and Operations,” that describes all major systems at the WCS CISF. The applicant briefly described the operation of the facility in SAR Section 1.3.2, “WCS Consolidated Interim Storage Facility Operations.”

The staff reviewed SAR Section 1.4, “Analysis of Operations,” that summarizes the analyses performed for normal, off-normal, and accident conditions at the WCS CISF. This SAR section also summarizes the maximum collective occupational dose from normal operations, annual public dose from normal operations, and the applicant’s accident analysis methodology and safety management programs (i.e., radiation protection, conduct of operations, and quality assurance programs).

Based on its review, the staff determined that the applicant provided a broad, nonproprietary overview of the WCS CISF that can be used to familiarize interested parties with the features of the WCS CISF, including the principal design characteristics of the facility. The staff compared the drawings provided in SAR Chapter 1 with the detailed drawings presented elsewhere in the SAR and determined that the drawings are consistent. The staff also determined the drawings in SAR Chapter 1 provide sufficient detail to describe the operational concept and safety-related features of the WCS CISF. The staff determined that the facility description is consistent with use of the facility for storage and not permanent disposal, and that the applicant provided

sufficient information about the spent fuel and GTCC waste it proposes to store to permit overall familiarization with the WCS CISF.

The staff verified that the applicant provided a summary description of the mode and arrangement of storage equipment at the WCS CISF. This summary contains a brief description of operating systems, including canister handling, waste treatment, and auxiliary systems. Based on its review, the staff determined the applicant provided sufficient information for interested parties to understand the systems involved. The staff found that the information acceptable because it meets the requirements of 10 CFR 72.24(b), (f), and (l) regarding descriptions of structures, features and operational modes to reduce to the extent practicable radioactive waste volumes generated at the facility and to maintain control over radioactive materials in gaseous and liquid effluent.

1.3.2 Identification of Agents and Contractors

The staff reviewed the description of agents and contractors in SAR Section 1.5, "Identification of Agents and Contractors." The applicant stated it will have responsibility for engineering, design, licensing, and construction. The applicant described the design, fabrication, and operation roles for TN Americas, WCS, and NAC International and stated it would use contractors for site preparation and construction of the WCS CISF, as necessary. In SAR Section 1.1, the applicant stated that construction of the WCS CISF is planned to start in September 2021, and operation is planned to begin in July 2023.

Based on its review, the staff determined that the applicant described the agents involved in design, construction, and operation of the WCS CISF, including principal consultants, service organizations, and quality assurance service providers. The staff verified that the application clearly defined the division and assignment of responsibilities among the participants on the WCS CISF project.

1.3.3 Material Incorporated by Reference

The staff reviewed SAR Section 1.6 that lists the SARs incorporated by reference into the WCS CISF SAR. SAR Table 1-4, "Table of Topical Reports (SARs) Incorporated by Reference," includes a cross-reference to appendices of the WCS CISF SAR that contain system-specific design criteria; descriptions of operating systems; and structural, thermal, radiation protection, criticality, confinement, and accident analyses. The staff confirmed that the applicant tabulated all topical reports and other documents incorporated by reference in the license application and summarized this information in the appropriate section of the WCS CISF SAR.

1.4 Evaluation Findings

Based on its review of the information provided in the application, the staff determines the following:

- The information presented in the license application and SAR Chapter 1 satisfies the requirements for general information in 10 CFR 72.22 and design and operational information in 10 CFR 72.24(b), (f), and (l). This finding is based on a review that considered the regulation itself; Regulatory Guide 3.48, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)," Revision 1, issued

August 1989; NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," issued March 2000; and accepted practices.

- The applicant identified the agents and contractors responsible for the design, construction, and operation of the installation.
- The applicant tabulated all topical reports and docketed material incorporated by reference in the SAR.

1.5 References

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

AREVA, Inc., "Updated Final Safety Analysis Report for the Standardized Advanced NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 6, August 2014 (nonpublic). NRC Docket No. 72-1029. Transmittal dated July 13, 2016. Agencywide Documents Access and Management System (ADAMS) Accession No. ML16200A178.

AREVA, Inc., "NUHOMS®-MP197 Transport Packaging Safety Analysis Report," Revision 17, April 2001 (nonpublic). NRC Docket No. 71-9302. Transmittal dated July 20, 2016. ADAMS Accession No. ML16207A498.

AREVA TN Americas, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 14, September 2014 (nonpublic). NRC Docket No. 72-1004. Transmittal dated July 13, 2016. ADAMS Accession No. ML16218A396.

ISP, "Submittal of License Application Revision 2 and Request to Restart Review of Application for Approval of the WCS CISF," Docket No. 72-1050, June 08, 2018. ADAMS Package Accession No. ML18166A003.

ISP, "WSC Consolidated Interim Storage Facility Safety Analysis Report," Revision 2, Docket No. 72-1050, July 19, 2018. ADAMS Package Accession No. ML18206A595.

ISP, "Submittal of Revision 4 of the License Application for the WCS CISF," Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML20237F469.

ISP, "Submission of Revision 5 of the Safety Analysis Report and Revision 4 of the License Application for the WCS CISF," Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML21105A766.

ISP, "WSC Consolidated Interim Storage Facility Safety Analysis Report," Revision 3, Docket No. 72-1050, May 22, 2020. ADAMS Package Accession No. ML 20150A337.

ISP, "WSC Consolidated Interim Storage Facility Safety Analysis Report," Revision 4, Docket No. 72-1050, September 2, 2020. ADAMS Package Accession No. ML20261H419.

NAC International, "MAGNASTOR® Final Safety Analysis Report," Revision 7, July 2015 (nonpublic). NRC Docket No. 72-1031. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A932.

NAC International, "NAC-MPC, NAC Multi-Purpose Cask, Final Safety Analysis Report," Revision 10, January 2014 (nonpublic). NRC Docket No. 72-1025. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A556.

NAC International, "NAC-UMS Universal Storage System Final Safety Analysis Report," Revision 10, October 2012 (nonpublic). NRC Docket No. 72-1015. Transmittal dated August 3, 2016. ADAMS Accession No. ML16245A212.

NAC International, "MAGNATRAN Safety Analysis Report," Revision 12A, October 2012. NRC Docket No. 71-9356. ADAMS Accession Nos. ML13024A258 and ML13010A092.

NAC International, "MAGNATRAN® Safety Analysis Report," Revision 14A, October 2014. NRC Docket No. 71-9356. ADAMS Accession No. ML14356A377.

NAC International, "MAGNATRAN Safety Analysis Report," Revision 15A, October 2015 (nonpublic). NRC Docket No. 71-9356. Transmittal dated October 15, 2015. ADAMS Accession No. ML15296A084.

NAC International, "NAC-STC, NAC Storage Transport Cask Safety Analysis Report," Revision 17, April 2011 (nonpublic). NRC Docket No. 71-9235. Transmittal dated May 25, 2011. ADAMS Accession No. ML11152A179.

NAC International, "Safety Analysis Report for the UMS® Universal Transport Cask," Revision 2, November 2005. NRC Docket No. 71-9270. ADAMS Accession No. ML16252A309.

NRC, "License Application to Construct and Operate a Consolidated Interim Storage Facility for Spent Nuclear Fuel in Andrews County, Texas - Accepted for Review (CAC No. L25175)". ADAMS Accession No. ML17018A168.

NRC, Regulatory Guide 3.48, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)," Revision 1, August 1989. ADAMS Accession No. ML003739163.

NRC, NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," March 2000. ADAMS Accession No. ML003686776.

Sacramento Municipal Utility District, "Rancho Seco Independent Spent Fuel Storage Installation, Final Safety Analysis Report, Volume 1, ISFSI System," Revision 4, June 2010 (nonpublic). NRC Docket No. 72-11. Transmittal dated August 11, 2016. ADAMS Accession No. ML16236A115.

Transnuclear, Inc., "Safety Analysis Report for the NUHOMS®-MP187 Multi-Purpose Cask," Revision 17, July 2003 (nonpublic). NRC Docket No. 71-9255. Transmittal dated July 15, 2016. ADAMS Accession No. ML16203A183.

WCS LLC, "License Application to Construct and Operate a Consolidated Interim Storage Facility for Spent Nuclear Fuel in Andrews County, Texas, Docket 72-1050," April 28, 2016. ADAMS Package Accession No. ML16133A070.

WCS LLC, "Request That NRC Temporarily Suspend All Safety & Environmental Review Activities As Well As Public Participation Activities Associated With WCS' License Application For Period Commencing On 04/18/2017 & Continuing Until Completion Of Sale Of WCS To Energy Solutions," April 18, 2017. ADAMS Accession No ML17110A206.

2 SITE CHARACTERISTICS

In Chapter 2, "Site Characteristics," of Revision 5 of the safety analysis report (SAR), Interim Storage Partners LLC (ISP or the applicant), described the proposed WCS Consolidated Interim Storage Facility (CISF) site, the population distribution around the site, land and water uses, and associated site activities. The applicant also evaluated the site characteristics with respect to safety and identified assumptions applied when evaluating the design for safety, establishing installation criteria for the design, and providing the design bases in other evaluations in the SAR.

2.1 Scope of Review

The staff evaluated the site characteristics in Chapter 2 of the SAR by reviewing the documents cited in or attached to the SAR, the applicant's responses to the staff's requests for additional information (RAIs), and other relevant literature. The staff reviewed the application information on site characteristics to determine whether the applicant (1) identified the external natural and human-induced phenomena and addressed the adequacy of the design basis with respect to these phenomena, (2) characterized local land and water use and population to determine the critical populations likely to be affected, and (3) characterized the transport processes that could move any released contamination from the facility to the maximally exposed individuals and populations. To make its determination, the staff reviewed the information in the application on area geography and demography; nearby industrial, transportation, and military facilities; and the meteorological, hydrological, geological, and seismological characteristics of the site and its surrounding area.

2.2 Regulatory Requirements

The regulatory requirements relevant to the siting evaluation of the proposed WCS CISF appear in the following sections of Title 10 of the *Code of Federal Regulations* (10 CFR):

- 10 CFR 72.24, "Contents of application: Technical information"
- 10 CFR 72.40, "Issuance of license"
- 10 CFR 72.90, "General considerations"
- 10 CFR 72.92, "Design basis external natural events"
- 10 CFR 72.94, "Design basis external man-induced events"
- 10 CFR 72.96, "Siting limitations"
- 10 CFR 72.98, "Identifying regions around an ISFSI [independent spent fuel storage installation] or MRS [monitored retrievable storage] site"
- 10 CFR 72.100, "Defining potential effects of the ISFSI or MRS on the region"
- 10 CFR 72.102, "Geological and seismological characteristics for applications before October 16, 2003 and applications for other than dry cask modes of storage"
- 10 CFR 72.103, "Geological and seismological characteristics for applications for dry cask modes of storage on or after October 16, 2003"
- 10 CFR 72.122, "Overall requirements"

Where appropriate, the staff makes findings of regulatory compliance with the requirements of 10 CFR Part 72, "Licensing requirements for the independent storage of spent nuclear fuel and high-level radioactive waste, and reactor-related greater than Class C waste," which are fully addressed in Chapter 2 of the SAR. Because compliance with some regulations can only be determined by the integrated review of several sections in Chapter 2, other chapters in the SAR,

or both, the staff did not make a finding of regulatory compliance in each major section unless the applicant fully addressed the specific regulatory requirement. However, the staff made findings of technical adequacy and acceptability for each section in Chapter 2 of the SAR as they relate to the regulatory requirements.

2.3 Staff Review and Analysis

Unless otherwise stated, the staff reviewed and evaluated the site characteristics of the proposed site discussed in Chapter 2 of the SAR, Revision 5; documents cited in or attached to the SAR; the applicant's responses to the staff's RAIs; and other relevant literature. The review covered site geography and demography; nearby industrial, transportation, and military facilities; meteorology; surface hydrology; subsurface hydrology; and geology and seismology.

2.3.1 Geography and Demography

The staff reviewed the information in SAR Section 2.1, "Geography and Demography of Site Selected," that discussed site location, site description, population distribution and trends, and land and water use.

2.3.1.1 Site Location

The staff reviewed the applicant's description of the proposed site location in the introduction to Chapter 2 of the SAR. The applicant proposed to site the WCS CISF on land leased from Waste Control Specialists LLC. Waste Control Specialists LLC controls approximately 14,000 acres (5,700 hectares) of land in northwestern Andrews County, NM. The WCS CISF site will be located 51 kilometers (32 miles) northwest of the city of Andrews, TX, and 8 kilometers (5 miles) east of the city of Eunice, NM. It is located approximately 0.5 mile (0.8 kilometer) east of the Texas-New Mexico state boundary and 1 mile north of Texas Highway 176. The approximate coordinates of the site are 32° 27' 08" north latitude and 103° 03' 35" west longitude. Based on its review of the information in the application, the staff confirmed that the applicant accurately described the features of the proposed site location and verified the location of the proposed site such that realistic impacts can be estimated consistent with the requirements in 10 CFR 72.24 and 10 CFR 72.96.

2.3.1.2 Site Description

The staff reviewed the applicant's description of the site in an arid and isolated part of Andrews County, TX. The applicant described the land uses within a few miles of the WCS CISF site, including agriculture, cattle ranching, drilling for production of oil and gas wells, quarry operations, uranium enrichment, municipal waste disposal, and surface recovery and land farming of oil field wastes. Surface quarrying of caliche, sand, and gravel is conducted in New Mexico, approximately 1 mile west of the WCS CISF. The oil field waste recovery facility is adjacent to this quarry. The Lea County, NM, municipal solid waste landfill is located adjacent to the State line to the immediate south and west of the WCS CISF. URENCO USA operates a uranium enrichment facility that uses centrifuge technology, located about 1 mile to the southwest of the HW-50397 Resource Conservation and Recovery Act (RCRA) landfill. Except for an historical marker and picnic area approximately 5.5 kilometers (3.3 miles) from the WCS CISF at the intersection of New Mexico Highways 234 and 18, no known public recreation areas or State or Federal parks are located within 8 kilometers (5 miles) of the WCS CISF.

Based on its review of information in the application, the staff finds that, consistent with the requirements in 10 CFR 72.24 and 10 CFR 72.96, the site description in the application clearly delineates (1) boundary and controlled areas as well as other possible effluent release points used in the applicant's accident analyses and (2) the orientation of plant structures with respect to nearby roads, railways, and waterways within the controlled area that can interfere with normal operations of the facility.

2.3.1.3 Population Distribution and Trends

The staff reviewed the applicant's description of the population distribution for the WCS CISF site. The 15-mile (24-kilometer) radius around the WCS CISF site is a very low-population area with some industry and mostly ranch land and very little seasonal variation in population. In Appendix A to the WCS CISF Environmental Report (ER), "Socioeconomic Impact Analysis," the applicant included 2010 census data, and Figure 1.2-1 shows the cities and towns within a 48.3-kilometer (30-mile) radius of the WCS CISF.

The applicant described the nearest residential area as approximately 8 kilometers (5 miles) due west of the WCS CISF in the city of Eunice, NM. The closest residence from the center of the WCS CISF is approximately 6 kilometers (3.8 miles) on the side of Eunice, NM. The nearest population center of 25,000 people or more is about 20 miles (32 kilometers) north of the WCS CISF in the city of Hobbs, NM.

The population within a 5-mile (8-kilometer) radius centered on the proposed WCS CISF consists of discrete (scattered) residences located in the eastern portion of the city of Eunice in Lea County, NM. The closest residents to the WCS CISF site reside within 20 homes located approximately 4 to 5 miles (6 to 8 kilometers) west of the proposed project location. The applicant presented the population distribution in SAR Figure 2-19, "Present Population Distribution within 5 Miles of the WCS CISF." No transient or institutional populations are known within 5 miles of the proposed WCF CISF. Except for an historical marker and picnic area approximately 5.5 kilometers (3.3 miles) from the WCS CISF at the intersection of New Mexico Highways 234 and 18, no public recreation areas or State or Federal parks are located within a 5-mile radius. Based on U.S. Census Bureau decennial data and applying the growth rate for Lea County, NM, of 0.55 percent from 1970 to 2010, the applicant projected a population of 72 persons within a 5-mile radius in 2064. In SAR Tables 2-8 through 2-10, the applicant provided the population projection calculations. In SAR Figure 2-20, "Projected Population Distribution within 5 Miles of the WCS CISF," the applicant showed the projected population distribution. Based on two other possible scenarios using the 2010–2040 Lea County projected population data, the University of New Mexico, "Geospatial & Population Studies, July 10, 2019," estimated the population projections for 2024, 2034, 2054, and 2064. The applicant stated that the Lea County projections for 2064 of 100 persons and 177 persons within a 5-mile radius are conservatively estimated using a 1.2-percent and a 2.4-percent growth rate, respectively.

Based on its review of the information described above, the staff finds that the applicant appropriately determined the population distribution and projections for cities and towns near the site because the applicant applied the available guidance and used a sector map of population for the area within a 5-mile (8-kilometer) radius of the site, as well as data available from the U.S. Census Bureau and a local agency, consistent with the requirements in

2.3.1.4 Land and Water Use

The staff reviewed the land and water uses at and in the area surrounding the proposed WCS CISF site described in the SAR.

In the opening to Chapter 2 of the SAR, the applicant described all land within the approximately 14,000-acre (5,700-hectare) Waste Control Specialists LLC property, which includes the proposed WCS CISF site. This land is under the control of Waste Control Specialists LLC. The SAR explains how Waste Control Specialists LLC currently operates an existing commercial waste management facility on approximately 1,338 acres (541 hectares) of land (within the 14,000-acre property) south of the proposed CISF site. In Sections 3.1 and 3.5.3 of the ER, the applicant stated that, while the proposed CISF site and other undeveloped lands within the Waste Control Specialists LLC property support shrub and grass vegetation typical of disturbed rangeland, livestock are not presently allowed to graze on any land currently controlled by Waste Control Specialists LLC. Satellite imagery dated February 12, 2021 suggests that the proposed WCS CISF site is presently undeveloped and supports vegetation typical of undeveloped lands in the surrounding landscape (Google Earth, accessed February 12, 2021), thereby corroborating the applicant's land use information.

In Section 2.1 of the SAR, the applicant reported that land uses within a few miles of the proposed CISF site include agriculture, cattle ranching, drilling for and production from oil and gas wells, quarrying operations, uranium enrichment, municipal waste disposal, and the surface recovery and land farming of oil field wastes. Other information in Chapter 2 of the SAR indicates that surface quarrying of caliche, sand, and gravel (the Permian Basin Materials sand and gravel quarry) takes place approximately 1 mile (1.6 kilometer) west of the proposed CISF site. The Lea County, NM, municipal solid waste landfill is situated immediately south and west of the proposed CISF site. URENCO operates a uranium enrichment facility about 1 mile to the southwest. The applicant characterized areas within a 15-mile (24-kilometer) radius around the proposed CISF site as having a low population and consisting mostly of ranch land and some industry. The applicant reports that no known public recreation areas or State or Federal parks are located within 5 miles of the proposed CISF site, other than an historical marker and picnic area situated approximately 3.3 miles (5.3 kilometers) distant, at the intersection of New Mexico Highways 234 and 18.

Aerial photographic imagery dated February 2019 supports the applicant's descriptions of land uses in the region. The imagery suggests that the predominant land use within a 5-mile radius of the CISF site is undeveloped shrubland (likely current or former rangeland), with areas of quarrying and industrial activity (including what might be a landfill) immediately west of the Waste Control Specialists LLC property and residential and other urban uses limited to the city of Eunice, NM, roughly 5 miles west of the property. The imagery does not suggest any agricultural use of land on the WCS CISF site. The nearest dryland cropland appears to be situated roughly 7 miles (11 kilometers) southeast of the proposed CISF site, and the nearest pivot irrigated cropland is located roughly 9 miles (14 kilometers) to the north and northeast. The imagery shows what appear to be many oil and gas production facilities scattered over the landscape to the west, south, north, and northeast.

The applicant characterizes surface water resources on and near the WCS CISF site in Section 2.4 of the SAR and subsurface water resources (groundwater) in Section 2.5. The applicant states that the area is characterized by ephemeral drainages, sheet flow, minor gullies and rills, internally-drained playas, and a salt lake basin. Section 2.4 of the SAR notes that the entire WCS CISF, including the access road, is situated above (out of) any floodplains, with the nearest 100-year floodplain situated approximately 4,000 feet south of the site, the nearest 500-

year floodplain situated approximately 3,965 feet south of the site, and the nearest probable maximum flood floodplain situated approximately 3,895 feet south of the site. Section 2.4 of the SAR also notes that there are no wetlands mapped by the National Wetlands Inventory on the WCS CISF site. Specific surface water features addressed in the SAR include:

- Monument Draw, a natural shallow drainageway situated southwest of the WCS CISF
- Depression Pond, a natural unnamed perennial basin with shallow water most of the year, situated approximately 5 miles from the WCS CISF
- Multiple unnamed cattle-watering holes where groundwater is pumped by windmill and stored in aboveground tanks
- Fish Pond, situated in a quarry west of the WCS CISF
- Multiple unnamed playas (small internally-drained basins), including one of about 15 acres approximately 0.5 mi of the existing WCS RCRA landfill
- Baker Spring, a natural intermediate surface-water feature situated about 1 mile west of the WCS CISF
- Ranch House Draw, a smaller draw than Monument Draw, that passes south of the WCS CISF site.

Satellite imagery dated February 12, 2021 generally corroborates the surface water information provided by the applicant. The Fish Pond, Monument Draw, and Ranch House Draw are easily resolved on the imagery, as are gaps in vegetation suggestive of possible playas, while smaller features such as the cattle-watering holes and Baker Spring are too small or inconspicuous to resolve on the imagery.

All of these surface water features are small, shallow, and/or seasonal sources of water that do not appear capable of serving as significant water sources other than to provide water to livestock. The applicant reports in Section 2.4 of the SAR that there are no public or private surface water drinking-water supplies in the vicinity of the WCS CISF. The applicant states an intention to tie the WCS CISF into existing potable water lines at the WCS site to supply potable water to the new facilities.

Section 2.5 of the SAR characterizes in detail groundwater sources in the area near the WCS CISF site, including the Ogallala Aquifer, Cretaceous Aquifer, Triassic Dockum Group Aquifer, and the Cenozoic Alluvium Aquifer. The applicant reports that the shallowest water bearing zone at the site is about 225 feet deep, and that the nearest downgradient drinking water well is situated approximately 6.5 miles east of the site.

The staff reviewed the information in SAR Sections Chapter 2 and finds that the applicant has adequately identified and assessed the land and water use for the site of the proposed facility. Based on a comparison with existing data, the staff finds that the applicant has appropriately investigated the region of the proposed site with respect to present and projected future uses of land and water within the region. The staff finds this information is acceptable for use in estimating the concentrations of radionuclides to populations from any potential airborne or liquid effluents released from the proposed site.

2.3.2 Nearby Industrial, Transportation, and Military Facilities

The staff reviewed the information in SAR Section 2.2, “Nearby Industrial, Transportation and Military Facilities,” for man-made hazards from facilities that may potentially affect the proposed WCS CISF.

The applicant identified the following industrial facilities located within 5 miles (8 kilometers) of the WCS CISF boundary: URENCO; Permian Basin Materials; the Lea County, NM, landfill; a future travel stop; and Sundance Services, Inc. URENCO uses centrifuge technology to provide uranium enrichment at the facility. Permian Basin Materials operates a quarry and crushing operation. The Lea County landfill does not generate or receive hazardous waste. The future travel stop to be operated by Love’s Travel Stops & Country Stores is located at the intersection of New Mexico State Highway 18 and Highway 176, about 3.5 miles (5.6 kilometers) from the WCS CISF. Sundance Services, Inc., provides oilfield waste disposal services.

Waste Control Specialists LLC also operates several permitted and licensed facilities immediately south of the WCS CISF, including a RCRA landfill, a low-level radioactive waste (LLRW) facility, and a byproduct materials landfill. The Waste Control Specialists LLC facilities include several fuel (diesel, gasoline, and propane) tanks used for fueling heavy equipment and facility operations. The tanks range from 350 to 8,000 gallons (1,325 to 30,283 liters) in capacity.

Texas State Highway 176 is a two-lane highway with 3.6-meter (12-foot)-wide driving lanes and 2.4-meter (8-foot)-wide shoulders and a 61-meter (200-foot)-wide right-of-way easement on each side. Access to the site is directly off Texas State Highway 176, which is approximately 1.5 miles (2.4 kilometers) from the WCS CISF. New Mexico Highway 18 is about 3.5 miles from the WCS CISF. As discussed below, the staff considered the potential for explosions to occur from the transportation of hazardous cargo on Highway 176 and Highway 18.

A 16-inch natural gas pipeline owned by Energy Transfer LP runs parallel to Texas State Highway 176 within an easement on Waste Control Specialists LLC property. The pipeline is approximately 7,700 feet from the WCS CISF at its closest point. An additional 14-inch natural gas pipeline is adjacent and parallel to the 16-inch pipeline; however, that pipeline has been idle for over 15 years. A 10-inch-diameter buried carbon dioxide pipeline runs along the western and northern boundaries of New Mexico Section 32 and over 8,000 feet from the WCS CISF at its closest point. As discussed below, the staff considered the 16-inch natural gas pipeline in its hazard evaluation.

Gas and oilfield operations are common in west Texas. Regionally, the WCS CISF is in the Permian Basin of west Texas and southeast New Mexico., Significant petroleum storage is not located within 5 miles of the WCS CISF. Locally within the Waste Control Specialists LLC property boundaries, oil and gas activity is very limited. There is no active oilfield activity within the WCS CISF footprint area and only one documented dry hole in the immediate area of the WCS CISF. That dry hole has been cemented to the surface, and proper plugging and abandonment protocol was observed. There is no evidence of any undocumented or “orphan” wells in the vicinity of the WCS CISF. If any open boreholes indicative of orphan wells are discovered during the construction process, the applicant stated it will conduct an assessment and remediate using plugging and abandonment procedures in accordance with Texas regulations. Waste Control Specialists LLC also holds 100 percent of the operating rights for producing oil, gas, and other minerals for the area of land where the storage pads for Phase I and the future phases of the WCS CISF would be located. These rights allow Waste Control Specialists LLC to prevent any drilling for oil, gas, and other minerals under the storage pads.

The applicant stated that few economically viable oil and gas resources are located within 1 mile (1.6 kilometers) of the WCS CISF, and the chances of petroleum recovery activities in this area seem unlikely.

The Texas & New Mexico Railway (TXN) consists of 111 miles (179 kilometers) of track that generally runs north-south between the Union Pacific lines in Monahans, TX, and its termination in Lovington, NM. The railway is 4.8 miles (7.7 kilometers) from the WCS CISF at its closest point, and the applicant considered the transportation of potentially hazardous/explosive cargo on this railway. The existing WCS railroad spur and loop exits the TXN near Eunice, NM. The WCS railroad loops to the south of the WCS CISF and connects from the east side. The applicant stated that no potentially explosive cargo is allowed on these railways.

The closest air transportation facility is the Lea County Airport, which is approximately 18 miles (29 kilometers) from the WCS CISF site. Twelve airports are located within 50 miles (80 kilometers) of the WCS CISF in Andrews County, TX; Gains County, TX; and Lea County, NM. No military facilities are located within 8 kilometers (5 miles) of the WCF CISF site. No military bases or airports are located within 50 miles (80 kilometers) of the WCS CISF. The closest military facility is Cannon Air Force Base, approximately 135 miles (217 kilometers) from the WCS CISF. Three Federal airways are near the WCS CISF: one low-altitude V68 airway with its center line passing approximately 4 miles (6.4 kilometers) from the proposed site, a high-altitude Q20 airway with its centerline passing about 4 miles (6.4 kilometers) from the proposed site, and a high-altitude J66 airway with its centerline passing approximately 12 miles from the proposed site.

The applicant briefly identified the nearby facilities such as Highway 176, a railroad, some landfills, and the Lea County airport. The applicant also identified gasoline and diesel fuel tanks, propane storage tanks, and pipelines for the transport of natural gas and carbon dioxide. The applicant evaluated the potential for postulated explosions from transportation accidents using Revision 2 of Regulatory Guide (RG) 1.91, "Evaluations of Explosions Postulated to Occur at Nearby Facilities and on Transportation Routes Near Nuclear Power Plants." The applicant provided its results for the evaluations of the man-made hazards from nearby facilities. The applicant determined that the minimum safe distance from an explosion producing 1 pound per square inch (psi) overpressure from a hazardous solid shipment of 50,000 pounds (23,680 kilograms) of explosive material by truck is approximately 1,660 feet (506 meters), which is less than the distance of Highway 176 at 1.5 miles (8,000 feet) from the WCS CISF site. For a single box car shipment of 132,000 pounds (59,900 kilograms) of solid explosive cargo, the minimum safe distance from an explosion producing 1 psi overpressure is estimated at 2,300 feet (700 meters), which is less than the distance of the TXN railroad from the site (4.8 miles [7.7 kilometers]). The applicant stated that Permian Basin Materials, LLC periodically employs blasting techniques for quarrying materials; however, this is outsourced to a third party and no explosives are stored onsite. Because all explosives are delivered by legal weight trucks, the maximum amount of explosives that could be delivered in one shipment is approximately 50,000 lbs (22,680 kg). The applicant stated that 11,000 lbs (4,990 kg) of explosives is typical for a single blasting event. The 16-inch natural gas pipeline is about 7,700 feet from the WCS CISF at its closest point. The minimum safe distance from an explosion from a pipe break producing 1 psi overpressure was determined to be less than this distance to preclude any adverse impacts to the facility.

The applicant evaluated and addressed the potential impacts from the quarry operation and gasoline, diesel, and propane tanks. The minimum safe distance from an explosion from the quarry operation or onsite tanks producing 1 psi overpressure is significantly less than the distance of the source from the WCS CISF. The staff finds the applicant's explosion analysis

and conclusions adequate and reasonable because they conform with the NRC guidance provided in RG 1.91.

The applicant performed an aircraft hazards evaluation for the WCS CISF and added a proprietary summary of the evaluation in SAR Section 2.2.1, "Aircraft Hazard Evaluation." The applicant identified 12 airports within 50 miles (80 kilometers) of the WCS CISF site. The closest airport is Lea County Airport in Hobbs, NM, which is about 18 miles (29 kilometers) from the site. For those airports meeting the screening criteria in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR [Light Water Reactor] Edition," Section 3.5.1.6, Revision 4, "Aircraft Hazards," the applicant further evaluated the aircraft hazards using the distance of each airport from the WCS CISF site and the respective annual number of flight operations. The applicant identified a low-altitude east-west airway V68 whose centerline passes approximately 4 miles (6 kilometers) from the plant site and that has a width of 9.2 miles (15 kilometers). The applicant identified two additional airways, a high-altitude Q20 northeast-southwest airway whose centerline passes approximately 4 miles from the plant site and that has a width of 9.2 miles, and a high-altitude J66 east-west jet route whose centerline passes approximately 12 miles (19 kilometers) from the site and that has a width of 9.2 miles. Based on the site-specific flight information and nearby airport locations, the applicant determined the annual aircraft crash probability of 3.81×10^{-7} at the WCS CISF site. Using an alternative conservative approach that considers all flights passing over the site, the applicant estimated an annual crash probability of about 7.38×10^{-7} . Both calculated annual aircraft crash probabilities are below the acceptable annual probability criterion of 1.0×10^{-6} given in NUREG-0800. Therefore, the applicant concluded that an aircraft crash at the WCS CISF site presents a low risk to public health and safety and is a design-basis consideration. The staff independently determined a comparable annual aircraft crash probability of 1.73×10^{-7} based on the total annual number flight operations at two nearby airports in Lea County, NM, and Andrews County, TX.

Based on the staff's review of the information described above, the applicant's supplemental information and evaluation, and the staff's independent confirmatory calculations, the staff finds that the applicant appropriately identified and analyzed the potential hazards associated with nearby facilities and transportation routes consistent with the requirements of 10 CFR 72.24, 10 CFR 72.40, 10 CFR 72.94, 10 CFR 72.98, 10 CFR 72.100, and 10 CFR 72.122. Therefore, the staff finds that the potential hazards from an explosion at a nearby facility or transportation route, or an aircraft crash at the site, present a low risk to public health and safety.

2.3.3 Meteorology

This section describes the staff's review of the information presented in SAR Section 2.3, "Meteorology." The topics reviewed are regional climatology, local meteorology, and the onsite meteorological measurement program.

2.3.3.1 Regional Climatology

In SAR Section 2.3.1, "Regional Climatology," the applicant described the location of the WCS CISF in the southwestern edge of the Southern High Plains and provided a high-level description of the regional climate for the Southern High Plains. The applicant described the climate as semiarid continental with low precipitation and four seasons, during which precipitation is heavier during the summer and fall and occasional winter periods are below freezing. The applicant described the regional weather pattern during the winter as being dominated by a high-pressure system in the central part of the western United States and a low-pressure system in north-central Mexico. During the summer, the applicant stated that the

region is affected by a low-pressure system located over Arizona. The pressure systems influence the source of water for precipitation.

In SAR Section 2.3.2, “Local Meteorology,” and Section 2.3.3, “Onsite Meteorological Data,” the applicant summarized and described weather data from regional and onsite weather stations in support of the regional climate description. The applicant obtained data from four National Weather Service (NWS) stations at various distances surrounding the WCS CISF site with long data records and from four WCS onsite weather stations with data for 2009–2015. The primary source of the offsite weather data was the Western Regional Climate Center (WRCC), a collaboration of the Desert Research Institute and several Federal agencies, including the National Oceanic and Atmospheric Administration (NOAA). In SAR Section 2.3.3, the applicant described severe weather based on meteorological inputs as follows:

- Minimum, maximum, and seasonal temperatures were derived from data obtained from the WRCC for the Andrews, TX, weather station for 1962–2010. The range of mean monthly temperatures and annual average temperatures were provided for normal load condition calculations for meeting the dry cask storage system criteria; extreme minimum and maximum recorded temperatures were provided for off-normal conditions.
- Extreme winds and atmospheric stability were based on data from WCS onsite stations, including wind roses, for 2009–2015; comparisons of data from the neighboring URENCO, the WCS LLRW site, and Midlands-Odessa, TX, supported the onsite wind rose and stability class data. Morning and afternoon mixing heights were derived for Midlands-Odessa, TX, using tables developed by the U.S. Environmental Protection Agency.
- Tornado and severe weather conditions in Andrews County, TX, were derived from data reported by NOAA for 1950–2015.
- Precipitation information was obtained from the WRCC for the Andrews, TX, weather station for 1914–2006 and from the onsite meteorological stations for 2009–2015.
- The number of days with thunderstorms was obtained for Hobbs, NM, and Midlands, TX, from NOAA and the Weather Disk Association, Inc. (SAR Chapter 2, Attachment H).

The staff reviewed the regional climate information in the SAR and finds the applicant’s description of the regional climate acceptable because reliable data sources such as the WRCC, NWS, and NOAA were used to characterize severe weather conditions representative of climatic conditions for the site. Therefore, the staff determined that the information on severe weather data is an acceptable source of input to develop the design bases of the facility, to perform additional safety analysis, and to demonstrate compliance with the regulatory requirements of 10 CFR 72.90(a), 10 CFR 72.90(b), and 10 CFR 72.122(b).

2.3.3.2 Local Meteorology

In SAR Sections 2.3.2 and 2.3.3, the applicant described the WCS onsite meteorological data and the support of regional offsite stations with longer records for representing most of the local WCS meteorological conditions. For wind and atmospheric stability estimates, however, the applicant relied on WCS onsite stations and described a favorable comparison of data for a 3-year and a 5-year period from a WCS onsite station and the Midland-Odessa, TX, station. For longer weather records, the applicant compiled data from the LLRW license that included data

for 1914–2006 in Attachment H, “Compiled Meteorological and Climatology Data,” to SAR Chapter 2.

The applicant obtained data from four NWS stations at various elevations and distances from the WCS CISF site with long data records of varying length from 58 to 92 years, and four WCS onsite weather stations with data for 2009–2015. For each of the offsite stations, SAR Section 2.3.3 and Attachment H to SAR Chapter 2 provided the length of record, station elevation, distance and direction from the WCS CISF, and seasonal summaries. The four stations encircle the WCS CISF at distances between 32 kilometers (20 miles) and 103 kilometers (64 miles): (1) Andrews, TX, to the southeast, (2) Hobbs, NM, to the north, (3) Jal, NM, to the south, and (4) Midland-Odessa, TX, to the northeast of the proposed WCS CISF. Midland-Odessa, TX, is the closest first-order weather station, and Hobbs, NM, is the closest of the four stations to the WCS site. All four offsite stations are in the Southern High Plains physiography at elevations ranging from 947 to 1,118 meters (3,107 to 3,668 feet) above mean sea level (amsl). The applicant reported that the existing minimum and maximum elevations of the WCS CISF site are approximately 1,061 meters and 1,073 meters (3,482 feet and 3,520 feet) amsl, respectively. The applicant provided topographic maps to illustrate that no prominent physiographic features separate the four offsite stations, other than small elevation differences. Further, the applicant analyzed the meteorological data from the four offsite stations and indicated that all stations are statistically similar.

In SAR Chapter 2, Attachment H, the applicant tabulated statistical representations of the data to facilitate comparison of the WCS station data with those of the four offsite stations. The WCS station is located approximately 0.5 mile (0.8 kilometer) from the center of the CISF near the southwest corner of the boundary. The analysis included a comparison of the short data records from the WCS onsite station near the southwest corner of the CISF site with the relevant period of record from the four offsite stations, and comparisons with the entire record from each offsite station. The tabulated and plotted data include temperature, wind roses, relative humidity, precipitation, and snow. The applicant stated that the comparisons were favorable and that any of the four offsite stations could be used to represent local conditions at the CISF. The wind rose data show that the predominant wind direction is from the south, southeast, and southwest, which is similar to the Midland-Odessa, TX, data. The applicant described several summary statistics for the onsite and offsite stations. The maximum recorded 1-hour wind speed at the WCS station was 32.8 and 43.6 miles per hour (52.8 and 70.2 kilometers per hour) at the 2-meter (6.6-foot) and 10-meter (33-foot) heights. The average annual precipitation at the WCS station is 15.8 inches (40.1 centimeters), and the range of the four offsite stations for their entire record is 12.5 to 16 inches (31.8 to 40.6 centimeters), with the differences generally corresponding with elevation. The 24-hour maximum precipitation is 7.6 inches (19 centimeters) at the four offsite stations. The average annual snowfall for the four offsite stations ranges from 3.5 to 5.1 inches (8.9 to 13 centimeters).

Based on its review of the local meteorological data and the discussions presented in the SAR, the staff finds the information acceptable because the applicant used reliable data sources such as the WRCC, NWS, and NOAA. The staff also finds that the applicant adequately summarized all relevant data, including weather data from nearby regional and WCS onsite meteorological stations, to define the expected meteorological conditions of the site. The staff reviewed the discussions of representativeness of the four offsite stations presented in the SAR and finds them acceptable because the statistical analysis results are similar among the stations and because all four stations lie in a similar geomorphic position at the southwestern extent of the Southern High Plains. Furthermore, the inputs used by the applicant in the design and performance analyses bound the summarized data.

Based on the discussion above, the staff finds that the information presented in the SAR is acceptable for use to develop the design bases of the facility, to perform additional safety analysis, and to demonstrate compliance with the regulatory requirements of 10 CFR 72.92(a), 10 CFR 72.98(a), 10 CFR 72.98(c)(3), and 10 CFR 72.122(b).

2.3.3.3 Onsite Meteorological Measurement Program

In SAR Section 2.3.3 and Section 2.3.4, "On-Site Meteorological Measurement Program," the applicant summarized the WCS onsite meteorological data and briefly described each of the four WCS onsite weather stations. Attachment A to Chapter 2 of the SAR, "Meteorological Data from Waste Control Specialists On-Site Weather Stations," provides hourly data from the WCS onsite stations for 2009–2015. The measurements include temperature, wind direction and speed, relative humidity at 2 and 10 meters (6.6 and 33 feet), barometric pressure, solar radiation, and precipitation at 2 or 4 meters (6.6 or 13 feet) depending on the particular station. In SAR Chapter 2, Attachment G, "Technical Specifications for Towers," the applicant provided detailed descriptions and data sheets for each onsite weather station, including details on placement and operation, types of sensors, instrument surveillance plans, and data acquisition and reduction methods, and information pertaining to accuracy, resolution, and range. Two of the WCS stations are within 200 meters (656 feet) of the southwestern and southeastern corners of the property. In SAR Figure 2-4, "Wind Rose Location Map," the station near the southwestern corner of the property is near the north side of a large man-made sediment pile, but no significant physiographic feature is evident near the station adjacent to the southeastern corner.

The applicant did not develop site-specific atmospheric diffusion estimates for the facility. Rather, in SAR Section 2.3.5, "Diffusion Estimates," the applicant described the inputs needed to estimate the atmospheric diffusion coefficients for (1) normal and off-normal conditions using D-Stability conditions and a wind speed of 5 miles per hour (8 kilometers per hour), and (2) accident conditions using F-Stability and a wind speed of 1 mile per hour (1.6 kilometers per hour). The diffusion coefficients are required inputs for independent site-specific atmospheric dispersion modeling of potential atmospheric releases. The applicant stated that it followed the guidance and methodology in NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," Revision 0, issued March 2000; NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems at a General License Facility," Revision 1, issued July 2010; and RG 1.145, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," Revision 1, issued November 1982, for the estimates of diffusion coefficients. Besides the wind data and stability categories, the applicant used a distance of 100 meters (328 feet) for the calculations. It stated that this choice was conservative because the distance to the boundary fence is greater than 100 meters (328 feet). SAR Table 2-7, "Atmospheric Dispersion Coefficients," gives the derived input values and the resulting atmospheric dispersion coefficients. In addition, the applicant provided topographic maps at three different scales, with the largest covering distances to 10 kilometers from the CISF, from which directional elevation profiles could be extracted for atmospheric dispersion analyses (see SAR Figure 2-14, "Geologic Atlas of Texas, Hobbs Sheet"; SAR Figure 2-2, "Waste Control Specialists Facility Site Plan"; and SAR Chapter 2, Attachment B, "Flood Plain Report").

Based on its review of SAR Sections 2.3.3 and 2.3.4 and SAR Chapter 2, Attachment G, the staff finds the applicant's onsite meteorological program acceptable because it is consistent with the guidance in RG 1.23, "Meteorological Monitoring Programs for Nuclear Power Plants," Revision 1, issued March 2007, for determining atmospheric dispersion estimates for both postulated accidents and expected routine releases of gaseous effluents. Therefore, the staff

finds the applicant's WCS onsite meteorological measurement program adequate for supporting the development of joint frequency distributions of wind speed and direction (wind rose) by atmospheric stability class for independent atmospheric dispersion analyses to assess the consequence of a release in compliance with the regulatory requirements in 10 CFR 72.90(e) and 10 CFR 72.98(c)(3).

2.3.4 Surface Hydrology

The staff reviewed SAR Section 2.4, "Surface Hydrology," with regard to (1) the hydrologic description, (2) floods, (3) the probable maximum flood (PMF) on streams and rivers, (4) potential dam failures, (5) probable maximum surge and seiche flooding, (6) probable maximum tsunami flooding, (7) ice flooding, (8) flood protection requirements, and (9) environmental acceptance of effluents.

2.3.4.1 Hydrologic Description

The applicant proposed to site the WCS CISF on the southwest-facing slope of the Southern High Plains that transitions to the Pecos Valley physiographic section in eastern New Mexico. Specifically, the proposed site is in western Andrews County, TX, near the border of Texas and New Mexico and north of Texas Highway 176, approximately 31 miles (50 kilometers) west of Andrews, TX, and 5 miles (8 kilometers) east of Eunice, NM. The existing WCS RCRA and LLRW site is directly south of the proposed WCS CISF site.

In Section 2.4.1, "Hydrologic Description," of the SAR, the applicant described the drainage area encompassing the proposed site as approximately 0.8 mile (1.3 kilometers) long and 1.8 miles (2.9 kilometers) wide, with a runoff-contributing area of approximately 1.4 square miles. A playa depression area is located southeast of the planned facility within the current WCS property boundary and will be used as a large water-detention basin during large rainfall events. Soils in the drainage area are mostly sands and sandy loams with intermingled gravels and clayey features. According to the U.S. Department of Agriculture's (USDA's) Natural Resources Conservation Service, the soils fall into various hydrologic classes, from A to D, with water infiltration and transmission rates from very low to very high. Restrictive features can be encountered within 20 inches (51 centimeters) below surface for a few soil groups (USDA, 2015).

Hydrologically, the area is generally characterized by ephemeral drainage features, sheet flow, minor gullies and rills, internally drained playas, and a salt lake basin. A continuous system of drainage channels is not apparent in the area on or adjacent to the CISF facility. The salt lake basin, located 5 miles (8 kilometers) east of the WCS CISF eastern boundary, is the only natural, perennial water feature that has a water depth rarely more than a few inches. Other perennial surface water bodies nearby are mostly man-made and are replenished by well water, including those on the New Mexico side of the border. Other man-made surface water features such as the Baker Spring, located at a historic quarry on WCS property west of the WCS CISF site in Lea County, NM, may hold rainwater during wet cycles but may be dry during extended dry periods. Two nearby ephemeral streams, the Mountain Draw near Eunice, NM, and the Ranch House Draw directly south of the existing WCS RCRA and LLRW facility, are 3 miles west and 1 mile south of the site, respectively.

The annual average precipitation of Andrew County, TX, is about 14.1 inches (35.8 centimeters) for 1895–2015 (PRISM, 2004). The average annual lake evaporation rate near Andrew County is 71.2 inches (181 centimeters, Texas Water Development Board, 2017) for 1954-2015, which is more than five times the average annual precipitation rate. The combination of these climatic

factors and local topographical relief in the drainage area surrounding the WCS CISF site results in most soils that are well drained (as classified in USDA, 2015), with a groundwater table more than 80 inches below the land surface.

According to the applicant, the site has no public or private surface water drinking water supplies on it. The City of Eunice, NM, will provide potable water for the WCS CISF that is sourced from groundwater at wells located west of Hobbs, NM, and north of Eunice, NM (City of Eunice, 2011). The applicant further stated that water taken from the perched groundwater above the red-bed clay in the area is primarily used for livestock watering.

The WCS CISF storage area is about 132 acres (53.4 hectares) and is situated on the northwestern side of the drainage area. Based on SAR Figure 2-26, "CJI C-1 Cross Section Layout," the storage pad elevation will be 3,504 feet (1,068 meters) amsl on the northwestern end and 3,490 feet (1,064 meters) amsl on the southeastern end. A collection ditch and a diversion berm will be constructed on the northeastern side of the storage area. As shown in SAR Figure 2-26 and Figure 2-28, "CJI C-3 Collection Ditch A Plan & Profile," the western end of the ditch will divert water to the western slope outside the facility. The eastern end of the ditch will collect and divert runoff from the upgradient area to the large playa depression southeast of the facility as depicted in SAR Figure 2-29, "CJI C-4 Collection Ditch B Plan & Profile STA. 0+00 – STA. 12+25." A railroad embankment will be constructed to extend the existing WCS rail track with a portion of the new rail track inside the storage area fences. Based on SAR Figure 2-26, a security/administration building and a cask transfer facility will be situated near the southwestern corner and the southern side of the storage area. The applicant stated that the foundations of the two buildings are at 3,496 feet (1,066 meters) amsl and 3,493 feet (1,065 meters) amsl, respectively.

Based on its review, the staff finds that the applicant sufficiently characterized the surface hydrologic features of the region, area, and site in detail to support the hydrologic engineering analyses and appropriately described the location, size, and hydrologic characteristics of all water sources that influence or may influence the site or facilities under severe hydrologic conditions. The applicant provided maps to support a clear understanding of these features. The staff also finds that the applicant identified the sources of the hydrologic information and the surface waters that could potentially be affected by normal or accidental effluents from the site, and the facility structures important to safety that may be affected by the hydrologic features of the proposed site.

2.3.4.2 Floods

The staff conducted a general search of the U.S. Geological Survey (USGS) flood reports, which did not indicate that the WCS CISF site area has experienced flooding in the past. The applicant noted that the drainage area encompassing the WCS CISF site contains no definitive, continuous stream channel or drainage feature. The Mountain Draw near Eunice, NM, and the Ranch House Draw directly south of the existing WCS RCRA and LLRW facility are ephemeral drainage features that only contain flowing water in response to direct, local precipitation events, often occurring briefly. Usually, the water does not flow through and merge with nearby, larger drainage ways.

The applicant conducted a drainage evaluation and flood plan study using the Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) model of the U.S. Army Corps of Engineers. The watershed contributing to drainage across the WCS CISF site is about 870 acres or 1.4 square miles (352 hectares) and is divided into four distinct subdrainage areas in the study (P DA 1 to P DA 4 in SAR Figure 2-35, "Developed Drainage Area Map"). Based

on a soil resources report of the site obtained from the USDA (2015), most of the soil groups within the watershed are well drained with hydraulic conductivities varying about three orders of magnitude, from 0.01 to 20 inches (0.02 to 51 centimeters) per hour.

The applicant's flood plan study includes rainfall events of three return-periods: a 100-year event as the design-basis flood, a 500-year event, and a probable maximum precipitation (PMP) event for potential extreme flood levels near the facility. Among the three storm events analyzed, the applicant determined that the flood levels and the flow rates for the PMP event are the highest. Based on its review, the staff finds the applicant's evaluation acceptable because it uses a commonly accepted model and areal precipitation information to determine the maximum flood levels and flow rates. Based on a confirmatory analysis performed by the staff, described below, the staff also finds that the PMP event results in the maximum flood level and flow rate. Therefore, the following discussion focuses on the PMP event that results in the PMF on the site.

2.3.4.2.1 Probable Maximum Precipitation

The applicant calculated the rainfall amount for the PMP event using the procedure reported in NWS Hydrometeorological Report No. 51, "Probable Maximum Precipitation Estimates, United States, East of the 105th Meridian" (Schreiner and Riedel, 1978). Using the procedure outlined in NWS Hydrometeorological Report No. 52, "Application of Probable Maximum Precipitation Estimates - United States East of the 105th Meridian," the applicant calculated a PMP of 40.5 inches distributed over a 72-hour period (Hansen et al., 1982). The staff notes that a local thunderstorm over a 6-hour period results in a PMP of 25 inches (64 centimeters) and is also embedded within the 72-hour PMP in the applicant's analyses. Using NWS Hydrometeorological Report No. 51, the staff performed a confirmatory analysis to independently estimate the 72-hour PMP to be approximately 40.6 inches (103 centimeters) and a local 6-hour thunderstorm PMP to be approximately 25.1 inches (64 centimeters). Based on its review and confirmatory analysis, the staff finds that the applicant appropriately determined the PMP because the applicant followed the commonly accepted general techniques (e.g., see Johnson, 2002) for assessing rainfall potential with minimal variability, namely the NWS hydrometeorological reports for specific regions of the United States, and a local 6-hour thunderstorm PMP occurring at the site is bounded by the 72-hour PMP.

2.3.4.2.2 Curve Numbers

Rainfall is usually converted to surface runoff by using a runoff curve number (CN) developed by the USDA's Natural Resources Conservation Service. A CN is developed based on soil types, plant covers, amount of impervious areas, interception, and surface storage or irregularities (USDA, 1986). A CN is also a function of antecedent moisture or runoff conditions (ARCs) in soils that may affect the capability of rainfall water to infiltrate topsoils and the amount of surface runoff. In accordance with the USDA report "Texas Engineering Technical Note No. 210-18-TX5" (USDA, 1990), the applicant stated that the ARC for the CNs for Andrew County, TX, falls within the region of ARC I for dry conditions. The applicant stated that its design-basis flood analysis used ARC II, average condition, and it conservatively used ARC III for wetter conditions to estimate the model's sensitivity to ARCs. However, a PMF analysis stipulates that the ARC be nearly saturated, preventing infiltration and maximizing potential runoff. Based on procedures outlined in USDA Technical Note No. 210-18-TX5, the applicant calculated the CNs under ARC III to vary between 91 and 96 for the four subdrainage areas within the contributing watershed of the WCS CISF site. The staff independently calculated the CNs to be between 88 and 96. Therefore, the staff finds the applicant's CNs acceptable

because the applicant used a commonly accepted method for determining the CNs and the CNs are comparable to the CNs independently calculated by the staff.

2.3.4.2.3 Lag and Time of Concentration

Lag is the delay between the time runoff from a rainfall event over a watershed begins until the time the runoff reaches its maximum. Time of concentration is the time required for runoff to travel from the hydraulically most distant point in the watershed to the point of interest (USDA, 2012). The applicant stated that it empirically estimated the lag as six-tenths (0.6) of the time of concentration for each subdrainage area (USDA, 2012). Based on its analysis, the staff determined that this estimated lag is acceptable because the major subdrainage area of the watershed is in average natural conditions and the runoff distribution for the drainage area is approximately uniform.

The applicant calculated the times of concentration for the four subdrainage areas using the velocity method outlined in USDA (2012) that considered three runoff legs: sheet flow, shallow concentrated flow, and open channel flow. The time of concentration for a subdrainage area is the sum of runoff travel times in individual legs. The applicant used the estimated lag of six-tenths (0.6) of the time of concentration as input to the HEC-HMS model.

The staff reviewed and compared the applicant's calculations with its independent calculations. The applicant-calculated lag times varied between 0.32 hour to 0.80 hour, while the staff's calculations varied between 0.32 hour to 0.65 hour. Based on its review and confirmatory calculations, the staff finds the applicant's lag and time of concentration analysis acceptable because the analysis generally followed the procedures outlined in USDA (2012) and the peak discharges are not sensitive to the differences between the lag times determined by the applicant and confirmed by the staff.

2.3.4.2.4 Rating and Storage-Elevation Curves of the Large Playa

The large playa depression to the east of the WCS CISF facility is the largest single hydrologic feature within the contributing subdrainage areas of the site and is used as a natural water detention basin that delays run-on from the WCS CISF site to the adjacent RCRA and LLRW site should discharge from the detention basin occur. Therefore, the flow rates on the associated subdrainage area and the outflow from the playa depression may impact the adjacent RCRA and LLRW facility.

A rating curve is an elevation-discharge relationship at a point along a flowpath, usually a stream or river channel. In the case of the large playa, a rating curve is the discharge rate and water-level relationship of the large playa, where the water level has a safety implication to the WCS CISF facility directly to its northwest. The storage-elevation curve of a detention basin is calculated, usually from a digital topographic survey, to determine the elevation of the storm water surface given the net inflow into the detention basin. The applicant estimated a storage-elevation curve for the playa depression using a topographic survey obtained in 2014.

In a submittal dated May 31, 2019, the applicant stated that it used the nonlevel dam top routine in the HEC-HMS model to calculate the rating curve across the large playa discharge area. The applicant used eight station elevation pairs in the HEC-HMS model to represent the large playa outflow cross-section. The model then used a broad-crested weir equation and a discharge coefficient to calculate outflow rates over the cross-section. To verify the applicant's calculation, the staff independently obtained a set of storage-elevation and outflow rating curves based on an outflow cross-section of the large playa from a 2011 digital elevation map made available by

the Texas Natural Resources Information System (tnris.org). With the latter, the staff calculated a maximum PMF flood water level of 3,488.0 feet (1,063.1 meters) at the WCS CISF facility, compared with the flood water level of 3,488.9 feet (1,063.4 meters) calculated by the applicant. Based on its review and independent calculations, the staff finds the applicant's rating curve acceptable because it is based on an industry-accepted method and the flood water level calculated by the applicant is comparable with the level calculated by the staff.

2.3.4.2.5 Flood Peak Discharge Determination

The applicant used the PMP rainfall depth, the CNs, the drainage areas and hydrologic lag time, and the rating curve of the large playa discharge area in the HEC-HMS model (U.S. Army Corps of Engineers, 2015) to determine the PMF peak discharges for all the four subdrainage areas. Of the four subdrainage areas surrounding the WCS CISF facility, the two subdrainage areas to the west of the facility produced offsite discharge, and the one subdrainage area southeast of the facility discharged into the large playa. Therefore, only the large playa drainage area where the facility is located has direct impact on flooding and water level of the WCS CISF facility. In Table 1 of Attachment B to SAR Chapter 2, "WCS-CISF Flood Analysis Post-Development Drainage Areas – Peak Flow," the applicant determined that the PMF for the large playa drainage area yielded a peak flood discharge of 2,849.7 cubic feet per second (ft³/s, 80.694 cubic meters per second [m³/s]). The staff independently determined a PMF peak discharge of 2,849.9 ft³/s (80.700 m³/s). Therefore, the staff considers the applicant's PMF peak discharge of 2,849.7 ft³/s acceptable.

2.3.4.2.6 Flood Impacts on Site Structures

The applicant's HEC-HMS model analysis indicated that the PMF peak discharge at the large playa depression resulted in a water surface elevation of 3,488.9 feet amsl. The applicant stated that elevations of the storage pads vary from 3,490 to 3,504 feet (1,064 to 1,068 meters) amsl, at least 1 foot above the PMF flood level. The foundation elevations of the security/administration building and the cask transfer facility are designed to be 3,496 feet amsl and 3,493 feet amsl, respectively.

At the State Line Road west of the facility, the calculated PMF water surface is about 0.8 foot (24 centimeters) above the road surface at an elevation of 3,487.3 feet (1,062.9 meters) amsl. Southwest of the facility, the PMF water surface is about 1.4 feet (0.43 meters) above the access railroad track at an elevation of 3,466.2 feet amsl. Near the southeast corner of the storage pad area on the WCS CISF site, the applicant calculated a water surface elevation of 3,488.9 feet amsl. Southeast of the facility, the calculated PMF water surface is about 1.5 feet (0.46 meters) above the access railroad track at an elevation of 3,488.9 feet amsl. The staff independently computed the PMF water surface elevations for a flood discharge of 2,849.9 ft³/s at the large playa discharge area of the site. For the four locations discussed above, the staff's computations yielded water surface elevations of 3,486.9 feet (1,062.8 meters) amsl, 3466.2 feet (1,056.5 meters) amsl, 3,488.9 feet (1,063.4 meters) amsl, and 3,488.0 feet (1,063.1 meters) amsl, respectively. Based on its independent analysis, the staff verified that the storage pads, the security/administration building, and the cask transfer facility will be above the maximum PMF water elevation.

In SAR Chapter 2, Attachment B, Appendix C, "HEC-RAS Model for the Calculation of the 100-Year Water Surface Profile," the applicant provided its calculations of the maximum water depth on the storage pad. The applicant calculated the maximum rainfall intensity among the three precipitation scenarios as 0.21 inch per minute. Based on a site slope of 0.8 percent and a concrete pad surface roughness coefficient of 0.015, the applicant determined a maximum

water depth of 1.1 inches (28 centimeters). The staff verified that the maximum rainfall intensity is associated with a 500-year USDA Soil Conservation Service Type II storm for 24 hours with a magnitude of 8.71 inches (22.1 centimeters). The staff's independent calculation, using the roughness coefficients reported in USGS Water Supply Paper 2339, "Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains" (USGS, 1989), resulted in water depths on the concrete pad varying between 0.9 and 1.3 inches (2.3 and 3.3 centimeters).

In conclusion, the staff reviewed the applicant's PMF analysis for the site and finds it acceptable because the staff's independent analysis confirmed that the potential PMP flood scenarios analyzed will not result in flooding of the cask storage pad. The staff determined that this information is acceptable for use to develop the design bases of the facility, to perform additional safety analysis, and to demonstrate compliance with the regulatory requirements of 10 CFR 72.90(c), 10 CFR 72.90(d), 10 CFR 72.90(f), and 10 CFR 72.122(b).

2.3.4.3 Probable Maximum Flood on Streams and Rivers

The applicant stated that the closest main surface water drainage feature is the Monument Draw, an ephemeral stream that is about 3 miles west of the WCS CISF in New Mexico. The maximum historical flow occurred on June 10, 1972, and measured 36.2 m³/s (1,280 ft³/s). At its location closest to the WCS CISF facility, the stream bed elevation is about 3,385 feet (1,062 meters) amsl, or about 100 feet (30 meters) below the lowest storage pad elevation (NRC, 2005, Figure 3-21, cited from Louisiana Energy Services (LES), 2005). The staff independently verified on USGS topographical maps the location and elevation of the stream bed identified by the applicant. The staff determined the stream flooding at this location will not impact the proposed CISF facility because of the ephemeral and intermittent nature of the stream flow (e.g., see New Mexico Rapid Watershed Assessments—Landreth-Monument Draws Watershed on <https://nrca.usda.gov>, USDA, 2020), and the distance and the elevation difference of the stream from the proposed CISF facility.

In Attachment B to Chapter 2 of the SAR, the applicant stated that an ephemeral drainage feature about 1 mile south of the WCS CISF and directly south of the existing WCS RCRA and LLRW disposal facility, referred to as the Ranch House Draw, crosses the WCS property from east to west. In its approved license application to the Texas Commission on Environmental Quality for the WCS LLRW disposal facility, the applicant conducted a study using a hydrological model built on U.S. Army Corps of Engineers Hydrologic Engineering Center River Analysis System (HEC-RAS) software. The study modeled the area around the proposed CISF as undeveloped with natural soil surface and vegetation coverage. The applicant stated that, according to the study, the northernmost limits of the PMP floodplain is 3,895 feet (1,187 meters) southeast of the CISF site. The study also indicated that the PMF elevation of the large playa is 3,488 feet (1,063 meters) amsl, and the PMP discharge from the large playa detention basin is 2,519 cubic feet per second (71.33 cubic meters per second). In comparison, the PMF elevation of the large playa is 3,488.9 feet amsl, and the PMF discharge rate is 2,849.7 cubic feet per second (80.694 cubic meters per second) according to the applicant's HEC-HMS model for the WCS CISF facility.

As discussed in Section 2.3.4.2.6 of this safety evaluation report (SER), "Flood Impacts on Site Structures," for flood impacts on site structures, the staff's confirmatory analysis suggests that water elevation of the large playa varies between 3,488.0 feet amsl near the discharge area and 3,488.9 feet (1,063.4 meters) amsl near the southeast corner of the proposed CISF facility. This is less than 1 foot (0.3 meter) of increase in flood water elevation in the large playa, comparable to that obtained by the applicant for the WCS RCRA and LLRW disposal facility and accounting

for the development of the CISF facility. Using the WCS RCRA and LLRW facility hydrological study, the staff independently estimated that the Ranch House Draw PMP flood water elevation nearest the CISF facility is more than 20 feet (6.1 meters) lower than the elevation of the southeast corner of the storage pad area. Based on these analyses, the staff determined that the PMF of the Ranch House Draw will not impact the proposed CISF facility.

Based on the review of the applicant's analysis and the staff's confirmatory analysis, the staff finds the increased stream water elevations in the Monument and Ranch House Draws during a PMP event are unlikely to impact the structures that are important to safety at the WCS CISF site.

2.3.4.4 Potential Dam Failures (Seismically Induced)

No dams are on or near the WCS CISF site. The nearest water bodies are the Red Bluff Reservoir about 65 miles (105 kilometers) southwest from the proposed site, and the Brantley and Salt Lakes about 55 miles (88 kilometers) west of the proposed site (USGS, 2017). The amount of water stored in these water bodies is unlikely to impact the site in the event of a failure, considering the distances from and elevations of the water bodies with respect to the proposed facility. Furthermore, the drainage area upstream of the WCS CISF facility contains no water storage, flow control, or embankment structures. Therefore, the applicant concluded that dam or control structure failure would pose no potential impacts on the site.

The applicant stated that the collection ditch and diversion earth berm northeast of the WCS CISF facility are primarily for operational convenience to minimize run-on of stormwater onto the CISF facility footprint. The applicant stated that during the first phase of construction of the facility, the berms and ditches will be constructed of compacted red-bed clay and armored with caliche available on site to minimize erosion and seepage. After normal and extreme precipitation events, the applicant plans to routinely inspect and maintain the berms and ditches and the site areas between the berms and the storage pads throughout all phases of the construction of the facility. The applicant stated that the areas of the site impacted by erosion and sediment buildup will be repaired to original grades.

SAR Figures 2-28 and 2-29 show the top of the diversion berm at an elevation of about 3,504 feet (1,068 meters) amsl at the west end and about 3,498 feet amsl at the east end. In comparison, the PMF flood level calculated by the applicant is at 3,488.9 feet (1,063.4 meters) amsl. The applicant stated that the ditch and berm were sized for a 100-year, 24-hour rainfall event with 1 foot of (0.3 meter) freeboard and would not convey all the runoff during the PMF. In the event of a PMF, flood water will overtop the diversion berm; cause temporary, localized flooding of the facility; and breach the earthen structure. The applicant developed an HEC-HMS model of the area upstream of the berms and ditches under the above-mentioned PMP weather condition. Assuming all surface runoff from the PMP event breaches the berm at an area closest to the pads, the applicant estimated the maximum depth of flow on the ground surface to be approximately 2.7 inches (6.8 centimeters) compared with the staff's independent calculation of 2.8 inches (7.1 centimeters). In contrast, the applicant calculated the maximum water depth of 1.1 inches (2.8 centimeters) on the storage pads without a berm breach under the PMP weather condition (see SER Section 2.3.4.2.6). The graded topography of the site allows sheet flow of the water on to the large playa, which will not cause erosion of the surface as it consists of concrete, the storage pads, and crushed rock. The berm breach does not change the PMF flood water level, as demonstrated by the applicant's flood analysis for the worst-case scenario in which the diversion berm and collection ditch are removed from the facility design. In that case, the storage pads remain 1 foot (0.3 meter) or more above the PMF flood level. Therefore, the failure of the diversion berm will not have a flooding impact on the cask storage area.

At the western intersection of the WCS CISF rail side track and the existing WCS railroad, an accumulation of flood water in combination with seismic activities may cause the railroad embankment to fail. The flood water at its peak is more than 23 feet (7.0 meters) below the elevation of the storage pads and will discharge to the southwest and away from the WCS CISF facility area. Therefore, the staff concludes that damage of the railroad embankment at this location will not flood the WCS CISF facility.

The subdrainage area to the southeast of the WCS CISF facility bounded by the existing WCS railroad and the CISF rail side track will also accumulate stormwater during PMP events. Damage of the embankments will result in stormwater with a peak surface elevation about 1 foot (0.3 meter) or more below the storage pads and draining into the large playa to the east or south to the existing drainage pathways of the WCS LLRW and RCRA facilities. Based on its review of the offsite discharge pattern of the stormwater, the staff concludes that damage of the railroad embankment at this location will not impact the WCS CISF facility.

The WCS RCRA and LLRW facilities to the south of the proposed WCS CISF have five man-made evaporation ponds on site. The elevations of the storage pads will be more than 30 feet (9.1 meters) higher than and upslope of the evaporation ponds. The applicant stated that a series of man-made ponds owned by Sundance Services, Inc., is located to the southwest near Eunice, NM. The staff independently verified on USGS topographical maps that the ponds are at least 4,000 feet (1,200 meters) away from the southwest corner of the storage pad area. The elevations of the ponds are about 15 feet (4.6 meters) or more lower than the storage pads. Therefore, the staff finds the applicant's conclusion about the impact of the ponds to the WCS CISF acceptable because of the distance and the topography that controls the flow of surface water on and near the WCS RCRA and LLRW facilities and on the Sundance Services, Inc., property.

The staff reviewed the applicant's analysis for potential dam failures and finds it acceptable because the analysis considered all the relevant dams and reservoirs that could affect the site in the event of failure. Based on its independent calculations, the staff confirmed the applicant's analysis that demonstrated potential berm embankment failure will not result in flooding of the cask storage pads. The staff finds this information acceptable for use to develop the design bases of the facility, to perform additional safety analysis, and to demonstrate compliance with the regulatory requirements of 10 CFR 72.90(c), 10 CFR 72.90(d), 10 CFR 72.90(f), and 10 CFR 72.122(b).

2.3.4.5 Probable Maximum Surge and Seiche Flooding

Surge and seiche affect sites adjacent to large water bodies or the oceans. The nearest water bodies are the Red Bluff Reservoir about 65 miles (105 kilometers) southwest from the proposed site, and the Brantley and Salt Lakes about 55 miles (88 kilometers) to the southwest and west of the proposed WCS CISF (USGS, 2017). The site elevation is about 650 feet (200 meters) above the Red Bluff Reservoir and approximately 240 feet (73 meters) above the Brantley and Salt Lakes. The amount of water stored in these bodies of water is relatively small (Dowell and Breeding, 1967; Stiteler, 2006). Therefore, surge or seiche flooding would not impact the site.

The staff reviewed the applicant's discussion of probable maximum surge and seiche flooding and finds it acceptable because there are no large bodies of water to impact the site by this phenomenon.

2.3.4.6 Probable Maximum Tsunami Flooding

The site is inland and not located adjacent to a coastal area. The Gulf Coast is about 500 miles (800 kilometers) to the southeast. Therefore, the applicant stated that flooding attributed to seismically induced ocean waves is not applicable to the site.

The staff reviewed the applicant's discussion of probable maximum tsunami flooding and finds it acceptable because the proposed site is not located on or near the coast and will not be affected by this phenomenon.

2.3.4.7 Ice Flooding

The proposed WCS CISF site is 55 miles from the nearest body of water. Evaporation ponds are located near the proposed site on the site of the existing WCS RCRA and LLRW facility. Evaporation ponds are shallow and unprotected surface water storage areas commonly used as a low-cost wastewater management practice (e.g., see the studies posted at <https://www.science.gov/topicpages/w/wastewater+evaporation+ponds>, such as National Aeronautics and Space Administration (NASA), 1989, and Kavvadias, et al., 2017). For the amount of water in the evaporation ponds, ice flooding to the proposed CISF site is not a likely phenomenon because (1) the local semiarid climate and geologic conditions preclude it, and (2) the ponds are more than 30 feet (9 meters) below the storage pads. The nearest stream, an ephemeral stream named Monument Draw, is about 3 miles (5 kilometers) west of the WCS CISF site in New Mexico, and it is unlikely to cause ice blockage and ice flooding at the site.

The staff reviewed the applicant's discussion of probable maximum ice flooding and finds it acceptable because the local climate and geologic conditions are not likely to support this phenomenon and the closest bodies of water are far below the site elevation.

2.3.4.8 Flood Protection Requirements

The applicant stated that the proposed WCS CISF site is not located in an area where flooding protection is required and that the site is not designated by the Federal Emergency Management Agency as a special flood hazard area. Therefore, the applicant did not propose a flood protection structure.

The staff reviewed the applicant's discussion of flood protection requirements and finds it acceptable because the elevation of the proposed dry cask storage pad remains above the flood level of the PMF event.

2.3.4.9 Environmental Acceptance of Effluents

In SAR Section 6.5, "Radiological Impact of Normal Operations Summary," the applicant stated that the design basis of the proposed WCS CISF precludes the release of radioactive effluents; therefore, stormwater runoff would not contain radiological effluents. In SAR Section 9.3, "Radiation Protection Design Features," the applicant stated that spent fuel will be maintained dry so no radioactive liquid will be available for release. The applicant also stated that the waste canisters are sealed by welding and would not be opened at the facility. Because the welded canisters are designed not to be breached under normal and off-normal conditions of transfer, handling, and storage, the applicant stated that no release of radioactive materials from inside the canister is expected under these conditions. The applicant further stated that the results of its analyses indicate that there are no credible accident scenarios for the WCS CISF that would result in a loss-of-confinement accident or a radiological release in excess of

regulatory radiological dose criterion, which was confirmed by staff independent calculations (SER Section 9.3.2, “Radionuclide Confinement Analysis”). The applicant also stated that stormwater runoff would be directed to the natural drainage system, presumably gravity-drained off-site or to the nearby large playa depression and then into the underlying soil horizons. Further, the WCS CISF design would direct domestic wastes to aboveground tanks on site that would be periodically drained, with the wastes transported off site for disposal. Since there is no liquid effluent as a result of the WCS CISF operations, the staff finds that the application meets the requirements of 10 CFR 72.122(b)(4) precluding transport of radioactivity to a surface water body or an aquifer. The staff reviewed the applicant’s discussion of the environmental acceptance of effluents and finds it acceptable because the applicant’s design basis precludes radioactive effluents as discussed in SER Section 15.3.

2.3.5 Subsurface Hydrology

The staff reviewed the information presented in SAR Section 2.5, “Subsurface Hydrology.” The applicant provided information on the regional groundwater system of west Texas, the hydrogeology of the WCS site as a whole, and the local hydrogeology of the CISF portion of the site. Information from the WCS LLRW site bordering to south of the CISF area supplements site-specific information on the CISF. This section discusses (1) regional groundwater characteristics, (2) site groundwater characteristics, and (3) contaminant transport analysis.

2.3.5.1 Regional Groundwater Characteristics

In SAR Section 2.5, the applicant described the primary regional aquifers as occurring in the following geologic units: (1) Cenozoic Alluvium, (2) Tertiary Ogallala and Gatuña Formations and Cretaceous Antler Formation, and (3) underlying Triassic Dockum Group. The staff reviews the regional geology in more detail in SER Section 2.3.6, “Geology and Seismology.” The applicant stated that the Cenozoic Alluvium Aquifer does not occur in the vicinity of the WCS CISF site. Regionally, the Tertiary and Cretaceous aquifers are described as often hydraulically connected and are generally considered together as the High Plains Aquifer system. For the CISF site, Davidson et al. (2019) stated that the Tertiary and Cretaceous geologic units are at their distal lateral extent. The applicant collectively referred to the Tertiary and Cretaceous units as the undifferentiated Ogallala-Antlers-Gatuña (OAG) unit because of difficulties in distinguishing the separate geologic layers.

In SAR Section 2.5, the applicant provided aquifer thicknesses, gradients, flow rates, water quality, recharge characteristics, and extent of the primary regional aquifers—the Ogallala, Antler, and Dockum Group Aquifers. The applicant stated that the Ogallala Aquifer is the primary freshwater aquifer of the Southern High Plains. The Ogallala Aquifer is typically under water table conditions (unconfined) and thickens to 300 feet (90 meters) to the north and east of the WCS site. The Ogallala Formation was formed as alluvial fans, which the applicant stated are recharged at playas, headwater creeks, and areas of irrigation. Groundwater discharge regionally from the Ogallala Aquifer occurs through springs, underflow, and evapotranspiration and artificially through pumping. As noted above, the Antler Formation Aquifer is often hydraulically connected to the Ogallala Aquifer, thus comprising the High Plains Aquifer system. The applicant described the regional gradients trending to the southeast for the Ogallala, Antler, and Dockum Group Aquifers. In the vicinity of the WCS CISF site, the applicant stated that OAG unit is largely unsaturated.

Regionally, the Dockum Group consists of interlayered clays, shales, siltstones, sandstones, and conglomerates. Aquifers in the lower portion of the Dockum Group, the Santa Rosa and Trujillo Formations, are known collectively as the Dockum Group Aquifers. The applicant

reported that most of the recharge to the sand layers of the Dockum Group occurred more than 15,000 years ago. The red beds of the Cooper Canyon Formation lie over the Santa Rosa and Trujillo Formations, which the applicant indicated acts as an aquitard for limiting recharge to the Dockum Group Aquifers or hydraulic connection with the overlying Antler or Ogallala Aquifers. The applicant indicated that further support for the Cooper Canyon Formation regionally acting as an aquitard is that the hydraulic head in the Dockum Group Aquifers is lower than that of the overlying Ogallala Aquifer by up to 300 feet (90 meters) in western Andrews County. The red beds of the Cooper Canyon Formation are present at the WCS site. The applicant indicated that the two deep wells near the WCS CISF site screened at two sandstone layers of the Dockum Group yielded nonpotable water with water levels of 2,852 and 3,172 feet (869 and 967 meters) amsl, which are at least 225 feet (68.6 meters) below ground surface (bgs) at the WCS site.

The staff reviewed the applicant's discussion of regional subsurface hydrology characteristics and finds it acceptable because the applicant used the general literature and reports from the government departments in Texas and New Mexico, the University of Texas Bureau of Economic Geology (which functions as the State geologic survey), and the USGS. The staff has determined that the application's description of the regional groundwater characteristics is acceptable for use to develop the design bases of the facility, to perform additional safety analysis, and to demonstrate compliance with the regulatory requirements in 10 CFR 72.98(c) and 10 CFR 72.122(b).

2.3.5.2 Site Groundwater Characteristics

SAR Section 2.5 and Section 2.6, "Geology and Seismology," and the references contained therein, describe the lithological and hydrogeological units below the WCS CISF site. Additional supporting documents with more details on the subsurface of the WCS CISF area and the WCS site include Grisak et al. (2011) and WSC's 2007 LLRW license application and references therein. Based on borings at the CISF site, the applicant described in SAR Section 2.6.1, "Basic Geology," a general section at the CISF site, from uppermost to lower lithologies, as follows:

- unconsolidated sediments, 60 to 100 feet (18 to 30 meters) thick
 - recent wind-blown sands
 - wind-blown sands of the Blackwater Draw Formation, which may include moderately developed caliche
 - undifferentiated OAG unit with alluvial and wind-blown sediments
 - upper unconsolidated graded sands
 - caprock caliche, which is well developed, dense, and indurated
 - lower unconsolidated sandy gravels to gravelly sands
- red beds of the Cooper Canyon Formation

At the CISF site, the hydrogeology consists of the undifferentiated OAG unconsolidated sediments and the underlying bedrock of Dockum Group red-bed claystones with saturated sandstone layers lower in the section. The CISF site is near the lateral distal extent of the Ogallala, Antler, and Gatuña Formations. The applicant stated that the shallowest water table is at a depth of 225 feet (69 meters) in the red beds of the Cooper Canyon Formation of the Dockum Group. Above the red-bed claystone bedrock, the applicant noted isolated areas or

lenses of saturation in the OAG hydrogeologic unit on the erosional paleosurface of the bedrock interface.

The applicant described groundwater use near the CISF site. The applicant stated that the southern limit of the Ogallala aquifer lies to the north and east of the WCS CISF site, with the nearest downgradient groundwater user 6.5 miles (10.5 kilometers) to the east of the WCS CISF site. Closer to the WCS site, the applicant described scattered windmills in the general area used primarily for livestock watering that take water from isolated pockets of groundwater perched on top of the Dockum Group red-bedrock claystone. The applicant stated that water for construction, operation, and decommission will not be obtained from local wells, but rather it will be obtained from the City of Eunice and piped to the site.

Hydrogeology of the Ogallala-Antlers-Gatuña Unit

The applicant indicated that the saturated thicknesses in the OAG unit in the footprint of the CISF site range from several inches to 5 feet (several centimeters to 1.5 meters). SAR Figure 2-10, "OAG Groundwater Elevation Near the Proposed WCS CISF," illustrates the distribution of saturation below the footprint; there is a small isolated lens on the southern side of the CISF site and saturation on the northern side of the CISF site that may continue to the north. Saturation data from 2016 and 2019 exhibit small variations in lateral extent and thickness (Figure 2-10, "OAG Groundwater Elevation Near the Proposed WCS CISF," in SAR Revision 2 and SAR Revision 5, respectively, for 2016 and 2019 data), which indicate the possibility of seasonal or annual responses to variations in precipitation. The applicant reported that the saturated zones of the OAG unit occur at the bedrock interface. In SAR Section 2.6, the applicant stated that the geotechnical borings at the CISF site did not find saturated horizons in the sediments higher up in the OAG unit. In addition, the applicant indicated in a submittal dated June 28, 2019, that no perched water has been observed in analogous stratigraphic positions in more than 500 borings across the WCS site. The isolated saturated zones in the OAG at the CISF site are at least 60 feet (18 meters) bgs. Because of the large separation of the saturated portions of the OAG and the near surface, and the lack of observations of perched water, the staff finds that groundwater flow in the OAG and overlying wind-blown sands will not affect construction components or operation activities.

The applicant indicated that focused infiltration in the CISF area occurs in playas and drainages and is the source of recharge to the isolated pockets of saturation at the bedrock surface. Lehman and Rainwater (2000, attachment to WCS, 2007) concluded that near-surface groundwater in the Antlers and Ogallala Formations on the WCS site resulted from local recharge through channels and closed surface depressions. Using additional monitoring well data, Grisak et al. (2011) linked responses in wells during and after precipitation events to proximity to surface drainages and depressions, and to connections to channels and depressions in the bedrock paleosurface. Both the surface topography and the erosion-derived paleotopographic surface of the bedrock affect the redistribution of water in the unconsolidated sediments. The surface drainage divide and the bedrock paleosurface divide are not coincident. The applicant described the east-west trending, buried red-bed ridge that crosses the WCS site as being approximately 1,200 feet (366 meters) south of the CISF area. Hence, the bedrock interface generally slopes to the north or northeast. For the ground surface topography and drainage, both the CISF site and the WCS site are located on the southwest-facing slope that transitions from the Southern High Plains to the Pecos Valley physiographic section.

Davidson et al. (2019) undertook an analysis to assess groundwater flow on the fringe of the Ogallala Aquifer by investigating the local hydrogeology and its relationship with the regional Ogallala Aquifer. The assessment included the response of water well-level data to

precipitation, hydraulic head and flow directions, and geochemical and stable isotope and tritium data, as well as contours of the paleosurface elevation of the bedrock at the base of the OAG unit. Davidson et al. (2019) noted that the paleosurface on top of the red beds slopes generally to the north across the CISF area, but with local depressions or channels where the isolated saturated lenses may occur. Davidson et al. (2019) listed six observations that led the authors to conclude that the fringe area was not hydraulically connected to the Ogallala Aquifer: (1) a discontinuous saturated zone for the study area on the fringe of the aquifer system, (2) no inflow to the fringe study area from the regional Ogallala Aquifer, (3) focused recharge beneath depressions and playas with limited local mixing between pockets of saturation based on geochemical data, (4) flow direction in the fringe study area orthogonal to that of the regional aquifer, (5) localized multiyear reversals in flow direction in the fringe study area following high-precipitation events, and (6) an evaluation of the influence of the paleoerosional topology of the bedrock on groundwater isolation and flow direction.

The staff reviewed the supporting information to evaluate the hydraulic connection between recharge to the OAG at the CISF site and the Ogallala Aquifer to the north and the east. The Ogallala Aquifer is used as the primary regional aquifer of the Southern High Plains. Because of the conceptualization of local recharge and the limited lateral extent of redistribution at the bedrock interface, particularly considering the conclusions of Davidson et al. (2019), the staff finds that recharge in the OAG at the CISF site is not hydraulically connected to the Ogallala Aquifer to the north and east of the site.

Hydrogeology of Bedrock

The applicant stated that the red beds of the Cooper Canyon Formation act as an aquitard for limiting any significant hydraulic connection of the Dockum Group Aquifers with the overlying OAG hydrogeological unit. The red beds are the uppermost bedrock unit at the CISF site. The applicant indicated that the two deep wells near the WCS CISF site screened at two sandstone layers of the Dockum Group yielded nonpotable water with water levels of 2,852 and 3,172 feet (869 and 967 meters) amsl, which are at least 225 feet (69 meters) bgs at the WCS site. Regional measurement of lower hydraulic heads in the Dockum Aquifers compared to those in the overlying Ogallala Aquifer suggest that the upper Dockum Cooper Canyon Formation acts as an aquitard.

The staff reviewed supporting information from the WCS site to evaluate the effectiveness of the red beds of the Cooper Canyon Formation of the upper Dockum Group to function as an aquitard between the OAG at the CISF site and the underlying Dockum Group Aquifers. By analogy, the red bed at the CISF should also act as an aquitard. WCS (2007, Attachment 6-6) states that groundwater from the OAG and red-bed Cooper Canyon Formation at the WCS site has marked difference in hydrogeochemical conditions and tritium and radiocarbon analyses indicative of limited hydrologic communication between the units. The OAG groundwater had tritium values indicative of post-thermonuclear testing, whereas the upper Dockum groundwater lacked tritium and had radiocarbon ages reflective of the Pleistocene. In addition, oxygen-18 and deuterium signatures were lower for the Dockum groundwater, reflective of precipitation under cooler conditions consistent with the Pleistocene. WCS (2007, Attachment 6-2) indicates that unsaturated conditions occur in the upper Dockum at the WCS site between saturated conditions in the overlying OAG and saturated sand layers lower in the Dockum. Matric potential and saturation state measured in the upper Dockum reflect the unsaturated state.

Summary

The staff reviewed the application and supporting documents with regard to the site characteristics and finds them acceptable because the groundwater characteristics are

adequately described and are based on site-specific observations and data. Based on the observed extent of saturated conditions in the OAG, the staff finds that the groundwater will not affect construction components. Furthermore, based on an analysis of hydraulic, geochemical, and isotopic data, the staff finds that the saturated conditions in the OAG are not hydraulically connected to the underlying Dockum Aquifers nor laterally connected to the Ogallala Aquifer to the north and east of the CISF site. The staff determined that this information is acceptable for use to develop the design bases of the WCS CISF facility, to perform additional safety analysis, and to demonstrate compliance with the regulatory requirements in 10 CFR 72.98(c) and 10 CFR 72.122(b).

2.3.5.3 Contaminant Transport Analysis

The applicant stated that it did not include a hydrologic transport analysis in the SAR because a release of effluents from the WCS CSIF facility is not expected. Based on the evaluation in SER Chapter 9, "Confinement Evaluation," and Chapter 15, "Waste Confinement and Management Evaluation," the staff finds the omission of the contaminant transport analysis acceptable for compliance with 10 CFR 72.122(b) because the facility and cask designs are expected to preclude the release of effluents for normal, off-normal, and accident conditions.

2.3.6 Geology and Seismology

The staff reviewed the information presented in SAR Section 2.6, in which the applicant described the geological and seismological setting of the proposed site, geographically located in the Andrews County, TX, on the border with New Mexico. The staff reviewed the discussion in the SAR on basic geologic and seismic information, ground vibration, surface faulting, the stability of subsurface materials, and slope stability.

2.3.6.1 Basic Geologic and Seismic Information

The staff reviewed the basic geologic and seismic characteristics of the site and vicinity as described in SAR Section 2.6.1, "Basic Geology." The applicant briefly described the near-surface stratigraphy and the geologic history of the area, including the origin of some structural features in the site region. The staff also reviewed relevant literature cited in the SAR and supporting documents in SAR Chapter 2, Attachment C, "Boring Logs"; Attachment E, "Geotechnical Investigation of WCS CISF"; and Attachment F, "Evaluation of Halite Dissolution in the Vicinity of Waste Control Specialists Disposal Site, Andrews County, TX."

Some areas immediately adjacent to the proposed WCS CISF site were previously studied in preparation for the construction of nearby facilities. The staff considered the geologic information from these previous investigations conducted in 2000 and 2004 (Leyman and Rainwater, 2000; Cook-Joyce, Inc., and Intera, Inc., 2004). The documents and related materials accompanying these investigations provide a substantial database and description of geological conditions for the WCS CISF site, some of which the applicant reported in the SAR.

In addition, the applicant performed additional field investigations to confirm site-specific conditions, including 15 monitoring wells/piezometers described in SAR Chapter 2, Attachment C, and 18 soil borings described in SAR Chapter 2, Attachment E. The staff reviewed the information in the boring logs of monitoring wells and piezometers, the seismic hazard evaluation report in SAR Chapter 2, Attachment D, "Seismic Hazard Evaluation for WCS CISF" (proprietary), and the results and boring logs from the geotechnical investigation at the site that supplement SAR Section 2.6.1.

In SAR Section 2.6.1, the applicant identified the stratigraphic units encountered from the Triassic Dockum Group to the surface. SAR Figure 2-14 presented the regional geology and SAR Figure 2-13, "Stratigraphic Column Central Basin Platform," provided the stratigraphic column for the Central Basin Platform on which the proposed site is located. The applicant described the Central Basin Platform as a horst-like structure flanked on the west, east, and south by the Delaware, Midland, and Val Verde structural basins, respectively. These basins and the Central Basin Platform collectively form the Permian Basin, a regional structure in west Texas and southeastern New Mexico. From the Triassic-age units upwards, the sedimentary rocks display a history of formation in an inland basin, erosion and submergence by a shallow sea during the Cretaceous period, and then uplift and erosion in the early Tertiary era. This latter uplift was the Laramide Orogeny, occurring around 60–50 million years ago. It formed the Cordilleran Mountains to the west of the WCS site, and erosion provided sediments for later Tertiary-age sediments in the region. The region has been tectonically stable since that time.

The upper sequence of rocks and soil is of most significance to the WCS CISF site. The upper ~400 meters (1,400 feet) has the following geologic formations beneath the proposed WCS CISF site, from oldest to youngest: the Triassic Dockum Group (claystones with occasional sandstone lenses), the Cretaceous Trinity Group Antlers Formation (gravels), the Late Tertiary stratigraphic equivalent of the Ogallala Formation (sand-silt), the Late Tertiary/Quaternary Gatuña Formation (alluvium with fine sand-silt), the Pleistocene windblown sands of the Blackwater Draw Formation, and Holocene windblown sands and playa deposits. A regional hard caliche, called the caprock caliche, developed on all pre-Quaternary formations before the Blackwater Draw sands were deposited. The units above the Triassic Dockum Group rocks form the sediments that were penetrated in the monitoring wells and boreholes and on which the WCS CISF would be constructed. In the region of the WCS CISF site, the units above the Triassic Dockum Group rocks are more than 100 feet (30 meters) thick but are thinner in other places.

The applicant provided geologic cross-sections of the upper rock layers under the WCS CISF site to a depth of approximately 100 feet in SAR Figure 2-16, "WCS CISF Cross Section West-East," and Figure 2-17, "WCS CISF Cross Section North-South," and additional information in SAR Chapter 2, Attachment C. These cross-sections document the lithology of the layers and, when combined with two cross-sections constructed from oil and gas well data of the upper approximately 600 meters (2,000 feet) of sedimentary rocks in the region, show that the strata are near horizontal and not folded. The applicant provided site stratigraphic information in Figure 18, "Generalized Geologic Profile at WCS Site," of SAR Chapter 2, Attachment D, and the monitoring well and borehole logs provided in SAR Chapter 2, Attachments C and E.

The staff reviewed the stratigraphic information in the application and determined that the material composition and thicknesses of the subsurface layers at the site vary among SAR Section 2.6.1; Figure 18 of SAR Chapter 2, Attachment D; Figures 2-15 through 2-17; and SAR Chapter 2, Attachments C and E. The applicant did not explain the differences in SAR Section 2.6.1. The depth to the top of the red beds (clay) varies from that reported in Figure 18 of SAR Chapter 2, Attachment D, to a range that deepens from the southwest to northeast of the site, with an average depth within the site area of approximately 66 feet in the monitoring well logs in SAR Chapter 2, Attachment C. The staff also noted inconsistent descriptions of subsurface units from borings and monitoring wells located in close proximity. Additionally, the boring logs did not specify the composition of the materials encountered at auger refusal. Four of the borehole logs described in SAR Chapter 2, Attachment E, penetrated deeper than 25 feet (7.6 meters), reaching auger refusal between 37 and 45 feet (11 and 14 meters), which the

report of geotechnical exploration provided as Attachment E in the initial submittal stated “may indicate dense gravel or cobble layers, boulders, and/or the very dense caliche.”

Therefore, the staff asked the applicant to provide additional information on the stratigraphy of the site and clarify the unit descriptions, thicknesses, material properties, and spatial associations among mapped units.

In its response dated June 28, 2019, the applicant clarified the name, composition or lithology, age, and material properties of the geologic units occurring in the subsurface, as documented in new SAR Figure 2-37, “Geologic Column of the WCS CISF Area.” This information includes the hardness and saturation level of each unit, as observed during the field logging. The applicant also clarified which figures represent site-specific geologic profiles for the proposed CISF as opposed to a generalized profile for the entire WCS site. The applicant also clarified the spatial associations between mapped units in the subsurface, noting that mechanical differences in sample retrieval may bias a sample’s description from borings and monitoring wells in close proximity. The applicant also noted that perched groundwater has not been observed in site borings or excavations. Finally, the applicant characterized the materials encountered at auger refusal as indurated caprock caliche and provided an updated report of geotechnical exploration as Attachment E in the revised SAR which states that the materials encountered at auger refusal were stage 3-5 caliche.

The staff reviewed the response to the RAI, focusing on the material descriptions and physical properties of the subsurface units. The staff concludes that the applicant provided sufficient explanation to clarify the composition and physical properties of the subsurface layers at the site. Additionally, the staff noted that the description of the materials encountered at auger refusal was consistent with the description of the composition and thicknesses of the subsurface materials in the response and new SAR Figure 2-37.

In SAR Figure 2-2, the applicant provided a large-scale topographic map showing the local geomorphology. The cross-sections in SAR Figures 2-16 and 2-17 also indicate no fault offsets or geologic structures in the underlying rocks within 5 to 6.5 kilometers (3 to 4 miles) of the WCS CISF site. However, in Attachment F to SAR Chapter 2, the applicant mentioned a geologic feature of unknown origin referred to as the “red-bed ridge,” which is neither included in the geologic cross-sections of SAR Figures 2-16 and 2-17 nor discussed in SAR Section 2.6.1. In the same attachment, the applicant concluded that the red-bed ridge is not the result of halite dissolution, but a “structural high exists in the southwestern part of the site area and is likely the eastern limb of a north-northwest trending anticline”; the anticline “appears to coincide with the red-bed ridge.” The staff reviewed the previous site investigation reports for a description of the origin of the red-bed ridge, which is alternately described as a paleotopographic divide between the Ogallala Aquifer and the Cenozoic basin fill aquifer or as a subsurface structure associated with a regional lineament that developed along the preferred jointing direction (300–310°). The staff noted that, based on the boring logs from the monitoring wells, the slope gradient of the top of red-beds beneath the site may be as high as 5 percent.

Accordingly, the staff asked the applicant to describe the red-bed ridge and discuss its origin and extent at the WCS site, including the relationship of the ridge to subsurface aquifers discussed in the previous investigation from 2000 (Leyman and Rainwater, 2000), other potential subsurface geologic structures (e.g., the inferred anticline described in SAR Chapter 2, Attachment F), and the regional lineament described in the previous investigation from 2004 (Cook-Joyce, Inc., and Intera, Inc., 2004). The staff also asked the applicant to estimate the slope gradient from the top of the red-bed ridge and passing beneath the WCS site.

In its response dated June 28, 2019, the applicant stated that the red-bed ridge is the top of the Triassic Dockum Group that is buried beneath the younger caprock and regionally extends more than 100 miles along a northwest trend. The maximum apparent slope at the WCS site is 1.77 percent, but it is lower in the footprint of the CISF. The red-bed ridge also is the position of a drainage divide between the Monument Draw Texas, which drains to the Colorado River, and the Monument Draw New Mexico, which drains to the Pecos River. The applicant noted that the red-bed ridge is structurally stable and not subject to mass wasting, in part due to the presence of erosion-resistant caprock caliche in the overlying units. The applicant also clarified that, although occurring coincident with the Mescalero Ridge, a prominent escarpment in the region, the presence of the caprock caliche over the crest of the red-bed ridge indicates it is not a buried erosional edge of the escarpment.

The staff reviewed the RAI response, particularly the clarification that the red-bed ridge is a structurally stable drainage divide with a low gradient and is not associated with the regional escarpment. Accordingly, the staff determined that the red-bed ridge does not represent a structural hazard to the proposed site.

The applicant described the structural, tectonic, and depositional history of the site area, to include Cambrian to late Mississippian structural deformation, late Mississippian to early Permian tectonic uplift, folding and faulting, and subsidence and erosion that formed the Permian Basin. The depositional history is reflected in the subsurface stratigraphy at the site, which the applicant stated includes thick sequences of carbonate and evaporite deposits in addition to shale, sand, and other sedimentary deposits.

The applicant stated that groundwater may circulate into Permian evaporite deposits because of joint channels opening along Precambrian lines of weakness. SAR Section 2.6.1 states, “near-surface regional structural controls may be locally modified by differential subsidence related to groundwater dissolution of Permian salt deposits.” However, the SAR does not specify where these locally modified areas of differential subsidence are located relative to the proposed site. The staff noted the presence of some features in SAR Figure 2-3, “Proposed WCS CISF 5-Mile Radius,” that are circular in shape (i.e., similar to sinkholes or swales), some of which are shallow depressions 2 to 7 feet (0.6 to 2 meters) in depth.

Accordingly, the staff asked the applicant to clarify the origin of the circular features identified in the red circles on SER Figure 2-1, which is a modified version of SAR Revision 2, Figure 2-3. Specifically, the staff asked the applicant to determine the dimensions of the features and whether these features represent surface deformation at the site due to subsurface dissolution from past or ongoing natural processes or human activities in the site area, as mentioned in SAR Section 2.6.1. The staff also asked the applicant to discuss the potential for similar features to develop at the site in the future.

Figure 2-1. Proposed CISF 1-mile Radius (Modified SAR Revision 2, Figure 2-3)

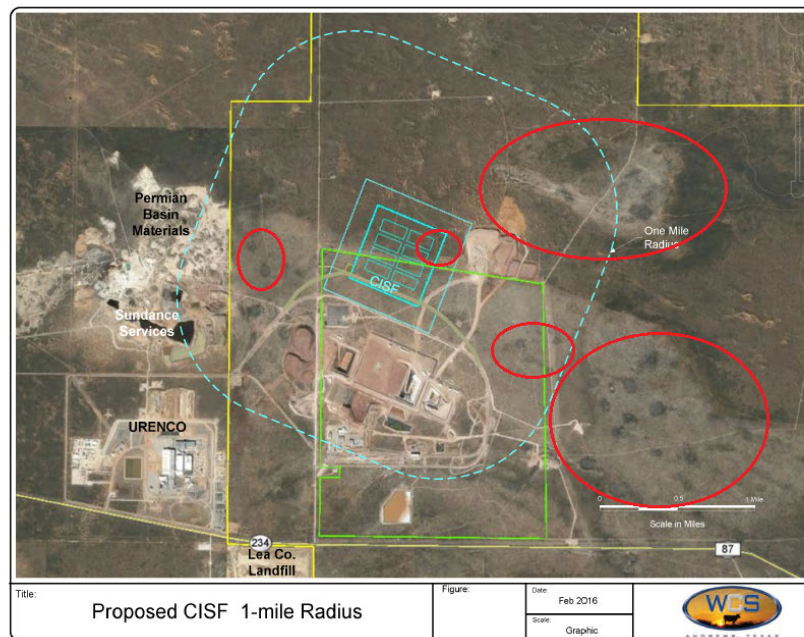


Figure 2-3
Proposed WCS CISF 1-mile Radius

In its response dated June 28, 2019, the applicant clarified the origin and extent of these features, as well as the relationship of these features and the regional history. The applicant stated that these features started as small erosional depressions in which accumulated water variably dissolved surface or near-surface calcrete and carbonate. The applicant further stated that there is no evidence that these features are the result of human activities, nor that they would form naturally at the site during the licensed period of the proposed facility, and that studies indicate that these features are at least thousands to tens of thousands of years old. The staff reviewed the new information, including a trench report (Holt and Powers, 2017) conducted in one of these features, and determined that the features are not the result of human activities in the subsurface. The staff also determined that because these features take tens of thousands of years to form, new features are unlikely to form at the site during the period of operation.

The staff reviewed the information submitted by the applicant on the geologic site characterization at the WCS site. Based on the staff's review of the submitted information and the responses to the staff's RAIs, discussed in the preceding sections, the staff concludes that the characterization of the local and regional geology is acceptable. The staff has determined that this information is acceptable for use in other sections of the SAR to develop the design bases of the facility, perform additional safety analysis, and demonstrate compliance with the

regulatory requirements in 10 CFR 72.92(a), 10 CFR 72.92(b), 10 CFR 72.102(e), and 10 CFR 72.122(b) with respect to this topic.

2.3.6.2 Ground Vibration

Section 2.6.2, "Vibratory Ground Motion," of the SAR discusses the development of design-basis vibratory ground motion associated with credible levels of vibratory ground motions that may be experienced at the WCS CISF site. In reviewing the applicant's development of vibratory ground motion, the staff considered factors related to the principal elements of seismic hazard analyses and procedures for determining the design earthquake (DE). The staff reviewed the applicant's investigations of basic geologic and seismic information, as discussed in Section 2.6.1 of this SER, and the following aspects of ground motion at the WCS CISF site: (1) fault seismic sources, (2) distributed seismic sources, (3) applicable ground motion attenuation relations, (4) site response analyses, and (5) development of site-specific design ground motion.

The applicant cited 10 CFR Part 72 as the basis for determining CISF DE ground motions. Until its revision in October 2003, this regulation, in particular 10 CFR 72.102, required the development of a DE in accordance with 10 CFR Part 100, "Reactor site criteria," Appendix A, "Seismic and Geologic Siting Criteria for Nuclear Power Plants." The seismic hazard methodology in 10 CFR Part 100, Appendix A, is based on a deterministic approach in which the largest credible earthquake that could occur on the closest approach of the seismic source to the site is considered as the DE. In 2003, the NRC amended 10 CFR Part 72. The rule change requires that uncertainties inherent in estimates of the DE be addressed through an appropriate analysis, such as a probabilistic seismic hazard analysis (PSHA) or suitable sensitivity analysis, as set forth by 10 CFR 72.103. RG 3.73, "Site Evaluations and Design Earthquake Ground Motion for Dry Cask Independent Spent Fuel Storage and Monitored Retrievable Storage Installations," issued October 2003 (NRC, 2003), provides general guidance on procedures acceptable to the staff for conducting the PSHA and developing the DE to satisfy the requirements of 10 CFR Part 72. RG 3.73 further specifies that the controlling earthquakes are to be developed for the vibratory ground motion corresponding to the mean annual frequency of exceedance of 5×10^{-4} per year.

The approach followed by the applicant in characterizing the vibratory ground motion and developing the licensing basis response spectra is based on a probabilistic approach, consistent with 10 CFR 72.103 and RG 3.73. The applicant followed the guidance in NUREG-0800 and NUREG/CR-6728, "Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard- and Risk-consistent Ground Motion Spectra Guidelines," issued October 2001.

2.3.6.2.1 Fault Seismic Sources

SAR Section 2.6.2 and Section 3.2.3, "Seismic Design," and Attachment D to SAR Chapter 2 provide details about the PSHA performed by the applicant to determine the site-specific design ground motion. The applicant determined that no faults are located within 100 kilometers (61 miles) of the site. In its PSHA, the applicant considered a number of faults within 200 kilometers (120 miles) of the site. For each fault in its database, the applicant developed a model of the fault's rupture (single plane or linked), probability of activity, geometry, maximum magnitude, and recurrence rate. The applicant used available geologic and literature information to develop each fault model for inclusion in its PSHA.

The staff reviewed the applicant's fault input and performed an independent search of available fault data. Specifically, the staff searched the USGS Quaternary fault database for faults within 200 kilometers (120 miles) of the site. The staff's confirmatory search identified one fault within 200 kilometers (120 miles) included in the USGS Quaternary fault database (USGS, 2018). This fault was included in the 2014 update to the USGS National Seismic Hazard Mapping Project (USGS NSHMP) 2014 analysis (USGS, 2014). The applicant included this fault in its PSHA, and the applicant's inputs for this fault are consistent with the values used by the USGS NSHMP. Based on the applicant's use of hazard-significant faults and the staff's independent catalog search of active or potentially active Quaternary faults in the region, the staff has determined that the applicant's model of fault seismic sources is acceptable.

2.3.6.2.2 Distributed Seismic Sources

Sections 2.6.2 and 3.2.3 and Attachment D to Chapter 2 of the SAR provide details on the PSHA inputs used by the applicant to develop a site-specific design ground motion. The applicant developed a single distributed seismicity region for its PSHA. The applicant used earthquake catalog data and developed earthquake recurrence inputs that included, in addition to naturally occurring earthquakes, both induced and potentially induced seismicity.

The staff reviewed the applicant's distributed seismic source model and performed an independent confirmatory PSHA, described in detail below in Section 2.3.6.2.6. The staff used information available in NUREG-2115, "Central and Eastern United States Seismic Source Characterization for Nuclear Facilities," dated January 31, 2012 (CEUS-SSC), as well as information used by the USGS NSHMP for the region surrounding the WCS site. The staff compared seismicity rates, maximum magnitudes, and recurrence parameters with those available in the NUREG-2115 and USGS NSHMP models. Overall, the applicant's seismicity rates are greater than those the staff calculated for the site region, due to the inclusion of induced seismicity in the applicant's calculations. In addition, the applicant's recurrence parameters and maximum magnitude values are consistent with the USGS NSHMP and NUREG-2115 models.

Based on the staff's review of the applicant's distributed seismic source model and the staff's independent confirmatory analysis, the staff concludes that the applicant's model for distributed seismicity is adequate to model seismic hazard in the WCS region.

2.3.6.2.3 Ground Motion Attenuation Relations

In Sections 2.6.2 and 3.2.3 and Attachment D to Chapter 2 of the SAR, the applicant described the process used to determine an appropriate ground motion attenuation model (GMM) for the site. In its PSHA, the applicant considered the site location relative to the boundary between the central and eastern United States and the western United States. These two regions have different tectonic histories that result in different responses to earthquakes. To account for the site location relative to this boundary and uncertainty in the location of the boundary, the applicant used two separate GMMs and weighted them according to its interpretation of the likely location of the boundary.

To account for the assumption that the WCS site rests in the more geologically active western United States, the applicant used the Next Generation Attenuation—West2 (NGA-West2) model (Abrahamson, et al., 2014; Boore, et al., 2014; Campbell and Bozorgnia, 2014; Chiou and Youngs, 2014). The NGA-West2 model consists of five separate ground motion prediction equations, of which the applicant used four. The NGA-West2 model assumes that the shallow

subsurface can be characterized as “firm rock” with a shear wave velocity (V_s) in the upper 30 meters (98.4 feet) of 760 meters per second (2,493 feet per second).

To account for the assumption that the WCS site rests within the more geologically stable central United States, the applicant used the Electric Power Research Institute (EPRI) GMM. The EPRI GMM is a model developed for use in evaluating seismic hazard at nuclear power plants and was created using an enhanced Senior Seismic Hazard Analysis Committee (SSHAC) Level II analysis (NUREG/CR-6372, “Recommendations for Probabilistic Seismic Hazard Analysis: Guidance on Uncertainty and the Use of Experts,” issued April 1997). The staff has evaluated the EPRI GMM and endorsed it for use until the Next Generation Attenuation—East GMM is complete and endorsed by the NRC. The EPRI (2013) GMM assumes that the shallow subsurface can be characterized as “hard rock.” This model assumes that the first rock encountered in the subsurface is crystalline bedrock with a V_s of 2,830 meters per second (9,282 feet per second).

As stated above, the applicant weighted each GMM in performing its PSHA; it gave the NGA-West2 model a weight of 0.6 and the EPRI (2013) model a weight of 0.4. Because the different GMMs have different assumptions about the type of material that underlies the WCS site, the applicant carried the resulting seismic hazard curves from each model through the site response and applied the weighting after developing a site-specific seismic hazard.

The staff reviewed the applicant’s selection of GMMs for the WCS site. The two models selected by the applicant represent the state of practice for their respective tectonic regions and were developed following NRC guidance (NUREG-0800). Based on the uncertainties in the exact location of the boundary between the tectonically stable central United States and the more active western United States, the applicant’s use of both models is reasonable. In addition, the relatively equal weights given to the separate models provide assurance that any deficiencies in an individual model relative to the tectonic setting of the WCS site will not dominate the PSHA and unduly impact the development of the DE. Finally, the staff performed an independent confirmatory analysis, described below, that shows that the applicant’s approach to selecting the GMMs for the WCS site is reasonable. Therefore, the staff determined that the applicant’s selection of GMMs for the WCS site is adequate.

2.3.6.2.4 Site Response Analysis

Because the seismic hazard curves developed using the GMMs discussed above are for generic site conditions that may not be consistent with the site-specific conditions found at the WCS site, the applicant performed a site response analysis described in SAR Section 2.6.2, Section 3.2.3, and Chapter 2, Attachment D. The applicant used shear wave velocity information and dynamic material properties determined at the site during site investigations, described in Section 2.6.4, “Stability of Subsurface Materials,” and Attachment D to Chapter 2 of the SAR. The applicant used the random vibration theory approach to propagate the seismic hazard at the reference rock level through the site profiles to determine seismic hazard curves at the surface, following Approach 3 as described in NUREG/CR-6728. The applicant then used these site-specific hazard curves to calculate the design response spectrum (DRS).

The staff reviewed the applicant’s approach to site response and, as described below, performed an independent confirmatory analysis. The applicant’s use of Approach 3 as described in NUREG/CR-6728 ensures that both epistemic uncertainty and aleatory variability in site response are carried through the entire hazard integral and that fully probabilistic site-specific hazard curves are generated as a result of the PSHA. As described below, the

staff's confirmatory analysis involves the independent development of site response inputs. Based on the applicant's use of up-to-date methods and models for site response, the applicant's incorporation of appropriate epistemic and aleatory uncertainties, and the staff's confirmatory analysis, the staff concludes that the applicant's site response results are adequate.

2.3.6.2.5 Design-Basis Ground Motion

The applicant provided its DRS in Section 2.6.2 of the SAR. The applicant developed its DRS as the 10,000-year return period uniform hazard spectrum (1×10^{-4} per year UHRS). To develop the DRS, the applicant used the 1×10^{-4} per year UHRS for both the firm rock (western United States) and hard rock (central and eastern United States) hazard curves and applied a 60-percent/40-percent weighting scheme, respectively, to determine a single, site-specific UHRS. To determine the vertical UHRS, the applicant multiplied the horizontal UHRS by a vertical to horizontal ratio that is frequency dependent. The applicant's horizontal 1×10^{-4} per year UHRS is anchored at a peak ground acceleration (PGA) value of 0.25 g, and its vertical UHRS is anchored at a PGA value of 0.175 g.

The staff reviewed the applicant's approach to developing the DRS. The applicant's approach is consistent with NRC guidance for performing a PSHA (e.g., RG 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," issued March 2007 (NRC, 2007); NUREG/CR-6728) and the current state of the practice in the industry. In addition, the applicant's probabilistic approach incorporates relevant uncertainties in earthquake magnitudes, locations, and recurrence rates, as well as uncertainties in ground motion attenuation relations and site response. Based on the above and the staff's independent confirmatory analysis, described below, the staff concludes that the applicant's DRS is acceptable.

2.3.6.2.6 NRC Staff Confirmatory Analysis

In order to better assess the adequacy of the applicant's PSHA, the staff performed a confirmatory analysis. The staff independently developed PSHA inputs using information available in the applicant's SAR as well from the USGS and previous NRC reviews.

The WCS site rests within the region modeled by the CEUS-SSC, published jointly by the NRC, the U.S. Department of Energy, and EPRI as NUREG-2115 (NRC, 2012). The CEUS-SSC is an NRC-endorsed seismic source model for the central and eastern United States and is an acceptable starting model for performing PSHAs. Because the 320-kilometer (200-mile) region surrounding the WCS site is not entirely within the CEUS-SSC model domain, the staff developed a model for the western portion of the study area. The staff treated this region as an area seismic source with seismicity parameters similar to those used by the USGS in its development of the NSHMP.

Because the WCS site region crosses the boundary from the stable central and eastern United States to the geologically active western United States, the staff used two separate ground motion models to develop its PSHA. For the portion of the study region covered by the central and eastern United States, the staff used the NRC-accepted GMM published by EPRI (EPRI, 2013). For the western portion of the study area, the staff applied the GMM developed during the southwestern United States GMM project (GeoPentech, 2015). Specifically, the staff used the elements of this model developed for use in the southern Basin and Range province. The staff applied a V_s -kappa correction to adjust the GMM for the western United States for use

at the WCS site. A V_s -kappa correction is a correction applied to a GMM to adjust for seismic velocities and damping in the upper crust. It represents the change in shape of a seismic response spectra as a result of changing crustal conditions. This correction produces seismic hazard curves that are consistent with the crustal characteristics of the WCS site and the source characteristics consistent with those found in the western United States.

The staff's PSHA included a confirmatory site response. The staff used site-specific depth and velocity information collected by the applicant, and provided in Attachment D to the SAR, over the upper 365 meters (1,200 feet) of the profile. At depth, the staff used information from regional geologic profiles and literature seismic velocities for similar rock types (Kenter et al., 1997). To represent input rock motions, the staff used a magnitude M6.5 with 11 input PGAs ranging from 0.1 to 1.5 g. The staff convolved the results of its amplification function with its confirmatory base rock PSHA results to develop site-specific seismic hazard curves at the surface.

The applicant's DRS and the staff's 1×10^{-4} per year UHRS are consistent, demonstrating that the different approaches used by the applicant and the staff have a relatively minor impact on the overall determination of site seismic hazard.

2.3.6.2.7 NRC Staff Conclusions Regarding Vibratory Ground Motion

The staff has reviewed the information submitted by the applicant regarding vibratory ground motion at the WCS site. Based on the staff's review of the submitted information and confirmatory PSHA results, discussed in the preceding sections, the staff concludes that the DRS developed by the applicant, the 10,000-year return period UHRS, is acceptable for use in the CISF design analyses and for use in other sections of the SAR to develop the design bases of the WCS CISF, perform additional safety analysis, and demonstrate compliance with the regulatory requirements in 10 CFR 72.92(a–b), 10 CFR 72.103(f), and 10 CFR 72.122(b) with respect to this topic.

2.3.6.3 Surface Faulting

In SAR Section 2.6.3, Section 5.1.1 of Attachment D to Chapter 2 of the SAR, entitled, "Fault Sources," and Section 3.3.4 of the WCS-CISF ER, the applicant presented information on surface faulting in the area of the proposed CISF site. The applicant stated that the CISF site is located on the western edge of the Permian Basin region, which has remained tectonically stable for the past 200 million years. The applicant determined that faults in the area are at least 50 million years old and located in the old rock sequences deep beneath the surface. The applicant concluded that there is no evidence of recent motion along these faults, nor is there evidence of surface or near-surface faulting.

Figure 2-11, "North to South Geologic Cross Section Showing Relationship of Ogallala Formation to Underlying Strata," and Figure 2-12, "West to East Geologic Cross Section Showing Relationship of Ogallala Formation to Underlying Strata," of the SAR, constructed from oil and gas well data of the upper approximately 600 meters (2,000 feet) of sedimentary rocks, show no evidence of offset in the sequences of underlying rocks at the CISF site. Regional cross-sections provided in ER Figures 3.3-6, "Dip-Oriented Stratigraphic Cross Section A – A'," and 3.3-7, "Strike-Oriented Stratigraphic Cross Section B – B'," also do not show evidence of fault displacement of the subsurface units of late Permian age and younger.

The two closest faults with Quaternary (2.6 million years ago) movement are in the Guadalupe Mountains, approximately 167 kilometers (104 miles) southwest of the WCS site. These two

faults show evidence of displacement within the last 1.6 million years, and as recently 15,000 years ago. The applicant identified the next closest fault with Quaternary deformation as the Alamogordo Fault 170 miles (270 kilometers) west of the site. The applicant concluded that there was no evidence of Quaternary faulting within the WCS site.

A potential fault was observed in the southeast wall of the RCRA landfill excavation on the WCS site to the south of the proposed CISF site. The potential fault occurred within the Triassic-age red beds, but the applicant noted that the overlying undisturbed Cretaceous Antlers Formation was continuous and not calichified. Therefore, the applicant concluded that there was no indication that offset along the fault affected the rocks of Cretaceous age and younger above the potential fault.

The staff assessed the information presented in the SAR and accompanying sources with respect to the presence or absence of surface faults and faulting in the vicinity of the CISF. Based on the evidence presented, which indicates that no surface or near-surface faults demonstrating Quaternary movement are located within the vicinity of the proposed CISF site, the staff concludes that the closest faults with determined Quaternary movement are more than 160 kilometers (100 miles) away.

The staff finds the above information acceptable because the lack of surface faults is well described and documented. The information is acceptable for use in other sections of the SAR to develop the design bases of the CISF facility, perform additional safety analysis, and demonstrate compliance with the regulatory requirements in 10 CFR 72.90(b–d), 10 CFR 72.92(a–c), 10 CFR 72.98(c)(3), and 10 CFR 72.122(b) with respect to this issue.

2.3.6.4 Stability of Subsurface Materials

In SAR Section 2.6.4, the applicant described subsurface materials in the area of the WCS CISF. The applicant stated that surficial material is underlain by a variable sequence of calcium carbonate-cemented caliche, and the caliche horizon contains varying amounts of feldspathic and quartzitic silt, sand and gravel fragments with a general trend of decreased cementation and increased silt, and sand and gravel content with depth. The applicant also stated that the WCS CISF subsurface conditions were explored with 18 soil borings through in situ testing by the standard penetration resistance test (SPT) and laboratory tests, including Atterberg limits, natural moisture content, particle size analysis, resistivity of soil, consolidated undrained triaxial test, standard proctor moisture-density tests, California bearing ratio (CBR), and consolidation. The applicant indicated that the geophysical survey investigation measured shear wave velocities for the upper 100 feet (30 meters) bgs. The applicant claimed that a liquefaction hazard does not exist for the proposed CISF because the geotechnical investigation did not find water in any of the borings. The applicant recommended allowable bearing capacity and some geotechnical-related parameters in Attachment E to SAR Chapter 2, including shear wave velocity, Poisson's ratio, total unit weight, mass density, and modulus.

The staff reviewed information presented in SAR Section 2.6.4 and evaluated the related information and analyses presented in other SAR sections and supporting documents, including SAR Section 2.6 and Section 7.6, "Other Structures, Systems, and Components Subject to NRC Approval," and "Report of Geotechnical Exploration, Consolidated Interim Storage Facility (CISF)," which appears in SAR Chapter 2, Attachment E. The staff focused its review on the geotechnical site characterization, the stability of subsurface materials and the storage pad foundation, and soil liquefaction potential. The following sections describe the staff's evaluation and conclusion.

2.3.6.4.1 Geotechnical Site Characterization

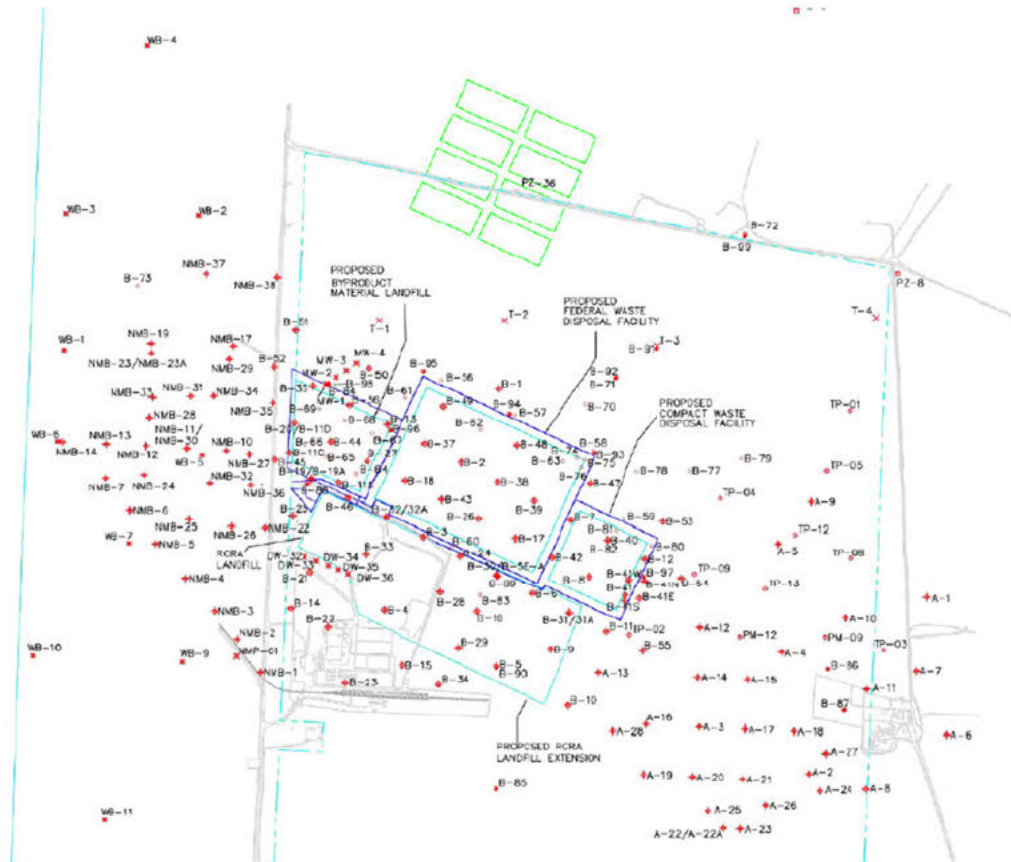
Based on the information provided in SAR Section 2.6.4 and the applicant's report of geotechnical exploration in Attachment E to SAR Chapter 2, the staff noted that 18 soil borings were conducted during site investigation. The staff also noted that, among the 18 borings, 4 borings encountered auger-refusal conditions at depths ranging from 37 to 45 feet (11 to 14 meters) bgs, and 14 borings terminated the remaining soil test at 25 feet (7.6 meters) bgs. Current engineering standards, such as U.S. Army Corps of Engineers EM 110-1-1804, "Geotechnical Investigations," dated January 1, 2001 (U.S. Army Corps of Engineers, 2001), and Federal Highway Administration (FHWA) Geotechnical Engineering Circular No. 5, "Evaluation of Soil and Rock Properties," issued April 2002 (FHWA, 2002), recommend guidelines for boring depth. For example, the boring depth (1) should be at least to a depth where the increased stress due to the estimated footing load is less than 10 percent of the existing effective overburden stress, (2) should be 1.5 times the minimum dimension of footing below the base of the footing, or (3) should penetrate a minimum of 3 meters (10 feet) into the bedrock, if bedrock is encountered before other required depths. Therefore, the staff requested additional information to justify why soil boring to depths greater than 45 feet (14 feet) is not needed. In its response dated May 18, 2020, the applicant stated that borings can be extended to a greater depth in order to obtain the soil parameters, or shear wave velocities can be used to extend the soil parameters necessary for settlement analysis. The applicant performed shear wave surveys in conjunction with the geotechnical exploration and provided shear wave velocities to a depth of 100 feet (30 meters) bgs for the CISF. Additionally, multiple previous geotechnical investigations as well as shear wave testing have been performed at the site. The applicant selected to use the historical data to extend the soil profile and engineering parameters to a depth of 600 feet (180 meters) bgs.

The staff reviewed the applicant's response. The staff noted that the information from the 18 borings and shear wave surveys for the CISF were supplemented with the data obtained from historical geotechnical investigations and geophysical surveys in the site area. These data were used to produce a soil stratigraphic column to 600 feet (180 meters) bgs along with the necessary engineering parameters. The staff compared the geologic stratigraphy to the soil column and found that the shear wave velocities of the soil column correlated well with geologic layer descriptions as shown in Table NP-2.6-3-2 in the applicant's response. The staff also reviewed the applicant's revised report of geotechnical exploration appearing in Attachment E to Chapter 2 of the SAR, and Attachment D to Chapter 2 of the SAR, which contains "Site-Specific Seismic Hazard Evaluation and Development of Seismic Design Ground Motions," Revision 0, dated March 16, 2016. The staff confirmed that the historical data from multiple previous geotechnical investigations and shear wave studies were used in addition to the applicant's report of geotechnical exploration appearing in Attachment E to Chapter 2 of the SAR to extend the soil profile and engineering parameters to a depth of 600 feet bgs. As shown in Figure NP-2.6-3-1 in the applicant's response, the staff observed that the historical borings adequately covered the site area. Further, the staff found that the depth of 600 feet meets general industry guidance of 1.5 times the minimum dimension of footing. Accordingly, the staff concludes that the depth of 600 feet is adequate for the site characterization and engineering evaluation, the method of combining the data from site investigation with historical data available at the site is justifiable, and the information gathered for site characterization and engineering evaluation from the CISF site investigation and historical data available at the site area is sufficient.

Table 2-1
WCS CISF Soil Column, reproduced from "Submission of ISP Responses for RAIs and Associated Document Markups from First Request for Additional Information, Parts 2, 3, and 4, Docket 72-1050 CAC/EPID 001028/L-2017-NEW-0002," Enclosure 3,
Table NP-2.6-3-2

Top (feet)	Bottom (feet)	N- Value (bpf)	Average Shear Wave Velocity (ft/s)	Layer Description	Constrained Modulus (ksf)
0	2	33		Cover Sands	890
2	10	54		Caliche with Sand Matrix - Moderately Hard	1,200
10	20	54		Caliche with Sand Matrix - Moderately Hard	1,200
20	25		1,530	Caliche - Very Hard	35,815
25	35		1,900	Caliche - Very Hard	55,232
35	50		2,290	Ogallala - Sand with Gravel	80,233
50	80		1,840	Ogallala - Sand with Gravel	53,870
80	100		2,790	Ogallala - Sand with Gravel	123,857
100	130		2,300	Dockum - Claystone and Siltstone	84,172
130	230		2,755	Claystone and Siltstone	120,769
230	275		2,755	Dockum - Claystone	120,769
275	300		2,755	Dockum - Silty Sands	120,679
300	360		2,755	Dockum - Claystone	120,679
360	600		3,115	Dockum - Claystone	154,394

Figure 2-2
Historical Borings at WCS Site, reproduced from “Submission of ISP Responses for RAIs and Associated Document Markups from First Request for Additional Information, Parts 2, 3, and 4, Docket 72-1050 CAC/EPID 001028/L-2017-NEW-0002,” Enclosure 3, Figure NP-2.6-3-1



The staff noted that, in SAR Section 2.6.4, the applicant identified the following tests conducted to support its application: Atterberg limits, natural moisture content, particle size analysis, resistivity of soil, consolidated undrained triaxial test, standard proctor moisture-density tests, CBR, and consolidation. However, Section 2.2, “Laboratory test program,” of the applicant’s report of geotechnical exploration states that consolidated undrained triaxial tests and consolidation tests were not conducted because undisturbed Shelby tube samples could not be obtained due to the caliche. Because these tests are important to determine the shear strength parameters and consolidation characteristics of soil, the staff asked the applicant to describe how it determined the soil strength and deformation properties of the cohesive soils and how it evaluated the settlement potential of the clay stratum given the absence of consolidated undrained triaxial tests and consolidated tests. The same section of the applicant’s report of geotechnical exploration states that one CBR test was performed. However, based on the staff’s review of the applicant’s report of geotechnical exploration, the applicant did not report the CBR test results. Accordingly, the staff asked the applicant to provide its CBR test results. Additionally, the staff noted that Section 2.2 of the applicant’s report of geotechnical exploration states, “At the time this report was prepared, some of the laboratory testing was still on-going.” To support the staff’s evaluation of the laboratory investigations, the staff asked the applicant to

describe the laboratory tests and the test results completed after the submittal of the applicant's report of geotechnical exploration.

In its response dated May 18, 2020, the applicant reiterated that the historical data available at the site, coupled with the 18 borings and new shear wave study, have allowed the development of a soil stratigraphic column to 600 feet (180 meters) along with the necessary engineering parameters required without additional new soil borings to greater depths. The applicant specified that the constrained modulus to a depth of 20 feet (6.1 meters) bgs was correlated to SPT N-values obtained in the borings according to the method outlined in the "Engineering Manual for Shallow Foundations" (Tan et al., 1991). In order to generate the deformation properties from depths of 20 to 600 feet, the applicant used the information from historical shear wave velocity surveys documented in Attachment D to SAR Chapter 2 to supplement the information obtained in preparation of the applicant's report of geotechnical exploration. The applicant calculated the constrained modulus values for soil depths from 20 to 600 feet based on the corresponding shear wave velocities. As for results from the CBR testing, the applicant provided the results of the analyses in the revised report of geotechnical exploration. The applicant performed two standard proctor tests, two CBR tests, and two soil resistivity tests after the submittal of the original report of geotechnical exploration and attached these test results to the applicant's revised report of geotechnical exploration.

The staff reviewed the response. As mentioned above in this section, the staff concluded that a depth of 600 feet (180 meters) bgs is adequate for site characterization and engineering evaluation, the method of combining the data from the site investigation with the historical data available at the site is justifiable, and the information gathered for site characterization and engineering evaluation is sufficient. The staff reviewed the method by Tan et al. (1991) to understand how the empirical correlation between soil deformational modulus to the SPT N-values obtained in the borings is established. The staff also reviewed the boring logs in Appendix A, "Figures and Boring Logs," to the applicant's report of geotechnical exploration and noted that the normalized SPT N-values range from 10 to 57 over the top 20 feet (6.1 meters) of the soil column at the CISF site. In addition, the staff noted that the refusal blow counts encountered in the top 20 feet were ignored; therefore, the average blow counts and the associated modulus to bound the settlement calculation in these materials were not overestimated. Because the correlation between soil deformational modulus and SPT N-values is widely applied in geotechnical practices, and the methodology by Tan et al. (1991) is well established for allowing the correlation of constrained modulus to SPT for N-values up to 70 blows per foot, the staff therefore finds the constrained modulus values to a soil depth of 20 feet bgs developed by the SPT N-values are reasonable and reliable.

The staff also reviewed the methodology of using shear wave velocity to generate the constrained modulus from depths of 20 to 600 feet (6.1 to 180 meters). The staff noted that the applicant appropriately used the relationship between wave velocities and small-strain modulus based on a body wave propagation mechanism in solid medium. This relationship is well acknowledged and widely used in geotechnical and seismic evaluation and analysis. The staff also reviewed the information on the shear wave velocity profiles presented in Attachment E to SAR Chapter 2 for a depth to 100 feet (30 meters), and in Attachment D to SAR Chapter 2 for depths beyond 100 feet. The staff concludes that the applicant properly studied and used the shear wave velocities for developing small-strain modulus as an alternative to construct soil deformation properties without additional new soil borings to greater depths.

The staff further noted that two standard proctor tests, two CBR tests, and two soil resistivity tests were performed after the submittal of the report of geotechnical exploration. Because the applicant attached the results of these tests to the revised report of geotechnical exploration to

complete the record of test results, the staff finds that the laboratory tests and results are complete and properly documented. The staff noted that, in Appendix D, "Static Elastic Modulus Calculation," to the applicant's report of geotechnical exploration, the applicant provided the calculated static elastic modulus for its design and analysis. The staff noted that the applicant based the calculated static elastic modulus values on the derived dynamic moduli from seismic wave values, specifically, the 20 percent of dynamic moduli, without further justification. The staff further noted that the applicant's calculated static elastic modulus values exceed the general range of modulus of elasticity for similar soils. Because of the importance of the soil static elastic modulus in the evaluation of the stability of subsurface materials and structural evaluation and design, the staff asked the applicant to provide its basis for using 20 percent of the dynamic modulus for the static elastic modulus.

In its response, the applicant stated that the soil stratigraphy has been extended to a depth of 600 feet (180 meters) bgs, and the static elastic modulus values have been revised and extended based on SPT tests and wave velocity surveys. The applicant reiterated that the historical data available at the site, coupled with the 18 borings and new shear wave study, have allowed the development of a soil stratigraphic column to 600 feet along with the necessary engineering parameters without additional new soil borings to greater depths. The applicant revised Appendix D to the report of geotechnical exploration accordingly.

The staff reviewed the response dated May 18, 2020. As indicated above in this section, the staff concluded that (1) the modulus values up to 20 feet (6.1 meters) bgs developed by the SPT N-values are reasonable, and (2) the shear wave velocities are properly studied and used by the applicant for developing small-strain modulus as an alternative to construct soil deformation properties for the depth from 20 to 600 feet (180 meters). Based on the modulus developed for each of the stratigraphic layers to the depth of 600 feet, the applicant used Settle3, a well-known finite difference software for three-dimensional soil settlement analysis using Westergaard Solution, to perform settlement evaluation. Taking into account any stress overlap between adjacent pads, the applicant calculated that the maximum total settlement for CISF pads is less than 0.75 inch (1.9 centimeters). Appendix H, "Settlement Calculations," to the applicant's report of geotechnical exploration documents the detailed settlement analysis. The staff also noted, in its response to another staff request, the applicant provided information on maximum strain from the highest load case at the midpoint of each soil layer to a depth of 600 feet. The applicant demonstrated through its analysis that the largest model strains level is in the top 20 feet before a sharp contrast at the transition from soil and intermediate geomaterial behavior to soft rock material behavior. The staff noted that, while the largest magnitude strain for soil and intermediate geomaterial in the top 20 feet is in the level of 5×10^{-3} , the strain level is dramatically decreased to the order of 1×10^{-5} starting at the depth of boring auger refusal condition and gradually reduced to the order of 1×10^{-7} at the bottom of the 600-foot soil column, as shown in Table P-2.6-3-3 in the applicant's response. Although the applicant tried to prove that the modulus hardly decreases with the increase of strain until 5×10^{-5} for soft rock material, as shown in Figure P-2.6-3-5 in the applicant's response, taken from Siegel (2004), the staff could still not determine whether the applicant's claimed strain levels were not underestimated because the shear modulus degradation curve was not developed for the site.

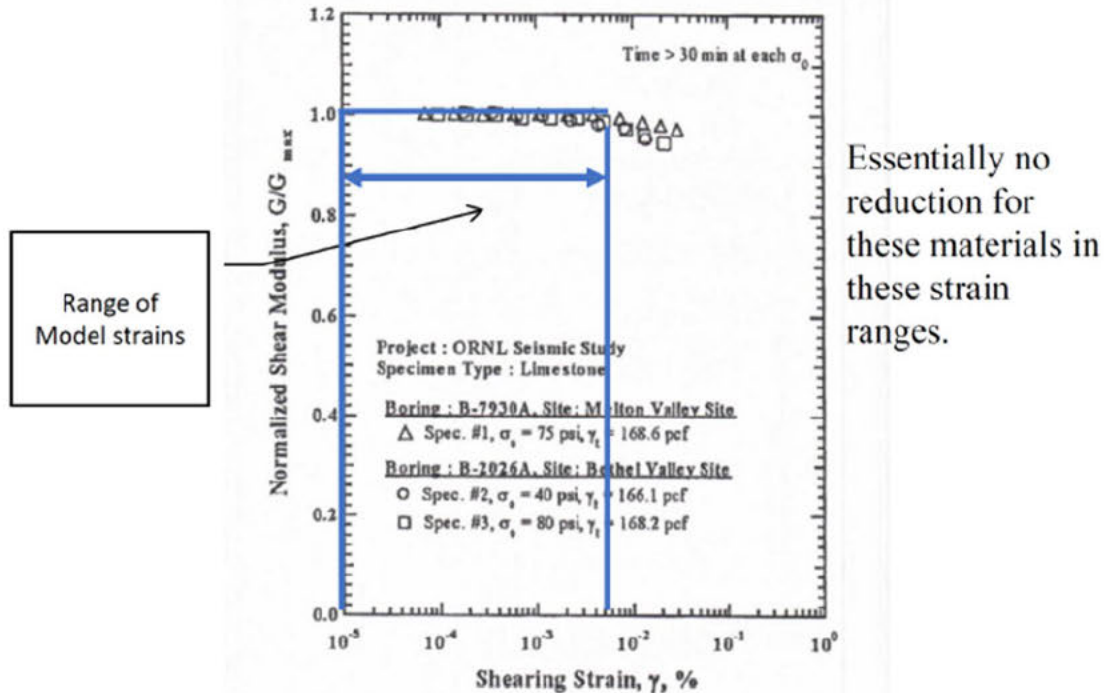
Since the purpose of determining the modulus values for stratigraphic layers is to conduct settlement evaluation, the staff performed confirmatory settlement calculations using the method by Bowles (1996) to verify that the applicant's settlement evaluation is unlikely to be underestimated due to small-strain modulus. Bowles presented a detailed reevaluation of the use of the general elastic solution for estimating the settlement of footings on sand and suggested several practical considerations for modifying the method, including foundation embedment, weighted average elastic modulus, and effective soil depth for evaluation. The

industry has widely recognized and used Bowles' method. In its calculation, the staff chose to use a 275-foot (83.8-meter)-deep stratigraphic column based on the Bowles depth recommendation of five times the foundation width. The staff used the modulus values developed by the SPT N-values for the top 20 feet (6.1 meters) of soil. The staff also varied and reduced the modulus values converted by the shear wave velocities for the depth from 20 to 275 feet to evaluate the settlement affected by the change in modulus values. The staff found that, even using 10 percent of the shear wave converted constrained modulus for the depth from 20 to 275 feet to simulate large strain modulus, the result from the staff's confirmatory analysis indicated that the settlement calculated by Bowles' method for the CISF pads is less than 0.75 inch (1.9 centimeters), the maximum total settlement calculated by the applicant. Based on its confirmatory results, the staff finds it is acceptable to use the applicant's settlement evaluation for design and analysis.

Table 2-2
Maximum Strains by Layer, reproduced from "Submission of ISP Responses for RAIs
and Associated Document Markups from First Request for Additional Information,
Parts 2, 3, and 4, Docket 72-1050 CAC/EPID 001028/L-2017-NEW-0002," Enclosure 3,
Table P-2.6-3-3

<u>Strain with Depth from highest loaded case</u>					Config 1 200214 input 5 File
	Layer	Thickness	Depth of Layer		Max Strain @ midpoint
			Bottom	Midpoint Depth	
SPT Blowcounts	Cover Sands	2	2	1	4.85E-03
	Caliche Sand 1	8	10	6	2.90E-03
	Caliche Sand 2	10	20	15	2.25E-03
Shear Wave Velocity	Caliche Hard 1	5	25	22.5	6.49E-05
	Caliche Hard 2	10	35	30	3.71E-05
	Ogallala 1	15	50	42.5	2.09E-05
	Ogallala 2	30	80	65	2.24E-05
	Ogallala 3	20	100	90	6.96E-06
	Dockum Claystone/Siltstone	30	130	115	7.59E-06
	Claystone and Siltstone	100	230	180	2.77E-06
	Dockum Clay/Claystone 1	45	275	252.5	1.57E-06
	Dockum Sily/Sands	25	300	287.5	1.24E-06
	Dockum Clay/Claystone 2	60	360	330	9.71E-07
	Dockum Clay/Claystone 3	240	600	480	3.79E-07

Figure 2-3
Normalized Shear Modulus vs. Shearing Strain from Siegel (2004), reproduced from
“Submission of ISP Responses for RAs and Associated Document Markups from First
Request for Additional Information, Parts 2, 3, and 4, Docket 72-1050
CAC/EPID 001028/L-2017-NEW-0002,” Enclosure 3, Table P-2.6-3-5



From Oak Ridge National Laboratory investigation by Siegel (2004). Sedimentary rock and residuum. Shear Wave Velocity profile similar to this site.

The staff reviewed the information in the application related to excavation and backfill. The staff noted that the plans and profiles in SAR Figure 2-26; Figure 2-31, “CJI C-6 Cross Section A-A’ STA. 0+00 – STA. 19+00”; Figure 2-32, “CJI C-7 Cross Section A-A’ STA. 19+00 – STA. 38+39”; and Figure 2-33, “CJI C-8 Cross Section B-B’ STA. 0+00 – STA. 25+25,” show the extent of excavations and backfill. The staff also noted that a thin layer of topsoil and cover sands at the surface will be excavated and replaced with compacted dense graded aggregate. Because the backfilled material provides direct support to the storage pad foundation and because the structural stability analysis relies on the properties of the backfill materials, especially soil–structure interaction analysis, the staff asked the applicant to provide the compaction criteria for the backfill material and the quality controls to ensure the proper placement and compaction of the backfill.

In its response dated May 31, 2019, the applicant stated that the backfill criteria recommendations for material, compaction, and quality control specified in Section 4.2.2, “Structural Soil Fill,” of the applicant’s report of geotechnical exploration are accepted as requirements, and it added references to those requirements to SAR Section 2.6.4 and Section 7.6.2.1, “Design Basis.” The applicant further stated that it updated additional

references to the report of geotechnical exploration in SAR Sections 7.6.2.2, 7.6.2.4, 7.6.3.2, and 7.7.

The staff reviewed the applicant's revised Section 4.2.2 of the report of geotechnical exploration and finds that it details the recommended fill soils and the placement and compaction criteria for fill and specifies the criteria for material type, characteristics, compaction procedures, and compaction control. The staff further noted that the fill lift thickness is proportioned to achieve 95 percent or more of the standard proctor maximum following the test methods in American Society for Testing and Materials D698, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort," 2012 edition, issued May 1, 2012.

Based on its review and verification of the backfill criteria for compaction and quality control for backfill, the staff finds that the applicant provided sufficient technical requirements for backfill materials, including grain size distribution, field placement, compaction and testing, in Section 4.2.2 of the report of geotechnical exploration. The staff confirmed that the applicant referenced those technical requirements for backfills in the related SAR sections. Based on its review, the staff concludes that the applicant-specified requirements are adequate, and the state of practice will ensure the stability of subsurface materials and the foundation.

The staff noted the varying descriptions in the SAR of the material composition and thicknesses of the subsurface layers at the site. In addition, the staff noted that the values calculated for the static elastic moduli in Appendix D to the applicant's report of geotechnical exploration exceed the typical range of values for similar soils reported in various engineering reference materials. For example, Table 2-8 in Bowles (1996) indicates that a typical range value for a silty sand is 725 to 2,900 psi, for a dense sand 7,251 to 11,748 psi, for dense sand and gravel 14,503 to 29,007 psi, and for hard clay 7,251 to 14,503 psi. However, in Table 9 of the applicant's initial report of geotechnical exploration, the applicant provided static elastic modulus values from 9,796 to 95,255 psi. Accordingly, the staff asked the applicant to provide the stratigraphic information by depth and associated material properties, including the static elastic modulus values, for the stratum depth causing settlement.

In its response dated May 18, 2020, the applicant restated that the historical data available at the site, coupled with the 18 borings and the new shear wave study, have allowed the development of a soil stratigraphic column to 600 feet (180 meters) along with the necessary engineering parameters without additional new soil borings to greater depths. The applicant provided the stratigraphic information by depth and associated material properties, including the static elastic modulus values, for the stratum depth causing settlement, as shown in Table NP-2.6-3-2 in applicant's response.

The staff reviewed the response. As indicated above, the staff concluded that the information for site stratigraphy and engineering evaluation, based on the combination of the data from site investigations with the available historical data, is sufficient and reliable for a soil and rock column of 600 feet (180 meters). The staff also concluded that the constrained modulus values up to 20 feet (6.1 meters) bgs developed by the SPT N-values are reasonable. Based on the staff's confirmatory settlement calculation described above, the staff further determined that it is acceptable to use the settlement calculated by the applicant for design and analysis. Additionally, the staff noted that the engineering parameters in the applicant's report of geotechnical exploration were revised correspondingly to the depth of 600 feet. Accordingly, the staff finds that the constrained modulus values as shown in Table NP-2.6-3-2 in the applicant's response are acceptable for settlement evaluation.

2.3.6.4.2 Stability of Subsurface Materials and Foundations

The stability of the subsurface materials and foundations is safety significant. The staff noted that SAR Figure 7-30, "Soil Characterization at Depth," presents the soil characterization by depth and estimated the depth to the red beds (clay) to be 40 to 85 feet (12 to 26 meters). The staff reviewed the settlement evaluation to determine the stability of the subsurface materials but did not find a discussion concerning the evaluation of consolidation and secondary compression settlement, which is a typical geotechnical behavior for clay material. Therefore, the staff asked the applicant to provide a settlement evaluation for consolidation and secondary compression.

In its response dated May 18, 2020, the applicant stated that Appendix H to the applicant's revised report of geotechnical exploration provides the settlement evaluation in accordance with a soil stratigraphic column to 600 feet (180 meters), along with the necessary engineering parameters. The applicant clarified that clay was not encountered in the borings at the WCS CISF site. The applicant further clarified that the clay/claystone was referenced as part of the Dockum Group at depths ranging from 230 to 275 feet (70 to 84 meters) and 300 to 600 feet (90 to 180 meters). The applicant concluded that secondary compression was not needed for the analysis because constrained modulus values for these clay/claystone layers are as high as very hard rock.

The staff review the response. The staff checked Appendix A to the report of geotechnical exploration and confirmed that the boring logs indicate no cohesive soils. The staff also checked the maximum strains by layer with the highest loaded case as shown in Table P-2.6-3-3 in the applicant's response and noticed that the strains for depths of 230 to 600 feet (70 to 180 meters) are very small, on the order of 1×10^{-6} to 1×10^{-7} . Based on the measurements of shear wave velocity, the staff agreed that these layers between 230 and 600 feet deep are rock, not clay. The staff further agreed that the strain-adjusted modulus values for these claystone layers are very high and concluded that the corresponding deformation can be ignored under the very low strains at the depth of 230 feet and below. Therefore, the staff concludes that secondary compression due to cohesive soil is not a concern at the site. In addition, because no consistent permanent water table is observed in the extensive geotechnical exploration of the areas, and most of the subsurface beneath the CISF site consists of unsaturated moisture-deficient materials, the staff further concludes that consolidation is negligible at the site.

The staff also reviewed Appendix H to the revised report of geotechnical exploration. The staff noted that the settlement analyses were performed using Settle3. The staff also noted that the stress computation method applied in this analysis was Westergaard Solution, which is widely used in settlement evaluations for considering multiple soil layers. The staff further noted that the settlement analysis considered different loading conditions by including a series of four pad loading conditions and exploring the effects of adjacent pads on total and differential settlement. Therefore, the staff considers the applicant's settlement evaluation to be proper and adequate. The staff noted that the material composition and thicknesses of the subsurface layers at the site vary throughout the WCS CISF. It was not clear to the staff whether the applicant considered the presence of subsurface water in its analyses of the settlement of the pad. SAR Section 2.6 and Section 7.5, "Cask Handling Building," described the near-surface sediments at the site as dry; however, saturated horizons were found with boreholes on the northeast side of the site and immediately to the south of the site. In addition, based on staff expertise in the semiarid environments of the western United States, saturation near the pad site may vary with time and space at the site, thus suggesting the geotechnical properties may also vary with space and time. Infiltration is highly likely episodic, both on a precipitation-event basis and on

an annual average basis. Hence, recharge is likely transient and may also be localized by the nature of the caliche and the interspersed layering of sand and gravel. Lateral flow, likely channelized, in the subsurface may occur due to the variations in lithology, such as the nonuniform occurrence of caliche layers. In addition, compression of soil by the pad may alter ambient channelized transient flow pathways. The combination of these factors may lead to variations in saturations at localized portions of the pad, which may lead to changes in the material properties that affect settlement. Accordingly, the staff asked the applicant to provide an evaluation of long-term differential settlement of the pad considering the effect of temporal and spatial variations in subsurface water saturation.

In its response dated June 28, 2019, the applicant provided detailed information on the subsurface material and water level to indicate that differential settlement due to spatial variation in subsurface water saturation will not likely occur.

The staff reviewed the response, focusing on the material descriptions and physical properties of the subsurface units to determine whether long-term differential settlement due to spatial variation of groundwater saturation is unlikely to occur, as claimed by the applicant. The staff concludes that the applicant provided sufficient information to clarify the composition and physical properties of the subsurface layers at the site, and to describe most of the subsurface as unsaturated moisture-deficient materials beneath the WCS CISF site. Because the shallow subsurface consists of sands, gravels, and caliche (0 to 100 feet [30 meters] bgs), and these are underlain by the claystones of the Dockum Group, the subsurface water saturation is not a potential concern. Accordingly, the staff concludes that long-term differential settlement is not a concern for WCS CISF Phase 1 foundations.

The settlement calculation needs to consider additional stresses due to the foundation load up to the influence depth of the settlement. SAR Section 7.6.2.5, "Calculations," presents a calculation of elastic settlements based on the theory of elasticity. The staff noted that the calculation assumed the stratum depth causing settlement to be 37 feet (11 meters) below the concrete pad. The SAR referenced Bowles (1996) for using a weighted average elastic modulus for elastic settlement evaluation. However, the staff noted that Bowles (1996) recommends that the depth used for evaluation should be either five times the width of the foundation or the depth where a hard stratum is encountered. A hard layer is defined as 10 times the static elastic modulus of the adjacent upper layer. Because the influence depth is important to the settlement evaluation as it relates to the stability of subsurface materials, which is safety significant, the staff asked applicant to justify the adequacy of the selected depth of 37 feet for evaluating settlement at the WCS CISF site.

In its response dated May 18, 2020, the applicant stated that the initial settlement analysis in SAR Section 7.6.2.5 was based on the assumption that any materials that could not be augered through were incompressible. The applicant further stated that since historical data from past geotechnical explorations, well installation logs, and shear wave studies at the property have been supplemented into the applicant's report of geotechnical exploration, the settlement analysis was extended to a depth of 600 feet (180 meters).

As discussed above, the staff concluded that the method of combining the data from site investigations with the available historical data for the site is justifiable. Additionally, the staff noted that below the Dockum Claystone layer at a depth of 600 feet (180 meters) is the Trujillo Sandstone Layer, with measured shear wave velocities ranging between 4,000 to 5,000 feet per second (1,200 to 1,500 meters per second), which is categorized as rock to hard rock and considered incompressible under very small strain levels on the order of 1×10^{-7} and below.

Therefore, the staff concludes that a depth extended to 600 feet is adequate for evaluating settlement at the site.

The staff noted that a subgrade modulus of 150 pounds per cubic inch (pci) was initially recommended in Section 4.3.2, "Mat Foundations (Storage Building)," of Attachment E to Revision 2 of the SAR. The staff also noted that this modulus is assigned to the GTSTRUDL model used for the structural analysis that calculated a maximum elastic vertical foundation displacement of 0.125408 inch (3 millimeters), as presented in SAR Section 7.6.1.8, "Concrete Pad Capacity." This estimated settlement is significantly less than that estimated by other methods. For example, even with likely inflated SPT N-values due to caliche, the applicant's settlement estimation by the FHWA empirical method based on SPT is still more than 10 times the estimated settlement from the GTSTRUDL model, which suggests that the assumed subgrade reaction modulus may be overestimated. Additionally, it appears that the settlement analyses are only from a single pad, not from multiple adjacent pads as shown in SAR Figure 1-6, "WCS CISF Storage Pad Layout." Also, the staff noted that the construction sequence of the pads is not considered in the total and differential settlement evaluations. Because the modulus of subgrade is an important safety parameter for the structural analyses, and the layout and construction sequence are important for the settlement evaluation performed to assess the stability of the site, the staff asked applicant to justify the geotechnical engineering basis for determining a subgrade modulus of 150 pci and provide the total and differential settlement evaluations influenced by the layout and construction sequence, given that the proposed storage facility area is about 350 feet by 800 feet (107 meters by 244 meters), as shown in SAR Figure 1-6.

In its response dated May 18, 2020, the applicant detailed the iterative process for developing the subgrade modulus. The applicant adjusted the subgrade modulus through the iterative process, considering pressure distribution on the mat and different loading configurations in order to obtain realistic deflections. The applicant continued this iterative process until the models converged. After completing the iterative process, the applicant used the resulting stress distributions in conjunction with the multiple storage pad layout to perform additional settlement models. The applicant calculated settlement and differential settlement depending on the construction and loading sequence of the pads. The applicant stated that Appendix H to the revised report of geotechnical exploration contains the resulting settlement analysis.

The staff reviewed the response, as well as Appendix H to the revised report of geotechnical exploration. The staff noted that the subgrade modulus was adjusted for wider loads on a mat foundation to reflect realistic pressure distributions and therefore to build appropriate relationships between stress and deflection. The staff also noted the iterative process was considered to achieve convergence when calculated soil modulus values and displacements did not change more than 10 percent between consecutive iterations, which conforms to common engineering practice. The staff further noted that the analysis of the modulus of subgrade reactions was performed on a single pad under the conditions of fully loaded, one-quarter loaded, half loaded, and three-quarters loaded to replicate possible loading configurations. Accordingly, the staff concludes that the method, procedure, and calculation for subgrade modulus described in Appendix H to the revised report of geotechnical exploration are proper and adequate. Additionally, because the layout of multiple pads and the sequence of construction and loading were considered, the staff decided that the applicant's settlement and differential settlement evaluations are reasonable.

2.3.6.4.3 Liquefaction Potential

In SAR Section 7.6.2, "Soil Liquefaction and VCC [Vertical Concrete Cask] Storage Pad Settlement," the applicant described its liquefaction potential evaluation. The applicant based its evaluation on NRC RG 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites." The applicant stated that a thin layer of topsoil and cover sands at the surface at the WCS CISF will be excavated and replaced with compacted dense graded aggregate. The applicant indicated that groundwater was not encountered within the explored depths. However, the applicant performed a liquefaction potential calculation considering the possibility of the site soils becoming fully saturated.

In its review of SAR Section 7.6.2, the staff evaluated the applicant's description of liquefaction potential, including and SPT-based liquefaction analyses of the WCS CISF site. The staff focused its review on the input parameters, assumptions, and processes used in the SPT empirical methodology. The staff reviewed the calculation package in Appendix F to Attachment E to Chapter 2 of the SAR. The applicant used the procedure described by Youd (2001), which evaluates soils strength against liquefaction based on SPT blowcount values and the induced cyclic stresses based on earthquake PGA and magnitude values. The staff noted that the applicant used several assumptions for its liquefaction potential calculation including: 60 percent for hammer energy correction purposes, the dense graded aggregate to be used for replacing excavated soils is not liquefaction susceptible, a fines content of 35 percent, the groundwater to be at the ground surface, and a total unit weight of 125 pcf. The applicant calculated the corrected mean minus one standard deviation SPT N-values ($N_{1_{60}}$) and deemed that further calculations were unnecessary based on Youd (2001) in which soils with a fines content of 35 percent and exhibiting a corrected blow count of about 21 or greater are not susceptible to liquefaction.

The staff reviewed SAR Figure 2-10, "OAG groundwater elevation near the proposed WCS CISF" and noted an isolated saturated area within the WCS CISF site. In addition, the applicant presented data on sixteen wells on the site with only three having completely dry conditions. Therefore, the staff believes that the applicant assumption of a fully saturated condition is appropriate for the evaluation. The staff reviewed the applicant's SPT data and the laboratory test results. The staff reviewed Appendix B of the report of geotechnical exploration (Attachment E to Chapter 2 of the SAR) which provides the soil data summary of the site for each boring. The staff found limited data available for fine contents. The applicant presented test results for nine out of 128 possible test samples. Of the nine sample test results, three samples represented depths from 8 to 14.2 feet (2.4 to 4.3 meters), and they all contained less than 35 percent fines. Another four out of the nine results are from the first 4 feet (1.22 meters), which will be excavated and replaced by the applicant. The staff reviewed the boring logs for the study of the WCS CISF site area that included the CISF-Phase I, the Transfer Building, and the Administration Building. The staff noted that the applicant performed 18 borings and encountered auger refusal conditions in four borings at depths ranging from 37 to 45 feet (11.3 to 13.7 meters) bgs. The staff noted that the applicant described all strata encountered in the test borings as silty sands, with some strata containing caliche and some containing traces of caliche. SAR Section 2.6.4 states, "The standard penetration resistance values have likely to be inflated due to the caliche." The applicant used the SPT N-values to evaluate and characterize the site-specific layered soil condition such as liquefaction potential.

The staff reviewed Lehman T and Rainwater K. (2000), "Geology of the WCS," which discussed a subsurface investigation in Andrews County, Texas. The report included borings with a measured water table at 55 feet (17 meters) bgs or deeper. The staff acknowledges that no water table was found by the applicant in its subsurface investigation. The staff performed a

confirmatory analysis and calculated the factors of safety for the liquefaction potential based on the phase one study of the WCS CISF site. The staff calculated all liquefaction factors of safety using the experimental data from 18 borings performed by the applicant in its subsurface investigation and assuming saturated soil conditions. In its independent calculation, the staff considered the uncertainties of the applicant laboratory and insitu test results. The staff performed liquefaction sensitivity calculations using lower values for fine contents and blow counts. The staff used the applicant's experimental values minus one standard deviation. Although the staff used lower values, the staff found that the phase one subsurface materials of the WCS CISF are not likely to liquefy. The staff found that all factors of safety were significantly higher than 1.4 and would suffer minor cyclic pore pressure generation in accordance to RG 1.198. In addition, the staff acknowledges that the applicant will excavate and replace the upper 4 feet (1.22 meters) of soil with compacted dense grade aggregate which will increase liquefaction resistance.

Based on the review of SAR Section 7.6.2 and the staff confirmatory analysis, the staff concurs with the applicant's conclusion that the subsurface materials for WCS CISF phase one are not likely to liquefy.

2.3.6.4.4 NRC Staff Conclusions Regarding the Stability of Subsurface Materials

The staff has reviewed SAR Section 2.6.4 and the associated information from other SAR sections. The staff also reviewed the applicant's responses to the staff's RAIs. Based on the staff's review of the submitted information and confirmatory settlement calculations and liquefaction analysis discussed in the preceding sections, the staff concludes that the information presented by the applicant is adequate for use in other sections of the SAR to develop the design bases of the facility, perform additional safety analysis, and demonstrate compliance with the regulatory requirements in 10 CFR 72.103(f)(1)(c) and 10 CFR 72.103(2)(iv).

2.3.6.5 Slope Stability

SAR Section 2.6.5, "Slope Stability," provides general information on the slope stability of the site. The applicant indicated that the WCS CISF site and the surrounding area are nearly flat. The applicant stated that the geologic strata are well consolidated, and surface soils have low moisture content. The applicant indicated that no surface water is present except during infrequent rainstorms.

The staff noted that the applicant provided limited information in SAR Section 2.6.5. In order to determine compliance with 10 CFR 72.103(f)(1) and 10 CFR 72.103(f)(2)(iv), the staff requested additional information about the presence of water resources in the site vicinity along with a description of their location, such as dams or natural or man-made ponds, and how the stability of their embankments might affect the site. In addition, SAR Section 2.7, "Summary of Site Conditions Affecting Construction and Operating Requirements," states, "There are no slopes, natural or manmade, close enough to the proposed WCS CISF facilities that their failure would adversely affect these facilities." The staff asked the applicant to define the words "close enough" relative to the WCS CISF facilities and to justify why the failure of these slopes would not adversely affect WCS CISF facilities for Phase 1 or for the total area of the proposed site, whichever applies.

In its response dated June 28, 2019, the applicant described the ponds and basins caused by depressions, and spring and drainage features near the WCS CISF. The applicant also provided information on five man-made ponds on the WCS property in the site vicinity used for

sedimentation control and evaporation, and a series of man-made ponds to the southwest in New Mexico used for oil field waste disposal operations. The applicant further described two significant soil material stockpiled embankments that are created from the construction of existing WCS landfills in the general area of the WCS CISF.

The staff reviewed the response to the RAI. The staff noticed that the ponds and basins caused by depressions, and spring and drainage features near the WCS CISF, do not have embankments, and these nonindustrial water resources are ephemeral and precluded from impacting the WCS CISF due to inherent topography. Based on the information on the elevations of man-made ponds in the site vicinity and in New Mexico, the staff noted that the lowest ground elevation of any WCS CISF structure is over 34 feet (10 meters) higher than any of the WCS pond embankment elevations, and over 13 feet (4.0 meters) higher than any elevations of the overflow points for the ponds from the oil industry. Therefore, the staff concludes that the stability of the embankments of man-made ponds does not affect the site. The staff further noted that the applicant provided detailed information for two stockpiles, including their locations, side slopes, and slope height, and demonstrated that any potential lateral spreads from two stockpiles are far short of having any impact on the WCS CISF. Accordingly, the staff concludes that no slopes, natural or man made, are close enough to the proposed WCS CISF facilities that their failure would adversely affect these facilities.

The staff finds the above information acceptable because the slope stability of the site is well described and documented. The information is acceptable for use in other sections of the SAR to develop the design bases of the CISF facility, perform additional safety analysis, and demonstrate compliance with the regulatory requirements in 10 CFR 72.103(f)(1) and 10 CFR 72.103(f)(2)(iv) with respect to this issue.

2.4 Evaluation Findings

Based on its review of the information in the application, the staff finds the following:

- The application provides an acceptable description and safety assessment of the site on which the ISFSI is to be located, in accordance with 10 CFR 72.24(a).
- The proposed site complies with the criteria of 10 CFR Part 72, Subpart E, "Siting Evaluation Factors," as required by 10 CFR 72.40(a)(2).
- The analyses of off-normal and accident events and conditions show that the design of the CISF will acceptably meet the requirements without endangering public health and safety, in compliance with the overall requirements of 10 CFR 72.122.

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3 OPERATION SYSTEMS

In Chapter 5, "Operation Systems and Procedures," of the Safety Analysis Report (SAR), Interim Storage Partners LLC, (ISP or the applicant) described its operations at the proposed WCS Consolidated Interim Storage Facility (CISF) including receiving and inspecting transportation casks with canisters containing spent nuclear fuel (SNF) or greater-than-Class C (GTCC) waste; transferring canisters to storage overpacks; placing storage overpacks on the CISF storage pads; surveillance of the storage overpacks; security; health physics; maintenance; removal of canisters from the CISF; operating systems for safe storage of the SNF or GTCC waste; and operation support systems.

3.1 Scope of Review

The staff evaluated the applicant's operation systems for the WCS CISF by reviewing the information in the SAR, the applicant's responses to the staff's request for supplemental and additional information, and the staff's previous evaluations for the proposed cask systems to be stored at the facility incorporated by reference in the SAR. The staff reviewed the information in the SAR Chapter 5 to determine whether the applicant provided a clear and complete description of all operations, including systems, equipment, and instrumentation related to the handling and storage of SNF or solidified high-level waste, confinement of nuclear material, and management of expected and potential radiological dose. In addition, the staff reviewed the applicable sections in SAR Chapter 1, "Introduction and General Description of Installation," Chapter 3, "Principal Design Criteria," Chapter 4, "Facility Design," and the information incorporated by reference discussed in the SAR appendices.

3.2 Regulatory Requirements

The regulatory requirements relevant to the overall function of the facility and the operation of the separate functional subsystems of the proposed WCS CISF appear in the following sections of Title 10 of the *Code of Federal Regulations* (10 CFR):

- 10 CFR 72.24, "Contents of application: Technical information"
- 10 CFR 72.40, "Issuance of license"
- 10 CFR 72.44, "License conditions"
- 10 CFR 72.104, "Criteria for radioactive materials in effluents and direct radiation from an ISFSI or MRS"
- 10 CFR 72.122, "Overall requirements"
- 10 CFR 72.124, "Criteria for nuclear criticality safety"
- 10 CFR 72.126, "Criteria for radiological protection"
- 10 CFR 72.128, "Criteria for spent fuel, high-level radioactive waste, reactor-related greater than Class C waste, and other radioactive waste storage and handling"
- 10 CFR 72.150, "Instructions, procedures, and drawings"

3.3 Staff Review and Analysis

Unless otherwise stated, the staff reviewed and evaluated the operation systems of the proposed site discussed in Chapter 5 of SAR Revision 5, documents cited in or attached to the SAR, the applicant's responses to the staff's requests for supplemental and additional information, and other relevant documents and literature. The staff reviewed and evaluated the functions and functional subsystems associated with receipt, transfer, maintenance, and

retrieval of the WCS CISF SNF and GTCC waste. Specifically, the staff reviewed and evaluated the operations at the WCS CISF and the canister handling systems at the WCS CISF. The staff used NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," dated March 2000, to support the review.

3.3.1 General Operating Functions

In SAR Section 1.2.4.1, "Use of NRC Approved Storage Cask Systems, the applicant listed the canisters and storage system configurations proposed for storage at the WCS CISF. SER Table 1-1 provides the cross reference to the applicable SAR appendix for each canister/storage overpack where the system-specific operating procedures are presented. The staff reviewed and evaluated the canister/storage systems described in Section 5, "Operating Procedures," of each SAR appendix related to the general operating functions.

In SAR Chapter 5, the applicant described the primary operations associated with storage of SNF at the independent spent fuel storage installation (ISFSI). The applicant noted in SAR Section 5.1.1, "Operations at Originating Site," that canister removal from the storage overpack at the originating site and transfer to an authorized transportation cask is conducted under the originating site's 10 CFR Parts 50 and 72 license and related procedures.

In SAR Section 5.1.2, "Operation between the Originating Sites and the WCS CISF," the applicant stated that transportation casks containing the canisterized SNF or GTCC waste are shipped by rail to the WCS CISF boundary.

In SAR Section 5.1.3, "Operations at the WCS CISF," the applicant described the activities upon receipt of the NUHOMS® systems and NAC systems received at the WCS CISF as follows:

- Post-transportation verification will invoke visual inspections of the two most limiting canisters from each reactor site.
- An evacuated volume helium leak test of each canister will verify the integrity of the canister inside the transportation cask in accordance with the requirements of WCS Quality Assurance Procedure QP-10.02, "Post Transport Package Evaluation," Revision 2, and confirm that a canister remains capable of performing its safety function and therefore, acceptable for storage at the WCS CISF.
- The receipt operations involve site receipt systems and the Cask Handling Building (CHB) cask off-loading and loading systems.

The staff reviewed SAR Section 5.1.3 and confirmed that the post-transportation package verification program listed above will provide reasonable assurance that the canister is acceptable to place back into storage at the WCS CISF. SER Section 9.3.3.1, "Confinement Casks or Systems," of the SER discusses the assessment criteria and the test requirements for the post-transportation verification program.

In SAR Section 5.1.4, "Flow Sheets," the applicant provided flow sheets illustrating operations for canister receipt, transfer, and placement into storage as shown in SAR Appendices A through G, Figures A.5-1, B.5-1, C.5-1, D.5-1, E.5-1, F.5-1 and G.5-1 for the NUHOMS MP187, Standardized Advanced NUHOMS, Standardized NUHOMS, NAC-MPC, NAC-UMS®, and NAC MAGNASTOR® storage systems. The staff reviewed the applicant's proposed operations sequence and determined it is consistent with the previously accepted operations sequences for

the proposed storage systems at the site and therefore, is acceptable because it would allow for the safe conduct of operations.

In SAR Section 5.1.5, "Identification of Subjects for Safety Analysis," the applicant provided an overview of the topics covered in the safety analysis, including criticality safety, chemical safety, operation shutdown modes, instrumentation, and maintenance techniques. The staff found the overview acceptable because the listed topics are addressed in the SAR.

3.3.2 Spent Fuel and High-Level Waste Handling Systems

In the SAR appendices, the applicant discussed the final safety analysis reports (FSARs) and transportations SARs for the cask systems proposed for storage at the site, which the applicant incorporated by reference. The FSARs and SARs detail the handling, transportation, and transfer of the casks containing SNF and GTCC waste which the staff previously reviewed and found acceptable. The applicant stated that handling operations at the WCS CISF will be consistent with the handling operations described in each of the previously approved storage systems and transportation package certificates of compliance. Based on its review, the staff finds the applicant's description of the SNF and waste handling systems acceptable because it incorporates by reference the staff's previous evaluation approving the cask storage system.

3.3.3 Canister Handling Systems

3.3.3.1 Operation Description

In SAR Section 5.2.1, "Canister Receipt, Handling and Transfer," the applicant discussed the canister handling systems and special safety features used for the receipt, handling, transfer and storage of SNF and GTCC waste canisters. The staff reviewed and evaluated the system functions and special features in the paragraphs below.

In SAR Section 5.2.1.1, "Canisterized Spent Fuel and GTCC Waste Receipt," the applicant noted that the SNF canisters and GTCC waste received are contained in transportation casks with impact limiters, and the transportation cask protects the enclosed canister from physical damage, provides shielding and criticality safety, and allows sufficient cooling of the canister while in route to the WCS CISF.

For the NUHOMS systems proposed for storage at the WCS CISF, the applicant stated that the transportation cask is inspected upon arrival, the integrity of the tamperproof seals are verified, the impact limiters are removed, the cask is staged for removal from the rail car, and surface contamination surveys of the transportation cask are performed.

For the Vertical Storage Systems proposed for storage at the WCS CISF, the applicant described the conduct of radiation and contamination surveys of the transport vehicle, the removal of the top and bottom impact limiters and the tie down assembly, the attachment of the CHB overhead crane with the appropriate special lifting device to the transportation cask, and the cask lifting into the vertical position.

In SAR Section 5.2.1.1.2, "Safety Features," the applicant noted that the safety features include the design, materials, and construction of the transportation casks. The applicant stated that the casks provide gamma and neutron shielding, conductive and radiant cooling, and structural strength to protect the canister. A tamperproof device on the cask indicates any unauthorized attempt to access to the cask. The applicant referenced additional information for these safety features in the transportation cask SARs incorporated by reference in SAR Sections 1.6.1.1,

“Transportation SARs,” and 1.6.2.1, “Storage SARs,” and listed in SER Chapter 1, “General Description.”

The staff reviewed the information provided by the applicant and confirmed the information incorporated by reference on the operation of the transportation cask systems which has been approved by the NRC. Based on its review, the staff finds that the applicant adequately identified and described the transportation cask systems and canister receipt operations and that its previously approved evaluation remains applicable and therefore, acceptable.

3.3.3.2 Canister Handling

In SAR Section 5.2.1.2.2, “Safety Features,” the applicant noted that the CHB houses the equipment used to handle the transition of canisters from transportation configurations under 10 CFR Part 71 to storage operations under 10 CFR Part 72. In SER Chapter 5, “Installation and Structural Evaluation,” the staff reviewed and evaluated the CHB, which houses the overhead CHB cranes and the stand-alone Canister Transfer System (CTS), that are both classified as important-to-safety (ITS) SSCs.

In SAR Section 5.2.1.2, “Canister Handling,” the applicant noted that operators use a CHB overhead bridge crane to lift loaded NUHOMS transportation casks from rail cars and to remove or install personnel barriers, impact limiters and small items from the transportation casks. The applicant stated that after receipt inspection and removal of the impact limiters, the not-important-to-safety (NITS) cask lifting device is attached to the top and bottom of the cask, and the CHB bridge crane lifts the loaded cask from the rail car onto the transfer cask support skid on the transfer trailer. In SAR Section 4.7.2, “Overhead Bridge Cranes,” the applicant stated that the ITS CHB bridge crane hoist used for the NUHOMS cask includes administratively-controlled limit switches to prevent crane hoist motion that would lift the cask above the maximum analyzed drop height of 80 inches. The yard tractor moves the transfer trailer to the storage pad and HSM.

For the Vertical Storage Systems, the applicant described the preliminary receipt inspection, the movement of the rail car and the transportation cask into the CHB to complete the receipt inspection, and the removal of the transportation cask impact limiters. In Section 5 of Appendices E, F, and G of the SAR for the NAC transportation casks for the NAC-MPC, NAC-UMS, and NAC MAGNASTOR storage systems, respectively, the applicant further describes the use of the CHB overhead cranes and special lifting devices specific to the transportation cask design to upright the transportation cask, lift it from the rail car, and place it in a laydown area where the VCT can be used for subsequent movement. The applicant then described using the VCT to position the upright transportation cask in the CTS near a designated storage overpack. In SAR Section 7.6.6, “Transport Cask Stability,” the applicant described its assessment demonstrating that the NAC transportation casks would remain upright through normal conditions and postulated seismic events in the general CHB operating areas for the period when the cask is neither restrained by the CHB overhead crane nor the VCT.

The staff reviewed the information provided by the applicant and the information incorporated by reference on the operation of transportation cask systems which have been approved by the NRC. Based on its review, the staff determined that the applicant adequately identified and described the transportation cask systems for the canister receipt operation at the WCS CISF and that its previously approved evaluation remains applicable and therefore, acceptable.

In SER Section 5.3.3, "Other SSCs Important to Safety," the staff evaluated the CHB identified by the applicant as an ITS – Category B steel structure designed to support two ITS bridge cranes used for cask lifting. Based on its review above, the staff finds that the canister handling operations in the CHB are adequately identified and described in the application.

3.3.3.3 Canister Transfer

In SAR Section 5.2.1.3, "Canister Transfer," the applicant noted the use of a transfer vehicle, called the transfer trailer, to move the NUHOMS transfer cask to and position it in front of a HSM for the canister transfer operation by hydraulic ram. In SAR Appendix Sections A.5.1, B.5.1, C.5.1, and D.5.1, "Operating Procedures," the applicant identified the previously approved MP187, MP197, and MP197HB cask systems as transfer casks.

In SAR Section 7.5.1, "Canister Transfer System," the applicant described the use of the CTS for transfer of the transportable storage canister (TSC) for the three types of storage systems (the NAC-MPC, NAC-UMS, and NAC MAGNASTOR) from the transportation cask to the vertical storage cask. To prepare for transfer operations, the transportation cask and the designated storage overpack are positioned within the CTS and prepared for loading/unloading, including placement of the transfer adapter. The CTS is essentially a hydraulic gantry crane consisting of vertical telescoping lifting booms, horizontal lifting beams, a trolley beam, and seismic cross-bracing. It is prepared for transfer by rigging the trolley beam with the transfer cask for the appropriate storage system and a chain hoist for hoisting the TSC into the transfer cask. The TSC transfer occurs in a configuration referred to as "stack-up," where the transfer cask is set on top of the transfer adapter, which is mounted on top of the transportation or storage cask, as appropriate. Operators position the CTS trolley beam with attached chain hoist over the transportation cask and use the chain hoist to pull the TSC up into the transfer cask. The operators then move the CTS with the attached transfer cask and TSC laterally to position it over the vertical concrete cask (VCC) storage overpack, before lowering the TSC into the VCC.

The applicant further noted that the VCT moves the loaded VCC to the designated storage pad for installation. In Section 7.5.2, "Vertical Cask Transporter (VCT)," of the SAR, the applicant stated that the transfer of the VCC from the CTS to the storage pad using the VCT is not considered ITS because the loaded VCC has been evaluated for drops within the potential range of lift heights. In SAR Appendix Sections E.4.1.3, F.4.1.4, and G.4.1.4, the applicant provided transfer cask design information associated with the canister transfer operation for the NAC-MPC, NAC-UMS, and NAC MAGNASTOR storage systems.

In SAR Section 5.2.1.3.2, "Safety Features," the applicant noted that the CTS meets the single-failure-proof criteria described in NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants, Resolution of Technical Activity A-36," by providing a combination of fail-safe features and redundant design factors, as well as structures designed to the criteria of American Society of Mechanical Engineers (ASME) NOG-1 for compliance with NUREG-0554, "Single-Failure Proof Cranes for Nuclear Power Plants," for single-failure-proof critical load handling.

In SER Sections 4.3.2, "Classification of SSCs," and 4.3.3, "Design Criteria for SSCs Important to Safety," the staff discussed its evaluation of the classification and design of ITS SSCs, including the CHB overhead cranes, the CTS, and the VCT. The staff discussed its review of the design of the CTS pad in SER Section 5.3.3.2. This evaluation addresses the design criteria and the single-failure-proof lifting capability during vertical NAC cask system transfer operations.

In SER Sections 4.3.2.2, 4.3.4, and 5.3.4, the staff evaluated the NUHOMS transfer trailer and other NITS SSCs. The staff accepted the classification of the transfer vehicle and the cask lifting device as NITS because transferring the loaded transfer cask onto the transfer vehicle and subsequent movement to the horizontal storage modules (HSM) is limited to a height of not more than 80 inches. This transfer cask horizontal lifting height limit was previously approved to ensure that the canister confinement boundary retains its structural integrity post cask lifting system failure.

Based on its review above, the staff finds that the applicant has adequately identified and described the canister transfer operations within the CHB and during movement to the storage pad.

3.3.3.4 Canister Storage

In SAR Section 5.2.2, "Canister Storage," the applicant defined the storage systems as the NUHOMS HSM and the VCC storage systems, which include the SNF and GTCC waste canisters placed in overpacks located on storage pad. The applicant noted that these storage systems are passive, require no support systems for long-term storage, and perform their functions under normal, off-normal, and accident-level conditions. The applicant stated that limits of operation associated with various normal and off-normal conditions and surveillance requirements are contained in the WCS CISF Technical Specifications.

In SAR Appendix Sections A.4.2, B.4.2, C.4.2, and D.4.2, the applicant discussed the previously approved HSM and AHSM overpack designs for storing applicable DSCs at individual ISFSI locations. In SAR Appendix Sections E.4.1.2, E.4.2.2, F.4.1.2, and G.4.1.2, the applicant discussed the previously approved NAC system overpack designs for storing applicable transportable storage canisters using the VCC at individual ISFSI locations.

In SER Section 5.3.1, "Description of Confinement Structures," the staff discussed its safety evaluation of the NUHOMS HSM and AHSM identified as ITS for the DSC storage operation at WCS CISF. In SER Section 5.3.1, "Design Criteria for Confinement Structures," the staff described its evaluation of the NAC VCC (also referred to as MAGNASTOR), configurations CC1 through CC4, for the TSC storage operation at WCS CISF. Based on its review above, the staff finds that the applicant adequately identified and described the canister storage operations at the WCS CISF.

3.3.4 Other Operating Systems

In SAR Section 5.1.3.4, "Health Physics Operations," the applicant stated that radiological surveys are planned for all incoming canisters as normal receiving operations at the facility, and should contamination above the acceptance levels be discovered, the canister will be returned to the shipper.

The applicant also noted that the storage overpacks are passive and do not require any other operating systems for safe storage of the SNF or GTCC waste.

The staff reviewed the description of the other operating systems described in SAR Sections 5.1, "Operation Description," and 5.3, "Other Operating Systems, and the relevant information in SAR Chapters 1 and 3. Based on its review and its evaluation of as-low-as-reasonably achievable (ALARA) in SER Chapter 12, "Radiation Protection Evaluation," the staff finds that the design and operations of the WCS CISF consider ALARA as required by 10 CFR

72.104(b), including radiological alarm systems and direct radiation monitoring in the design consistent with the requirements of 10 CFR 72.126(b) and (c).

3.3.5 Operation Support Systems

As discussed in the SAR Section 4.3.17, "Operation Support Systems," the applicant stated that the storage overpacks have thermal monitoring capabilities as described in the Technical Specifications applicable to each system. SAR Table 4-1 provides a cross reference to the applicable appendix and section for each canister/storage overpack where the individual storage overpack thermal monitoring systems are discussed.

The staff reviewed SAR Appendices A through H and the applicant's proposed Technical Specifications Sections 3.0 "Limiting Condition for Operation (LCO) and Surveillance Requirement (SR) Applicability," and 5.0, "Administrative Controls," and verified the information is consistent with the previously approved systems incorporated by reference. Based on its review, the staff finds the thermal monitoring capabilities included in the Technical Specifications applicable to WCS CISF acceptable because the application incorporated by reference the previously approved systems, and no additional monitoring is required.

The proposed design of the WCS CISF does not require ITS utility systems or redundant systems to maintain the ability to perform safety functions assuming a single failure. Therefore, the requirements of 10 CFR 72.122(k)(1) are not applicable. The proposed design of the WCS CISF does not require utility systems during spent fuel storage. Therefore, the emergency utility services required by 10 CFR 72.122(k)(2) are not applicable. The proposed design does not include systems and subsystems that require continuous electric power to permit continued functioning. Since the design of the WCS CISF does not require emergency power, 10 CFR 72.122(k)(3) is also not applicable.

3.3.6 Control Room and Control Area

As discussed in the SAR Sections 4.3.15, "Control Room and Control Area," and 5.5, "Control Room and Control Areas," the applicant stated that the WCS CISF is a passive installation, with no need for operator actions. Thus, no control room is needed for normal operations. However, the instrumentation used to monitor storage overpack temperatures has readouts in the Security and Administration Building.

Based on its review, the staff finds the applicant's description of Control Room and Control Area acceptable because the 10 CFR 72.122 requirement is not applicable to the WCS CISF because the storage systems are passive and require no control room to ensure safe operation.

3.3.7 Analytical Sampling

As discussed in the SAR Section 5.6, "Analytical Sampling," the applicant stated that no analytical sampling is required because the NUHOMS and NAC cask system designs will preclude release of effluents for normal, off-normal, and accident conditions during storage. Although not required, the applicant stated it will establish a monitoring system for surface water runoff, consisting of quarterly soil sampling coupled with weekly and monthly radiological surveys on the storage overpacks and storage pad.

The applicant stated in SAR Section 5.6 that no sampling is required for liquid radioactive waste, solid radwaste, and gaseous waste for the safe operation of the WCS CISF. The applicant will perform air monitoring for each offload and will notify all the applicable regulatory entities if contamination is detected above Department of Transportation conveyance limits.

Based on its review, the staff finds that the information regarding analytical sampling that the applicant incorporated by reference from the previously approved cask system FSARs remains applicable and, therefore, no additional analytical monitoring is required.

3.3.8 Monitoring and Testing of SSCs Important to Safety

3.3.8.1 Cask Repair and Maintenance

In SAR Section 4.5, "Transportation Casks and Associated Components," the applicant stated that at the WCS CISF, the transportation cask is unloaded from the rail car inside the CHB and, depending on the Cask System, moved to the CTS where the transportation cask is opened and the canister is removed or transferred to the Storage Pad where the canister is removed. The applicant further stated that after the canister is unloaded, the transportation cask is resealed and shipped off site. However, the applicant also stated that if visual inspections reveal the need for repairs or maintenance, these activities will be performed either at the WCS CISF or in another appropriate location, based on the nature of the work to be performed. The applicant stated that work will be performed under the NRC-approved WCS CISF Quality Assurance Program Description in accordance with written procedures that meet the transportation license requirements under 10 CFR Part 71. The applicant stated that if transportation cask repair or maintenance activities are necessary, the designated location is in a section of the CHB as shown on SAR Figure 1-7 or at a vendor-designated location.

The applicant indicated that maintenance activities carried out at the CHB include leak tests, fastener inspections and replacement, impact limiter inspections, seal areas and groove inspections, trunnion inspections, and rupture disk and gasket inspections. The applicant stated that any transportation cask maintenance and repair activity conducted at WCS CISF will be performed in accordance with the applicable NRC Certificate of Compliance (CoC) for Radioactive Materials Packages issued under 10 CFR Part 71, and Chapter 8, "Acceptance Tests and Maintenance Program," of the SAR referenced in the CoC. The applicant also stated that ISP will be a registered user for all transportation casks used at WCS CISF and perform any transportation cask maintenance and repair activity under an approved NRC Quality Assurance Program.

The staff reviewed the application information on shipping cask repair and Chapter 8 of the CoC SARs incorporated by reference in the application. The staff confirmed that the repair and maintenance activities identified in the SAR Section 4.5.1, "Transportation Cask Repair and Maintenance Activities," are consistent with the required maintenance activities for each of the transportation systems. Based on its review, the staff finds that the maintenance and repair requirements for the transportation packages described in SAR Section 4.5.1 are acceptable because the requirements are consistent with the previously approved repair and maintenance requirements identified in Chapter 8 of the CoC SARs incorporated by reference.

3.3.8.2 Repair and Maintenance of Other Important to Safety SSCs

In SAR Sections 7.5.1, and 7.5.2, the applicant described inspection, testing, and maintenance activities to ensure the ITS CTS and VCT operate safely, respectively. The CTS and VCT are

both hydraulic gantry cranes relying on vertical hydraulic jacking towers designed to the criteria of ASME B30.1, "Jacks, Industrial Rollers, Air Casters, and Hydraulic Gentries," as the lift mechanism. The CTS and VCT include ITS lift beams and other special lifting devices designed to the criteria of ANSI N14.6, "Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More". The CTS also includes an air-driven chain hoist designed to the criteria of ASME NUM-1, "Rules for Construction of Cranes, Monorails, and Hoists (with Bridge or Trolley or Hoist of the Underhung Type)," criteria for Type 1B hoists for lifting or lowering the canister with the outer casks in the "Stack-up" configuration.

The applicant identified specific measures for inspection, maintenance and repairs of the CTS and VCT. In SAR Section 7.5.1.13, "Maintenance," the applicant specified the maintenance and inspection activities that would be applied to the CTS. The applicant stated that the hydraulic gantry portion of the CTS shall be maintained in accordance with ASME B30.1 and the chain hoist shall be maintained in accordance with ASME B30.16, "Overhead Hoists (Underhung)." In SAR Section 7.5.1.6, "Emergency Repairs," the applicant described capabilities to repair the CTS in place or to move the gantry and lower the load using backup equipment and alternate controls. In SAR Section 7.5.2.3, "VCT Inspections," the applicant identified the VCT inspections would be performed as specified in ASME B30.1 for the mobile hydraulic gantry and as specified in ANSI N14.6 for the VCT lift links, lifting pins, and the lifting beam.

The SAR includes Section 4.7.5, "CISF Heavy Loads Program," and Table 4-3, "Heavy Load Handling Equipment Certification." The applicant intended the heavy loads program provide administrative controls for safely handling heavy loads, including areas of maintenance and testing/inspection to demonstrate continuing compliance with design. The heavy loads program included in SAR Section 4.7.5 specifies the following:

- Special lifting devices shall be controlled per applicable site documents in accordance with ANSI N14.6.
- Permanent heavy load handling equipment shall be maintained in accordance with the applicable ANSI/ASME standard.

In SAR Table 4-3, the applicant identified ASME B30.2, "Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)," as the applicable standard for the CHB overhead cranes. In SAR Table 4-3, the applicant identified the following standards as applicable to inspection of the VCT, CTS, and associated rigging, as applicable:

- ASME B30.1, "Jacks, Industrial Rollers, Air Casters, and Hydraulic Gentries"
- ANSI N14.6, "Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More"
- ASME B30.16, "Overhead Hoists (Underhung)"
- ASME B30.9, "Slings"
- ASME B30.10, "Hooks"
- ASME B30.20, "Below-the-Hook Lifting Devices"

The staff found that the specified inspections and maintenance satisfy the intent of guidance in NUREG-0612 to maintain ITS lifting equipment in good working order and minimize the potential for equipment failure leading to cask drop events. Therefore, the staff finds that an acceptable capability to test and monitor ITS cask handling systems and components are provided in the design and procedures for the CISF, consistent with the requirements of 10 CFR 72.128(a)(1).

3.4 Evaluation Findings

Based on information in the application, the staff concludes:

- The SAR includes acceptable descriptions and discussions of the projected operating characteristics and safety considerations, in compliance with 10 CFR 72.24(b).
- The SAR provides reasonable assurance that the activities to be authorized by the license can be conducted without endangering the health and safety of the public and will be in compliance with the applicable regulations of 10 CFR 72.40(a)(13).
- The operating procedures and schedule for operations for the CISF acceptably provides for control during storage operations to be accomplished from the security/monitoring/surveillance office facility and for control during loading, transfer, and unloading operations to be from temporary control facilities, for which there are acceptable provisions included in the design. This is considered to acceptably comply with 10 CFR 72.122(j).
- The descriptions of the proposed CISF functions and operating systems with regard to retrieval of stored radioactive material from storage, in normal, off-normal, and accident conditions are acceptable and comply with 10 CFR 72.122(l).
- Acceptable capability to test and monitor components ITS are provided in the design and procedures for the CISF, in compliance with 10 CFR 72.128(a)(1).

3.5 References

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

American Society of Mechanical Engineers (ASME) NUM-1, "Rules for Construction of Cranes, Monorails, and Hoists (with Bridge or Trolley or Hoist of the Underhung Type)."

American Society of Mechanical Engineers (ASME) B30.1-2009, "Jacks, Industrial Rollers, Air Casters, and Hydraulic Gantries."

American Society of Mechanical Engineers (ASME) B30.2-2005, "Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)".

American Society of Mechanical Engineers (ASME) B30.10-2009, "Hooks".

American Society of Mechanical Engineers (ASME) B30.16-2007, "Overhead Hoists (Underhung)".

American National Standards Institute (ANSI) N14.6-1993, American National Standard for Radioactive Materials – "Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More," 1993.

AREVA, Inc., "Updated Final Safety Analysis Report for the Standardized Advanced NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 6, August 2014 (nonpublic). NRC Docket No. 72-1029. Transmittal dated July 13, 2016. Agencywide Documents Access and Management System (ADAMS) Accession No. ML16200A178.

AREVA, Inc., "NUHOMS®-MP197 Transport Packaging Safety Analysis Report," Revision 17, April 2001 (nonpublic). NRC Docket No. 71-9302. Transmittal dated July 20, 2016. ADAMS Accession No. ML16207A498.

AREVA TN Americas, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 14, September 2014 (nonpublic). NRC Docket No. 72-1004. Transmittal dated July 13, 2016. ADAMS Accession No. ML16218A396.

ISP, "WSC Consolidated Interim Storage Facility Safety Analysis Report," Revision 5, Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML21105A766.

ISP, "Submittal of Revision 4 of the License Application for the WCS CISF," Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML21105A766.

NAC International, "MAGNASTOR® Final Safety Analysis Report," Revision 7, July 2015 (nonpublic). NRC Docket No. 72-1031. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A932.

NAC International, "NAC-MPC, NAC Multi-Purpose Cask, Final Safety Analysis Report," Revision 10, January 2014 (nonpublic). NRC Docket No. 72-1025. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A556.

NAC International, "NAC-UMS Universal Storage System Final Safety Analysis Report," Revision 10, October 2012 (nonpublic). NRC Docket No. 72-1015. Transmittal dated August 3, 2016. ADAMS Accession No. ML16245A212.

NAC International, "MAGNATRAN Safety Analysis Report," Revision 12A, October 2012. NRC Docket No. 71-9356. ADAMS Accession Nos. ML13024A258 and ML13010A092.

NAC International, "MAGNATRAN® Safety Analysis Report," Revision 14A, October 2014. NRC Docket No. 71-9356. ADAMS Accession No. ML14356A377.

NAC International, "MAGNATRAN Safety Analysis Report," Revision 15A, October 2015 (nonpublic). NRC Docket No. 71-9356. Transmittal dated October 15, 2015. ADAMS Accession No. ML15296A084.

NAC International, "NAC-STC, NAC Storage Transport Cask Safety Analysis Report," Revision 17, April 2011 (nonpublic). NRC Docket No. 71-9235. Transmittal dated May 25, 2011. ADAMS Accession No. ML11152A179.

NAC International, "Safety Analysis Report for the UMS® Universal Transport Cask," Revision 2, November 2005. NRC Docket No. 71-9270. ADAMS Accession No. ML16252A309.

NRC, NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," March 2000. ADAMS Accession No. ML003686776.

NRC, NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants, Resolution of Generic Technical Activity A-36," July 1980. ADAMS Accession No. ML070250180.

NRC, NUREG-0554, "Single-Failure Proof Cranes for Nuclear Power Plants," May 1979. ADAMS Accession No. ML110450636.

Sacramento Municipal Utility District, "Rancho Seco Independent Spent Fuel Storage Installation, Final Safety Analysis Report, Volume 1, ISFSI System," Revision 4, June 2010 (nonpublic). NRC Docket No. 72-11. Transmittal dated August 11, 2016. ADAMS Accession No. ML16236A115.

Transnuclear, Inc., "Safety Analysis Report for the NUHOMS®-MP187 Multi-Purpose Cask," Revision 17, July 2003 (nonpublic). NRC Docket No. 71-9255. Transmittal dated July 15, 2016. ADAMS Accession No. ML16203A183.

WCS, Quality Assurance Procedure QP-10.02, Revision 2, "Post-Transport Package Evaluation" (proprietary), dated January 20, 2017. Transmittal dated March 16, 2017. ADAMS Accession No. ML17082A021.

4 CLASSIFICATION OF STRUCTURES, SYSTEMS, AND COMPONENTS AND DESIGN CRITERIA

In Chapter 3, “Principal Design Criteria,” of Revision 5 of its safety analysis report (SAR), dated April 12, 2021, the Interim Storage Partners LLC (ISP or the applicant) described the principal design criteria used in the design of the proposed WCS Consolidated Interim Storage Facility (CISF). In SAR Appendices A through H, the applicant provided information related to the storage of spent nuclear fuel (SNF) and reactor-related greater-than-Class C (GTCC) waste at the WCS CISF using canister-based storage cask systems previously licensed or certified (or both) by the U.S. Nuclear Regulatory Commission (NRC).

4.1 Scope of Review

The staff reviewed the application related to the systems, structures, and components (SSCs) and design criteria in the above-mentioned portions of the SAR to ensure that the applicant acceptably defined the limiting characteristics of the SNF and reactor-related GTCC waste to be stored, the classification of SSCs according to their importance to safety, and the design criteria and design bases for the SSCs during normal and off-normal operations and accident conditions, including external conditions and natural phenomena events. The staff also reviewed applicable sections in SAR Chapters 1, 2, 4, 5, and 7 and the proposed technical specifications (TS) in Appendix A to the application. For the decommissioning considerations, the staff reviewed SAR Section 13.6, “Decommissioning Plan”; and Appendices B and D to the license application, entitled, “Preliminary Decommissioning Plan”; and “Decommissioning Funding Plan,” respectively.

4.2 Regulatory Requirements

The regulatory requirements relevant to the SSCs and the design criteria of the proposed WCS CISF appear in the following sections of Title 10 of the *Code of Federal Regulations* (10 CFR):

- 10 CFR 72.2, “Scope”
- 10 CFR 72.3, “Definitions”
- 10 CFR 72.6, “License required; types of licenses”
- 10 CFR 72.24, “Contents of application: Technical information”
- 10 CFR 72.30, “Financial assurance and recordkeeping for decommissioning”
- 10 CFR 72.103, “Geological and seismological characteristics for applications for dry cask modes of storage on or after October 16, 2003”
- 10 CFR 72.104, “Criteria for radioactive materials in effluents and direct radiation from an ISFSI or MRS”
- 10 CFR 72.106, “Controlled area of an ISFSI or MRS”
- 10 CFR 72.120, “General considerations”
- 10 CFR 72.122, “Overall requirements”

- 10 CFR 72.124, “Criteria for nuclear criticality safety”
- 10 CFR 72.126, “Criteria for radiological protection”
- 10 CFR 72.128, “Criteria for spent fuel, high-level radioactive waste, reactor-related Greater than Class C waste, and other radioactive waste storage and handling”
- 10 CFR 72.130, “Criteria for decommissioning”
- 10 CFR 72.144, “Quality assurance program”
- 10 CFR 72.182, “Design for physical protection”

4.3 Staff Review and Analysis

Unless otherwise stated, the staff reviewed and evaluated the applicant’s description of the SSCs discussed in SAR Revision 5 as described in Section 4.1 of this safety evaluation report (SER), documents cited in or attached to the SAR, the applicant’s responses to the staff’s requests for supplemental and additional information, and other relevant literature.

The staff reviewed and evaluated the following topics in the application: materials to be stored, classification of SSCs, design criteria for SSCs important to safety (ITS), and design criteria for other SSCs not important to safety (NITS).

4.3.1 Materials To Be Stored

In SAR Section 3.1.1, “Materials to Be Stored,” the applicant described the materials to be stored at the facility, which include spent boiling-water reactor and pressurized-water reactor SNF assemblies and reactor-related GTCC waste.

4.3.1.1 Spent Fuel

In SAR Section 3.1.1, the applicant stated that the SNF to be stored at the WCS CISF includes irradiated boiling-water reactor and pressurized-water reactor fuel assemblies from multiple reactor sites, sealed in welded metallic canisters inside vertical or horizontal concrete storage overpacks. The applicant further stated that Phase 1 of the facility is designed to store approximately 470 canisters in overpacks, with a total SNF storage capacity of 5,000 metric tons (5,512 tons) of heavy metal.

In SAR Table 1-1, “Storage Systems at the WCS CISF,” the applicant identified the final safety analysis reports (FSARs) for the six different storage systems incorporated by reference. The staff noted that the NRC previously approved all six storage systems, and the contents are limited to the specific fuel and canister types listed in SAR Table 1-1. The FSARs incorporated by reference describe in detail the physical, thermal, and radiological characteristics of the SNF. In SAR Appendices A through G, the applicant provided additional information and references to each cask storage system proposed for storage at the WCS CISF.

The staff found this information acceptable because it meets the requirements of 10 CFR 72.2(a)(1), as it concerns power reactor spent fuel that will be stored in a complex designed and constructed for storage of power reactor spent fuel aged for at least one year. Furthermore, it is consistent with descriptions of SNF previously approved by the NRC for storage in the six storage systems to be used at the WCS CISF. Additionally, the description of

the facility design meets the requirements of 10 CFR 72.120(b) for storing only SNF and solid reactor-related GTCC waste, as described below.

4.3.1.2 Greater-Than-Class-C Waste

The applicant described the WCS CISF as designed to store up to 510,000 pounds (231.3 metric tons) of reactor-related GTCC waste contained in canisters similar to those used to store SNF. The applicant stated that the reactor-related GTCC waste is limited to solid activated materials, consisting primarily of metallic vessel internals and in-core instrumentation. The applicant is not requesting the storage of GTCC liquid or process wastes at the facility.

For the physical, thermal, and radiological characteristics of the GTCC waste canisters to be stored at the facility, the applicant referenced SAR Section 3.2.1.1, "Greater than Class C Waste," the FSAR for the Rancho Seco independent spent fuel storage installation (ISFSI) under Docket No. 72-11 and the SARs and the certificates of compliance for the NAC-UMS[®] (under Docket No. 71-9270), NAC-STC (under Docket No. 71-9235), and NAC MAGNATRAN[®] (under Docket No. 71-9356) transportation packages. The applicant stated that the GTCC canisters from the Rancho Seco, Maine Yankee, Connecticut Yankee, Yankee Rowe, and Zion nuclear power plants are proposed to be stored at the facility. In SAR Appendix H, "Canisterized GTCC Waste," the applicant provided additional details and descriptions of the GTCC waste proposed for storage.

The staff found this information acceptable because it meets the requirements of 10 CFR 72.2(a)(1) and 10 CFR 72.120(b), as the facility will store solely reactor-related GTCC waste in a solid form. Additionally, it is consistent with descriptions of reactor-related GTCC waste previously approved by the NRC.

4.3.2 Classification of Structures, Systems, and Components

In SAR Section 3.4, "Classification of Structures, Components, and Systems," the applicant identified the SSCs classified as ITS and the quality assurance classifications. The applicant listed the ITS and NITS SSCs in SAR Table 3-5, "Quality Assurance Classification of Structures, Systems, and Components as Utilized at the WCS CISF." The applicant stated that SSCs classified as ITS are designed, fabricated, constructed, and tested in accordance with the Quality Assurance (QA) Program referenced in SAR Section 1.4.4.3. The applicant further stated that each SSC classified as ITS is given a level of importance based on QA classification categories as detailed in NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety," issued February 1996. The applicant provided specific information in SAR Appendices A through H for each of the storage systems incorporated by reference. In SAR Table 3-4, "References for WCS CISF Storage System Components Important-to-Safety," the applicant identified the SAR appendix sections, the corresponding sections in the specific license or certificate SAR, and SAR appendix sections containing drawings for the ITS SSCs.

4.3.2.1 Classification of Structures, Systems, and Components—Items Important to Safety

In SAR Table 3-5, the applicant listed the SNF canister as the only ITS Classification Category A component. In SAR Section 3.4, the applicant stated that Category A items include SSCs whose failure or malfunction could directly result in a condition adversely affecting public health and safety.

In SAR Section 3.4, the applicant stated that ITS Category B (ITS-B) applies to SSCs whose failure could indirectly (i.e., in conjunction with the failure of another component) result in a condition adversely affecting public health and safety. In SAR Table 3-5, the applicant listed the components classified as ITS-B:

- storage overpacks
- canister transfer system (CTS), which is used to transfer vertical fuel storage canisters between transportation and storage overpacks
- vertical cask transporter (VCT), which is the principal means to handle and transport vertical storage canisters while located within a licensed overpack
- cask handling building (CHB) (structural steel, overhead crane supports, concrete foundations and slab on grade, and overhead crane bridge trucks and trolley seismic clips)
- CHB overhead cranes
- special lifting devices for NAC transportation casks

The applicant stated that the equipment supporting hoisting, lifting, and rigging operations within the CHB involving a vertical NAC storage canister containing fuel would be classified as ITS. The CTS and VCT handling systems contain components (e.g., the structural members supporting the canister and the connected special lifting devices) essential to preventing an inadvertent drop of a loaded vertical storage canister under conditions (i.e., drop height and canister overpack configuration) that have not been shown to maintain the fuel in a safe storage condition. Therefore, the applicant classified certain components of the CTS and VCT handling systems as ITS-B.

In SAR Section 3.4, the applicant stated that ITS Category C (ITS-C) items include SSCs whose failure or malfunction would not significantly reduce the packaging effectiveness and would not be likely to create a situation adversely affecting public health and safety. SAR Table 3-5 identifies the vertical concrete cask (VCC) storage pad and the CTS pad in the CHB as ITS-C. Furthermore, the applicant stated that the following SSCs are treated as ITS-C in all respects except that the provisions for reporting of defects and noncompliances, pursuant to 10 CFR Part 21, "Reporting of defects and noncompliance," do not apply:

- train line derail device or derailer
- backup electric power generators
- central alarm system
- security alarm systems
- security lighting
- security cameras

4.3.2.2 Classification of Structures, Systems, and Components—Items Not Important to Safety

In SAR Section 3.4, the applicant stated that all other components are classified as NITS because their failure would not result in an unsafe condition. NITS SSCs include the facility infrastructure, security and administration buildings, facility utilities including electrical and

water, roads, rail lines, the fire protection system, the communication system, radiation monitors, and associated support equipment. In SAR Table 3-5, the applicant also identified as NITS the overhead building crane lifting device for the NUHOMS transportation casks, the NUHOMS cask transfer trailer, and the storage pad supporting the NUHOMS storage modules. The applicant stated that the classification of the overhead building crane lifting devices for the NUHOMS transportation cask was based on the transportation cask remaining below its analyzed drop height, thereby providing assurance of safety.

4.3.2.3 Classification of Structures, Systems, and Components—Conclusion

The staff reviewed the classification of the SSCs at the proposed WCS CISF. The staff determined that the applicant's classification of ITS SSCs is acceptable because the applicant followed the recommendations for storage systems in Table 6 of NUREG/CR-6407. The classification is also consistent with the safety classification of the storage systems incorporated by reference.

The staff evaluated the quality classifications of the ITS SSCs specific to the WCS CISF (i.e., CHB structure, VCT, CTS, CHB overhead crane, special lifting devices for the NAC transportation casks, and cask pads). The staff concluded that the applicant had a reasonable basis to classify these SSCs used for critical single-failure-proof lifts as ITS-B because the failure of these components would not directly result in an unsafe condition due to redundancy or because the component was of simple and standard design with a low likelihood of complete failure. Similarly, the staff concluded that the applicant had a reasonable basis to classify the CTS pad and the VCC storage pad as ITS-C because failure of these components alone would not challenge safe storage, and the VCC pad classification is consistent with its classification in the applicable cask system FSARs.

For NITS SSCs, the staff determined that the classification is acceptable because the NITS SSCs are neither credited to perform safety functions nor to protect SSCs that perform safety functions.

For the reasons stated above, the applicant's SSC classification satisfies the requirements of 10 CFR 72.3, 10 CFR 72.24(n), and 10 CFR 72.144(a) and (c) for the identification of SNF handling systems to be covered by the quality assurance program.

4.3.3 Design Criteria for Structures, Systems, and Components Important to Safety

The applicant identified the principal design criteria for the ITS SSCs in SAR Chapter 3 and listed the following ITS SSCs: SNF canisters, storage overpacks, the CTS, the VCT, the CHB overhead cranes and associated ITS lifting devices, the CHB structure, and pads for the CTS and storage of the vertical concrete systems.

4.3.3.1 General Information

The applicant stated that the principal design criteria considered for the design of ITS systems and components are defined in the SARs incorporated by reference for each cask system proposed for storage and compared with the WCS CISF site-specific conditions to demonstrate that the cask systems bound the WCS CISF site conditions. For its structural evaluations, the applicant described in SAR Chapter 7, "Installation Design and Structural Evaluation," the specific load values based on these criteria for comparison with the design basis for each cask system proposed for storage.

In Section 2.1, “Functional and Operating Limits,” of the TS in the application, the applicant listed the SNF canisters proposed for storage at the WCS CISF. In SAR Table 3-1, “Physical Design Characteristics of Storage Systems at the WCS CISF,” the applicant provided the cross-reference to the SAR appendix that presents the design criteria of each cask system and compares them with the WCS CISF site-specific criteria. As noted in SAR Section 3.2, “Structural and Mechanical Safety Criteria,” the applicant considered the following:

- normal and off-normal loads:
 - dead loads
 - live loads
 - handling loads
 - snow and ice loads
 - wind loads
 - internal/external pressure
 - lateral soil pressure
- accident-level loads:
 - explosion overpressure
 - drop/tip-over
 - accident pressurization
 - fire
 - tornado wind/missiles
 - floods
 - earthquake

The applicant also considered thermal loads for normal, off-normal, and accident-level conditions.

SAR Table 1-2, “Summary of WCS CISF Principal Design Criteria,” summarizes the principal design criteria for the WCS CISF, which are based on the characteristics of the site. The applicant described additional details of how the design criteria for these loads were used for each of the ITS SSCs in SAR Appendices A through H. In SAR Chapter 12, “Accident Analysis,” the applicant addressed the site-specific accident conditions and provided a crosswalk to additional details in the SAR appendices for each cask system in SAR Table 12-1, “Off-Normal and Accident Evaluations for the Storage Systems at the WCS CISF.”

Based on its review, the staff finds that the applicant identified the principal design criteria for the WCS site and incorporated by reference the principal design criteria for each of the cask systems proposed for storage at the facility. The staff finds that the structural design criteria presented meet applicable requirements given in 10 CFR 72.24(c)(1), (c)(2), (c)(4), and (n); 10 CFR 72.106(a); 10 CFR 72.120(a) and (b); 10 CFR 72.122(a), (b), (c), (d), (e), (f), (g), (h), (i), (j), (k), and (l) and 10 CFR 72.144.

4.3.3.2 Structural Design Criteria

The applicant incorporated by reference the design criteria for the storage system SSCs that are ITS and detailed this information in Section 3, “Principal Design Criteria,” of SAR Appendices A through G. The applicant provided specific information in Table 3-1, “Summary of WCS CISF Principal Design Criteria,” of SAR Appendices A through G for each of the storage systems incorporated by reference, including a comparison of the WCS CISF design criteria with the cask system design criteria. For the GTCC canisters, the applicant stated that the design criteria of the SSCs are the same as those for the corresponding SNF canisters in the cask

systems incorporated by reference and listed in Table 3-1 of each SAR appendix. The individual storage system FSARs describe normal, off-normal, and accident loads, as appropriate. The staff finds that the design criteria for the individual cask systems incorporated by reference are adequately referenced.

The sections below discuss the site-specific structural design criteria applicable to the WCS CISF facility that were compared with each of the cask system criteria. SER Chapter 5 provides the staff's evaluation on how these loads were used for the structural analysis of the SSCs.

4.3.3.2.1 Tornado and Wind Design Criteria

In SAR Section 3.2.1, "Tornado and Wind Loadings," the applicant discussed the principal design criteria for the WCS CISF related to tornado and wind loading. These criteria were applied to the design of the CHB and the storage facility. The criteria do not apply to the handling systems and the fuel canisters during handling and transfer operations. The applicant noted that the design-basis tornado characteristics are based on NRC Regulatory Guide 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," Revision 1, issued March 2007 and NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," Revision 3, dated March 2000, Sections 3.3.1, "Wind Loading," 3.3.2, "Tornado Loads," and 3.5.1.4, "Missiles Generated by Tornadoes and Extreme Winds." The applicant noted that the loaded storage overpacks are designed to remain stable and to maintain the confinement boundary when subjected to tornado-generated missiles. SAR Table 1-2 lists the resulting design criteria from tornado and wind loadings for the WCS CISF. The staff reviews and evaluates the tornado-generated wind loadings and missiles for the CHB and other SSCs in SER Chapter 5.

The guidance in NUREG-0800, Section 3.5.1.4, "Missiles Generated by Tornadoes and Extreme Winds," states that the applicant's evaluation should include at least three objects as potential tornado missiles: a massive high-kinetic-energy missile that deforms on impact, a rigid missile to test penetration resistance, and a small rigid missile of a size sufficient to just pass through any openings in protective barriers. The applicant described the load determination parameters consistent with American Society of Civil Engineers (ASCE)-7, "Minimum Design Loads for Buildings and Other Structures," issued 1995, which include a wind velocity of 90 miles per hour (145 kilometers per hour) with a 3-second gust for Exposure Category C for the facility structure. The staff finds that the tornado and wind design criteria are consistent with the applicable guidance from NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," issued March 2000, and NUREG-0800 and are therefore acceptable.

The applicant proposed to exclude the effects of tornadoes from the design criteria applied to certain ITS SSCs used to handle loaded canisters during transient normal operating conditions. The basis for the exclusion included administrative measures to further reduce the likelihood of tornado effects during the period of time that individual loaded canisters are handled in configurations for which the handling systems (i.e., the CHB crane and the CTS during the transfer of loaded canisters between transportation and storage casks) and the surrounding transfer casks have not been evaluated to withstand the effect of tornadoes (i.e., not contained within transportation casks configured for transportation in accordance with 10 CFR Part 71, "Packaging and transportation of radioactive material," or storage casks configured for outdoor storage in accordance with 10 CFR Part 72, "Licensing requirements for the independent storage of spent nuclear fuel, high-level radioactive waste, and reactor-related greater than Class C waste"). In SAR Section 7.5.3.2.1, "Load Definitions," and Section 7.6.6, "Transport Cask Stability," the applicant stated that the transportation cask unloading or loading process

and the transfer process between the transportation cask and the VCC would not begin unless the current and forecasted weather indicate safe weather conditions, as defined in SAR Section 7.5.3.2.1. In SAR Section 7.5.3.2.1, the applicant also stated that the loading/unloading and transfer processes for each canister could be completed within 8 hours and would be expeditiously completed once begun. Given that each loaded canister would undergo one loading, two transfer, and one unloading operation, each loaded canister would be in a less than fully protected configuration for about 32 hours over many years at the CISF. Furthermore, because the maximum number of loaded canisters at the CISF is limited to a few hundred over its 40-year license, the loading/unloading and transfer operations would occur over a small fraction of the licensed period of operation. Thus, the applicant has justified that the likelihood of a tornado coincident with loading/unloading and transfer operations is sufficiently low that the loading combination need not be considered in the design of the associated SSCs based on the following elements: the low potential of a tornado strike in general; the forecast condition at the time the loading/unloading or transfer process starts; the limited period of time to complete the loading/unloading or transfer process; the partial protection against tornado effects provided by the CHB framing design as evaluated in SER Chapter 5; and the additional protection against direct missile strike provided by the sealed canister and the surrounding cask (i.e., transportation cask, transfer cask, or VCC).

The staff determined that appropriate design criteria have been established for the storage casks (as incorporated by reference) and the CHB that appropriately considered the most severe effects of tornadoes in the area based on the use of guidance contained in RG 1.76 and NUREG-0800. The staff concluded that the administrative controls governing the performance of loading/unloading and transfer operations reflected appropriate consideration of combinations of normal and accident conditions and the effects of natural phenomena while loaded canisters are within the CHB. Therefore, the staff found that the design criteria applied to tornado protection for ITS SSCs satisfied the requirements of 10 CFR 72.24(c)(1), (c)(2) and 10 CFR 72.122(b).

4.3.3.2.2 Water Level (Flood) Design Criteria

In SAR Section 3.2.2, "Water Level (Flood) Design," the applicant discussed the design of the facility to address potential floods and noted that the proposed site in Andrews County, TX, has a semi-arid climate with approximately 16 inches (41 centimeters) of rain per year. Considering the probable maximum flood (PMF) elevation and the applicable design load for the storage systems, the applicant indicated that the SSCs are not in a floodplain and are above the PMF elevation. SAR Table 1-2 lists the resulting design criteria for the WCS CISF. The staff reviews and evaluates the flood design criteria for the CHB and other SSCs in SER Chapter 5. The review of the flood evaluation in SER Section 2.3.4 on site characteristics concludes that the SSCs at the WCS CISF site are not located in a floodplain and are above the PMF elevation. Therefore, the staff finds that the flood design criterion for the SSCs at the site is met, is consistent with guidance from NUREG-1567, and is acceptable.

4.3.3.2.3 Seismic Design Criteria

In SAR Section 3.2.3, "Seismic Design," the applicant discussed the seismic loadings associated with the WCS CISF design-basis ground motion. The applicant determined the ground motion characteristics by a probabilistic seismic hazard analysis as discussed in SAR Section 2.6, "Geology and Seismology," with the exception of the CHB. In SER Chapter 5, the staff reviews and evaluates the applicant's CHB seismic loading considerations. In SAR

Section 2.6.2, "Vibratory Ground Motion," the applicant provided its design-basis ground motion evaluation and stated that the ground surface design response spectrum peak horizontal acceleration for 0.01 seconds is 0.25g and for the vertical is 0.175g.

The applicant evaluated seismic loading input derived for the site design response spectra and design acceleration time histories in SAR Section 3.2.3. In SAR Section 3.2.3.3, "Design Response Spectra Derivation," the applicant stated that the derivation of the seismic analysis design response spectra is consistent with the requirements in 10 CFR 72.103, "Geological and seismological characteristics for applications for dry cask modes of storage on or after October 16, 2003," and the guidance in NUREG-0800 and NUREG/CR-6728, "Technical Basis for Revision of Regulatory Guidance on Design Ground Motions: Hazard- and Risk-Consistent Ground Motion Spectra Guidelines," issued October 2001. SER Section 2.3.6 provides additional information. In SAR Chapter 7, the applicant included additional seismic loading details evaluated by the staff in SER Chapter 5 for individual structures or systems. SAR Table 1-2 lists the resulting seismic design criteria for the WCS CISF. The staff notes that the applicant considered applicable guidance for protection against seismic events for the SSCs, including but not limited to the calculation of response spectra, damping values, and combination of modal responses. The staff finds that the design criteria are consistent with applicable guidance from NUREG-0800, NUREG/CR-6728, and NUREG-1567, and is, therefore, acceptable.

4.3.3.2.4 Snow and Ice Loadings

In SAR Section 3.2.4, "Snow and Ice Loadings," the applicant discussed the snow and ice loadings considering maximum recorded snowfall in any month near the WCS CISF identified in SAR Table 2-4, "Andrews, TX Period of Record Snow Data (1914–2006)," as less than 14 inches (36 centimeters). The applicant documented the bounding snow load of 10 pounds per square foot (479 pascals) in SAR Section 2.3.3.4, "Precipitation Exposure." In SAR Chapter 7, the applicant included additional snow and ice loading details evaluated by the staff in SER Chapter 5 for individual structures or systems. SAR Table 1-2 lists the resulting snow and ice loading for the WCS CISF. The staff finds that the snow and ice loads are bounding for the WCS CISF site, are consistent with guidance from NUREG-1567, and are therefore acceptable.

4.3.3.2.5 Lightning Design

In SAR Section 3.2.7, "Lightning," the applicant stated that the SSCs with the potential to be outdoors and exposed to lightning are designed to withstand the effects of lightning without impairing the capability to perform their safety function. In addition, the applicant noted that the CHB is provided with lightning protection in accordance with the International Building Code to protect personnel and equipment. The staff reviewed and evaluated the lightning criterion for the SSCs at the WCS CISF and finds that the respective FSARs for each system address a lightning accident, and the previous evaluations continue to be acceptable. Therefore, the staff finds that the lightning criterion is consistent with the guidance from NUREG-1567 and is acceptable.

4.3.3.2.6 Combined Load Criteria

The applicant reviewed the combined load criteria for the ITS SSCs. In SAR Section 3.2.8, "Combined Load Criteria," the applicant stated that all appropriate loads and load combinations, as required, were considered in the design of applicable SSCs. The applicant stated that the

design loads are determined from normal, off-normal, and accident-level conditions and are combined to simulate the most adverse load conditions. The applicant provided additional details on specific structures and systems in Section 7, "Structural Evaluation," of each SAR appendix, which the staff evaluates in SER Chapter 5.

In SAR Section 3.2.8.1, "NUHOMS and Vertical Cask Systems," the applicant stated that the NUHOMS storage systems and the vertical storage systems are designed to provide long-term storage of SNF because the canister materials are selected to protect against degradation during the storage period, including the application of system-specific aging management programs. The staff reviews and evaluates the structural analysis applicable to the various storage cask systems in SER Chapter 5.

In SAR Section 3.2.8.2, "Cask Storage Pad Load Combinations," the applicant identified the storage pads for the vertical system storage modules as ITS and stated that the load combinations are provided in SAR Section 7.6.1.4, "Load Combinations." The staff reviews and evaluates the loads applicable to the cask storage pad in SER Chapter 5.

In SAR Section 3.2.8.3, "Canister Transfer System," the applicant stated that the CTS is considered ITS and the load combinations are in accordance with American Society of Mechanical Engineers (ASME) NOG-1-2010, "Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)."

In SAR Section 3.2.8.4, "Cask Handling Building Load Combinations," the applicant described the CHB as a structural steel building with metal siding that will support two overhead cranes, the effects of which are considered on loading combinations. The applicant stated that the design of the structure and consideration of the load combinations are in accordance with nuclear facility codes as described in SER Section 5.3.3.1.2. The applicant provided additional information in SAR Section 7.5.3, "Cask Handling Building Structural Design."

In SAR Section 3.2.8.5, "Cask Handling Building Foundation," the applicant described the foundation for the CHB as a conventional mat foundation of reinforced concrete construction. The applicant further described the design of the foundation as consistent with American Concrete Institute 349-06, "Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-06) and Commentary," for load combinations, load factors, and allowable stresses used in the design.

In SAR Section 3.2.8.6, "Cask Handling Building Cranes," the applicant stated that the overhead bridge cranes are classified as ITS and are designed as Type 1 single-failure-proof cranes in accordance with ASME NOG-1-2015, "Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)." The applicant described the overhead bridge cranes rails as attached to the CHB structure in a manner that provides adequate assurance that the rails will remain attached to the CHB structure. Further, the applicant stated that the cranes are procured and designed to follow the loading conditions and combinations established in ASME NOG-1-2015.

Based on the discussion above, the staff finds that the applicant identified adequate combined loads for the ITS SSCs at the WCS CISF site. This is because of the applicant's consideration of normal, off-normal, and accident level loads for the SSCs, as applicable. The applicant combined the aforementioned loads to simulate the most adverse load conditions on the ITS SSCs, as applicable. For these reasons, the staff finds that the identified combined loads are consistent with the guidance in NUREG-1567 and NUREG-1536, "Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility," Revision 1, issued July 2010,

and is therefore acceptable. The staff reviews and evaluates the structural analysis applicable to the various storage cask systems, including combined loads, in SER Chapter 5.

4.3.3.2.7 Structural Design Criteria – Summary

Based on its review, the staff finds that the applicant identified the structural design criteria for the ITS SSCs consistent with the information incorporated by reference for each of the cask systems proposed for storage at the facility. In addition, the staff finds that the applicant identified and analyzed the site-specific structural design criteria applicable to the WCS CISF facility and compared them against each of the cask system's criteria. The staff reviews and evaluates the structural analysis in SER Chapter 5. The staff finds that the structural design criteria presented are acceptable because they meet the structural requirements in 10 CFR 72.24(c)(1), (c)(2), (c)(3), and (n); 10 CFR 72.103; 10 CFR 72.120(a) and (b); and 10 CFR 72.122(a), (b)(1), (b)(2), (b)(3), (c), (d), (f), (g), (h), (i), (j), and (k).

4.3.3.3 Confinement

The applicant stated in SAR Section 3.3.2.1, "Confinement Barriers and Systems," that the primary confinement barrier for SNF and GTCC is the canister shell and the canister provides confinement for normal, off-normal, and accident storage conditions when inside the storage overpack or transfer cask. In SAR Table 3-5, the applicant identified that all components of the canister confinement boundary of the storage systems are classified as ITS Classification Category A components.

The staff's evaluation of and findings for each canister of the six storage systems proposed for storage at the WCS CISF appear in SER Section 9.3. The staff presents the evaluation and findings on radionuclide confinement analysis in SER Section 9.3.2, confinement monitoring in SER 9.3.3, and protection of stored material from degradation in SER 9.3.4. The staff finds that the WCS CISF confinement design criteria are consistent with applicable guidance from NUREG-1567, (a) Section 4.4.3.4, "Shielding and Confinement," which states that the applicant must identify confinement design criteria and bases; and (b) Section 4.5.3.4, "Shielding and Confinement" which states that the reviewer should confirm that the method of sealing is defined and meet regulations for redundant seals and that the maximum leak rates are specified and do not result in exceeding dose requirements.

The applicant has identified and characterized those design criteria and bases related to confinement. For the reasons discussed above and for the analysis in SER Chapter 9, the staff finds the criteria and bases are acceptable because the information meets the regulatory requirements of 10 CFR 72.24(c)(1), (c)(2), (c)(4) and (n); 10 CFR 72.104(a), (b), and (c); 10 CFR 72.106(a) and (b); 10 CFR 72.122(a), (b), (c), (d), (e), (f), (g), (h), and (i); 10 CFR 72.126(a), (b), (c), and (d); and 10 CFR 72.128(a) and (b).

4.3.3.4 Cask Handling Systems

The applicant described the design criteria for SSCs used for canister handling operations in SAR Section 3.3.7.1, "Spent Fuel or High-Level Radioactive Waste Handling and Storage." This section states that the CHB cranes and associated cask/canister lifting equipment are designed using the standards identified in the TS. Design Features TS 4.4.1 describes the design standards and their applicability to SSCs used for handling casks and canisters during transfer operations within the CHB. This TS contains the following information on design criteria:

- The CTS shall be classified as a Type 1 crane in accordance with ASME NOG-1-2015. Load Combinations and allowable stresses used in the CTS structural design shall be in accordance with ASME NOG-1. The CTS shall be designed, fabricated, operated, tested, inspected, and maintained in accordance with the guidelines of NUREG-0612. The specific applicable standard being applied to each primary gantry system component is as follows:
 - Hydraulic Locking Telescoping Boom Gantry Leg Assemblies on Self Propelled Dollies – ASME B30.1
 - Lift Beams (spanning the Telescoping Gantry Leg Assemblies) – ASME NOG-1 for design, fabrication and initial testing; ANSI N14.6 for testing, inspection, and maintenance
 - Trolley Beam (spanning the Lift Beams & also mounted on Self Propelled Dollies) – ASME NOG-1 for design, fabrication and initial testing; ANSI N14.6 for testing, inspection, and maintenance
 - Standard Lift Links – ASME B30.26
 - Standard Shackles – ASME B30.26
 - Standard Slings – ASME B30.9
 - Transfer Cask Lift Plates – ANSI N14.6
 - Air Operated Chain Hoist (suspended from Trolley Beam) – ASME NUM-1, Type I-B for design, fabrication and initial testing; ASME B30.16 for testing, inspection, and maintenance
 - Canister Lift Adapter (which mates with canister) – ANSI N14.6
- The VCT with TRANSPORTATION CASK lifting devices shall be designed, fabricated, operated, tested, inspected and maintained in accordance with the guidance of NUREG-0612, Section 5.1. The specific applicable standard being applied to each primary VCT is as follows:
 - Hydraulic Locking Telescoping Boom Assemblies – ASME B30.1
 - Lift Beam(s) (spanning the Telescoping Boom Assemblies) ANSI N14.6
 - Cask Lift Links – ANSI N14.6
- The CHB CRANES with TRANSPORTATION CASK lifting devices shall be designed, fabricated, operated, tested, inspected and maintained in accordance with the guidance of NUREG-0612, Section 5.1. The specific applicable standard being applied to each crane is as follows:
 - Crane structure and main hoist system: ASME NOG-1, 2015 Type I for design, fabrication and initial testing; ASME B30.2 for operation, testing, inspection, and maintenance
 - Cask Lifting Devices – ANSI N14.6

The staff evaluated the above design criteria. The staff found the above standards provide criteria appropriate for the safe handling of loaded canisters and casks because the standards define design features for reliable handling; redundancy or appropriate enhanced factors of safety to minimize the potential for loss of function or failure, including following postulated

component failures and natural phenomena; quality assurance applicable to design, fabrication and testing; and acceptance criteria for maintenance, testing and inspection to ensure continued reliability in use. Therefore, the staff found that the design criteria applied to ITS cask handling SSCs satisfied the requirements of 10 CFR 72.24(c)(1), (c)(2), (c)(4), and (n); 10 CFR 72.120(a); and 10 CFR 72.122(a), (b), and (f).

4.3.3.5 Thermal

In SAR Section 3.2.5, "Thermal," the applicant stated that thermal design criteria are derived from the WCS site characteristics and include ambient temperature and insolation. The applicant addressed specific load values for these criteria in SAR Chapter 8, "Thermal Evaluation." The staff's evaluation of and findings for these criteria appear in SER Section 6.3.3. The staff presents its evaluation and findings on fire protection in SER Section 6.3.5. The staff finds that the WCS CISF thermal design criteria are consistent with applicable guidance from NUREG-1567, Section 4.4.3.3, "Thermal," which states that the applicant must identify thermal design criteria and bases, and that these criteria and bases must recognize the site temperature range and the specific materials used in the ISFSI. Section 4.4.3.3 also states that another aspect of thermal design criteria and design bases is fire protection. As discussed above, the applicant has identified and characterized those criteria and bases and, therefore, the staff finds the criteria and bases acceptable because the information meets the regulatory requirements of 10 CFR 72.122(a), (b)(1), (b)(2), (b)(3), (c), (d), (f), (g), (h), and (i); and 10 CFR 72.128(a)(4) with respect to thermal considerations.

4.3.3.6 Radiation Protection

In SAR Section 3.3.5.2, "Shielding," the applicant stated that the WCS CISF is designed, constructed, and operated in accordance with 10 CFR 72.106(b). The applicant noted that the facility provides shielding and confinement for radioactive materials to limit the maximum individual dose at or beyond the WCS CISF site-controlled area boundary as the result of a design-basis accident to (1) 5 rem (0.05 sievert (Sv)) (to the whole body); and/or (2) the sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue (other than the lens of the eye) of 50 rem (0.5 Sv); and/or (3) the lens dose equivalent not to exceed 0.15 Sv (15 rem) and the shallow dose equivalent to skin or any extremity not to exceed 50 rem. The staff's evaluation of the applicant's shielding design, documented in Chapter 7 of this SER, confirms that the facility shielding design is sufficient to meet the dose limits in 10 CFR 72.106(b).

In SER Table 4-1, the staff summarizes the information reviewed related to the criteria used in the design of the cask radiological protection features and confinement detailed in the SAR appendices for the NUHOMS-MP187 Cask System, Standardized Advanced NUHOMS System, Standardized NUHOMS System, NAC-MPC System, NAC-UMS System, and NAC MAGNASTOR® System. The staff evaluates the design criteria for confinement in SER Section 4.3.3.3.

Table 4-1 Summary of WCS CISF Design Criteria for Shielding and Confinement

Design Parameters	Design Conditions	Reference
Storage Systems Design Dose Rate Limits	As specified in NUHOMS-MP187 Cask System FSAR	Rancho Seco FSAR, Volume I, Sections 10.3.11, 10.3.12, and 10.3.13
	As specified in Standardized Advanced NUHOMS System FSAR	Advanced Standardized NUHOMS System FSAR, Sections 2.3.2.5 and 2.3.5
	As specified in Standardized NUHOMS System FSAR	Standardized NUHOMS System FSAR, Sections K.2.3.5, K.3.3.5, T.2.3.5, and T.3.3.5
	As specified in NAC-MPC FSAR (NRC Docket No. 72-1025)	NAC-MPC FSAR, Sections 10.2.1 and 10.2.2
	As specified in NAC-UMS FSAR (NRC Docket No. 72-1015)	NAC-UMS FSAR, Sections 10.2.1 and 10.2.2
	As specified in NAC MAGNASTOR FSAR	NAC MAGNASTOR FSAR, Section 2.4.7
Individual Workers Dose Rate	Total effective dose equivalent 5 rem/year (0.05 Sv/year) Dose to eye lens 15 rem/year (0.15 Sv/year) Dose to skin and extremities 50 rem/year (0.5 Sv/year)	10 CFR 20.1201
Restricted Area Boundary Dose Rate	2 mrem/hour (0.02 millisievert (mSv)/hour), maximum	10 CFR 20.1301
Owner-Controlled Area Boundary Dose Rate	25 mrem/year (0.25 mSv/year) whole body 75 mrem/year (0.75 mSv/year) thyroid, maximum 25 mrem/year (0.25 mSv/year) to any other critical organ 5 rem (0.05 Sv) accident dose or 50 rem (0.5 Sv) total organ dose equivalent (one time)	10 CFR 72.104 10 CFR 72.106

The applicant described the basic concept for the WCS CISF shielding and confinement system as protection by multiple barriers and systems, as required by 10 CFR 72.126(a) through (c). Based on its review, the staff finds the applicant's use of the proposed cask systems at the WCS CISF, which are weld-sealed canister-based systems, satisfies the confinement requirements of 10 CFR 72.122(h)(1) that the spent fuel cladding must be protected during storage against degradation, and that the facility operating procedures, shielding design, and access controls provide the necessary radiological protection to ensure radiological exposures to facility personnel and the public are as low as reasonably achievable (ALARA) as required by 10 CFR 72.126(d).

Based on the above discussion, the staff finds the criteria and bases acceptable for shielding, confinement, radiation protection, and ALARA considerations because they meet the regulatory requirements as given in 10 CFR 72.24(c)(1), (c)(2), (c)(4), and (n); 10 CFR 72.104(a), (b),

and (c); 10 CFR 72.106(a) and (b); 10 CFR 72.122(a), (b), (c), (d), (e), (f), (g), (h), and (i); 10 CFR 72.126(a), (b), (c), and (d); and 10 CFR 72.128(a) and (b).

4.3.3.7 Criticality

The staff reviewed the discussion on the criticality design criteria of SSCs with respect to the applicable regulatory requirements.

In SER Table 4-2, the staff summarizes the criteria used in the criticality design of the cask systems detailed in the SAR appendices for the six storage systems proposed for storage at the WCS CISF. The staff details its criticality evaluation in SER Chapter 8. Based on its review, the staff finds that the applicant identified the criticality design criteria consistent with the information incorporated by reference for the cask systems proposed for storage at the facility. The criteria for control method and k_{eff} satisfy the requirements of 10 CFR 72.124(b) for methods of criticality control and 10 CFR 72.124(a) for design for criticality safety, respectively. These criteria are acceptable based on prior approvals of these cask systems.

Table 4-2 Summary of WCS CISF Design Criteria for Criticality

Design Parameters	Design Conditions	Applicable Criteria and Codes
Control Method	Geometry of fuel assemblies assuming no moderator	FSARs for NUHOMS-MP187 Cask System, Standardized Advanced NUHOMS System, Standardized NUHOMS System, NAC-MPC, NAC-UMS, and NAC MAGNASTOR
k_{eff}	≤ 0.95	NUREG-1567

4.3.3.8 Decommissioning Considerations

As part of its license application, the applicant submitted a preliminary decommissioning plan (DP). The staff reviewed the preliminary DP in Appendix B to the application to determine whether the applicant's provisions for decommissioning the facility give reasonable assurance that decontamination and decommissioning of the facility at the end of its useful life will provide adequate protection of public health and safety.

In Chapter 10, "Decommissioning Plan," of its application, the applicant stated that when the WCS CISF is no longer used to store SNF and reactor-related GTCC low-level radioactive waste from commercial nuclear power plants and the SNF is removed, it must submit a DP for review and approval pursuant to the Timeliness Rule (10 CFR 72.54, "Expiration and termination of licenses and decommissioning of sites and separate buildings or outdoor areas") before any decommissioning activities begin.

The staff recognizes that DPs submitted with the license application are prospective in nature and do not have the benefit of knowledge gained over the course of facility operation. Therefore, the staff conducted its review with a limited scope to determine whether the preliminary DP includes elements required by the regulations such as design and operational

features that will facilitate decontamination and decommissioning, a decommissioning funding plan, a cost estimate, and a financial assurance mechanism.

The staff summarizes its review of the preliminary DP in SER Chapter 14. The staff finds that the SAR and docketed materials relating to the design criteria for decommissioning of the facility comply with 10 CFR 72.130 because the facility is designed for decommissioning and provisions have been made to facilitate decommissioning in the future.

4.3.3.9 Retrieval Capability

In SAR Section 1.3.1, “WCS Consolidated Interim Storage Facility Systems,” the applicant stated that the storage systems incorporated by reference allow for the ready retrieval of canisters for shipment offsite. The applicant described the retrieval operations conducted as using the reverse of the operations employed to transfer the canisters received in transportation casks to their respective storage systems. The applicant further described retrieval operations for the NUHOMS systems in SAR Section 5.1.3.1.1, “NUHOMS Systems,” and retrieval operations for the vertical storage systems in SAR Section 5.1.3.1.2, “NAC Systems.” In SAR Appendices A through H, the applicant included procedures for the retrieval of canisters from the storage systems for shipment offsite.

The applicant stated in SAR Section 3.3.7.1, “Spent Fuel or High-Level Radioactive Waste Handling and Storage,” that the WCS CISF uses storage and handling systems that are designed to meet the functional requirements to receive, transfer, store, and retrieve canisterized SNF and GTCC waste for shipment offsite. The applicant stated that the cask/canister handling systems are designed in accordance with 10 CFR 72.128(a) to ensure adequate safety under normal and accident conditions. In addition, the applicant stated that additional criteria for cask systems are also satisfied, including the following:

- Cask systems are designed and certified to withstand a drop event from heights specified in the WCS CISF TS for each individual system. WCS CISF operation procedures and limitations ensure casks are within the heights specified in the WCS CISF TS.
- Cask systems that transfer canisters are designed to withstand the impact of the postulated tornado missiles or administrative provisions are implemented to protect against impacts from tornado missiles during transfer operations.
- Cask systems using vertical transfer must be qualified for a 6-inch (15-centimeter) drop of the storage overpack or transportation cask lid during transfer operations.

The applicant stated in SAR Section 5.1.4, “Flow Sheets,” that flow sheets illustrating operations for canister receipt, transfer, and placement into storage appear in SAR Figures A.5-1, B.5-1, C.5-1, D.5-1, E.5-1, F.5-1, and G.5-1 in the SAR appendices. The applicant stated that the sequence of operations to remove canisters from the WCS CISF is the reverse of the receipt, transfer, and placement operation. The applicant provided procedures for retrieval and offsite shipment for each system incorporated by reference in the SAR appendices. The applicant noted in SAR Table 5-1, “Operating Procedures for the Storage Systems at the WCS CISF,” that the operational procedures for retrieval of the GTCC canisters are the same as those for SNF canisters incorporated by reference.

The staff reviewed the SAR and the storage and transportation system SARs incorporated by reference. The staff noted that the storage systems incorporated by reference were originally licensed using the retrievability guidance in Spent Fuel Storage and Transportation Interim Staff Guidance 2 (SFST-ISG-2), "Fuel Retrievability," Revision 0, issued October 1998. This guidance document stated, "as long as the design of the storage system has a method to repackage into a transportation cask for shipments offsite for further processing or disposal, a facility meets the requirements of 10 CFR 72.122(l)." The staff also noted that the NRC has since revised SFST-ISG-2, and the current guidance reflected in SFST-ISG-2, Revision 2, dated April 26, 2016, states the following:

In order to demonstrate the ability for ready retrieval, a licensee should demonstrate it has the ability to perform any of the three options below. These options may be utilized individually or in any combination or sequence, as appropriate.

- A. remove individual or canned spent fuel assemblies from wet or dry storage,
- B. remove a canister loaded with spent fuel assemblies from a storage cask/overpack,
- C. remove a cask loaded with spent fuel assemblies from the storage location.

The staff noted that the procedures for retrieval and offsite shipment for each system incorporated by reference in the SAR are consistent with Option C in SFST-ISG-2, Revision 2.

NUREG-1567, Section 4.4.3.7, "Retrieval," states that the general regulatory requirements for retrieval capability are given in 10 CFR 72.122(a), (b)(1), (b)(2), (b)(3), (c), (f), and (h). Retrievability is specifically outlined in 10 CFR 72.122(l). However, SFPO-ISG-3, "Post Accident Recovery and Compliance with 10 CFR 72.122(l)," dated 1998, reevaluated the applicability of 10 CFR 72.122(l) and determined that the retrievability requirement applies to normal and off-normal design conditions and not to accidents. SFPO-ISG-3 also states that upon identification, an accident event shall be evaluated against the requirements of 10 CFR 72.106 and 72.122(b). Further, SFPO-ISG-3 states that recovery methods or the need for over-packs or dry transfer systems to maintain safe storage conditions would then not be considered and evaluated as part of the licensing process. As such, the staff did not consider the regulatory requirements of 10 CFR 72.122(b)(1) and (b)(2) when evaluating retrieval capability because these regulatory requirements focus on accident conditions.

The WCS CISF application does not include underwater storage of spent fuel or GTCC waste, nor does the application include handling of base fuel assemblies or components that would require ventilation and off-gas systems to ensure the confinement of airborne radioactive particulates. As such, the staff determined that the regulatory requirements in 10 CFR 72.122(h)(2) and (h)(3) do not apply to the assessment of retrievability for the WCS CISF. In addition, the regulatory requirements of 10 CFR 72.122(h)(5) apply to high-level radioactive waste and reactor-related GTCC waste. Because the WCS CISF application is for the storage of spent fuel and reactor-related GTCC waste, the regulatory requirements of 10 CFR 72.122(h)(5) is only applicable to reactor-related GTCC waste storage systems.

The staff reviewed the SAR and docketed materials relating to the design bases and criteria for retrieval capability. Only the canisters currently stored at the Rancho Seco ISFSI licensed

under special nuclear materials license SNM-2510 were designed and reviewed to the regulatory requirements given in 10 CFR 72 Subpart F, "General Design Criteria." The staff review of the storage system design basis and criteria are documented in the SER for the Rancho Seco ISFSI. The evaluation of retrievability for the storage system canisters at the Rancho Seco are documented in Section 4.3.7 of the Rancho Seco ISFSI FSAR. As stated in that SER, SFST-ISG-3 provides the staff position on post-accident recovery involving spent fuel storage activities and states that 10 CFR 72.122(l) applies to normal and off-normal design conditions and not to accidents.

For the spent fuel and GTCC storage systems licensed under SMN-2510, the previous NRC evaluation documented in the Rancho Seco SER determined that the regulatory requirements for retrievability were met. The regulatory requirements in 10 CFR 72.122(a), (f), (h)(1), (h)(4), (h)(5), and (l) describe storage system design and operational controls and are independent of site-specific conditions. Because staff determined that the regulatory requirements in 10 CFR 72.122(a), (f), (h)(1), (h)(4), (h)(5) and (l) were satisfied in the Rancho Seco SER, the spent fuel and GTCC storage systems licensed under SMN-2510 meet these regulatory requirements for the WCS CISF.

For the storage systems incorporated by reference in the WCS CISF application that have been approved for use by a general licensee, the staff review of the storage systems documented in the SERs associated with the respective CoCs and amendments are conducted using the regulatory requirements of 10 CFR 72 Subpart L, "Approval of Spent Fuel Storage Casks." Within 10 CFR 72 Subpart L, 10 CFR 72.236, "Specific requirements for spent fuel storage cask approval," provides the requirements for dry storage systems that may be used by general licensees. The retrievability requirement included in 10 CFR 72.236(m) states, "To the extent practicable in the design of spent fuel storage casks, consideration should be given to compatibility with removal of the stored spent fuel from a reactor site, transportation, and ultimate disposition by the Department of Energy." In addition, 10 CFR 72.236 includes specific requirements for fuel specifications, design basis and design criteria, maintaining fuel in a subcritical condition, radiation shielding and confinement, heat removal capability, safe storage of spent fuel and system maintenance as required, compatibility with wet or dry loading and unloading capabilities, decontamination, inspection, marking, maintaining confinement under all normal, off-normal, and accident conditions, and protection of safeguards information. SAR Section 5.1.1, "Operations at Originating Site," states that the applicant will verify that the canisters shipped to the WCS CISF comply with the approved TS of the storage systems for the FSARs which the applicant incorporated by reference, which are identified in SER Table 1-1. This includes verifying that the approved TS for those systems were followed in loading operations. The TS for those systems proposed for storage at the WCS CISF include verification of maximum heat loads, fuel drying requirements, helium backfill requirements, helium leak testing, and non-destructive examination of the closure welds.

For the CoCs incorporated by reference identified in SER Table 1-1, the staff compared the regulatory requirements in 10 CFR 72.122(a), (f), (h)(1), (h)(4), (h)(5) and (l) to the requirements in 10 CFR 72.236 and the technical approaches used to meet these regulatory requirements. The staff determined the following:

- The regulatory requirements in 10 CFR 72.122(a), (f), (h)(1), (h)(4), (h)(5), and (l) describe storage system design and operational controls and are independent of site-specific conditions.

- The requirements in 10 CFR 72.236 associated with a CoC are comparable to the regulatory requirements of 10 CFR 72.122(a), (f), (h)(1), (h)(4), (h)(5), and (l) for a specifically licensed ISFSI.
- The relevant ISGs (SFST-ISG-2; SFST-ISG-11, “Cladding Considerations for the Transportation and Storage of Spent Fuel, Revision 3, dated SFST-ISG-15, and SFST-ISG-22) that address the technical issues related to the regulatory requirement for retrievability identify both the applicable regulatory requirements in 10 CFR Part 72, Subpart F, which are applicable to specifically licensed ISFSIs, and those in Subpart L, which are applicable to CoCs.
- The technical guidance included in these ISGs was universally used by both specifically licensed ISFSI applicants and CoC applicants including the systems incorporated by reference in SER Table 1-1.

Based on the staff assessment described above, the staff determined that the storage system CoCs incorporated by reference in SER Table 1-1 that meet the regulatory requirements for 10 CFR 72.236 also comply with the regulatory requirements in 10 CFR 72.122(a), (f), (h)(1), (h)(4), (h)(5), and (l).

The staff’s review regarding compliance with 10 CFR 72.122(b)(3) appears in SER Chapter 2, and the staff’s review regarding compliance with 10 CFR 72.122(c) appears in SER Sections 2.3.2 and 6.3.5.

Based on its review, the staff finds that the design of the storage systems incorporated by reference and the procedures used by the applicant are consistent with the guidance, including but not limited to, SFST-ISG-2, Revision 2, and meet the requirements in 10 CFR 72.122(a), (b)(3), (c), (f), (h), and (l).

4.3.4 Design Criteria for Other Structures, Systems, and Components Not Important to Safety

The applicant stated that the design criteria are applied in a graded manner for SSCs, consistent with their function, including those that are NITS. In addition, the applicant stated that the design criteria for NITS SSCs that have importance to operations or security, such as backup power systems, transport vehicles, fire detection and suppression systems, security systems, radiation monitoring systems, and temperature monitoring systems, are designed in accordance with the applicable codes and standards. In SAR Section 3.4.2.2.4, “Design and Construction Standards,” the applicant listed the applicable codes and standards for the following SSCs:

- SSCs important to fire protection
- piping systems for water, compressed air, oil, and sewer
- heating, ventilation, and air conditioning systems
- electrical systems

The applicant stated that WCS CISF SSCs not designated as ITS are considered to be of conventional quality. The applicant stated that SSCs of conventional quality are designed and constructed in accordance with commercial standards. In addition, the applicant stated that the following SSCs are designed, constructed, maintained, and tested as commercial grade:

- security and administration building
- receiving area
- storage pad for NUHOMS storage modules

In SAR Section 4.3, “Auxiliary Systems,” the applicant provided additional detail on the auxiliary systems and stated that the security and administration building will be designed for protection against natural phenomena as required by standard local building codes.

The applicant stated that no special maintenance techniques are necessary that would require a safety analysis. The applicant stated that the NITS SSCs at the WCS CISF that require routine periodic maintenance include the fire suppression system located in the CHB, the rail cars, the cask transporters, and the temperature monitoring equipment. The applicant indicated that preventive and routine maintenance activities are scheduled and established to ensure that SSCs are being maintained according to the equipment manufacturer's recommended standards.

The applicant stated in SAR Section 3.4.2, “Design Criteria for Other SSCs Not Important-to-Safety,” that the WCS CISF radiation monitors are classified as NITS and are not used to prevent or mitigate any credible accidents. The applicant stated that the facility will use several types of radiation monitors, including area monitors, thermoluminescent dosimeters, portable hand-held monitors, personnel dosimetry, and portable airborne monitors. The staff finds the use of several different types of monitors acceptable because it ensures that redundant methods are in place to detect high radiation conditions and provide warning for onsite personnel.

The staff noted that the following systems are not applicable to the WCS CISF:

- SNF pool, ventilation, and off-gas systems
- steam supply and distribution system
- cold chemical systems
- gas utilities

Based on its review of the design criteria for NITS SSCs discussed above, the staff finds that the applicant applied the criteria in a graded manner consistent with the function of the SSCs, and that the design criteria for the NITS SSCs are acceptable. Additionally, the applicant identified the design criteria for the NITS SSCs consistent with the information incorporated by reference for each of the cask systems proposed for storage at the facility. In addition, the staff finds that the that the applicant identified and analyzed the site-specific design criteria applicable to the NITS SSCs. The staff reviews and evaluates the structural analysis in SER Chapter 5. For the above mentioned reasons, the staff finds that the design criteria for NITS SSCs structures are acceptable because they meet the requirements in 10 CFR 72.24(a), (b), (c), (d), (e), (f), and (g), and the appropriate requirements as given in Subpart E, “Siting Evaluation Factors,” and Subpart F of 10 CFR Part 72.

4.4 Evaluation Findings

Based on the information in the application, the staff concludes the following:

- The SAR and docketed materials adequately identify and characterize the spent fuel and GTCC waste to be stored at the site in conformance with the requirements given in 10 CFR 72.2(a)(1). The description of the SNF and reactor-related GTCC waste is

acceptable for demonstrating that the ISFSI design meets the requirements given in 10 CFR 72.120(b).

- The SSCs have been classified according to their function as ITS or NITS and meet the requirements given in 10 CFR 72.3, 10 CFR 72.24(n), and 10 CFR 72.144(a) and (c).
- The SAR and the docketed materials relating to the design bases and criteria meet the general requirements as given in 10 CFR 72.24(c)(1), (c)(2), (c)(4), and (n); 10 CFR 72.106(a); 10 CFR 72.120(a) and (b); 10 CFR 72.122(a), (b), (c), (d), (e), (f), (g), (h), (i), (j), (k), and (l); and 10 CFR 72.144.
- The SAR and docketed materials relating to the design bases and criteria for structures categorized as ITS meet the requirements given in 10 CFR 72.24(c)(1), (c)(2), (c)(3), and (n); 10 CFR 72.103; 10 CFR 72.120(a) and (b); and 10 CFR 72.122(a), (b)(1), (b)(2), (b)(3), (c), (d), (f), (g), (h), (i), (j), and (k).
- The SAR and docketed materials meet the regulatory requirements for design bases and the criteria for thermal consideration as given in 10 CFR 72.122(a), (b)(1), (b)(2), (b)(3), (c), (d), (f), (g), (h), and (i) and 10 CFR 72.128(a)(4).
- The SAR and docketed materials relating to the design bases and criteria for shielding, confinement, radiation protection, and ALARA considerations meet the regulatory requirements as given in 10 CFR 72.24(c)(1), (c)(2), (c)(4), and (n); 10 CFR 72.104(a), (b), and (c); 10 CFR 72.106(a) and (b); 10 CFR 72.122(a), (b), (c), (d), (e), (f), (g), (h), and (i), 10 CFR 72.126(a), (b), (c), and (d); and 10 CFR 72.128(a) and (b).
- The SAR and docketed materials relating to the design bases and criteria for criticality safety meet the regulatory requirements as given in 10 CFR 72.124(a) and (b).
- The SAR and docketed materials relating to the design criteria for decommissioning of the facility comply with the regulatory requirements given in 10 CFR 72.130.
- The SAR and docketed materials relating to the design bases and criteria for retrieval capability meet the regulatory requirements given in 10 CFR 72.122(a), (b)(3), (c), (f), (h), and (l).
- The SAR and docketed materials relating to the design bases and criteria for other SSCs not ITS but subject to NRC approval meet the general regulatory requirements as given in 10 CFR 72.24(a), (b), (c), (d), (e), (f), and (g), and the appropriate requirements as given in Subpart E and Subpart F of 10 CFR Part 72.

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NRC, SFPO-ISG-3, "Post Accident Recovery and Compliance with 10 CFR 72.122(I)," October 1998. ADAMS Accession No. ML092800380.

NRC, SNM-2510, "License for Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste, Sacramento Municipal Utility District, Rancho Seco Nuclear Generating Station," June 2000. ADAMS Accession No. ML003729742.

NRC, "Safety Evaluation Report for the Rancho Seco Independent Spent Fuel Storage Installation," June 2000. ADAMS Accession No. ML003729758.

NRC, SFST-ISG-11, Revision 3, "Cladding Considerations for the Transportation and Storage of Spent Fuel," November 2003. ADAMS Accession No. ML033230335.

NRC, SFST-ISG-22 "Potential Rod Splitting due to Exposure to an Oxidizing Atmosphere During Short-Term Cask Loading Operations in LWR or Other Uranium Oxide Based Fuel," May 2006. ADAMS Accession No. ML061170217.

NRC, SFST-ISG-15 "Materials Evaluation," January 2001. ADAMS Accession No. ML010100170.

Sacramento Municipal Utility District, "Rancho Seco Independent Spent Fuel Storage Installation, Final Safety Analysis Report, Volume 1, ISFSI System," Revision 4, June 2010 (nonpublic). NRC Docket No. 72-11. Transmittal dated August 11, 2016. ADAMS Accession No. ML16236A115.

Transnuclear, Inc., "Safety Analysis Report for the NUHOMS®-MP187 Multi-Purpose Cask," Revision 17, July 2003 (nonpublic). NRC Docket No. 71-9255. Transmittal dated July 15, 2016. ADAMS Accession No. ML16203A183.

5 INSTALLATION AND STRUCTURAL EVALUATION

In Chapter 3, “Principal Design Criteria,” of the Safety Analysis Report (SAR), Revision 5, dated April 12, 2021, Interim Storage Partners LLC (the applicant) described the systems, structures and components (SSCs) classified as important to safety (ITS) and not important to safety (NITS) but relied on for site operations at the proposed WCS Consolidated Interim Storage Facility (CISF). In SAR Chapter 7, “Installation Design and Structural Evaluation,” the applicant provided the structural description, design criteria, material properties, and design analysis for the ITS structures at the proposed WCS CISF. In SAR Appendices A through H, the applicant described the proposed cask systems to be stored at the site, including ITS SSCs.

5.1 Scope of the Review

This review covers the installation and structural information provided in SAR Chapter 7 and SAR Appendices A through H. The review also considers selected sections and documents referenced in SAR Chapter 1, “General Information,” and Chapter 3, which discuss general information and the principal design criteria of the installation, respectively.

The proposed WCS CISF uses dry-cask storage systems only. The applicant stated that there will be no liquid greater-than-Class-C (GTCC) waste stored at the facility. It does not use a pool and pool confinement facilities to conduct loading and unloading activities.

5.2 Regulatory Requirements

The regulatory requirements relevant to the installation and structural evaluation of the proposed WCS CISF appear in the following sections of Title 10 of the *Code of Federal Regulations* (10 CFR):

- 10 CFR 72.24, “Contents of application: technical information”
- 10 CFR 72.40, “Issuance of license”
- 10 CFR 72.120, “General considerations”
- 10 CFR 72.122, “Overall requirements”
- 10 CFR 72.128, “Criteria for spent fuel, high-level radioactive waste, reactor-related Greater than Class C waste, and other radioactive waste storage and handling”

5.3 Staff Review and Analysis

The objective of the staff’s review is to ensure compliance of the facility SSCs with the NRC’s regulatory requirements. The review assesses the acceptability of the SSCs on the site, with emphasis on the structural integrity of ITS SSCs as well as NITS SSCs needed to ensure compliance with the WCS CISF site features and to support other areas of evaluation. The SSCs may provide functions including confinement, subcriticality, radiation shielding, and retrievability of the stored materials and must be appropriately maintained under all credible loads for normal, off-normal, and design-basis accident conditions, including natural phenomena events. Spent fuel dry storage facilities are designed for safe confinement and storage of spent nuclear fuel (SNF) and GTCC waste.

The sections of the safety evaluation report (SER) below discuss major categories of safety protection systems, which include confinement SSCs, reinforced concrete structures, ITS SSCs, and NITS SSCs relied upon to support facility operation.

The applicant proposed six NRC-approved storage cask systems for use at the WCS CISF and incorporated by reference the final safety analysis reports (FSARs) for those NRC-approved systems into the WCS CISF application. SAR Table 1-1, "Storage Systems at the WCS CISF," lists the following systems:

- NUHOMS®-MP187 Cask System described and analyzed in "Rancho Seco Independent Spent Fuel Storage Installation Safety Analysis Report," Revision 4, issued June 2016, under NRC Docket No. 72-11 (Rancho Seco ISFSI FSAR)
- Standardized NUHOMS Storage System described in "Updated Final Safety Analysis Report for the Standardized NUHOMS Horizontal Modular Storage System for Irradiated Nuclear Fuel," Transnuclear (TN) Americas Document No. NUH-003, Revision 14, issued September 2014, under NRC Docket No. 72-1004 (Standardized NUHOMS Storage System FSAR)
- Standardized Advanced NUHOMS Storage System described in "Updated Final Safety Analysis Report for the Standardized Advanced NUHOMS Horizontal Modular Storage System for Irradiated Nuclear Fuel," TN Americas Document No. ANUH-01.0150, Revision 6, issued August 2014, under NRC Docket No. 72-1029 (Standardized Advanced NUHOMS Storage System FSAR)
- NAC-MPC storage system described in "NAC Multipurpose Cask Final Safety Analysis Report," Revision 10, issued January 2014, under NRC Docket No. 72-1025 (NAC-MPC FSAR)
- NAC-UMS® Storage System described in "Final Safety Analysis Report for the UMS Universal Storage System," Revision 10, issued October 2010, under NRC Docket No. 72-1015 (NAC-UMS Storage System FSAR)
- NAC MAGNASTOR® storage system described in "MAGNASTOR Final Safety Analysis Report," Revision 7, issued July 2015, under NRC Docket No. 72-1031 (NAC MAGNASTOR FSAR)

The applicant also incorporated by reference the following five SARs describing cask transportation systems:

- TN Americas, "NUHOMS-MP197 Transport Packaging Safety Analysis Report," Revision 17, issued April 2001, under NRC Docket No. 71-9302 (MP197 Transport Packaging SAR)
- TN Americas, "Safety Analysis Report for the NUHOMS-MP187 Multi-Purpose Cask," Revision 17, issued July 2003, under NRC Docket No. 71-9255 (MP187 Multi-Purpose Cask SAR)
- NAC International, "NAC-STC, NAC Storage Transport Cask Safety Analysis Report," Revision 17, issued April 2011, under NRC Docket No. 71-9235 (NAC-STC SAR)
- NAC International, "Safety Analysis Report for the UMS® Universal Transport Cask," Revision 2, issued November 2005, under NRC Docket No. 71-9270 (NAC-UMS Transport Cask SAR)

- NAC International, "Safety Analysis Report for the MAGNATRAN® Transport Cask," Revisions 12A, 14A, and 15A, issued October 2012, under NRC Docket No. 71-9356 (NAC-MAGNATRAN Transport Cask SAR)

Where applicable, the staff relied on its previous evaluations of the FSARs and SARs approving the cask systems in its review of the SAR. For those areas where the WCS CISF site parameters deviated from or exceeded the design-basis features for the storage casks, the staff reviewed and evaluated the applicant's analysis to address the differences.

5.3.1 Confinement Structures, Systems, and Components

This section describes the staff's review and evaluation to determine whether the confinement SSCs, which are ITS, have sufficient structural capability to withstand all credible loads under normal, off-normal, and accident conditions, including natural phenomena events. The staff's review verified that the SAR has the following:

- adequate description of the confinement structures ITS
- acceptable design criteria
- appropriate sources of data for material properties
- acceptable structural analyses

The staff's evaluation determines whether the structural performance of the WCS CISF SSCs meets the requirements of 10 CFR Part 72, "Licensing requirements for the independent storage of spent nuclear fuel, high-level radioactive waste, and reactor-related greater than Class C waste," to preclude (1) unacceptable risk of criticality, (2) unacceptable release of radioactive materials, (3) unacceptable radiation levels, and (4) impairment of ready retrievability of stored materials.

5.3.1.1 Description of Confinement Systems

The staff reviewed the descriptions of the confinement structures in SAR Section 7.2, "Confinement SSCs," and in SAR Appendices A through H for each storage system canister, including the GTCC waste canister. The staff confirmed that the descriptions are consistent with the staff's previous evaluations, approving the use of each storage system. The staff also confirmed that the canisters are classified as ITS.

Based on its review, the staff concludes that the WCS CISF has adequately described the canister-based confinement structures to meet the system description requirements for SNF and GTCC waste in 10 CFR 72.24.

5.3.1.2 Design Criteria for Confinement Structures

Table 1-2, "Summary of WCS CISF Principal Design Criteria," of the SAR summarizes the principal design criteria for the WCS CISF, which are based on the loads on the SSCs under normal, off-normal, and accident conditions, including natural phenomena events.

SAR Section 3.2, "Structural and Mechanical Safety Criteria," states that the loads considered in the design criteria for the WCS CISF site are categorized as follows:

- normal and off-normal conditions
 - dead loads
 - live loads
 - handling loads
 - snow and ice loads
 - wind loads
 - internal/external pressure
 - lateral soil pressure
 - thermal loads
- accident conditions
 - accident thermal loads
 - explosion overpressure
 - drop/tip-over
 - accident pressurization
 - fire
 - tornado wind/missiles
 - floods
 - earthquake

The staff reviewed these loads in SER Section 4.3.3 and finds them acceptable for the WCS CISF. The NRC has used the above loads in previous reviews of the individual cask systems, which are described in the respective FSARs, as appropriate.

SAR Table 3-1, “Physical Design Characteristics of Storage Systems at the WCS CISF,” specifies where in the SAR the design criteria for individual cask systems that the NRC has licensed or certified are provided. SAR Section 3.2 discusses the design criteria, and SAR Chapter 7 and Appendices A through H further describe them. SAR Sections A.3.3, B.3.3, C.3.3/D.3.3, E.3.1.1/E.3.2.1, F.3.1.1, and G.3.1.1 in Appendices A through G provide selected design criteria for the NUHOMS-MP187, Standardized Advanced NUHOMS, Standardized NUHOMS 61BT/NUHOMS 61BTH Type 1, NAC-MPC, NAC-UMS, and NAC MAGNASTOR systems, respectively. SAR Chapter 12, “Accident Analysis,” discusses the NUHOMS design criteria for accident conditions; SAR Table 12-1, “Off-Normal and Accident Evaluations for the Storage Systems at the WCS CISF,” provides a crosswalk to the appropriate appendix sections for each canister/cask system that the NRC has previously approved. SAR Chapter 7 discusses the NAC design criteria for accident conditions.

The staff reviewed the information in SAR Chapter 3, Chapter 7, and Appendices A through H for each storage system canister, including the GTCC waste canisters. The sections below discuss the applicant’s description of the selection of loads to develop the design criteria for the individual cask systems and the staff’s review of the design criteria as they pertain to the structural analysis. SER Section 5.3.1.4 provides the staff’s evaluation of the structural analysis using the design criteria.

5.3.1.2.1 NUHOMS-MP187 Cask System—Fuel Only-Dry Shielded Canister, Fuel/Control Component-Dry Shielded Canister, Failed Fuel-Dry Shielded Canister, and Greater-Than-Class-C Canisters

SAR Table 1-1 lists the dry shielded canisters (DSCs) related to the NUHOMS-MP187 cask system as the fuel only (FO)-DSC, fuel/control component (FC)-DSC, failed fuel (FF)-DSC, and GTCC waste canisters. In SAR Table A.3-1, “Summary of WCS CISF Principal Design Criteria,”

the applicant compared the design criteria for the WCS CISF and the NUHOMS-MP187 cask system. The table shows how the design parameters for normal, off-normal, and accident conditions among the NUHOMS-MP187 cask system DSCs were determined to be the most limiting or needed further evaluation. The applicant referred to Section 3.2.5.2 of Volume I of the Rancho Seco ISFSI FSAR for additional details on the principal design criteria of the DSCs.

In SAR Appendix A, “NUHOMS-MP187 Cask System,” Section A.3.3, “Design Criteria for Environmental Conditions and Natural Phenomena,” the applicant further described the site-specific environmental conditions and natural phenomena considered for the DSCs in both transfer and storage configurations and referred to Section 3.2 of Volume 1 of the Rancho Seco ISFSI FSAR. The applicant indicated that applicable portions of criteria sections have been reviewed against the environmental conditions at the WCS CISF and have been shown to be either bounded by the analysis performed for the NUHOMS-MP187 cask system components or evaluated using the WCS CISF site-specific conditions. The review included the following site-specific aspects:

- The applicant stated that the design-basis tornado wind and missiles incorporated by reference and previously analyzed for the NUHOMS-MP187 cask system bound the site-specific parameters at the WCS CISF site.
- The applicant credited the fact that the WCS CISF site is above the probable maximum flood elevation level, which precludes a site-specific flood analysis.
- The applicant stated that the seismic design criteria are provided by the enveloping acceleration response spectra at the concrete pad base and horizontal storage module (HSM) center of gravity obtained by the WCS CISF soil-structure interaction (SSI) analysis. The seismic design criterion for the NUHOMS-MP187 cask system did not bound the design criterion for the WCS site. The applicant performed a seismic reconciliation, which the staff reviews in SER Section 5.3.1.4.
- The applicant stated that the snow and ice loading incorporated by reference and previously analyzed for the NUHOMS-MP187 cask system bounds the site-specific parameters at the WCS CISF site.
- The applicant also considered the likelihood of lightning striking the HSM, which protects the DSC during storage, and determined that simple lightning protection equipment and grounding for the HSM structures is acceptable in accordance with the HSM design.

The staff reviewed applicable portions of the documents incorporated by reference to ensure that the design criteria listed for the NUHOMS-MP187 cask system were adequate. The staff finds that the structural design criteria for the NUHOMS-MP187 cask system DSCs were appropriately selected between the cask system and the site because the applicant selected the most limiting criteria or analyzed them as necessary.

5.3.1.2.2 Standardized Advanced NUHOMS Storage System—24PT1 DSC

SAR Table 1-1 lists the DSC related to the Standardized Advanced NUHOMS Storage System as the NUHOMS 24PT1 canister. In SAR Table B.3-1, “Summary of WCS CISF Principal Design Criteria,” the applicant compared the design criteria for the WCS CISF and the Standardized Advanced NUHOMS DSC. The table shows how the design parameters for

normal, off-normal, and accident conditions between the Standardized Advanced NUHOMS Storage System DSCs were determined to be the most limiting or needed further evaluation.

In SAR Appendix B, "Standardized Advanced NUHOMS® System," Section B.7, "Structural Evaluation," the applicant noted that Section 2.2, Section 3.1.2, and Tables 3.1-2 through 3.1-7, respectively, of the Standardized Advanced NUHOMS Storage System FSAR summarize the NUHOMS 24PT1 DSC design approach, design criteria, and load combinations for the transfer and storage conditions. Table 3.1-1 of the same FSAR identifies the codes and standards used for design and fabrication of the canister.

In SAR Appendix B, Section B.3.3, "Design Criteria for Environmental Conditions and Natural Phenomena," the applicant further described the site-specific environmental conditions and natural phenomena considered for the DSC in both transfer and storage configurations and referred to Section 2.2 of the Standardized Advanced NUHOMS Storage System FSAR. The applicant indicated that applicable portions of criteria sections have been reviewed against the environmental conditions at the WCS CISF and have been shown to be either bounded by the analysis presented in the Standardized Advanced NUHOMS Storage System FSAR or evaluated using the WCS CISF site-specific conditions. The review included the following site-specific aspects:

- The applicant described design-basis tornadoes and missiles, flooding, snow and ice loading, and lightning strikes.
- The applicant credited the performance of the Advanced Horizontal Storage Module (AHSM), which protects the NUHOMS 24PT1 DSC against the design-basis tornado wind and missiles. The AHSM was previously analyzed in the Standardized Advanced NUHOMS Storage System FSAR, which is incorporated by reference and bounds the site-specific parameters at the WCS CISF site. Further, the applicant also credited the protection given by the NUHOMS-MP187 cask to the DSC during transit to the storage pad from adverse environmental effects such as tornado winds and missiles.
- The applicant stated that the NUHOMS 24PT1 DSC and the AHSM were evaluated for flooding conditions. In addition, the applicant credited the fact that the WCS CISF site is not in a floodplain and is above the probable maximum flood elevation and, therefore, will remain dry in the event of a flood.
- The applicant noted that the design-basis earthquake as analyzed in the Standardized Advanced NUHOMS Storage System FSAR bounds the enveloping acceleration response spectra at the concrete pad base and HSM center of gravity obtained by the WCS CISF SSI analysis.
- The applicant stated that the snow and ice loading incorporated by reference and previously analyzed in the Standardized Advanced NUHOMS Storage System FSAR bounds the site-specific parameters at the WCS CISF site.
- The applicant also considered the likelihood of lightning striking the AHSM, which protects the DSC during storage, and determined that simple lightning protection equipment and grounding for the AHSM structures is acceptable in accordance with the AHSM design.

The staff reviewed applicable portions of the documents incorporated by reference to ensure that the design criteria listed for the Standardized Advanced NUHOMS Storage System were adequate. The staff finds that the structural design criteria for the Standardized Advanced NUHOMS Storage System DSCs were appropriately selected between the cask system and the site because the applicant selected the most limiting criteria.

5.3.1.2.3 Standardized NUHOMS System—61BT and 61BTH Type 1 Dry Shielded Canisters

SAR Table 1-1 lists the DSC related to the Standardized NUHOMS Storage System as the NUHOMS 61BT DSC and 61BTH Type 1 DSC. In SAR Tables C.3-1 and D.3-1, both entitled, “Summary of WCS CISF Principal Design Criteria,” the applicant compared the design criteria for the WCS CISF and the Standardized NUHOMS DSCs. The tables show how the design parameters for normal, off-normal, and accident conditions between the Standardized NUHOMS Storage System DSCs were determined to be the most limiting or needed further evaluation.

In SAR Appendix C, “Standardized NUHOMS-61BT System,” Section C.7, “Structural Evaluation,” the applicant stated that Appendix K, Sections K.2.5 and K.3, of the Standardized NUHOMS Storage System FSAR summarize the 61BT DSC design approach, design criteria, and load combinations for transfer and storage.

In SAR Appendix D, “Standardized NUHOMS-61BTH Type 1 System,” Section D.7, “Structural Evaluation,” the applicant stated that Appendix T, Sections T.2 and T.3, of the Standardized NUHOMS Storage System FSAR summarize the 61BTH Type 1 DSC design approach, design criteria, and load combinations for transfer and storage.

In SAR Appendices C and D, Sections C.3.3 and D.3.3, both entitled “Design Criteria for Environmental Conditions and Natural Phenomena,” the applicant further described the site-specific environmental conditions and natural phenomena considered for both DSCs in both transfer and storage configurations. The applicant indicated that applicable portions of criteria sections have been reviewed against the environmental conditions at the WCS CISF and have been shown to be either bounded by the analysis presented in the Standardized NUHOMS Storage System FSAR or evaluated using the WCS CISF site-specific conditions. The review included the following site-specific aspects:

- The applicant described design-basis tornadoes and missiles, flooding, snow and ice loading, and lightning strikes.
- The applicant credited the performance of the Standardized NUHOMS Horizontal Modular Storage System HSM Model 102, which protects the 61BT DSC and 61BTH Type 1 DSC against the design-basis tornado wind and missiles. The HSM Model 102 was previously analyzed in the Standardized NUHOMS Storage System FSAR and is incorporated by reference and bounds the site-specific parameters at the WCS CISF site. Further, the applicant also credited the protection given by the MP197HB cask to the DSC during transit to the storage pad from adverse environmental effects such as tornado winds and missiles.
- The applicant stated that the 61BT DSC and 61BTH Type 1 DSC and the HSM Model 102 were evaluated for flooding conditions. In addition, the applicant credited the fact that the WCS CISF site is not in a floodplain and is above the probable maximum flood elevation and, therefore, will remain dry in the event of a flood.

- The applicant selected the WCS CISF site-specific enveloping spectra as the seismic design basis for the 61BT and 61BTH Type 1 DSC system components. The seismic design criterion for the storage cask system did not bound the design criterion for the WCS site. The applicant performed a seismic reconciliation, which the staff reviews in SER Section 5.3.1.4.
- The applicant stated that the snow and ice loading incorporated by reference and previously analyzed in the Standardized NUHOMS Storage System FSAR bounds the site-specific parameters at the WCS CISF site.
- The applicant also considered the likelihood of lightning striking the HSM Model 102, which protects the DSC during storage, and determined that simple lightning protection equipment and grounding for the HSM structures are considered acceptable in accordance with the HSM design.

The staff reviewed applicable portions of the documents incorporated by reference to ensure that the design criteria listed for the Standardized NUHOMS Storage System were adequate. The staff finds that the structural design criteria for the Standardized NUHOMS Storage System DSCs were appropriately selected between the cask system and the site because the applicant selected the most limiting criteria or analyzed them as necessary.

5.3.1.2.4 NAC-MPC Storage System

In SAR Appendix E, “NAC-MPC,” Section E.3, “Principal Design Criteria,” the applicant provided the principal design criteria for the NAC-MPC storage system. The NAC-MPC storage system for use at the WCS CISF site consists of the Connecticut Yankee MPC (CY-MPC), Yankee Rowe MPC (Yankee-MPC), and the NAC MPC-LACBWR. The Yankee-MPC and CY-MPC are generically referred to as the NAC-MPC. Chapter 2 of the NAC-MPC FSAR describes the design criteria for the CY-MPC and the Yankee-MPC. Similarly, Chapter 2, Appendix 2.A of the NAC-MPC FSAR describes the NAC MPC-LACBWR.

The applicant referred to SAR Appendix E, Table E.3-1, “Summary of WCS CISF Principal Design Criteria,” for a comparison between the design criteria for the WCS CISF and the NAC-MPC storage system. In SAR Appendix E, Sections E.3.1.1 and E.3.2.1, both titled, “Design Criteria for Environmental Conditions and Natural Phenomena,” the applicant further described the site-specific environmental conditions and natural phenomena considered for both the NAC-MPC and NAC MPC-LACBWR cask systems, respectively. The table shows how the design parameters for normal, off-normal, and accident conditions between the NAC-MPC storage system DSCs were determined to be the most limiting or needed further evaluation. The applicant indicated that applicable portions of criteria sections have been reviewed against the environmental conditions at the WCS CISF and have been shown to be either bounded by the analysis presented in the NAC-MPC FSAR or evaluated using the WCS CISF site-specific conditions. The review included the following site-specific aspects:

- The applicant described design-basis tornadoes and missiles, flooding, and snow and ice loading.
- The applicant referred to Section 11.2.13 of the NAC-MPC FSAR, Revision 10, incorporated by reference, for demonstration of compliance against the design-basis tornado wind and missiles. The applicant demonstrated that the NAC-MPC design meets the design criteria established in Regulatory Guide (RG) 1.76, “Design-Basis

Tornado and Tornado Missiles for Nuclear Power Plants,” and NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition,” and concluded that no further WCS CISF site-specific evaluations are required.

- The applicant stated that the NAC-MPC was evaluated for flooding conditions. In addition, the applicant credited the fact that the WCS CISF site is not in a floodplain and is above the probable maximum flood elevation and, therefore, will remain dry in the event of a flood.
- The seismic loading on the cask system components is based on the site-specific SSI analysis of the WCS CISF pad, which exceeds slightly the design-basis earthquakes evaluated in the NAC-MPC FSAR. The applicant performed a seismic reconciliation, which the staff reviews in SER Section 5.3.1.4.
- The applicant referred to the snow and ice loading incorporated by reference in Sections 2.2.4 and 3.4.4.2.2 of the NAC-MPC FSAR, Revision 10. The applicant stated that the NAC-MPC FSAR considered snow loads and determined that they are bounded by the weight of the fully loaded transfer; therefore, no further site-specific evaluations are required.

The staff reviewed applicable portions of the documents incorporated by reference to ensure that the design criteria listed for the NAC-MPC storage systems were adequate. The staff finds that the structural design criteria for the NAC-MPC storage systems DSCs were appropriately selected between the cask system and the site because the applicant selected the most limiting criteria or analyzed them as necessary.

5.3.1.2.5 NAC-UMS Storage System

In SAR Appendix F, “NAC-UMS,” Section F.3, “Principal Design Criteria,” the applicant provided the principal design criteria for the NAC-UMS Storage System, which are described in Chapter 2 of the NAC-UMS Storage System FSAR. The applicant referred to SAR Table F.3-1, “Summary of WCS CISF Principal Design Criteria,” for a comparison between the design criteria for the WCS CISF and the NAC-UMS Storage System. The table shows how the design parameters for normal, off-normal, and accident conditions for the NAC-UMS Storage System DSCs were determined to be the most limiting or needed further evaluation. The applicant indicated that applicable portions of criteria sections have been reviewed against the environmental conditions at the WCS CISF and have been shown to be either bounded by the analysis presented in the NAC-UMS Storage System FSAR or evaluated using the WCS CISF site-specific conditions.

In SAR Appendix F, Section F.3.1.1, “Design Criteria for Environmental Conditions and Natural Phenomena,” the applicant further described the site-specific environmental conditions and natural phenomena, which include design-basis tornado wind and tornado missiles, flood loading, and snow and ice loading. The review included the following site-specific aspects:

- The applicant referred to Section 11.2.11 of the NAC-UMS Storage System FSAR, Revision 10, incorporated by reference, for demonstration of compliance against the design-basis tornado wind and missiles. The applicant demonstrated that the NAC-UMS Storage System design meets the design criteria established in RG 1.76, Revision 0, and NUREG-0800 and concluded that no further WCS CISF site-specific evaluations are required.

- The applicant stated that the NAC-UMS Storage System was evaluated for flooding conditions. In addition, the applicant credited the fact that the WCS CISF site is not in a floodplain and is above the probable maximum flood elevation and, therefore, will remain dry in the event of a flood.
- The seismic loading on the cask system components in terms of seismic motion is based on the site-specific SSI analysis of the WCS CISF pad, which slightly exceeds the design-basis earthquakes evaluated in the NAC-UMS Storage System FSAR. The applicant performed a seismic reconciliation that the staff reviews in SER Section 5.3.1.4.
- The applicant referred to the snow and ice loading incorporated by reference in Section 2.2.4 of the NAC-UMS Storage System FSAR. The applicant stated that the NAC-UMS Storage System FSAR considered snow loads and determined that they are bounded by the weight of the fully loaded transfer cask; therefore, no further site-specific evaluations are required.
- In SAR Appendix F, Section F.3.1.1.5, "Combined Load Criteria," the applicant provided the combined load criteria for the NAC-UMS Storage System. The individual load cases considered a combination of thermal, seismic, external and internal pressure, tornado-generated missile impacts, drops, snow and ice loads, and flood water forces.

The staff reviewed applicable portions of the documents incorporated by reference to ensure that the design criteria listed for the NAC-UMS Storage System were adequate. The staff finds that the structural design criteria for the NAC-UMS Storage System DSCs were appropriately selected between the cask system and the site because the applicant selected the most limiting criteria or analyzed them as necessary.

5.3.1.2.6 NAC MAGNASTOR Storage System

In SAR Appendix G, "NAC-MAGNASTOR," Section G.3, "Principal Design Criteria," the applicant provided the principal design criteria for the NAC MAGNASTOR storage system, which are described in Chapter 2 of the NAC MAGNASTOR FSAR. The applicant referred to SAR Appendix G, Table G.3-1, "Summary of WCS CISF Principal Design Criteria," for a comparison between the design criteria for the WCS CISF and the NAC MAGNASTOR storage system. The table shows how the design parameters for normal, off-normal, and accident conditions between the NAC MAGNASTOR storage systems DSCs were determined to be the most limiting or needed further evaluation. In SAR Appendix G, Section G.3.1.1.5, "Combined Load Criteria," the applicant provided the combined load criteria for the NAC MAGNASTOR storage system. The applicant indicated that applicable portions of criteria sections have been reviewed against the environmental conditions at the WCS CISF and have been shown to be either bounded by the analysis presented in the NAC MAGNASTOR FSAR or evaluated using the WCS CISF site-specific conditions.

In SAR Appendix G, Section G.3.1.1, "Design Criteria for Environmental Conditions and Natural Phenomena," the applicant further described the site-specific environmental conditions and natural phenomena. The review included the following site-specific aspects:

- The applicant referred to Section 12.2.11 of the NAC MAGNASTOR FSAR, incorporated by reference, for demonstration of compliance against the design-basis tornado wind and missiles. The applicant demonstrated that the NAC MAGNASTOR storage system

design meets the design criteria established in RG 1.76 and NUREG-0800 and concluded that no further WCS CISF site-specific evaluations are required.

- The applicant stated that the NAC MAGNASTOR storage system was evaluated for flooding conditions. In addition, the applicant credited the fact that the WCS CISF site is not in a floodplain and is above the probable maximum flood elevation and, therefore, will remain dry in the event of a flood.
- The seismic loading on the cask system components in terms of seismic motion is based on the site-specific SSI analysis of the WCS CISF pad, which slightly exceeds the design-basis earthquakes evaluated in the NAC MAGNASTOR FSAR. The applicant performed a seismic reconciliation that the staff reviewed in SER Section 5.3.1.4.
- The applicant referred to the snow and ice loading incorporated by reference in Section 2.3.4 of the NAC MAGNASTOR FSAR. The applicant stated that the NAC MAGNASTOR FSAR considered the snow loads and determined that they are bounded by the weight of the fully loaded transfer cask; therefore, no further site-specific evaluations are required.

The staff reviewed applicable portions of the documents incorporated by reference to ensure that the design criteria listed for the NAC MAGNASTOR storage system were adequate. The staff finds that the structural design criteria for the NAC MAGNASTOR storage system DSCs were appropriately selected between the cask system and the site because the applicant selected the most limiting criteria or analyzed them as necessary.

5.3.1.2.7 Design Criteria for Confinement Structures – Summary

Based on its review above, the staff concludes that the WCS CISF has adequately discussed the structural design criteria for the canister-based confinement structures and meets the requirements in 10 CFR 72.24(c)(1), (c)(2), and (c)(4); 10 CFR 72.40(a)(1); 10 CFR 72.120(a) and (b); 10 CFR 72.122(a), (b), (c), (d), (f), (g), (h), (i), (j), (k), and (l); and 10 CFR 72.128(a) and (b).

5.3.1.3 Material Properties of Confinement Structures

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

Table 3-1 in SAR Appendices A through G summarizes the principal design criteria for the specific license (i.e., Rancho Seco) and certificate of compliance (CoC) FSARs incorporated by reference. Table 3-1 in each appendix compares the principal design criteria to the conditions of the WCS CISF storage site as follows:

- In SAR Appendices A through G, the applicant provided mechanical properties of materials for the individual canister systems, which are considered in the structural analysis that is evaluated by the staff in SER Section 5.3.1.4 for the canister confinement barriers.
- In SAR Appendix A, Section A.7.2, “Summary of Mechanical Properties of Materials,” the applicant noted that the Rancho Seco canisters are based on the Standardized

NUHOMS Storage System design for the 24PT1 DSC, which is discussed in the Rancho Seco ISFSI FSAR. Table 8.1-3 of the Standardized NUHOMS Storage System FSAR presents the material properties of the Standardized NUHOMS HSM Model 80.

- In SAR Appendix B, Section B.7.2, “Summary of Mechanical Properties of Materials,” the applicant provided the material properties for the canister and the AHSM, which are given in Section 3.3 of the Standardized Advanced NUHOMS Storage System FSAR.
- In SAR Appendix C, Section C.7.2, “Summary of Mechanical Properties of Materials,” the applicant stated that Appendix K, Section K.3.3, of the Standardized NUHOMS Storage System FSAR contains the material properties for the 61BT DSC.
- In SAR Appendix D, Section D.7.2, “Summary of Mechanical Properties of Materials,” the applicant stated that Appendix T, Section T.3.3, of the Standardized NUHOMS Storage System FSAR provides the material properties for the 61BTH Type 1 DSC.
- In SAR Appendix E, Section E.7.1.3, “Mechanical Properties of Materials,” the applicant stated that Section 3.3 of the NAC-MPC FSAR gives the mechanical properties of materials of the NAC-MPC storage system for the Yankee-MPC and CY-MPC.
- In SAR Appendix E, Section E.7.2.3, “Mechanical Properties of Materials,” the applicant stated that Section 3.A.3 of the NAC-MPC FSAR gives the mechanical properties of materials of the NAC MPC-LACBWR system.
- In SAR Appendix F, Section F.7.1.3, “Mechanical Properties of Materials,” the applicant stated that Section 3.3 of the NAC-UMS Storage System FSAR presents the mechanical properties of materials used in the NAC-UMS Storage System.
- In SAR Appendix G, Section G.7.1.3, “Materials,” the applicant stated that Chapter 8 of the NAC MAGNASTOR FSAR defines the mechanical and thermal properties of materials used in components of the NAC MAGNASTOR storage system.

In SAR Appendix H, “Canisterized GTCC Waste,” Section H.3, “Principal Design Criteria,” the applicant stated that all GTCC waste canisters will be stored in the same storage overpacks used to store SNF canisters for each of the storage systems. In addition, the applicant further described that the physical characteristics of the GTCC waste canisters are similar, and, in most cases, identical to the SNF canisters. Therefore, the mechanical material properties of the GTCC waste canisters are the same as the properties described in SAR Appendices A through G.

In SER Chapter 10, the staff’s comparison shows that for most of the design parameters for the storage systems, the WCS CISF site-specific considerations for the confinement structures and their material properties are either the same as or are bounded by the design criteria for the original specific license and CoCs. Where necessary, the applicant provided new evaluations, including thermal, transfer loads, and seismic events, to show that the storage system designs are adequate for the WCS site-specific conditions for normal, off-normal, and accident conditions. The staff reviewed these evaluations and concluded in SER Chapter 10 that the material properties are acceptable to support the structural analyses of the confinement systems, which the staff evaluates in SER Section 5.3.1.4. The SAR and docketed materials

relating to suitable structural material properties for use in the design and construction of the confinement SSCs meet the requirements of 10 CFR 72.24(c)(3).

5.3.1.4 Structural Analysis of Confinement Structures

The following sections describe the staff's review and evaluation of the confinement structural analysis for the cask systems.

5.3.1.4.1 NUHOMS-MP187 Cask System

The staff reviewed the applicant's structural analysis of the NUHOMS-MP187 cask system confinement structure in SAR Appendix A, Section A.7, "Structural Evaluation," to determine whether the structural integrity of the canisters will be maintained during transfer and storage operations at the WCS CISF site. The NUHOMS-MP187 cask system consists of the FO-DSC, FC-DSC, and FF-DSC canister models. In SAR Appendix A, Section A.7.3, "Structural Analysis of MP187 Cask with a Canister (Transfer Configuration)," and Section A.7.4, "Structural Analysis of HSM Model 80 with a Canister (Storage Configuration)," the applicant discussed the Rancho Seco ISFSI FSAR structural analysis incorporated by reference in the application for the canister in the transfer and storage configurations, respectively, for normal, off-normal, and accident conditions and natural phenomena. During storage, the DSCs related to the NUHOMS-MP187 cask system will be stored inside the HSM Model 80 overpack, which the staff evaluates in SER Section 5.3.2.4. The staff's review of the relevant structural information in the Rancho Seco ISFSI FSAR includes the following:

- structural analysis acceptance criteria for the canisters—FSAR Section 3.2
- design-loading criteria for the canisters—FSAR Table 3-3
- load combinations for the canister structural analyses according to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code Service Levels A, B, C, and D—FSAR Table 3-6
- applicable ASME B&PV Code stress allowable values for the combined loads—FSAR Table 3-7
- normal and off-normal loads applicable to each component—FSAR Section 8.1
- accident loads applicable to each component—FSAR Section 8.2

Rancho Seco ISFSI FSAR Section 3.2.5.2 describes a design-by-analysis method used to evaluate the DSC structural performance for meeting the stress intensity allowable values of the ASME B&PV Code, 1992 Edition with 1993 Addenda, Section III, Division 1, Subsections NB, NF, and NG, for Class I components and supports. The staff finds this approach acceptable because the stresses are below the values allowed under the ASME B&PV Code.

In SAR Appendix A, Section A.7.3.1, "Normal and Off-Normal Conditions," the applicant discussed the normal and off-normal loads during the canister transfer operation. The loads unique to the HSM storage mode of operation are evaluated for the HSM in Volume II, Chapter 8 of the Rancho Seco ISFSI FSAR. The staff previously found these loads acceptable for the Rancho Seco ISFSI. These loads are the same as the loads at the WCS site, as illustrated in SAR Appendix A, Table A.3-1, and are therefore acceptable.

In SAR Appendix A, Section A.7.3.2, "Accident Conditions," the applicant discussed the postulated accidents during the canister transfer operation, which are discussed in Volume I, Chapter 8 of the Rancho Seco ISFSI FSAR. The postulated accident loads include (1) accidental cask drop, (2) canister leakage, (3) accident pressurization, (4) earthquake, and (5) fire. In addition, Section 3.2 of the Rancho Seco ISFSI FSAR, discusses natural phenomena-type loads, such as flood loading, tornado wind loads, and tornado missiles. The staff finds that the applicant considered the applicable accident conditions and their respective loads. The SER discusses earthquake loads and a seismic reconciliation further below.

In SAR Appendix A, Section A.7.3.3, "Load Combinations," the applicant stated that the load combination stress results for the NUHOMS-MP187 Cask System FO-DSC, FC-DSC, and FF-DSC, including the GTCC waste canisters, are bounded by the FO-DSC. These are presented in Volume I of the Rancho Seco ISFSI FSAR for normal, off-normal, and accident conditions. The staff finds that the normal and off-normal operating conditions at WCS CISF are either bounded by or the same as those used in evaluating the previously approved canisters. In SAR Appendix A, Section A.7.4.3, "Load Combinations," the applicant discussed the load combination stress results for the FO-DSC, FC-DSC, and FF-DSC in the HSM Model 80 storage configuration and noted that the stress results are bounding for the WCS CISF site. The staff reviewed the load combination stress results and finds this assessment acceptable.

The applicant stated that the accident condition loadings for the canisters loaded in the Rancho Seco HSM are the same or bounded by the 24PT1 DSC in the HSM, as discussed in Appendix B to the Rancho Seco ISFSI FSAR, except for the seismic load evaluations, which is addressed in SAR Appendix A, Section A.7.5, "Seismic Reconciliation of the MP187 Cask, Canisters, and HSM Model 80," as a seismic reconciliation for the site-specific ground motion at WCS CISF. Since the original HSM in Appendix B to the Rancho Seco ISFSI FSAR was subsequently designated as the HSM Model 80, the applicant stated that the results for the canisters stored in the HSM Model 80 are acceptable.

For the seismic reconciliation, which appears in SAR Appendix A, Section A.7.5, the applicant noted that, for the zero period acceleration (ZPA) values of 0.25g (horizontal) and 0.175g (vertical) of the WCS CISF ground motion, the spectral accelerations for certain frequency bands are higher than the design-basis spectral accelerations used for the HSM approved previously by the staff. As such, the applicant performed a seismic reconciliation analysis of the canisters. The canisters are stored in the HSM Model 80, which the applicant analyzed using the enveloped acceleration spectra at the HSMs center of gravity (CG) and at the HSM base derived from the concrete pad SSI analysis. The applicant discussed the SSI analyses for the HSM support pad in SAR Section 7.6.4; the staff reviewed and evaluated these analyses in SER Section 5.3.4.3.

In SAR Appendix A, Section A.7.5.2, "Canisters," the applicant noted that the ANSYS finite element analyses used to determine the natural frequencies of the DSCs were considered bounding canister model attributes. Two different analyses were performed to encompass the directional loading of the basket and spent fuel assemblies. The first analysis simulated the axial direction seismic load, and the second analysis simulated the vertical and lateral direction seismic load. The applicable spectral accelerations for this case in the horizontal and vertical directions are determined to be less than 0.7g and 0.62g, respectively. To account for the effects of possible multimode response, the applicant increased the spectral values by a factor of 1.5 to result in 1.05g and 0.93g in the horizontal and vertical directions, respectively.

In SAR Appendix A, Section A.7.5.2, the applicant noted the minimal stiffness differences among all the DSCs based on the modal analyses. The staff evaluated the stiffness differences

and because the differences are minimal, determined this is an acceptable means to demonstrate that the previously approved Rancho Seco seismic stability analysis of the DSCs for the NUHOMS-MP187 cask system continues to be applicable to the storage operation at the WCS CISF site.

In SAR Appendix A, Section A.7.5.2, the applicant evaluated the seismic stability of the canister placed on the same support rails with alignment at 30 degrees for both HSM HS and HSM 80/102. The staff reviewed and verified the applicant's evaluation and concluded that the previous canister seismic stability analyses continue to be applicable because the seismic input time-history spectral values are compatible with the ZPAs at the WCS CISF site. This demonstrates that the DSCs will remain stable on the HSM rails.

The staff confirmed that the canister shell components analyses in the original analyses considered the seismic loading with ZPAs of 3.0g and 1.0g for the horizontal and vertical directions, respectively. This seismic loading bounds the seismic accelerations demand of 1.05g and 0.93g, as discussed in the preceding paragraphs for the canisters stored at the WCS CISF. Therefore, the staff concludes that the DSCs will perform their intended structural function during seismic events at the WCS CISF.

In SAR Appendix A, Section A.7.7, "Structural Evaluation of A.7.7 Canister Confinement Boundary under Normal Conditions of Transport," the applicant evaluated the canister confinement boundary under normal conditions of transport. In SAR Section 7.7.1.6, "Stress Evaluation Results," the applicant presented stress analysis results for the FC-DSC and FF-DSC shells. The maximum component stress ratio is equal to 0.88 and occurs in the cylindrical shell for the canister side drop. In SAR Section 7.7.2.6, "Stress Evaluation Results," the applicant presented stress analysis results for the FO-DSC shell and the 24PT1 DSC shell, which applies to the Standardized Advanced NUHOMS Storage System evaluated in SER Section 5.3.1.4.2. The maximum component stress ratio is equal to 0.78 and occurs in the cylindrical shell for the canister side drop. The staff finds that the stress ratios, which are computed by dividing the calculated stress with the stress allowable, are less than unity (1.0) and are therefore acceptable to demonstrate canister structural capability for the normal conditions of transport loading.

The applicant considered the SAR Appendix A, Section A.7.7 stress analysis results bounding, which demonstrates the canister structural capability for the normal storage operating conditions. The staff reviewed the applicant's assessment and confirmed that the stress analysis results are bounding and are, therefore, acceptable.

Based on its review above, the staff determined that the bounding analyses documented in the Rancho Seco ISFSI FSAR and the seismic reconciliation analysis in the SAR are acceptable. As a result, the staff concludes that the structural integrity of the canisters approved for the NUHOMS-MP187 cask system at the Rancho Seco ISFSI is acceptable for the WCS CISF.

5.3.1.4.2 Standardized Advanced NUHOMS Storage System

In SAR Appendix B, Sections B.7.3 and B.7.4, entitled "Structural Evaluation of MP187 Transfer Cask with Canister (Transfer Configuration at WCS CISF)," and "Structural Analysis of AHSM with a Canister (Storage Configuration)," respectively, the applicant discussed the structural analyses of the 24PT1 DSC in the transfer and storage configurations, respectively, at WCS CISF. The applicant incorporated by reference these structural analyses from the Standardized Advanced NUHOMS Storage System FSAR.

SAR Appendix B, Section B.7.3.1, "Evaluation of MP187 Cask Loaded with a Canister," states that the evaluation of the DSC 24PT1 in the NUHOMS-MP187 cask transportation configuration appears in Appendix A to the NUHOMS-MP187 Multi-Purpose Cask SAR. To demonstrate structural adequacy of the canister in the transfer operation when placed in the NUHOMS-MP187 cask in transfer configuration, the applicant compared the design features of the FO-DSC and FC-DSC to those of the 24PT1 DSC. In a design similarity evaluation, the applicant noted that, except for the modified spacer disc spacing and support rod configuration, the 24PT1 DSC design is the same as the FO-DSC. Section A.2.6.11 of the NUHOMS-MP187 Multi-Purpose Cask SAR addressed the modified design feature. On this basis, the applicant concluded that the FO-DSC and FC-DSC design bounds the 24PT1 DSC design to permit the 24PT1 DSC to be qualified for transfer with the NUHOMS-MP187 cask in the transfer configuration. For the canister structural performance in the transfer operation, the applicant determined that governing design features of the 24PT1 DSC are bounded by those of the FO-DSC, FC-DSC, and FF-DSC. As a result, the applicant stated that the structural evaluation of the cask drop accident for the NUHOMS-MP187 cask in the transport configuration loaded with the FO-DSC and FC-DSC is applicable to the NUHOMS-MP187 cask loaded with a 24PT1 DSC. The staff reviewed the design similarity evaluation and determined that the applicant compared pertinent design features and provided sufficient justification to demonstrate similarities between the 24PT1 DSC and the FO-DSC and FC-DSC. The staff finds that the NUHOMS-MP187 cask loaded with the FO- and FC-DSCs bounds the NUHOMS-MP187 cask loaded with a 24PT DSC and is therefore acceptable.

In SAR Appendix B, Section B.7.3.2, "Evaluation of the Canister in the MP187 Transfer Cask," the applicant noted the structural analysis of the 24PT1 DSC held in the MP187 cask in the transfer configuration for the normal, off-normal, and accident conditions appears in Sections 3.6.1, 11.1, and 11.2, respectively, of the Standardized NUHOMS Storage System FSAR. The applicant discussed the transfer and handling loads and load combinations applicable to the canister by referencing Tables 3.6-1 through 3.6-9 of the Standardized NUHOMS Storage System FSAR, which include results for normal and off-normal conditions for the canister shell assembly and the controlling load combinations. Additionally, for design-basis structural evaluations involving transfer operations of the canister in the OS197 transfer cask, the applicant performed a similarity analysis, comparing the assumptions considered in modeling canister structural behavior. The applicant indicated that the evaluation results for the loaded OS197 transfer cask provide the basis for acceptance of the MP187 cask for transfer operations of the canister. The staff evaluated the design similarity evaluation and determined that the applicant compared pertinent design features and provided sufficient justification to demonstrate that the loaded OS197 transfer cask structural analysis results are applicable to the MP187 cask in the transfer configuration. The staff finds this design similarity evaluation between the OS197 transfer cask and the MP187 transfer cask acceptable.

In SAR Appendix B, Section B.7.4, the applicant discussed the structural analysis of the 24PT1 DSC in the AHSM storage configuration for the normal, off-normal, and accident conditions in Sections 3.6, 11.1, and 11.2, respectively, of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. The applicant noted that Tables 3.6-2 through 3.6-9 of the Standardized NUHOMS Storage System FSAR summarize the analysis results, as applicable. It is necessary to note that, during storage, the 24PT1 DSC related to the Standardized Advanced NUHOMS Storage System will be stored inside the AHSM overpack, which the staff evaluates in SER Section 5.3.2.4.

In SAR Appendix B, Section B.7.5, "Seismic Reconciliation of the Advanced NUHOMS 24PT1 DSC and AHSM Storage Components and the MP187 Transfer Cask," the applicant performed

a seismic reconciliation analysis of the 24PT1 DSC held in the AHSM and in the MP187 cask in the transfer configuration. The staff evaluates the seismic reconciliation analysis of the AHSM storage components in SER Section 5.3.2.2.2. The applicant performed an SSI analysis of the storage pad using spectrum-compatible acceleration time histories as input to derive the seismic design basis for the Standardized Advanced NUHOMS components. SAR Appendix B, Figure B.7-2, "Design Basis Response Spectra for Canister, and AHSM compared to the Spectra at the C.G. of the HSM from WCS CISF Soil Structure Interaction Analysis," shows the design-basis band-broadened response spectra, which are obtained at the AHSM CG. As shown in SAR Figure B.7-2, the design-basis seismic criteria for the canister and AHSM significantly exceed the seismic design criteria for the AHSM and 24PT1 on the pad. Therefore, the staff finds that the canister and the AHSM designs have significant margins, and no additional reconciliation for seismic loads needs to be performed for these components on the storage pad.

For seismic reconciliation of the 24PT1 DSC held in the MP187 cask in the transfer configuration, the applicant stated that the SAR Appendix B, Section B.7.3 evaluation has demonstrated the similarity of the 24PT1 DSC to the FO-DSC. As such, the applicant concluded that the seismic reconciliation of the MP187 cask loaded with a bounding FO-DSC, FC-DSC, and FF-DSC presented in SAR Appendix A, Section A.7.5.1, "MP187 Cask," and reviewed in SER Section 5.3.1.4.1 is applicable to the MP187 cask in the transfer configuration loaded with a 24PT1 DSC. The staff evaluated the design similarity evaluation and determined that the applicant compared pertinent design features and provided sufficient justification to demonstrate similarities between the 24PT1 DSC and the FO-DSC and the FC-DSC. The staff finds this design similarity evaluation acceptable.

In SAR Appendix B, Section B.7.6, "Thermal Stress Reconciliation of the Standardized Advanced NUHOMS System Components," the applicant performed a thermal stress reconciliation of the Standardized Advanced NUHOMS system components. By comparing the WCS CISF environmental ambient conditions with the environmental ambient conditions used for the AHSM and canister analyses in the Standardized Advanced NUHOMS Storage System FSAR, the applicant determined the maximum temperatures and thermal stress evaluation results reported in the Standardized Advanced NUHOMS Storage System FSAR for the AHSM and canisters remain bounding for the WCS CISF. The staff verified the thermal stress results and finds that they remain bounding.

In SAR Appendix B, Section B.7.7, "Conclusions of the Structural Analysis," the applicant stated that the design requirements and environmental conditions that form the design basis upon which the NRC licensed the MP187 cask bound the requirements and environmental conditions at the WCS CISF site. The staff verified the statement and determined that the information was properly assessed.

Based on its review above, the staff confirmed that the information in the SAR is consistent with the previous analyses incorporated by reference in the Standardized Advanced NUHOMS Storage System FSAR and finds it acceptable. The staff finds that the applicant compared pertinent design parameters with applicable WCS CISF site-specific parameters and that structural analysis results were found to be either the same or bounded by the structural properties original design criteria. On the basis of the evaluations discussed in preceding paragraphs, the staff concludes that the 24PT1 DSC is structurally acceptable during transfer and storage operations at the WCS CISF site.

5.3.1.4.3 Standardized NUHOMS Storage System

5.3.1.4.3.1 61BT Dry Shielded Canister

In SAR Appendix C, Section C.7.5, “Structural Analysis of 61BT DSC (Storage and Transfer),” the applicant discussed the analysis of the 61BT DSC for storage and transfer operations, citing the structural analyses of the DSC presented in Sections K.3.6.1, K.3.6.2 and K.3.7 of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. Table K.3.7-12 in the Standardized NUHOMS Storage System FSAR summarizes results for normal and off-normal loads, and Table K.3.7-14 presents results for accident loads. During storage, the DSCs related to the Standardized NUHOMS Storage System will be stored inside the HSM Model 102 overpack, which the staff evaluates in SER Section 5.3.2.4.

The applicant noted that Appendix K to the Standardized NUHOMS Storage System FSAR evaluates the 61BT DSC structural performance for transfer operations using the OS197 transfer cask. The applicant indicated that the DSC transfer operation at the WCS CISF site will use the MP197HB transfer cask instead of the OS197 cask. By comparing the key geometric attributes of the two transfer casks, including the cask cavity inner diameter and the sleeve installed inside the MP197HB cask, the applicant concluded that the analyses of the 61BT DSC shell and basket assemblies for the transfer operation in the OS197 transfer cask are applicable for the transfer operation at the WCS CISF site with the MP197HB cask. The staff reviewed the design similarity evaluation and determined that the applicant compared pertinent design features and provided sufficient justification to demonstrate that the loaded OS197 transfer cask structural analysis results are applicable to the MP197HB cask. Therefore, the staff finds this evaluation acceptable.

In SAR Appendix C, Section C.7.5.1, “Normal Loads (Storage in HSM Model 102 and Transfer in MP197HB Cask),” the applicant discussed the structural analysis of the 61BT DSC for the normal condition loads, citing Section K.3.6.1 of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. Similarly, in SAR Appendix C, Section C.7.5.2, “Off-Normal Loads,” the applicant discussed the structural analysis of the 61BT DSC for the off-normal loads, citing Section K.3.6.2 of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. The staff reviewed the aforementioned information and finds that the applicant considered the appropriate loads and that the resulting stresses, where appropriate, are within the values allowed by the ASME B&PV Code. Therefore, the staff finds the approach acceptable.

In SAR Appendix C, Section C.7.4, “Reconciliation of Thermal Loads for the 61BT DSC in the HSM Model 102 and MP197HB Cask,” the applicant performed a thermal stress reconciliation analysis of the 61BT DSC. The applicant determined that the previously approved thermal stress evaluations for transfer operation in the OS197 transfer cask are applicable for the transfer operation in the MP197HB cask. The staff finds that the applicant compared pertinent design features and provided sufficient justification to demonstrate that the loaded OS197 transfer cask structural analysis results are applicable to the MP197HB cask. The staff finds this evaluation acceptable.

In SAR Appendix C, Section C.7.5.3, “Accident Loads,” the applicant discussed a structural analysis of the 61BT DSC for accident level loads, citing Section K.3.7 of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. The applicant discussed flood loads and accidental cask drop loads as possibly affecting the canister. The applicant concluded that resulting stresses from these situations are less than the

corresponding values allowed by the ASME B&PV Code. The staff evaluated these results and finds the applicant's conclusions to be acceptable.

The applicant performed a seismic reconciliation for the canister. In SAR Appendix C, Section C.7.3, "Seismic Reconciliation of the 61BT DSC, HSM Model 102, and MP197HB Cask," the applicant noted that for the WCS CISF ground-motion ZPA values of 0.25g (horizontal) and 0.175g (vertical), the spectral accelerations for certain frequency bands are higher than the design-basis spectral accelerations used for the HSM approved previously by the staff. As a result, in SAR Appendix A, Section A.7.5.2, the applicant performed a reconciliation analysis of the site-specific seismic loads for the NUHOMS storage systems supported on the concrete pad. The seismic loads, which envelop the acceleration spectra at the HSM CG and the base, are derived from the concrete pad SSI analysis. The SSI analyses, which are presented in SAR Section 7.6.4, "Load Combinations," and reviewed in SER Section 5.3.4.3, define the seismic loads for structural analyses of cask components.

In SAR Appendix C, Section C.7.3.3, "61BT DSC," the applicant referred to Section K.3.7.3 of the Standardized NUHOMS Storage System FSAR to note that the canister shell components are evaluated for seismic loading of 3.0g and 1.0g for the horizontal and vertical directions, respectively. The basket components are evaluated for a bounding acceleration of 2g in each of the axial, transverse, and vertical direction. The reconciliation of WCS CISF site-specific loading in SAR Appendix A, Section A.7.5.2, calculated a bounding acceleration of 1.05g and 0.93g in the horizontal and vertical directions, respectively, on the 61BT DSC. As a result, the applicant concluded that the seismic accelerations used in the original seismic evaluations of the DSC bound the site-specific seismic accelerations at WCS CISF. The staff reviewed the resulting seismic accelerations above and finds that sufficient margin exists, as the approved DSC seismic accelerations bound the WCS CISF site-specific accelerations. Therefore, the staff concludes that the seismic performance of the 61BT DSC is acceptable for the WCS CISF site.

In SAR Appendix C, Section C.7.4, the applicant performed reconciliation of thermal loads for the canister in the HSM Model 102 and in the MP197HB cask. The applicant noted that, in accordance with the evaluation in Appendix C, Section C.8, "Thermal Evaluation," the thermal performance of the HSM Model 102 with the 61BT DSC at the WCS CISF for normal, off-normal, and accident conditions is bounded by the design-basis evaluations, as described in Appendix K.4 to the Standardized NUHOMS Storage System FSAR. The staff reviewed the applicant's justification that the temperatures of the canister components during storage at the WCS CISF are bounded by the analyses in the Standardized NUHOMS Storage System FSAR and concludes that the analyses for design-basis internal pressure and normal thermal loads, as well as the allowable stress criteria, are bounded.

The applicant noted that SAR Appendix C, Section C.8, "Thermal Evaluation," details the thermal analyses of the 61BT DSC for transfer conditions at the WCS CISF for normal, off-normal, and accident conditions in the MP197HB cask. Comparison of the maximum canister component temperatures shown in SAR Table C.8-2, "NUHOMS 61BT DSC Fuel Cladding and Canister Component Temperatures for Transfer in MP197HB Cask at the WCS CISF," (for transfer conditions at the WCS CISF) and Table K.4-2 in the Standardized NUHOMS Storage System FSAR indicates that the canister shell temperature for the off-normal condition increases by 8 degrees Fahrenheit (F) (4 degrees Celsius (C), 2 percent) for transfer in the MP197HB cask at the WCS CISF. The applicant also noted that the canister internal basket component temperatures are lower or essentially equal (0.6 degree C (1 degree F) increase for fuel compartment temperature) for transfer in the MP197HB cask at the WCS CISF. As a result,

the applicant determined that this very small increase in temperature is inconsequential for the thermal-stress evaluations, as the temperatures used to determine the component material properties and allowable stresses in Tables K.3.7-12, K.3.7-14, and K.3.7-16 of the Standardized NUHOMS Storage System FSAR bound the maximum temperatures during transfer in the MP197HB cask. The applicant provided sufficient justification that the allowable stresses of the Standardized NUHOMS Storage System FSAR continue to bound the maximum stresses during transfer; therefore, the staff finds that this approach is acceptable.

The staff reviewed the above evaluations incorporated by reference and the additional analysis in the SAR. The staff verified the information and determined that the analysis results show adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events. As a result, the staff concludes that the structural integrity of the 61BT DSC, which was previously approved for the Standardized NUHOMS Storage System, is acceptable for the WCS CISF.

5.3.1.4.3.2 61BTH Type 1 Dry Shielded Canister

In SAR Appendix D, Section D.7.5, "Structural Analysis of Canister (Storage and Transfer)," the applicant discussed an analysis of the 61BTH Type 1 DSC for storage and transfer operations, citing the structural analyses of the DSC presented in Sections T.3.6.1, T.3.6.2, and T.3.7 of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. Table T.3.7-12 in the Standardized NUHOMS Storage System FSAR summarizes the results for normal and off-normal loads, and Table K.3.7-14 presents the results for accident loads. It is necessary to note that, during storage, the DSCs related to the Standardized NUHOMS Storage System will be stored inside the HSM Model 102 overpack, which the staff evaluates in SER Section 5.3.2.4

The applicant noted that Appendix T to the Standardized NUHOMS Storage System FSAR evaluates the 61BTH Type 1 DSC structural performance for transfer operations using the OS197 transfer cask. The applicant indicated that the DSC transfer operation at the WCS CISF site will use the MP197HB transfer cask instead of the OS197 cask. By comparing the key geometric attributes of the two transfer casks, including the cask cavity inner diameter and the sleeve installed inside the MP197HB cask, the applicant concluded that the analyses of the 61BTH Type 1 DSC shell and basket assemblies for the transfer operation in the OS197 transfer cask are applicable for the transfer operation at the WCS CISF site with the MP197HB cask. The staff finds that the applicant compared pertinent design features and provided sufficient justification to demonstrate that the loaded OS197 transfer cask structural analysis results are applicable to the MP197HB cask. The staff finds this evaluation acceptable.

In SAR Appendix D, Section D.7.5.1, "Normal Loads (Storage in HSM Model 102 and Transfer in MP197HB Cask)," the applicant discussed an analysis of the 61BTH Type 1 DSC for the normal condition loads, citing Section T.3.6.1 of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. Similarly, in SAR Appendix D, Section D.7.5.2, "Off-Normal Loads," the applicant discussed a structural analysis of the 61BTH Type 1 DSC for the off-normal loads, citing Section T.3.6.2 of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. The staff finds that the applicant considered the appropriate loads and that the resulting stresses are within the values allowed by the ASME B&PV Code. Therefore, the staff finds the approach acceptable.

In SAR Appendix D, Section D.7.5.3, "Accident Loads," the applicant discussed a structural analysis of the 61BTH Type 1 DSC for accident-level loads, citing Section T.3.7 of the

Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. The applicant discussed flood loads and accidental cask drop loads as possibly affecting the canister. The applicant concluded that resulting stresses from these situations are less than the corresponding values allowed by the ASME B&PV Code. The staff evaluated these results and finds the applicant's conclusions to be acceptable. Additionally, the applicant stated that a seismic reconciliation was performed for the canister, as discussed below.

In SAR Appendix D, Section D.7.3, "Normal Loads (Storage in HSM Model 102 and Transfer in MP197HB Cask)," the applicant noted that, for the WCS CISF ground motion ZPA values of 0.25g (horizontal) and 0.175g (vertical), the spectral accelerations for certain frequency bands are higher than the design-basis spectral accelerations used for the HSM approved previously by the staff. As a result, in SAR Appendix A, Section A.7.5.2, the applicant performed a reconciliation analysis of the site-specific seismic loads for the NUHOMS storage systems supported on the concrete pad. The seismic loads, which envelop the acceleration spectra at the HSM CG and the base, are derived from the concrete pad SSI analysis. The SSI analyses, which are presented in SAR Section 7.6.4 and reviewed in SER Section 5.3.4.3, define the seismic loads for structural analyses of cask components.

In SAR Appendix D, Section D.7.3.3, "61BTH Type 1 DSC," the applicant referred to Section T.3.7.2.1 of the Standardized NUHOMS Storage System FSAR to note that the canister shell components are evaluated for seismic loading of 3.0g and 1.0g for the horizontal and vertical directions, respectively. The basket components are evaluated for a bounding acceleration of 2g in each of the axial, transverse, and vertical direction. The reconciliation of WCS CISF site-specific loading in SAR Appendix A, Section A.7.5.2, calculated a bounding acceleration of 1.05g and 0.93g in the horizontal and vertical directions, respectively, on the 61BTH Type 1 DSC. As a result, the applicant concluded that the seismic accelerations used in the original seismic evaluations of the DSC bound the site-specific seismic accelerations at WCS CISF. The staff reviewed the aforementioned and finds that sufficient margin exists, as the original DSC seismic accelerations bound the site-specific accelerations. Therefore, the staff concludes that the seismic performance of the 61BTH Type 1 DSC is acceptable for the WCS CISF site.

In SAR Appendix D, Section D.7.4, "Reconciliation of Thermal Loads for the Canister in the HSM Model 102 and in the MP197HB Cask," the applicant performed reconciliation of thermal loads for the canister in the HSM Model 102 and in the MP197HB cask. The applicant noted that, in accordance with the evaluation in Appendix D, Section D.8, "Thermal Evaluation," the thermal performance of the HSM Model 102 with the 61BTH Type 1 DSC at the WCS CISF for normal, off-normal, and accident conditions is bounded by the design-basis evaluations described in Appendix T, Section T.4, of the Standardized NUHOMS Storage System FSAR. Since the temperatures of the canister components during storage at the WCS CISF are bounded by the analyses in the Standardized NUHOMS Storage System FSAR, the applicant further concluded that the analyses for design-basis internal pressure and normal thermal loads, as well as the allowable stress criteria, are also bounded. The staff reviewed the applicant's justification that the temperatures of the canister components during storage at the WCS CISF are bounded by the analyses in the Standardized NUHOMS Storage System FSAR and concludes that the analyses for design-basis internal pressure and normal thermal loads, as well as the allowable stress criteria, are bounded.

The applicant noted that the thermal analyses of the 61BTH Type 1 DSC for transfer conditions at the WCS CISF for normal, off-normal, and accident conditions in the MP197HB cask are detailed in SAR Appendix D, Section D.8. A comparison of the maximum canister component

temperatures shown in SAR Table D.8-2, “NUHOMS 61BTH Type 1 DSC Fuel Cladding and DSC Component Temperatures for Transfer in MP197HB TC at the WCS CISF,” (for transfer conditions at the WCS CISF) and Table T.4-18 in the Standardized NUHOMS Storage System FSAR indicates that the canister shell temperature for the off-normal condition increases by 8 degrees F (4 degrees C, 2 percent) for transfer in the MP197HB cask at the WCS CISF. The applicant also noted that the canister internal basket component temperatures are lower or essentially equal (1-degree F (0.6-degree C) increase for fuel compartment temperature) for transfer in the MP197HB cask at the WCS CISF. As a result, the applicant determined that this very small increase in temperature is inconsequential for the thermal stress evaluations, as the temperatures used to determine the component material properties and allowable stresses in Tables T.3.7-12, T.3.7-14, and T.3.7-16 bound the maximum temperatures during transfer in the MP197HB cask. The applicant provided sufficient justification that the allowable thermal stresses of the Standardized NUHOMS Storage System FSAR continue to bound the maximum thermal stresses during transfer; therefore, the staff finds that this approach is acceptable.

The staff reviewed the above evaluations incorporated by reference and additional analysis in the SAR. The staff verified the information and determined that the analysis results show adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events. As a result, the staff concludes that the structural integrity of the 61BTH Type 1 DSC, which was previously approved for the Standardized NUHOMS Storage System, is acceptable for the WCS CISF.

5.3.1.4.4 NAC-MPC Storage System

In SAR Appendix E, Section E.7, “Structural Evaluation,” the applicant discussed a structural analysis of the NAC-MPC storage system canisters under normal operating conditions, citing information from the NAC-MPC FSAR, which the applicant incorporated by reference. The applicant evaluated off-normal and accident conditions in SAR Appendix E, Section E.12, “Accident Analysis.” During storage, the canisters related to the NAC-MPC storage system will be stored inside the vertical concrete cask (VCC) overpack, which the staff evaluates in SER Section 5.3.2.4.

The applicant noted in SAR Appendix E, Section E.7.1.7, “NAC-MPC Components Under Normal Operating Loads,” that NAC-MPC FSAR Section 3.4.4 provides the evaluations of the NAC-MPC components under normal operating loads. Additionally, the applicant noted in SAR Appendix E, Section E.7.1.11, “Structural Evaluation of Yankee-MPC and CY-MPC Canister Confinement Boundaries under Normal Conditions of Transport,” that NAC-STC SAR Sections 2.6.13 and 2.6.15 evaluate the NAC-MPC canister shells for normal conditions of transport. In a submittal dated January 17, 2020, the applicant provided an evaluation to demonstrate the loading conditions considered in the NAC-STC SAR bound those for the storage operation. Therefore, the applicant stated that the result of the structural analysis in NAC-STC SAR Sections 2.6.13 and 2.6.15 is acceptable for the loads and load combinations to demonstrate structural acceptance of the NAC-MPC canisters for normal operating conditions at the WCS CISF site. The staff reviewed and verified the applicant’s evaluation and concludes that the structural performance of the NAC-MPC canisters is adequate for normal storage operating conditions at WCS CISF because loading conditions remain bounding.

In SAR Appendix E, Section E.7.2.7, “MPC-LACBWR Components Under Normal Operating Loads,” the applicant noted that NAC-MPC FSAR Section 3.A.4.4 provides the evaluations of the NAC MPC-LACBWR components to demonstrate structural adequacy under normal operating loads.

In SAR Appendix E, Sections E.3.1.1 and E.3.2.1, for certain environmental conditions and natural phenomena, the applicant discussed a structural analysis of the NAC-MPC and NAC MPC-LACBWR canisters, respectively, citing the NAC-MPC FSAR, which the applicant incorporated by reference, as follows:

- In SAR Appendix E, Sections E.3.1.1.2 and E.3.2.1.2, the applicant noted that, as documented in SAR Sections 2.4.2.2 and 3.2.2, entitled, “Flood Design Considerations,” and “Water Level (Flood) Design,” respectively, the WCS CISF site is not in a floodplain and is above the probable maximum flood elevation and, therefore, will remain dry in the event of a flood. The staff verified the applicant’s assessment and finds it acceptable that no further site-specific evaluations of the NAC-MPC are required.
- In SAR Appendix E, Sections E.3.1.1.3 and E.3.2.1.3, both entitled, “Seismic Design,” the applicant noted that Sections 11.2.2 and 11.A.2.2 of the NAC-MPC FSAR calculate the seismic ground acceleration that will cause the NAC-MPC and NAC MPC-LACBWR storage casks, respectively, to tip over. The staff evaluates the seismic stability of the storage cask against sliding and tip-over on the WCS CISF concrete pad in SER Section 16.3.2.6. The structural performance of the canister under the seismic loading is bounded by the acceleration resulting from the cask tip-over event, which the staff evaluates in SER Section 5.3.1.4.4.
- In SAR Appendix E, Section E.3.1.1.4, “Snow and Ice Loadings,” for the NAC-MPC system, the applicant noted that it assumed a worst case ground snow load value of 100 pounds per square foot (psf, 4,788 pascals (Pa)). The applicant noted that the snow load is bounded by the previous evaluation in the load combinations described in NAC-MPC FSAR Section 3.4.4.2.2. The staff verified the applicant’s assessment and finds it acceptable that no further site-specific evaluations of the NAC-MPC storage system are required.
- In SAR Appendix E, Section E.3.2.1.4, “Snow and Ice Loadings,” for the NAC MPC-LACBWR system, the applicant stated that the snow and ice loadings design criteria that are defined in NAC-MPC FSAR Section 2.2 apply to the NAC MPC-LACBWR system in their entirety. The staff verified the applicant’s assessment and finds it acceptable that no further site-specific evaluations of the NAC-MPC storage system are required.

In SAR Appendix E, Section E.12, “Accident Analysis,” the applicant discussed an analysis of the off-normal and accident design events, including natural phenomena, citing those presented in Chapter 11 of the NAC-MPC FSAR, which describes the design-basis load conditions for the Yankee-MPC transportable storage canister and which the applicant incorporated by reference. The applicant noted that the canister analyzed for the loads imposed during transportation envelop the loads for the storage condition analyzed in this SER.

The applicant noted that the NAC-MPC FSAR presents the off-normal and accident conditions evaluation, including natural phenomena, for each NAC-MPC and CY-MPC configuration separately when appropriate due to differences in capacity, weight, and principal dimensions. Appendix 11.A to the NAC-MPC FSAR presents the evaluation for the NAC MPC-LACBWR configuration.

The applicant stated that for the storage of reactor-generated GTCC waste previously loaded at Yankee Rowe (YR) and CY, the accident analyses for the storage of their fuel bounds the

storage of GTCC waste. The applicant indicated that the GTCC-Canister-YR and GTCC-Canister-CY and concrete overpacks are similar in design to the SNF canisters and overpacks, and the storage heat load for GTCC waste is significantly below that of the stored SNF. The staff verified the applicant's assessment, particularly the design similarities, of the thermal conditions for the GTCC waste canisters and determined that the conditions have properly been evaluated and are therefore acceptable.

SAR Appendix E, Section E.12.1, "Yankee Rowe MPC and Connecticut Yankee MPC," refers to Section 11.1 of the NAC-MPC FSAR for the off-normal and accident conditions previously evaluated for the Yankee-MPC and CY-MPC. The off-normal conditions evaluated in SAR Appendix E, Section E.12.1.1, "Off-Normal Events," for demonstrating structural performance include the canister off-normal handling load and severe environmental conditions (100 degrees F (38 degrees C) and -40 degrees F (-40 degrees C)).

SAR Appendix E, Section E.12.1.2, "Accidents," refers to Section 11.2 of the NAC-MPC FSAR for the results of analyses of the design-basis and postulated accident conditions and natural phenomena previously evaluated for the NAC-MPC storage system for the Yankee-MPC and CY-MPC. The accident conditions evaluation for each configuration is presented separately when appropriate due to differences in capacity, weight, and principal dimensions. The NAC-MPC FSAR presents the analyses relevant to the evaluation in the following sections:

- accident pressurization—Section 11.2.1
- earthquake event—Section 11.2.2
- explosion—Section 11.2.3
- fire accident—Section 11.2.5
- flood—Section 11.2.6
- lightning—Section 11.2.9
- maximum anticipated heat load (125 degrees F (56.1 degrees C) ambient temperature)—Section 11.2.10
- storage cask 6-inch (15-centimeter) drop—Section 11.2.11
- tip-over of the vertical concrete cask—Section 11.2.12
- tornado and tornado-driven missiles—Section 11.2.13

In SAR Appendix E, Section E.12.1.3, "Concrete Cask Non-Mechanistic Tip-Over Analysis," the applicant used an LS-DYNA finite element analysis to perform a concrete cask non-mechanistic tip-over analysis of the NAC-MPC storage system holding either the Yankee-MPC or the CY-MPC canister. The analysis follows the common modeling approach presented in Section 12.2.12 of the NAC-MPC FSAR for the design-basis tip-over analysis of the cask, with the exception that the cask-specific and site-specific pad design features and soil properties are considered. For the Yankee-MPC, the applicant noted that the design-basis acceleration used in the basket and canister evaluations was 45g. Considering the site-specific peak basket acceleration of 31.8g, which bounds the peak calculated canister acceleration, and recognizing the site-specific accelerations being significantly bounded by the design-basis acceleration, the applicant concluded that the previous Yankee-MPC canister and basket evaluations are bounding for the conditions at the WCS CISF. Because the design basis accelerations are larger than the site-specific peak basket acceleration, staff finds that the previous MPC canister evaluations remain bounding for the WCS site.

For the CY-MPC, the applicant stated that the acceleration used in the design-basis basket and canister evaluations was 40g. Considering the site-specific peak basket acceleration of 35.9g,

which bounds the peak calculated canister acceleration, and recognizing the calculated peak accelerations being bounded by the design-basis acceleration, the applicant concluded that the previous CY-MPC canister and basket evaluations are bounding for the conditions at the WCS CISF. The staff reviewed the applicant's tip-over evaluations and finds that the site-specific tip-over analysis was properly performed and demonstrates adequate structural performance of the cask system under the tip-over event because the design basis accelerations remain bounding for this canister for the WCS site.

SAR Appendix E, Section E.12.2, "La Crosse MPC," identifies where in Section 11.A.4 of the NAC-MPC FSAR the off-normal and accidents are evaluated for the NAC MPC-LACBWR. The off-normal conditions evaluated in SAR Appendix E, Section E.12.2.1, "Off-Normal Events," for demonstrating structural performance include the canister off-normal handling load and severe environmental conditions (100 degrees Fahrenheit (F, 38 degrees Celsius (C)) and -40 degrees F (-40 degrees C)).

SAR Appendix E, Section E.12.2.2, "Accidents," refers to Section 11.A.2 of the NAC-MPC FSAR for the results of analyses of the design-basis and postulated accident conditions evaluated for the NAC MPC-LACBWR system. The following sections of the NAC-MPC FSAR provide the analyses relevant to the evaluation:

- accident pressurization—Section 11.A.2.1
- earthquake event—Section 11.A.2.2
- explosion—Section 11.A.2.3
- fire accident—Section 11.A.2.5
- flood—Section 11.A.2.6
- lightning—Section 11.A.2.9
- maximum anticipated heat load (125 degrees F (56.1 degrees C) ambient temperature)—Section 11.A.2.10
- storage cask 6-inch (15-centimeter) drop—Section 11.A.2.11
- tip-over of the vertical concrete cask—Section 11.A.2.12
- tornado and tornado-driven missiles—Section 11.A.2.13
- transfer cask seismic accident condition—Section 11.A.2.14

In SAR Appendix E, Section E.12.2.3, "Concrete Cask Non-Mechanistic Tip-Over Analysis," the applicant used an LS-DYNA finite element analysis to perform a concrete cask tip-over analysis of the NAC MPC-LACBWR storage cask for the WCS CISF. The analysis follows the modeling approach used in the design-basis cask tip-over analysis in Section 12.A.2.12 of the NAC-MPC FSAR, with the exception that the site-specific pad design features and soil properties are considered. The applicant noted that acceleration used in the design-basis basket and canister evaluations was 25g. Considering the site-specific peak basket acceleration of 21.8g and canister acceleration of 23.5g and recognizing the site-specific peak accelerations being bounded by the design-basis acceleration, the applicant concluded that the previous NAC MPC-LACBWR canister and basket evaluations are bounding for the conditions at the WCS CISF. The staff reviewed the applicant's tip-over evaluations and finds that the site-specific tip-over analysis was properly performed and demonstrates adequate structural performance of the cask system in a tip-over event because the design basis accelerations remain bounding for this canister for the WCS site.

As noted, the staff reviewed the above evaluations incorporated by reference and the additional analyses in the SAR. The staff verified the information and determined that the analysis results

show adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events. As a result, the staff concludes that the structural integrity of the canisters, which was previously approved for the NAC-MPC storage system, is acceptable for the WCS CISF.

5.3.1.4.5 NAC-UMS Storage System

In SAR Appendix F, Section F.7, "Structural Evaluation," the applicant discussed a structural analysis of the NAC-UMS Storage System canister under normal operating conditions, citing the NAC-UMS Storage System FSAR, which the applicant incorporated by reference. The applicant evaluated off-normal and accident conditions in SAR Appendix F, Section F.12, "Accident Analysis." During storage, the canisters related to the NAC-UMS Storage System will be stored inside the VCC overpack, which the staff evaluates in SER Section 5.3.2.4.

The applicant noted in SAR Appendix F, Section F.7.1.7, "NAC-UMS Components Under Normal Operating Conditions," that NAC-UMS Storage System FSAR Section 3.4.4 evaluates the NAC-UMS components under normal operating loads. Additionally, the applicant noted in SAR Appendix F, Section F.7.1.11, "Structural Evaluation of NAC-UMS Canister Confinement Boundaries under Normal Conditions of Transport," that the evaluation of the NAC-UMS canister shells for normal conditions of transport appears in Section 2.6.12 of the NAC-UMS Universal Transport Cask SAR, Revision 2, issued November 2005. The applicant indicated that the discussion in SAR Appendix F, Section F.7.1.7, provides a means to demonstrate that the loading conditions considered in the NAC-UMS Universal Transport Cask SAR bound those for the storage operation. Therefore, the applicant stated that the result of the structural analysis in NAC-UMS Universal Transport Cask SAR Section 2.6.12 is acceptable for the loads and load combinations to demonstrate structural acceptance of the NAC-UMS canister for normal operating conditions at the WCS CISF site. The staff reviewed and verified the information incorporated by reference and determined that it is acceptable because, as discussed previously, the loading conditions considered in the NAC UMS Universal Transport Cask SAR bound those for the WCS CISF storage operation. As a result, the staff concludes that the structural performance of the NAC-UMS canister is acceptable for normal storage operating conditions at the WCS CISF.

In SAR Appendix F, Section F.3.1.1, for certain environmental conditions and natural phenomena, the applicant discussed a structural analysis of the NAC-UMS canisters, citing the NAC-UMS Storage System FSAR, as follows:

- In SAR Appendix F, Section F.3.1.1.2, "Water Level (Flood) Design," the applicant noted that, as documented in SAR Sections 2.4.2.2 and 3.2.2, the WCS CISF is not in a floodplain and is above the probable maximum flood elevation and, therefore, will remain dry in the event of a flood. The staff verified the applicant's assessment and finds it acceptable that no further site-specific evaluations of the NAC-UMS Storage System are required.
- In SAR Appendix F, Section F.3.1.1.3, "Seismic Design," the applicant discussed the seismic ground acceleration calculated to cause a tip-over event. The staff evaluates the seismic stability of the storage cask against sliding and tip-over as deployed on the WCS CISF pad in SER Section 5.3.2.3.1. The structural performance of the canister under the seismic loading is bounded by the acceleration resulting from the cask tip-over event, which the staff evaluates in SER Section 5.3.1.4.4.

- In SAR Appendix F, Section F.3.1.1.4, “Snow and Ice Loadings,” the applicant noted that a worst case ground snow load value of 100 psf (4,788 Pa) was assumed. The applicant noted that the snow load is bounded by the previous evaluation in the load combinations described in NAC-UMS Storage System FSAR Section 3.4.4.2.2. The staff verified the applicant’s assessment and finds it acceptable that no further site-specific evaluations of the NAC-UMS Storage System are required.

In SAR Appendix F, Section F.12, the applicant discussed an analysis of the off-normal and accident design events, including natural phenomena, citing those presented in Chapter 11 of the NAC-UMS Storage System FSAR, which the applicant incorporated by reference.

For the storage of reactor-generated GTCC waste previously loaded at Maine Yankee (GTCC-Canister-MY), the applicant noted that the accident analyses for the storage of NAC-UMS pressurized-water reactor (PWR) fuel bounds the storage of Maine Yankee GTCC waste. The applicant also stated that the GTCC-Canister-MY and concrete overpacks are similar in design to the PWR fuel canisters and overpacks, and the storage heat load for GTCC waste is significantly below that of the stored SNF.

In SAR Appendix F, Section F.12.1, “Maine Yankee,” the applicant identified where in Section 11.1 of the NAC-UMS Storage System FSAR the off-normal and accidents conditions are evaluated for the NAC-UMS Storage System. The off-normal conditions evaluated include the canister off-normal handling load and severe environmental conditions (106 degrees F (41.1 degrees C) and -40 degrees F (-40 degrees C)) in Sections 11.1.3 and 11.1.1 of the NAC-UMS Storage System FSAR.

In SAR Appendix F, Section F.12.1.2, “Accidents,” the applicant identified where in Section 11.2 of the NAC-UMS Storage System FSAR the results of analyses of the design-basis and postulated accident conditions and natural phenomena are evaluated for the NAC-UMS Storage System. The following sections of the NAC-UMS Storage System FSAR contain the analyses relevant to the evaluation:

- accident pressurization—Section 11.2.1
- 24-inch (61-centimeter) drop of vertical concrete cask—Section 11.2.4
- explosion—Section 11.2.5
- fire accident—Section 11.2.6
- maximum anticipated heat load (133 degrees F (56.1 degrees C) ambient temperature)—Section 11.2.7
- earthquake event—Section 11.2.8
- flood—Section 11.2.9
- lightning—Section 11.2.10
- tornado and tornado-driven missiles—Section 11.2.11
- tip-over of the vertical concrete cask—Section 11.2.12

The staff reviewed the above evaluations incorporated by reference and the additional analyses in the SAR. The staff verified the information and determined that the analysis results show adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events. As a result, the staff concludes that the structural integrity of the canisters, which was previously approved for the NAC-UMS Storage System, is acceptable for the WCS CISF.

In SAR Appendix F, Section F.12.1.3, "Concrete Cask Non-Mechanistic Tip-Over Analysis," the applicant used an LS-DYNA finite element analysis to perform a concrete cask non-mechanistic tip-over analysis of the NAC-UMS Storage System. The analysis follows the common modeling approach presented in Section 12.2.2 of the NAC-UMS Storage System FSAR for the design-basis tip-over analysis of the cask, with the exception that the cask-specific and site-specific pad design features and soil properties are considered. The applicant noted that the acceleration used in the basket and canister evaluations was 40g, which bounds the site-specific peak basket acceleration of 37.7g (and also bounds the peak canister acceleration). As a result, the applicant concluded that the previous evaluations of NAC-UMS canister and basket evaluations are bounding for the conditions at the WCS CISF.

The staff reviewed and verified the applicant's evaluation and determined that the site-specific tip-over analysis was properly performed and demonstrates acceptable structural performance of the cask system under the tip-over event because the design basis accelerations remain bounding for the WCS site.

5.3.1.4.6 NAC MAGNASTOR Storage System

In SAR Appendix G, Section G.7, "Structural Evaluation," the applicant discussed a structural analysis of the NAC MAGNASTOR storage system canister under normal operating conditions, citing the NAC MAGNASTOR FSAR, which the applicant incorporated by reference. The applicant evaluated off-normal and accident conditions in SAR Appendix G, Section G.12, "Accident Analysis." During storage, the transportation storage canister (TSC) related to the NAC MAGNASTOR storage system will be stored inside the VCC overpack, which the staff evaluates in SER Section 5.3.2.4

The applicant referred to SAR Appendix G, Sections G.7.1.1 through G.7.1.8, for the normal operating conditions structural analysis of the canister with undamaged and damaged PWR fuel. As presented in the bounding evaluation in SAR Appendix G, Section G.7.1.9, "Structural Evaluation of NAC MAGNASTOR Canister Confinement Boundaries under Normal Conditions of Transport," the applicant used the structural analysis results in Section 2.6.12 of the NAC-MAGNATRAN Transport Cask SAR, Revision 12A, issued October 2012, to demonstrate that the canister confinement boundary is adequate for normal storage operating conditions. The staff reviewed and verified the applicant's evaluation and concludes that the structural performance of the NAC MAGNASTOR canister is adequate for normal storage operating conditions at the WCS CISF.

In SAR Appendix G, Section G.3.1.1, for certain environmental conditions and natural phenomena, the applicant discussed a structural analysis of the NAC MAGNASTOR canister, based on the NAC MAGNASTOR FSAR that the applicant incorporated by reference, as follows:

- In SAR Appendix G, Section G.3.1.1.1, "Tornado Missiles and Wind Loadings," the applicant noted that the design-basis tornado and wind loading is based on RG 1.76 and NUREG-0800. In SAR Appendix G, Section G.3.1, "Undamaged and Damaged PWR Fuel," the applicant stated that the design criteria for environmental conditions and natural phenomena for the NAC MAGNASTOR storage system, as described in Section 2.3 of the NAC MAGNASTOR FSAR, which include the design-basis tornado and wind loading, have been reviewed against the environmental conditions at the WCS CISF. The applicant further noted that analyses presented in Section 3.7.3.2 and discussed in Section 12.2.11 of the NAC MAGNASTOR FSAR demonstrate that the

NAC MAGNASTOR design meets these design-basis criteria. The staff verified the applicant's assessment and finds it acceptable that no further site-specific evaluations of the NAC MAGNASTOR storage system are required.

- In SAR Appendix G, Section G.3.1.1.2, "Water Level (Flood) Design," the applicant noted that, as documented in SAR Sections 2.4.2.2 and 3.2.2, the WCS CISF is not in a floodplain and is above the probable maximum flood elevation. The applicant stated that the site will remain dry in the event of a flood. The staff verified the applicant's assessment and finds it acceptable that no further site-specific flood evaluations of the NAC MAGNASTOR storage system are required.
- In SAR Appendix G, Section G.3.1.1.3, "Seismic Design," the applicant noted that the accelerations obtained from the design-basis tip-over analysis are applied to the TSC and basket structural evaluations presented in NAC MAGNASTOR FSAR Sections 3.7.1 and 3.7.2, respectively. The cask is shown to not suffer significant adverse consequences due to this event. The TSC and basket are shown to maintain performance requirements for design-basis structural integrity. The applicant stated that the existing analysis bounds the WCS CISF site pad design limits for accelerations at the top pad surface. The staff verified the applicant's evaluation and applicable NAC MAGNASTOR FSAR Section and finds the applicant's assessment acceptable that no further evaluations of the canister are required because the existing analysis bounds the WCS CISF site pad design limits for accelerations at the top pad surface.
- In SAR Appendix G, Section G.3.1.1.4, "Snow and Ice Loadings," the applicant noted that a worst case ground snow load value of 100 psf (4,788 Pa) was assumed. The applicant noted that the snow load is bounded by the previous evaluation, including that in Section 2.3.4 of the MAGNASTOR FSAR. The staff verified the applicant's assessment and finds it acceptable that no further site-specific evaluations of the NAC MAGNASTOR canister are required.

In SAR Appendix G, Section G.12, "Accident Analysis," the applicant discussed the off-normal and accident design events, including natural phenomena, citing those presented in Chapter 12 of the NAC MAGNASTOR FSAR, which the applicant incorporated by reference.

In SAR Appendix G, Section G.12.1, "Undamaged and Damaged PWR Fuel," the applicant discussed analyses of the off-normal and design-basis postulated accident conditions, including natural phenomena for undamaged and damaged PWR fuel, referencing Sections 12.1 and 12.2, respectively, of the NAC MAGNASTOR FSAR, which the applicant incorporated by reference. The NAC MAGNASTOR FSAR contains the analyses relevant to the evaluation:

- severe ambient temperature events (106 degrees F (41.1 degrees C) and -40 degrees F (-40 degrees C))—Section 12.1.1
- blockage of one-half of the air inlets—Section 12.1.2
- off-normal TSC handling load—Section 12.1.3
- failure of instrumentation—Section 12.1.4
- small release of radioactive particulate from the TSC exterior—Section 12.1.5
- crane failure during loaded transfer cask movements—Section 12.1.6
- accident pressurization—Section 12.2.1
- failure of all fuel rods with a ground-level breach of the TSC—Section 12.2.2
- fresh fuel loading in the TSC—Section 12.2.3

- 24-inch (61-centimeter) drop of the concrete cask—Section 12.2.4
- explosion—Section 12.2.5
- fire accident—Section 12.2.6
- maximum anticipated heat load (133 degrees F (56.1 degrees C) ambient temperature)—Section 12.2.7
- earthquake event—Section 12.2.8
- flood—Section 12.2.9
- lightning strike—Section 12.2.10
- tornado and tornado-driven missiles—Section 12.2.11
- tip-over of concrete cask—Section 12.2.12
- full blockage of the concrete cask air inlets—Section 12.2.13

The staff reviewed and verified the above analyses, which the applicant incorporated by reference. The staff determined that the analysis results show adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events. As a result, the staff concludes that the structural integrity of the canister, which was previously approved for the NAC MAGNASTOR storage system, is acceptable for the WCS CISF.

In SAR Appendix G, Section G.12.1.3, “Concrete Cask Non-Mechanistic Tip-Over Analysis,” the applicant used an LS-DYNA finite element analysis to perform a concrete cask non-mechanistic tip-over analysis of the NAC MAGNASTOR storage system. The analysis follows the common modeling approach presented in Section 12.2.2 of the NAC MAGNASTOR FSAR for the design-basis tip-over analysis of the cask, with the exception that the cask-specific and site-specific pad design features and soil properties are considered. The applicant stated that the acceleration used in the basket and canister evaluations was 35g. The applicant stated that the site-specific peak basket and canister accelerations, 33.1g and 28g, respectively, continue to be bounded by the design-basis acceleration of 35g. As a result, the staff finds that the previous evaluations of NAC MAGNASTOR canister and basket evaluations are bounding for the conditions at the WCS CISF and therefore the structural integrity will be maintained.

5.3.1.4.7 Greater-Than-Class-C Waste Canisters

The WCS CISF uses the storage overpacks for storage of SNF canisters as well as GTCC waste canisters. In SAR Section 1.1, “Introduction,” the applicant stated that all canisters (SNF and GTCC waste) for a given system identified in SAR Table 1-1 have the same exterior dimensions, are functionally identical, and are designed to be accepted by the applicable identified transportation cask, transfer cask, and storage overpack. Additionally, the applicant indicated that the GTCC waste canisters are all licensed for transport under a CoC under 10 CFR Part 71, “Packaging and transportation of radioactive material,” listed in Table 1-1. The section below shows the staff’s review of the structural capability of the GTCC waste canisters in maintaining confinement function under the effects of the site environmental conditions associated with normal and off-normal operations and postulated accident conditions.

SAR Table 1-1 lists the canisters for storing GTCC waste in the storage overpack designs described in SAR Appendix H under the WCS CISF license. This includes the following:

- the GTCC waste canister to be stored in the NUHOMS-MP187 cask storage system
- the GTCC-Canister-CY and GTCC-Canister-YR to be stored in the NAC-MPC storage system

- the Maine Yankee GTCC canister to be stored in the NAC-UMS Storage System
- the GTCC-Canister-Zion to be stored in the NAC MAGNASTOR storage system

In SAR Section 1.6, "Material Incorporated by Reference," the applicant incorporated by reference the design description of the GTCC waste canisters, citing the relevant information provided in the Rancho Seco ISFSI FSAR for the canister to be stored in the NUHOMS-MP187 cask storage system. For the canisters loaded with the NAC GTCC waste at WCS CISF, the applicant incorporated by reference the relevant information provided in the individual NAC transportation cask SARs and CoCs, which include the following:

- NAC-STC SAR and CoC No. 9235
- NAC-UMS Universal Transport Cask SAR and CoC No. 9270
- NAC-MAGNATRAN Transport Cask SAR and CoC No. 9356

In SAR Appendix H, Section H.3.2.2, "Load Combination Criteria," the applicant noted that the GTCC waste canisters are designed to withstand the environmental conditions in SAR Table 1-2 for the effects of the site characteristics and environmental conditions associated with normal operation, maintenance, and testing of the WCS CISF and to withstand postulated off-normal and accident conditions.

In SAR Appendix H, Section H.8.1, "Normal and Off-Normal Operations," the applicant analyzed the GTCC waste canisters structural performance for the normal and off-normal WCS CISF operations for dead weight, operational loads, and live loads. The applicant stated that the various GTCC waste canisters are comparable to the SNF canisters in terms of the following parameters:

- The nominal thickness of the various GTCC waste canister shells and cover plates are equal to or greater than the thickness specified for the SNF canisters for the associated cask system.
- The chemical and physical properties specified for the various GTCC waste canister shell assemblies are identical to the material properties specified for the SNF canisters for the associated cask system.
- The required thickness of the welds in the various GTCC waste canister shells is equal to or greater than the nominal thickness specified for the SNF canisters for the associated cask system.

The staff evaluated the above and finds that the applicant compared pertinent design features and provided sufficient justification to demonstrate that the GTCC waste and SNF canisters are comparable.

Because of the comparable canister shell assembly design attributes as described above, the applicant evaluated the canister by addressing only the temperature variation effect on the canister structural performance. The applicant stated that the GTCC waste canisters contain insignificant heat load, and the corresponding internal pressures are therefore not anticipated to be significantly greater than the helium backfill pressures. The applicant further noted that the temperature variations in the GTCC waste canister shell assemblies are small. Since the heat load is small and the material temperatures are only slightly greater than ambient, the temperature variations at any point in the shells are approximately equal to the variation in

ambient temperature. As a result, the applicant concluded that these small temperature cycles do not result in damage to, or failure of, the various GTCC waste canister shell assemblies. The staff reviewed the applicant's assessment and, for the reason stated above, found it appropriate for the applicant to only address the temperature variation effect on the canister structural performance. Staff reviewed the applicable temperature conditions and found them to be acceptable because the temperature variations are expected to be negligible and thus will not challenge the structural integrity of the canisters. Therefore, the staff finds that the GTCC waste canisters are structurally adequate for the storage operation at the WCS CISF.

In SAR Appendix H, Section H.8.2.4, "Earthquake," the applicant stated that the GTCC waste canisters are comparable to the previously analyzed SNF canisters for the associated cask system listed in SAR Table 1-1. As such, the applicant incorporated by reference the evaluations of the effects and consequences of the earthquake event for the storage overpacks, which are addressed in SAR Chapter 12. As noted above, the staff finds that the applicant provided sufficient justification to demonstrate that the GTCC waste canisters are comparable to the SNF canisters such that the incorporated by reference earthquake evaluations are applicable. Staff's review of the earthquake evaluations is further described in SER Sections 5.3.1.4.1, 5.3.1.4.4, 5.3.1.4.5, and 5.3.1.4.6.

5.3.1.4.8 Structural Analysis of Confinement Structures – Summary

Based on its review above, the staff concludes that the WCS CISF has adequately presented acceptable structural analyses for the canister-based confinement structures to meet the structural requirements of 10 CFR 72.24(d) and (i) and 10 CFR 72.122(b)(1), (b)(2), (b)(3), (c), (d), (f), (g), (h), (i), (j), (k), and (l).

5.3.2 Reinforced Concrete Structures Important-to-Safety

This section discusses the staff's review of the ITS NUHOMS HSM and AHSM (generically called NUHOMS HSM), NAC-MPC, NAC-UMS and NAC MAGNASTOR (generically called NAC VCC) reinforced concrete overpack structures. The overpacks are classified as ITS because they protect the DSCs against environmental events such as earthquakes and tornado missiles, provide heat transfer for the DSCs, and offer shielding protection. This section also discusses the staff's review of the ITS independent spent fuel storage installation (ISFSI) pad concrete structure used to support the VCCs.

5.3.2.1 Description of the Reinforced Concrete Structures

The staff reviewed and confirmed that the descriptions of the reinforced concrete overpack structures in SAR Section 7.4, "Reinforced Concrete Structures – Important To Safety," Table 7-2, "Structural Evaluations for the Storage Systems at the WCS CISF," and in SAR Appendices A through H for each storage system overpack are consistent with the staff's evaluation approving the use of each storage system. The staff describes the storage pad for the NAC VCCs in SER Section 5.3.2.5.

Based on its review, the staff concludes that the WCS CISF has adequately described the reinforced concrete overpack structures to meet the system description structural requirements in 10 CFR 72.24(a) and (b).

5.3.2.2 Design Criteria for Reinforced Concrete Overpacks

SAR Table 1-2 summarizes the WCS CISF principal design criteria based on the site characteristics. Table 3-1 in each SAR appendix (e.g., Tables A.3-1, B.3-1, C.3-1) lists the design criteria associated with the individual cask systems, which the NRC has previously licensed for comparison with specific criteria required for the WCS CISF design. SER Section 4.3.3 discusses the staff's review of the loading conditions for the structural evaluation of canister and concrete overpack of individual storage cask systems. Loading conditions applicable to the canister storage overpack include thermal loads, tornado wind and tornado missiles, floods, snow and ice, and earthquake.

Sections A.3.3, B.3.3, C.3.3, D.3.3, E.3.1.1/E.3.2.1, F.3.1.1, and G.3.1.1 of SAR Appendices A through G provide the design criteria for environmental conditions and natural phenomena for the NUHOMS MP187, Standardized Advanced NUHOMS, Standardized NUHOMS 61BT/NUHOMS 61BTH Type 1 DSC, NAC-MPC, NAC-UMS, and NAC MAGNASTOR systems, respectively. SER Section 5.3.1.2 provides additional information about the design criteria applicable to each of the aforementioned storage systems. These design criteria, which are defined in individual storage system SARs and have been previously approved by the NRC, are considered in the reinforced concrete overpacks structural analysis reviewed in SER Section 5.3.2.4 and in the following sections.

5.3.2.2.1 Horizontal Storage Module—Model 80

In SAR Appendix A, Section A.7.4, "Structural Analysis of HSM Model 80 with a Canister (Storage Configuration)," the applicant noted that Section 3.2.5 of the Standardized NUHOMS Storage System FSAR discusses the design approach, design criteria, and loading combinations for the reinforced concrete HSM Model 80 and its DSC steel support structure. Tables 3.2-5 and 3.2-8 of the same FSAR provide the loads and load combinations for the HSM concrete and DSC steel support structure, respectively. The applicant noted that the loads and load combination criteria for analysis are the same as those shown in Volume II of the Rancho Seco ISFSI FSAR, Tables 3-4 and 3-6. SAR Appendix A, Section A.7.4, describes how the design criteria for the HSM Model 80 compare to the WCS CISF site. The applicant stated that the loading and structural design criteria for the Rancho Seco ISFSI and the Standardized NUHOMS components bound the WCS CISF design requirements, with the exception of the seismic reconciliation, discussed in SER Section 5.3.1.4. SER Section 5.3.1.2 discusses design criteria applicable to the Standardized NUHOMS cask system.

The staff reviewed applicable portions of the documents incorporated by reference to ensure that the design criteria listed for the HSM Model 80 were adequate. The staff finds that the structural design criteria for the HSM Model 80 were appropriately selected between the cask system and the site because the applicant selected the most limiting criteria or analyzed them as necessary.

5.3.2.2.2 Advanced Horizontal Storage Module

In SAR Appendix B, Section B.7.4, the applicant noted that Sections 2.2 and 3.1.2 and Tables 3.1-9 through 3.1-13 of the Standardized Advanced NUHOMS Storage System FSAR discuss the design approach, design criteria, and loading combinations for the reinforced concrete AHSM and its DSC support structure. SAR Appendix B, Section B.7.4, describes how

the design criteria for the AHSM compare to the WCS CISF site. SER Section 5.3.1.2 discusses design criteria applicable to the Standardized Advanced NUHOMS cask system.

The staff reviewed applicable portions of the documents incorporated by reference to ensure that the design criteria listed for the AHSM were adequate. The staff finds that the structural design criteria for the AHSM were appropriately selected between the cask system and the site because the applicant selected the most limiting criteria.

5.3.2.2.3 Horizontal Storage Module—Model 102

In SAR Appendices C and D, Sections C.7.4 and D.7.4, entitled, “Reconciliation of Thermal Loads for the 61BT DSC in the HSM Model 102 and MP197HB Cask,” and “Reconciliation of Thermal Loads for the Canister in the HSM Model 102 and in the MP197HB Cask),” respectively, the applicant stated that Section 3.2.5.1 of the Standardized NUHOMS Storage System FSAR discusses the design approach, design criteria, and loading combinations for the reinforced concrete HSM Model 102 and its DSC steel support structure. As noted in SAR Appendices C and D, Sections C.7.6 and D.7.6, entitled, “Structural Analysis of HSM Model 102 with 61BT DSC (Storage Configuration),” and “Structural Analysis of HSM Model 102 with Canister (Storage Configuration),” respectively, summaries of loading types applicable to each affected overpack component appear in Tables 8.1-1, 8.1-2, and 8.2-1 of the Standardized NUHOMS Storage System FSAR for normal, off-normal, and accident conditions, respectively. SAR Appendices C and D, Sections C.7.4 and D.7.4, describe how the design criteria for HSM Model 102 compare to the WCS CISF site. The applicant stated that HSM Model 102 was previously analyzed in the Standardized NUHOMS Storage System FSAR, which is incorporated by reference, and that the structural design criteria analyzed in that FSAR bound the site-specific parameters at the WCS CISF site with the exception of the seismic reconciliation discussed in SER Section 5.3.1.4. SER Section 5.3.1.2 discusses design criteria applicable to the Standardized Advanced NUHOMS Storage System FSAR.

The staff reviewed applicable portions of the documents incorporated by reference to ensure that the design criteria listed for HSM Model 102 were adequate. The staff finds that the structural design criteria for HSM Model 102 were appropriately selected between the cask system and the site because the applicant selected the most limiting criteria or analyzed them as necessary.

5.3.2.2.4 NAC-MPC Vertical Concrete Cask

In SAR Appendix E, Section E.3, the applicant noted that Chapter 2 and Appendix 2.A of the NAC-MPC FSAR describe the principal design criteria for the NAC-MPC and NAC MPC-LACBWR storage casks or VCC, respectively. The applicant indicated that applicable portions of criteria sections have been reviewed against the environmental conditions at the WCS CISF and have been shown to be either bounded by the analysis presented in the NAC-MPC FSAR or require no further analysis. SAR Appendix E, Section E.3, describes how the design criteria for the NAC-MPC and NAC MPC-LACBWR VCCs compare to the WCS CISF site. The staff discusses seismic design criteria in SER Section 5.3.2.5. SER Section 5.3.1.2 discusses design criteria applicable to the NAC-MPC FSAR.

The staff reviewed applicable portions of the documents incorporated by reference to ensure that the design criteria listed for the NAC-MPC and NAC MPC-LACBWR VCCs were adequate. The staff finds that the structural design criteria for these storage casks were appropriately

selected between the cask system and the site because the applicant selected the most limiting criteria or analyzed them as necessary.

5.3.2.2.5 NAC-UMS Vertical Concrete Cask

In SAR Appendix F, Section F.3, the applicant noted that Chapter 2 of the NAC-UMS Storage System FSAR describes the principal design criteria for the NAC-UMS storage casks or VCC. The applicant indicated that applicable portions of the criteria sections have been reviewed against the environmental conditions at the WCS CISF and have been shown to be either bounded by the analysis presented in the NAC-UMS Storage System FSAR or require no further analysis. SAR Appendix F, Section F.3, describes how the design criteria for the NAC-UMS VCCs compare to the corresponding parameters of WCS CISF site. The staff further discusses seismic design criteria in SER Section 5.3.2.5.

The staff reviewed applicable portions of the documents incorporated by reference to ensure that the design criteria listed for the NAC-UMS VCCs were adequate. The staff finds that the structural design criteria for these storage casks were appropriately selected between the cask system and the site because the applicant selected the most limiting criteria or analyzed them as necessary.

5.3.2.2.6 NAC-MAGNASTOR Vertical Concrete Cask, Configurations CC1 through CC4

In SAR Appendix G, Section G.3, the applicant noted that Chapter 2 of the NAC MAGNASTOR FSAR describes the principal design criteria for the NAC MAGNASTOR VCC. The applicant indicated that applicable portions of the criteria sections have been reviewed against the environmental conditions at the WCS CISF, and the latter have been shown to be either bounded by the analysis presented in NAC MAGNASTOR FSAR or require no further analysis. The staff discusses seismic design criteria in SER Section 5.3.2.5.

The staff reviewed applicable portions of the documents incorporated by reference to ensure that the design criteria listed for the NAC MAGNASTOR VCCs were adequate. The staff finds that the structural design criteria for these storage casks were appropriately selected between the cask system and the site because the applicant selected the most limiting criteria or analyzed them as necessary.

5.3.2.2.7 Design Criteria for Reinforced Concrete Overpacks - Summary

The staff reviewed and verified the information above and determined that the design criteria for the reinforced concrete overpacks are consistent with those presented in the FSAR approving each cask storage system. On this basis, the staff concludes that those design criteria are acceptable for use in the structural analysis of the reinforced concrete overpacks evaluated in SER Section 5.3.2.4.

Based on its review, the staff concludes that the WCS CISF has adequately discussed the structural design criteria of each cask system's reinforced concrete structures important to safety and meets the requirements in 10 CFR 72.24(c)(1), (c)(2), and (c)(4); 10 CFR 72.40(a)(1); 10 CFR 72.120(a) and (b); 10 CFR 72.122(a), (b), (c), (d), (f), (g), (h), (i), (j), (k) and (l); and 10 CFR 72.128(a) and (b).

5.3.2.3 Material Properties of Reinforced Concrete Overpack Structures

Table 3-1 in SAR Appendices A through G (i.e., Tables A.3-1, B.3-1, C.3-1, D.3-1, E.3-1, F.3-1, G.3-1) summarizes the principal design criteria for the specific license (i.e., Rancho Seco) and CoCs incorporated by reference. Table 3-1 in each appendix also compares the principal design criteria to the conditions of the WCS CISF storage site.

In SAR Appendices A through G, the applicant provided mechanical properties of materials for the individual storage systems. The staff considered the material properties in its structural analysis in SER Section 5.3.2.4 for the reinforced concrete overpack structures, as follows:

- In SAR Appendix A, Section A.7.2, the applicant noted that Table 8.1-3 of the Standardized NUHOMS Storage System FSAR presents the material properties of Standardized NUHOMS HSM Model 80, which are used for storing the MP187 DSCs at the WCS CISF.
- In SAR Appendix B, Section B.7.2, the applicant noted that Section 3.3 of the Standardized Advanced NUHOMS Storage System FSAR provides the material properties for the AHSM.
- In SAR Appendix C, Section C.7.2, the applicant noted that the material properties for Standardized NUHOMS HSM Model 102 to store the 61BT DSC appear in Appendix K, Section K.3.3, of the Standardized NUHOMS Storage System FSAR.
- In SAR Appendix D, Section D.7.2, the applicant noted that the material properties for Standardized NUHOMS HSM Model 102 to store the 61BTH, Type 1 DSC appear in Appendix T, Section T.3.3, of the Standardized NUHOMS Storage System FSAR.
- In SAR Appendix E, Section E.7.1.3, the applicant stated that Section 3.3 of the NAC-MPC FSAR provides the mechanical properties of materials of the NAC-MPC storage system for the Yankee-MPC and CY-MPC.
- In SAR Appendix E, Section E.7.2.3, the applicant stated that Section 3.A.3 of the NAC-MPC FSAR provides the mechanical properties of materials of the NAC MPC-LACBWR system.
- In SAR Appendix F, Section F.7.1.3, the applicant stated that Section 3.3 of the NAC-UMS Storage System FSAR provides the mechanical properties of materials of the NAC-UMS Storage System.
- In SAR Appendix G, Section G.7.1.3, the applicant stated that Chapter 8 of the NAC MAGNASTOR FSAR defines the mechanical and thermal properties of materials used in components of the NAC MAGNASTOR storage system.

In SER Chapter 10, the staff's comparison shows that for most storage systems, the WCS CISF site-specific considerations of material properties are either the same as or bounded by the material properties design criteria for the original specific license and CoCs. Where necessary, the applicant provided new evaluations for thermal events, transfer loads, and seismic events to show that the storage system designs were adequate for the WCS site-specific conditions for normal, off-normal, and accident conditions. The staff reviewed these evaluations and

concluded that the material properties are acceptable to support the structural analyses of the reinforced concrete overpack structures systems, which are evaluated in SER Section 5.3.2.4.

5.3.2.4 Structural Analysis of Reinforced Concrete of Systems, Structures and Components Important to Safety

The following sections present the staff's structural review of the reinforced concrete overpack structures for the six storage cask systems and the ITS concrete pad supporting the NAC VCCs.

5.3.2.4.1 Horizontal Storage Module for MP187 DSCs—Model 80

In SAR Appendix A, Section A.7.4, the applicant noted that the Rancho Seco HSM design is similar to that of the Standardized NUHOMS HSM, which was subsequently designated as HSM Model 80. Additionally, the applicant noted that other Model 80 design attributes, including the loading criteria, with the exception of the seismic loading for the HSM concrete and DSC steel support structure, are the same or bound those approved for the NUHOMS-MP187 DSCs at the WCS CISF site.

In SAR Appendix A, Section A.7.4.1, "Normal and Off-Normal Conditions," the applicant discussed an analysis of the HSM Model 80 reinforced concrete overpack structure, citing the relevant structural evaluation information in the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference and which includes the following:

- Tables 8.1-1 and 8.1-2 present the normal and off-normal loads, which are unique to the HSM storage mode of operations.
- Sections 8.1.1.4 through 8.1.1.7 and 8.1.2 contain the structural analyses of the HSM Model 80 for normal and off-normal operating conditions.
- Tables 8.1-14 through 8.1-19 give the structural analysis results for normal and off-normal conditions.

The applicant referred to Table 8.2-1 in the Standardized NUHOMS Storage System FSAR for the postulated accident loads used in analyzing HSM Model 80, which include tornado winds and tornado-generated missiles, design-basis earthquake, design-basis flood, lightning effects, snow and ice loads, and fire/explosion. Section 8.2 of the Standardized NUHOMS Storage System FSAR presents the structural analyses of HSM Model 80 for accident loads. As the applicant noted, Table 8.2-3 of the Standardized NUHOMS Storage System FSAR presents the HSM structural analyses results for the reinforced concrete floor slab, side wall, front wall, and roof slab of the HSM overpack for the accident conditions.

Because the WCS CISF ground-motion spectral accelerations of the WCS CISF shown in SAR Appendix A, Section A.7.5.3, "HSM Model 80," are higher than those of the HSM design basis, the applicant performed a seismic reconciliation analysis of HSM Model 80 in SAR Appendix D, Section D.7.3.1, "HSM Model 80 and Model 102." The applicant also analyzed the HSM Model 102 modules in SAR Appendix D, Section D.7.3.1. The staff reviews the seismic reconciliation in SER Section 5.3.1.4. In addition, the staff reviews the resulting seismic stresses for HSM Model 102 in SER Section 5.3.2.4.3; the stresses are the same as those for HSM Model 80.

In SAR Appendix A, Section A.7.6, “Thermal Stress Reconciliation of the MP187 Cask System Components,” the applicant performed a thermal stress reconciliation of the MP187 cask system, comparing the WCS CISF environmental ambient conditions with the environmental ambient conditions used for the HSM Model 80 and canister analyses in the Standardized NUHOMS Storage System FSAR. The applicant determined that the maximum temperatures and thermal stress evaluation results in the Standardized NUHOMS Storage System FSAR for the AHSM and canisters remain bounding for the WCS CISF.

In SAR Appendix A, Section A.7.6.1, “Reconciliation of WCS CISF Environmental Ambient Conditions with Environmental Ambient Conditions in the Standardized NUHOMS UFSAR,” the applicant performed a reconciliation of the environmental ambient conditions at the WCS CISF with those evaluated in the Standardized NUHOMS Storage System FSAR. The applicant noted that the normal ambient temperature of 100 degrees F (37.8 degrees C) and off-normal maximum temperature of 125 degrees F (51.7 degrees C) considered in the Standardized NUHOMS Storage System FSAR bound the daily average ambient temperatures of 81.5 degrees F (27.5 degrees C) and 105 degrees F (40.6 degrees C) for normal and off-normal conditions, respectively, at the WCS CISF. In addition, the lowest off-normal ambient temperature at the WCS CISF is 30.1 degrees F (-1.06 degrees C), which is also bounded by the -40 degrees F (-40 degrees C) considered in the Standardized NUHOMS Storage System FSAR.

The staff reviewed the temperature information and confirmed that the temperatures are bounding. This demonstrates that the maximum temperatures and thermal stress evaluation results reported in the Standardized NUHOMS Storage System FSAR for HSM Model 80 remain bounding for the WCS CISF.

The staff reviewed the above evaluations, including those incorporated by reference. The staff verified the information and determined that the analysis results show adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events. As a result, the staff concludes that the structural integrity of HSM Model 80 approved previously is acceptable for the WCS CISF.

5.3.2.4.2 Standardized Advanced NUHOMS Horizontal Storage Module

In SAR Appendix B, Section B.7.4, the applicant discussed a structural analysis of the AHSM reinforced concrete overpack structure, including its internal DSC steel support structure, for normal, off-normal, and accident conditions, citing Sections 3.6, 11.1, and 11.2, respectively, of the Standardized Advanced NUHOMS Storage System FSAR, which the applicant incorporated by reference. The applicant noted that Table 3.6-12 and Table 3.6-13, respectively, of the Standardized Advanced NUHOMS Storage System FSAR describe load combinations applicable to the AHSM reinforced concrete and the DSC steel support structure.

For the component capabilities, the applicant noted that Table 3.6-14 of the Standardized Advanced NUHOMS Storage System FSAR tabulates the calculated ultimate capacities of the AHSM concrete components. Other relevant information from the same FSAR incorporated by reference includes the following:

- the comparison of the capacities with the resulting forces and moments—Table 3.6-15
- the stress analysis results for the DSC steel support structure—Tables 3.6-16 through 3.6-18

- the stress qualification for the AHSM ties and concrete keys—Table 3.6-21

In SAR Appendix B, Section B.7.5, the applicant performed seismic reconciliation of the AHSM structural components. The applicant noted that in Section 2.2.3.1 of the Standardized Advanced NUHOMS Storage System FSAR, the response spectra compatible with NRC RG 1.60, “Design Response Spectra for Seismic Design of Nuclear Power Plants,” Revision 1, dated December 1973, which are anchored at a ZPA of 1.5g and 1.0g for horizontal and vertical seismic motions, respectively, are used to evaluate the AHSM structural performance.

In SAR Appendix B, Figure B.7-2, “Design Basis Response Spectra for Canister, and AHSM compared to the Spectra at the C.G. of the HSM from WCS CISF Soil Structure Interaction Analysis” [proprietary], the applicant showed that the design-basis seismic criteria for the 24PT1 canister and the AHSM significantly exceed the site-specific seismic criteria for the AHSM deployed at the WCS CISF pad. As such, the applicant concluded that the canister and the AHSM designs have significant margins and no reconciliation for seismic loads needs to be performed for the AHSM overpack structural components. The staff confirmed the applicant’s analysis in SAR Appendix B, Figure B.7-2, and finds that the AHSM has sufficient seismic margins.

The staff reviewed the above evaluations, including those incorporated by reference. The staff verified the information and determined that the analysis results show adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events. On this basis, the staff concludes that the structural integrity of the AHSM is acceptable for the WCS CISF.

5.3.2.4.3 Standardized NUHOMS Horizontal Storage Module

5.3.2.4.3.1 Horizontal Storage Module Model 102 for 61BT Dry Shielded Canister

In SAR Appendix C, Section C.7.6, the applicant discussed the structural analysis of the NUHOMS HSM Model 102 reinforced concrete overpack structures, including its internal DSC steel supports, for normal, off-normal, and accident conditions, citing the design approach, design criteria, and loading combinations discussed in Section 3.2.5.1 of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. Tables 8.1-1, 8.1-2, and 8.2-1 of the Standardized NUHOMS Storage System FSAR summarize the loading types applicable to each affected component for normal, off-normal, and accident conditions, respectively.

In evaluating the applicability of the analysis results, the applicant discussed Section K.3.7.10.5 of the Standardized NUHOMS Storage System FSAR and stated that the maximum weight of the 61BT DSC of 88,390 pounds (40,090 kilograms) exceeds the originally analyzed canister design-basis weight of 80,000 pounds (39,920 kilograms). As a result, the applicant adjusted the analysis results to account for the increased weight and determined that the results in Table K.3.7-2 of the Standardized NUHOMS Storage system FSAR continue to remain acceptable for the increased 61BT DSC weight. The staff verified the results in Table K.3.7-2 and noted that a scaling factor was used to address the increased weight. The table and scaling factor were shown to be acceptable.

For the HSM Model 102 reinforced concrete overpack and its steel support structure, the applicant incorporated by reference information on normal load conditions presented in the Standardized NUHOMS Storage System FSAR. This includes the following:

- Section 8.1.1.4, which evaluates the HSM Model 102 DSC steel support structure for normal condition loads. Tables 8.1-14 through 8.1-16 present the results of the analyses.
- Section 8.1.1.5, which evaluates the HSM reinforced concrete structure for normal condition loads. The structure was evaluated in accordance with American Concrete Institute "Code Requirements for Nuclear Safety-Related Concrete Structures (ACI 349-85) and Commentary," considering frame and shear wall behavior using a finite element model. The normal loads considered are deadweight, live loads, creep and shrinkage, thermal stress, and radiation effects. Table 8.1-19 presents the results.
- Section 8.1.1.6, which evaluates the HSM door for deadweight and a uniform pressure of 10 pounds per square inch (psi, 0.069 MPa). The applicant stated that this pressure envelops the equivalent pressure load associated with the seismic and tornado wind pressure.
- Section 8.1.1.7, which evaluates the HSM heat shield for normal condition loads due to the self-weight of the heat shield. The applicant stated that the design of the heat shields allows for free thermal expansion.

In SAR Appendix C, Section C.7.6.2, "Off-Normal Loads," the applicant discussed an analysis for off-normal load conditions presented in the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. This includes the following:

- Section 8.1.2, which evaluates the DSC steel support structure for jammed canister and off-normal thermal loads. Tables 8.1-14, 8.1-15, and 8.1-16 present the results of the DSC steel support structure analyses.
- Section 8.1.2, which evaluates the HSM reinforced concrete structure. Table 8.1-19 shows the results of the HSM analyses.

In SAR Appendix C, Section C.7.6.3, "Accident Loads," the applicant discussed an analysis for the accident conditions and the natural phenomenon loads presented in the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. This includes the following:

- Section 8.2, which evaluates the DSC steel support structure for accident condition loads.
- Section 8.2.3.2, which evaluates the DSC steel support for the design basis earthquake. The seismic loads are the RG 1.60 response spectra anchored at 0.25g and 0.17g in the horizontal and vertical directions, respectively. The ANSYS finite element analysis results demonstrate that all stresses are within allowable limits. The factors of safety against overturning and sliding were calculated. However, a seismic reconciliation for the WCS CISF site-specific seismic loading, which is higher than the design basis, was performed in SAR Appendix C, Section C.7.3.1, "HSM Model 102," and reviewed in SER Section 5.3.2.4.3.
- Section 8.2.2, which evaluates the HSM for tornado wind and tornado-generated missile effects. The resistance of the HSM concrete to tornado-generated missile perforation and scabbing was determined using the National Defense Research Committee formula

with additional margin added based on the requirements of ACI 349-85. The HSM door was shown to be adequate to protect against tornado missile impact. For the massive missile impact, the maximum sliding distance of the HSM was calculated, and the maximum tipping angle of rotation was much less than the critical angle leading to tip-over of the HSM.

- Section 2.4, which evaluates the HSM for the effects of flood loading. The results in Table 8.2-3 demonstrate the safety factors of 1.55 and 1.13 against HSM overturning and sliding, respectively.
- The Section 8.2.6 evaluation of the lightning event which shows that lightning will not affect the operation of the HSM.
- Section 8.2.7, which evaluates the blocked vent thermal loads. The DSC steel support structure was analyzed for thermal stresses associated with growth differential between the steel and concrete structure.

In SAR Appendix C, Section C.7.3.1, the applicant stated that the reconciliation of the seismic loading on HSM Model 102 appears in SAR Appendix D, Section D.7.3.1. SAR Appendix D, Section D.7.3.1, considers the WCS CISF site-specific seismic loading on an HSM Model 102 loaded with a 61BTH Type 1 DSC, the weight of which bounds the 61BT DSC. SER Section 5.3.2.4.3.2 shows the staff's review of the seismic reconciliation of HSM Model 102.

The staff reviewed the above evaluations, including those incorporated by reference. The staff verified the information and determined that the analysis results show adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events. As a result, the staff concludes that the structural integrity of the HSM Model 102 approved previously for storing the 61BT DSC is acceptable for the WCS CISF.

5.3.2.4.3.2 Horizontal Storage Module Model 102 for 61BTH Type 1 Dry Shielded Canister

The Standardized NUHOMS HSM is used at the WCS CISF for storing both the 61BT and 61BTH Type 1 DSCs. In SAR Appendix D, Section D.7.3.1, the applicant discussed an evaluation of the structural analysis of the HSM reinforced concrete overpack and its internal DSC steel supports based on information from the FSAR incorporated by reference. By comparing the information presented as design basis in Section 8 and Appendix K of the Standardized NUHOMS Storage System FSAR to those at the WCS CISF, the applicant determined that, with the exception of seismic loading, the design-basis loads are bounding. As noted in the safety review in SER Section 5.3.2.4.3.1, the staff concludes that applicant's evaluation is acceptable to demonstrate adequate structural adequacy of the HSM for the WCS CISF.

In SAR Appendix D, Section D.7.6, for storing the 61BTH Type 1 DSC in the same Standardized NUHOMS HSM as the 61BT DSC, the applicant discussed a structural analysis, citing relevant information in Section 8 and Appendix T, instead of Appendix K, of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. In recognizing certain design feature differences between the 61BT and 61BTH Type 1 DSCs, the applicant noted that the analysis considers the bounding features to demonstrate structural adequacy of the HSM for the DSCs. The relevant design features considered in the Standardized NUHOMS Storage System FSAR include the following:

- The FSAR considers the analyses and results originally performed for a bounding canister weight of 80.0 kips (356 kilonewtons (kN)) as opposed to the maximum weight of 88.7 kips (394 kN) for the 61BTH Type 1 DSC presented in Table T.3.2-1.
- The FSAR considers the HSM DSC steel support structure qualification in Appendix M for a bounding weight of 102 kips (454 kN), which bounds the maximum weight of the 61BTH Type 1 DSC. The HSM door and heat shields are not affected by the weight of the canister and are, therefore, qualified by the design-basis calculations described in Sections 8.1 and 8.2. The staff finds that the applicant provided sufficient justification to demonstrate that the weight of the canister has no adverse effect on the design-basis calculation and hence is acceptable.

In SAR Appendix D, Section D.7.3, the applicant performed seismic reconciliation of HSM Model 102 for the WCS CISF seismic loads, which exceeds the Standardized NUHOMS Storage System design-basis loads. In SAR Appendix D, Section D.7.3.1, the applicant considered the enveloping response spectra at the HSM CG obtained from the WCS CISF SSI analysis for the structural performance calculation. The applicant indicated that this reconciliation evaluation employs the same analysis methodology used for the seismic evaluation of the HSM in Section 8.2.3.2.B of the Standardized NUHOMS Storage System FSAR.

The applicant performed a response spectrum analysis of the HSM using the 7-percent damped response spectra at the HSM CG obtained from the WCS CISF SSI analysis. The ANSYS finite element analysis model includes an 88.7-kips (394-kN) canister, which is the weight of the 61BTH Type 1 DSC and bounding for the DSC types considered in this application. The forces and moments in the various concrete components of the HSM and its steel support structures are evaluated and compared to the previous approved results in the Standardized NUHOMS Storage System FSAR, as applicable. The staff evaluated the comparison of the analysis results as follows.

- In SAR Appendix D, Section D.7.3.1.3, the applicant evaluated the forces and moments for each HSM subcomponent (roof slab, walls, and floor slab), citing the results described in Section 8.1.1.5.E of the Standardized NUHOMS Storage System FSAR. For the comparison shown in SAR Table D.7-1, "Comparison of Seismic Load Combination Forces and Moments on HSM Concrete Components with Capacities (kip/ft, kip-in/ft)," the applicant indicated that the demand-to-capacity ratios for all the HSM concrete subcomponents are less than 1.0. As such, the applicant stated that the HSM concrete components are acceptable for the WCS CISF site-specific seismic loading. For this reason, the staff confirmed the applicant's analysis and finds that sufficient margin exists, and therefore the results are acceptable.
- In SAR Appendix D, Section D.7.3.1.4, "Evaluation of the DSC Steel Support Structure," the applicant evaluated the forces and moments for each DSC steel support structure component. The applicant showed that the resulting stresses have either a factor of safety greater than unity or a stress interaction ratio less than 1.0, when compared to the values allowed by the American Institute of Steel Construction (AISC), Specification for Structural Steel Buildings, dated 1989. As such, the applicant stated that the DSC steel support structure components are qualified and are acceptable for the WCS CISF site-specific seismic loading. For this reason, the staff confirmed the applicant's analysis and finds that sufficient margin exists, and therefore the results are acceptable.

- In SAR Appendix D, Section D.7.3.1.5.1, “Evaluation of the DSC Axial Retainer,” the applicant evaluated the DSC axial retainer, referencing the evaluation presented in Section 8.2.3.2(C)(iii) of the Standardized NUHOMS Storage System FSAR. The seismic load on the retainer is calculated from a response spectrum analysis, and the maximum shear and bending stresses in the retainer are shown to be below the respective allowable values. For this reason, the staff finds that sufficient margin exists, and therefore the results are acceptable.
- In SAR Appendix D, Section D.7.3.1.5.2, “Evaluation of the Heat Shields,” the applicant evaluated the HSM heat shield plates, citing the evaluation presented in Section 8.1.1.7 of the Standardized NUHOMS Storage System FSAR. The seismic load for the heat shields is calculated from a response spectrum analysis. The resulting maximum bending stress in the shield plate is shown as less than the allowable. Therefore, the applicant stated that the heat shield plates are adequate for the WCS CISF seismic loading. Additionally, the applicant evaluated the heat shield stud anchorage for the axial, shear, and bending forces. The staff noted that the computed maximum axial, bending, and shear stresses in the studs are shown to be less than the stress allowable values. On this basis, the applicant concluded that the structural integrity of the heat shield plate and its stud anchorage are acceptable for the WCS CISF seismic loading. The staff finds that sufficient margin exists because the calculated stresses on the heat shield and its related components are less than the allowable and therefore the results are acceptable.
- In SAR Appendix D, Section D.7.3.1.6, “Evaluation of HSM Seismic Stability and Sliding,” the applicant evaluated the HSM seismic stability against sliding and overturning for the WCS CISF seismic loading condition. The applicant noted the maximum calculated sliding distance, rocking angle, and uplift height of 0.19 inch (0.48 centimeter), 0.05 degree, and 0.08 inch (0.20 centimeter), respectively, for the HSM, based on an SSI analysis, which the staff reviews in SER Section 5.3.1.4.3. As a result, the applicant stated that the sliding and overturning stability characteristics of the HSM are acceptable for the WCS CISF seismic loading. The staff finds that significant sliding margin exists between adjacent HSMs and the edge of the pad, which makes the approach adequate.

As noted, the staff reviewed the above evaluations, including those incorporated by reference. The staff verified the information and determined that the analysis results show adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events. As a result, the staff concludes that the structural integrity of the HSM Model 102 approved previously for storing the 61BTH Type 1 DSC is acceptable for the WCS CISF.

5.3.2.4.4 NAC-MPC Vertical Concrete Cask

In SAR Appendix E, Sections E.7.1.7 and E.7.2.7, the applicant discussed an evaluation of the structural performance of the NAC-MPC and NAC MPC-LACBWR storage systems, respectively, under normal operating conditions, referring to the safety analysis provided in the NAC-MPC FSAR, which the applicant incorporated by reference. The relevant analyses for the two VCCs include those presented in Sections 3.4.4 and 3.A.4.4 of the NAC-MPC FSAR.

In SAR Appendix E, Sections E.12.1.1 and E.12.2.1, the applicant discussed a structural analysis of the NAC-MPC and NAC MPC-LACBWR VCCs, respectively, under off-normal conditions, referring to the safety analyses provided in the NAC-MPC FSAR, which the applicant incorporated by reference. The evaluations for the design-basis accident conditions, including natural phenomena, appear in Appendix E, Sections E.12.2.1 and E.12.2.2, of the NAC-MPC FSAR. The following NAC-MPC FSAR sections contain the analyses relevant to the NAC-MPC for the Yankee-MPC and CY-MPC VCCs:

- earthquake event—Section 11.2.2
- explosion—Section 11.2.3
- flood—Section 11.2.6
- lightning—Section 11.2.9
- storage cask 6-inch (15-centimeter) drop—Section 11.2.11
- tip-over of the vertical concrete cask—Section 11.2.12
- tornado and tornado-driven missiles—Section 11.2.13

The analyses relevant to the NAC MPC-LACBWR VCCs appear in the following NAC-MPC FSAR sections:

- earthquake event—Section 11.A.2.2
- flood—Section 11.A.2.6
- tip-over of the vertical concrete cask—Section 11.A.2.12
- tornado and tornado-driven missiles—Section 11.A.2.13

In SAR Appendix E, Section E.3.1.1, the applicant discussed the design criteria for environmental conditions and natural phenomena for the design-basis structural analyses of the NAC-MPC for the Yankee-MPC and CY-MPC presented in the NAC-MPC FSAR. The staff reviewed the design criteria for comparison with those associated with the WCS CISF to demonstrate that the design-basis analyses remain applicable for the WCS CISF, as follows:

- SAR Appendix E, Section E.3.1.1.1, “Tornado and Wind Loadings,” notes that the design-basis tornado missile impacts are defined in NUREG-0800, Section 3.5.1.4, “Missiles Generated by Tornadoes and Extreme Winds,” Subsection III, Paragraph 4. The staff reviewed Section 11.2.13 of the NAC-MPC FSAR and confirmed that the tornado missile design criteria had been used properly in analyzing the NAC-MPC VCC. Because the NAC-MPC design criteria meet or bound those for the WCS CISF, the staff finds acceptable the applicant’s statement that no further site-specific evaluations are required.
- In SAR Appendix E, Section E.3.1.1.2, “Water Level (Flood) Design,” the applicant noted that, as discussed in SAR Sections 2.4.2.2 and 3.2.2, the WCS CISF is not in a floodplain and is above the probable maximum flood elevation. As such, the staff finds acceptable the applicant’s statement that no further site-specific flood evaluations are required.
- In SAR Appendix E, Section E.3.1.1.3, the applicant noted that the NAC-MPC VCCs will not tip over during a design-basis seismic event with the acceleration components of 0.25g horizontal and 0.167g vertical at the concrete storage pad top surface. Nonetheless, since the design-basis earthquake motions are exceeded by the site-specific earthquake motions, the applicant reevaluated the VCC seismic stability in

SAR Section 7.6.3.4, “Results and Conclusions,” which the staff reviews in SER Section 5.3.2.5.

- In SAR Appendix E, Section E.3.1.1.4, the applicant noted that the design-basis snow load in Section 2.2.4 of the NAC-MPC FSAR had been considered in the cask system load combinations presented in Section 3.4.4.2.2 of the NAC-MPC FSAR. As such, the staff finds acceptable the applicant’s statement that no further site-specific evaluations are required.

The staff reviewed the above evaluations incorporated by reference. The staff verified the information and determined that the analysis results show adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events. As a result, the staff concludes that the NAC-MPC VCC is structurally capable for the WCS CISF and is acceptable.

In SAR Appendix E, Section E.3.2.1, the applicant noted that the environmental conditions and natural phenomena used in structural analyses of the NAC MPC-LACBWR are the same in their entirety as those for the NAC-MPC for the Yankee-MPC and CY-MPC cask storage systems. As such, the staff concludes that the analyses in SAR Appendix E, Section E.3.1.1, based on information incorporated by reference and reviewed in the preceding paragraphs, are applicable and no further staff safety evaluation of the NAC MPC-LACBWR VCC is needed.

5.3.2.4.5 NAC-UMS Vertical Concrete Cask

In SAR Appendix F, Section F.7.1.7, the applicant discussed a structural analysis of the NAC-UMS VCC under normal operating conditions, referring to the safety analysis provided in the NAC-UMS Storage System FSAR, which the applicant incorporated by reference. The relevant analyses for the VCCs include those presented in Section 3.4.4 of the NAC-UMS Storage System FSAR.

In SAR Appendix F, Section F.12.1.1, “Off-Normal Events,” the applicant discussed a structural analysis of the NAC-UMS VCC under off-normal conditions, referring to the safety analyses provided in the NAC-UMS Storage System FSAR, which the applicant incorporated by reference. The staff found that no off-normal event identified in the section warranted a VCC structural evaluation. SAR Appendix F, Section F.12.1, presents the evaluations for the design-basis accident conditions, including natural phenomena. The analyses relevant to the NAC-UMS VCC appear in the following sections of the NAC-UMS Storage System FSAR:

- earthquake event—Section 11.2.8
- flood—Section 11.2.9
- tornado and tornado-driven missiles—Section 11.2.11
- tip-over of the vertical concrete cask—Section 11.2.12

In SAR Appendix F, Section F.3.1.1, the applicant discussed the design criteria for environmental conditions and natural phenomena for the design-basis structural analyses of the NAC-UMS presented in the NAC-UMS Storage System FSAR. The design basis analyses remain applicable for the WCS CISF, as shown in the following comparison of the design criteria with those associated with the WCS CISF:

- In SAR Appendix F, Section F.3.1.1.1, the applicant noted that the design-basis tornado missile impacts are defined in NUREG-0800, Section 3.5.1.4, Subsection III,

Paragraph 4. The staff reviewed Section 11.2.13 of the NAC-UMS Storage System FSAR and confirmed that the tornado missile design criteria had properly been used in analyzing the NAC-UMS VCC. Because the NAC-UMS Storage System design criteria meet or bound those for the WCS CISF, the staff finds acceptable the applicant's statement that no further site-specific evaluations are required.

- In SAR Appendix F, Section F.3.1.1.2, the applicant noted that, as discussed in SAR Sections 2.4.2.2 and 3.2.2, the WCS CISF is not in a floodplain and is above the probable maximum flood elevation. As such, the staff finds acceptable the applicant's statement that no further site-specific flood evaluations are required for the NAC-UMS VCC.
- In SAR Appendix F, Section F.3.1.1.3, the applicant discussed an analysis of the VCC seismic response, referring to Section 12.2.8 of the NAC-UMS Storage System FSAR, which the applicant incorporated by reference. The applicant stated that the NAC-UMS VCC is seismically stable against sliding and tip-over during a design-basis earthquake event with a horizontal acceleration of 0.37g. The vertical acceleration for this evaluation is defined as two-thirds of the horizontal acceleration. Nonetheless, since the design-basis earthquake motions are exceeded by the site-specific earthquake motions, the applicant reevaluated the VCC seismic stability in SAR Section 7.6.3, "Soil Structure Interaction of the VCC Storage Pad," which the staff reviews in SER Section 5.3.2.5.
- In SAR Appendix F, Section F.3.1.1.4, the applicant noted that the design-basis snow load in Section 2.3.4 of the NAC-UMS Storage System FSAR had previously been considered in approving the cask system. As such, the staff finds acceptable the applicant's statement that no further site-specific evaluations are required.

The staff reviewed the above evaluations incorporated by reference. The staff verified the information and determined that the analysis results show adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events. As a result, the staff concludes that the NAC-UMS VCC is structurally capable for the WCS CISF and is acceptable.

5.3.2.4.6 NAC MAGNASTOR Vertical Concrete Casks, Configurations CC1 through CC4

In SAR Appendix G, Section G.7.1.7, "Normal Operating Conditions," the applicant discussed a structural analysis of the NAC MAGNASTOR storage system under normal operating conditions, referring to the safety analysis provided in the NAC MAGNASTOR FSAR, which the applicant incorporated by reference. The relevant analyses for the two VCCs include those presented in Section 3.5 of the NAC MAGNASTOR FSAR.

In SAR Appendix G, Section G.12.1.1, "Off-Normal Events," the applicant discussed structural evaluations of the structural performance of the NAC MAGNASTOR concrete cask under off-normal conditions, referring to the safety analyses provided in the NAC MAGNASTOR FSAR, which the applicant incorporated by reference. The staff found that no off-normal event identified warranted a structural evaluation of the concrete casks. The evaluations for the design-basis accident conditions, including natural phenomena, appear in SAR Appendix G, Section G.12.1.2, "Accidents and Natural Phenomena." The following sections of the NAC MAGNASTOR FSAR contain the analyses relevant to the concrete cask structural evaluation:

- earthquake event—Section 11.2.8
- flood—Section 11.2.9
- tornado and tornado-driven missiles—Section 11.2.11
- tip-over of the vertical concrete cask—Section 11.2.12

In SAR Appendix G, Section G.3.1.1, the applicant discussed the design criteria for environmental conditions and natural phenomena for the design-basis structural analyses of the NAC MAGNASTOR concrete cask presented in the NAC MAGNASTOR FSAR. The following summarizes the staff's review comparing the design criteria with those associated with the WCS CISF to demonstrate that the design-basis analyses remain applicable for the WCS CISF:

- In SAR Appendix G, Section G.3.1.1.1, the applicant noted that the design-basis tornado missile impacts are defined in NUREG-0800, Section 3.5.1.4, Subsection III, Paragraph 4. The staff reviewed Section 11.2.11 of the NAC MAGNASTOR FSAR and confirmed that the tornado missile design criteria had properly been used in analyzing the concrete cask. Because the NAC MAGNASTOR design criteria meet or bound those for the WCS CISF, the staff finds acceptable the applicant's statement that no further site-specific evaluations are required.
- In SAR Appendix G, Section G.3.1.1.2, the applicant noted that, as discussed in SAR Sections 2.4.2.2 and 3.2.2, the WCS CISF is not in a floodplain and is above the probable maximum flood elevation. As such, the staff finds acceptable the applicant's statement that no further site-specific flood evaluations are required.
- In SAR Appendix G, Section G.3.1.1.3, the applicant discussed an analysis of the NAC MAGNASTOR concrete cask seismic response, referring to Section 12.2.8 of the NAC MAGNASTOR FSAR, which the applicant incorporated by reference. The applicant stated that the NAC MAGNASTOR concrete cask is seismically stable against sliding and tip-over during a design-basis earthquake event with a horizontal acceleration of 0.37g. The vertical acceleration for this evaluation is defined as two-thirds the horizontal acceleration. However, since the site-specific earthquake motions exceed the design-basis earthquake motions, the applicant reevaluated the concrete cask seismic stability in SAR Section 7.6.3.4, which the staff reviews in SER Section 5.3.2.5.
- In SAR Appendix G, Section G.3.1.1.4, the applicant noted that the NRC had previously considered the design-basis snow load in Section 2.3.4 of the NAC MAGNASTOR FSAR in approving the cask system. As such, the staff finds that no further site-specific evaluations are required.

The staff reviewed the above evaluations incorporated by reference. The staff verified the information and determined that the analysis results show adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events. As a result, the staff concludes that the NAC MAGNASTOR VCC is structurally capable for the WCS CISF and is acceptable.

5.3.2.4.7 Structural Analysis of Reinforced Concrete of Systems, Structures and Components Important to Safety – Summary

Based on its review, the staff concludes that the WCS CISF has adequately presented acceptable structural analyses for the cask specific reinforced concrete SSCs ITS and meets

the structural requirements of 10 CFR 72.24(d) and (i) and 10 CFR 72.122(b)(1), (b)(2), (b)(3), (c), (d), (f), (g), (h), (i), (j), (k), and (l).

5.3.2.5 NAC Vertical Concrete Cask Storage Pad

5.3.2.5.1 Description of the Vertical Concrete Cask Storage Pad

The WCS CISF storage pads for the NAC VCC systems are conventional cast-in-place, reinforced concrete, mat foundation structures. The storage pads are 135 feet (41.1 meters) long, 55 feet (17 meters) wide, and 3 feet (1 meter) thick and provide a level and stable surface for placement and storage of VCCs. The steel reinforcement consists of #9 rebar at 8 inches (20 centimeters) each way. SAR Figure 1-3, "WCS CISF Site Overview," shows the locations of concrete storage pads and dimensions. Additionally, drawings NAC004-C-001 and NAC004-C-002 of NAC004-CALC-04 provide structural details for the VCC pad. The storage pads are classified as ITS. The staff reviewed the aforementioned drawings and determined that the applicant provided sufficient information to describe the VCC storage pad.

The applicant stated that three types of storage casks will be housed at the VCC storage pad: the NAC MAGNASTOR, NAC-UMS, and NAC-MPC storage casks. The applicant stated that based on the weight and size of the three casks, the NAC MAGNASTOR cask envelops the other NAC casks to be stored at the WCS CISF and is therefore chosen as the bounding cask for the analyses. The licensing basis VCC configuration is a 3 x 8 array of NAC MAGNASTOR casks. The staff reviewed pertinent characteristics, including weight and size, of the different casks and determined that the NAC MAGNASTOR cask bounds the other NAC casks to be stored at the WCS CISF.

Based on its review, the staff concludes that the WCS CISF has adequately described the NAC VCC storage to meet the system description structural requirements in 10 CFR 72.24(a) and (b).

5.3.2.5.2 Design Criteria for the Vertical Concrete Cask Storage Pad

In SAR Section 7.6.1, "Storage Pads for VCCs," the applicant referenced guidance in NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," issued March 2000; NUREG-1536, "Standard Review Plan for Dry Cask Storage Systems," issued July 2010; and NUREG-0800, dated March 2007, in its evaluation to structurally qualify the VCC storage pad. The codes of record and regulatory guides used for the design include ACI 318-08, "Building Code Requirements for Structural Concrete"; ACI 349-06; American Society of Civil Engineers (ASCE)/Structural Engineering Institute (SEI) 7-05, "Minimum Design Loads for Buildings and Other Structures"; ASCE/SEI 43-05, "Seismic Design Criteria for Structures, Systems, and Components in Nuclear Facilities"; RG 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," Revision 1, issued March 2007; and RG 1.76, Revision 1.

The applicant discussed design inputs for the storage pads in SAR Section 7.6.1.1, "Design Inputs." The reinforced concrete pad has a minimum concrete compressive strength of 4,000 psi (27.6 megapascals (MPa)), concrete elastic modulus of 3,605 kilopounds per square inch (ksi) (24,855 MPa), and reinforcing steel with a yield strength of 60 ksi (413.7 MPa). The pads are supported by in situ soil with an allowable bearing capacity of 3,000 psf (0.14 MPa). The modulus of subgrade reaction is 150 psi per inch (0.40 MPa per centimeter), and the

coefficient of friction between the concrete pad and bearing soil is 0.35. Subsurface water was not observed at the WCS CISF site.

The applicant discussed the design loads applicable to the VCC storage pad and considered criteria established in NUREG-1536 and ACI 349-06 to calculate governing load combinations. Governing load combinations were compiled based on code load combinations, considerations for reduced dead load and live load effects, and directions of seismic excitation. The resulting load combinations include both strength and stability considerations. SAR Section 7.6.1.4, "Load Combinations," contains the resulting governing load combinations. The staff finds that the resulting load combinations are appropriate and consistent with the guidance in NUREG-1536 and ACI 349-06.

Based on its review, the staff concludes that the WCS CISF has adequately discussed the structural design criteria of VCC storage pad and meets the structural requirements in 10 CFR 72.24(c)(1), (c)(2), and (c)(4); 10 CFR 72.40(a)(1); 10 CFR 72.120(a) and (b); 10 CFR 72.122(a), (b), (c), (d), (f), (g), (h), (i), (j), (k), and (l); and 10 CFR 72.128(a) and (b).

5.3.2.5.3 Structural Analysis of the Vertical Concrete Cask Storage Pad

The reinforced concrete storage pad has a minimum concrete compressive strength of 4,000 psi (27.6 MPa) and the reinforcing steel has a yield strength of 60 ksi (413.7 MPa).

5.3.2.5.3.1 Model Characteristics

In SAR Section 7.6.1.5, "Cask Layout Configurations," the applicant discussed the various aspects of the structural analysis of the storage pad. The applicant considered different aspects, such as cask layout configurations, concrete pad modeling, and concrete pad stiffness properties. The applicant used the GTSTRUDL model for this analysis.

The applicant stated that during the life of the storage pad, several different cask layout configurations and numbers of casks are possible. The applicant analyzed four representative enveloping cask configurations. In addition, the applicant included several permutations of vertical cask transporter (VCT) locations in each configuration to assess its impact on the response. The cask layout configurations include the following:

- 6 casks on 2 rows, quarter-loaded
- 12 casks on 2 rows, half-loaded
- 18 casks on 6 rows, three-quarter loaded
- 24 casks on 8 rows, fully loaded

The applicant modeled the storage pad using the static GTSTRUDL model, which uses a four-node, six-degree-of-freedom, plate-bending and stretching element to represent the concrete pad. The finite element mesh is sufficiently refined to accurately capture the pad bending moments between adjacent VCCs.

In order to model the casks on the pad, the applicant used rigid members to locate the cask CG in the model. The weight of the cask and the seismic forces are applied at the CG. The lower ends of the frame members are pin-connected to the top of the mat to avoid transferring bending moments. The applicant simulated the rigid behavior of the casks through the cross-sectional area and moments of inertia of the frame members. A pin connection is conservative, as it prevents sliding, therefore increasing the forces upon the pad. Element body

forces are used to represent the self-weight of the concrete. Element surface loads are used to represent live loads on the pad.

The applicant reduced the pad stiffness to account for cracking by reducing the numerical value of the elastic and shear moduli by 50 percent. The applicant used guidance in ASCE/SEI 43-05 to approximate the effective stiffness of the storage pad. This approach is conservative, as it better represents the effective flexural and shear rigidity of the pad and promotes flexibility in the pad.

The applicant used a nonlinear spring model in the GTSTRUDL analysis. Soil springs were included at each storage pad node. The applicant did not reduce the soil spring stiffness at the perimeter of the storage pad to account for the effect of the elastic half space. The applicant provided an alternative approach that consisted of an iterative process using SETTLE3 software in which the subgrade modulus was permutated, and displacements were calculated. This iterative process was continued until the calculated soil modulus values and displacements did not change more than 10 percent between consecutive iterations. The approach considers the nodal forces between the elements on the pad and the underlying soil and can be considered a good indication of pad flexibility. For the above-mentioned reasons, the staff finds the approach taken in the modeling to be acceptable.

5.3.2.5.3.2 Structural Capacity of the Vertical Concrete Cask Pad

The applicant performed the structural analysis of the pad using GTSTRUDL. As discussed earlier, the applicant considered various cask configurations and load combinations including VCT loading. Based on the GSTSRUDL results, the applicant obtained maximum positive and negative moments in the long and short directions of the pad as well as the maximum one-way shear force in the pad. In order to ascertain the structural capacity of the pad, the applicant's evaluation included the following:

- minimum shrinkage and temperature reinforcement
- design flexural capacity of the pad (evaluation of maximum moments in both directions)
- one-way shear capacity of the pad (consideration of the worst case shear resultants in both directions for this approach)
- punching (two-way) shear capacity of the pad (use of the maximum shear resultant for this approach)

Based on the analyses performed, the applicant concluded that #9 rebar at 8 inches (20 centimeters) on center for each face in each direction in addition to the 36-inch- (91-centimeter)-deep concrete pad and 4,000-psi (27.6-MPa) concrete compressive strength provide sufficient capacity to resist the maximum moments and shears as well as provide adequate reinforcement for shrinkage and temperature effects. The staff reviewed the evaluation and notes that the applicant used conservatism when appropriate. In particular, the staff noted that applicable portions of ACI 349-06 and ACI 318-08 were used in the design calculations. Overall, the staff finds that the structural capacity of the VCC storage pad is consistent with the guidance provided in NUREG-1567 and is acceptable.

5.3.2.5.4 Vertical Concrete Cask Storage Pad Stability

The applicant discussed soil-bearing pressure for the VCC storage pads. The applicant calculated maximum bearing pressure of the pad against the soil as a function of the modulus of subgrade reaction and compared it to the necessary soil-bearing capacity. The applicant estimated a factor of safety greater than 1, and therefore the staff finds this calculation acceptable.

The applicant discussed the elastic settlement of the VCC pad and liquefaction potential of SAR Section 2.6.4, "Stability of Subsurface Materials," discussed further in SER Section 2.3.6.4. The applicant stated that an elastic settlement analysis is appropriate for the site. The staff finds that this approach is acceptable, as the aforementioned soils are mostly cohesionless soils; therefore, the elastic approach is adequate. The applicant considered the ISFSI concrete pad to be flexible for settlement purposes, which results in a conservatively larger settlement in comparison to assuming a rigid pad. The applicant considered a uniform pressure applied to the pad. The applicant also considered best and lower bound estimates of the soil elastic modulus to account for uncertainty. SAR Section 7.6.2.4, "Elastic Settlement Evaluation," shows the calculated settlements at the center and corner of the pad. The applicant concluded that the maximum expected settlement for the pad is expected to be 0.70 inch (1.8 centimeters). The staff finds that the applicant's settlement analysis includes appropriate conservatisms and is acceptable because expected bending moments related to this amount of settlement are not expected to adversely affect the structural capacity of the pad.

In SAR Section 7.6.2.5, "Calculations," the applicant described the liquefaction potential evaluation for the site. Further details appear in SER Section 2.3.6.4. The applicant indicated that groundwater was not encountered within the explored depths; nevertheless, the applicant performed a liquefaction potential calculation considering the possibility of the site soils becoming fully saturated. The applicant based its evaluation on RG 1.198, "Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites," Revision 0, issued November 2003. Based on the evaluations performed, the applicant concluded that soils beneath the pads are not susceptible to liquefaction. The staff finds this approach acceptable because the in situ data demonstrate that no groundwater was found at the site, which precludes the possibility of soil liquefaction.

5.3.2.5.5 Soil Structure Interaction of the Vertical Concrete Cask Storage Pad

For the SSI study, the applicant followed the guidelines presented in NUREG-0800, Section 3.7.2, "Seismic System Analysis," Revision 3, dated March 2007. Additionally, to account for potential effects of variability in the underlying rock and soil conditions, the applicant considered three different soil profiles. Best estimate (BE), lower bound (LB), and upper bound (UB) profiles were calculated based on field data results. This is consistent with the guidance in NUREG-0800, Section 3.7.2.

The applicant's SSI study, described in SAR Section 7.6.3, considered three earthquake time histories: Coyote Lake, Norcia (Italy), and North Palm Springs. Each of these include three components (two horizontal and one vertical). All components were applied to the SSI model simultaneously to generate a combined response output. The staff notes that the input time histories are developed in accordance with NUREG-0800, Section 3.7.1, "Seismic Design Parameters," Subsection I, Paragraph B, Option 1. In addition, the results for time histories are enveloped to conservatively account for variability among ground motions.

The applicant's SSI soil model consists of a surface-founded storage pad located at the bottom of the proposed excavation. The site soil profile is truncated with the top 4 feet (1.2 meters) of in situ (backfill) material removed down to 1,043 feet (318 meters) below ground surface. The first 40 feet (12 meters) were classified as silty sand with the subsequent layers consisting of clay and rock. The first 40 feet (12 meters) were assigned a Poisson's ratio of 0.35 for sand, while the remaining clay/rock layers were assigned a Poisson's ratio of 0.25, consistent with published values for rock. The applicant considered three strain compatible soil profiles (BE, UB, and LB). Each soil profile had its respective shear wave velocities and damping ratios.

The applicant used the SC-SASSI computer program for the SSI analysis. The concrete pad was generated using four-node shell elements, while the VCCs are modeled using rigid beam and spring elements. The mass of each cask is lumped at their respective CG. The staff notes that rigid members are configured to minimize any finite element stiffening effects on the concrete pad. The staff noted that pad finite element mesh is sufficiently refined to accurately capture the pad bending moments between adjacent VCCs.

As discussed previously, the applicant considered a total of 36 SSI analysis cases. These cases represent four different cask configurations, three soil profiles cases, and three time histories. The applicant found that the enveloping maximum accelerations at the cask CG are as follows:

- 0.45g in the X/east-west direction
- 0.40g in Y/north-south direction
- 0.28g in Z/vertical direction

5.3.2.5.6 Vertical Concrete Cask Stability Analyses

The applicant calculated VCC sliding using the reserve energy method, as discussed in ASCE/SEI 43-05. A sliding coefficient was calculated using the peak vertical acceleration of the cask and the static friction coefficient between the pad and cask. The cask sliding distance was calculated taking into consideration the 10-percent-damped vectoral spectral horizontal acceleration of the cask and a factor of safety of 2, as stated in ASCE/SEI 43-05. The applicant stated that the calculated distance is within tolerable limits. The staff found that conservatisms were used when appropriate; in particular, the staff noted that the coefficient of friction between concrete and steel was used, which provides a more conservative approach. In addition, the staff noted that the estimated sliding is considerably less than the distance between adjacent casks and the edge of the pad. Therefore, the staff finds that sufficient sliding margin exists, such that any adverse sliding effects are mitigated.

The applicant discussed VCC overturning potential. The applicant calculated the factor of safety against overturning by calculating the resisting moment due to vertical acceleration against the overturning moments due to horizontal acceleration. This was performed for all 36 SSI analysis cases at each time step. The applicant reported a minimum factor of safety against overturning greater than 1.1, in accordance with ASCE/SEI 43-05. The applicant used applicable inputs in the calculations, such as a range of soil profiles (BE, UB, LB), time histories and cask configurations in the approach, and the results are acceptable. On this basis, the staff concludes that the VCCs will not overturn under the design conditions.

Based on its review, the staff concludes that the WCS CISF has adequately presented acceptable structural analyses for the VCC storage pad and meets the structural requirements of 10 CFR 72.24(d) and (i) and 10 CFR 72.122(b)(1), (b)(2), (b)(3), (c), (d), (f), (g), (h), (i), (j), (k), and (l).

5.3.3 Other Structures, Systems, and Components Important to Safety

5.3.3.1 Cask Handling Building

5.3.3.1.1 Description of the Cask Handling Building

SAR Section 7.5, "Cask Handling Building," and Section 7.5.3, "Cask Handling Building Structural Design," describe design-basis information for the cask handling building (CHB). The CHB and its foundations are ITS Category B structures used to transfer canisters from the transportation cask to the storage overpack. The CHB is approximately 175 feet (53.3 meters) long by 193 feet (58.8 meters) wide with roof deck elevation of 72 feet (22 meters). The building is a two-bay steel structure with metal siding, designed to support two overhead cranes used to move a transportation cask from the rail car to the transport vehicle. The two overhead bridge cranes, which are classified as ITS, are attached to the CHB structural steel columns to provide for vertical and horizontal load capacity during seismic events. SAR Figure 1-7, "Cask Handling Building Plan," and Figure 1-8, "Cask Handling Building Section View," provide plan and elevation views of the CHB, including general elements of the overhead bridges.

Areas of the CHB will house the canister transfer system (CTS) (see SER Section 3.3.3.3), an area for transferring transportation casks from rail car to the transportation vehicle, and an area for cask storage. The specific functions credited in the SAR for the CHB are (1) receive, inspect, and prepare shipments of canisterized SNF and GTCC waste for storage, (2) prepare canisterized SNF and GTCC waste stored at the site for offsite transport, and (3) provide for transportation cask light maintenance.

The CHB structural design includes three separate structural systems: a steel-framed system, the reinforced concrete foundations, and the two overhead bridge cranes. The CHB steel-framed structure comprises braced framed systems with roof trusses. Ordinary, concentrically braced frames will be used as the seismic lateral force-resisting system for the CHB in both the north-to-south and east-to-west directions. The reinforced concrete foundations are shallow spread-footings to support the CHB columns base plates. The foundation depth will be a minimum of 9 feet (2.7 meters) below grade to provide uplift support during tornado-induced uplift pressures and to ensure the foundations are sitting on top of soil with competent bearing material properties.

The staff concludes that the applicant has provided a general description of the CHB that adequately identifies the function of the CHB, the processes housed in the building, and the structural features. The staff finds acceptable the classification of the CHB as ITS Category B, consistent with the definition in NUREG/CR-6407, "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety," issued February 1996, which is based on the safety functions of the CHB as a building structure protecting ITS equipment. Category B structures are defined as SSCs whose failure or malfunction could indirectly result in a condition adversely affecting public health and safety.

5.3.3.1.2 Design Criteria for the Cask Handling Building

SAR Section 7.5.3.2, "Design Criteria," provides the design loads for the CHB. The applicant stated that the analysis and design of the CHB structures is governed by nuclear facility codes and standards, as applicable to those ITS structures. The list includes the following specific codes and standards as well as the specific application of the standard for the CHB design:

- American National Standards Institute (ANSI)/AISC N690-18, “Specification for Safety-Related Steel Structures for Nuclear Facilities”—applicable to the definition of steel design-load combinations and steel member and connection design requirements
- ANSI/AISC 360-16, “Specification for Structural Steel Buildings”—applicable to the design, fabrication and erection of the structural steel system or systems with structural steel
- ANSI/AISC 341-16, “Seismic Provisions for Structural Steel Buildings”—applicable to the 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 the definition of concrete design-load combinations and design of reinforced concrete structures and anchorages
- ASCE/SEI 43-05, applicable to the 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 CHB and its foundations
- ASCE/SEI 7-16, “Minimum Design Loads and Associated Criteria for Buildings and Other Structures”—applicable to the development of normal operating wind loads, snow and rain loads, and overhead crane operating loads
- ASCE/SEI 7-05, applicable to transforming tornado wind speed into pressures applicable to the CHB, in accordance with NUREG-0800, Section 3.3.2, “Tornado Loads,” dated March 2007
- ASME NOG-1-2015, “Rules for Construction of Overhead and Gantry Cranes (Top Running Bridge, Multiple Girder)” —applicable to the analysis and design of the two 130-ton overhead cranes supported by the CHB
- Crane Manufacturers Association of America 70-2015, “Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes”—applicable to the design of the CHB crane runway system.

The SAR described the following load cases: tornado hazards, dead load, live load, lateral soil pressure load, thermal load, wind load, flood load, and earthquake load. SAR Section 7.5.3.2.1 “Load Definitions,” also specifies loads definitions and load combinations, including the loads discussed below. The following summarizes these cases:

- Dead load was defined as the mass of the structure and permanent equipment loads including the overhead crane. A 20-psf (958 Pa) allowance will be applied to the roof areas and elevated platforms to account for miscellaneous equipment.
- Live load will include, among others, movable equipment loads, rain, snow, ice, transportation vehicle loads, crane and hoist loads, and floor loads. The applicant stated

that rain, snow, and ice live loads would be in accordance with the International Building Code and ASCE/SEI 7-16.

- The applicant excluded hydrostatic fluid pressure loads since the CHB does not contain internal tanks. Soil loads were also excluded since the CHB is a slab-on-grade structure. Thermal loads are those identified from operation and environmental conditions affecting the facility.
- The design of the CHB also excluded flood loads because SAR Chapter 2, "Site Characteristics," concluded that the finished floor elevation of the CHB is above the probable maximum flood.

5.3.3.1.2.1 Wind Loads and Tornado Hazards

The SAR defines the wind loads as pressure loads generated by straight winds. The wind loads are derived from ASCE/SEI 7-16. The applicant obtained velocity pressures using Equation 26.10-1 from ASCE/SEI 7-16 with a basic wind speed of 115 miles per hour (185 kilometers per hour).

The SAR states that the CHB will be designed to withstand tornado-generated wind loadings and missiles to ensure that the structural integrity and stability of the primary framing system are maintained. Therefore, only those members critical to lateral stability, vertical stability, or both of the overall structure are required to survive under any potential tornado missile impact scenario. The CHB will be designed to resist failure of structural members under concurrent loading by design-basis tornado winds, atmospheric pressure change, and tornado missiles. In addition, the SAR credits an administrative control to preclude the presence of loaded storage, transportation, or transfer casks inside the CHB during a tornado watch or other inclement weather watches, as well as restrictions to movements of the overhead cranes and railcar loading operations. The SAR credits these actions to eliminate the potential for collapse of overhead cranes onto canisters during receipt, transfer, and retrieval operations.

As part of the detailed design of the CHB, the applicant will use RG 1.76, Revision 1, to evaluate automobile missile impacts to framing members up to 30 feet (9.1 meters) above grade. The applicant will obtain calculated demands from missile impacts using a linear elastic analysis to superimpose those impacts due to tornado wind, atmospheric pressure change, and other normal loading conditions.

5.3.3.1.2.2 Seismic Loads

The SAR indicates that the applicant determined seismic loads using nuclear facility codes and standards, including ASCE/SEI 4-16 and ASCE/SEI 43-05, to prevent collapse in order to meet 10 CFR 72.122(b)(2)(ii). The applicant used modal response spectrum analysis to determine seismic demands for structural design of the CHB. Site-specific response spectra generated by the probabilistic seismic hazard analysis for the WCS CISF site, as referenced in SAR Chapter 2, will be used for the design. Design spectral response accelerations will be used in the analysis and design of the building structure, crane supports, and seismic clips used as restraint for the overhead bridge crane and trolley.

The SAR indicates that SSI effects are minimal and used the criteria in ASCE/SEI 4-16, Section 5.1.1, to perform fixed-based analysis of the structure using the surface design response spectra. The SAR notes that during the detailed design of the CHB, the applicant will

consider an SSI analysis performed for the crane support systems in accordance with ASCE/SEI 4-16 due to vertical response.

5.3.3.1.2.3 Load Combinations

The applicant stated that structural-steel load combinations applicable to the CHB are based on the load and resistance factor design load combinations given in ANSI/AISC N690-18. Crane load combinations applicable to the design of the overhead bridge cranes are developed in accordance with ASME NOG-1-2015, Section 4140. For the reinforced concrete foundations, design-load combinations will be performed in accordance with the requirements of ACI 349-13.

5.3.3.1.2.4 Conclusions on Cask Handling Building Design Criteria

The staff reviewed the information and finds that the applicant adequately identified and defined loads applicable to the design of the CHB. The definitions of design loads are consistent with the application of codes, standards, and industry practices. In addition, and due to the categorization of the CHB as an ITS structure, the staff finds adequate the use of nuclear codes and standards for the design-applicable element of the CHB. The staff finds the applicant's characterization of the site as a dry site to be acceptable, as discussed in SER Section 2.3.4; therefore, the staff finds the exclusion of hydrostatic pressures as well as flood loads to be acceptable. The staff also finds that soil load pressures can be excluded given that the CHB is a slab-on-grade structure.

The staff finds adequate the assumptions and methodology used for the calculation of wind-load pressures and the assumptions used to determine the impacts of tornado hazards at the site. The staff finds the design approach to be adequate to ensure that the CHB maintains structural integrity and stability of the primary framing system during tornado hazards. The approach is consistent with the safety function of the CHB and ensures adequate protection is provided to ITS components housed at the CHB. Furthermore, the staff finds that the administrative control to limit operations during inclement weather provides additional levels of protection and defense in depth to prevent circumstances leading to accidents of concern.

The staff finds adequate the methodology and assumptions used for the determination of seismic loads, as they are consistent with the application of nuclear codes, standards, and industry practices. The staff finds adequate the use of modal response spectrum analysis and site-specific response spectra, as these will adequately capture the hazard condition and uncertainties associated with the site. The staff also finds the assumptions and considerations made related to the potential effects of SSI on the design of the CHB to be appropriate.

5.3.3.1.3 Structural Analysis and Design for the Cask Handling Building

5.3.3.1.3.1 Structural Steel

SAR Section 7.5.3.3, "CHB Structural Steel Design," states that a detailed three-dimensional structural analysis model generated in the structural analysis program STAAD.Pro was used to evaluate the structural performance of the steel framing using the loads and load combinations previously identified. The applicant indicated that the CHB meets the AISC limitations for the use of the first-order analysis method to address stability requirements since the structure has minimal second-order deformations.

Model assumptions such as stiffness properties were used from built-in AISC section properties in STAAD.Pro, and properties of the built-up crane and trolley members were manually inputted.

The applicant indicated that static-analysis methods are used to determine member forces, column reactions, and structure deflections due to gravity loads, crane operating loads, and wind and tornado pressures.

5.3.3.1.3.2 Seismic Analysis

SAR Section 7.5.3.3.3, “Seismic Analysis,” states that the seismic response of the CHB was evaluated using modal response spectrum analysis, in accordance with ASCE/SEI 43-05 and ASCE/SEI 4-16. In addition, to evaluate the significance of SSI effects for the CHB, an assessment of site soil properties and dominant structural frequencies was performed in accordance with ASCE/SEI 4-16, Section 5.1.1. Using the results of the assessment, the applicant analyzed the seismic loading to provide initial demand-to-capacity ratios using a fixed-based approach. The SAR notes that during detailed design of the CHB, consideration of SSI analysis will be performed in accordance with ASCE/SEI 4-16 to appropriately account for potential amplifications from the vertical response in the crane support system. The SAR states that performing SSI analysis will ensure amplification due to SSI effects is captured in the crane support system response and in the resulting crane in-structure response spectra needed for detailed design of an ASME NOG-1-2015 crane.

SAR Table 7-43, “Maximum Demand/Capacity Ratios (DCRs),” presents the demand/capacity ratios (DCRs) using fixed-based analysis. The SAR notes that the DCRs for tornado wind and missile load combinations govern the design of the CHB framing member types, and potential increases in demand from SSI analyses can be accommodated without requiring changes to the CHB primary framing systems.

5.3.3.1.3.3 Tornado Missile Analysis

SAR Section 7.5.3.3.4, “Tornado Missile Impact Analysis,” indicates that the applicant performed transient dynamic analyses with STAAD.Pro, which uses the mode superposition method of calculating structural response at each time step. For each impact location of interest, the applicant executed a separate STAAD.Pro model to perform static analyses for all other tornado wind, atmospheric pressure change, and gravity load cases in the tornado load combinations, along with a missile impact from an automobile. Member demands were obtained for all primary framing members in the STAAD.Pro model, and the envelope of all load combination demands from all models were considered in the member design check.

5.3.3.1.3.4 Structural Design

SAR Section 7.5.3.4, “CHB Steel Building Design,” describes the CHB steel framing design methodology and indicates that the steel framing design is performed in accordance with the requirements of ANSI/AISC N690-18. The applicant’s methodology evaluates the lateral force resisting system in accordance with the design requirements and acceptance criteria given in ASCE/SEI 43-05 and ANSI/AISC 341-16. Member design was evaluated using applicable strength limit states and serviceability requirements.

SAR Section 7.5.3.5, “Reinforced Concrete Structural Analysis and Design,” describes analysis and design of the CHB reinforced concrete foundations. The SAR indicates that the design was developed in accordance with the requirements of ACI 349-13, Appendix D, “Anchoring to Concrete,” for the column baseplate anchorage.

The applicant summarized design DCRs for key structural elements, 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. SAR Table 7-43 provides governing DCRs from gravity, seismic, tornado wind pressure, and tornado missile impact with tornado wind pressure.

The staff finds adequate the assumptions used for the structural analysis of the CHB structure. The analysis of the CHB through the use of a three-dimensional analysis model as well as the methodologies described to calculate demands and design capacities for the structural members of the CHB are consistent with codes, standards, and industry practices. As previously described and consistent with the guidance in NUREG-1567, the staff did not review the analysis and calculations associated with the CHB. The staff review and conclusions described above are based on a review of the assumptions, methodologies, and expected application of practices in codes and standards. As described in NUREG-1567, during the applicant's detailed analysis of the CHB, design analyses should be prepared such that the analyses may be readily audited to permit determination of the sources of expressions used, values of material properties, data from other supporting calculations, and assumptions.

Based on the staff review of the preliminary design DCRs in SAR Table 7-43, the governing load conditions are primarily for the tornado missile impact with tornado wind pressure. The crane support system (crane girder) is governed by seismic loads, and the sacrificial crane vertical bracing is governed by gravity loads. Consistent with the descriptions provided in the SAR, the applicant will perform further detailed design analysis to evaluate the effects of SSI in member demands. The staff finds adequate the applicant's commitment in note 6 of Table 7-43 that the maximum member DCR during detailed design shall not exceed 0.90, as that will provide margin from the imposed loading conditions.

Based on the review of the applicant's description, proposed design criteria, defined material properties, and the adequacy of the assumptions used in the structural analysis, the staff concludes that the CHB design analysis is in conformance with the expected safety function to provide protection to ITS components housed in the CHB. Therefore, the staff concludes that the SAR and docketed materials are acceptable to demonstrate, based on adequate implementation of the structural design methods described above, that the structural integrity of the CHB will meet the requirements of 10 CFR 72.122(b)(1) and (b)(2).

5.3.3.2 Canister Transfer System

The applicant described the SSCs used for canister-handling operations in SAR Section 4.7, "Canister Handling Operation Systems." The applicant developed separate transfer processes for the canisters designed for horizontal storage in the NUHOMS system and the canisters designed for vertical storage in the NAC systems. The staff addresses the NUHOMS transfer component design in SER Section 5.3.4.

The applicant stated that the canisters designed for vertical storage would be transferred in the transportation cask from the rail car to the ITS CTS by use of the CHB overhead cranes and the VCT. The applicant stated that in addition to performing ancillary lifts such as those for removing impact limiters, the CHB overhead crane would be used to upright and transfer the transportation cask from the rail car to a laydown area within the CHB. The VCT would perform the ITS function to move the transportation cask from the laydown area to the appropriate position under the CTS for transfer operations. The applicant stated that the CTS would provide the ITS function of transferring the vertical canisters from the upright transportation cask to the VCC storage overpack. The applicant stated that the VCT transfers the vertical canisters in licensed VCC storage overpacks from the CTS to the cask storage pad location. The

evaluations below address the design of the vertical NAC cask handling systems for the transfer operations. The staff addresses the VCT design in SER Section 5.3.3.3 and the CHB overhead crane design in SER Section 5.3.3.5.

SAR Section 7.5.1, "Canister Transfer System," discusses the CTS for the WCS CISF site. The applicant described CTS design and operation in SAR Section 4.7.4, "NAC Cask Transfer System," and Section 7.5.1. The applicant described the CTS as a hydraulic gantry crane with a pre-rigged transfer cask licensed for the canister and a chain hoist for independent lifting and lowering of the canister. The applicant described the use of the CTS for transfer of the TSC for the three types of NAC storage systems (the NAC MAGNASTOR, NAC-UMS, and NAC-MPC) from the transportation cask to the VCC.

The applicant cited the guidance in NUREG-0554, "Single-Failure-Proof Cranes for Nuclear Power Plants," issued May 1979; NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants: Resolution of Generic Technical Activity A-36," issued July 1980; ASME NOG-1-2015; and ANSI N14.6 in describing the design of the CTS and its components. In SAR Section 5.2.1.3.2, "Safety Features," the applicant stated that the CTS fully meets the single failure proof (SFP) criteria of NUREG0612 by providing a combination of failsafe features and redundant design factors, as well as structures designed to the criteria of ASME NOG12015.

Major components of the CTS include the gantry crane telescoping booms, lift beams, trolley beam, chain hoist, canister lift adapter, and slings. The applicant stated that safe handling of the canister is accomplished by ensuring, through the use of redundancy in active components within the load path or through the use of increased factors of safety, that failure of the heavy load system is highly unlikely and therefore provides adequate defense in depth for the CTS heavy loads. The staff noted that the CTS structural design considers SFP features, special lifting devices, and multiple load combinations, among other design features. The staff noted that the seismic design considered multiple load combinations and site-specific SSI accelerations to calculate various component stresses, which were then compared to allowable stresses in accordance with the guidance in ASME NOG-1-2015. SAR Tables 7-6 and 7-7, entitled, "Stress Ratios for Gantry Crane Members," and "Factors of Safety for Main Components for Transfer Cask Lift," respectively, show the resulting stress ratios and factors of safety, which indicate adequate safety margin.

The applicant described the application of design standards to the CTS. For the CTS, the applicant used applicable portions of ASME NOG-1-2015 for the hydraulic gantry crane structural components, including the seismic cross-bracing, lifting beams, and trolley beam. CTS components not within the scope of ASME NOG-1-2015, such as the hydraulic lift booms, lift links, shackles, slings, transfer cask lift plates, chain hoist, and canister lift adapter, invoke applicable ANSI or ASME B30 standards and are designed with increased factors of safety or redundancy, or both. Special lifting devices used in SFP applications in accordance with ANSI N14.6 have factors of safety of at least 6 on material yield strength and at least 10 on material ultimate strength. For the chain hoist, the applicant invoked ASME NUM-1, "Rules for Construction of Cranes, Monorails, and Hoists (with Bridge or Trolley or Hoist of the Underhung Type)," Type IB criteria for design. The applicant described the specific application of the above CTS design standards in SAR Section 7.5.1.2, "Code Applicability," and Section 7.5.1.3, "Component Design Basis." The applicant stated that all of the components and their standards work together to provide a lifting system designed for the specific and limited purpose of safely transferring canisters from transportation casks through transfer casks to storage casks, and vice versa.

As described in SAR Section 7.5.1.7, "Hoisting Machinery," the CTS includes four hydraulic lifting booms that lift the licensed transfer cask and an air-powered chain hoist to transfer NAC fuel canisters between the appropriate transportation cask or the storage cask and the pre-rigged transfer cask. Wedge locks on the hydraulic boom and hydraulic locking valves on the hydraulic lift cylinders internal to the boom provide redundant capability to hold each lift boom in position under load. Each pair of lifting booms supports a lifting beam, and the two lifting beams support a transverse trolley beam. The trolley beam supports three pairs of 55-ton lifting links, with slings attached to the two outboard pairs of lifting links to carry the transfer cask weight via the transfer cask lift plates. The inboard pair of links are attached to the 110-ton chain hoist. The applicant described the chain hoist as having a single disc brake of 200 percent design capacity and inherent air-motor braking acting through the gear train, which provide a redundant capability to slow the gear train and prevent a drop of the attached load. The applicant selected the hoist to have a capacity of twice the maximum critical load to ensure the reliability of the nonredundant portions of the hoist. The hoist connects to the canister-lifting adapter. The applicant classified both the canister-lifting adapter and transfer cask lift plates as special lifting devices designed to ANSI N14.6 criteria.

The staff evaluated the design of the CTS and the standards used in its design with respect to the intent of NUREG-0612 guidelines for the safety of the lifting system during load handling activities. The staff concluded that the hydraulic gantry system relies on redundant and diverse means of maintaining the hydraulic jack position in the event of credible component failures. The staff found that the structure of the CTS is designed to appropriate standards to withstand loads resulting from normal operations, extreme environmental loads (including seismic), and abnormal events resulting from postulated component failures. The design of special lifting devices doubles the normal factor of safety to minimize the potential for component failure. Finally, the overhead air-operated chain hoist includes suitable design features, such as diverse means of braking and enhanced factors of safety, for reliable handling of the loaded fuel canister during transfer between either the transportation cask or VCC and the transfer cask rigged onto the CTS. Therefore, the staff found that the applied design criteria satisfy the intent of NUREG-0612 guidelines in providing protection against unacceptable canister loading that could result from handling operations, with appropriate consideration of maximum normal operating loads, environmental conditions, and abnormal events that would challenge the ability of the CTS to retain the suspended load.

The staff also evaluated the stability of the freestanding vertical NAC transportation casks and the design of the CTS pad supporting the freestanding vertical NAC transportation casks and the VCC in this SER section. With regard to the CTS pad, Section 7.5.1.4 of the WCS SAR states that the CTS pad is classified as ITS-C. The classification of components is shown in SAR Table 3-5 and it identifies the CTS pad in the same categorization as the VCC storage pad. Furthermore, WCS SAR section 7.5.1.4 states that the CTS pad is designed to codes and standards that are similar to the codes and standards used for the design of the VCC storage pad. The staff reviewed the VCC storage pad (refer to SER section 5.3.2.5) and found its design methodology and codes and standards acceptable. Therefore, because the CTS pad is classified and designed using the same categorization and codes and standards as the VCC storage pad, the staff finds the design methodology for the CTS pad acceptable.

In SAR Section 7.6.6, "Transport Cask Stability," the applicant discussed the stability of NAC transportation casks during cask receipt operations. The applicant stated that the operations will occur inside the CHB. The applicant stated that the VCT will drive up to the transport cask, engage for lifting, and raise the cask for movement to the CTS. During these operations, the transportation cask will be vertically unrestrained for some time. The applicant performed a

tip-over evaluation for these casks while in this configuration. The tip-over calculation was based on the most limiting condition, which is a seismic event. The applicant considered three NAC transport casks, namely the STC, UMS, and MAGNATRAN, which are documented in the three SARs for NAC SNF transportation systems that the applicant incorporated by reference. The applicant considered the design earthquake horizontal ground acceleration of 0.261g. The vertical acceleration was defined as two-thirds of the horizontal acceleration based on guidance from ASCE 4-86, "Seismic Analysis of Safety-related Nuclear Structures and Commentary on Standard for Seismic Analysis of Safety-related Nuclear Structures," dated September 1986. In addition, the applicant considered pertinent dimensions of the transport casks for this analysis. The applicant calculated overturning and resisting moments for all transport casks of interest and found the minimum factor of safety against overturning to be 1.19. The staff finds that the applicant used appropriate assumptions, transportation cask dimensions, and ground accelerations for this evaluation. The staff finds that the approach is acceptable, as it is similar to other seismic stability approaches performed for storage casks, and concludes that the transportation casks will not overturn when in this configuration. Based on the above, the staff finds that the description of the CTS in the SAR description and docketed materials satisfies the requirements of 10 CFR 72.24 and the design of the CTS satisfies applicable portions of 10 CFR 72.122 related to design criteria and safety analysis.

5.3.3.3 Vertical Cask Transporter

In SAR Section 7.5.2, "Vertical Cask Transporter (VCT)," the applicant stated that the VCT lift of the transportation cask for vertical storage cask systems within the CHB is considered ITS. The applicant also stated that the handling of the VCC storage casks would not be considered ITS because the VCC had been evaluated for drops within the range of lift heights used to move the VCC between the CTS and the storage pad. The applicant provided a diagram of the VCT as SAR Figure 4-4, "Vertical Cask Transporter," [proprietary], which depicts a mobile, hydraulic gantry hoist with two hydraulic jacking towers and a single transverse header beam.

In SAR Section 7.5.2, the applicant described the VCT as a commercially developed vehicle with a hydraulic gantry designed, fabricated, and tested to ASME B30.1, "Jacks, Industrial Rollers, Air Casters, and Hydraulic Gantries," for the hydraulic lifting units and ANSI N14.6 for the header beam, lifting links, and lifting pins. The applicant stated that these components were selected based on the specified design criteria for twice the load to enhance their reliability. The applicant proposed the resultant increased safety factors as a basis for considering the VCT SFP for the ITS movement of the transport casks. In addition, the applicant stated that, similar to the CTS design, the hydraulic lifting cylinders have wedge locks as a backup to the hydraulic pistons to maintain position of the header beam following credible component failures.

In SAR Section 5.2.1.2, "Canister Handling," the applicant described the handling of the vertical storage system transportation casks using the VCT. The applicant stated that the VCT would be used to lift the transportation cask between 3 and 6 inches off the CHB floor for movement to or from the CTS. Similarly, the applicant stated that the VCC movement between the CTS and the storage pad would be conducted by lifting the VCC no more than 6 inches above the travel path to remain within the analyzed drop height.

The staff evaluated the design of the VCT and the standards used in its design with respect to the intent of the NUREG-0612 guidelines for safety of the lifting system during load handling activities. The staff concluded that the hydraulic gantry system relies on redundant and diverse means of maintaining the hydraulic jack position in the event of credible component failures. The staff finds that the design of the hydraulic lifting units to conform to ASME B30.1 and the

design of the structural lifting elements to conform to ANSI N14.6 with twice the specified factor of safety provide reasonable assurance that the hydraulic gantry assembly satisfies the intent of NUREG-0612 with respect to design and fabrication.

The common use of similarly designed vehicles and the low maximum lift height provide reasonable assurance of overall safety of the VCT cask transportation process. The administrative controls in TS 5.2.1, "Lifting Height and Temperature Limits," specify the maximum lift height of the VCC when transported by the VCT based on the safety analyses for the loaded canister. Therefore, the staff finds that the applied design criteria satisfy the intent of the NUREG-0612 guidelines in providing protection against unacceptable canister loading that could result from handling operations, with appropriate consideration of maximum normal operating loads, environmental conditions, and abnormal events that would challenge the ability of the VCT to retain the suspended load. Based on the above, the staff finds that the description of the VCT in the SAR description and docketed materials satisfies the requirements of 10 CFR 72.24 and the design of the VCT satisfies applicable portions of 10 CFR 72.122 related to design criteria and safety analysis.

5.3.3.4 Transfer Casks and Cask Handling Auxiliaries

This section provides the staff's review and evaluation to determine whether the ITS canister transfer casks have sufficient structural capability to meet their intended safety functions. The staff's review includes verification that the SAR has (1) an adequate description of the ITS transfer casks, (2) acceptable design criteria, (3) appropriate sources of data for material properties, and (4) acceptable structural analyses. The staff's evaluation will determine whether the transfer cask systems are designed to ensure adequate safety under normal, off-normal, and accident conditions, including natural phenomena. The staff reviews ITS handling auxiliaries of the NAC cask transfer system, which are used in operating the transfer casks, in SER Section 5.3.3.4.5. The staff reviews NITS handling systems, which are used in transfer operation for the NUHOMS casks, in SER Section 5.3.4.2.

5.3.3.4.1 Description of Transfer Casks

The staff reviewed and confirmed that the descriptions of the transfer casks in SAR Section 3.1, "Purposes of Installation," and applicable sections of Appendices A through H, for each storage system's transfer casks, are consistent with the staff's evaluation approving the use of each storage system. The staff confirmed that the transfer casks are classified as ITS and designed to maintain structural integrity under normal, off-normal, and accident conditions, including natural phenomena, without losing their canister protection safety function.

Based on its review, the staff concludes that the applicant has adequately described the transfer casks of the canister-based storage systems to meet the 10 CFR 72.24 system description requirements for SNF and GTCC waste.

5.3.3.4.2 Design Criteria for Transfer Casks

In SAR Table 1-2, the applicant summarized the WCS CISF principal design criteria based on the site characteristics. SAR Table 3-1 lists the design criteria for the individual cask systems to be used at the WCS CISF that the NRC has licensed or certified previously for comparison with the specific criteria required for the WCS CISF design. SER Section 4.3.3 describes the staff's review of the loading conditions for the structural evaluation of components of individual storage cask systems. SER Section 5.3.1.2 provides additional information about the design criteria

applicable to each of the individual cask systems. Loading conditions applicable to the transfer casks include thermal loads, tornado wind and tornado missiles, and earthquakes.

Sections A.3.3 through D.3.3 and Sections E.3.1.1/E.3.2.1 through G.3.1.1 in SAR Appendices A through G provide the design criteria for environmental conditions and natural phenomena for the TN and NAC transfer casks, respectively. The NRC has previously approved these design criteria, which are defined in the FSARs for the individual storage systems. The design criteria are considered in the transfer cask structural analyses reviewed in SER Section 5.3.3.4 as follows.

In SAR Appendix A, Section A.3.1.4, “NUHOMS Transfer Equipment,” the applicant noted that for the NUHOMS-MP187 cask system, the MP187 transportation cask is qualified for canister transfer operation and is referred to as the MP187 transfer cask for the onsite transferring of the Rancho Seco DSCs at the WCS CISF.

In SAR Appendix A, Section A.7.1, “Discussion,” the applicant noted that the design criteria for the Rancho Seco ISFSI envelops the design criteria for the WCS CISF with the exception of the site-specific seismic criteria. In SAR Appendix A, Section A.7.3, the applicant discussed relevant design criteria information for the MP187 cask as presented in the following sections and tables of Volume I of the Rancho Seco ISFSI FSAR, which the applicant incorporated by reference:

- the structural design criteria for the MP187 cask—Section 3.2
- design loading criteria for the MP187 cask—Table 3-4
- load combinations—Table 3-8
- stress allowable values for the MP187 cask according to the ASME B&PV Code Service Levels A, B, C, and D—Table 3-9

As noted in SAR Appendix B, Section B.3.1.4, “NUHOMS Transfer Equipment,” the applicant will also use the MP187 transfer cask for onsite transfer of the 24PT1 DSC for its storage in the Standardized Advanced NUHOMS Storage System at the WCS CISF.

In SAR Appendix C, Section C.3.1.4, “NUHOMS Transfer Equipment,” the applicant noted that the MP197HB transportation cask is qualified for transfer operations for the Standardized NUHOMS-61BT storage system and is referred to as a transfer cask for the onsite transfer of the 61BT DSC at the WCS CISF.

In SAR Appendix C, Section C.7.1, “Discussion,” the applicant noted that with the exception of the seismic design, the design criteria for the MP197HB cask components, which are described in the Standardized NUHOMS Storage System FSAR, envelop the design criteria for the WCS CISF. As summarized in SAR Appendix C, Section C.7, the relevant structural design criteria for the MP197HB cask include the following:

- design approach, design criteria, and loading combinations—Section C.7.7.1
- load combinations for associated service levels—Table C.7-1
- steel component stress acceptance criteria—Table C.7-2

As noted in SAR Appendix D, Section D.3.1.4, “NUHOMS Transfer Equipment,” the applicant will also use the MP197HB cask for the onsite transfer of the 61BTH Type 1 DSC for its storage in the Standardized NUHOMS Storage System at the WCS CISF.

In SAR Section 4.7.1.1, the applicant noted that the CTS is pre-rigged with a transfer cask for canister transfer operations. The applicant indicated that the transfer casks for the individual NAC-MPC, NAC-UMS and NAC MAGNASTOR storage systems are designed to interface with the transportation and storage configurations in the CTS.

In Sections E.3.1.1.5, E.3.2.1.5, F.3.1.1.5, and G.3.1.1.5 of SAR Appendices E through G, the applicant discussed the combined load criteria for the NAC-MPC, NAC MPC-LACBWR, NAC-UMS, and NAC MAGNASTOR system transfer casks, respectively. The applicant incorporated by reference the FSARs for these transfer casks. Each transfer cask is considered a special lifting device designed to the requirements of ANSI N14.6 and NUREG-0612. The applicant considered the load criteria in the transfer cask structural analyses reviewed in SER Section 5.3.3.4.5.

The staff reviewed applicable portions of the documents incorporated by reference to ensure that the design criteria listed for the various transfer cask systems continue to remain adequate. The staff finds that the structural design criteria for the transfer casks were appropriately selected between the cask system and the site because the applicant selected the most limiting criteria or analyzed them as necessary.

Based on its review, the staff concludes that the applicant has adequately described the structural design criteria for the transfer casks SSCs and meets the applicable requirements in 10 CFR 72.24, 72.40(a)(1), 72.120, 72.122, and 72.128.

5.3.3.4.3 Material Properties for Transfer Casks

In SAR Appendices A through G, the applicant provided mechanical properties of materials for the individual SNF and GTCC waste storage systems. The applicant incorporated by reference the relevant mechanical properties of materials, which are considered in the transfer cask structural analyses evaluated in SER Section 5.3.2.4, from the following individual cask system safety analysis reports:

- the mechanical properties of materials for the MP187 cask—NUHOMS-MP187 Multi-Purpose Cask SAR Section 2.3
- the mechanical properties of materials for the MP197HB cask—NUHOMS MP197 Transport Packaging SAR Section A.2.2
- the mechanical properties of materials for the NAC-MPC and NAC MPC-LACBWR transfer casks—NAC-MPC FSAR Sections 3.3 and 3.A.3, respectively
- the mechanical properties of materials for the NAC-UMS transfer casks—NAC-UMS Storage System FSAR Section 3.3
- the mechanical properties of materials for the NAC-MAGNASTOR transfer casks— NAC MAGNASTOR FSAR Tables 3.3-1 through 3.3-14

The applicant incorporated by reference the analyses for the transfer casks and transportation casks. SER Section 10.3.10 discusses the staff’s review of the reported mechanical properties

of the materials used in the CTS and verified that the reported values are consistent with the referenced ASTM standards. On this basis, the staff finds the mechanical properties of the materials for the transfer casks, which have been considered for the previously approved structural analyses, are acceptable for the structural analysis of the transfer casks for the WCS CISF.

5.3.3.4.4 Structural Analysis for NUHOMS Transfer Casks

5.3.3.4.4.1 NUHOMS-MP187 Cask

In SAR Appendices A and B, Sections A.3.4.2 and B.3.4.2, both entitled, "Structural," the applicant noted that the MP187 transfer cask is being used for onsite transfer of the DSC for its storage in the HSM and AHSM. As such, the staff reviewed relevant structural analyses provided in SAR Appendices A and B.

In SAR Appendix A, Section A.7.3.1, the applicant discussed the structural analysis of the MP187 cask for normal and off-normal operating conditions during transfer operations, referencing the analyses discussed in the Rancho Seco ISFSI FSAR, Volume I, Section 8.1, which the applicant incorporated by reference. The normal loads considered include (1) dead-weight loads, (2) design-basis internal pressure loads, (3) design-basis thermal loads, (4) normal operational handling loads, and (5) design-basis live loads. The off-normal loads include the off-normal handling and the off-normal temperature and pressure loads. Rancho Seco ISFSI FSAR Volume I, Table 8-3, summarizes the stress results for normal and off-normal conditions. The stresses in the MP187 cask and the canister components are shown to meet the criteria for stress allowable values in the ASME B&PV Code. As a result, the staff finds that sufficient margin exists, and the results are acceptable.

In SAR Appendix A, Section A.7.3.2, the applicant discussed the structural analysis of the MP187 cask for the postulated accidents during transfer operations, referencing the Rancho Seco ISFSI FSAR, Volume I, Section 8.2, which the applicant incorporated by reference. The postulated accident loads considered include (1) accidental cask drop, (2) canister leakage, (3) accident pressurization, (4) earthquake, and (5) fire. Additionally, the applicant incorporated by reference the structural analyses of the MP187 cask from the Rancho Seco ISFSI FSAR, Volume I, Section 3.2, for the natural phenomena loads, including loads from tornado wind, tornado-generated missiles (including impact stability in transfer configuration), and floods. Rancho Seco ISFSI FSAR, Table 8-8, summarizes the accident condition stress results.

In SAR Appendix B, Section B.7.8.1, "Assumptions," the applicant used the methodology based on the report, "Design of Structures for Missile Impact," to evaluate the transfer cask stability for the tornado missile impact. The staff finds that the applicant made conservative assumptions for the structural analysis, which include the wind gust factor G-value of 0.85 taken from ASCE/SEI 7-05, a minimum combined weight of the MP187 cask and its support skid and transfer trailer of 270 kips (1201 kN), and the dimensions of the transfer trailer and its support footprint. The stability design acceptance criteria, as provided in SAR Appendix B, Section B.7.8.3, include the permissible angle of cask rotation to be equal to one-third of the critical angle of rotation. The acceptance criteria for cask body metal component stress are based on the at-temperature stress allowable values in ASME B&PV Code, Section III, Division 1, Appendix F.

In SAR Appendix B, Section B.7.8.4, "Methodology," the applicant discussed the methodologies involving hand calculations for the stability analysis, stress analysis, and penetration analysis. In SAR Appendix B, Section B.7.8.5, "Design Input Loads & Data," the applicant calculated the

design input loads, the design-basis maximum tornado pressure load of 102.45 psf (4,905 Pa) at the height of the centroid of the analyzed assembly, to result in a wind force of 16.14 kips (71.79 kN) at the height of the centroid of the analyzed assembly.

As evaluated in SAR Appendix B, Section B.7.8.6, "Tornado & Missile Impact Loads Analysis - Stability Evaluations," the applicant determined the restoring moment of 1,417.50 kip-ft (1,921.77 kN-m) for the cask or transfer-trailer assembly, with the minimum weight of 270 kips (1,200 kN). The maximum overturning moment for the cask-skid-trailer is calculated to be 265.66 kip-ft (360.23 kN-m). The applicant stated a factor of safety against overturning of 5.34 ($1,417.50/270 = 5.34$), which is much greater than unity. As a result, the staff finds that there is sufficient margin and the results are therefore acceptable.

For the tornado-generated missile, the applicant performed a stability analysis of the most critical impact for the 4,000-pound (1,814-kilogram) automobile missile conservatively assumed to hit the cask side and at the topmost point of the cask. The analysis shows an angle of rotation of 1.09 degrees. Since the resulting angle of rotation is less than or equal to the permissible angle of cask rotation of 10.85 degrees, set as one-third the critical angle of rotation at 32.54 degrees ($32.54/3 = 10.85$), the staff finds that the cask-in-transfer operation is demonstrated to be stable for the tornado-generated automobile missile.

The applicant also performed a time-dependent analysis to determine the maximum angle of rotation attained by the cask-skid-trailer assembly for the design-basis tornado wind. The input loading is the summation of the wind pressure loading of 102.45 psf (4,905 Pa) and the massive missile impact force of 340 kip (1,512.32 kN) calculated in SAR Appendix B, Section B.7.8.5. Using the standard equations of rotational motion solved with an approximate stepwise linear procedure, the applicant determined the governing angle of rotational motion at 3 degrees for the assembly. This angle is less than or equal to the same permissible angle of cask rotation of 10.85 degrees used previously, which demonstrates that the cask-in-transfer operation will remain stable when subject to the effect of design-basis tornado wind and the tornado-generated automobile missile. As a result, the staff finds that there is sufficient safety margin, and the analysis is therefore acceptable.

In SAR Appendix B, Section B.7.8.7, "Tornado Wind and Missile Analysis - Stress Evaluations," the applicant performed a stress evaluation of cask components exposed to tornado wind and tornado-generated missile loads. The applicant considered the cask as a thin-walled vessel and the cover plates as simply supported thin circular plates and used stress formulas from "Roark's Formula for Stress and Strain" (2011). For the cask outer shell, top cover plate, and hydraulic ram system closure plate summarized in SAR Table B.7-9, "Combined Tornado Effect on MP187 Cask – Stress Results," the results show that the maximum primary membrane-plus-bending stress of 55.93 ksi (385.6 MPa), which occurs to the cask outer shell, is acceptable because it is less than the allowable of 64.4 ksi (444 MPa). The staff finds that there is sufficient safety margin, and therefore the approach is acceptable.

In SAR Appendix B, Section B.7.8.8, "Tornado Missile Analysis - Penetration Evaluations," the applicant used Nelms' formula from the Oak Ridge National Laboratory report, "Structural Analysis of Shipping Casks, Effects of Jacket Physical Properties and Curvature on Puncture Resistance" (Nelms, 1968), to perform a tornado missile penetration analysis. The threshold thickness values causing perforation for the outer shell, top cover plate, and hydraulic ram system closure plate according to Nelms' correlation are calculated to be 0.43 inch (1.1 centimeters) each. The applicant conservatively increased the above-calculated thicknesses by 25 percent to obtain the minimum thickness of 0.53 inch (1.3 centimeters) ($0.43 \times 1.25 = 0.53$) required to prevent perforation of the MP187 cask. The staff finds this

analysis acceptable because the resulting minimum thickness is less than the thickness of the MP187 cask outer shell, top cover plate, and hydraulic ram system closure plate of 2.49 inches (6.32 centimeters), 6.50 inches (16.5 centimeters), and 3.18 inches (8.08 centimeters), respectively.

In SAR Appendix A, Section A.7.5.1, the applicant presented a reconciliation analysis showing that the spectral accelerations demand at the WCS CISF is higher than those of the design-basis earthquakes used to qualify the seismic performance of the storage cask systems approved by the staff for certain sites, including the Rancho Seco ISFSI. The staff reviewed the spectral acceleration demand calculated in SAR Section 7.6.4 for the NUHOMS storage pad at the WCS CISF site. The applicant noted that the MP187 cask, as an approved transportation cask, is structurally qualified for the 30-foot (9.1-meter) free drop event. Since the 30-foot drop would incur much higher inertia force than that of the spectral acceleration demand at the WCS CISF, the staff concludes that the MP187 cask is seismically acceptable for the WCS CISF canister transfer operation.

Based on the structural analysis presented in this section, the staff concludes that the NUHOMS-MP187 cask is structurally acceptable for onsite transfer operations of the DSC for storage in the HSM and AHSM.

5.3.3.4.4.2 NUHOMS MP197HB Cask

In SAR Appendix C, Section C.7.7.1, "General Information," the applicant performed a structural analysis of the MP197HB cask for onsite transfer of either the 61BT or the 61BTH Type 1 DSC for storage in the HSM. The analysis consists of finite element analyses and hand calculations to demonstrate the structural capability of the MP197HB cask.

The applicant continued to use the finite element analysis model presented in the NUHOMS MP197 Transportation Package SAR for the structural analysis of the cask body. The seven cask body components evaluated are the outer shell, inner shell, top cover plate (lid), top flange, bottom flange, bottom plate, and hydraulic ram system (access) closure plate. The applicant qualified certain cask components, such as lid bolts and the neutron shield shell, citing the bounding load analyses documented in the NUHOMS MP197 Transportation Package SAR, which the applicant incorporated by reference.

In SAR Appendix C, Section C.7.7.2, "Normal and Off-Normal Conditions," the applicant discussed the structural analyses and results for normal and off-normal conditions. SAR Table C.7-1, "Load Combination and Service Levels for MP197HB Cask," lists the load and load combinations analyzed, which include canister lifting and handling, canister HSM insertion, and off-normal canister temperature conditions. SAR Tables C.7-7 and C.7-8, entitled, "Stress Results Envelope for Transfer Handling Load," and "Stress Results Envelope for Lifting Loads," respectively, list the resultant cask component stresses for the cask handling and lifting conditions. The stress ratios computed as the calculated stresses divided by the allowable stresses are all less than unity. This demonstrates that all analyzed load cases meet the applicable ASME B&PV Code stress criteria. The staff finds that sufficient margin exists, and therefore the results for normal and off-normal conditions are acceptable.

In SAR Appendix C, Section C.7.7.3, "Accident Conditions," the applicant performed structural analyses for the accident loads, considering the postulated horizontal, vertical, and oblique corner drop events from a height of 80 inches (203 centimeters). The applicant noted that the 75g cask decelerations associated with the horizontal drop have been approved as a conservative basis for the accident drop evaluations of site-specific (MP187 cask) and general

license (OS197 transfer cask) transfer casks. As such, the applicant evaluated the design attributes of those casks and determined that they are sufficiently similar to continue considering the 75g inertia load bounding for the structural analysis of the MP197HB cask for the WCS CISF site. The staff finds that the applicant provided sufficient justification to show that the design attributes are similar and finds the 75g inertia load bounding for the structural analysis of the MP197HB cask.

SAR Figures C.7-15 and C.7-16, entitled, “MP197HB Cask—Stress Intensity (psi) - the 75g Side Drop,” and “MP197HB Cask—Deformation (inch) - 75g Side Drop,” show the maximum stress intensity and the deformation plots, respectively, for the MP197HB cask subject to the 75g side drop. SAR Table C.7-10, “Side Drop – Summary of Results,” shows that stresses in all cask components are within the allowable stresses for the 75g side-drop event. As a result, the staff finds that sufficient margin exists and the analysis is acceptable.

In SAR Appendix C, Section C.7.7.4, “MP197HB Cask Stability and Missile Penetration Analyses,” the applicant performed cask stability and penetration analyses of the MP197HB cask loaded either with the 61BT or 61BTH DSC for the design-basis tornado wind and tornado-generated missiles. The applicant followed the same approach used for the MP187 cask, as discussed in SER Section 5.3.3.4.4.1, with the exception that the staff used only the MP197HB design attributions to evaluate the loading characteristics and the corresponding cask structural performance. The following analysis details are relevant to the MP197HB cask:

- The same wind gust factor G of 0.85 and a minimum combined weight of the MP197HB and its transfer skid/transfer vehicle of 249.97 kips (1,112 kN) are discussed in SAR Appendix C, Section C.7.7.4.1, “Assumptions.”
- The permissible angle of cask rotation equal to one-third the critical angle of rotation and the Nelms' formula for missile penetration analysis are discussed in SAR Appendix C, Section C.7.7.4.3, “Design Criteria.”
- The maximum wind force of 17.17 kips (76.38 kN) applied to the MP197HB cask or transfer-trailer assembly and the corresponding factor of safety of 4.61 against overturning are calculated in SAR Sections 7.7.4.5 and 7.7.4.6, entitled, “Design Input Loads & Data,” and “Tornado & Missile Impact Loads Analysis - Stability Evaluations,” respectively.

The calculated angle of rotation is 1.09 degrees, which is less than the permissible angle or rotation of 10.95 degrees. The staff noted that the permissible angle of rotation represents 1/3 of the tip over angle which provides additional margin. Therefore, the staff finds that sufficient margin exists, and the analysis is acceptable.

SAR Appendix C, Section C.7.7.4.7, “Tornado Wind and Missile Analysis - Stress Evaluations,” presents a stress evaluation of cask components exposed to tornado wind and tornado-generated missile loads. The evaluations considered the cask as a thin-walled vessel and the cover plates as simply supported thin, circular plates and used stress formulas from “Roark’s Formula for Stress and Strain” appropriate for the analyzed loads, including wind pressure and massive missiles and characteristics. The applicant analyzed the cask outer shell, top cover plate, and hydraulic ram system closure plate.

SAR Appendix C, Table C.7-17, “Combined Tornado Effect on MP197HB Cask—Stress Results,” presents the stress results for the cask body components calculated in SAR Appendix C, Section C.7.7.4.7. The maximum primary membrane-plus-bending stress of

47.27 ksi (326 MPa), which occurs to the cask outer shell, is acceptable because it is less than the allowable of 70.0 ksi (483 MPa) based on classical stress mechanics formulas (i.e. Roark's Formula for Stress and Strain). The staff finds that sufficient margin exists, and therefore the evaluation is acceptable.

SAR Appendix C, Section C.7.7.4.8, "Tornado Missile Analysis - Penetration Evaluations," uses Nelms' formula to perform a tornado missile penetration analysis. SAR Appendix C, Section C.7.7.4.7, states that the perforation threshold thickness for the outer shell, top cover plate, and hydraulic ram system closure plate is 0.43 inch (1.1 centimeters) each. The applicant determined this acceptable because the thresholds are less than the thickness of the MP197HB cask outer shell, top cover plate, and hydraulic ram system closure plate of 2.75 inches (6.98 centimeters), 4.5 inches (11.4 centimeters) and 2.5 inches (6.35 centimeters), respectively. As a result, the staff finds that sufficient margin exists, and the analysis is acceptable.

The staff reviewed and verified the information discussed above. On this basis, the staff concludes that the MP197HB cask loaded with the 61BT DSC is structurally acceptable for the canister transfer at the WCS CISF.

In SAR Appendix D, Section D.7.7, "Structural Analysis of MP197HB Cask as On-Site Transfer Cask," the applicant noted that the MP197HB cask serves as the onsite transfer cask for both the 61BT and 61BTH Type 1 DSCs. The applicant performed a structural analysis of the MP197HB cask loaded with the 61BTH Type 1 DSC for the transfer operation, referencing the relevant information provided in SAR Appendix C, Sections C.7.7.1 through C.7.7.4. The analysis references the NUHOMS MP197 Transportation Package SAR, which the applicant incorporated by reference.

Based on the structural analysis presented in SAR Appendix C, Section C.7.7, "Structural Analysis of MP197HB Cask as On-Site Transfer Cask," which is reviewed in SER Section 5.3.3.4.4.2, the staff concludes that the MP197HB cask is structurally acceptable for the cask transfer operation for the 61BTH Type 1 DSC at the WCS CISF.

5.3.3.4.5 Structural Analysis for NAC Transfer Cask

5.3.3.4.5.1 NAC-MPC Transfer Cask

In SAR Appendix E, Section E.7, the applicant presented a structural analysis of the NAC-MPC storage system, which includes the transfer casks. The applicant referenced the detailed structural analyses presented in the NAC-MPC FSAR, which the applicant incorporated by reference, for the NAC-MPC (Yankee-MPC and CY-MPC) and NAC MPC-LACBWR configurations under normal operating conditions.

As indicated in SAR Appendix E, Sections E.3.1.1.5 and E.3.2.1.5, both entitled, "Combined Load Criteria," the applicant analyzed the NAC-MPC and NAC MPC-LACBWR system transfer casks, respectively, as a special lifting device designed to the criteria of ANSI N14.6 and NUREG-0612. The applicant noted that Section 3 of the NAC-MPC FSAR presents relevant structural analyses that meet or exceed those design criteria. The staff reviewed and confirmed that the applicant's structural analyses are consistent with the staff's previous evaluation approving the transfer casks, including that the design criteria meet or exceed ANSI N14.6 and NUREG-0612. As a result, the staff finds acceptable the applicant's assessment that no further site-specific evaluations of the transfer casks are required for normal conditions.

In SAR Appendix E, Sections E.12.1 and E.12.2, the applicant presented an analysis of the NAC-MPC and NAC MPC-LACBWR cask system components including the transfer casks for off-normal and accident-level design events, citing the analyses presented in Section 11 of the NAC-MPC FSAR, which the applicant incorporated by reference. The staff reviewed and confirmed that the applicant's structural analyses are consistent with the staff's previous evaluation approving the transfer casks. Since the design of the transfer casks remains the same, the staff finds that the evaluations continue to be valid and the design criteria continue to be met. In addition, SAR Section 7.5.1 describes the canister transfer system, which includes seismic restraints during transfer cask operations; SER Section 5.3.3.2 presents the staff's analyses.

The staff noted that transfer casks for the NAC systems (NAC-MPC, NAC-UMS and NAC-MAGNASTOR), as specified in their respective FSARs incorporated by reference, are not analyzed against impacts from tornado missiles during transfer operations. The applicant proposed to use administrative controls in order to provide adequate protection which the applicant discussed in proposed Technical Specification Section 5.4, "Severe Weather." Under the suggested administrative controls, transfer operations will not be permitted unless current and forecasted weather for the approaching eight hours indicate safe weather conditions. In addition, the applicant stated in SAR Section 7.5.3.2.1, that transfer operations will be performed in an expeditious manner and that the total transfer time is estimated to be approximately 8 hours (i.e., 6 hours to complete the lifts and 2 hours to install the bolts for a total of 8 hours). The staff noted that for the WCS site located in Andrews, TX, NUREG/CR-4461 indicates that the expected return frequency of a tornado with maximum wind speeds equal or greater than specified in FSAR Table 3-1 is smaller than 1×10^{-7} . In addition, the staff notes that the high-speed wind frequencies do not include the missile strike probability for a particular target, which would reduce the overall frequency even more.

Therefore, in aggregate, the staff finds that the applicant provided reasonable assurance of adequate protection from the effects of tornado missiles for the NAC transfer casks based on the low potential of a tornado strike in general; the administrative controls proposed for the transfer operations; the limited period of time to complete the transfer operations; the partial protection against tornado effects provided by the CHB framing design as evaluated in SER Section 5.3.3.1; and the additional protection against direct missile strike provided by the sealed canister and the surrounding cask (i.e., transportation cask, transfer cask, or VCC).

As a result, the staff concludes that adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events remain applicable; therefore, the structural integrity of the transfer casks, which were previously approved for the NAC-MPC storage system, will continue to be met for the WCS CISF.

5.3.3.4.5.2 NAC-UMS Transfer Cask

In SAR Appendix F, Section F.7, the applicant discussed the structural analysis of the NAC-UMS Storage System, which includes the transfer casks, citing the detailed structural analyses presented in the NAC-UMS FSAR, which the applicant incorporated by reference.

As indicated in SAR Appendix F, Section F.3.1.1.5, the applicant analyzed the NAC-UMS cask system, including the transfer cask as a special lifting device designed to ANSI N14.6 and NUREG-0612. The applicant noted that Section 3 of the NAC-UMS Storage System FSAR presents relevant structural analyses, which meet or exceed those design criteria. The staff reviewed and confirmed that the applicant's structural analyses are consistent with the staff's

previous evaluation approving the transfer cask, including that the design criteria meet or exceed ANSI N14.6 and NUREG-0612. As a result, the staff finds acceptable the applicant's assessment that no further site-specific evaluations of the transfer cask are required.

In SAR Appendix F, Section F.12.1, the applicant presented an analysis of the NAC-UMS and cask system components, including the transfer cask, for off-normal and accident-level design events, citing the analyses presented in Section 11 of the NAC-UMS FSAR, which the applicant incorporated by reference. The staff reviewed and confirmed that the applicant's structural analyses are consistent with the staff's previous evaluation approving the transfer casks. Since the design of the transfer casks remains the same, the staff finds that the evaluations continue to be valid and the design criteria continue to be met. SAR Section 7.5.1 describes the canister transfer system, which includes seismic restraints during transfer cask operations; SER Section 5.3.3.2 presents the staff's analyses. SER Section 5.3.3.4.5.1 provides additional information on the NAC-UMS transfer cask performance against tornado missile.

As a result, the staff concludes that adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events remain applicable; therefore, the structural integrity of the transfer casks, which were previously approved for the NAC-UMS storage system, will continue to be met for the WCS CISF.

5.3.3.4.5.3 NAC MAGNASTOR Transfer Cask

In SAR Appendix G, Section G.7, the applicant presented a structural analysis of the NAC MAGNASTOR storage system, which includes the transfer casks, citing the detailed structural analyses presented in the NAC MAGNASTOR FSAR, which the applicant incorporated by reference.

As indicated in SAR Appendix G, Section G.3.1.1.5, the applicant analyzed the NAC MAGNASTOR storage system, including the transfer cask, as a special lifting device designed to ANSI N14.6 and NUREG-0612. The applicant noted that Section 3 of the NAC MAGNASTOR FSAR presents the relevant structural analyses, which meet or exceed those design criteria. The staff reviewed and confirmed that the applicant's structural analyses are consistent with the staff's previous evaluation approving the transfer cask, including that the design criteria meet or exceed ANSI N14.6 and NUREG-0612. As a result, the staff finds acceptable the applicant's assessment that no further site-specific evaluations of the transfer cask are required.

In SAR Appendix G, Section G.12.1, the applicant presented an analysis of the NAC MAGNASTOR storage system components, including the transfer cask, for off-normal and accident-level design events, citing the analyses presented in Section 11 of the NAC MAGNASTOR FSAR, which the applicant incorporated by reference. The staff reviewed and confirmed that the applicant's structural analyses are consistent with the staff's previous evaluation approving the transfer casks. Since the design of the transfer casks remains the same, the staff finds that the evaluations continue to be valid and the design criteria continue to be met. In addition, SAR Section 7.5.1 describes the canister transfer system, which includes seismic restraints during transfer cask operations; SER Section 5.3.3.2 presents the staff's analyses. SER subsection 5.3.3.4.5.1 provides additional information on the NAC MAGNASTOR transfer cask performance against tornado missile.

As a result, the staff concludes that adequate safety margins for normal and off-normal conditions, postulated accidents, and natural phenomena events remain applicable; therefore,

the structural integrity of the transfer casks, which were previously approved for the NAC MAGNASTOR storage system, will continue to be met for the WCS CISF.

5.3.3.4.6 NAC Transfer Cask Lifting Auxiliaries

In SAR Table 3-4, “References for WCS CISF Storage System Components Important-to-Safety,” and Sections E.3.1.2.1, E.3.2.1, F.3.1.2.1, and G.3.1.2.1 of SAR Appendices E through G, the applicant discussed the relevant sections and tables in the NAC-MPC, NAC MPC-LACBWR, NAC-UMS, and NAC MAGNASTOR FSARs, respectively, for the ITS auxiliary equipment, which the NRC has previously approved for operating the NAC transfer casks and which the applicant incorporated by reference. As noted in Sections E.4.1.4, E.4.2.4, F.4.1.4, and G.4.1.7 of SAR Appendices E through G, the ITS auxiliary equipment used in operating the transfer casks includes an adapter plate with a hydraulic supply system, a lifting yoke for lifting and handling the transfer cask, and rigging equipment.

In SAR Appendix E, Sections E.7.1.6 and E.7.2.6, each titled, “Lifting Devices,” the applicant evaluated the lifting devices for the NAC-MPC and MPC-LACBWR systems, respectively, citing the relevant information provided in Section 3.4.3 of the NAC-MPC Storage System FSAR, which the applicant incorporated by reference. The applicant noted that the NAC-MPC Storage System FSAR does not include concrete cask design with lifting lugs for vertical lifts. The applicant referred to an additional evaluation that was incorporated by reference in the NAC-MPC Storage System FSAR and made references to the relevant information provided in drawings and calculation packages for the approved FSAR, the applicant indicated that the design of a concrete cask with lifting lugs for the CY-MPC and Yankee-MPC is adequate for lifting the VCC constructed with lifting lugs at the WCS CISF. The staff verified the relevant information and noted that the applicant considered a bounding weight for the analysis that encompassed the three MPC systems: Yankee-MPC, CY-MPC, and MPC-LACBWR. The staff finds that the bounding conditions analyzed demonstrate that the lifting devices are adequate for the NAC-MPC transfer cask lifting operation at the WCS CISF.

In SAR Appendix F, Section F.7.1.6, “Lifting Devices,” the applicant evaluated the NAC-UMS lifting devices, citing the description and structural analyses provided in Section 3.4.3 of the NAC-UMS Storage System FSAR, which the applicant incorporated by reference. The structural evaluations consider the bounding conditions and define the acceptance criteria for each aspect of the analysis. Since the design of the transfer casks and its lifting auxiliaries remains the same, the staff finds that the evaluations in the NAC-UMS FSAR continue to be valid and the design criteria continue to be met.

In SAR Appendix G, Section G.7.1.6, “Lifting Devices,” the applicant evaluated the lifting devices of the NAC MAGNASTOR storage system, citing the relevant information provided in Section 3.4.3 of the NAC MAGNASTOR FSAR, which the applicant incorporated by reference. Since the design of the transfer casks and its lifting auxiliaries remains the same, the staff finds that the evaluations in the NAC MAGNASTOR FSAR continue to be valid and the design criteria continue to be met.

5.3.3.4.7 Transfer Casks and Cask Handling Auxiliaries – Summary

Based on its review, the staff concludes that the WCS CISF has adequately presented acceptable structural analyses for the NUHOMS and NAC transfer casks and their related SSCs and meets the structural requirements of 10 CFR 72.24(d) and (i) and 10 CFR 72.122(b)(1), (b)(2), (b)(3), (c), (d), (f), (g), (h), (i), (j), (k), and (l).

5.3.3.5 Overhead Bridge Cranes

As described in SAR Section 4.7.1, "Cask Handling Building," the CHB houses two 130-ton overhead bridge cranes. The cranes are used primarily for loading and unloading transportation casks off or onto the rail car and to or from the transfer trailer. These cranes are classified as ITS and are designed and procured to follow the loading conditions and combinations established in ASME B30.2, "Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)." As noted in SAR Section 7.5.3.1 "Descriptions of Systems, Structures, and Components," and reviewed in SER Section 5.3.3.1, the overhead bridge crane 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 a seismic event. This design feature supports the safety function of the CHB crane to remain on the CHB rails under design conditions associated with normal operations, accident conditions, and natural phenomena.

The applicant described the design criteria applied to the design of the ITS CHB overhead cranes. In SAR Section 3.2.8.6, "Cask Handling Building Cranes," the applicant stated that the overhead bridge cranes are designed as SFP (Type I) in accordance with ASME NOG-1-2015, and designed to follow the loading combinations established in ASME NOG-1-2015. In SAR Section 3.2.3.10.9, "Seismic Analysis of Overhead Cranes," the applicant noted that the CHB overhead cranes were analyzed for seismic effects in accordance with ASME NOG-1-2015 for Type I SFP cranes. The structural design criteria in ASME NOG-1-2015 for Type I cranes address normal operational conditions that include the handled load, extreme environmental conditions including seismic events, and abnormal event loads related to single component failures or certain credible operational errors. Design criteria applied to individual mechanical components in ASME NOG-1-2015 for Type I cranes similarly consider normal operating loads, extreme environmental loads to the extent necessary to ensure retention of the suspended load, and abnormal event loads that include load hang-up and single credible-component failures.

For the NUHOMS transportation cask transfer between the railcar and transfer trailer, the cranes will be administratively controlled (i.e., proposed Technical Specification Section 5.2.1, "Lifting Height and Temperature Limits") and use interlocks to ensure that the 80-inch (203-centimeter) design-basis drop accidents the NRC previously approved remain bounding. The NUHOMS cask lift will use the NITS WCS lift beam assembly designed and fabricated in accordance with SAR Section 4.10, "Supplemental Data Drawings," Drawing WCS012100, "WCS Lift Beam Assembly." These conditions provide assurance that the NUHOMS casks are not lifted above the analyzed drop height, and, therefore, the use of the NITS lift beam assembly for this transfer is acceptable.

The staff evaluated the design criteria applied to the CHB overhead cranes with respect to regulatory requirements for their ITS function of preventing credible abnormal operating conditions resulting in cask impact loads beyond those evaluated as acceptable. The staff found that the applied design criteria are consistent with the guidelines of NUREG-0612 in providing protection against unacceptable cask loading that could result from handling operations with appropriate consideration of maximum normal operating loads, environmental conditions, and abnormal events that would challenge the ability of the crane to retain the suspended load. Based on the above, the staff finds that the description of the CHB overhead cranes in the SAR and docketed materials satisfies the requirements of 10 CFR 72.24, and the design of the CHB overhead cranes satisfies applicable portions of 10 CFR 72.122 related to design criteria and safety analysis.

5.3.4 Other Structures, Systems, and Components Not Important to Safety

SAR Table 3-5, "Quality Assurance Classification of Structures, Systems, and Components as Utilized at the WCS CISF," lists the quality assurance classifications for major SSCs as used at the WCS CISF, which are reviewed in SER Section 4.3.2. For canister transfer operation in the ITS CHB, the NAC canisters are handled by the VCT and CHS, which are ITS and reviewed in SER Sections 5.3.3.4.3 and 5.3.3.4.2, respectively. The major NITS SSCs listed in SAR Table 3-5 for the NUHOMS system include the NUHOMS lift beam assembly, cask transfer trailer, and storage pads. The staff reviews the stated NITS SSCs below.

The applicant noted that the SSCs handling SNF and GTCC waste canisters at the WCS CISF include primarily the CHB, the overhead bridge cranes, CTSs, a NUHOMS cask transfer trailer, and a NUHOMS storage pad. The CHB, CTS, and overhead bridge crane are ITS and are evaluated in SER Section 5.3.3; the other SSCs that are NITS, but subject to NRC approval, are evaluated in this section.

SAR Section 4.7.4 notes that, for the NAC systems, the transportation cask containing the loaded canister is received by and prepared within the VCT, which is ITS and reviewed in SER Section 5.3.3.4.3. After transfer preparation, the cask is moved to the CTS, which is ITS and reviewed in SER Section 5.3.3.4.2, where the canister is unloaded and placed in the VCC using a dedicated transfer cask within the CTS. The VCT then moves the loaded VCC to the storage pad for storage. Because the canister transfer involves only a few ITS auxiliary lifting devices, which are reviewed in SER Section 5.3.3.4.5, the NRC does not need further review of other NITS SSCs for the NAC vertical cask transfer operations.

5.3.4.1 NUHOMS Lift Beam Assembly

The applicant described the transfer process for canisters designed for horizontal storage using the CHB overhead crane with the attached lift beam assembly. The applicant stated that the canisters have been evaluated to maintain safe storage conditions for drops of up to 80 inches during transfer operations. The applicant stated that administrative controls and a lift height interlock would be used to ensure that the NUHOMS transportation cask would be handled at elevations within its analyzed drop height of 80 inches. Therefore, the applicant classified the lift beam assembly as NITS.

As indicated in SAR Section 4.10, the lift beam would be fabricated for a rated load of 140 tons and load tested in accordance with ANSI N14.6 criteria for a critical lift. The staff finds the safety classification, fabrication, and load testing acceptable because the cask lift height is limited to be less than the 80-inch design-basis lift height, and the failure of either the overhead bridge crane or the lift beam assembly will not reduce the effectiveness of the NUHOMS cask to continue to maintain its safety function.

5.3.4.2 NUHOMS Cask Transfer Trailer

As noted in SAR Section 5.2.1, "Canister Receipt, Handling, and Transfer," the loaded NUHOMS cask will be offloaded from a rail car and placed onto a transfer-trailer assembly, which will be moved by a yard tractor to the HSM storage pad. SAR Figures 4-1 through 4-3 provide general-arrangement sketches or pictures of the NUHOMS transfer system, which include primarily a transfer trailer, a transfer cask support skid, and a hydraulic ram. In SAR Section 3.4.2, "Design Criteria for Other SSCs Not Important-to-Safety," the applicant committed to use applicable codes and standards for the design and fabrication of the NITS SSCs. As

such, the transfer-trailer assembly, which includes the support skid and hydraulic ram, is expected to be properly fabricated to meet its structural and mechanical performance requirements. The staff finds the safety classification, fabrication, and testing to commercial standards acceptable because the cask height while mounted on the trailer is less than the 80-inch design-basis lift height and the failure of the trailer assembly would not reduce the effectiveness of the NUHOMS transfer cask to maintain its safety function.

5.3.4.3 NUHOMS Horizontal Storage Module Storage Pad

The staff's review of the NITS NUHOMS storage pad is to verify that the pad design can adequately support the static and dynamic loads (including SSI effects) of the NUHOMS modules without a loss of ability to withstand future loadings throughout its service life

5.3.4.3.1 Description of the NUHOMS Storage Pad

The applicant described the NUHOMS storage pad design in SAR Section 7.6.5, "NUHOMS NITS Storage Pad Design." The NUHOMS pad is 480 feet (146 meters) long, 50 feet (15 meters) wide, and 3 feet (1 meter) thick with a concrete compressive strength of 4,000 psi. SAR Section 7.6.5.1, "Design Inputs," discusses the material properties and design loads related to the NUHOMS pad. The applicant stated that the pad reinforcement will consist of #11 ASTM A 706 or ASTM A 615 Grade 60 steel rebar with a yield strength of 60 ksi (414 MPa), spaced at 10 inches (25 centimeters) each way, each face. SAR Figure 7-53, "NUHOMS NITS Pad Design," provides structural details for the pad. This storage pad is classified as NITS because, according to the NUHOMS FSARs (e.g., Standardized NUHOMS Storage System FSAR Section 3.4.3), it does not meet the criteria in 10 CFR 72.3, "Definitions." Nonetheless, the applicant considered the seismic criteria in the design of the pad.

The staff reviewed the aforementioned license drawings and finds that the licensee provided sufficient information to describe the NUHOMS storage pad. The NUHOMS pad will accommodate a total of 92 TN Model NUHOMS HSMs. The applicant stated that the AHSM design bounds the weight and CG height of the other NUHOMS HSM types planned for the WCS CISF site. The TN system is arranged in a 2-by-46 array. The end HSM units for each stage have a 3-foot-thick shield wall. The staff reviewed pertinent characteristics, including weight and size, of the different HSMs and finds that the AHSM cask bounds the design for the storage pad for these aspects.

5.3.4.3.2 Design Criteria for the NUHOMS Storage Pad

The applicant referenced guidance in NUREG-1567, NUREG-1536, and NUREG-0800 in its evaluation to structurally qualify the NUHOMS storage pad. The codes of record and RGs used for the design include ACI 318-08, ACI 349-06, ASCE/SEI 7-05, ASCE/SEI 43-05, RG 1.61, Revision 1, and RG 1.76, Revision 1.

The applicant discussed design inputs for the storage pad in SAR Section 7.6.5.1. The applicant compiled the governing load combinations based on load combinations, considerations for reduced dead-load and live-load effects, and directions of seismic excitation. The applicant considered the criteria established in NUREG-1536 and ACI 349-06 to calculate governing load combinations. The staff finds that the resulting load combinations and design criteria are consistent with the guidance in NUREG-1536 and are acceptable.

5.3.4.3.3 Structural Analysis of the NUHOMS Storage Pad

5.3.4.3.3.1 Model Characteristics

In SAR Section 7.6.5.4, “Analysis Methodology,” the applicant discussed various aspects of the structural analysis of the NUHOMS storage pad. The applicant considered different aspects, such as cask layout configurations, concrete pad model (i.e., ANSYS), concrete pad stiffness properties, and underlying soil properties.

The applicant stated that during the life of the storage pad, several different cask layout configurations and numbers of casks are possible. As shown in SAR Table 7-36, “ANSYS Finite Element Models for Storage Pad Structural Evaluation,” the applicant performed an analysis using the following five representative, enveloping configurations:

- (1) 4 AHSM on 2 rows back to back
- (2) 8 AHSM on 4 rows back to back
- (3) 22 AHSM on 11 rows back to back
- (4) 42 AHSMs on 21 rows back to back
- (5) 92 AHSMs on fully loaded pad

The storage pad was modeled using equivalent static analyses performed with finite element models, developed using the ANSYS program. The pad model uses ANSYS SOLID45 eight-node brick elements. Contact elements were placed between the bottom of the pad and the top of the supporting soil. This approach is conservative as it slows pad uplift if necessary.

The AHSMs were modeled using rigid SOLID45 elements attached to the surface of the pad. The top elevation of the block assembly corresponds to the CGs of the AHSM. The staff finds that this approach is adequate as it permits the transmission of seismic inertial loads and weight of the AHSMs onto the pad.

The underlying soil layer is modeled into nine layers of ANSYS SOLID45 eight-node brick elements. The thickness and material properties of each layer are consistent with the applicant’s subsurface investigation results. The staff finds that sufficient clearance exists between the pad model and the boundaries of the soil model to allow mitigation of any boundary condition effect.

5.3.4.3.3.2 Structural Capacity of the Pad

The applicant used ANSYS to perform the structural analysis of the pad. As discussed above in SER Section 5.3.4.2.2.1, the applicant considered various cask configurations and load combinations; the applicant performed the structural analysis of the pad by postprocessing stress outputs of the SOLID45 element to calculate the maximum internal moments and shear forces. The enveloped maximum and minimum values of the moments and shears obtained from all five models are used for the design of the pad. In order to ascertain the structural capacity of the pad, the applicant’s overall analysis followed the acceptance criteria of ACI 349, and considered the following factors:

- minimum shrinkage and temperature reinforcement
- design flexural capacity of the pad (the applicant evaluated maximum moments in both directions)

- one-way shear capacity of the pad (the applicant considered the worst case shear resultants in both directions for this approach)
- punching (two-way) shear capacity of the pad (the applicant stated that the controlling case occurs during HSM installation with the loaded 300-ton crane on the pad)

Using the enveloped moments and shear forces and the aforementioned ACI 349 acceptance criteria, the applicant confirmed that the #11 steel reinforcement at 10 inches (25 centimeters) on center, top and bottom, each way with mechanical lap splices is sufficient to meet the load demands on the pad.

The staff reviewed the overall analysis and notes that the applicant used conservatism when appropriate. In particular, the staff noted that more conservative portions of ACI 349 were used in the design of the NUHOMS pad, which is a NITS structure. Overall, the staff finds that the structural capacity of the NUHOMS storage pad is consistent with the guidance in NUREG-1567 and is acceptable.

5.3.4.3.4 Storage Pad Stability

In SAR Section 7.6.5.5, "Analysis Results," the applicant discussed soil-bearing pressure for the HSM storage pads. The applicant calculated ultimate bearing capacity of the pad and considered two different load combinations that included dead, live, and seismic loads. The staff finds that the factors of safety against bearing capacity failure for both cases were acceptable. As a result, the staff finds this analysis acceptable.

In SAR Section 7.6.5.5, the applicant referred to Attachment E of SAR Chapter 2, which states that soils at the site consist mainly of sand, sandy gravel, and caliche. In addition, the site has no subsurface water; therefore, the soil layers are almost all characterized as dry. Based on the previously discussed site information, the applicant stated that an elastic settlement analysis is appropriate for the site. As the aforementioned soils are mostly cohesionless soils, the staff finds that the elastic approach is adequate. In addition, since the presence of cohesive soils at the site is minimal, a consolidation settlement analysis is not necessary. The applicant considered the WCS ISFSI concrete pad to be flexible for settlement purposes, which results in a conservatively larger settlement in comparison to assuming a rigid pad. The applicant also considered best and lower bound estimates of the soil elastic modulus to account for uncertainty. The staff finds that the applicant's settlement analysis includes conservatism and is appropriate because expected bending moments related to this amount of settlement are not expected to adversely affect the structural capacity of the pad.

5.3.4.3.4.1 Soil Structure Interaction Analysis of the NUHOMS Storage Pad

SAR Section 7.6.4 discusses the SSI of the NUHOMS pad. The SSI analysis is conducted in accordance with the guidance in NUREG-0800. The SSI analysis is performed using three HSM loading configurations, three sets of strain-compatible soil properties, and three sets of spectrally matched time histories, for a total of 27 different models. The models address various characteristics, such as variations in loading, uncertainties in the ground motion, and diverse soil parameters. The applicant's approach consisted of enveloping accelerations at the CG of the HSMs and acceleration response spectra at the base and CG of the HSMs. The maximum accelerations at the CG of the HSMs are used in the structural evaluation of the concrete pad. The response spectra and maximum accelerations at the CG of the HSM are also used in the seismic evaluation of HSM sliding and rocking uplift. To account for potential effects of

variability in the underlying rock and soil conditions, the applicant considered three different profiles. This approach is consistent with the guidance in NUREG-0800, Section 3.7.2.

The applicant considered three earthquake time histories for the SSI analysis. The staff notes that the input time histories were developed in accordance with NUREG-0800, Section 3.7.1, "Seismic Design Parameters," Subsection I, Paragraph B, Option 1. Each of these includes three components (two horizontal and one vertical). All components were applied to the SSI model simultaneously to generate a combined response output. In addition, the results for time histories are enveloped to conservatively account for variability among ground motions.

The applicant used the SC-SASSI computer program for the SSI analysis. The concrete pad was generated using eight-node brick elements. The concrete pad was analyzed as surface founded at the bottom of the excavated depth using corresponding surface input motions compatible with the strain compatible soil profiles.

The HSMs were modeled by a vertical beam from its base to the CG of the loaded HSM. The weight and moments of inertia of each module are lumped at the CG of the HSM. The material and geometric properties of the beam representing the module are adjusted to match the lowest frequencies of the AHSM in each direction. The bases of the modules were modeled with horizontal rigid beams located at the surface of the pad. Each module is connected to the pad by three-dimensional rigid springs at six points. The configuration of springs does not prevent the pad from bending, and the springs are configured to minimize any stiffening effects on the pad. The vertical springs force the six points of vertical connection to remain on a plane; however, the pad inside the area defined by those six vertical connection points is able to experience bending deformations.

The staff finds that the applicant's analysis is consistent with the guidance in NUREG-0800 and is therefore adequate. The applicant considered conservatism when appropriate, mainly by using enveloping accelerations at the CG of the HSMs, employing adequate time histories, and accounting for variability in the soil.

5.3.4.3.4.2 Horizontal Storage Module Stability Analyses

The applicant discussed HSM sliding in SAR Section 7.6.4.4.2, "Sliding and Rocking Stability Evaluations." A sliding coefficient was calculated using the peak vertical acceleration of the cask and the static friction coefficient between the pad and cask. In accordance with ASCE/SEI 43-05, the cask sliding distance was calculated considering the 10-percent damped vectorial spectral horizontal acceleration of the module. The applicant conservatively used a 7-percent damped spectral acceleration, with the spectral accelerations located at the base and the CG of the HSM module. The calculated maximum sliding distance was 0.188 inch (0.478 centimeter). The applicant stated that the aforementioned sliding distance is negligible. Conservatism was used when appropriate; the staff noted that sufficient sliding margins exist between adjacent HSMs and the edge of the pad, which makes the approach adequate.

The applicant discussed HSM cask overturning potential. The applicant calculated the factor of safety against overturning by calculating the resisting moment due to vertical acceleration against the overturning moments due to horizontal acceleration. This was performed for all 27 SSI analysis cases at each timestep. From this analysis, the applicant identified the situation with the highest potential for rocking and then calculated a static stability angle and the maximum uplift height. The maximum uplift height is 0.0808 inch (0.205 centimeter), and the maximum rotation angle is 0.046 degrees. Thus, the analysis concluded that the maximum rocking angle and uplift are very small. The staff finds that the applicant used applicable inputs

into the calculations—such as range of soil profiles (BE, UB, LB), time histories, and cask configurations—and that the results are acceptable. On this basis, the staff concludes that the HSM casks will not overturn under the conditions discussed.

The staff finds that the applicant provided sufficient information to demonstrate that the structural integrity of the NUHOMS storage pad design can adequately support the static and dynamic loads (including SSI effects) of the NUHOMS modules without a loss of ability to withstand future loadings throughout its service life. Therefore the staff finds that the structural requirements of 10 CFR 72.24(d)(1), (d)(2), and (i) and 10 CFR 72.122(b)(1), (b)(2), (b)(3), (c), (d), (f), (g), (h), (i), (j), (k), and (l) are met.

5.4 Evaluation Findings

The staff makes the following findings about confinement SSCs:

- The SAR and docketed materials relating to the description of confinement SSCs meet the requirements of 10 CFR 72.24(a) and (b).
- The SAR and docketed materials relating to the structural design criteria, including applicable codes and standards, meet the requirements of 10 CFR 72.24(c)(1), (c)(2), and (c)(4); 10 CFR 72.40(a)(1); 10 CFR 72.120(a) and (b); 10 CFR 72.122(a), (b), (c), (d), (f), (g), (h), (i), (j), (k), and (l); and 10 CFR 72.128(a) and (b).
- The SAR and docketed materials relating to suitable structural material properties for use in the design and construction of the SSCs meet the requirements of 10 CFR 72.24(c)(3).
- The SAR and docketed materials provide adequate analytical reports, test reports, or both, to ensure the structural integrity of the SSCs and meet the structural requirements of 10 CFR 72.24(d) and (i) and 10 CFR 72.122(b)(1), (b)(2), (b)(3), (c), (d), (f), (g), (h), (i), (j), (k), and (l).

The staff makes the following findings about reinforced concrete SSCs:

- The SAR and docketed materials relating to the description of reinforced concrete SSCs meet the requirements of 10 CFR 72.24(a) and (b).
- The SAR and docketed materials relating to structural design criteria, including applicable codes and standards, meet the requirements of 10 CFR 72.24(c)(1), (c)(2), and (c)(4); 10 CFR 72.40(a)(1); 10 CFR 72.120(a) and (b); 10 CFR 72.122(a), (b), (c), (d), (f), (g), (h), (i), (j), (k), and (l); and 10 CFR 72.128(a) and (b).
- The SAR and docketed materials relating to suitable structural material properties for use in the design and construction of the SSCs meet the requirements of 10 CFR 72.24(c)(3).
- The SAR and docketed materials provide adequate analytical reports, test reports, or both, to ensure the structural integrity of the SSCs and meet the structural requirements of 10 CFR 72.24(d)(1), (d)(2), and (i) and 10 CFR 72.122(b)(1), (b)(2), (b)(3), (c), (d), (f), (g), (h), (i), (j), (k), and (l).

The staff makes the following findings about other ITS SSCs:

- The SAR and docketed materials relating to the description of other ITS SSCs meet the requirements of 10 CFR 72.24(a) and (b).
- The SAR and docketed materials relating to structural design criteria, including applicable codes and standards, meet the requirements of 10 CFR 72.24(c)(1), (c)(2), and (c)(4); 10 CFR 72.40(a)(1); 10 CFR 72.120(a) and (b); 10 CFR 72.122(a), (b), (c), (d), (f), (g), (h), (i), (j), (k), and (l); and 10 CFR 72.128(a) and (b).
- The SAR and docketed materials relating to suitable structural material properties for use in the design and construction of the SSCs meet the requirements of 10 CFR 72.24(c)(3).
- The SAR and docketed materials provide adequate analytical reports, test reports, or both, to ensure the structural integrity of the SSCs and meet the structural requirements of 10 CFR 72.24(d)(1), (d)(2), and (i) and 10 CFR 72.122(b)(1), (b)(2), (b)(3), (c), (d), (f), (g), (h), (i), (j), (k), and (l).

The staff makes the following findings about other NITS SSCs:

- The SAR and docketed materials relating to the description of other NITS SSCs subject to NRC approval meet the requirements of 10 CFR 72.24(a) and (b).
- The SAR and docketed materials relating to structural design criteria, including applicable codes and standards, meet the requirements of 10 CFR 72.24(c)(1), (c)(2), and (c)(4); 10 CFR 72.40(a)(1); 10 CFR 72.120(a) and (b); 10 CFR 72.122(a), (b), (c), (d), (f), (g), (h), (i), (j), (k), and (l); and 10 CFR 72.128(a) and (b).
- The SAR and docketed materials relating to suitable structural material properties for use in the design and construction of the SSCs meet the requirements of 10 CFR 72.24(c)(3).
- The SAR and docketed materials provide adequate analytical reports, test reports, or both, to ensure the structural integrity of the SSCs and meet the structural requirements of 10 CFR 72.24(d)(1), (d)(2), and (i) and 10 CFR 72.122(b)(1), (b)(2), (b)(3), (c), (d), (f), (g), (h), (i), (j), (k), and (l).

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6 THERMAL EVALUATION

In Safety Analysis Report (SAR) Chapter 8, “Thermal Evaluation,” Interim Storage Partners LLC (the applicant) presented information to demonstrate that the proposed WCS Consolidated Interim Storage Facility (CISF) structures, systems, and components (SSCs) important to safety and spent nuclear fuel (SNF) material temperatures remain within allowable values or criteria for normal, off-normal, and accident conditions.

6.1 Scope of Review

The U.S. Nuclear Regulatory Commission (NRC) staff evaluated the thermal evaluation for the WCS CISF by reviewing the documents cited in or attached to the SAR, the applicant’s responses to the staff’s requests for additional information (RAIs), and other relevant literature. In addition to the information in SAR Chapter 8, the staff reviewed the information in SAR Chapter 3, “Principal Design Criteria,” related to the additional design criteria for cask systems used at the proposed site and in SAR Appendices A through H related to the specific canister or cask system thermal safety evaluations previously approved under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 72, “Licensing requirements for the independent storage of spent nuclear fuel, high-level radioactive waste, and reactor-related greater than Class C waste.”

6.2 Regulatory Requirements

The regulatory requirements relevant to the thermal evaluation of the proposed WCS CISF appear in the following sections of Title 10 of the *Code of Federal Regulations* (10 CFR):

- 10 CFR 72.92, “Design basis external natural events”
- 10 CFR 72.122, “Overall requirements”
- 10 CFR 72.128, “Criteria for spent fuel, high-level radioactive waste, reactor-related greater than Class C waste, and other radioactive waste storage and handling”

The applicant proposed to use the cask systems identified in the SER Table 1-1, each of which have been reviewed and approved by the U.S. Nuclear Regulatory Commission (NRC) staff under either the site-specific or general license provisions of 10 CFR Part 72.

6.3 Staff Review and Analysis

Unless otherwise stated, the staff reviewed and evaluated the applicant’s thermal evaluation for the proposed site discussed in Chapters 3 and 8 and Appendices A through H of SAR Revision 5; documents cited in or attached to the SAR; the applicant’s responses to the staff’s RAIs; and other relevant literature. The specific topics covered are decay heat removal systems; material temperature limits; thermal loads and environmental conditions; analytical methods, models, and calculations; and protection from fire and fire explosion.

The following sections describe the staff’s evaluation to determine whether the decay heat removal system is capable of reliable operation so that the temperatures of materials used for SSCs important to safety, fuel assembly cladding material, and solidified high-level waste packages remain within the allowable limits under normal, off-normal, and accident conditions. The staff reviewed and evaluated the dry fuel assembly transfer systems for adequate decay heat removal under normal, off-normal, and accident conditions and the fire hazards analysis

and fire protection measures for the WCS CISF to determine whether the applicant provided an acceptable basis for the independent spent fuel storage installation (ISFSI) design and location of safety-related structures and systems to minimize the probability and effect of fires and explosions. Lastly, the staff reviewed the information in the application to confirm that the thermal design of the WCS CISF has been analyzed with acceptable analytical and test methods.

6.3.1 Decay Heat Removal Systems

6.3.1.1 General Considerations

The staff reviewed the information in the application, particularly the technical specifications, the SAR, and SAR Appendices A through H, and confirmed that the applicant incorporated by reference the previously approved storage systems for both SNF and greater-than-Class-C (GTCC) waste. The staff reviewed SAR Chapters 1, 2, and 4 and confirmed that the application provided a detailed description of the GTCC canister systems to be used in the WCS CISF.

6.3.1.2 Dry Storage Systems

The staff reviewed Appendices A through H of the SAR and confirmed that the applicant described in detail the heat removal characteristics for each of the previously approved storage cask systems proposed for use at the WCS CISF site. The staff noted that these systems are designed with passive heat removal capabilities and are expected to operate reliably under normal, off-normal, and accident conditions. In addition, the staff confirmed that the referenced final safety analysis report (FSAR) for the NUHOMS®-MP187 System and the SARs for the NAC-STC® Transportation System, NAC-UMS® Transportation System, and NAC MAGNATRAN® system, included the canisters to store GTCC waste.

The staff also noted that Section 5.1.3, “HSM Thermal Monitoring Program,” in the technical specification administrative controls, which the applicant proposed in Revision 3 of the license application, contained provisions for daily visual inspections of the horizontal storage module (HSM) air vents. The applicant’s proposed provisions are acceptable because they are consistent with the analysis of air vent blockage in Section 8.2.7, “Blockage of Air Inlet and Outlet Openings,” of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference.

6.3.1.3 Dry Transfer Systems

The staff reviewed SAR Chapters 1, 2, and 4 and the description of the dry transfer systems to transfer canisterized SNF and GTCC waste into the dry storage systems. For vertical cask systems, the application described the use of the canister transfer system to transfer SNF and GTCC waste canisters from the upright transportation casks to the vertical storage overpacks. The application identified the major components of this system, which include a shielded transfer cask, mobile gantry crane, and ancillary equipment used to move the canisters from the upright transportation cask to the vertical storage overpack. For horizontal systems, the application described the use of the dry transfer systems to transfer the cask out to the HSM and transfer the canister into the HSM or retrieve it. The application identified the major components of the horizontal system, which include the transfer trailer, skid, skid positioning system, HSM/cask restraint system, hydraulic ram, and alignment equipment. The staff confirmed that the description of these systems is consistent with the information incorporated by reference and that the systems are designed with passive heat removal capabilities. Based

on its review, the staff concludes that the applicant described the decay heat removal systems in sufficient detail for the staff to determine that the requirements of 10 CFR 72.122(h)(1) and 10 CFR 72.128(a) have been adequately satisfied because the description includes the necessary details specified in the regulatory requirements.

6.3.2 Material Temperature Limits

6.3.2.1 General Considerations

The staff reviewed SAR Appendices A through H, which discussed several FSARs that the applicant incorporated by reference and that contain the necessary information about material temperature limits. The staff confirmed that the information incorporated by reference included (1) the limits for each specific cask and material of construction and (2) the SNF cladding allowable limits for the allowable contents. The applicant did not provide material temperature limits for the contents for GTCC waste. The applicant stated that GTCC contents are bounded by the canisters containing SNF. The staff finds this statement acceptable because GTCC waste has a much lower decay heat than SNF. The staff confirmed that the material temperature limits for the canisters and overpacks are provided in the respective FSARs for each system that is designed to store GTCC waste.

6.3.2.2 Fuel Cladding

The staff reviewed the information in SAR Appendices A through H, which discussed information from FSARs that NRC previously evaluated to certify the different storage and transfer systems for SNF and that the applicant incorporated by reference. The staff confirmed that the following FSAR sections provide the fuel cladding temperature limits for each cask system incorporated by reference for each SNF storage system proposed for use at the WCS CISF:

- The NUHOMS-MP187 System will use the HSM Model 80 overpack (see Section 3.3.7.1.1 of “Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel,” Revision 14 (Standardized NUHOMS Storage System FSAR), issued July 13, 2016.
- The Standardized NUHOMS Storage System will use the HSM Model 102 overpack. Section 3.3.7.1.1 of the Standardized NUHOMS Storage System FSAR gives the allowable fuel cladding temperature limits for both the NUHOMS-MP187 System and Standardized NUHOMS Storage System. The limits are for both boiling-water reactor (BWR) and pressurized-water (PWR) design-basis fuel for normal, off-normal, and accident conditions.
- The Standardized Advanced NUHOMS Storage System will use the Advanced HSM overpack. Section 3.5.1 of the Standardized Advanced NUHOMS Storage System FSAR gives the allowable cladding temperature limits for the Standardized Advanced NUHOMS Storage System. The limits are for PWR design-basis fuel for normal, off-normal, and accident conditions.
- The NAC-MPC System will use NAC-MPC overpack. Section 3.5 of “NAC Multi-Purpose Canister Final Safety Analysis Report,” Revision 10, issued January 2014, gives the allowable cladding temperature limits for the NAC-MPC storage system. The limits are for PWR and BWR design-basis fuel for normal, off-normal, and accident conditions.

- The NAC-UMS Storage System` will use the Vertical Concrete Cask overpack. Sections 2.1.3.1.6 and 3.5 of “Final Safety Analysis Report for the UMS Universal Storage System,” Revision 10, issued October 2012, gives the allowable cladding temperature limits for the NAC-UMS Storage System. The limits are for PWR and BWR design-basis fuel for normal, off-normal, and accident conditions.
- The MAGNASTOR storage system will use the Concrete Cask overpack. Section 3.8.3 of “MAGNASTOR® Final Safety Analysis Report,” Revision 7, issued July 2015, gives the allowable cladding temperature limits for the MAGNASTOR storage system. The limits are for PWR and BWR design-basis fuel for normal, off-normal, and accident conditions.

6.3.2.3 Special Thermal Criteria for Reinforced Concrete

The staff reviewed SAR Appendices A through H, which discussed information from FSARs that NRC previously evaluated to certify the different storage and transfer systems for SNF and that the applicant incorporated by reference. The staff confirmed that the FSAR for each SNF storage system proposed for use at the WCS CISF provides the concrete temperature limits. The staff confirmed that concrete allowable temperature limits were based on American Concrete Institute (ACI) criteria. The staff verified that for cases where the ACI recommended limit was exceeded (for example, the allowable limit was set at 350 degrees Fahrenheit (F) (177 degrees Celsius (C))) during off-normal and accident conditions), the referenced designs followed the recommended ACI criteria for elevated concrete temperatures.

6.3.2.4 Extreme Low Temperatures

In SAR Table 2-2, “Summary of Maximum and Minimum Temperatures for Andrews, TX, Period of Record: 1962 to 2010,” the applicant summarized recorded maximum and minimum temperatures for Andrews, TX, for the period from 1962 to 2010. Because the proposed WCS CISF would be located approximately 32 miles northwest of Andrews, TX, the applicant used the recorded temperatures of that location to characterize the WCS CISF maximum and minimum temperatures. In the same table, the applicant listed the lowest daily minimum temperature of -1 degree F (-18 degrees C) recorded during this period. Therefore, the applicant considered -1 degree F the extreme minimum value recorded at the site. The staff reviewed and confirmed that the FSARs incorporated by reference for the proposed storage systems to be used at the WCS CISF considered an extreme minimum temperature of -40 degrees F (-40 degrees C). Therefore, the staff concludes that the WCS CISF characteristics and environmental conditions for low temperature are acceptable because they are enveloped by the corresponding characteristics and conditions previously evaluated for the cask systems proposed for storage at the WCS CISF. Based on review of the application and FSARs incorporated by reference, the staff concludes that the WCS CISF meets the regulatory requirements of 10 CFR 72.122(h)(1) and (l).

6.3.3 Thermal Loads and Environmental Conditions

The staff reviewed SAR Tables A.3-1, B.3-1, C.3-1, D.3-1, E.3-1, F.3-1, and G.3-1, which specify the WCS CISF principal design criteria compared with the design-basis thermal loads (including total and per assembly decay heat) for the proposed cask storage systems. The applicant specified the total and per assembly decay heat at the site as the design basis of the respective storage systems. Because the NRC has previously reviewed and approved these

cask storage systems and because the design-basis heat load at the WCS CISF site is the same as that for each storage system, the staff finds the design values acceptable for meeting the requirements in 10 CFR 72.92 and 10 CFR 72.122.

The thermal evaluation of the storage systems proposed for use at the WCS CISF site applies insulation values from 10 CFR 71.71(c)(1). Because of the large thermal inertia of a storage cask, the thermal evaluation described in the respective FSARs for storage systems averaged the insulation values in 10 CFR Part 71 over a 24-hour day assuming steady-state conditions. Therefore, the staff finds the insulation values used for the storage systems acceptable because from the physical point of view, averaged values are adequate based on the large cask thermal inertia.

In SAR Table 2-2, the applicant provided the mean monthly temperature during the period described in SAR Section 2.3.3.1, "Maximum and Minimum Temperatures." The table listed the maximum mean monthly temperatures recorded for the months of June, July, and August, with July as the highest value recorded during the period. The table also listed a monthly-averaged value of 81.5 degrees F (27.5 degrees C) for July, which the applicant considered as the normal ambient temperature value including seasonal variations. However, examination of the values in SAR Table 2-2 indicated that a more representative value for the site would be closer to 95 degrees F (35 degrees C). This value would assure a bounding maximum normal ambient temperature for the site. As described in their respective FSARs incorporated by reference, the thermal evaluations for the proposed storage systems for use at the WCS CISF assumed annual-averaged ambient temperatures. As described in the respective FSARs for the proposed cask storage systems, the annual-averaged ambient temperature does not consider seasonal variations. Since the FSAR information incorporated by reference used different annual-averaged temperatures, the applicant considered each cask storage system separately. SAR Tables A.3-1, B.3-1, C.3-1, D.3-1, E.3-1, F.3-1, and G.3-1 specified the WCS CISF principal design criteria compared with the proposed storage systems for use at the site. SAR Tables A.3-1, B.3-1, C.3-1, and D.3-1 showed that ambient temperatures of 101 degrees F (38.3 degrees C), 104 degrees F (40.0 degrees C), and 100 degrees F (37.8 degrees C) used for the NUHOMS-MP187, Standardized Advanced NUHOMS, and Standardized NUHOMS storage systems, respectively, bound the WCS CISF site maximum normal ambient temperature of 95 degrees F (35 degrees C). However, SAR Tables E.3-1, F.3-1, and G.3-1 showed that the ambient temperatures of 75 degrees F (24 degrees C), 76 degrees F (24 degrees C), and 76 degrees F used for the NAC-MPC, NAC-UMS, and MAGNASTOR storage systems, respectively, do not bound the WCS CISF site. In its response to an RAI, the applicant stated that the transportation cask is only licensed for 23 kilowatts (kW) and that this reduction in the heat load would compensate for the use of a lower ambient temperature in the thermal analysis. The staff performed sensitivity calculations to determine the effect of the reduction in the heat load. The staff's sensitivity analysis results showed that to the reduced heat load would compensate for the difference in ambient temperature.

SAR Tables A.3-1, B.3-1, C.3-1, D.3-1, E.3-1, F.3-1, and G.3-1 specified the WCS CISF principal design criteria compared with the proposed storage systems for use at the site. SAR Tables A.3-1, B.3-1, C.3-1, and D.3-1 showed that off-normal temperatures of 120 degrees F (48.9 degrees C), 117 degrees F (47.2 degrees C), and 125 degrees F (51.7 degrees C) used for the NUHOMS-MP187, Standardized Advanced NUHOMS, and Standardized NUHOMS storage systems, respectively, bound the WCS CISF site off-normal temperature of 113 degrees F (45.0 degrees C) in SAR Table 1-2. However, SAR Tables E.3-1, F.3-1, and G.3-1 showed that off-normal temperatures of 100 degrees F (37.8 degrees C), 106 degrees F (41.1 degrees C), and 106 degrees F used for the NAC-MPC, NAC-UMS, and

MAGNASTOR storage systems, respectively, do not bound the WCS CISF site off-normal temperature. In its response to an RAI, the applicant stated that the transportation cask is only licensed for 23 kW and that this reduction in the heat load would compensate for the use of a lower ambient temperature in the thermal analysis. The applicant further stated that additional margin is available because, for off-normal events, the analysis results for the different NAC storage systems showed predicted temperatures much lower than allowable limits for off-normal conditions. Based on the discussion above, the staff confirmed that the WCS CISF characteristics and environmental conditions are either enveloped or adequately justified (as described above) by the FSARs for the cask storage systems proposed for use at the site.

The staff has reasonable assurance that the design parameters of the proposed storage systems bound the WCS CISF site thermal loads and environmental conditions and, therefore, meet the requirements of 10 CFR 72.92(a) and 10 CFR 72.122(b).

6.3.4 Analytical Methods, Models, and Calculations

In SAR Chapter 8, the applicant discussed the approved storage systems for both SNF and GTCC waste. The staff confirmed that the FSARs incorporated by reference fully described the SNF storage casks. The staff reviewed the detailed description of the GTCC canister systems proposed for use at the WCS CISF. In SAR Table 8-1, "Thermal Evaluations for the Storage Systems at the WCS CISF," the applicant provided the cross-reference to the applicable SAR appendix and SAR section for the thermal evaluation for each storage system and GTCC waste canister system.

The staff reviewed the information pertaining to the WCS CISF analytical methods, models, and calculations and finds the information acceptable because the applicant incorporated by reference the previously approved analytical methods, models, and calculations used to establish the thermal characteristics of the NUHOMS-MP187, Standardized NUHOMS, Standardized Advanced NUHOMS, NAC-MPC, NAC-UMS, and MAGNASTOR storage systems.

Based on the discussion above, the staff has reasonable assurance that the WCS CISF is adequately designed to protect SSCs important to safety from all postulated normal, off-normal, and accident thermal loads and environmental conditions and, therefore, meets the requirements of 10 CFR 72.122(h)(1) and 10 CFR 72.128(a).

6.3.5 Protection from Fire and Explosions

In SAR Chapter 8, the applicant provided information to satisfy the design criteria requirements of 10 CFR 72.122(c) that require SSCs classified as important to safety be designed and located to continue to perform their safety functions effectively under credible fire and explosion exposure conditions. The applicant stated that a maintenance program to control any significant growth of vegetation through the crushed rock surface of the protected area and the isolation zone will be established before commencing ISFSI operations. Therefore, the surface of the protected area is noncombustible. The staff reviewed the NUHOMS system fire analysis, which assumed a fire with 300 gallons (1136 liters) of diesel fuel and, therefore, bounds the quantity of fuel in the transfer vehicle. The applicant stated that during operations, the amount of flammable liquids in the cask handling building would be administratively controlled to maintain the amount of flammable liquids below the fire load limits for the respective systems. If a fire occurred, the fire suppression system in the cask handling building would mitigate the consequences. The applicant stated that WCS CISF-initiated explosions are not considered

credible because (1) no explosive materials are present and (2) the effects of externally initiated explosions are bounded by the design-basis tornado-generated missile load analysis performed for the previously approved storage systems.

Based on its review of the information and evaluations in the application, the staff has reasonable assurance that the WCS CISF is adequately designed to protect SSCs important to safety from all postulated fires and explosions to meet the requirements of 10 CFR 72.122(c).

6.4 Evaluation Findings

Based on its review of the SAR, the staff determined the following:

- The SAR described SSCs important to safety in sufficient detail to enable an evaluation of their heat removal effectiveness. The cask SSCs important to safety remain within their operating temperature ranges in accordance with 10 CFR 72.122.
- The WCS CISF is designed with a heat removal capability having testability and reliability consistent with its importance to safety as required by 10 CFR 72.128.
- The spent fuel cladding is protected against degradation that leads to gross ruptures by maintaining the cladding temperature for 40 years below 400 degrees C (752 degrees F) in an inert environment. Protection of the cladding against degradation will allow ready retrieval of the spent fuel assembly for further processing or disposal as required by 10 CFR 72.122.
- The staff concludes that the site-specific fire and explosion hazard evaluations are acceptable and that the fire protection program meets the requirements of 10 CFR 72.122(c). This conclusion is based on the applicant meeting the guidelines of Branch Technical Position (BTP) 9.5-1, "Fire Protection Program," as well as applicable industry standards. In meeting these guidelines, the applicant has (1) provided an acceptable basis for the design and location of safety-related structures and systems to minimize the probability and effect of fires and explosions, (2) used noncombustible and heat-resistant materials whenever practical, and (3) provided fire detection and firefighting systems of appropriate capacity and capability to minimize adverse effects of fire on systems important to safety.

6.5 References

AREVA, Inc., "Updated Final Safety Analysis Report for the Standardized Advanced NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 6, August 2014 (nonpublic). NRC Docket No. 72-1029. Transmittal dated July 13, 2016. Agencywide Documents Access and Management System (ADAMS) Accession No. ML16200A178.

AREVA TN Americas, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 14, September 2014 (nonpublic). NRC Docket No. 72-1004. Transmittal dated July 13, 2016. ADAMS Accession No. ML16218A396.

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

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Interim Storage Partners LLC, "WSC Consolidated Interim Storage Facility Safety Analysis Report," Revision 5, Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML21105A766.

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NAC International, "MAGNASTOR® Final Safety Analysis Report," Revision 7, July 2015 (nonpublic). NRC Docket No. 72-1031. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A932.

NAC International, "NAC-MPC, NAC Multi-Purpose Cask, Final Safety Analysis Report," Revision 10, January 2014 (nonpublic). NRC Docket No. 72-1025. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A556.

NAC International, "NAC-UMS Universal Storage System Final Safety Analysis Report," Revision 10, October 2012 (nonpublic). NRC Docket No. 72-1015. Transmittal dated August 3, 2016. ADAMS Accession No. ML16245A212.

NRC, NUREG-2174, "Impact of Variation in Environmental Conditions on the Thermal Performance of Dry Storage Casks," March 2016.

NRC, Branch Technical Position CMEB 9.5-1, "Guidelines for Fire Protection for Nuclear Power Plants," (formerly Branch Technical Position ASB 9.5-1), Revision 3, dated July 1981. ADAMS Accession No. ML070660454.

Sacramento Municipal Utility District, "Rancho Seco Independent Spent Fuel Storage Installation, Final Safety Analysis Report, Volume 1, ISFSI System," Revision 4, June 2010 (nonpublic). NRC Docket No. 72-11. Transmittal dated August 11, 2016. ADAMS Accession No. ML16236A115.

Transnuclear, Inc., "Safety Analysis Report for the NUHOMS®-MP187 Multi-Purpose Cask," Revision 17, July 2003 (nonpublic). NRC Docket No. 71-9255. Transmittal dated July 15, 2016. ADAMS Accession No. ML16203A183.

7 SHIELDING EVALUATION

Interim Storage Partners LLC (the applicant) described the shielding for the proposed WCS Consolidated Interim Storage Facility (CISF) in Chapter 9, “Radiation Protection,” of the safety analysis report (SAR), Revision 5, as well as in relevant information in SAR Chapter 3, “Principal Design Criteria,” and Chapter 4, “Facility Design.” In addition, the applicant provided system-specific information on shielding in SAR Appendices A through H.

7.1 Scope of Review

The staff evaluated the applicant’s shielding evaluation for the WCS CISF by reviewing the information in the SAR, the applicant’s responses to the staff’s requests for additional information, and the staff’s previous evaluations for the proposed cask systems to be stored at the facility that have been incorporated by reference in the SAR. The staff reviewed the information in SAR Chapter 9 and Appendices A through H to ensure that radiation exposures to workers and the public meet U.S. Nuclear Regulatory Commission (NRC) regulatory criteria and are maintained as low as reasonably achievable (ALARA). This chapter also evaluates radiation doses to workers and the public from the operation of the facility. The staff also considered relevant information in SAR Chapters 3 and 4.

7.2 Regulatory Requirements

The regulatory requirements relevant to the shielding evaluation of the proposed WCS CISF appear in the following regulations in Title 10 of the *Code of Federal Regulations* (10 CFR):

- 10 CFR 72.24, “Contents of application: Technical information”
- 10 CFR 72.104, “Criteria for radioactive materials in effluents and direct radiation from an ISFSI or MRS”
- 10 CFR 72.106, “Controlled area of an ISFSI or MRS”
- 10 CFR 72.126, “Criteria for radiological protection”
- 10 CFR 72.128, “Criteria for spent fuel, high-level radioactive waste, reactor-related greater than Class C waste, and other radioactive waste storage and handling”
- 10 CFR 20.1101, “Radiation protection programs”
- 10 CFR 20.1201, “Occupational dose limits for adults”
- 10 CFR 20.1301, “Dose limits for individual members of the public”
- 10 CFR 20.1302, “Compliance with dose limits for individual members of the public.”

These requirements address the information to be submitted in an application; the applicable radiation dose limits; and the requirements for structures, systems, and components (SSCs) and operations to control radiation exposures to personnel.

The applicant proposed to use the cask systems identified in Table 1-1 of this safety evaluation report (SER), each of which the NRC staff has reviewed and approved under either the site-specific or general license provisions of 10 CFR Part 72, “Licensing requirements for the independent storage of spent nuclear fuel and high-level radioactive waste, and reactor-related greater than Class C waste.”

7.3 Staff Review and Analysis

7.3.1 Radiation Sources

Section 9.2, "Radiation Sources," of the SAR identifies the source of gamma and neutron radiation to be the spent nuclear fuel (SNF) and Greater than Class C (GTCC) radioactive waste stored in the various cask systems to be stored at the WCS CISF. The SNF that will be stored in the storage casks is limited to the approved contents specified in the applicant's proposed technical specifications (TS), Section 2.1, "Functional and Operating Limits," which identify approved contents for the previously licensed cask systems that the applicant plans to use at the facility. The initial enrichment, burnup, and cooling time for the pressurized-water reactor (PWR) and boiling-water reactor (BWR) SNF allowed to be stored at the site varies with each cask system. The final safety analysis report (FSAR) for each cask system, which the applicant incorporated by reference, provides a detailed assessment of the radiation sources, specific radiological source terms, and calculation methods for the SNF and GTCC waste to be stored in each cask system. The staff has previously reviewed and found these assessments acceptable in the SER for each system.

SAR Section 3.1.1.2 identifies the GTCC waste that may be received at the WCS CISF. For GTCC waste currently stored at the Rancho Seco Independent Spent Fuel Storage Installation (ISFSI) in the NUHOMS®-MP187 System, the radiation source is limited to the approved contents specified in the facility license. The staff previously reviewed and found the assessment of this radiation source acceptable, as part of its review of the Rancho Seco ISFSI Final Safety Analysis Report, Revision 4, which the applicant incorporated by reference. For other GTCC waste to be stored at the WCS CISF, the radiation source is described in transportation package certificates of compliance for which the canisters are authorized contents. Specifically, the NAC-UMS® Universal Transport Cask certificate of compliance (Docket No. 71-9270) describes the Maine Yankee GTCC canister, the NAC-STC Storage Transport Cask certificate of compliance (Docket No. 71-9235) describes the Connecticut Yankee and Yankee Rowe GTCC canisters, and the NAC MAGNATRAN® transportation package certificate of compliance (Docket No. 71-9356) describes the Zion GTCC canister. The staff previously reviewed and found the assessment of these radiation sources acceptable, as documented in the SERs for each of these transportation package designs. The applicant stated in the FSARs for the facility and transportation package designs referenced above that the GTCC waste to be stored at the WCS CISF will be in solid form and will not be stored in the same canister as SNF. The staff finds that the GTCC waste description provided by the applicant meets the requirements of 10 CFR 72.120(b).

Section 9.2.1.1, "Spent Nuclear Fuel and GTCC Waste," of the SAR references the appropriate section of each system FSAR that describes the radiation sources for each system. The applicant assumed that the radiation sources for each cask system are the design-basis source terms used to determine system and site dose rates for each cask system in its associated FSAR. No credit is taken for any additional cooling time that may have elapsed between initial loading and operation of the WCS CISF. Section 9.4, "Estimated On-Site Collective Dose Assessment," of the SAR describes the calculation methods used in the site-specific dose calculations for the facility.

The staff finds the description of radiation sources and calculation methods to be consistent with the information approved in the FSARs for the NUHOMS-MP187, Standardized Advanced NUHOMS, Standardized NUHOMS, NAC-MPC, NAC-UMS, and MAGNASTOR® systems and sufficient to meet the requirements of 10 CFR 72.24(c). The staff finds the use of design-basis

SNF source terms from the previously approved FSARs for these cask systems to be conservative because many of the actual systems will have been loaded and cooled for decades. Actual dose rates during operation of the facility will be measured by active and passive radiation monitoring in order to verify compliance with the radiological limits in 10 CFR Part 20, "Standards for protection against radiation," and 10 CFR Part 72. The applicant will also operate the facility under a radiation protection program to assure that radiation fields are continually monitored, and radiation doses to workers and members of the public are maintained ALARA. Actual dose information will be gathered during operations. The staff evaluations of radiation monitoring at the facility and the radiation protection program appear in Chapter 12 of this SER.

7.3.2 Storage and Transfer Systems

7.3.2.1 Design Criteria

Section 3.3.5, "Radiological Protection," and Section 9.3, "Radiation Protection Design Features," of the SAR describe the shielding design criteria for the facility. The storage systems to be used at the WCS CISF are designed to limit the average external contact dose rates to ALARA levels on the sides and top and at the air inlets and outlets, based on design-basis SNF. The transfer casks are also designed to reduce dose rates from a loaded canister to ALARA levels. The staff finds the use of these design criteria for the facility to be acceptable, since they provide (1) radiation protection systems to minimize personnel exposure, (2) radiological alarm systems in accessible work areas, (3) means for measuring and monitoring radioactive effluents and direct radiation, and (4) procedures and engineering controls to achieve occupational and public doses that are ALARA. The staff finds the applicant's description of the design criteria sufficient to meet the requirements of 10 CFR 72.120(a). These design criteria, along with the design features in discussed in the next section of this SER and the radiation shielding analysis provided in Chapter 9 of the SAR, provide reasonable assurance that the facility will meet the dose limits specified in 10 CFR 72.104(a) and 10 CFR 72.106(b). Additionally, these design criteria provide reasonable assurance that the facility will provide adequate safety based on the use of sufficient shielding in accordance with 10 CFR 72.128(a)(2).

7.3.2.2 Design Features

Section 9.3 of the SAR describes the shielding design features for the storage and transfer system. Facility design features that ensure that dose rates are ALARA and within regulatory limits include the following:

- The only sources of radiation that can lead to significant exposure to workers or members of the public at the facility are the sealed canisters containing SNF assemblies or GTCC waste. These canisters will always be shielded by a transportation package, storage cask, or transfer cask.
- The transportation, transfer, and storage casks are heavily shielded to minimize external dose rates. The storage cask consists of thick layers of steel-reinforced concrete. The transportation and transfer casks are composed of layers of steel, lead, and neutron-shielding materials.
- The originating sites have procedures to prevent loose surface contamination on the exterior of the canisters, as discussed in Section 9.2.2, "Airborne Radioactive Material

Sources,” of the SAR. Canisters will not be transported to the WCS CISF unless contamination levels are within specified limits.

- Canisters will not be opened at the WCS CISF, nor will SNF assemblies or GTCC waste be removed from the canisters. Additionally, the SNF assemblies and GTCC waste will be stored dry inside the canisters, so that no radioactive liquid is available for release.
- The WCS CISF site layout provides substantial distance between the storage area and the owner-controlled area (OCA) boundary, minimizing radiation exposures to individuals outside the OCA and assuring offsite dose rates are well below the 10 CFR 72.104 criteria. The minimum distance from a storage pad to the OCA boundary is more than 4,300 feet (1,310 meters).
- The Security and Administration Building is located at least 330 feet (100 meters) from the storage area. These distances provide separation of radioactive material handling and storage functions from other functions on the site.
- The location of the Cask Handling Building inside the protected area minimizes the distance to the storage pads, provides for minimal other traffic on the route, and maintains substantial distance from the OCA boundary.
- The WCS CISF is located far from population centers. The distance to the nearest town is approximately 5 miles (8 kilometers). The nearest residence is approximately 4 miles (6 kilometers) away in Lea County, NM.

The staff finds the applicant sufficiently described the design of the shielding components important to safety and the means for controlling and limiting occupational radiation exposures and for meeting ALARA goals. Therefore, the staff finds that the facility storage and transfer systems satisfy the requirements of 10 CFR 72.24(b), (c)(3), and (e). The staff finds that the facility shielding design features satisfy the requirements of 10 CFR 72.126(a)(6) because they include heavy shielding to minimize personnel radiation exposure. The staff finds that the SAR provides sufficient information for the staff to determine whether the requirements of 10 CFR 72.128(a)(2) are met; this information includes a description of the shielding materials that will provide radiation protection under normal and accident conditions. Based on this description, the staff finds the effectiveness of the shielding design features in limiting dose rates around the facility to the values specified in 10 CFR Part 20 and 10 CFR Part 72 can be evaluated. The staff evaluation of the shielding design features appears in Section 7.3.4.2 and Chapter 12 of this SER.

7.3.3 Shielding Composition and Details

7.3.3.1 Composition and Material Properties

The FSARs for the storage systems referenced in Chapter 7 of this SER describe the shielding composition and material properties. Section 9.3.3, “Shielding,” of the SAR describes the composition of additional temporary shielding that may be employed during cask handling. The primary shielding during storage will be from the concrete and steel in the various storage cask systems used at the WCS CISF. The primary shielding during transfer operations will be from the steel, lead, and neutron shields in the various transfer casks used at the WCS CISF. The FSARs for the NUHOMS-MP187, Standardized Advanced NUHOMS, Standardized NUHOMS,

NAC-MPC, NAC-UMS, and MAGNASTOR systems give the detailed properties of the materials included in the shielding model.

The staff finds that the description of the shielding composition and details in each respective storage system FSAR are sufficient to meet the requirements of 10 CFR 72.24(b) and 10 CFR 72.24(c)(3). The applicant described the material composition, density, and geometry in sufficient detail to evaluate the effectiveness of the shielding in reducing the dose rates around the facility to within regulatory limits.

7.3.3.2 Shielding Details

Section 9.3.3 of the SAR and the FSARs for the NUHOMS-MP187, Standardized Advanced NUHOMS, Standardized NUHOMS, NAC-MPC, NAC-UMS, and MAGNASTOR systems describe the details of the shielding. Phase 1 of the WCS CISF will consist of approximately 470 canisters in vertical or horizontal storage overpacks containing either SNF or GTCC waste. The total storage capacity for Phase 1 is limited to 5,000 metric tons of heavy metal for SNF and 510,000 pounds (230,000 kilograms) of GTCC waste. The storage casks will be placed on a concrete storage pad in the arrangement shown in Figure 1-6, "WCS CISF Storage Pad Layout," of the SAR.

The FSARs for the NUHOMS-MP187, Standardized Advanced NUHOMS, Standardized NUHOMS, NAC-MPC, NAC-UMS, and MAGNASTOR systems describe in detail each storage cask and transfer cask shielding design. Each storage system provides significant concrete shielding in the radial direction, and steel and concrete shielding in the axial direction. The storage overpack vent ports are designed with sharp bends to avoid radiation streaming out of these ports. Each transfer cask is equipped with heavy neutron and gamma shielding to reduce the dose rates from a loaded canister to ALARA levels. Prior staff review found that the description of the shielding composition and the details in each system FSAR satisfy the requirements of 10 CFR 72.126(a)(6). The staff finds that the radiation protection systems that will shield onsite personnel from radiation exposure have been sufficiently described.

7.3.4 Analysis of Shielding Effectiveness

7.3.4.1 Computational Methods

The applicant described the computational methods and data used to analyze the effectiveness of the shielding for dose points in and around the facility in Section 9.4 of the SAR. To determine the dose rates close to the transfer and storage casks, the individual vendors previously conducted analyses that are contained in the FSARs for the NUHOMS-MP187, Standardized Advanced NUHOMS, Standardized NUHOMS, NAC-MPC, NAC-UMS, and MAGNASTOR systems. The staff reviewed and approved these analyses.

The applicant performed the shielding analysis separately for the NUHOMS horizontal storage modules (documented in AREVA Calculation WCS01-0503, "Site Dose Calculation for NUHOMS Component at WCS (SAR)" (nonpublic), dated December 2015) and the NAC vertical concrete casks (documented in NAC International Calculation 30039-5001, "WCS ISFSI Phase I Site Dose Rate Evaluation," (December 2015)). The applicant combined the calculated dose rates from these first two analyses into the total dose rates at various locations in and around the WCS CISF in a third calculation, AREVA Calculation WCS01-0505, "WCS ISFSI Dose due to Combined Contribution from NUHOMS and NAC Storage Systems (SAR) after Loading Phase I" (April 2016).

The applicant performed the shielding analysis of the NUHOMS horizontal storage modules at the WCS CISF using the computer code MCNP5 version 1.40 with the continuous energy ENDF/B-VI gamma and neutron cross-section library. For the NAC vertical concrete casks, the applicant used MCNP6 version 1.0 with the continuous energy ENDF/B-VII.1 gamma and neutron cross-section library. MCNP is a three-dimensional Monte Carlo N-Particle transport code that uses Monte Carlo techniques with a combinatorial geometry modeling capability able to model the complex surfaces associated with the storage casks. The applicant used gamma and neutron flux-to-dose conversion factors from American National Standards Institute (ANSI)/American Nuclear Society (ANS)-6.1.1-1977, "Neutron and Gamma-Ray Flux-to-Dose-Rate Factors," for all dose rates calculated for the WCS CISF. The computer codes employed by the applicant are widely used for shielding analyses and are considered acceptable by the staff for use in modeling the shielding configurations and materials at the facility. Therefore, the staff finds the ANSI/ANS-6.1.1-1977 flux-to-dose conversion factors acceptable for use in the shielding evaluations.

7.3.4.2 Dose Rate Estimates

Section 9.4 and Section 9.6, "Doses to Off-Site Public," of the SAR describe the estimates of dose rates at various locations on the site and beyond the edge of the controlled area.

All the sealed metal storage canisters to be stored at the WCS CISF will be received in transportation packages previously certified by the NRC to meet the external dose rate requirements of 10 CFR Part 71, "Packaging and Transportation of Radioactive Material." Additionally, the transfer casks, which may be used to move SNF or GTCC waste canisters to the storage pad, have been previously analyzed in the FSARs for the NUHOMS-MP187, Standardized Advanced NUHOMS, Standardized NUHOMS, NAC-MPC, NAC-UMS, and MAGNASTOR systems to determine bounding external dose rates. All of the transportation packages and transfer casks are designed to reduce dose rates from a loaded canister to ALARA levels. Transfers of SNF and GTCC waste canisters to their respective storage overpacks will occur either in the Cask Handling Building, or on the storage pad. Due to the low dose rates calculated for transportation packages and transfer casks, the large distance between the location for transfer operations and the controlled area boundary, and the short duration of transfer operations, the staff finds reasonable assurance that the offsite doses from these operations will be negligible.

The applicant calculated offsite dose rates for the WCS CISF based on PWR, BWR, and GTCC waste design-basis source terms from each storage system, as discussed in Section 7.3.1 of this SER. The applicant calculated bounding surface gamma and neutron currents for each storage system at the WCS CISF. Using these surface currents, the applicant calculated dose rates at various locations both within the facility and off site. Figure 9-1, "WCS CISF Conceptual Plan," of the SAR shows dose rate locations. The applicant calculated a dose rate at the nearest site boundary of 8.58×10^{-6} millirem (mrem) per hour for 467 casks from direct and scattered radiation exposure. As discussed in Chapter 9 of this SER, no release of radioactive material in effluent is expected during normal operations. However, the Fuel Only (FO-), Fuel/Control Component (FC-), and Failed Fuel Dry Shielded Canisters (FF-DSCs) of the NUHOMS-MP187 System are tested to a leakage rate criterion (1×10^{-5} reference cubic centimeters per second (ref-cm³/s)) that is not considered leak-tight according to ANSI N14.5 (2014), "American National Standard for Radioactive Materials—Leakage Tests on Packages for Shipment." Therefore, the applicant considered a non-mechanistic release of radioactive material from these canisters, as discussed in Section A.11, "Confinement Evaluation," of the

SAR. The site boundary dose rate cited above includes the dose calculated from this postulated release.

The applicant extrapolated the site boundary dose rate out to approximately 4 miles (6.4 kilometers) and calculated an annual dose of 5.0×10^{-13} mrem to the nearest resident, assuming the resident is continually present for 8,760 hours per year. The applicant also calculated an annual dose of 7.52×10^{-2} mrem for a hypothetical person living at the site boundary (e.g., non-facility worker), assuming the person is at the site boundary continuously for 8,760 hours per year. These dose rates are less than the 10 CFR 72.104(a) dose limit of 25 mrem per year to the whole body to a member of the public.

Neither the SAR nor the FSARs for the NUHOMS-MP187, Standardized Advanced NUHOMS, Standardized NUHOMS, NAC-MPC, NAC-UMS, and MAGNASTOR systems identified any accidents that could cause significant loss of shielding or complete penetration of the storage casks. The worst accident identified for each storage system evaluated was the tornado missile impact. This design-basis accident could cause localized thinning of the storage cask shielding. However, only a small number of casks would be damaged, and much of the shielding would remain intact. Therefore, the offsite dose due to direct and scattered radiation would not increase significantly as a result of this accident, as discussed in the accident analysis section of each storage system FSAR. Further, as discussed in Chapter 9 of this SER, no release of radioactive material in effluent is expected during accident conditions, as nearly all canisters are leak-tight in accordance with the definition in ANSI N14.5. However, the FO-, FC-, and FF-DSCs of the NUHOMS-MP187 system are tested to a leakage rate criterion (1×10^{-5} std cm³/s) that is not considered leak-tight according to ANSI N14.5. Therefore, the applicant considered a non-mechanistic release of radioactive material from these canisters, as discussed in Section A.11 of the SAR. The applicant estimated the dose due to hypothetical leakage from a single canister to be 0.951 mrem to an individual continuously present at the OCA boundary for 30 days. Thus, the staff finds reasonable assurance that the total dose (i.e., dose due to direct and scattered radiation and to a hypothetical release) from any design-basis accident will be less than the 10 CFR 72.106(b) limit of 5 rem.

Based on the results of the applicant's shielding analysis, the staff finds reasonable assurance that the dose rates, at locations on and off site, will be below the limits specified in 10 CFR 20.1201, 10 CFR 20.1301, 10 CFR 20.1302, and 10 CFR 72.104(a). As discussed in Section 7.3.1 of this SER, the staff finds the burnup and cooling parameters acceptable for demonstrating the shielding capability of the facility. The staff finds that the applicant's shielding analysis satisfies the requirements of 10 CFR 72.24(m), 10 CFR 72.126, and 10 CFR 72.128 by demonstrating that radiation exposures to workers and members of the public will be adequately limited through the use of shielding at the facility. The applicant's shielding analysis also demonstrates that no credible accident will significantly increase the dose rates, including consideration of natural phenomena and fires and explosions, as required by 10 CFR 72.122(b)(2)(i) and 10 CFR 72.122(c). Therefore, the staff finds there is reasonable assurance that under accident conditions, dose rates will remain below the limits specified in 10 CFR 72.106(b).

Chapter 12 of this SER discusses the staff's review of the applicant's evaluation of the combined radiological exposure from the direct and scattered radiation doses and any potential radioactive materials in effluents. The evaluation verifies the radiation protection design of the facility and that its radiological protection program satisfies the occupational exposure and public dose requirements in 10 CFR 20.1201, 10 CFR 20.1301, 10 CFR 20.1302, 10 CFR 72.104(a), and 10 CFR 72.106(b). Chapter 12 of this SER also discusses the staff's

review of the applicant's evaluation of the proximity of other nuclear facilities and the cumulative effects of their combined operations, which ensures that the radiation dose evaluation satisfies the requirements of 10 CFR 71.122(e).

7.3.5 Confirmatory Calculations

The staff performed confirmatory calculations of the dose rates that could be expected around the protected area and outside of the WCS CISF-controlled area. The ORIGAMI sequence of the SCALE 6.2.1 code (Oak Ridge National Laboratory, 2016) was used to develop an independent source term based on the design-basis SNF properties for each storage system to be used at the WCS CISF. For simplicity and conservatism, the GTCC waste canisters were assumed to have the same SNF bounding source term as the associated SNF storage system. This assumption is conservative since previously reviewed applications for storage (for Rancho Seco GTCC waste canisters) and transportation (for all other GTCC waste canisters) demonstrated that the GTCC waste canister radiation source term is far less than that of a design-basis SNF canister of the same storage or transportation design. The MAVRIC shielding analysis sequence in SCALE 6.2.1 was used to confirm near- and far-field dose rates calculated by the applicant for the WCS CISF. The analysis used ENDF/B-VI1.1 neutron and gamma cross-section data, and neutron and gamma flux-to-dose conversion factors from ANSI/ANS 6.1.1-1977. These calculations confirmed the onsite dose rates calculated by the applicant within the protected area. They also confirmed that the offsite dose rate would be less than the 25 mrem per year whole body dose allowable to a member of the public as required by 10 CFR 72.104. Based on its confirmatory calculations, the staff finds the applicant's shielding analysis to be acceptable.

7.4 Evaluation Findings

The staff makes the following findings as a result of its evaluation:

- The SAR provides specifications for the radioactive materials to be stored at the proposed facility in sufficient detail that adequately defines the allowed materials and permits evaluation of the facility shielding design for the proposed materials. The SAR includes analyses that are adequately bounding for the radiation source terms associated with the proposed materials' specifications. (10 CFR 72.24(c) and 10 CFR 72.120(b))
- The SAR describes the facility SSCs, including those that are important to safety that are relied on for shielding, in sufficient detail to allow evaluation of their effectiveness for the proposed license term. The descriptions include design criteria and design bases for the design, fabrication, construction, and performance requirements of SSCs important to safety. (10 CFR 72.24(b), 10 CFR 72.24(c), 10 CFR 72.120(a), and 10 CFR 72.120(b))
- The facility design includes SSCs and features to shield personnel from radiation exposure to meet 10 CFR 72.126(a)(6) and for radiation protection under normal and accident conditions to meet 10 CFR 72.128(a)(2). Evaluation of the suitability of the shielding to perform these functions is described in the radiation protection review, documented in Chapter 12 of this SER.

- The SAR provides reasonable and appropriate information, including dose rates, to allow evaluation of the facility's compliance with 10 CFR 72.24(e). This evaluation is described in the radiation protection review, documented in Chapter 12 of this SER.
- The SAR provides reasonable and appropriate information, including dose rates, to enable performance of the evaluations required in 10 CFR 72.24(m) and to allow evaluation of the facility's ability to meet the radiation protection requirements for members of the public in 10 CFR 72.104, 10 CFR 72.106, and 10 CFR Part 20. This information includes impacts to shielding and dose rates to support evaluations of compliance with the requirements in 10 CFR 72.122(b)(2)(i), 10 CFR 72.122(c), and 10 CFR 72.122(e) as well. These evaluations are described in the radiation protection review, documented in Chapter 12 of this SER.

The applicant's evaluation includes appropriate shielding analyses for the configurations of facility SSCs and features that exist during the different stages of storage operations, including the impacts of normal, off-normal, and accident conditions. The evaluation includes dose rates that support the facility's ability to meet the radiation protection requirements in 10 CFR 72.104, 10 CFR 72.106, and 10 CFR Part 20, including doses to members of the public and occupational doses estimated to result from facility operations. The applicant adequately considered and incorporated ALARA principles into the facility design and operations. For these reasons, the staff finds reasonable assurance that the design features relied on for shielding for the WCS CISF have been adequately identified and evaluated. The staff reached this finding on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, accepted engineering practices, the statements and representations in the SAR, and the staff's confirmatory analyses.

7.5 References

ANSI N14.5, "American National Standard for Radioactive Materials—Leakage Tests on Packages for Shipment," American National Standards Institute (2014).

ANSI/ANS 6.1.1-1977, "Neutron and Gamma Ray Flux-to-Dose-Rate Factors," American Nuclear Society Standards Committee Working Group, 1977.

AREVA, Inc. Calculation WCS01-0503, "Site Dose Calculation for NUHOMS Component at WCS (SAR)", Revision 0, December 2015 (proprietary). Transmittal dated June 20, 2016. Agencywide Documents Access and Management System (ADAMS) Accession No. ML16229A548.

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Code of Federal Regulations, Title 10, Part 20, “Standards for Protection Against Radiation.”

Code of Federal Regulations, Title 10, Part 71, “Packaging and Transportation of Radioactive Material.”

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

Interim Storage Partners LLC, “WSC Consolidated Interim Storage Facility Safety Analysis Report,” Revision 5, Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML21105A766.

MCNP5 version 1.40, Los Alamos National Laboratory.

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NAC International, “MAGNASTOR® Final Safety Analysis Report,” Revision 7, July 2015 (nonpublic). NRC Docket No. 72-1031. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A932.

NAC International, “NAC-MPC, NAC Multi-Purpose Cask, Final Safety Analysis Report,” Revision 10, January 2014 (nonpublic). NRC Docket No. 72-1025. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A556.

NAC International, “NAC-UMS Universal Storage System Final Safety Analysis Report,” Revision 10, October 2012 (nonpublic). NRC Docket No. 72-1015. Transmittal dated August 3, 2016. ADAMS Accession No. ML16245A212.

NAC International Calculation 30039-5001, “WCS ISFSI Phase I Site Dose Rate Evaluation,” Revision 0, December 2015 (nonpublic). Transmittal dated June 20, 2016. ADAMS Accession No. ML16229A548.

NRC, Certificate of Compliance for Radioactive Material Packages, Certificate No. 9356, Revision 2, Model No. MAGNATRAN. Issued June 2, 2020. ADAMS Accession No. ML20139A101.

NRC, Certificate of Compliance for Radioactive Material Packages, Certificate No. 9235, Revision 23, Model No. NAC-STC. Issued December 6, 2019. ADAMS Accession No. ML19318G674.

NRC, Certificate of Compliance for Radioactive Material Packages, Certificate No. 9270, Revision 5, Model No. UMS Universal Transport Cask Package. Issued October 24, 2017. ADAMS Accession No. ML17297B417.

ORNL/TM-2005/39, “SCALE Code System,” Version 6.2.1, B.T. Rearden and M.A. Jessee, Editors, Oak Ridge National Laboratory, 2016. Available from the Radiation Safety Information Computational Center as CCC-834.

Sacramento Municipal Utility District, “Rancho Seco Independent Spent Fuel Storage Installation, Final Safety Analysis Report, Volume 1, ISFSI System,” Revision 4, June 2010

(nonpublic). NRC Docket No. 72-11. Transmittal dated August 11, 2016. ADAMS Accession No. ML16236A115.

Transnuclear, Inc., "Safety Analysis Report for the NUHOMS®-MP187 Multi-Purpose Cask," Revision 17, July 2003 (nonpublic). NRC Docket No. 71-9255. Transmittal dated July 15, 2016. ADAMS Accession No. ML16203A183.

8 CRITICALITY EVALUATION

Interim Storage Partners LLC (the applicant) described the criticality analysis for the proposed WCS Consolidated Interim Storage Facility (CISF) in the following Safety Analysis Report (SAR) chapters: Chapter 3, “Principal Design Criteria,” Chapter 4, “Facility Design,” and Chapter 10, “Criticality Evaluation.” In addition, the applicant provided system-specific details on the proposed spent nuclear fuel and GTCC waste to be stored at the site in SAR Appendices A through H.

8.1 Scope of Review

The staff evaluated the applicant’s criticality analysis for the WCS CISF by reviewing the information in the SAR, the applicant’s responses to the staff’s requests for additional information, and the staff’s previous evaluations for the proposed cask systems to be stored at the facility. In the SAR, the applicant incorporated by reference the final safety analysis reports (FSARs) for these cask systems. The staff reviewed the information in SAR Chapters 3, 4, and 10, and Appendices A through H, to ensure the stored spent nuclear fuel and GTCC waste will remain subcritical and that the criticality safety features and criticality analyses performed for each previously approved cask system bound the design criteria and features of the WCS CISF. Since the GTCC waste to be stored at the facility will contain no spent fuel material, according to the description of GTCC waste contained in Section H.7.2 of the SAR, a criticality analysis and evaluation is not needed for the GTCC waste storage systems. Hence, the criticality evaluation in this SER chapter is limited to the proposed spent nuclear fuel, the storage cask systems for that fuel, and SAR Chapters 3, 4, and 10, and Appendices A thru G.

8.2 Regulatory Requirements

The regulatory requirements relevant to the criticality evaluation of the proposed WCS CISF appear in the following sections of Title 10 of the *Code of Federal Regulations* (10 CFR):

- 10 CFR 72.40, “Issuance of License”
- 10 CFR 72.124, “Criteria for nuclear criticality safety”

These requirements ensure that the stored materials remain subcritical under normal, off-normal, and accident conditions during all operations, transfers, and storage at the proposed facility.

The applicant proposed to use the cask systems identified in the SER Table 1-1, each of which have been reviewed and approved by the U.S. Nuclear Regulatory Commission (NRC) staff under either the site specific or general license provisions of 10 CFR Part 72.

8.3 Staff Review and Analysis

Unless otherwise stated, the staff reviewed and evaluated the criticality evaluation of the proposed facility discussed in Chapters 3, 4, and 10, and Appendices A through G of SAR Revision 5, documents cited in or attached to the SAR, the applicant’s responses to the staff’s requests for additional information, and other relevant literature. The specific topics covered in the staff’s criticality evaluation are criticality design criteria and features, stored spent fuel specifications, analytical means, and the applicant’s criticality analysis.

The applicant did not identify any site-specific conditions that could impact the criticality safety of the cask systems. In Chapter 12 of the SAR, "Accident Analysis," the applicant discussed the effects of off-normal and accident scenarios at the WCS CISF. In Chapter 11 of the SAR, "Confinement Evaluation," the applicant evaluated canister confinement under all normal, off-normal, and accident conditions. Based on its evaluation in SER Chapter 16, "Accident Analysis," and SER Chapter 9, "Confinement Evaluation," the staff finds that the geometry of the fuel basket and confinement integrity are maintained, and therefore criticality safety is maintained for each of the cask systems proposed for use at the WCS CISF under all site specific normal, off-normal, and accident scenarios.

8.3.1 Criticality Design Criteria and Features

This section describes the staff's evaluation to determine whether the proposed criticality safety design criteria and features will maintain the stored spent fuel in a subcritical configuration. The applicant described the facility design criteria and features related to criticality safety in SAR Section 3.3.4, "Nuclear Criticality Safety," and SAR Chapter 10, "Criticality Evaluation." In SAR Section 10.1, "Criticality Design Criteria and Features," the applicant discussed the WCS CISF design with respect to criticality safety. The applicant stated that it did not rely on the use of burnup credit or burnable neutron absorbers for ensuring criticality safety.

8.3.1.1 Criticality Design Criteria

The staff reviewed the applicant's description of the criticality safety design criterion in SAR Section 3.3.4, "Nuclear Criticality Safety." The applicant stated that the casks are designed such that at least two unlikely, independent, and concurrent or sequential changes to the conditions essential to criticality safety must occur before an accidental criticality is possible. The design criterion for criticality safety is that the effective multiplication factor, k_{eff} , including statistical biases and uncertainties shall not exceed 0.95 under all credible normal, off-normal, and accident conditions and events. The staff confirmed that the proposed cask systems, identified in SAR Table 3-1, "Physical Design Characteristics of Storage Systems at the WCS CISF," and listed in SER Table 1-1 meet this design criterion.

The staff reviewed the proposed design criteria, identified in Chapter 3 of the SAR, for the facility and the cask system design criteria to ensure consistency with the facility. Based on its review, the staff finds the proposed design criteria acceptable because they require that the spent fuel be stored such that subcriticality is maintained with k_{eff} not to exceed 0.95 for all normal, off-normal and accident conditions and will, therefore, meet the requirements of 10 CFR 72.124(a). The staff also finds that the applicant's use of NRC-certified casks for the spent nuclear fuel ensures that the activities involving spent nuclear fuel at the proposed ISFSI will be performed without endangering the health and safety of the public, in accordance with 10 CFR 72.40(a)(13).

8.3.1.2 Features

The applicant described the WCS CISF criticality safety design features in SAR Section 10.1.2, "Features." The proposed cask systems, listed in SAR Table 10-1, "Criticality Evaluations of Storage Systems at the WCS CISF," maintain the spent fuel in a subcritical configuration independent of the facility. The applicant stated that the cask design features relied upon to prevent criticality are the canister geometry and integral neutron absorber materials. The canister geometry establishes sufficient fuel assembly separation, as described in the SAR Appendices for each cask system listed in SAR Table 10-1 and in the various cask system

FSARs referenced in each SAR Appendix. Neutron absorber materials are present in each canister basket design and control criticality when the canister is full of fresh or borated water. As described in the application, all canisters will arrive at the facility in a dry condition and will not be opened at the facility. The canisters are transferred to the corresponding storage casks, which are each designed such that there is no credible mechanism to allow water to enter the canister during storage.

Pursuant to 10 CFR 72.124(c), a criticality monitoring system is not required because the spent fuel remains packaged in its stored configuration under a 10 CFR Part 72 license and the canisters are not opened at the facility.

The staff verified that the applicant clearly identified and adequately described the design features important to criticality safety. The staff finds that the design features are based on a favorable geometry and therefore meet the requirements of 10 CFR 72.124(b). The staff also finds that the stored spent fuel will be maintained in a subcritical configuration; therefore, the design provides reasonable assurance that the activities authorized by the license can be conducted without endangering the health and safety of the public as required by 10 CFR 72.40(a)(13).

8.3.1.3 Stored Material Specifications

This section describes the staff's evaluation of the stored material specifications in SAR Section 3.1.1, "Materials to Be Stored," to ensure that the spent nuclear fuel stored on the site will be maintained in a subcritical configuration. The applicant stated that the stored materials will consist of the PWR and BWR spent fuel assemblies approved for storage in the cask systems identified in SAR Table 1-1, "Storage Systems at the WCS CISF." The technical specifications for each cask system list the approved contents to be stored at the WCS CISF. The proposed Technical Specifications for the WCS CISF specify that the spent nuclear fuel to be stored at the facility shall meet the requirements of each cask system's approved Technical Specifications.

The staff reviewed the proposed facility's spent fuel specifications and confirmed it is bounded by the approved contents for each cask system identified in SAR Table 1-1. Therefore, the staff finds that the proposed spent fuel specifications are adequate to ensure that the contents will be maintained subcritical and that before a nuclear criticality accident is possible, at least two unlikely, independent, and concurrent or sequential changes must occur in the conditions essential to nuclear criticality safety, in compliance with 10 CFR 72.124(a).

8.3.2 Analytical Means

This section describes the staff's evaluation of the analytical means used by the applicant to show that the spent nuclear fuel stored at the facility will remain subcritical. The applicant provided relevant information concerning each cask system to be stored at the WCS CISF in SAR Section 10.1, "Criticality Design Criteria and Features," and in SAR Appendices A through G.

8.3.2.1 Model Configuration

The staff reviewed the individual cask model configurations during the certification process for each cask system and the staff's SER for each system documented its approval. The analysis for each cask system conservatively assumed fresh fuel at the maximum allowed enrichments, worst case configuration, and flooding with fresh or borated water at various densities

depending on whether the analysis credited boron present in PWR spent fuel pools during loading and unloading. The analysis also considered a single cask and an array of casks. The staff confirmed that there are no site-specific conditions which could impact the criticality safety analysis of the casks proposed for storage at the WCS CISF, as all site-specific conditions are bounded by those considered for the previously approved dry storage systems and facilities. Therefore, the staff agrees with the applicant's conclusion that no additional modeling is necessary for the facility.

8.3.2.2 Material Properties

The staff confirmed that material properties described in the SAR are consistent with the material properties reviewed and approved during the certification process for each cask system listed in SER Table 1-1.

8.3.3 Applicant Criticality Analysis

This section describes the staff evaluation to determine whether the applicant addressed the most reactive conditions in its analysis and whether the applicant used the appropriate computer programs to evaluate this system. In SAR Table 10-1, the applicant referenced the applicable SAR appendix and section for each cask system to be stored at the WCS CISF. Each SAR appendix then points to the applicable criticality analysis for each cask system to be stored at the WCS CISF. Based on its review, the staff concluded that no additional calculations are necessary for the facility because there are no site-specific conditions that affect the criticality safety analysis.

8.3.3.1 Computer Program

The staff confirmed that the SAR description of the computer programs used to perform the criticality analysis for each cask system to be stored at the WCS CISF is consistent with the staff's SER certifying the cask system.

8.3.3.2 Multiplication Factor

The staff confirmed that the results of the criticality analyses for each cask system described in the SAR is consistent with the results in the staff's SER certifying each cask system. Based on its review, the staff confirmed that the k_{eff} of each system will not exceed 0.95 for all allowed fuel loadings under all normal, off-normal, and accident conditions and therefore, meets the design criterion for the facility.

8.3.3.3 Benchmark Comparisons

The staff confirmed that the SAR description of the benchmark comparisons used in the criticality analysis for each cask system listed in SER Table 1-1 is consistent with the SER certifying each cask system.

8.3.3.4 NRC Independent Criticality Analysis

Based on its review, the staff determined that no additional criticality calculations are necessary for the facility because the applicant incorporated by reference the calculations previously approved in the certification of each cask system and there are no site-specific factors which could affect the analysis. Therefore, the staff did not perform any confirmatory calculations.

8.3.4 Burnup Credit

The applicant did not rely on burnup credit for the criticality analysis of any of the cask systems listed in SER Table 1-1 to be stored at the WCS CISF. Therefore, the staff did not perform any analysis or evaluation related to burnup credit.

8.4 Evaluation Findings

Based on its review of the SAR, the staff determined that:

- The design, procedures, and descriptions of the stored materials for the proposed WCS CISF provide reasonable assurance that the activities authorized by the license can be conducted without endangering the health and safety of the public, in compliance with 10 CFR 72.40(a)(13) with respect to nuclear criticality safety.
- The design and proposed use of the WCS CISF handling, packaging, transfer, and storage systems for the radioactive materials to be stored reasonably ensure that the materials will remain subcritical and that, before a nuclear criticality accident is possible, at least two unlikely, independent, and concurrent or sequential changes must occur in the conditions essential to nuclear criticality safety. The SAR analyses adequately show that acceptable margins of safety will be maintained in the nuclear criticality parameters commensurate with uncertainties in the data and methods used in calculations, and demonstrate safety for the handling, packaging, transfer and storage of the stored materials under normal, off-normal, and accident conditions in compliance with 10 CFR 72.124(a) and (b).
- A criticality monitoring system is not required at the WCS CISF since the special nuclear material remains packaged in its stored configuration under a 10 CFR Part 72 license for all operations at the WCS CISF, in compliance with 10 CFR 72.124(c).

8.5 References

AREVA, Inc., "Updated Final Safety Analysis Report for the Standardized Advanced NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 6, August 2014 (nonpublic). NRC Docket No. 72-1029. Transmittal dated July 13, 2016. Agencywide Documents Access and Management System (ADAMS) Accession No. ML16200A178.

AREVA TN Americas, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 14, September 2014 (nonpublic). NRC Docket No. 72-1004. Transmittal dated July 13, 2016. ADAMS Accession No. ML16218A396.

Interim Storage Partners LLC, "WSC Consolidated Interim Storage Facility Safety Analysis Report," Revision 5, Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML21105A766.

NAC International, "MAGNASTOR® Final Safety Analysis Report," Revision 7, July 2015 (nonpublic). NRC Docket No. 72-1031. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A932.

NAC International, "NAC-MPC, NAC Multi-Purpose Cask, Final Safety Analysis Report," Revision 10, January 2014 (nonpublic). NRC Docket No. 72-1025. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A556.

NAC International, "NAC-UMS Universal Storage System Final Safety Analysis Report," Revision 10, October 2012 (nonpublic). NRC Docket No. 72-1015. Transmittal dated August 3, 2016. ADAMS Accession No. ML16245A212.

NRC, NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," March 2000. ADAMS Accession No. ML003686776.

Sacramento Municipal Utility District, "Rancho Seco Independent Spent Fuel Storage Installation, Final Safety Analysis Report, Volume 1, ISFSI System," Revision 4, June 2010 (nonpublic). NRC Docket No. 72-11. Transmittal dated August 11, 2016. ADAMS Accession No. ML16236A115.

9 CONFINEMENT EVALUATION

In Chapter 11, “Confinement Evaluation,” of the safety analysis report (SAR), Revision 5, dated April 12, 2021, Interim Storage Partners LLC (ISP or the applicant) addressed the confinement criteria adopted for each of the canisters proposed for storage at the proposed WCS Consolidated Interim Storage Facility (CISF) identified in SAR Table 1-1, “Storage Systems at the WCS CISF.” In addition, the applicant provided details on the proposed SNF to be stored at the site in SAR Appendices A through H. The applicant summarized the system design features that ensure radiological releases are within limits and will remain as low as reasonably achievable, and that the SNF cladding and SNF assemblies are protected from degradation during storage.

In SAR Chapter 11, the applicant also described its evaluation to demonstrate that, during normal conditions of transport, cask system loads do not exceed the criteria in American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section III, Division 1, Subsection NB, Article NB 3200 (Level A allowables).

9.1 Scope of Review

The staff evaluated the applicant’s confinement evaluation in SAR Chapter 11 by reviewing the documents cited in or attached to the SAR, and the applicant’s responses to the staff’s requests for supplemental information (RSIs) and requests for additional information (RAIs). The staff reviewed this information to ensure that radiological releases from the WCS CISF storage system to the environment will be within the limits established by the regulations and that the spent fuel cladding and fuel assemblies will be sufficiently protected during storage against degradation that might otherwise lead to gross ruptures. To make its determination, the staff reviewed the application with regard to the radionuclide confinement analysis, confinement monitoring, and protection of stored materials from degradation. Specifically, the staff reviewed the information in the application on confinement to evaluate (1) the applicant’s estimate of the amounts of radionuclides that would be released to the environment under normal operations, anticipated occurrences, and design-basis accident conditions, (2) the proposed monitoring systems, and (3) the systems for protecting stored materials from degradation.

9.2 Regulatory Requirements

The regulatory requirements relevant to the confinement evaluation of the proposed WCS CISF appear in the following sections of Title 10 of the *Code of Federal Regulations* (10 CFR):

- 10 CFR 72.24, “Contents of application: Technical information”
- 10 CFR 72.44, “License conditions”
- 10 CFR 72.104, “Criteria for radioactive materials in effluents and direct radiation from an ISFSI or MRS”
- 10 CFR 72.106, “Controlled area of an ISFSI or MRS”
- 10 CFR 72.122, “Overall requirements”
- 10 CFR 72.126, “Criteria for radiological protection”
- 10 CFR 72.128, “Criteria for spent fuel, high-level radioactive waste, reactor-related greater than Class C waste, and other radioactive waste storage and handling”

The applicant proposed to use the cask systems identified in the SER Table 1-1, each of which has been reviewed and approved by the U.S. Nuclear Regulatory Commission (NRC) staff under either the site specific or general license provisions of 10 CFR Part 72.

9.3 Staff Review and Evaluation

Unless otherwise stated, the staff reviewed and evaluated the applicant's confinement evaluation discussed in Chapter 11 and Appendices A through H of SAR Revision 5, documents cited in or attached to the SAR, and the applicant's responses to the staff's RSIs and RAIs.

The following sections of this safety evaluation report (SER) describe the staff's review and evaluation to ensure the following:

- Confinement of each canister type for the six storage cask systems proposed for use at the WCS CISF is demonstrated as a condition of loading a canister into storage configuration prior to shipment to the WCS CISF.
- Confinement is confirmed after shipment to the WCS CISF by a primary means showing that loads during normal conditions of transport do not exceed Level A service limits in the ASME B&PV Code.
- Post-shipment leakage testing of accessible portions of the confinement boundary is performed, as a secondary confirmation, to verify that the dose exposures are below the limits of 10 CFR 72.104(a) and 10 CFR 72.106(b) on every loaded transport cask received at the WCS CISF.

The staff finds these post-transportation verification tests acceptable because the tests provide reasonable assurance that the confinement boundary of each canister will continue to perform its safety function when placed into storage at the WCS CISF.

9.3.1 Confinement Description

The applicant stated in SAR Chapter 11 that the storage cask systems received at the WCS CISF are designed to ensure confinement of stored materials under normal, off-normal, and accident conditions during all operations, transfers, and storage. It also stated that the confinement boundary of each canister type authorized for storage at the WCS CISF will be evaluated to demonstrate that the loads during normal conditions of transport do not exceed the criteria in ASME B&PV Code, Subsection NB, Article NB-3200 (Level A allowables), to ensure that the confinement boundary of the canisters is not adversely impacted during transport to the WCS CISF.

Table 9-1 details the confinement boundary components for each cask system proposed for use at the WCS CISF.

**Table 9-1 Confinement Boundary Components for the Cask Systems
Proposed for Storage at the WCS CISF**

Cask System	Canister	SAR Sections and Tables Addressing Confinement Boundary Components
NUHOMS®-MP187 System	FO, FC, FF-DSC	Section A.11.1 and Table A.11-9
	GTCC Canister	
Standardized Advanced NUHOMS Storage System	NUHOMS 24PT1	Section B.11.1 and Table B.11-1
Standardized NUHOMS Storage System	NUHOMS 61BT	Section C.11.1 and Table C.11-1
	NUHOMS 61BTH Type 1	Section D.11.1 and Table D.11-1
NAC-MPC	Yankee Rowe	

Cask System	Canister	SAR Sections and Tables Addressing Confinement Boundary Components
	Connecticut Yankee	Sections E.11.1 and E.11.2 and Table E.11-1
	LACBWR	
	GTCC-Canister-CY	
	GTCC-Canister-YR	
NAC-UMS®	Classes 1–5	Section F.11.1 and Table F.11-1
	GTCC-Canister-MY	
NAC MAGNASTOR®	Transportable Storage Canister (TSC)1–TSC4	Section G.11.1 and Table G.11-1
	GTCC-Canister-ZN	

In Appendices A through H to the SAR, the applicant described the confinement boundary for each canister type to be stored at the WCS CISF with reference to the corresponding storage system final safety analysis reports (FSARs). The paragraphs below summarize the confinement system of each canister type for the six storage cask systems proposed for storage at the WCS CISF.

9.3.1.1 FO-, FC-, and FF-DSCs (NUHOMS-MP187 System)

In SAR Section A.11.1, “Confinement Boundary,” and Table A.11-9, “Canister Confinement Boundaries,” the applicant presented the Fuel Only, Fuel/Control Component, and Failed Fuel Dry Shielded Canister (FO-, FC-, and FF-DSC) confinement system and boundary, which are also documented in Section 3.3.2.1 of the FSAR for the independent spent fuel storage installation (ISFSI) for Rancho Seco.

The applicant stated in SAR Section A.11.1 that during fabrication and closure operations for FO-, FC-, and FF-DSCs, the confinement boundary was leak tested to 1×10^{-5} ref-cm³/sec in accordance with American National Standards Institute (ANSI) N14.5-1997, “Radioactive Materials—Leakage Tests on Packages for Shipment.”¹ Therefore, for these canister designs, the applicant considered a release of radioactive material from these canisters even though they are demonstrated to have no leakage to a sensitivity of 1×10^{-5} ref-cm³/sec. In SAR Table A.11-1, “SNF Assembly Activities,” the applicant presented the SNF assembly activities of the nuclides used for the containment analyses for the nonleaktight FO-, FC-, and FF-DSCs, which are also documented in Section 3.3.2.1 of the Rancho Seco ISFSI FSAR, Revision 4, dated June 2010.

The applicant stated in SAR Appendix A, Section A.3, “Principal Design Criteria,” that the NUHOMS-MP187 system principal design criteria is documented in the Rancho Seco ISFSI FSAR Revision 4. The NUHOMS-MP187 system, used as a transportation cask to ship FO-, FC-, and FF-DSCs to the WCS CISF, is also used as a transfer cask for transfer operations at the site. Therefore, the related loading operations of the NUHOMS-MP187 system need to meet the site characteristics and criteria.

Based on review, the staff ensured that (a) there is no change on the DSCs from the referenced designs, and (b) the related loading operations of the NUHOMS-MP187 system meet the site

¹ A unit of leakage rate of one cubic centimeter of dry air per second at 1 atmosphere absolute pressure (760 mm Hg) and 25 °C.

characteristics and criteria, and the staff confirmed that the confinement system and boundary for the FO-, FC-, and FF-DSCs described in the SAR are consistent with the confinement system and boundary of the FO-, FC-, and FF-DSCs as described in the Rancho Seco ISFSI FSAR.

9.3.1.2 24PT1-DSC (Standardized Advanced NUHOMS Storage System)

In SAR Section B.11.1, "Confinement Boundary" and Table B.11-1, "Canister Confinement Boundaries," the applicant presented the 24PT1-DSC confinement system and boundary, which are also documented in Chapter 7 of the Standardized Advanced NUHOMS Storage System FSAR, Revision 6, August 2014.

In SAR Section B.11.2, "Requirement for Normal Conditions of Storage," and Section B.11.3, "Confinement Requirements for Hypothetical Accident," the applicant stated that the 24PT1-DSC is designed, fabricated, and tested to be leak-tight to prevent the leakage of radioactive materials and the DSC will continue to maintain a dry and inert atmosphere for storage of the spent fuel under normal conditions and hypothetical accident conditions of storage.

Based on its review, the staff confirmed that the confinement system and boundary for the 24PT1-DSC described in the SAR are consistent with the confinement system and boundary of the 24PT1-DSC as described in the Standardized Advanced NUHOMS Storage System FSAR.

9.3.1.3 NUHOMS 61BT-DSC (Standardized NUHOMS Storage System)

In SAR Section C.11.1, "Confinement Boundary" and Table C.11-1, "Canister Confinement Boundaries," the applicant presented the 61BT-DSC confinement system and boundary, which are also documented in Chapter 7 of Appendix K to the Standardized NUHOMS Storage System FSAR, Revision 14, September 2014.

Based on its review, the staff confirmed that the confinement system and boundary for the 61BT-DSC described in the SAR are consistent with the confinement system and boundary of the 61BT-DSC as described in the Standardized NUHOMS Storage System FSAR.

9.3.1.4 61BTH Type 1 DSC (Standardized NUHOMS Storage System)

In SAR Section D.11.1, "Confinement Boundary" and Table D.11-1, "Canister Confinement Boundaries," the applicant presented the 61BTH Type 1 DSC confinement system and boundary, which are also documented in the Standardized NUHOMS Storage System FSAR.

Based on its review, the staff confirmed that the confinement system and boundary for the 61BTH Type 1 DSC described in the SAR are consistent with the confinement system and boundary of the 61BTH Type 1 DSC as described in the Standardized NUHOMS Storage System FSAR.

9.3.1.5 NAC Yankee-MPC, CY-MPC, and MPC-LACBWR

In SAR Section E.11.1, "Confinement Boundary" and Table E.11-1, "Canister Confinement Boundaries," the applicant presented the Yankee Rowe-MPC and Connecticut Yankee (CY)-MPC confinement systems and boundaries, which are also documented in Section 7.1 of the NAC-MPC FSAR, Revision 10, issued January 2014. In SAR Section E.11.2, "LaCrosse MPC," the applicant presented the MPC-LaCrosse Boiling Water Reactor (LACBWR) Transportable

Storage Canister (TSC) confinement system and boundary, which are also documented in Section 7.A.1 of the NAC-MPC FSAR, Revision 10.

Based on its review, the staff confirmed that the confinement system and boundary for the Yankee-MPC, CY-MPC, and MPC-LACBWR described in the SAR are consistent with the confinement system and boundary of the Yankee-MPC, CY-MPC, and MPC-LACBWR as described in the NAC-MPC FSAR, Revision 10.

9.3.1.6 NAC-UMS Universal Storage System

In SAR Section F.11.1.1, “Confinement Boundary” and Table F.11-1, “Canister Confinement Boundaries” for Maine Yankee, the applicant presented that the NAC-UMS canister confinement system and boundary, which are consistent with the confinement system and boundary of the NAC-UMS canister (Classes 1–5) documented in Section 7.1 of the NAC-UMS FSAR, Revision 10.

Based on its review, the staff confirmed that the confinement system and boundary for the NAC-UMS canister described in the SAR are consistent with the confinement system and boundary of the NAC-UMS canister as described in the NAC-UMS FSAR, Revision 10, issued October 2012.

9.3.1.7 NAC MAGNASTOR Cask System

In SAR Section G.11.1, “Confinement Boundary” and Table G.11-1, “Canister Confinement Boundaries,” the applicant presented the NAC MAGNASTOR TSC (TSC1–TSC4) confinement system and boundary, which are consistent with the confinement system and boundary of the NAC-MAGNASTOR TSC (TSC1–TSC4) documented in the NAC MAGNASTOR FSAR, Revision 7, issued July 2015.

Based on its review, the staff confirmed that the NAC MAGNASTOR TSC (TSC1–TSC4) confinement system and boundary described in the SAR are consistent with the confinement system and boundary of the NAC MAGNASTOR TSC (TSC1–TSC4) described in the NAC MAGNASTOR FSAR, Revision 7.

9.3.1.8 Greater-Than-Class-C Canister

The applicant indicated in SAR Chapter 11 that the GTCC canisters to be stored at the WCS CISF are designed to be leak-tight; therefore, the confinement of the GTCC waste is maintained under normal, off-normal, and accident conditions. The applicant presented the confinement system and confinement components for each type of GTCC canister proposed for use at the WCS CISF as summarized in SER Table 9-1.

The applicant stated in SAR Section H.8.2.2, “GTCC Canister Leakage,” that the various GTCC canister shells are designed with pressure-retaining features to prevent the leakage of contaminated materials, and that there are no credible conditions that can breach the canister shell or fail the welds at each end of the canisters. The GTCC waste closure lid welds are multi-pass closure welds and are the same as the closure welds for canisters loaded with SNF.

Based on its review, the staff finds that the storage configuration and confinement boundary/components of each type of GTCC canister are consistent with those shown in their respective NUHOMS FSAR and NAC SARs. Therefore, the storage of the GTCC waste at the WCS CISF will have no adverse confinement effect on the safe storage of the SNF.

The staff concludes that the information in SAR Chapter 11 and Appendices A through H is consistent with the staff's evaluation approving each of the six storage cask systems proposed for storage at the WCS CISFs and that the applicable design and acceptance criteria for each cask system are in compliance with 10 CFR Part 72.

9.3.2 Radionuclide Confinement Analysis

9.3.2.1 Identification of Release Events

9.3.2.1.1 All Canister Types Authorized for Storage at the WCS CISF

In Section 7 of in each of SAR Appendices A through G, the applicant presented bounding structural evaluations demonstrating that the confinement boundary for the canisters do not exceed ASME B&PV Subsection NB Article NB-3200 (Level A allowables) during normal conditions of transport to provide reasonable assurance that the confinement boundary is not adversely impacted by transport to the WCS CISF. The normal conditions of transport evaluations of the confinement boundary are included as part of the licensing basis and are referenced in the sections of the WCS CISF SAR where these evaluations are documented.

The staff reviewed the applicant's structural evaluations presented in Section 7 of each SAR appendix (Appendices A through G) and determined the applicant's structural assessments to be acceptable. The applicant's calculated stress ratios on the DSC shell for all canister types used for storage at the WCS CISF are less than unity and are, therefore, acceptable to demonstrate canister structural capability for the normal conditions of transport loading conditions. The staff confirmed that the WCS CISF license includes the evaluations for the conditions that the canister confinement boundary will experience during transportation.

The applicant stated in SAR Chapter 11 (confinement) and in each SAR appendix, Section 7 (structural) and Section 11 (confinement), that structural analyses are being used as the primary means of verifying that canisters remain within the conditions evaluated in the safety analyses of their respective certificate of compliance (CoC)/license upon receipt at the WCS CISF and, therefore, the canisters meet the conditions for storage at the facility.

The staff recognizes that structural analyses are used to ensure that the confinement boundary of the canisters proposed for storage at the WCS CISF is not adversely impacted during transport to the WCS CISF.

9.3.2.1.2 FO-, FC-, and FF-DSCs (NUHOMS-MP187 Cask System)

The applicant indicated in SAR Appendix A that the NUHOMS-MP187 cask can be configured either as a transfer cask for transfer operations in accordance with 10 CFR Part 72 or as a transportation cask in accordance with 10 CFR Part 71. Under the requested license for the WCS CISF, once the NUHOMS-MP187 cask is received at the WCS CISF site following transport, the cask will be reconfigured for transfer operations, for which the canisters rather than the cask provide confinement. The applicant stated in SAR Section A.11.1 that the bounding evaluations in SAR Section A.7.7, "Structural Evaluation of Canister Confinement Boundary under Normal Conditions of Transport," are performed to demonstrate that the confinement boundaries for the FO-, FC-, and FF-DSCs do not exceed the criteria in ASME B&PV Code, Subsection NB, Article NB-3200, during normal conditions of transport.

The staff reviewed SAR Section A.11 and the response to RSI NP-9.8 and confirmed that the bounding evaluations described in SAR Section A.7.7 provide reasonable assurance that the confinement boundary is not adversely impacted by transport to the WCS CISF.

The applicant stated in SAR Section 11.3, "Potential Release Source Term," that all the canisters proposed for storage at the WCS CISF are designed, fabricated, and tested to be leak-tight as defined by ANSI N14.5-1997 under all normal, off-normal, and accident conditions and normal conditions of transport. Therefore, the confinement of SNF is maintained under all conditions. The only exceptions to this are the FO-, FC-, and FF-DSCs that were only leak tested to a leakage rate of 1×10^{-5} ref-cm³/sec. In its response dated August 31, 2016, the applicant provided the AREVA Confinement Calculations (Microsoft Excel spreadsheet WCS01-0502R0-0B.xls, nonpublic) in response to RSI-P9.2 for the staff's verification of the confinement evaluation, in accordance with ANSI N14.5-1997.

The staff recognizes that the FO-, FC-, and FF-DSCs proposed for storage at the WCS CISF were only leak tested to a leakage rate of 1×10^{-5} ref-cm³/sec, and therefore the confinement analyses for FO-, FC-, and FF-DSCs to evaluate the dose releases are required. The staff reviewed SAR Section A.11.1 and the spreadsheet WCS01-0502R0-0B.xls to ensure the doses released under normal, off-normal, and accident conditions of storage meet the criteria of 10 CFR 72.104(a) and 10 CFR 72.106(b). SER Section 9.3.2.2 summarizes the staff's review.

9.3.2.2 Evaluation of Release Estimates, FO-, FC-, and FF-DSCs (Rancho Seco ISFSI)

The applicant provided its confinement evaluation for the NUHOMS system (FO-, FC-, and FF-DSC) proposed for storage at the WCS CISF consistent with the staff guidance found in NUREG-1536, Revision 1, "Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility—Final Report," issued July 2010, and NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," issued March 2000. The applicant used the method from ANSI N14.5-1997 to calculate exposures due to the postulated release of radionuclides for normal, off-normal, and accident conditions and compared its results with the criteria of 10 CFR 72.104(a) and 10 CFR 72.106(b).

The applicant provided the confinement analysis in SAR Section A.11.3, "Confinement Analysis," and AREVA Confinement Calculation WCS01-0502R0-0B.xls, for the NUHOMS-MP187 Cask System canisters under normal, off-normal, and accident conditions of storage. In SAR Section A.11.3, the applicant presented the potential release source terms for these canisters in SAR Table A.11-1, the fuel-to-canister release fractions in SAR Table A.11-2, "Fuel-to-Canister Release Fractions," the canister-to-environment release fractions in SAR Table A.11-3, "Canister-to-Environment Release Fractions," the fuel-to-environment release fractions in SAR Table A.11-4, "Fuel-to-Environment Release Fractions," the specific activities for release per canister in SAR Table A.11-5, "Specific Activities for Release per Canister," the isotope specific release rates in SAR Table A.11-6, "Isotope Specific Release Rates, Q_i ," and the atmospheric dispersion coefficients in SAR Table A.11-7, "Atmospheric Dispersion Coefficients". Information in these tables is used to calculate potential doses released under normal, off-normal, and accident conditions of storage. The applicant presented the analytical results in SAR Table A.11-8, "Summary of Dose Results."

Using the assumptions and the design input and data for a postulated release of the radioactive material (1×10^{-5} ref-cm³/sec) provided in SAR Tables A.11-1 through A.11-7 and AREVA Calculation Package No. WCS-01-00502R0-0B.xls (nonpublic), the applicant computed the leakage rates of 4.4914×10^{-6} , 7.5892×10^{-6} , and 2.5413×10^{-5} cm³/sec for normal, off-normal, and accident conditions, respectively. The applicant presented these results in SAR Table A.11-8.

As shown in SAR Table A.11-8, the applicant calculated the deep dose equivalents due to air submersion, the committed dose equivalents due to inhalation, and the total effective dose equivalents at all distances at or beyond 100 meters for normal, off-normal, and accident conditions for comparison with the criteria in 10 CFR 72.104(a) and 10 CFR 72.106(b). In SAR Section A.11.3.5, "Dose Computations," the applicant stated that as shown in Table A.11-8, normal operation doses to the thyroid and other organs are also within the 10 CFR 72.104(a) limits. The applicant stated that all calculated accident doses are well below the applicable 10 CFR 72.106(b) limits; therefore, it concluded that the NUHOMS system at the WCS CISF satisfied the confinement criteria.

The staff reviewed the applicant's confinement evaluation, including the assumptions, design input and data, and methodology. The staff also performed a confirmatory analysis to validate that the dose calculations are below the corresponding limits required by the regulations. Based on a review of SAR Tables A.11-1 through A.11-8, plus the staff's confirmatory analysis, the staff finds the applicant's confinement evaluation acceptable because it is consistent with the guidance in ANSI N14.5-1997 and Regulatory Guide 1.145, Revision 1, "Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants," reissued February 1983, and demonstrated that all calculated accident doses are well below the applicable 10 CFR 72.106(b) limits.

9.3.3 Confinement Monitoring

The applicant stated in SAR Section 11.2, "Confinement Monitoring," that no confinement monitoring is required for any of canisters to be stored at the WCS CISF because all canisters include welded closure. The applicant stated that because the canisters proposed for storage at the site are sealed by welding and placed in storage casks on storage pads, there are no credible events that could result in releases of radioactive material from inside the canisters or unacceptable increases in direct radiation levels. The applicant also stated in Interim Storage Partners LLC, procedure QP-10.02, Revision 2, "ISP Procedure of Quality Assurance for Post-Transport Package Evaluation," issued 2016 (proprietary), that the combination of post-transportation leakage testing and visual inspections can be used to conclude, with high confidence, that the canister confinement boundary is intact.

The staff reviewed SAR Chapter 11 and accepts that the WCS CISF does not need to meet the requirement in 10 CFR 72.122(h)(4) for the capability for continuous monitoring for any of the canisters on the pad at the WCS CISF for the following reasons:

- The confinement effectiveness of the canisters allowed for storage at the WCS CISF can be verified and assured through (1) visual inspection on a minimum of two "bounding" canisters from each site of origin, (2) helium leakage testing on all canisters shipped to the WCS CISF, and (3) the design and licensing basis analysis. These conditions are specified in proposed Technical Specification 4.4.2.
- There are no credible events that could result in releases of radioactive material from inside the canisters or unacceptable increases in direct radiation levels.

Therefore, the staff has reasonable assurance that the canisters maintain confinement for all normal, off-normal, and accident conditions, in compliance with confinement requirements in 10 CFR Part 72.

9.3.3.1 Confinement Casks or Systems

The applicant stated in SAR Section 11.5, "Protection of Stored Materials from Degradation," that a record review will be performed before receipt of a canister to verify that the canister was fabricated, loaded, stored, and maintained in accordance with the site-specific or general license requirements and in compliance with the WCS CISF license conditions. The applicant stated that it will perform a receipt inspection of the canister upon arrival at the WCS CISF.

The applicant stated that two "bounding" canisters need inspections and enhanced monitoring before transport from each reactor or ISFSI site, combined with the helium leakage check of 100 percent of the canisters. The applicant stated that the visual inspection of these canisters upon receipt at the WCS CISF forms a post-transportation package evaluation program and provides reasonable assurance that the canister confinement barrier remains intact to perform its safety function. For the post-transport helium leakage test, the applicant identified the accessible portions and inaccessible portions of each canister received at the WCS CISF in SAR Appendices A through G, Tables A.11-9, B.11-1, C.11-1, D.11-1, E.11-1, F.11-1, and G.11-1, as shown in SER Table 9-1.

The applicant indicated the following in ISP procedure QP-10.02, Revision 2:

- a) The criteria used to screen and select the two bounding canisters from each reactor site are based on the canister susceptibility assessment criteria developed in the Electric Power Research Institute report, Susceptibility Assessment Criteria for Chloride-Induced Stress Corrosion Cracking (CISCC) of Welded Stainless-Steel Canisters for Dry Cask Storage Systems (Report No. 3002005371, September 2015).
- b) Personnel performing visual examinations shall be qualified and certified in accordance with the American Society of Mechanical Engineers (ASME) Code Section XI, IWA-2300, Visual Examination, Personnel Qualification and the Responsible Individual, including the requirements of ASME XI, Appendix VI, Rounded Indications, latest edition.
- c) Post-transport leak testing shall comply with ANSI N14.5-1997, "American National Standard for Radioactive Materials—Leakage Tests on Package for Shipment,"
- d) Post-transport leak testing will be conducted in accordance with approved procedures by a Nondestructive Testing (NDT) Level III specialist or examiner, and
- e) Personnel performing post-transport leak testing shall be certified as LT Level II, or LT Level III in accordance with the American Society for Nondestructive Testing (ASNT) Practice No. SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing, up to the 2006 edition as permitted by the 2013 Code Edition.

The staff reviewed ISP procedure QP-10.02, Revision 2; SAR Section 11.5; and tables in SAR Appendices A through G, as mentioned above, and confirmed that the WCS CISF will perform visual examination of the two canisters most likely to present chloride-induced stress-corrosion cracking in accordance with ASME B&PV Code, Section XI, Article IWA-2300, and all canisters

will have helium leakage testing performed in accordance with requirements of ANSI N14.5-1997; ASNT Practice No. SNT-TC-1A (2006 Edition); and ISP procedure QP-10.02, Revision 2. ISP procedure QP-10.02, Revision 2, states that an ASNT NDT Level III specialist or examiner needs to approve the test procedure for post-transport leakage testing.

The staff also confirmed that the post-transport package evaluation, including visual inspection and helium leakage testing, will provide reasonable assurance that the accessible portions of the canister confinement boundary remain intact and the canister will have an actual leakage rate equal to or less than 1.0×10^{-7} ref-cm³/sec or below the allowable leakage rates, and therefore the canister is acceptable to place back into storage at the WCS CISF.

9.3.3.2 Chemical Gaseous Release

The applicant stated in SAR Chapter 11 that the probability of releasing radioactive gases during post-transport leakage testing of transportation casks or the unloading of canisters from the transportation casks is very small, and any release would be minor because the canisters to be stored at the WCS CISF are seal-welded and have been tested to assure compliance with the standard of ANSI N14.5-1997, or equivalent.

Based on its review, the staff finds that chemical gaseous releases would be very minor because the canisters are seal-welded and have been tested to assure compliance with the leak-tight standard of ANSI N14.5-1997 or equivalent. The staff reaches the same finding for the FO-, FC-, and FF-DSCs that were leak tested to a leakage rate of 1×10^{-5} ref-cm³/sec because the forces experienced during normal conditions of transport have been found not be large enough to result in a breach that could cause a release.

9.3.4 Protection of Stored Materials from Degradation

9.3.4.1 Safe Storage against Degradation

A welded canister shell provides the confinement, and redundant closures and fuel cladding integrity would be ensured by storing the spent fuel in an inert atmosphere and maintaining the storage cladding temperatures below the limits that can cause degradation of the cladding.

The applicant noted in SAR Section 11.5 that there is no significant degradation of any safety components caused by galvanic or chemical reactions or long-term exposure of the materials to neutron or gamma radiation, high temperature, or other possible conditions. The applicant stated that the canister materials were selected such that degradation is not expected during normal conditions of transport to the WCS CISF and for the storage period at the WCS CISF. A records review is performed to verify that the canister being received was fabricated, loaded, stored, and maintained in accordance with the site-specific or general license requirements and will comply with WCS CISF license conditions and technical specifications. A receipt inspection of the canisters is performed upon arrival at the WCS CISF, which includes a post-transport package evaluation. The aging management programs (AMPs) approved by the NRC will be incorporated into the WCS CISF license to assure safe long-term storage at the WCS CISF.

Based on the conditions described above and in SAR Section 11.5, the staff finds that the fuel cladding integrity can be maintained with the fuel cladding temperatures maintained below 400 degrees Celsius and the SNF stored in an inert helium atmosphere to prevent degradation of the cladding, specifically cladding rupture due to oxidation and its resulting volumetric expansion of the SNF, consistent with the guidance in Spent Fuel Storage and Transportation Interim Staff Guidance 11 (SFST-ISG-11), "Cladding Considerations for the Transportation and

Storage of Spent Fuel,” Revision 3, dated November 17, 2003, and thereby complies with 10 CFR 72.122(h)(1).

9.3.4.2 Corrective Action Program

The applicant stated in SAR Section 11.5 that in the highly unlikely event that a nonconforming canister is found during the receipt inspection, the canister will be placed in a safe condition, the issue entered into the ISP Corrective Action Program, and the corrective action subject to a reportability determination in accordance with 10 CFR Part 21, “Reporting of defects and noncompliance”; 10 CFR 72.242, “Recordkeeping and records”; 10 CFR 71.95, “Reports”; 49 CFR 171.15, “Immediate notice of certain hazardous materials incidents”; and other applicable regulations. The applicant noted that the reportability determination procedure provides the regulatory requirements for reporting to the appropriate agency, including the deadlines for such notification and the appropriate licensing actions initiated to resolve the situation. The corrective actions will include, but are not limited to, the following:

- (1) Notify the NRC as required. Confer with the NRC as needed.
- (2) Maintain the canister inside the transportation cask in its transportation configuration until appropriate corrective actions are determined. The safety for temporary storage will be confirmed using a 10 CFR Part 71 analysis as appropriate.
- (3) Develop an action plan with a time frame that will include input from the discussion with the NRC.
- (4) Obtain the NRC’s approvals as necessary.
- (5) Proceed with corrective actions.

The applicant stated in SAR Section 11.5 that the timeline by which a canister will be returned to the place of origin, or other facility licensed to perform fuel loading procedures, will depend on the specific corrective actions required to address the condition identified by the corrective action evaluation performed.

Based on its review of the information discussed above, the staff finds the approach proposed by the applicant acceptable because its implementation would include suspending the receipt of canisters, determining a root cause, evaluating the extent of condition, and developing corrective actions to prevent recurrence.

The staff also confirmed that the AMP required by WCS CISF License Condition 17 to protect the stored materials and cask components from degradation appropriately requires the applicant to pursue AMP updates that would commit to the AMPs that would be approved as part of the future renewals of CoCs 1015, 1025, and 1031 for all applicable NAC spent fuel canisters and storage overpacks.

9.4 Evaluation Findings

Based on its review of the SAR, the staff determined the following:

- Section 11 of SAR Appendices A through H describe the confinement structures, systems, and components important to safety in sufficient detail to permit an evaluation of their effectiveness.

- The confinement system is provided by a seal-welded cask system, and the design of each cask system proposed for use at the WCS CISF continues to maintain the effectiveness of the confinement system through the post-transport package evaluation.
- The application has assessed the quantity of radioactive nuclides postulated to be released to the environment. In SAR Chapter 11, the dose from these releases will be added to the direct dose to show that the cask accepted at the WCS CISF satisfies the regulatory requirements of 10 CFR 72.104(a) and 10 CFR 72.106(b).
- The design and proposed operations of the WCS CISF provide adequate measures for protecting the spent fuel cladding against degradation that might otherwise lead to gross ruptures of the material to be stored, in compliance with 10 CFR 72.122(h)(1).
- The cask confinement system at the WCS CISF has been evaluated by appropriate tests or by other means acceptable to the Commission to demonstrate that it will reasonably maintain the confinement of radioactive material under normal, off-normal, and credible accident conditions.
- The staff concludes that the design of the confinement system for each canister type for the six storage cask systems is in compliance with 10 CFR Part 72 and that the applicable design and acceptance criteria have been satisfied. The evaluation of the confinement system design provides reasonable assurance that each canister type for the six storage cask systems proposed for use at the WCS CISF will allow for the safe storage of spent fuel. This finding is reached on the basis of a review that considered the regulation itself, appropriate regulatory guides, applicable codes and standards, the applicant's analysis and the staff's confirmatory analysis, and accepted engineering practices.

9.5 References

American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel (B&PV) Code, Section III, Division 1, Subsection NB, 1992, including 1993 Addenda.

American National Standards Institute N14.5, "Radioactive Materials—Leakage Tests on Packages for Shipment," 1997.

American Society for Nondestructive Testing, Practice No. SNT-TC-1A, 2006, "Personnel Qualification and Certification in Nondestructive Testing," up to the 2006 Edition as permitted by the 2013 ASME B&PV Code Edition.

AREVA Confinement Calculation, Excel Spreadsheet "WCS01-0502R0-0B.xls" (nonpublic). Transmittal Letter dated July 25, 2016. Agencywide Documents Access and Management System (ADAMS) Accession No. ML16229A549.

AREVA, Inc., "Updated Final Safety Analysis Report for the Standardized Advanced NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 6, August 2014 (nonpublic). NRC Docket No. 72-1029. Transmittal dated July 13, 2016. ADAMS Accession No. ML16200A178.

AREVA TN Americas, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 14, September 2014

(nonpublic). NRC Docket No. 72-1004. Transmittal dated July 13, 2016. ADAMS Accession No. ML16218A396.

Code of Federal Regulations, Title 10, Part 21, “Reporting of Defects and Noncompliance.”

Code of Federal Regulations, Title 10, Part 71, “Packaging and Transportation of Radioactive Material.”

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

Code of Federal Regulations, Title 10, Part 171, “Annual Fees for Reactor Licenses and Fuel Cycle Licenses and Material Licenses, including Holders of Certificates of Compliance, Registrations, and Quality Assurance Program Approvals and Government Agencies Licensed by the NRC.”

Electric Power Research Institute, Report No. 3002005371, “Susceptibility Assessment Criteria for Chloride-Induced Stress Corrosion (CISCC) of Welded Stainless-Steel Canisters for Dry Cask Storage System,” September 2015.

ISP, “Submission of ISP Responses for RAIs and Associated Document Markups from First Request for Additional Information, Part 2, Docket 72-1050 CAC/EPID 001028/L-2017-NEW-0002,” January 17, 2020. ADAMS Accession No. ML20028E843 (package).

ISP, “WSC Consolidated Interim Storage Facility Safety Analysis Report,” Revision 5, Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML21105A766.

NAC International, “MAGNASTOR® Final Safety Analysis Report,” Revision 7, July 2015 (nonpublic). NRC Docket No. 72-1031. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A932.

NAC International, “NAC-MPC, NAC Multi-Purpose Cask, Final Safety Analysis Report,” Revision 10, January 2014 (nonpublic). NRC Docket No. 72-1025. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A556.

NAC International, “NAC-UMS Universal Storage System Final Safety Analysis Report,” Revision 10, October 2012 (nonpublic). NRC Docket No. 72-1015. Transmittal dated August 3, 2016. ADAMS Accession No. ML16245A212.

NRC, NUREG-1536, “Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility,” Revision 1, July 2010.

NRC, NUREG-1567, “Standard Review Plan for Spent Fuel Dry Storage Facilities,” March 2000. ADAMS Accession No. ML003686776.

NRC, Regulatory Guide 1.145, “Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants,” Revision 1, February 1983. ADAMS Accession No. ML003740205.

NRC, SFST-ISG-11, “Cladding Considerations for the Transportation and Storage of Spent Fuel,” Revision 3, November 17, 2003.

Sacramento Municipal Utility District, “Rancho Seco Independent Spent Fuel Storage Installation, Final Safety Analysis Report, Volume 1, ISFSI System,” Revision 4, June 2010

(nonpublic). NRC Docket No. 72-11. Transmittal dated August 11, 2016. ADAMS Accession No. ML16236A115.

Waste Control Specialists LLC, "Supplemental Information to Support a License Application for a Consolidated Interim Storage Facility for Spent Nuclear Fuel in Andrews, Texas, Docket 72-1050," August 31, 2016. ADAMS Accession No. ML16265A454.

Waste Control Specialists LLC, Quality Assurance Procedure QP-10.02, Revision 2, "Post-Transport Package Evaluation" (proprietary), dated January 20, 2017. Transmittal dated March 16, 2017. ADAMS Accession No. ML17082A021.

Waste Control Specialists LLC, "Supplemental Information to Support a License Application for a Consolidated Interim Storage Facility for Spent Nuclear Fuel in Andrews, Texas, Docket 72-1050," August 31, 2016. ADAMS Accession No. ML16265A454.

10 MATERIALS EVALUATION

In Chapter 15, “Materials Evaluation,” of the safety analysis report (SAR), Revision 5, Interim Storage Partners LLC (the applicant) described the materials selected for use in the storage systems at the proposed WCS Consolidated Interim Storage Facility (CISF) site. The applicant stated that the storage overpack structures and concrete pads to be used at the CISF will be newly constructed structures, systems, and components (SSCs) and will be fabricated and tested in accordance with previously approved system designs identified in SAR Table 1-1, “Storage Systems at the WCS CISF.”

10.1 Scope of Review

The staff evaluated the applicant’s materials evaluation for the WCS CISF by reviewing the information in the SAR, the applicant’s responses to the staff’s request for supplemental and additional information, and the staff’s previous evaluations for the proposed cask systems to be stored at the facility. The staff reviewed the information in the SAR Chapter 15 to determine whether the applicant provided a clear and complete description of the materials specifications, drawings and materials properties for the storage systems, transportation systems, and material handling equipment related to the storage systems for SNF and greater-than-Class-C (GTCC) waste. In addition, the staff reviewed the applicable sections in SAR Chapter 1, “Introduction and General Description of Installation,” Chapter 3, “Principal Design Criteria,” Chapter 4, “Facility Design,” Chapter 7, “Installation Design and Structural Evaluation,” and the information incorporated by reference discussed in the SAR appendices.

10.2 Regulatory Requirements

The U.S. Nuclear Regulatory Commission (NRC) requirements for the overall function of the ISFSI, the design criteria, and the operation of certain separate functional subsystems appear in the following sections of Title 10 of the *Code of Federal Regulations* (10 CFR):

- 10 CFR 72.24(c) and (d)
- 10 CFR 72.120(a) and (d)
- 10 CFR 72.122(a), (b), (h), and (l)
- 10 CFR 72.124(b)
- 10 CFR 72.128(a)

10.3 Staff Review and Analysis

This safety evaluation report (SER) chapter describes the staff’s review of systems associated with the receipt, transfer, storage, maintenance, and retrieval of the WCS CISF SNF and greater-than-Class-C (GTCC) waste. Unless otherwise stated, the staff reviewed and evaluated the operation systems of the proposed site discussed in Chapter 15 of SAR Revision 5, documents cited in or attached to the SAR, the applicant’s responses to the staff’s requests for supplemental and additional information, and other relevant documents and literature. The staff reviewed and evaluated whether the materials for the SSCs meet applicable codes, standards, and specifications necessary to support the intended functions of the SSCs under all credible loads for normal, off-normal, and accident conditions, including the effects of environmental conditions and natural phenomena for the WCS CISF site. The staff also evaluated operations that ensure adequate materials performance, including material qualification, welding, drying of spent nuclear fuel (SNF), inerting of the confinement system, and the management of materials degradation. The staff’s review followed the guidance in Spent Fuel Project Office Interim Staff

Guidance-15, "Materials Evaluation," Revision 0, SFST-ISG-15. The staff's review ensures that materials will support the functions of the storage system and site facility SSCs by fulfilling the following principal acceptance criteria that reflect the above regulations and areas of review:

- The applicant must provide information on materials of construction, including their fabrication, testing, and general arrangement, with sufficient detail to support a safety finding.
- Material properties should have an adequate technical basis and must demonstrate the ability to support the performance of the intended functions of SSCs under credible loads in normal, off-normal, and accident conditions.
- Materials must not undergo adverse environmental degradation, chemical reactions, or other reactions that could challenge the ability of SSCs to safely handle, package, transfer, and store SNF, reactor-related GTCC waste, or high-level radioactive waste.
- The applicant must ensure that the SNF cladding is protected against gross ruptures or is otherwise confined and that the SNF, high-level radioactive waste, and reactor-related GTCC waste are always retrievable.
- Materials and special processes must conform to all applicable codes and standards. Non-code materials must have adequate controls for their qualification and fabrication.

10.3.1 General Information

The applicant described a CISF designed to accept pressurized-water reactor (PWR) and boiling-water reactor (BWR) commercial SNF and GTCC waste contained in dual-purpose (transportation and storage) cask and canister systems that have been approved by the NRC for SNF.

Operations at the CISF will be limited to SNF and GTCC previously loaded in canister-based systems received from off site. After receipt and acceptance inspection, the applicant will transfer the canisters from the transportation cask to the appropriate storage overpack. The applicant will perform these transfers in either the cask handling building (CHB) or the storage area, depending on the cask system design. The applicant will accomplish all transfer and handling activities in a dry mode using cask-transfer equipment and WCS CISF SSCs. The WCS CISF design does not employ a spent fuel pool or other bare-fuel handling capability.

The applicant stated that the storage overpack structures and concrete pads to be used at the CISF will be newly constructed SSCs and will be fabricated and tested in accordance with previously approved system designs identified in SAR Table 1-1. The applicant stated that the systems specific to the WCS CISF will include the CHB; the cask off-loading and loading system (including overhead bridge cranes, a vertical cask transporter (VCT) for vertical storage systems, and a transfer skid for horizontal systems); and the canister transfer system (CTS) that includes a transfer cask, mobile gantry crane, and ancillary equipment. As noted, the facility will accept only existing SNF and GTCC canisters currently in use at either generally licensed or specifically licensed ISFSIs. The following sections describe the previously licensed systems identified by the applicant and the final safety analysis reports (FSARs) incorporated by reference.

The staff reviewed the general information describing the WCS CISF, the facility layout and design, and the intended operations for each system described in the WCS CISF application

and SAR. Based on its review, the staff determined that the applicant sufficiently described the purpose of each major system that will be used in the CISF operation.

10.3.2 Storage System Design

The applicant stated that the SNF stored at the WCS CISF will arrive in NRC-approved cask systems. The cask systems include transportable canister-based storage systems. For Phase 1 of the WCS CISF application, the applicant proposed six cask systems consisting of 11 different canisters plus GTCC waste canisters, stored in five overpacks for storage at the WCS site. SER Table 1-1 summarizes the proposed cask systems.

The applicant stated that the NUHOMS®-MP187 Multi-Purpose Cask GTCC waste canister is currently included in a specific license for storage and is also certified by the NRC for transport under 10 CFR Part 71, "Packaging and Transportation of Radioactive Material." The NRC has certified the GTCC waste canisters for the NAC International (NAC) systems for transport under 10 CFR Part 71. The applicant stated that the WCS CISF will ultimately accommodate 40,000 metric tons uranium or mixed oxide, or metric tons heavy metal, and will have a service life of at least 40 years.

SAR Appendices A through G, Tables A.3-1 through G.3-1, compare the design parameters for the storage systems incorporated by reference to the conditions at the WCS CISF storage site. For most design parameters in SAR Appendices A through G, Tables A.3-1 through G.3-1, the applicant showed that the WCS CISF site specific conditions were either the same as or bounded by the design criteria for the original specific license and certificates of compliance (CoCs). Where necessary, the applicant provided new evaluations including thermal, transfer loads and seismic events to show that the storage system design was adequate for the WCS site specific conditions for normal, off-normal, and accident conditions.

The staff reviewed the information incorporated by reference on the NRC-approved storage system designs in use at both generally licensed and site specific ISFSIs and the new evaluations provided by the applicant. The staff reviewed the applicant's comparison of design parameters for the storage systems incorporated by reference and the new evaluations provided by the applicant to the conditions at the WCS CISF storage site summarized in SAR Appendices A through G, Tables A.3-1 through G.3-1. Details of the staff review are documented in Section 5.3.1.2, "Design Criteria for Confinement Structures," Section 5.3.1.3, "Material Properties of Confinement Structures," and Section 5.3.1.4, "Structural Analysis of Confinement Structures." The staff determined that the systems incorporated by reference are acceptable because either (1) the design criteria for the original specific license and CoCs are either the same as or bounded by design criteria for the storage systems, or (2) the new evaluations provided the applicant demonstrate that the storage systems designs are adequate for all normal, off-normal, and accident conditions at the WCS CISF site. Based on its review, the staff determined that the applicant adequately described in the SAR the systems identified for storage.

10.3.3 Engineering Drawings

The SAR incorporates by reference the FSARs for the cask systems proposed for storage at the WCS CISF. The cask system FSARs include engineered drawings of all SSCs in the storage systems. The applicant stated that the FSARs and the CoCs of the three TN Americas storage systems and the three NAC systems include the Phase 1 engineering drawings of the storage systems, as described in SER Table 1-1.

SAR Appendix A, Tables A.3-3 through A.3-6, provide the quality classification for the fuel-only (FO) dry storage casks (DSCs), fuel with control components (FC) DSCs, failed fuel (FF) DSCs, and the NUHOMS-MP187 Multi-Purpose Cask transportation package, because the original engineering drawings did not include this information.² As the applicant noted, the Rancho Seco GTCC waste canister shell is a thicker version of the FO/FC DSC designs, and the structural evaluations performed for the GTCC waste canister shell rely on the structural evaluations for the FO/FC DSCs. In a submittal dated May 31, 2019, the applicant clarified that the internal structure of the Rancho Seco GTCC canister is not important to safety and is only used to facilitate loading.

The applicant described the WCS lift beam assembly in SAR Section 4.7.3, “NUHOMS Transfer System,” and included drawings for the WCS lift beam assembly required for the transfer of the NUHOMS systems in SAR Section 4.10, “Supplemental Data Drawings.” The applicant described the CTS in SAR Section 4.7.4, “NAC Cask Transfer System,” and Section 7.5.1, “Canister Transfer System,” and included a figure of the CTS, which is based on an existing systems design. The applicant described the VCT in SAR Section 4.7.4 and Section 7.5.2, “Vertical Cask Transporter,” and included an engineered drawing of the VCT.

The staff reviewed the documents incorporated by reference and confirmed that the NRC-approved FSARs include all of the SSCs for the storage systems identified in the SAR. Therefore, the staff determined that the information provided by the applicant on the design, construction, and materials for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(c)(3) and 10 CFR 72.120(a).

The staff reviewed the CTS and the VCT in Chapter 5 of this SER.

10.3.4 Applicable Codes and Standards

The applicant identified the quality assurance classification of SSCs used at the WCS CISF in SAR Table 3-5, “Quality Assurance Classification of Structures, Systems, and Components as Utilized at the WCS CISF.” The SNF canisters are identified as Classification Category A. The storage overpacks, the CTS, the VCT, and the CHB are identified as Classification Category B. The storage pads for the vertical concrete storage overpacks are identified as Classification Category C. The SER sections below identify the applicable codes and standards for the canisters and the storage overpacks. SER Sections 10.3.4.7 through 10.3.4.10 describe the codes and standards applicable to the remaining Classification Category B and C SSCs.

The applicant referenced the applicable revision of the FSAR and the CoC for the codes and standards used for the Standardized NUHOMS Storage System (CoC No. 1004), the Standardized Advanced NUHOMS Storage System (CoC No. 1029), and the NUHOMS-MP187 Multi-Purpose Cask system currently in use at the Rancho Seco ISFSI. The applicant referenced the applicable revision to the FSAR and the CoC for the codes and standards used for the NAC MAGNASTOR® storage system (CoC No. 1031), the NAC Multi-Purpose Cask (NAC-MPC) system (CoC No. 1025), and the NAC-UMS® system (CoC No. 1015).

The applicant described the CHB in SAR Section 7.5, “Cask Handling Building,” and the CHB structural design in SAR Section 7.5.3, “Cask Handling Building Structural Design.”

² For the NUHOMS-MP187 Cask System, the MP187 transportation cask is qualified for transfer operations and also referred to as a transfer cask.

10.3.4.1 NUHOMS-MP187 Multi-Purpose Cask Systems

The WSC CISF application incorporates by reference Revision 17 of the NUHOMS-MP187 Multi-Purpose Cask SAR and Revision 4 of the Rancho Seco ISFSI FSAR.

The staff reviewed the application, including the NUHOMS-MP187 Multi-Purpose Cask SAR and the Rancho Seco ISFSI FSAR. The staff reviewed SAR Appendix A, Section A.3, "Principal Design Criteria, NUHOMS-MP187 Cask System," which includes the principal design criteria for the NUHOMS-MP187 Multi-Purpose Cask, including the FO, FC, and FF DSCs and the Model 80 horizontal storage module (HSM). The staff also reviewed SAR Appendix H, Section H.3, "Principal Design Criteria, Canisterized GTCC Waste," which includes the principal design criteria for the GTCC DSC in use at the Rancho Seco ISFSI. Based on its review, the staff notes the following:

- The reinforced concrete HSM is designed in accordance with American Concrete Institute (ACI) 349, issued 1985, and constructed to the requirements of ACI 318, issued 1983.
- The FO, FC, and FF DSCs included in the NUHOMS-MP187 Multi-Purpose Cask system are designed to meet the stress intensity allowables of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, 1983 Edition, Section III, Division I, Subsections NB, NF, and NG, for Class I components and supports, as applicable.
- ASME B&PV Code Service Levels A and B allowables are used for normal and off-normal operating conditions, and ASME B&PV Code Service Levels C and D allowables are used for accident conditions such as a postulated cask-drop accident.
- The NUHOMS-MP187 multi-purpose cask structural components are designed to meet the stress allowables of ASME B&PV Code, Section III, Subsection NB, for structural or shell components or Subsection NF for the neutron shield jacket assembly.
- The allowable stress limits for the lifting trunnions meet the recommendations of American National Standards Institute (ANSI) N14.6-1993, "Special Lifting Devices for Shipping Containers Weighing 10 000 Pounds (4500 kg) or More," for critical loads.
- Appendix A to the Rancho Seco ISFSI updated FSAR provides the ASME B&PV Code exceptions for the NUHOMS-MP187 multi-purpose cask FO, FC, and FF DSCs.
- The Rancho Seco GTCC waste canister design report specifically states that ASME B&PV Code, Subsection NB, is not applicable to the design analysis, fabrication, and inspection; therefore, no code alternatives are specified for the GTCC canister.

Based on its review, the staff determined that the applicant identified and incorporated the applicable codes and standards for the NUHOMS-MP187 multi-purpose cask FO, FC, FF, and GTCC DSCs; and the Model 80 HSM. Therefore, the staff determined that the information provided by the applicant on the design, construction, materials, and applicable codes and standards for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(c)(4). In addition, the staff reviewed the applicant's analysis of the NUHOMS-MP187 multi-purpose cask included in SAR Appendix A, Table A.3-1, "Summary of WCS CISF Principal Design Criteria." The staff also determined that the design of the NUHOMS-MP187 multi-purpose cask is adequate because the analysis in SAR Appendix A, Section A.3.3, "Design

Criteria for Environmental Conditions and Natural Phenomena,” shows that the design criteria incorporated by reference are either the same as or bounding for normal, off-normal, accident conditions, and the effects of environmental conditions and natural phenomena at the WCS CISF site. Therefore, the staff determined that the information provided by the applicant on the design and performance of SSCs important to safety for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(d) and 10 CFR 72.122(b).

10.3.4.2 Standardized Advanced NUHOMS Storage Systems

The SAR incorporates by reference Revision 6 of the Standardized Advanced NUHOMS Storage System FSAR and Revision 17 of the NUHOMS-MP187 Multi-Purpose Cask SAR.

The staff reviewed the material incorporated by reference in the application, including the Standardized Advanced NUHOMS Storage System FSAR and the NUHOMS-MP187 Multi-Purpose Cask SAR. The staff also reviewed the information included in SAR Appendix A, Section A.3, and Appendix B, Section B.3, “Principal Design Criteria,” which contain the principal design criteria for the NUHOMS-MP187 Multi-Purpose Cask, the 24PT1 DSC, and the Standardized Advanced Horizontal Storage Module (AHSM). Based on its review, the staff notes the following:

- The reinforced concrete AHSM is designed in accordance with ACI 349 (1997) and built to ACI-318 (1989).
- The 24PT1 DSC is designed, fabricated, and inspected to the maximum practical extent in accordance with ASME B&PV Code, Section III, Division 1, 1992 Edition with Addenda through 1994.
- The Standardized Advanced NUHOMS Storage System FSAR, Table 3.1-14, “ASME Code Exceptions for the 24PT1-DSC (NB),” identifies exceptions to ASME B&PV Code, Section III, Subsections NB, NF, and NG.
- The NUHOMS-MP187 multi-purpose cask structural components are designed to meet the stress allowables of ASME B&PV Code, Section III, Subsection NB, for structural or shell components or Subsection NF for the neutron shield jacket assembly.
- Appendix A to the Rancho Seco ISFSI FSAR provides ASME B&PV Code exceptions for the NUHOMS-MP187 multi-purpose cask.

Based on its review, the staff determined that the applicant incorporated the applicable codes and standards for the 24PT1 DSC and the NUHOMS AHSM. Therefore, the staff determined that the information provided by the applicant on the design, construction, materials, and applicable codes and standards for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(c)(4). The staff determined that the use of transfer casks included in the Standardized Advanced NUHOMS Storage System is not required because the applicant indicated that the NUHOMS-MP187 multi-purpose cask transportation package will transfer the DSCs to the HSMs. The staff reviewed the applicant’s summary of the principal design criteria included in SAR Appendix A, Table A.3-1, for the NUHOMS-MP187 multi-purpose cask system and in SAR Appendix B, Table B.3-1, for the Standardized Advanced NUHOMS Storage System. The staff also determined that the designs of the Standardized Advanced NUHOMS Storage System and the NUHOMS-MP187 multi-purpose cask system are adequate because the analyses in SAR Appendix A, Section A.3.3, and Appendix B, Section B.3.3, show that the design criteria incorporated by reference are either the same as or

bounding for normal, off-normal, accident conditions, and the effects of environmental conditions and natural phenomena at the WCS CISF site. Therefore, the staff determined that the information provided by the applicant on the design and performance of SSCs important to safety for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(d) and 10 CFR 72.122(b).

10.3.4.3 Standardized NUHOMS Storage Systems

The SAR incorporates by reference Revision 14 of the Standardized NUHOMS Storage System FSAR (Docket No. 72-1004) and the Revision 17 of the NUHOMS-MP197 Transportation System SAR (Docket No. 71-9302).

The staff reviewed the material incorporated by reference in the application, including the Standardized NUHOMS Storage System FSAR and the NUHOMS-MP197 Transportation System SAR. The staff also reviewed the information included in SAR Appendix C, Section C.3, and Appendix D, Section D.3, both entitled, "Principal Design Criteria," which contain the principal design criteria for the 61BT DSC, the 61BTH DSC, and the Model 102 HSMs, as well as information from the applicant's submittal dated May 31, 2019. Based on its review, the staff notes the following:

- Model 102 HSMs are designed to meet the requirements of ACI 349 (1985) and constructed from reinforced concrete in accordance with ACI 318 (1983).
- The 61BT DSC shell is designed to the extent possible in accordance with the ASME B&PV Code, Section III, Division 1, Subsection NB, 1998 Edition with 1999 Addenda.
- The 61BT DSC basket and internal components are designed in accordance ASME B&PV Code, Section III, Division 1, Subsections NG and NF.
- For the 61BT DSC shell and basket, the Standardized NUHOMS Storage System FSAR, Table K.3.1-2, and Technical Specification (TS) Section 4.2.4 describe exceptions to the ASME B&PV Code.
- Appendix T to the Standardized NUHOMS Storage System FSAR indicates that the 61BTH DSC shell is designed to the extent possible in accordance with ASME B&PV Code, Section III, Division 1, Subsection NB, 1998 Edition with the 2000 Addenda.
- The 61BTH DSC basket and internal components are designed in accordance ASME B&PV Code, Section III, Division 1, Subsections NG and NF.
- For the 61BTH DSC shell and basket, the Standardized NUHOMS Storage System FSAR, Table T.3.1-2, and TS Section 4.2.4 describe exceptions to the ASME B&PV Code.
- The NUHOMS-MP197/MP197HB transportation cask is designed and constructed to meet the requirements of 10 CFR Part 71.
- The NUHOMS-MP197/MP197HB transportation cask containment vessel is designed to the maximum practical extent as an ASME Class I component, in accordance with the rules of ASME B&PV Code, Section III, Subsection NB; the neutron shield shell is designed, fabricated, and inspected in accordance with ASME B&PV Code, Section III, Subsection NF, 2004 Edition with 2006 Addenda.

- NUHOMS-MP197 transportation system SAR Table A.2.13.13-1 provides the ASME code alternatives for the NUHOMS-MP197HB cask containment boundary.
- The design and fabrication of the lifting trunnions for the NUHOMS-MP197/MP197HB transportation cask are in accordance with the requirements of ANSI N14.6-1993.

Based on its review, the staff determined that the applicant identified and incorporated the applicable codes and standards for the 61BT DSC, the 61BTH DSC, and the Model 102 HSMs included in the Standardized NUHOMS Storage System FSAR and the NUHOMS-MP197 Transportation System SAR. Therefore, the staff determined that the information provided by the applicant on the design, construction, materials, and applicable codes and standards for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(c)(4). The staff determined that the use of transfer casks included in the Standardized NUHOMS Storage System FSAR is not required because the applicant has indicated that the NUHOMS-MP197/MP197HB transportation casks will be used to transfer the DSCs to the HSMs. In addition, the staff reviewed the applicant's summary of principal design criteria for the Standardized NUHOMS Storage System included in SAR Appendix C, Table C.3-1, and Appendix D, Table D.3-1, both entitled, "Summary of WCS CISF Principal Design Criteria." The staff determined that the designs of the 61BT and 61BTH DSCs described in the Standardized NUHOMS Storage System FSAR and the NUHOMS-MP197 Transportation System SAR are adequate because the analyses in SAR Appendix C, Section C.3.3, and Appendix D, Section D.3.3, both entitled, "Design Criteria for Environmental Conditions and Natural Phenomena," show that the design criteria incorporated by reference are either the same as or bounding for normal, off-normal, accident conditions, and the effects of environmental conditions and natural phenomena at the WCS CISF site. Therefore, the staff determined that the information provided by the applicant on the design and performance of SSCs important to safety for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(d) and 10 CFR 72.122(b).

10.3.4.4 NAC-MPC Storage System

The SAR incorporates by reference Revision 10 of the NAC-MPC FSAR (Docket No. 72-1025) and Revision 17 of the NAC-STC SAR (Docket No. 71-9235).

The staff reviewed the material incorporated by reference in the application, including the NAC-MPC FSAR and the NAC-STC SAR. The staff also reviewed the information included in SAR Appendix E, Section E.3, and Appendix H, Section H.3, both entitled, "Principal Design Criteria," which contain the principal design criteria for the NAC-MPC transportable storage canisters (TSCs), including the Yankee-MPC, Connecticut Yankee (CY)-MPC, MPC for the La Crosse BWR (MPC-LACBWR), GTCC-Canister-CY, GTCC-Canister-YR MPCs, Yankee-MPC Vertical Concrete Cask (VCC), CY-MPC VCC, CY-MPC transfer cask, and Yankee-MPC transfer cask. Based on its review, the staff notes the following:

- ACI 349 (1985) and ACI 318 (1995) govern the NAC-MPC system VCC design and construction, respectively. The NAC-MPC canisters are designed to the extent possible in accordance with the ASME B&PV Code, 1995 Edition with Addenda through 1995.
- NAC-MPC FSAR, Table 1.2-3, summarizes the TSC fabrication specifications for the CY-MPCs and Yankee MPCs.

- NAC-MPC FSAR, Table 1.3-5, summarizes the damaged fuel can design and fabrication specifications for the Yankee-MPC.
- NAC-MPC FSAR, Table 1.3-6, summarizes the damaged fuel can design and fabrication specifications for the CY-MPC.
- NAC-MPC FSAR, Table 1.A.2-2, summarizes the MPC-LACBWR TSC fabrication specifications, and Table 1.A.3-3 summarizes the MPC-LACBWR damaged fuel can design and fabrication specification.
- NAC-MPC CoC No. 1025, Amendment 6, Appendix B, “Approved Contents and Design Features,” Table B3-1, “List of ASME Code Alternatives for the NAC-MPC System,” which the applicant referenced in SAR Appendix E, Section E.11, “Confinement Evaluation, NAC-MPC,” includes the exceptions to the ASME B&PV Code for the design and construction of the TSC and basket assembly.
- SAR Appendix E, Table E.4-2, “Concrete Cask Construction Specification Summary,” summarizes the VCC construction specifications.
- ANSI N14.6-1993 and NUREG-0612, “Control of Heavy Loads at Nuclear Power Plants,” issued July 1980, govern the NAC-MPC system transfer cask designs, operations, fabrication, testing, inspection, and maintenance.
- NAC-STC SAR, Section 1.2.1.2.8.2, describes design and materials for the Yankee-MPC GTCC basket and the CY-MPC basket.

Based on its review, the staff determined that the applicant identified and incorporated the applicable codes and standards for the NAC-MPC System and the NAC-STC Storage Transport Cask. Therefore, the staff determined that the information provided by the applicant on the design, construction, materials and applicable codes and standards for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(c)(4). In addition, the staff reviewed the applicant’s summaries of principal design criteria included in SAR Appendix E, Table E.3-1, “Summary of WCS CISF Principal Design Criteria,” for the NAC-MPC system and Appendix H for the NAC GTCC storage systems. The staff determined that the designs of the NAC-STC transportation cask and the NAC-MPC System are adequate because the analyses in SAR Appendix E, Section E.3.3, “Principal Design Criteria, NAC-MPC,” and Appendix H, Section H.3, “Principal Design Criteria,” compare the principal design criteria for the systems incorporated by reference and, where necessary, new evaluations provided by the applicant for the conditions of the WCS CISF storage site. The staff reviewed the applicant’s evaluation and determined that the applicant provided information to show that the systems incorporated by reference are acceptable for normal, off-normal, accident conditions, and the effects of environmental conditions and natural phenomena at the WCS CISF. Therefore, the staff determined that the information provided by the applicant on the design and performance of SSCs important to safety for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(d) and 10 CFR 72.122(b).

10.3.4.5 NAC-UMS Storage Systems

The SAR incorporates by reference Revision 10 of the NAC-UMS FSAR (Docket No. 72-1015) and Revision 2 of the NAC-UMS Universal Transport Cask SAR (Docket No. 71-9270).

The staff reviewed the material incorporated by reference in the application, including the NAC-UMS FSAR and the NAC-UMS Universal Transport Cask SAR. The staff also reviewed the information included in SAR Appendix F, Section F.3, "Principal Design Criteria," and Appendix H, Section H.3, which contain the principal design criteria for the NAC-UMS TSCs (NAC-UMS System Classes 1–5 and GTCC-Canister-MY TSCs) VCC and the NAC-UMS transfer cask. Based on its review, the staff notes the following:

- The NAC-UMS VCC design and construction are in accordance with ACI 349 (1985) and ACI 318 (1995).
- The NAC-UMS TSC is designed and constructed to the extent possible in accordance with ASME B&PV Code, Section III, Subsections NB and NG, 1995 Edition with Addenda through 1995.
- NAC-UMS FSAR, Table 1.2-3, summarizes the TSC fabrication specifications.
- TS Table B3-1, "List of ASME Code Exceptions for the NAC-UMS System," of Amendment No. 5 to CoC No. 1015 for the NAC-UMS Storage System, dated January 12, 2009, which the applicant referenced in SAR Appendix F, Section F.11, "Confinement Evaluation," includes exceptions to the ASME B&PV Code for the design and construction of the TSC and basket assembly.
- NAC-UMS FSAR, Table 2.1.3.1-2, summarizes the damaged fuel can design and fabrication specifications.
- SAR Table F.4-1, "Concrete Cask Construction Specification Summary," summarizes the VCC construction specifications.
- The NAC-UMS transfer cask design, operation, fabrication, testing, inspection, and maintenance are in accordance with the ANSI N14.6-1993 and NUREG-0612.
- NAC-UMS Universal Transport Cask SAR, Section 2.1.1.5, "GTCC Waste Canister and Basket," includes the design criteria for the GTCC waste canister and basket and the GTCC-Canister-MY; Section 1.3.1.1.2, "Maine Yankee Greater Than Class C Waste," of that document describes the GTCC waste.
- NAC-UMS Universal Transport Cask SAR, Table 2.1.2-1, "Exceptions to Codes and Standards," lists the ASME B&PV Code, Section III, Subsection NF, exceptions for the GTCC-Canister-MY basket.

Based on its review, the staff determined that the applicant identified and incorporated the applicable codes and standards for the NAC-UMS Universal Transport Cask and the NAC-UMS Storage Systems. Therefore, the staff determined that the information provided by the applicant on the design, construction, materials, and applicable codes and standards for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(c)(4). In addition, the staff reviewed the applicant's summary of principal design criteria for the NAC-UMS system included in SAR Appendix F, Table F.3-1, "Summary of WCS CISF Principal Design Criteria," and Appendix H for the NAC GTCC storage systems. The staff determined that the designs of the NAC-UMS Universal Transport Cask and the NAC-UMS Storage System are adequate because the analyses in SAR Appendix F, Section F.3, and Appendix H, Section H.3, show that the design criteria incorporated by reference are either the same as or bounding for normal,

off-normal, accident conditions, and the effects of environmental conditions and natural phenomena at the WCS CISF site. Therefore, the staff determined that the information provided by the applicant on the design and performance of SSCs important to safety for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(d) and 10 CFR 72.122(b).

10.3.4.6 NAC MAGNASTOR Storage System

The SAR incorporates by reference Revision 7 of the NAC MAGNASTOR FSAR (Docket No. 72-1031) and Revision 12A of the NAC MAGNATRAN® SAR (Docket No. 71-9356).

The staff reviewed the material incorporated by reference in the application, including the NAC MAGNASTOR FSAR and the NAC MAGNATRAN SAR. The staff also reviewed the information included in SAR Appendix G, Section G.3, "Principal Design Criteria," and Appendix H, Section H.3, which contain the principal design criteria for the NAC MAGNASTOR storage system (Zion (ZN) TSC TSC1–TSC4 and GTCC-Canister-ZN) with CC1 through CC4 overpacks that are part of NRC Docket No. 72-1031, VCC and the NAC MAGNASTOR MTC1 and MTC2 transfer casks. Based on its review, the staff notes the following:

- The NAC MAGNASTOR VCC design and construction are in accordance with ACI 349 (1985) and ACI 318 (1995).
- The NAC MAGNASTOR TSC is designed and constructed to the extent possible in accordance with ASME B&PV Code, Section III, Subsections NB and NG, 2001 Edition with Addenda through 2003.
- NAC MAGNASTOR FSAR, Table 1.3-2, summarizes the TSC fabrication specifications, and Table 2.1-2 lists the ASME B&PV Code alternatives for NAC MAGNASTOR TSC, damaged fuel can, and basket components.
- NAC MAGNASTOR FSAR, Tables 1.3-3 and 1.3-4, identify the concrete cask and lid construction specifications.
- ANSI N14.6-1993 and NUREG-0612 govern the NAC MAGNASTOR system transfer cask designs, operations, fabrication, testing, inspection, and maintenance.
- NAC MAGNATRAN SAR, Section 1.3, states that the GTCC waste basket liner and TSC are designed, fabricated, and inspected in accordance with ASME B&PV Code, Section III Division 1, Subsection NF.

Based on its review, the staff determined that the applicant identified and incorporated the applicable codes and standards for the NAC MAGNATRAN transportation system and the NAC MAGNASTOR storage system. Therefore, the staff determined that the information provided by the applicant on the design, construction, materials, and applicable codes and standards for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(c)(4). In addition, the staff reviewed the applicant's analysis for the NAC MAGNASTOR system and the NAC GTCC storage systems included in SAR Appendix G, Table G.3-1, "Summary of WCS CISF Principal Design Criteria," and Appendix H respectively. The staff determined that the designs of the NAC MAGNATRAN transportation system and the NAC MAGNASTOR storage system are adequate because the principal design criteria in SAR Appendix G, Section G.3, and Appendix H, Section H.3, show that the design criteria incorporated by reference are either the same as or bounding for normal, off-normal, accident conditions, and the effects of

environmental conditions and natural phenomena at the WCS CISF site. Therefore, the staff determined that the information provided by the applicant on the design and performance of SSCs important to safety for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(d) and 10 CFR 72.122(b).

10.3.4.7 Cask Handling Building and Overhead Cranes

The staff review of the CHB and overhead cranes is summarized in SER Section 4.3.3.3, "Structural," and Section 5.3.3.1, "Cask Handling Building."

10.3.4.8 NUHOMS Transfer System

The staff review of the CHB, overhead cranes, and the WCS lift beam is summarized in SER Section 4.3.3.3, Section 5.3.3.1, and Section 5.3.4.1, "Overhead Bridge Crane."

10.3.4.9 NAC Canister Transfer System and Vertical Cask Transporter

The staff reviewed the CTS and the VCT in SER Section 4.3.3.3, Section 5.3.3.2, "Cask Transfer System," and Section 5.3.3.3, "Vertical Cask Transporter."

10.3.5 Content Specifications

In SAR Section 1.2.4, "Materials to be Stored," the applicant described the materials to be stored at the WCS CISF. In addition, in WCS CISF TS, Section 2.1, "Functional and Operating Limits," the applicant listed the approved systems and their approved contents. The applicant stated all high burnup fuel would be required to be placed in damaged fuel cans inside the canisters received and to be stored at the WCS CISF. The applicant stated that the WCS CISF will receive only NRC-approved canisters for commercial light-water (PWR and BWR) SNF and GTCC waste. In addition, the applicant stated that the controls for limiting the types and forms of SNF received at the WCS CISF include those placed on the cask systems by the NRC-issued site licenses or CoCs for the transportation and storage systems included in SAR Table 1-1. In SAR Section 1.2.4, the applicant summarized the type, form, and sources authorized for storage as follows:

- canisterized SNF elements from commercial nuclear utilities licensed pursuant to 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities," and associated radioactive materials related to the receipt, transfer, and storage of that SNF
- uranium or mixed oxide in the form of intact spent fuel assemblies, damaged fuel assemblies, and fuel debris, as specified in WCS CISF TS, Section 2.1
- canisterized GTCC waste that consists of only reactor-related low-level radioactive waste generated as a result of plant operation and decommissioning, and that exceed the radionuclide concentration limits of Class C waste in 10 CFR 61.55, "Waste Classification"

The applicant clarified that the GTCC waste may include such components as in-core components, core support structures, and small reactor-related miscellaneous parts resulting from the processes for reactor vessel internals segmentation and decommissioning. The applicant stated that all waste stored within the various GTCC canisters will be in the physical form of activated metals that may have surface contamination. In addition, the applicant stated that the GTCC canisters will not contain process wastes with paper, plastics, or ion exchange

resins that could result in the generation of combustible gases or chemical or galvanic corrosion reactions with the canister.

For Phase 1 of WCS CISF operation, the applicant's proposed TS Section 2.1, "Functional and Operating Limits," and SAR Section 3.1.1.2, "Greater Than Class C Waste," reference the content specifications included in the following NRC materials license and CoC TS:

- NUHOMS-MP187 multi-purpose cask system contents currently authorized in NRC Special Nuclear Materials (SNM) License No. SNM-2510, Amendment 4.
- Standardized NUHOMS Storage System 61BT DSC contents currently authorized in NRC CoC No. 1004, Amendments 3–13, Table 1-1c, "BWR Fuel Specifications for Fuel to be Stored in the Standardized NUHOMS-61BT DSC," or Table 1-1j, "BWR Fuel Specification of Damaged Fuel to be Stored in the Standardized NUHOMS-61BT DSC."
- Standardized NUHOMS Storage System 61BTH DSC contents currently authorized in NRC CoC No. 1004, Amendments 10–13, Table 1-1t, "BWR Fuel Specification for the Fuel to be Stored in the NUHOMS-61BTH DSC."
- Standardized Advanced NUHOMS Storage System 24PTH1 DSC contents currently authorized in NRC CoC No. 1029, Amendments 0, 1, and 3, Section 2.1, "Fuel to be Stored in the 24PT1-DSC."
- NAC-MPC System CoC No. 1025, Amendments 0–6, Appendix B, Section B.2.1, "Fuel Specifications and Loading Conditions."
- NAC-UMS Storage System CoC No. 1015, Amendments 0–5, Appendix B, Section B 2.1.2, "Maine Yankee Site Specific Fuel Preferential Loading."
- NAC MAGNASTOR System CoC No. 1031, Amendments 0–3, Revision 1, and Amendments 4 and 5, Appendix B, Table B.2-1, "PWR Fuel."
- NAC-UMS Universal Transport Cask CoC No. 9270, Revision 4, Section 5.(b)(1)(iv), "Greater Than Class C Waste from Maine Yankee (GTCC-Canister-MY)."
- NAC-STC Storage Transport Cask CoC No. 9235, Revision 13, Section 5.(b)(1)(iii), "Greater than Class C waste from Connecticut Yankee (GTCC-Canister-CY) and Greater than Class C waste from Yankee Rowe (GTCC-Canister-YR)."
- NAC MAGNATRAN CoC No. 9356, Revision 2, Section 5.(b)(1)(iv), "Greater Than Class C Waste for Zion (GTCC-Canister-ZN)."

Based on its review, the staff confirmed that the NRC has previously approved the content specifications for the canisters proposed for storage at the WCS CISF. Because the NRC previously reviewed and approved the content specifications for the proposed systems, the staff determined that the content specifications of the dry storage systems in the WCS CISF application are acceptable. Therefore, the staff determined that the information provided by the applicant, which concerned how the design of the storage systems and the content specifications show that the fuel cladding will be protected during storage against degradation that leads to gross ruptures and will not pose operational safety problems with respect to its

removal from storage, was sufficient to meet the regulatory requirements in 10 CFR 72.122(h)(1) and 10 CFR 72.122(h)(5).

10.3.6 Welding

In SAR Section 1.2.4, the applicant stated that SNF proposed for storage at the WCS CISF will be in previously NRC-approved canister-based systems, CTSSs, and canister storage overpack structures. The applicant also described the design and fabrication of transfer equipment used for the receipt and transfer of canisters contained within NRC-approved transportation casks.

The staff reviewed the description of the WCS CISF materials to be stored, CISF operations, and materials incorporated by reference listed in SAR Section 1.2.4.1, "Use of NRC-Approved Storage Cask Systems." Based on its review, the staff determined that the applicant's description of the systems is accurate, and no welding operations are required for the receipt and transfer of storage systems at the WCS CISF site because all systems received will be transportable, canister-based systems that have been loaded to the approved TS of the system.

10.3.7 Confinement Weld Design, Inspection, and Testing

The SAR incorporates by reference the canister-based system FSARs described in SER Table 1-1. The design descriptions and engineered drawings in the respective FSARs for these canister systems include the confinement weld design and inspection of these systems. The applicant stated that, with the exception of the FO, FC, and FF DSCs, all of the canisters to be stored at the WCS CISF are designed to be leak tight, in accordance with ANSI N14.5-1997 under all normal, off-normal, and accident conditions. The applicant stated that confinement of the SNF or GTCC waste in these canisters is maintained under all conditions. The applicant stated that the FO, FC, and FF DSCs were leak tested to a leakage rate of 1×10^{-5} standard cubic centimeters per second. SAR Appendix A, Section A.11, "Confinement Evaluation," provides a confinement evaluation for these canisters. The staff's evaluation of the FO-, FC-, and FF-DSC confinement system and boundary is described in SER Section 9.3.1.1.

As noted in SER Section 10.3.2 "Storage System Design," the applicant has incorporated by reference storage systems that have previously been reviewed and approved by the NRC. The staff previously reviewed the confinement weld design, inspection, and testing for the systems in the FSARs incorporated by reference in the SAR. Based on its prior reviews, the staff determined that the information incorporated by reference for the NRC-approved canister-based systems and canister storage overpack structures shows that these systems are designed, fabricated, erected, and tested using applicable codes and standards with quality assurance programs and control of special processes that are sufficient to meet the regulatory requirements in 10 CFR 72.24(c)(4) and 10 CFR 72.122(a). Therefore, the staff determined that the canisters that were designed, inspected, and tested in accordance with the approved License No. SNM-2510 and CoCs listed in SER Table 1-1 are acceptable for storage at the WCS CISF.

10.3.8 Transfer Casks

The SAR incorporates by reference the transfer cask FSARs and transportation cask SARs described in SER Table 1-1. The system design descriptions and engineered drawings in the respective FSARs for the transportation casks and transfer casks include the weld design and inspection for these casks.

As noted in SER Section 10.3.2 “Storage System Design,” the applicant has incorporated by reference storage systems that have previously been reviewed and approved by the NRC. The staff previously reviewed the weld design, inspection, and testing for the systems in the FSARs incorporated by reference in the SAR. Based on its prior reviews, the staff determined that the information incorporated by reference for the NRC-approved canister-based systems and transfer casks shows that these systems are designed, fabricated, erected, and tested using applicable codes and standards with quality assurance programs and control of special processes that are sufficient to meet the regulatory requirements in 10 CFR 72.24(c)(4) and 10 CFR 72.122(a). Therefore, the staff determined that the casks that were designed, inspected, and tested in accordance with the approved License No. SNM-2510 and CoCs listed in SER Table 1-1 are acceptable for use at the WCS CISF.

In addition to the transfer casks incorporated by reference, the applicant stated that the MP197HB transportation cask will be used at the WCS CISF for transfer operations for the NUHOMS 61BT and 61BTH DSCs. The applicant provided information to qualify the MP197HB transportation cask for these transfer operations in SAR Appendices C and D. SER Section 5.3.1.4.3 discusses the staff evaluation of the information provided by the applicant to support the MP197HB for transfer operations.

10.3.9 Other Transfer Components

For the NUHOMS systems, the SAR states that transfer equipment will include the 130-ton overhead bridge cranes in the CHB and the WCS lift beam assembly described in SAR Section 4.7, “Canister Handling Operation Systems,” and the NUHOMS transfer system that consists of a transfer trailer, skid, skid positioning system, HSM/cask restraint system, hydraulic ram, and alignment equipment. The 130-ton overhead crane is an important-to-safety component, as described in SAR Section 7.5.3. The WCS lift beam assembly is a not important-to-safety component, as described in SAR Section 4.7.3. The NUHOMS transfer system is identical to systems currently in use at ISFSIs that use the NUHOMS storage systems and are also considered to be not important to safety.

The SAR includes drawings, material specifications, welding, inspection, and testing requirements for the WCS lift beam assembly that will be used with the 130-ton overhead crane to remove loaded NUHOMS transportation casks from incoming railcars to the NUHOMS transfer system. The SAR drawing for the WCS lift beam assembly identifies fabrication codes and standard and identifies nondestructive examination requirements. The WCS lift beam assembly is load tested in accordance with ANSI N14.6-1993.

SAR Sections 4.7.4.1, “Vertical Cask Transporter,” and 7.5.2 describe the VCT used to lift, stabilize, and move both the transportation cask and the VCC storage overpacks during loading operations at the WCS CISF. The VCT is designed and inspected in accordance with ASME B30.1-2009, “Jacks, Industrial Rollers, Air Casters, and Hydraulic Gentries,” and ANSI N14.6-1993. Welding of the VCT is performed in accordance with AWS D1.1. Staff qualified as Level II by the American Society for Nondestructive Testing will examine all welds using magnetic particle testing.

The staff reviewed weld design, inspection, and testing for the canister handling systems included in the SAR. The staff determined the weld design testing and inspection requirements for each of the transfer system components were adequately identified and appropriate for the system function and are acceptable for use at the WCS CISF. Therefore, the staff determined that the information provided by the applicant shows that the canister transfer and handling systems are designed, fabricated, erected, and tested using applicable codes and standards

with quality assurance programs and control of special processes that are sufficient to meet the regulatory requirements in 10 CFR 72.24(c)(4) and 10 CFR 72.122(a).

10.3.10 Mechanical Properties of Materials

The SAR incorporates by reference the FSARs and SARs for the canister-based systems, transportation casks, transfer casks, HSMs, and vertical concrete overpacks for the systems described in SER Table 1-1. The materials used in the construction of these SSCs have the following mechanical properties:

- tensile properties as a function of temperature for stainless steels, carbon steels, and low-alloy steel canister components, canister baskets, and internal structures, including damaged fuel canisters
- tensile properties of carbon steel and low-alloy steel components of vertical concrete overpack components
- fracture resistance of carbon steel and low-alloy steel components
- thermal expansion coefficients, modulus of elasticity, and density for stainless steels, carbon steels, and low-alloy steels

SAR Appendices A through G, Tables A.3-1 through G.3-1, summarize the principal design criteria for the storage systems incorporated by reference. These tables compare the principal design criteria for the systems and, where necessary, new evaluations provided by the applicant for the conditions of the WCS CISF storage site.

The staff previously reviewed the mechanical properties of the approved systems incorporated by reference in the SAR. As noted in Section 10.3.2 “Storage System Design,” the staff reviewed the applicant’s comparison of design parameters for the storage systems incorporated by reference and the new evaluations provided in the WCS CISF SAR and determined that the applicant provided information sufficient to show that the systems incorporated by reference are acceptable for all normal, off-normal, and accident conditions at the WCS CISF site. Therefore, the staff determined that the mechanical properties of these materials are applicable to analyses for the WCS CISF site.

SAR Section 15.3.1, “ITS Storage Pads,” provides the mechanical properties of the storage pads important to safety, including the American Society for Testing and Materials (ASTM) C150 Type II Portland Cement and the ASTM A615/A615M Grade 60 carbon steel reinforcing bar at a reference temperature of 100 degrees Fahrenheit (F) (38 degrees Celsius (C)).

SAR Section 15.3.2, “Canister Transfer System,” provides the mechanical properties of the materials used for the CTS, including carbon steels, low-alloy steels, and precipitation-hardened stainless steels are included.

SAR Section 15.3.3, “Vertical Cask Transporter,” provides the mechanical properties of the materials used for the VCT, including low-alloy steels and precipitation-hardened stainless steels.

The staff reviewed the reported mechanical properties of the materials used in the CTS and VCT and verified that the reported values are consistent with the referenced ASTM standards. Based on the confirmation of reported mechanical properties, the staff determined that the

mechanical properties of the materials used in the construction of the CTS and the VCT are acceptable for use at the WCS CISF. Therefore, the staff determined that the information provided by the applicant was sufficient to show that the materials used storage, canister transfer and canister handling systems are tested to quality standards commensurate with the importance to safety of the function to be performed and sufficient to meet the regulatory requirements in 10 CFR 72.122(a). In addition, the staff determined that the information provided by the applicant on the design and performance of the important to safety SSCs was sufficient to meet the regulatory requirements in 10 CFR 72.24(d) and 10 CFR 72.122(b).

10.3.10.1 Fracture Resistance

The SAR incorporates by reference the FSARs and SARs for the canister-based storage systems, transportation casks, transfer casks, HSMS, and vertical concrete overpacks described in SER Table 1-1. SAR Appendices A through G, Tables A.3-1 through G.3-1, summarize the principal design criteria for the storage systems incorporated by reference. These tables compare the principal design criteria for the systems and, where necessary, new evaluations provided by the applicant for the conditions of the WCS CISF storage site.

The staff previously reviewed the fracture resistance of ferritic steel components used in the approved system FSARs incorporated by reference in the SAR. As noted in Section 10.3.2 "Storage System Design," the staff reviewed the applicant's comparison of design parameters for the storage systems incorporated by reference and the new evaluations provided in the WCS CISF SAR and determined that the applicant provided information sufficient to show that the systems incorporated by reference are acceptable for all normal, off-normal, and accident conditions at the WCS CISF site. Therefore, the staff determined that the fracture resistance of ferritic steel components has been adequately considered in the analysis of the system components included in the approved License No. SNM-2510 and CoCs listed in SER Table 1-1, and such components are acceptable for use at the WCS CISF.

SAR Section 7.5.1.4, "Operations Specification and Design Criteria," addresses the testing of the CTS for protection against brittle fracture. The applicant stated that the CTS is specifically used for NAC vertical storage systems and is a shielded handling system used to remove the canister contents from the transportation cask and place them into the VCC. The applicant stated that the CTS is primarily constructed from ASTM A572 Grade 50 plate material. The applicant stated that, in accordance with the requirements of ASME NOG-1, "Rules for Construction of Overhead Gantry Cranes (Top Running Bridge, Multiple Girder)," and ASME B&PV Code, Section III, carbon steel materials exceeding 5/8 inch (16 millimeters) are impact tested in accordance with ASTM A370, "Standard Test Methods and Definitions for Mechanical Testing of Steel Products," and weld filler materials for welds with an effective throat exceeding 5/8 inch (16 millimeters) are also impact tested. The applicant stated that ASME NOG-1 requires that the impact test temperature be at least 30 degrees F (17 degrees C) below the minimum operating temperature. The applicant stated that acceptance values shall be in accordance with ASTM A370, Section 26.1, with the lowest service temperature of 32 degrees F (0 degrees C).

SAR Section 7.5.2 addresses the VCT used to lift, stabilize, and move both the transportation cask and the VCC storage overpacks during loading operations at the WCS CISF. The VCT is a commercially developed, self-contained, onsite vehicle designed, fabricated, and tested in accordance with ASME B30.1 and ANSI N14.6. The applicant stated that ANSI N14.6-1993, Section 4.2.6, addresses protection against brittle fracture and specifies that ferritic materials for loadbearing members shall be subjected to a drop-weight test, in accordance with ASTM E208,

“Standard Test Method for Conducting Drop-Weight Test to Determine Nil-Ductility Transition Temperature of Ferritic Steels E208,” or a Charpy impact test, in accordance with ASTM A370.

The staff also reviewed the impact toughness fabrication notes for the WCS lift beam assembly that will be used to transfer the NUHOMS transportation casks from the incoming railcar to the transfer skid. The staff determined that the impact toughness testing requirements for the WCS lift beam were adequate because they are appropriate, based on the material specifications, and rely on ASTM standard testing methods to ensure resistance to brittle fracture during operation. The staff reviewed the applicant’s approach to testing of the CTS materials for protection against brittle fracture, including the service temperature limit of 32 degrees F (0 degrees C), specifications for the ASTM A572 Grade 50 plate material, the requirements of ASME NOG-1 and ASME BPV Code, Section III, and the testing requirements outlined in ASTM A370. The staff also reviewed the testing requirements for the CTS, which are summarized in SAR Table 7-10, “Testing Requirements.” The staff determined that the applicant’s approach satisfactorily addresses the testing requirements for carbon and low-alloy steel important-to-safety components for protection against brittle fracture.

The staff reviewed the applicant’s description of the testing for the VCT in SAR Section 7.5.2. In SAR Section 7.5.2, the applicant clarified that ANSI N14.6-1993, Section 4.2.6, specifies that ferritic materials for loadbearing members shall be subjected to testing in accordance with ASTM E208 or ASTM A370. The staff determined that the revised information provided by the applicant was acceptable because the ASTM testing requirements identified by the applicant are sufficient to ensure resistance to brittle fracture during operation. Therefore, the staff determined that the information provided by the applicant was sufficient to show that the materials used storage, canister transfer and canister handling systems are tested to quality standards commensurate with the importance to safety of the function to be performed and sufficient to meet the regulatory requirements in 10 CFR 72.122(a). In addition, the staff determined that the information provided by the applicant on the design and performance of the important to safety SSCs was sufficient to meet the regulatory requirements in 10 CFR 72.24(d) and 10 CFR 72.122(b).

10.3.10.2 Performance of Aluminum Components

The SAR incorporates by reference the FSARs and SARs for the canister-based storage systems, transportation casks, transfer casks, HSMs, and vertical concrete overpacks described in SER Table 1-1. In SAR Section 15.1.4, “Canisters and Storage Overpacks,” the applicant stated that the WCS CISF will accept only previously loaded canisters. SAR Appendices A through G, Tables A.3-1 through G.3-1, summarize the principal design criteria for the storage systems incorporated by reference. These tables compare the principal design criteria for the systems and, where necessary, new evaluations provided by the applicant for the conditions of the WCS CISF storage site.

The staff previously reviewed the performance of aluminum components of the approved systems incorporated by reference in the SAR. As noted in Section 10.3.2 “Storage System Design,” the staff reviewed the applicant’s comparison of design parameters for the storage systems incorporated by reference and the new evaluations provided in the WCS CISF SAR and determined that the applicant provided information sufficient to show that the systems incorporated by reference are acceptable for all normal, off-normal, and accident conditions at the WCS CISF site. Therefore, the staff determined that the performance of aluminum components has been adequately considered in the analysis of the system components included in the approved License No. SNM-2510 and CoCs listed in SER Table 1-1, and such components are acceptable for use at the WCS CISF. Therefore, the staff determined that the

information provided by the applicant on the design and performance of the important to safety SSCs of the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(d) and 10 CFR 72.122(b).

10.3.11 Thermal Properties

The SAR incorporates by reference the FSARs and SARs for the canister-based storage systems, transportation casks, transfer casks, HSMs, and vertical concrete overpacks described in SER Table 1-1. In SAR Section 15.1.4, the applicant stated that, because the WCS CISF will accept only previously loaded canisters, the material properties of the system remain unchanged from what the NRC had previously reviewed and approved for the systems incorporated by reference. SAR Appendices A through G, Tables A.3-1 through G.3-1, summarize the principal design criteria for the storage systems incorporated by reference. These tables compare the principal design criteria for the systems and, where necessary, new evaluations provided by the applicant for the conditions of the WCS CISF storage site.

The staff previously reviewed the thermal properties of the materials used in the approved systems incorporated by reference in the SAR. As noted in Section 10.3.2 "Storage System Design," the staff reviewed the applicant's comparison of design parameters for the storage systems incorporated by reference and the new evaluations provided in the WCS CISF SAR and determined that the applicant provided information sufficient to show that the systems incorporated by reference are acceptable for all normal, off-normal, and accident conditions at the WCS CISF site. Based on its prior reviews, the staff determined that the information incorporated by reference was sufficient to show that the NRC canister-based systems are designed, fabricated, erected, and tested to quality standards commensurate with the importance to safety of the function to be performed and sufficient to meet the regulatory requirements in 10 CFR 72.122(a). The staff also determined that the information provided by the applicant on the design and performance of SSCs important to safety for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(d) and 10 CFR 72.122(b). In addition, the staff determined that the information provided by the applicant on the design of the storage systems and the content specifications, which shows that the fuel cladding will be protected during storage against degradation that leads to gross ruptures and will not pose operational safety problems with respect to its removal from storage, was sufficient to meet the regulatory requirements in 10 CFR 72.122(h)(1), 10 CFR 72.122(h)(5), and 10 CFR 72.122(l).

Therefore, the staff determined that the thermal properties of the materials used in the approved systems have been adequately considered in the analysis of the system components included in the approved License No. SNM-2510 and CoCs listed in SER Table 1-1, and the materials are acceptable for use at the WCS CISF.

10.3.12 Radiation Shielding and Criticality Control Materials

The SAR incorporates by reference the FSARs and SARs for the canister-based storage systems, transportation casks, transfer casks, HSMs, and vertical concrete overpacks described in SER Table 1-1. In SAR Section 15.1.4, the applicant stated that, because the WCS CISF will only accept previously loaded canisters, the material properties of the system remain unchanged from what has been previously reviewed and approved for the systems incorporated by reference. SAR Appendices A through G, Tables A.3-1 through G.3-1, summarize the principal design criteria for the storage systems incorporated by reference. These tables compare the principal design criteria for the systems and, where necessary, new evaluations provided by the applicant for the conditions of the WCS CISF storage site.

The staff previously reviewed the radiation shielding and criticality control properties of the materials used in the approved systems incorporated by reference in the SAR. As noted in Section 10.3.2 "Storage System Design," the staff reviewed the applicant's comparison of design parameters for the storage systems incorporated by reference and the new evaluations provided in the WCS CISF SAR and determined that the applicant provided information sufficient to show that the systems incorporated by reference are acceptable for all normal, off-normal, and accident conditions at the WCS CISF site. Therefore, the staff determined that the information provided by the applicant on the design of the storage systems, including the criticality control and radiation shielding materials, was sufficient to meet the regulatory requirements in 10 CFR 72.124(b) and 10 CFR 72.128(a). Therefore, the staff determined that the properties for the radiation shielding and criticality control materials used in the approved systems have been adequately considered in the analysis of the system components included in the approved License No. SNM-2510 and CoCs listed in SER Table 1-1, and the materials are acceptable for use at the WCS CISF.

10.3.13 Concrete and Reinforcing Steel

The SAR incorporates by reference the FSARs and SARs for the canister-based storage systems, transportation casks, transfer casks, HSMs, and vertical concrete overpacks described in SER Table 1-1. In SAR Section 15.1.4, the applicant stated that, because the WCS CISF will accept only previously loaded canisters, the material properties of the system remain unchanged from what has been previously reviewed and approved in the systems incorporated by reference. SAR Appendices A through G, Tables A.3-1 through G.3-1, summarize the principal design criteria for the storage systems incorporated by reference. These tables compare the principal design criteria for the systems and, where necessary, new evaluations provided by the applicant for the conditions of the WCS CISF storage site.

For the NUHOMS-based storage systems, the concrete pad structures are described in SAR Appendix A, Section A.4.1, for the NUHOMS Model 80 used for the NUHOMS-MP187 multi-purpose cask system; Appendix B, Section B.4.1, for the NUHOMS AHSM used for the 24PT1 DSC in the Standardized Advanced NUHOMS system; Appendix C, Section C.4.1, for the NUHOMS HSM model 102 used for the 61BT DSC in the Standardized NUHOMS system; and Appendix D, Section D.4.1 1, for the NUHOMS HSM Model 102 used for the 61BTH DSC in the Standardized NUHOMS system. For all NUHOMS-based systems, the applicant has clarified in the respective SAR sections that the basemat and approach slabs are not important to safety.

The applicant provided operating function and design description information on the HSM models in SAR Appendices A through D, Sections A.4.2, B.4.2, C.4.2, and D.4.2, respectively. All HSM designs are considered quality category B components. The applicant provided design and construction codes for the HSMs in SAR Section 15.2.2, "Storage Overpacks." In addition, the applicant included TS 5.3 for concrete testing of the HSM, stating that concrete shall be tested during the fabrication process for elevated temperatures to verify that there are no significant signs of spalling or cracking and that the concrete compressive strength is greater than that assumed in the structural analysis.

For the NAC storage systems, the applicant summarized the materials, welding, construction, and quality assurance specifications for the VCCs in the appendices for each system. SAR Appendices E, F, and G, Tables E.4-2, F.4-1, and G.4-1, summarize the NAC-MPC, NAC-UMS, and NAC MAGNASTOR systems, respectively.

In SAR Section 15.3.1, the applicant included material specifications and required material properties for the important-to-safety storage pad that will be used for the NAC system canisters in. The applications provided specifications and material properties for ASTM C150 Type II Portland Cement and ASTM A615/615M Grade 60 carbon steel reinforcing bar. The applicant also included the storage pad design and construction requirements in SAR Appendices E, F, and G, Tables E.4-1, F.4-2, and G.4-2, for the NAC-MPC, NAC-UMS, and NAC MAGNASTOR systems, respectively.

The staff previously reviewed the concrete and reinforcing steel materials used in the approved systems incorporated by reference in the SAR. The staff reviewed the specification summaries for the VCCs and determined that the applicant provided complete and accurate information for the materials, welding, construction, and quality assurance specifications for the VCCs. The NRC reviewed the material specifications included in SAR Section 15.3.1. The staff reviewed the design descriptions for the HSMs and VCCs in SAR Section 15.2.2 and TS 5.3 for the HSM concrete testing. Staff review of the concrete structures at the WCS CISF is included in Section 5.3.2, "Reinforced Concrete Structures Important to Safety." Based on its prior reviews, the staff determined that the information incorporated by reference was sufficient to show that the NRC-approved canister-based systems are designed, fabricated, erected, and tested to quality standards commensurate with the importance to safety of the function to be performed and sufficient to meet the regulatory requirements in 10 CFR 72.122(a). Therefore, the staff determined that the properties of the concrete and steel reinforcing materials used in the approved systems have been adequately considered in the analysis of the system components included in the approved License No. SNM-2510 and CoCs listed in SER Table 1-1, and the materials are acceptable for use at the WCS CISF.

10.3.14 Bolt and Seal Materials

The SAR incorporates by reference the FSARs and SARs for the canister-based storage systems, transportation casks, transfer casks, HSMs, and vertical concrete overpacks described in SER Table 1-1. In SAR Section 15.1.4, the applicant stated that, because the WCS CISF will use only NRC-approved systems, the material properties of bolts used in these systems remain unchanged from what has been previously reviewed and approved in the systems incorporated by reference. Tables A.3-1 through G.3-1 in SAR Appendices A through G summarize the principal design criteria for the storage systems incorporated by reference. These tables compare the principal design criteria for the systems and, where necessary, new evaluations provided by the applicant to the conditions of the WCS CISF storage site.

The staff previously reviewed bolt applications and materials used in the approved systems incorporated by reference in the SAR. As noted in Section 10.3.2 "Storage System Design," the staff reviewed the applicant's comparison of design parameters for the storage systems incorporated by reference and the new evaluations provided in the WCS CISF SAR and determined that the applicant provided information sufficient to show that the systems incorporated by reference are acceptable for all normal, off-normal, and accident conditions at the WCS CISF site. Based on its prior reviews, the staff determined that the information incorporated by reference was sufficient to show that the NRC-approved canister-based systems are designed, fabricated, erected, and tested to quality standards commensurate with the importance to safety of the function to be performed and sufficient to meet the regulatory requirements in 10 CFR 72.122(a). In addition, the staff determined that the information provided by the applicant on the design and performance of SSCs important to safety for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(d) and 10 CFR 72.122(b). Therefore, the staff determined that the bolt and seal applications and the

properties of the bolting materials and seal used in the approved systems have been adequately considered in the analysis of the system components included in the approved License No. SNM-2510 and CoCs listed in SER Table 1-1, and the materials are acceptable for use at the WCS CISF.

10.3.15 Corrosion Resistance and Coatings

The SAR incorporates by reference the FSARs and SARs for the canister-based storage systems, transportation casks, transfer casks, HSMs, and vertical concrete overpacks described in SER Table 1-1. In SAR Section 15.1.4, the applicant stated that the WCS CISF will only accept previously loaded canisters and will use NRC-approved systems. The applicant stated that the WCS CISF systems will use the specified materials, and the material properties of the systems remain unchanged from what has been previously reviewed and approved in the systems incorporated by reference. SAR Appendices A through G, Tables A.3-1 through G.3-1, summarize the principal design criteria for the storage systems incorporated by reference. These tables compare the principal design criteria for the systems and, where necessary, new evaluations provided by the applicant for the conditions of the WCS CISF storage site.

The staff previously reviewed the materials used in the approved systems incorporated by reference in the SAR. As noted in Section 10.3.2 "Storage System Design," the staff reviewed the applicant's comparison of design parameters for the storage systems incorporated by reference and the new evaluations provided in the WCS CISF SAR and determined that the applicant provided information sufficient to show that the systems incorporated by reference are acceptable for all normal, off-normal, and accident conditions at the WCS CISF site. Therefore, the staff determined that the information provided by the applicant on the design and performance of SSCs important to safety for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(d), 10CFR 72.120(d), and 10 CFR 72.122(b). Therefore, the staff determined that the corrosion resistance of materials and the properties of coatings used in the approved systems have been adequately considered in the analysis of the system components included in the approved License No. SNM-2510 and CoCs listed in SER Table 1-1, and such materials are acceptable for use at the WCS CISF.

10.3.16 Content Reactions

The applicant stated that no additional loading or handling of spent fuel or stored contents will take place at the WCS CISF. In SAR Section 15.1.4, the applicant stated that the WCS CISF will only accept previously loaded canisters and will use NRC-approved systems. The SAR incorporates by reference the canister-based storage systems, transportation casks, transfer casks, HSMs, and vertical concrete overpacks described in SER Table 1-1. The applicant also provided the procedure that will be used to test the canisters for leak tightness, which provides assurance that the inert helium environment inside the canisters is maintained. The applicant has also stated that approved aging management programs (AMPs) applicable to all systems in the period of extended operation will be incorporated through amendments.

The staff previously reviewed the potential for content reactions, including the generation of hydrogen, during loading operations in the approved systems incorporated by reference in the SAR. Because the staff's previous assessment adequately considered in the analysis of the system components included in the approved License No. SNM-2510 and CoCs listed in SER Table 1-1, the staff determined that the previously approved storage systems referenced are acceptable for use at the WCS CISF. In addition, the staff determined that the potential for detrimental content reactions is not possible at the WCS CISF because (1) no new systems will be loaded at the WCS CISF, (2) all previously loaded storage canisters will be tested to verify

that the canisters are leak tight, and (3) approved AMPs applicable to all systems in the period of extended operation will be incorporated through amendments to ensure that the canister contents will be maintained in an inert environment. Therefore, the staff determined that the information provided by the applicant on the design and performance of SSCs important to safety for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.120(d) and 10 CFR 122(h)(1).

10.3.17 Management of Aging Degradation

The SAR incorporates by reference the canister-based storage systems, transportation casks, transfer casks, HSMs, and vertical concrete overpacks described in SER Table 1-1. In SAR Section 1.1, the applicant stated that any canisters stored at the WCS CISF will have been loaded under these previously approved NRC CoCs and licenses, and their “time in service” clock for triggering the implementation of required AMP activities will have begun at the time of loading for each individual canister. The applicant stated that as these systems approach 20 years of service time, their applications for renewal, including AMP requirements, will be submitted to the NRC for review and approval. For the AMPs that will be included in the renewal of NAC systems, including CoC No. 1015, CoC No. 1025, and CoC No. 1031, the applicant proposed a license condition to incorporate the required aging management activities for all applicable NAC spent fuel canisters and storage overpacks into the WCS CISF license within 120 days of the effective date of the renewal authorization system’s CoC, or within 120 days of the effective date of this license, whichever is later.

The applicant noted that CoC No. 1004 was renewed for an additional 40 years. At the time of the submittal, the applicant noted that the NRC was reviewing applications for license renewal for License No. SNM-2510, which uses the NUHOMS-MP187 multi-purpose cask and CoC No. 1029, for an additional 40 years. The applicant provided an aging management review (AMR) for the components of these systems that are proposed to be relocated to the WCS CISF site. The applicant conducted the AMR for the relevant components included in the NUHOMS-MP187 multi-purpose cask and CoC No. 1029 using the specific system designs and considered the materials, operating environments, and safety functions of the systems SSCs. Based on the results of the AMR, the applicant assessed the aging management activities for the NUHOMS-MP187 multi-purpose cask and CoC No. 1029 system. This included a review of existing time-limited aging analyses (TLAAs) applicable to each system and application of the AMPs developed for the CoC No. 1004 renewal.

The staff reviewed the information provided by the applicant, including the information incorporated by reference for the NRC-approved storage system designs that are in use at both generally licensed and specific ISFSIs listed in SER Table 1-1. The staff also reviewed the applicant’s approach to incorporating through amendments and implementing required aging management activities including AMPs and TLAAs when the important-to-safety SSCs enter the period of extended operation. The staff reviewed the approach taken to implement AMP requirements for canisters based on the time of loading for each individual canister. The staff determined that the approach taken by the applicant is consistent with the regulatory requirements for aging management activities for important-to-safety SSCs in the period of extended operation and is acceptable for the WCS CISF. Therefore, the staff determined that the information provided by the applicant on the design, maintenance, and monitoring of the important to safety SSCs were sufficient to meet the regulatory requirements in 10 CFR 72.120(a), 10 CFR 122(h)(1), and 10 CFR 72.128(a).

10.3.17.1 Aging Management Review

The applicant used the AMRs conducted for the CoC No. 72-1004 Standardized NUHOMS system renewal. The applicant provided tables to document the applicability of the CoC No. 1004 AMRs for the various subcomponents of the other NUHOMS-based systems, including the NUHOMS-MP187 multi-purpose cask, to the FO, FC, FF, and GTCC DSCs currently in service at the Rancho Seco ISFSI, and the CoC No. 1029 Standardized Advanced NUHOMS system with the 24PT1 DSCs in service at the San Onofre Nuclear Generating Station ISFSI. The applicant provided a justification for the applicability of the CoC No. 1004 AMPs for the NUHOMS-MP187 multi-purpose cask to the FO, FC, FF, and GTCC DSCs; the CoC No. 1029 24PT1 DSCs; and the AHSM. The applicant's justification was based on the AMRs for each DSC type and the AHSM and included an assessment of the materials of construction, the operating environment, and the safety functions. The applicant identified TLAAAs and AMPs applicable to the NUHOMS systems. The following sections include a detailed summary of the TLAAAs and AMPs and the staff's review of these aging management activities.

The staff reviewed the applicant's AMR using the guidance in NUREG-1927, Revision 1, "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel," issued June 2016. The staff compared the results of the applicant's AMR to the guidance in NUREG-2214, "Managing Aging Processes In Storage (MAPS) Report," issued July 2019. The staff determined that the applicant's AMR was acceptable because it follows the guidance in NUREG-1927, Revision 1, and the results of the applicant's AMR are consistent with the guidance in NUREG-2214. Therefore, the staff determined that the information provided by the applicant on the design, maintenance, and monitoring of the important to safety SSCs were sufficient to meet the regulatory requirements in 10 CFR 72.120(a), 10 CFR 122(h)(1), and 10 CFR 72.128(a).

10.3.17.2 Time-Limited Aging Analysis

The applicant reviewed the TLAAAs included in the renewal applications for the Rancho Seco ISFSI, the CoC No. 1029 Standardized Advanced NUHOMS system, and the CoC No. 1004 Standardized NUHOMS system.

For the Rancho Seco ISFSI renewal NUHOMS-MP187 multi-purpose cask, in SAR Appendix A, Section A.13.2, "Time Limited Aging Analyses," the applicant stated that the following TLAAAs were credited with managing aging effects during the period of extended operation:

- fatigue evaluation of the DSCs
- boron depletion of the neutron poison plates

The applicant stated that the analysis performed to determine the amount of boron depletion in the FO and FC DSC boron-containing poison plates was for a total of 100 years. The applicant stated that the analysis of the boron-containing poison plates was valid for the WCS CISF. The applicant stated that the fatigue evaluation for the NUHOMS-MP187 multi-purpose cask DSCs was revisited to address the actions and loadings associated with the transportation of the DSC from the original ISFSI to the WCS CISF. In SAR Appendix C, Section C.13.2, "Time Limited Aging Analyses," the applicant provided a revised fatigue TLAA for all DSCs, including the NUHOMS-MP187 multi-purpose cask DSCs from the Rancho Seco ISFSI.

For the CoC No. 1029 Standardized Advanced NUHOMS system, in SAR Appendix B, Section B.13.2, "Time Limited Aging Analyses," the applicant stated that the following TLAAs were credited with managing aging effects during the period of extended operation:

- boron depletion in the BORAL® plates in the 24PT1 DSCs
- fatigue evaluation of the DSCs
- irradiation embrittlement of metals in 24PT1
- irradiation effects on the concrete in the AHSM
- establishment of cladding temperature limits for fuel stored in the 24PT1 DSC

The applicant stated that only the following TLAAs did not bound the period of extended operation and were updated in the CoC No. 1029 renewal:

- fatigue analyses for the 24PT1 DSC shells
- irradiation embrittlement of metals in the 24PT1 DSC
- irradiation effects on the concrete in the AHSM

The applicant stated that the CoC No. 1029 renewal describes an analysis that demonstrates that the irradiation embrittlement of metals in the 24PT1 DSCs and the irradiation effects on the concrete in the AHSM will not lead to a loss of intended safety functions for a 100-year service life. In SAR Appendix C, Section C.13.2, the applicant provided a revised fatigue TLAA for all DSCs, including the 24PT1 DSCs from the CoC No. 1029 Standardized Advanced NUHOMS system.

For the CoC No. 1004 Standardized NUHOMS system, in SAR Appendix C, Section C.13.2, and SAR Appendix D, Section D.13.2, "Time Limited Aging Analyses," the applicant stated that the following TLAAs were credited with managing aging effects during the period of extended operation:

- fatigue evaluation of the DSCs
- boron depletion of the neutron poison plates
- evaluation of neutron fluence and gamma radiation on storage system structural materials

The applicant stated that the analysis performed to determine the amount of boron depletion in the boron-containing poison plates of the DSC in the CoC No. 1004 Standardized NUHOMS system was for a period of 100 years. The applicant stated that the analysis of the boron-containing poison plates was valid for the WCS CISF. The applicant stated that the CoC No. 1004 renewal describes an analysis that demonstrates that the irradiation embrittlement of metals in the 61BT and 61BTH DSCs and the irradiation effects on the concrete in the HSM will not lead to a loss of intended safety functions for a 100-year service life.

In SAR Appendix C, Section C.13.2, the applicant provided a revised fatigue TLAA for all DSCs, including the 61BT and 61BTH DSC from the CoC No. 1004 Standardized NUHOMS system. The applicant's revised TLAA considers the updated TLAAs conducted for renewals of the Rancho Seco ISFSI, CoC No. 1029, and CoC No. 1004. In addition, the applicant also considered the operations necessary to relocate the existing DSC at the current ISFSI locations to the proposed WCS CISF. These operations included transferring the DSCs to the NRC-approved transportation systems, transporting the DSCs to the WCS CISF, leak testing the DSCs, and transferring the DSCs from the transportation system to the HSMs. In the

evaluation, the applicant addressed the effects of the transportation and transfer operations to determine whether fatigue effects needed to be specifically evaluated in accordance with the six criteria in ASME B&PV Code, Section III, Division 1, Subsection NB 3222.4(d). The applicant stated that the previous TLAA's showed that all six criteria were satisfied; therefore, evaluation of fatigue effects was not required.

Considering the effects of the transportation and transfer operations, the applicant determined that no revisions to the existing fatigue analysis were necessary to address the following criteria in ASME B&PV Code, Section III, Division 1, Subsection NB 3222.4(d):

- Criterion #1, "Atmospheric to Service Pressure Cycle"
- Criterion #2, "Normal Service Pressure Fluctuation"
- Criterion #4, "Temperature Difference—Normal Service"
- Criterion #5, "Temperature Difference—Dissimilar Materials"

The applicant updated the evaluation to address the effects of transportation and transfer operations on ASME B&PV Code, Section III, Division 1, Subsection NB 3222.4(d), Criterion #3, "Temperature Difference—Startup and Shutdown," stating that the transfer and transportation loads cause one additional cycle due to removal from the existing HSM and loading into the HSM at the WCS CISF facility. The applicant determined that the updated evaluation considering the effects of transfer and transportation operations still satisfied the requirements of Criterion #3.

The applicant updated the evaluation to address the effects of transportation and transfer operations on ASME B&PV Code, Section III, Division 1, Subsection NB 3222.4(d), Criterion #6, "Mechanical Loads." The applicant stated that for storage loads, the existing evaluation conservatively considers 2,000 cycles of handling loads for the bounding service life of 100 years. The applicant revised the assessment transportation loads to consider the effects of vibration and shock. For the vibration loads, the applicant's assessment conservatively used the analysis in ANSI N14.23-1980, "Design Basis for Resistance to Shock and Vibration of Radioactive Material Packages Greater than One Ton in Truck Transport." For shock loads, the applicant's assessment conservatively used the analysis in NUREG-766510, "Shock and Vibration Environments for Large Shipping Containers on Rail Cars and Trucks," issued July 1977. For both vibration and shock loads, the applicant assumed a travel distance of 5,000 miles. The applicant determined that the updated evaluation considering the effects of transfer and transportation operations still satisfied the requirements of Criterion #6.

The applicant determined that the all six criteria in ASME B&PV Code, Section III, Division 1, Subsection NB 3222.4(d), remained satisfied after considering the specific effects of transfer and transportation operations. Because all six criteria were satisfied, the applicant determined that specific fatigue evaluations of the DSCs were not required.

The staff reviewed the applicant's evaluation of TLAA's included in the renewal applications for the Rancho Seco ISFSI, the CoC No. 1029 Standardized Advanced NUHOMS system, and the CoC No. 1004 Standardized NUHOMS system. The staff reviewed the applicant's assessment of TLAA's that did not require additional analysis to be used at the WCS CISF. The staff determined that the applicant's assessment of these TLAA's was acceptable because the TLAA's (1) were either originally evaluated for 100 years or were updated in the renewal application for a period of 100 years and (2) were not affected by the proposed transfer and transportation operations necessary to relocate the DSCs to the WCS CISF. The staff reviewed the applicant's revised TLAA for fatigue of the DSCs. The staff determined that the revised TLAA was acceptable because the applicant considered the potential effects of transfer and

transportation operations on all six criteria included in ASME B&PV Code, Section III, Division 1, Subsection NB 3222.4(d), and all six criteria were satisfied with the revised TLAA. The staff notes that the applicant revised the assessment for Criterion #3 to account for the additional cycle due to removal from the existing HSM and loading into the HSM at the WCS CISF facility. The staff also notes that the applicant's revised assessment for Criterion #6 conservatively assessed shock and vibration loads. Therefore, the staff determined that the information provided by the applicant on the design and performance of SSCs important to safety for the storage systems was sufficient to meet the regulatory requirements in 10 CFR 72.24(d) and 10 CFR 72.120(a).

10.3.17.3 Aging Management Programs

The applicant described the AMPs applicable to the NUHOMS-MP187 multi-purpose cask currently used at the Rancho Seco ISFSI, the CoC No. 1029 Standardized Advanced NUHOMS system, and the CoC No. 1004 Standardized NUHOMS system in SAR Appendix C, Section C.13.3, "Aging Management Programs." The applicant stated that the purpose of the AMPs is to ensure that aging effects do not result in a loss of intended function of the SSCs. The applicant stated that the AMPs are based on the results of the AMRs for the DSCs, HSMs, and concrete basemat.

The staff reviewed the AMPs provided by the applicant and confirmed that the AMPs for these storage systems were based on the AMPs provided to support the renewal of the CoC No. 1004 Standardized NUHOMS system and previously reviewed by the staff. The staff confirmed that the structure of the AMPs is consistent with the 10 program elements described in NUREG-1927, Revision 1. The sections below describe these AMPs and the associated staff reviews.

10.3.17.3.1 Dry Storage Cask External Surfaces Aging Management Program

The applicant stated that the DSC External Surfaces AMP applies to all DSCs except those for which the AMP for aging management of the effects of chloride-induced stress-corrosion cracking (CISCC) applies. The applicant stated that the AMP includes visually inspecting and monitoring the external surfaces of the DSC that may be subject to loss of material and cracking. The applicant stated that a minimum of one DSC from each originating ISFSI is selected for inspection. Based on its review, the staff noted that the applicant provided the following information for the 10 AMP elements:

- Scope of Program—This element describes the DSC materials, operating environments for the components, areas of inspection, and aging effects managed by the AMP.
- Preventive Actions—This element is not applicable. The DSC External Surfaces AMP is a condition-monitoring AMP.
- Parameters Monitored or Inspected—Visual inspections monitor for material degradation of the DSC shell assembly, including welds, weld heat affected zones, and crevice locations.
- Detection of Aging Effects—This element includes inspection methods, inspection frequency, and personnel qualification.
- Monitoring and Trending—A baseline inspection is performed as part of the monitoring and trending activities so that the inspection results can be used for subsequent

trending. Monitoring is conducted in accordance with the provisions of the TN Americas 10 CFR Part 72, "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater than Class C Waste," Subpart G, "Quality Assurance," program in the AMP element. The applicant has adopted the TN Americas program and is responsible for implementing it.

- **Acceptance Criteria**—Specific acceptance criteria are provided and reference the applicable ASME B&PV Code, Section XI, for conducting VT-1 and VT-3 inspections.
- **Corrective Actions**—This element provides details of actions to be taken, including the disposition of canisters with aging effects and extent of condition assessments if the acceptance criteria are not met.
- **Confirmation Process**—Confirmatory actions are implemented as part of the TN Americas corrective action program in the AMP element.
- **Administrative Controls**—The TN Americas quality assurance procedures and corrective action program provide a formal review and approval process.
- **Operating Experience**—This element describes the Calvert Cliffs Nuclear Power Plant ISFSI inspection and results. It outlines the process and describes how future operating experience will be incorporated to have a learning AMP.

The staff reviewed the AMP provided by the applicant and the AMR for the NUHOMS-MP187 multi-purpose cask currently used at the Rancho Seco ISFSI, the CoC No. 1029 Standardized Advanced NUHOMS system, and the CoC No. 1004 Standardized NUHOMS system, which the applicant identified as the basis for the DSC External Surfaces AMP. The staff compared the AMP provided by the applicant to the AMP used to support the CoC No. 1004 Standardized NUHOMS system renewal and the staff's previous review of the CoC No. 1004 renewal. In addition, the staff reviewed the guidance in NUREG-1927, Revision 1, and NUREG-2214, Table 6-2, "Example Aging Management Program for Localized Corrosion and Stress Corrosion Cracking of Welded Stainless Steel Dry Storage Canisters." The staff determined that the DSC External Surfaces AMP was acceptable because the AMP provided by the applicant (1) is applicable to all of the NUHOMS systems, (2) follows the guidance provided in NUREG-1927 and includes all of the information recommended for each AMP element, and (3) is consistent with the example AMP included in NUREG-2214. Therefore, the staff determined that the information provided by the applicant on the design, maintenance, and monitoring of the important to safety SSCs was sufficient to meet the regulatory requirements in 10 CFR 72.120(a), 10 CFR 122(h)(1), and 10 CFR 72.128(a).

10.3.17.3.2 Dry Storage Cask Aging Management Program for the Effects of Chloride-Induced Stress-Corrosion Cracking

The applicant stated that the DSC AMP for the CISCC is applicable to DSCs from ISFSIs that may have sufficient atmospheric chlorides to initiate CISCC. The applicant stated that a site-specific applicability evaluation is performed to determine whether this AMP is applicable to the DSC. The applicant stated that the AMP visually inspects and monitors the external surfaces of the DSC that may be subject to loss of material and cracking. The applicant stated that a minimum of one DSC from each originating ISFSI is selected for inspection. Based on its review, the staff noted that the applicant provided the following information for the 10 AMP elements:

- **Scope of Program**—This element describes the DSC materials, operating environments for the components, areas of inspection, and aging effects managed by the AMP.
- **Preventive Actions**—This element is not applicable. The DSC CISCC AMP is a condition-monitoring AMP.
- **Parameters Monitored or Inspected**—Visual inspections monitor for material degradation of the DSC shell assembly, including welds, weld heat affected zones, and crevice locations. Chloride salts on the surfaces of selected DSC shell or shells are collected and measured.
- **Detection of Aging Effects**—This element includes inspection methods, inspection frequency, and personnel qualification.
- **Monitoring and Trending**—A baseline inspection is performed as part of the monitoring and trending activities so that the inspection results can be used for subsequent trending. Monitoring is conducted in accordance with the provisions of the TN Americas 10 CFR Part 72, Subpart G, program in the AMP element.
- **Acceptance Criteria**—Specific acceptance criteria are provided and reference the applicable ASME B&PV Code, Section XI, for conducting VT-1 and VT-3 inspections.
- **Corrective Actions**—This element details actions to be taken, including the disposition of canisters with aging effects and extent of condition assessments if the acceptance criteria are not met.
- **Confirmation Process**—Confirmatory actions are implemented as part of the TN Americas corrective action program in the AMP element.
- **Administrative Controls**—The TN Americas quality assurance procedures and corrective action program provide a formal review and approval process.
- **Operating Experience**—This element describes the Calvert Cliffs ISFSI inspection and results. It outlines the process and describes how future operating experience will be incorporated to have a learning AMP.

The staff reviewed the AMP provided by the applicant along with the AMR for the NUHOMS-MP187 multi-purpose cask currently used at the Rancho Seco ISFSI, the CoC No. 1029 Standardized Advanced NUHOMS system, and the AMR for the CoC No. 1004 Standardized NUHOMS system, which the applicant identified as the basis for the DSC CISCC AMP. The staff compared the AMP provided by the applicant to the AMP used to support the CoC No. 1004 Standardized NUHOMS system renewal and the previous staff review. In addition, the staff reviewed the guidance in NUREG-1927, Revision 1, and NUREG-2214, Table 6-2. The staff determined that the DSC CISCC AMP was acceptable because the AMP provided by the applicant (1) is applicable to all of the NUHOMS systems, (2) follows the guidance provided in NUREG-1927 and includes all of the information recommended for each AMP element, and (3) is consistent with the example AMP included in NUREG-2214. Therefore, the staff determined that the information provided by the applicant on the design, maintenance, and monitoring of the important to safety SSCs was sufficient to meet the regulatory requirements in 10 CFR 72.120(a), 10 CFR 122(h)(1), and 10 CFR 72.128(a).

10.3.17.3.3 Horizontal Storage Module Aging Management Program for External and Internal Surfaces

The applicant stated that the HSM AMP includes visual inspection of accessible concrete and steel components, including the HSM walls, roof, and floor slab (if applicable); HSM access door; DSC support structure and rail assembly; heat shields; air inlet and outlet vents; embedments and anchorages; and ISFSI storage pad for evidence of concrete degradation. Based on its review, the staff noted that the applicant provided the following information for the 10 AMP elements:

- Scope of Program—This element describes HSM materials, operating environments, components covered by the AMP, and aging effects managed by the AMP.
- Preventive Actions—This element is not applicable. The HSM AMP is a condition monitoring AMP.
- Parameters Monitored or Inspected—This element describes inspection of concrete; structural steels including carbon steel, coated carbon steel, and stainless steel; and aluminum components commensurate with industry codes, standards, and guidelines; and monitoring of groundwater chemistry.
- Detection of Aging Effects—This element includes inspection methods, inspection frequency, and personnel qualification.
- Monitoring and Trending—A baseline inspection is performed as part of the monitoring and trending activities so that the inspection results can be used for subsequent trending. Monitoring is conducted in accordance with the provisions of the TN Americas 10 CFR Part 72, Subpart G, program in the AMP element.
- Acceptance Criteria—Specific acceptance criteria are provided and reference applicable ACI, ANSI, American Society of Civil Engineers, ASME B&PV Code, and American Institute of Steel Construction specifications.
- Corrective Actions—Deficiencies are either corrected or evaluated to be acceptable for continued service through engineering analysis and include root cause determinations for preventing recurrence if the acceptance criteria are not met.
- Confirmation Process—Confirmatory actions are implemented as part of the TN Americas corrective action program in the AMP element.
- Administrative Controls—The TN Americas quality assurance procedures and corrective action program provide a formal review and approval process.
- Operating Experience—This element cites Information Notice 2013-07, “Premature Degradation of Spent Fuel Storage Cask Structures and Components from Environmental Moisture,” dated April 16, 2013, which describes the operating experience on NUHOMS HSMs installed at the Three Mile Island Nuclear Station, Unit 2, ISFSI at Idaho National Laboratory. It describes the Calvert Cliffs ISFSI inspection and results. It outlines the process and describes how future operating experience will be incorporated to have a learning AMP.

The staff reviewed the AMP provided by the applicant along with the AMR for the NUHOMS-MP187 multi-purpose cask currently used at the Rancho Seco ISFSI, the CoC No. 1029 Standardized Advanced NUHOMS system, and the AMR for the CoC No. 1004 Standardized NUHOMS system, which the applicant identified as the basis for the HSM AMP. The staff compared the AMP provided by the applicant to the AMP used to support the CoC No. 1004 Standardized NUHOMS system renewal and the staff's previous review. In addition, the staff reviewed the guidance in NUREG-1927, Revision 1, as well as NUREG-2214, Table 6-3 and Table 6-4, "Example Aging Management Program for Monitoring of Metallic Surfaces." The staff determined that the HSM AMP was acceptable because the AMP provided by the applicant (1) is applicable to all of the NUHOMS systems, (2) follows the guidance provided in NUREG-1927 and includes all of the information recommended for each AMP element, and (3) is consistent with the example AMPs included in NUREG-2214. Therefore, the staff determined that the information provided by the applicant on the design, maintenance, and monitoring of the important to safety SSCs was sufficient to meet the regulatory requirements in 10 CFR 72.120(a), 10 CFR 122(h)(1), and 10 CFR 72.128(a).

10.3.18 Spent Fuel

The SAR incorporates by reference the FSARs and SARs for the canister-based storage systems, transportation casks, transfer casks, HSMs, and vertical concrete overpacks described in SER Table 1-1. In SAR Section 15.1.4, the applicant stated that, because the WCS CISF will accept only previously loaded canisters, the canister contents, including spent fuel specifications, classification, and the inert gas backfill of the system, remain unchanged from what has been previously reviewed in the systems incorporated by reference. The applicant also provided the procedure that will be used to test that the canisters remain leak tight, which provides assurance that the inert gas environment inside the canisters is maintained. The applicant also stated that approved AMPs applicable to all systems in the period of extended operation will be incorporated through amendments. The applicant stated that no additional loading or handling of spent fuel or stored contents will take place at the WCS CISF.

The staff previously reviewed the spent fuel specifications of the systems incorporated by reference in the SAR. The staff previously evaluated the spent fuel classification, cover gas specifications, and spent fuel specifications, including cladding alloys, cladding mechanical properties, peak cladding temperature, effect of drying operations, treatment of high-burnup fuel, and the design and contents of damaged fuel cans, included in the approved License No. SNM-2510 and CoCs listed in SER Table 1-1. Therefore, the staff determined that the description of the previously approved storage systems referenced are acceptable for use at the WCS CISF. In addition, the staff determined that the applicant adequately considered the potential for the degradation of spent fuel in the systems to be stored at the WCS CISF because (1) no new systems will be loaded at the WCS CISF, (2) all previously loaded storage canisters will be tested to verify that the canister are leak tight, and (3) approved AMPs applicable to all systems in the period of extended operation will be incorporated through amendments. Therefore, the staff determined that the information provided by the applicant on the design, maintenance, and monitoring of the important to safety SSCs was sufficient to meet the regulatory requirements in 10 CFR 72.120(a), 10 CFR 122(h)(1), and 10 CFR 72.128(a).

10.4 Evaluation Findings

The staff makes the following evaluation findings:

- The applicant has met the requirements in 10 CFR 72.24(c)(3) and 10 CFR 72.120(a). The applicant described the materials used for SSCs important to safety in sufficient detail to support a safety finding.
- The applicant has met the requirements in 10 CFR 72.24(d) and 10 CFR 72.128(a). The properties of the materials in the storage facility design have been demonstrated to support the safe storage and handling of storage systems for SNF and reactor-related GTCC waste for the life of the facility under normal, off-normal, and accident conditions.
- The applicant has met the requirements in 10 CFR 72.124(b). Neutron absorbing materials are demonstrated to effectively control criticality without significant degradation over the life of the facility.
- The applicant has met the requirements in 10 CFR 72.120(d), 10 CFR 72.122(b)(1), and 10 CFR 72.124(b). Materials and storage contents are compatible with their operating environment such that there will be no adverse degradation or significant chemical or other reactions.
- The applicant has met the requirements in 10 CFR 72.122(h)(1). The SNF cladding has been demonstrated to be adequately protected against gross ruptures, or the fuel has been demonstrated to be otherwise confined.
- The applicant has met the requirements in 10 CFR 72.122(h)(5) and 10 CFR 72.122(l). The packaging of reactor-related GTCC waste ensures that handling and retrievability is adequately maintained. The storage system is designed to allow ready retrieval of SNF and reactor-related GTCC waste.
- The applicant has met the requirements in 10 CFR 72.24(c)(4) and 10 CFR 72.122(a). The use of codes and standards, quality assurance programs, and control of special processes are demonstrated to be adequate to ensure that the design, testing, fabrication, and maintenance of materials support SSC intended functions.

10.5 References

ACI, "Code Requirements for Nuclear Safety-Related Concrete Structures," ACI 349, issued 1985.

ACI, "Code Requirements for Nuclear Safety-Related Concrete Structures," ACI 349, issued 1997.

ACI, "Building Code Requirements for Structural Concrete," ACI 318, issued 1983.

ACI, "Building Code Requirements for Structural Concrete," ACI 318, issued 1995.

American Welding Society, AWS D1.1-1996, "Structural Welding Code," 1996.

ANSI, "Design Basis for Resistance to Shock and Vibration of Radioactive Material Packages Greater than One Ton in Truck Transport," Draft American National Standard N14.23, American National Standards Institute, Washington, DC, 1980.

ANSI, "American National Standard for Radioactive Materials – Leakage Tests on Package for Shipment," N 14.5-1997 American National Standards Institute, New York, NY, 1997

ANSI, "Special Lifting Devices for Shipping Containers Weighing 10 000 Pounds (4500 kg) or More," N14.6-1993, American National Standards Institute, New York, NY, 1993.

AREVA, Inc., "NUHOMS®-MP197 Transport Packaging Safety Analysis Report," Revision 17, April 2001 (nonpublic). NRC Docket No. 71-9302. Transmittal dated July 20, 2016. Agencywide Documents Access and Management System (ADAMS) Accession No. ML16207A498.

AREVA, Inc., "Updated Final Safety Analysis Report for the Standardized Advanced NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 6, August 2014 (nonpublic). NRC Docket No. 72-1029. Transmittal dated July 13, 2016. ADAMS Accession No. ML16200A178.

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11 CONDUCT OF OPERATIONS EVALUATION

In Chapter 13, "Conduct of Operations," of its safety analysis report (SAR), Interim Storage Partners LLC (ISP or the applicant) described the organization for the design, fabrication, construction, testing, operation, modification, and decommissioning of the proposed WCS Consolidated Interim Storage Facility (CISF). The applicant included descriptions of the organizational structure, personnel responsibilities and qualifications, and interface with contractors and other outside organizations, as well as a quality assurance (QA) plan and an emergency response plan. Separate from its application, the applicant provided a physical security plan (PSP), a safeguards contingency plan, and a security training and qualification plan. The applicant stated that the radiation safety plan and environmental monitoring described in SAR Chapter 9, "Radiation Protection," will be adopted or adapted to ensure the safe operation and maintenance of the WCS CISF under Title 10 of the *Code of Federal Regulations* (10 CFR) Part 72, "Licensing requirements for the independent storage of spent nuclear fuel and high-level radioactive waste, and reactor-related greater than Class C waste."

11.1 Scope of Review

The U.S. Nuclear Regulatory Commission (NRC) staff evaluated the applicant's information related to the conduct of operations for the WCS CISF by reviewing the documents cited in or attached to the SAR, the applicant's responses to the staff's requests for supplemental and additional information, and other relevant literature. The staff reviewed this information to determine whether the applicant had described an appropriate infrastructure to manage, test, and operate the facility, including provisions for effective training, emergency planning, and physical security programs.

11.2 Regulatory Requirements

The NRC requirements relevant to the conduct of operations evaluation of the proposed WCS CISF appear in the following sections of Title 10 of the *Code of Federal Regulations* (10 CFR):

- 10 CFR 72.24, "Contents of application: Technical information"
- 10 CFR 72.28, "Contents of application: Applicant's technical qualifications"
- 10 CFR 72.40, "Issuance of license"
- 10 CFR 72.180, "Physical protection plan"
- 10 CFR 72.182, "Design for physical protection"
- 10 CFR 72.184, "Safeguards contingency plan"
- 10 CFR 72.190, "Operator requirements"
- 10 CFR 72.192, "Operator training and certification program"
- 10 CFR 72.194, "Physical requirements"
- 10 CFR 73.51, "Requirements for the physical protection of stored spent nuclear fuel and high-level radioactive waste"
- 10 CFR 73.71, "Reporting of safeguards events"

Additional requirements related to security appear in "Additional Security Measures for Access Authorization and Fingerprinting at Independent Spent Fuel Storage Installations," dated December 19, 2007, and "Additional Security Measures for Independent Spent Fuel Storage Installations," dated September 28, 2007.

11.3 Staff Review and Evaluation

Unless otherwise stated, the staff reviewed and evaluated the applicant's description of the conduct of operations for the proposed site discussed in SAR Chapter 13, Revision 5; documents cited in or attached to the SAR; the applicant's responses to the staff's requests for additional information (RAIs); and the security-related plans submitted separately from the application.

The staff reviewed and evaluated the application's discussion of the proposed organizational structure; pre-operational testing and startup operations; normal operations; personnel selection, training, and certification; emergency planning; physical security plan; security training and qualification plan; and safeguards contingency plan.

11.3.1 Organizational Structure

In SAR Section 13.1, "Organizational Structure," the applicant described the relationship among five entities: Orano CIS Limited Liability Company (LLC) (OCIS), Orano SA, Orano USA LLC (OUSA), TN Americas, LLC, WCS LLC, J.F. Lehman & Company (JFLCO), and ISP LLC.

The applicant described OCIS as the 51-percent parent of ISP and owned 100 percent by OUSA. OUSA's business includes decommissioning activities, support of the U.S. Department of Energy (DOE) laboratory complex, transportation and logistics of materials supporting the nuclear fuel cycle, the supply of components and services related to the storage of used nuclear fuel, and the sale of uranium conversion and enrichment services. Orano SA is the parent of OUSA, and TN Americas LLC is a subsidiary of OUSA that performs transportation and logistics of materials supporting the nuclear fuel cycle and the supply of components and services related to the storage of used nuclear fuel.

The applicant stated that WCS LLC owns and operates facilities in west Texas used in the processing, treatment, storage, and disposal of a range of low-level radioactive, hazardous, toxic, and other wastes. WCS is currently the only facility in the United States that can accept Class A, B, and C low-level radioactive waste for disposal from generators across the United States and provides waste management services to the commercial sector and Federal Government waste generators.

The application stated that JFLCO and its partners recently acquired 100 percent of WCS through a holding company, Fermi Holdings. The application described JFLCO as a private equity firm founded in 1992 that focuses exclusively on investing in companies in the defense, aerospace, and maritime industries and companies using the technical capabilities that originate from these sectors.

Lastly, the applicant described ISP as a joint venture of OCIS (51 percent) and WCS LLC (49 percent). The applicant stated that the sole purpose of ISP is to license, design, construct, and operate the CISF at the WCS site in Andrews, TX. The application further described the ISP organization at the time of filing the revised application as consisting of TN Americas personnel, WCS corporate personnel, WCS CISF personnel, and contracted support for engineering, design and operations, public affairs, and other necessary expertise. The application stated that it will identify additional positions and employees as the project moves through the licensing phases to the operational phase. Before commencing construction, operation, and receipt of licensed material at the WCS CISF, the applicant stated that it expects to enter into a contract(s) with the DOE or other entities that may hold title to the spent fuel and

that will provide the funding for facility construction, operation, and decommissioning, including any fees paid to hosting public entities.

11.3.1.1 Corporate Organization

The staff reviewed the applicant's corporate organization detailed in SAR Section 13.1.1, "Corporate Organization." The applicant identified the ISP Chief Executive Officer (CEO)/President as the executive in charge of ISP, managing all ISP functional areas including those actions necessary to comply with the applicable requirements of 10 CFR Part 72, Subpart G, "Quality Assurance," and 10 CFR Part 71, "Packaging and transportation of radioactive material," Subpart H, "Quality Assurance." The applicant further described the role of the ISP CEO/President is to establish the basic policies of the quality assurance program (QAP). The ISP CEO/President is the highest level of management responsible for ISP policies, goals, and objectives, including the field services and operations and fleet asset management functions associated with storage and transportation systems and other related activities subject to the requirements of the QAP. The application stated that the ISP CEO/President has the authority and reporting responsibility as the Responsible Officer associated with 10 CFR Part 21, "Reporting of defects and noncompliance." The application included the following direct reports to the ISP CEO/President:

- The Director of Quality Assurance has overall responsibility for the implementation of the QAP, including developing, maintaining, and verifying proper implementation of the QAP; setting priorities and objectives; and ensuring activities subject to the requirements of the QAP Description are performed in accordance with the implementing procedures.
- The Chief Engineer, CISF Licensing and Engineering, is responsible for the facility's license and the overall operation and administration of the facility.
- The Chief Financial Officer is responsible for managing budgets, payroll, cash flows, and financial security.
- The Vice President, Legal Services, serves as the liaison with the NRC and other organizations on all legal matters.

The applicant illustrated the organizational structure in SAR Figure 13-1, "ISP Organization Chart."

The application described additional positions in the corporate structure, summarized as follows:

- The Director of Operations/Construction reports to the Chief Engineer, CISF Licensing and Engineering, and is responsible for project personnel scheduling, WCS CISF work activities, operations, maintenance, project management functions, and performance data.
- The Radiation Safety Officer (RSO)/Director of Health and Radiation Safety reports to the Director of Operations/Construction and has a direct line to the ISP CEO/President. This position is responsible for the radiation safety program and (industrial) health and safety program and ensuring compliance with the radioactive materials license(s) and State and Federal regulations related to radiological safety.

- The Training Manager reports to the Director of Operations/Construction and is responsible for staff training and improvement initiatives focused on upgrading performance across the ISP organization.
- The Director of Contracts and Administrative Services reports to the Vice President, Legal Services, and is responsible for records management and quality-related purchasing activities. This position is responsible for negotiating contracts and issuing procurement documents in support of engineering, fabrication, maintenance, testing, and other activities associated with storage and transportation systems and other related activities subject to the requirements of the QAP.

The applicant further described the role of TN Americas and WCS as the contractors for the design, development, construction, operation, and maintenance of the WCS CISF. As the construction contractor for the WCS CISF, the applicant stated that TN Americas will provide an acceptable construction QAP to ISP, and ISP QA staff will perform surveillances and audits of activities required by the construction QAP throughout construction to verify conformance to quality, technical, and regulatory requirements (e.g., design bases, specifications, license conditions). The applicant described its contractors and suppliers of services or items classified as important-to-safety and quality-affecting activities that are preapproved before award according to QA procedures.

The application described the modification of the onsite ISP organization as needed to ensure an appropriate interface with the WCS CISF operating contractor organization to perform the management and oversight functions. With respect to its technical staff, the applicant stated that it includes ISP joint venture member WCS's Andrews County site and corporate personnel, contractor TN Americas, subcontractors, and licensing consultants. The application noted that TN Americas will provide to ISP information on the storage systems and transportation casks necessary to support the licensing, design, construction, operation, and maintenance of the WCS CISF. The applicant stated that ISP personnel will review and approve designs, calculations, and analyses performed by vendors before construction. The applicant noted that information on the actual qualifications, training, and experience of the ISP and contractor staff providing oversight to the design, construction, and operation of the WCS CISF will be maintained on file to demonstrate compliance with the minimum requirements.

Based on its review, the staff finds the applicant's description of its corporate organization complete and adequate because the corporate functions, responsibilities, and authorities related to each aspect of the installation, including interfaces with outside organizations and contractors, are fully described. Therefore, the description meets the requirements of 10 CFR 72.24, 10 CFR 72.28, and 10 CFR 72.40.

11.3.1.2 Onsite Organization

In SAR Section 13.1.2, "Operating Organization, Management, and Administrative Control System," the applicant described its onsite organization, including the Chief Engineer, CISF Licensing and Engineering; the Director of Operations/Construction; the Director of Quality Assurance; the RSO/Director of Health and Radiation Safety; and the WCS CISF and contractor combined organization during the operational phase. The applicant stated that the WCS CISF operations organization will be staffed with technical personnel from the existing ISP joint venture member WCS organization and TN Americas to perform the functions of WCS CISF specialists and key management. The applicant noted that lines of authority, responsibility, and communication will be established and defined for all WCS CISF organization and supporting

positions. The applicant described the responsibility of WCS administrative staff common to the adjacent site facilities for many of the administrative requirements of the WCS CISF, subject to ISP oversight, including the maintenance of records in accordance with conditions of the license. The applicant further stated that contractors may maintain their own personnel functions, services, and records, periodically transferring custody of operating records to ISP as required. The applicant described the WCS CISF Safety Review Committee as responsible for reviewing and advising the ISP CEO/President on matters relating to the safe storage of spent nuclear fuel (SNF). The Safety Review Committee will include at least a chairperson (the Chief Engineer, CISF Licensing and Engineering) and four members. The applicant stated that this committee is responsible for the review of the following:

- proposed changes to the WCS CISF Technical Specifications or the license
- violations of codes, orders, license requirements, or internal procedures and instructions that are related to important-to-safety storage of SNF
- indications of unanticipated deficiencies in any aspect of design or operation of structures, systems, and components (SSCs) that could affect the safe storage of SNF
- significant accidental, unplanned, or uncontrolled radioactive releases, including corrective action to prevent recurrence
- significant operational abnormalities or deviations from normal and expected performance of equipment that affects the safe storage of SNF
- the performance of the corrective action system
- internal and external experience information related to the safe storage of SNF that may indicate areas for improving facility safety
- significant audit findings that affect the safe storage of SNF

The applicant described the role of the Radiation Safety Supervisor, who reports to the RSO/Director of Health and Radiation Safety and is responsible for implementation of the radiation safety program at the WCS CISF. The applicant noted that the Facility Security Officer/Security Manager, who reports to the Director of Operations/Construction, and the security staff personnel will be responsible for WCS CISF security during routine, emergency, and contingency operations. The applicant also described the WCS CISF security organization as establishing formal arrangements, through memoranda of understanding, that will be made with various government law enforcement and emergency response agencies relative to the construction and operation of the WCS CISF.

Based on its review, the staff finds the applicant's description of its onsite organization complete and adequate because it fully covers the onsite personnel functions, responsibilities, and authorities related to each aspect of the installation, including interfaces with outside organizations and contractors. Therefore, the description meets the requirements of 10 CFR 72.24, 10 CFR 72.28, and 10 CFR 72.40.

11.3.2 Pre-operational Testing and Startup Operations

The staff reviewed the information in SAR Section 13.2, “Pre-Operational Testing and Operation,” to determine whether the applicant adequately described its plans for pre-operational testing and initial facility (startup) operations, including all of the necessary tests and provisions for proper evaluation, approval, and use of the test results. The applicant described its testing program as consisting of pre-operational testing before SNF receipt, and operational or startup testing after SNF receipt.

11.3.2.1 Pre-Operational Testing Plan

In a submittal dated April 7, 2020, the applicant provided two draft pre-operational test plans (one for the NUHOMS® systems and one for the NAC systems) specific to operations, transfer operations, and overpack loading and retrieval. The applicant stated that procedures will be developed for conducting tests to ensure that structures, systems, and components satisfactorily perform the required functions to ensure that the WCS CISF has been properly designed. The applicant also stated that the pre-operational test plans, including test summaries for all systems, will be made available to the NRC at least 90 days before the start of testing. Further, the applicant stated that the system for preparing, reviewing, approving, and implementing testing procedures and instructions for WCS CISF operations will be in accordance with written procedures meeting QAP requirements. Changes to, or deviations from, procedures and instructions will be reviewed and approved in accordance with Technical Specifications requirements of the 10 CFR Part 72 license through the 10 CFR 72.48 process.

The staff noted that the safety classification for SSCs for the storage systems and transportation/transfer casks proposed for use at the WCS CISF are the same as those specified in previously approved NRC certificates of compliance or site-specific licenses and incorporated by reference in the application. Further, the staff noted that functional tests of WCS CISF operations, transfer operations, and overpack loading and retrieval will be performed to verify the storage system components (e.g., canisters, casks, transfer systems) can be operated safely and effectively.

Based on its review, the staff finds the applicant’s description of its pre-operational testing (e.g., operations, transfer operations, and overpack loading and retrieval) acceptable because the pre-operational test plan, as described in SAR Section 13.2, includes the necessary tests and provides for proper evaluation, approval, and use of the test results. Further, the applicant has committed to develop test procedures for conducting tests, including operation of the cask handling building and transfer vehicles/crawlers, as well as the associated handling equipment (e.g., lifting equipment), to ensure that structures, systems, and components satisfactorily perform their required functions and that the WCS CISF has been properly designed and constructed and is ready to operate in a manner that protects public health and safety. Controlled, pre-operational test plans, including test summaries for all systems, will be made available to the NRC at least 90 days before the start of testing. Elements listed in the test plans will detail the type of test, the response expected, test acceptance criteria, and the validation method for each component or system tested. The staff’s review found that the SAR describes the program covering pre-operational testing and meets the requirements of 10 CFR 72.24.

11.3.2.2 Startup Plan

The staff noted that the applicant did not describe its startup plan but stated that an operating startup plan will be prepared to implement the procedures necessary for the initial receipt of spent fuel and greater-than-Class-C (GTCC) waste at the WCS CISF site, and the subsequent transfer of the spent fuel and GTCC waste to storage. The applicant stated that the plan will identify specific operations unique to the initial handling of spent fuel and GTCC waste to be placed into storage. The operating startup plan will include reviews and tests of the operating procedures, confirmation of radiation exposure times and received doses, direct measurement of radiation dose rates from transportation and transfer casks and storage systems, evaluation of shielding methods, verification of heat-removing features in accordance with the technical specifications, and notification to the NRC of the first loaded cask placed in storage. Upon completion of the plan, the effectiveness of procedures, actions, and equipment will be evaluated and documented to improve operations for subsequent spent fuel shipments.

In SAR Section 13.2.4, "Operating Startup Plan," the applicant described its commitment to implement an operating startup plan at least 90 days before the receipt and storage of canisterized SNF and GTCC waste at the WCS CISF. In addition, the applicant proposed License Condition 18 to require that the licensee shall submit a startup plan to the NRC at least 90 days before receipt and storage of the material at the facility. The staff finds this acceptable, in part because the description provided by the applicant is consistent with the guidance in NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," issued March 2000, on the elements that a startup plan should include. In addition, the staff shall assess the applicant's startup plan before implementation and the receipt and storage of the material at the facility.

11.3.3 Normal Operations

The staff reviewed SAR Section 13.4, "Facility Operations," to determine whether the applicant adequately described the procedures and recordkeeping in support of normal operations. In addition, the staff reviewed the application to confirm all operations identified in the proposed technical specifications and the operating, maintenance, testing, and surveillance functions important to safety.

11.3.3.1 Procedures

In SAR Section 13.4.1, "Facility Procedures," the applicant described the WCS CISF programs for conducting normal facility operations, including descriptions of procedure and record management programs and the facility review and audit, facility modification management, and employee concerns programs.

The staff noted that the WCS CISF is designed to use storage overpacks that use both horizontal (NUHOMS) and vertical (NAC) storage systems. The applicant stated that the major activities for the horizontal storage systems include receiving the NUHOMS-MP187 and MP197HB transportation casks, lifting the NUHOMS-MP187 and MP197HB casks onto transfer vehicles, moving the casks to the outdoor storage pad, and placing SNF canisters into the NUHOMS horizontal concrete storage vaults. Similarly, the applicant stated that the major activities for the vertical storage systems include the receipt and unloading of transportation casks, the transfer of SNF canisters from transportation casks to the vertical concrete casks, and the transfer and placement of vertical concrete casks on outdoor storage pads. The staff noted that all WCS CISF operations important to safety shall be conducted using detailed

written and approved procedures, all of which will be made available to the NRC before use. The applicant stated that operational testing associated with a particular cask system design shall be performed the first time the cask system is used at the WCS CISF. In addition, the staff noted that testing shall be performed in accordance with the requirements in the cask transportation certificates of compliance; operations steps identified in SAR Chapter 5, "Operation Systems & Procedures," and associated appendices; and the license Technical Specifications requirements.

Based on its review, the staff finds that the applicant adequately described its plan for the conduct of all operations important to safety at the proposed site. The WCS CISF programs include detailed written and approved procedures for major site activities consistent with the certificates of compliance and license Technical Specifications requirements. Therefore, the description meets the requirements of 10 CFR 72.24(h).

11.3.3.2 Records

The staff reviewed the information in SAR Section 13.4.2, "Facility Records," to determine whether the applicant adequately described a management system for maintaining records in which original or reproduced copies of documents are stamped, initialed, signed, or otherwise authenticated and dated by authorized personnel. Computer storage of data may be used.

The applicant described the control of access to and use of the WCS CISF records storage facility. The documents in the records storage system will be legible and the subject identifiable. The applicant stated that the WCS CISF records storage system shall provide for accurate retrieval of information without undue delay. Written instructions on the storage of records in the records storage system will include, but not be limited to, QA requirements; operating records that document principal maintenance, alterations, and additions to facilities; records of off-normal occurrences and events associated with radioactive releases; records for decommissioning; and environmental surveys.

Based on its review, the staff finds the applicant's description of its records management system acceptable because of its commitments to assure proper development, maintenance, and retrieval of records consistent with the requirements of 10 CFR 72.30(f); 10 CFR 72.44, "License conditions"; 10 CFR 72.72(a) and (d); 10 CFR 72.156, "Identification and control of materials, parts, and components"; and 10 CFR 72.174, "Quality assurance records."

11.3.4 Personnel Selection, Training, and Certification

The staff reviewed SAR Section 13.1.3, "Personnel Qualification Requirement," and Section 13.3, "Training Program," to determine whether the applicant identified the organization responsible for personnel selection, training, and certification and described a program to ensure that personnel with responsibilities for functions important to safety will be appropriately qualified and trained. The staff noted that the applicant's training program is in accordance with TN America's LLC, Services Program Manual (SPM) 2.1, "Systematic Approach to Training," Revision 9, dated August 1, 2018. This procedure establishes the guidelines for training and certification and for developing and maintaining a training program consistent with the Institute of Nuclear Power Operations Systematic Approach to Training model.

11.3.4.1 Personnel Organization

The staff reviewed the organization for the design, fabrication, construction, testing, operation, modification, and decommissioning of ISP's WCS CISF in SAR Chapter 13. The applicant described the organizational structure, personnel responsibilities and qualifications, and interface with contractors and other outside organizations. The staff reviewed the minimum qualification requirements for the WCS CISF positions that are important to safety during off-loading, transfer, storage, loading, and other SNF handling operations at the WCS CISF. The staff noted that WCS CISF personnel trained and qualified in accordance with WCS training program will perform or supervise all off-loading, transfer, loading, and other SNF handling operations at the WCS CISF. The staff also reviewed the minimum training and qualification requirements for WCS CISF personnel responsible for operations, radiation safety, QA, maintenance, waste acceptance, and security as well as for the RSO/Director of Health and Radiation Safety. The staff noted that the applicant identified specific technical training modules included in the initial training programs and requirements for continuous training.

The staff noted that ISP will control unescorted access to the WCS CISF and that individuals meeting the unescorted access requirements pursuant to 10 CFR Part 73, "Physical protection of plants and materials," will receive this type of access. The applicant stated that the WCS CISF will use dual authentication identity verification before granting unescorted facility access. Further, the applicant described that procedures will define the WCS CISF clearance and security practices for ensuring that only individuals approved for unescorted access are able to gain such access to the WCS CISF. The applicant stated that individuals requiring unescorted access will complete training followed by a written test, which must be passed at the 80-percent level of competency before unescorted access is allowed into a restricted area.

Based on its review, the staff finds that the applicant has identified an organization responsible for personnel selection, certification, and training consistent with the requirements in 10 CFR 72.28(c) and 10 CFR Part 72, Subpart I, "Training and Certification of Personnel." The SAR provides a general description for the training and qualification of personnel consistent with the Institute of Nuclear Power Operations Systematic Approach to Training model. ISP has revised SAR Section 13.3 to point to the existing training program, SPM 2.1, developed under the governing TN Americas QAP (see SAR Section 1.4.4.3, "Quality Assurance Program"). The staff noted that that training criteria and training program content provide an adequate basis for the training and qualification of personnel. The staff shall verify implementation of the training program before initiation of operations with spent fuels or solidified high-level waste, including completion of staff training and certification before receipt of the radioactive material to be stored.

11.3.4.2 Selection and Training of Security Guards

The staff reviews and evaluates the security organization in Section 11.3.6, "Physical Security and Safeguards Contingency Plans," of this safety evaluation report (SER).

11.3.5 Emergency Planning

This section describes the staff's review and evaluation of the WCS ERP-100, "Consolidated Emergency Response Plan [ERP]," dated February 8, 2019, to determine whether the applicant has established adequate emergency management facilities and procedures to protect workers, the public, and the environment. The regulations in 10 CFR 72.40(a)(11) require that for the issuance of a license, the applicant's emergency plan must comply with the regulatory

requirements for independent spent fuel storage installation emergency plans in 10 CFR 72.32, "Emergency Plan."

The WCS ERP was developed in accordance with Regulatory Guide (RG) 3.67, "Standard Format and Content for Emergency Plans for Fuel Cycle and Materials Facilities," Revision 1, issued April 2011. The NRC outlines the acceptance criteria for the staff's review of the emergency plan in Section 10.5.5, "Emergency Planning," of NUREG-1567, as revised by Spent Fuel Storage and Transportation Interim Staff Guidance 16 (SFST-ISG-16), "Emergency Planning," issued June 2000, and Revision 1 to RG 3.67.

11.3.5.1 Facility Description

The staff reviewed Section 1.0, "Introduction," of the WCS ERP, which describes the licensed activity, facility, site, and area near the site. The WCS ERP also included the following figures:

- Figure 1, "WCS Site Evacuation Plan"
- Figure 2, "Emergency Planning Map-50 Mile Radius"
- Figure 3, "Emergency Planning Map-10 Mile Radius"
- Figure 4, "Detail Map Eunice, New Mexico"
- Figure 5, "Location of the WCS Emergency Operations Center and Emergency Response Vehicle"
- Figure 6, "Site and RCRA [Resource Conservation and Recovery Act] Boundaries"

The staff reviewed the information, which included the following:

- a description of the site location and layout
- a description of the major structures to be located at the site, including the cask storage area and important supporting structures
- locations of population concentrations
- locations of industrial facilities
- identification of primary routes for access by emergency equipment or for evacuation
- locations of fire and police stations, hospitals, and other offsite emergency support organizations
- the types of terrain and the land use patterns around the site

Based on its review, the staff finds that the application contains the necessary information to meet the requirements of 10 CFR 72.32(a)(1) because the WCS emergency plan provides a brief description of the facility and the area near the site.

11.3.5.2 Types of Accidents

The staff reviewed the information in Section 2.0, “Types of Accidents,” of the WCS ERP, which describes the types of accidents that could result in the release of radioactive material, physical locations where they could occur, and how they could occur. The staff reviewed the following accident scenarios of interest to the facility, including the onsite and offsite consequences of potential accidents:

- fire
- explosion
- vehicle or equipment accidents
- natural events (e.g., tornados, lightning, earthquakes)
- blockage of air inlet/outlets
- cask drop accident/vertical concrete overpack tipover

Based on its review, the staff finds that the application contains the necessary information to meet the requirements of 10 CFR 72.32(a)(2) because the WCS emergency plan identifies each type of radioactive materials accident.

11.3.5.3 Classification of Accidents

The staff reviewed Appendix D, “WCS CISF Facility Emergency Action Levels,” of the WCS ERP, which provides a classification system based on emergency action levels that classifies the accidents identified by the applicant and evaluated in SER Section 11.3.5.2. The applicant developed the classification system consistent with the guidance in RG 3.67. In the WCS ERP, the applicant provided emergency action levels that specifically characterize the occurrence of accidents that warrant the declaration of the Unusual Event and Alert classifications.

Based on its review, the staff finds that the information in the application meets the requirements of 10 CFR 72.32(a)(3) because the WCS emergency plan provides a classification system for classifying accidents as Alerts and is consistent with the NRC guidance in RG 3.67.

11.3.5.4 Detection of Accidents

The staff reviewed Section 2.2, “Detection of Accidents,” of the WCS ERP, which describes the emergency monitoring equipment available for personnel and area monitoring. The emergency monitoring equipment is dependent on personnel observation, fire and smoke alarms, and radiation monitoring instrumentation.

Based on its review, the staff finds that the information in the application meets the requirements of 10 CFR 72.32(a)(4) because the WCS emergency plan describes the means for detecting accident conditions.

11.3.5.5 Mitigation of Accident Consequences

The staff reviewed the following information in the WCS ERP related to the mitigation of accident consequences:

- Section 5.3, "Mitigating Actions," describes the equipment, training, and methods to mitigate emergency events, including the fire protection system and equipment to mitigate fires; mitigation of spills, natural events, and injuries; and actions to be taken by trained site personnel to mitigate emergency events.
- Section 5.4, "Protective Actions," describes radiological protective actions to be taken to protect onsite personnel.
- Section 4.9, "Local Off-site Assistance," describes arrangements made for medical and hospital services, firefighters, and local law enforcement.
- Section 6.0, "Emergency Response Equipment and Facilities," describes the response equipment, facilities, and communications equipment that will be available to support mitigation efforts. It also describes the types and locations of the equipment.
- Section 7.5, "Maintenance and Inventory of Emergency Equipment, Instrumentation, and Supplies," describes provisions for inventory and test equipment.

Based on its review, the staff finds that the information in the application meets the requirements of 10 CFR 72.32(a)(5) because the WCS emergency plan briefly describes the means and equipment provided to mitigate the consequences of the accidents in terms of the protection of workers and the program to maintain the equipment provided consistent with the NRC guidance in RG 3.67.

11.3.5.6 Assessment of Releases

The staff reviewed Section 6.0, "Emergency Response Equipment and Facilities," which provides that WCS has a central facility from which management and support personnel carry out coordinated emergency response activities. The Emergency Operations Center (EOC) is equipped with communications and informational materials to carry out the assigned emergency response mission. The primary EOC is the Executive Conference Room located in the southern section of the main Administrative Building. The secondary EOC is the Low-Level Radioactive Waste Administration Building. The primary and secondary EOC will have accident assessment and communication capabilities. The location of an incident and environmental factors determines which EOC is utilized. In addition, RAI response EP-03 states the fire, smoke, and radiation alarms and instrumentation for the CISF will be monitored from the central alarm panel located within the Central Alarm Station (CAS) in the Security and Administration Building. Section 1.6, "Meteorology," states that WCS has an on-site meteorological tower for conducting environmental monitoring. Therefore, real time meteorological data is available for use in emergency response.

As noted in the following section of the SER, 11.3.5.7, the Incident Commander or his designee is responsible for immediately directing and taking appropriate emergency response actions. In the WCS ERP, the applicant designated the RSO as the communicator of offsite dose projections or potential impact assessment information to State and local agencies, as appropriate.

Based on its review, the staff finds that the information in the application meets the requirements of 10 CFR 72.32(a)(6) because the WCS emergency plan provides a brief description of the methods and equipment that will be used to assess releases of radioactive material.

11.3.5.7 Responsibilities

The staff reviewed the responsibilities of facility personnel during normal operations and during emergency situations as described in Section 4.0, "Responsibilities," of the WCS ERP. In an emergency, the Vice President of Operations/Site General Manager is the primary Incident Commander (IC). Accordingly, the IC or designee is responsible for immediately directing and taking appropriate emergency response actions within the site boundary and for immediate notification to State and local emergency jurisdictions. The IC has the following responsibilities:

- declaring an emergency
- classifying emergencies
- making decisions about offsite assistance
- activating the emergency response organization (ERO)
- directing response activities
- declaring a site evacuation
- declaring an end to emergencies
- returning authority for the command and control of site activities back to facility management
- emergency reporting
- post event assessment
- recordkeeping

In Section 4.0 of the WCS ERP, the applicant also summarized the responsibilities of the remaining onsite staff, including health and safety specialists, the RSO, security supervisors and officers, and managers and supervisors. The applicant identified other ERO members, including the staff for the following areas and positions:

- operations
- safety
- logistics
- procurement
- technical support
- finance
- maintenance
- Emergency Response Coordinator
- Public Information Officer
- Radiation Safety Technician

The staff reviewed Section 7.0, "Maintaining Emergency Preparedness Capability," of the WCS ERP, which describes the normal site organization and identifies personnel responsible for maintaining and updating the ERP, implementing procedures, and related records.

The applicant will have responsibility for all NRC emergency planning requirements. In Chapter 11 of the application, "Emergency Plan", the applicant stated that the ISP will contract with WCS, as a member of the ISP joint venture and in coordination with existing emergency planning activities at the WCS site, to maintain the emergency plan and implement it under ISP's direction and oversight.

Based on its review, the staff finds that the information in the WCS ERP meets the requirements of 10 CFR 72.32(a)(7) because the WCS emergency plan provides a brief description of the responsibilities of personnel should an accident occur, including the prompt notification of offsite response personnel and the NRC, as well as responsibilities for developing, maintaining, and updating the plan.

11.3.5.8 Notification and Coordination

The staff reviewed Section 4.10, "Activation of the ER [Emergency Response] Plan," of the WCS ERP, which contains a commitment to promptly notify offsite response organizations. In Table B, "WCS CISF Emergency Classification," the applicant identified that the NRC Operations Center will be notified immediately after notification of the offsite authorities, and in any case within 1 hour of the declaration of an Alert classification.

The staff reviewed Section 4.9 of the WCS ERP, which describes the means to notify offsite response organizations; the means to request offsite assistance, including medical assistance; and the identification of the personnel responsible to perform the notifications. The IC or designee is responsible to activate the ERO and perform notifications in a timely manner under accident conditions, during normal and off-normal hours. The applicant described diverse methods of notification in Section 6.2, "Communications Equipment," of the WCS ERP.

The staff noted that the WCS CISF has primary and secondary Emergency Operations Centers for management and support personnel to carry out coordinated emergency response activities. The primary and secondary Emergency Operations Centers have accident assessment and communication capabilities that allow for the performance of notification and activation even if some personnel, equipment, or parts of the facility are unavailable.

Based on its review, the staff finds that the information in the WCS ERP meets the requirements of 10 CFR 72.32(a)(8) because the WCS emergency plan contains a commitment to and a brief description of the means to promptly notify offsite response organizations, including the NRC Operations Center, and request offsite assistance. The plan also provides a process to establish a control point and a plan for notification and coordination.

11.3.5.9 Information To Be Communicated

The staff reviewed Section 4.10 of the WCS ERP, which states the following:

Whenever an emergency notification is made, the following information will be provided:

- IC name and telephone number;
- The facility name;
- The time and type of incident (e.g., release, fire);
- The type and quantity of material(s) involved, to the extent known;
- The extent of injuries, if any, and

- The possible hazards to human health and the environment outside the facility.

Based on its review, the staff finds that the information in the WCS ERP meets the requirements of 10 CFR 72.32(a)(9) because the WCS emergency plan provides a brief description of the types of information on facility status, radioactive releases, and recommended protective actions, if necessary, to be given to offsite response organizations and the NRC consistent with the NRC guidance in RG 3.67.

11.3.5.10 Training

The staff reviewed Section 7.2, "Training," of the WCS ERP, which describes the general employee training provided to all facility employees who may have to take protective actions (e.g., assembly, evacuation) in the event of an operational emergency. This section states that specialized training is provided to personnel directly involved in emergency response actions. In Section 7.2.2, "Emergency Response Personnel," of the WCS ERP, the applicant stated that ERO training is conducted in accordance with the requirements listed in plant procedures. ERO training includes, but is not limited to, Radiation Worker, 24-hour HAZWOPER Training, and basic Resource Conservation and Recovery Act training, which covers how to use personal protection equipment (i.e., respirators, eye and ear protection, breathing apparatus, protective clothing) and how to perform basic first aid. ERO personnel are not certified firefighters but do understand the correct methods and techniques for eliminating and responding to fire emergencies.

The applicant stated that drills and exercises are part of the training curriculum. With respect to fires, radiological response training is offered to members of the Andrews County and Eunice City Fire Departments using the same guidelines set for WCS employees for hazardous materials.

The staff reviewed Section 7.6, "Letters of Agreement," of the WCS ERP, which states that upon request, the applicant will provide training for physicians that will include types of radiation, radiation detection and risks, signs and symptoms of radiation exposure, contamination control, and methods of decontamination. The applicant further described that the training program will be offered to offsite support agency personnel who may be called upon to assist the facility.

Based on its review, the staff finds that the information in the WCS ERP meets the requirements of 10 CFR 72.32(a)(10) because the WCS emergency plan briefly describes the training that will be provided to workers on how to respond to an emergency and any special instructions, and radiological response training that will be offered to fire, police, medical, and other emergency personnel.

11.3.5.11 Safe Condition

The staff reviewed Section 9.0, "Recovery and Facility Restoration," of the WCS ERP, which describes the means for restoring the WCS CISF to safe operation after an accident.

The applicant described that the CISF Site Manager shall ensure the following items are addressed before initiating the recovery plan:

- recovery strategy
- recovery tasks and assignments

- regulatory notifications and follow-ups
- insurance and risk management notification
- logistical support needs
- offsite logistical support needs
- appointment of a Recovery Manager

The application stated that the IC is responsible for determining when an emergency situation is sufficiently stable to enter the recovery phase. The IC, through the Public Information Officer, disseminates information on the relaxation of public protective actions.

The application described that the recovery organization develops and coordinates plans and schedules for recovery operations. The application describes recovery as including those actions necessary to return an incident and the surrounding environment to pre-emergency conditions, and the applicable Director of Operations, or his/her designee, will serve as the Recovery Manager. The Recovery Manager will establish recovery team(s) to restore all vital systems back to normal operation. Exposure levels will be established for estimating dosage and for protecting workers and the general public from hazardous exposure during recovery activities.

Based on its review, the staff finds that the information in the WCS ERP meets the requirements of 10 CFR 72.32(a)(11) because the WCS emergency plan provides a brief description of the means for restoring the facility to safe operation after an accident, consistent with the NRC guidance in RG 3.67.

11.3.5.12 Exercises

The staff reviewed Section 7.3, "Drills and Exercises," of the WCS ERP, which describes the drill and exercise program, including biennial exercises, annual radiological drills, annual medical drills, and annual fire drills. The application states that offsite response organizations will be invited to participate in the drills and exercises, which is consistent with the NRC guidance that recommends but does not require such participation.

Consistent with the requirements in 10 CFR 72.32(a)(12), the WCS ERP describes documented quarterly communications checks with offsite response organizations, including the check and update of all necessary telephone numbers.

The WCS ERP describes the evaluation of drills, the correction of identified deficiencies, and the confidentiality of exercise scenarios. Drills and exercises will be evaluated in accordance with the implementing procedures for emergency response training and drills. The applicant will critique each drill and exercise using individuals who do not have direct responsibility for implementing the plan. Critiques of exercises will evaluate the appropriateness of the ERO, emergency procedures, facilities, equipment, personnel training, and overall effectiveness of an incident response. Deficiencies found by the drill and exercise evaluations will be corrected using the WCS CISF corrective action process.

Based on its review, the staff finds that the information in the WCS ERP meets the requirements of 10 CFR 72.32(a)(12) because the WCS emergency plan includes the necessary exercises, drills, and communications tests at the required frequency.

11.3.5.13 Hazardous Chemicals

The staff reviewed Section 10, "Compliance with Community Right-to-Know Act," of the WCS ERP, which states that the WCS CISF complies with the Emergency Planning and Community Right-to-Know Act by submitting the following reports:

- Texas Tier-II reports
- Toxic Release Inventory reports

Based on its review, the staff finds that the information in the WCS ERP meets the requirements of 10 CFR 72.32(a)(13) because the WCS emergency plan certifies that the licensee has met its responsibilities under the Emergency Planning and Community Right-to-Know Act of 1986, Title III, Pub. L. 99-499.

11.3.5.14 Comments on the Emergency Plan

The applicant stated in its application that the WCS ERP was reviewed by Andrews County and Lea County, the off-site authorities expected to respond to the site in the event of an accident, with local law enforcement, fire support as well as medical services. The applicant also stated in the RAI response EP-10 that agreements are currently in place with the Andrews Police Department, the Andrews County Sheriff's Department, and the Eunice Police Department for the Waste Control Specialists SP&D facilities. Under the current agreements, the Eunice Police Department, the Andrews Police Department, and the Andrews County Sheriff's Department are responsible for coordinating with Waste Control Specialists to establish law enforcement, traffic control, and evacuation services (should they be needed at the Waste Control Specialists site) within their respective states. The Eunice Police Department may request assistance from the New Mexico State Police and the Andrews Police Department may request assistance from the Texas Department of Public Safety as part of their efforts to coordinate traffic control and evacuation services.

The applicant further states that once the WCS CISF license application is approved, the Agreements with the Eunice Police Department, the Andrews Police Department, and Andrews County Sheriff's Department will be amended to include the WCS CISF.

Based on its review, the staff finds that the information in the WCS ERP meets the requirements of 10 CFR 72.32(a)(14) because offsite response organizations expected to respond in case of an accident have been provided 60 days to comment on the initial submission of the WCS emergency plan before the applicant submitted it to the NRC. Additionally, the WCS ERP states that comments from offsite response organizations on future revisions to the WCS ERP will be allowed for up to 60 days and such comments will be provided to the NRC with the WCS ERP updates.

11.3.5.15 Offsite Assistance

The staff reviewed Section 4.9 of the WCS ERP, which describes the means for requesting assistance from offsite response organizations when necessary. At its discretion, the IC, or designee, will contact outside agencies for help at the site from the fire, law enforcement, or ambulance service (or a combination of these). The WCS ERP describes local offsite organizations that may assist the facility during an emergency. In Section 7.6 of the WCS ERP, the applicant stated that letters of agreement will be reviewed annually and renewed at least every 4 years, and training will be offered to offsite response organizations.

Based on its review, the staff finds that the information in the WCS ERP meets the requirements of 10 CFR 72.32(a)(15) because the WCS emergency plan briefly describes the arrangements for requesting and effectively using offsite assistance.

11.3.5.16 Public Information

The staff reviewed Section 5.1.4, “Public Information Program” of the WCS ERP, which describes the arrangements for providing information to the public. The WCS ERP states that depending on the severity of the event, the potential public impact, and the level of public interest, either the WCS Vice President/Site General Manager (who serves as the Public Information Officer) or the WCS Corporate Office are the only WCS employees who have authority to disseminate emergency related public information. The IC will establish a liaison that will communicate real time emergency event information directly to the WCS Management and the public.

Based on its review, the staff finds that the information in the WCS ERP meets the requirements of 10 CFR 72.32(a)(16) because the WCS emergency response plan briefly describes the arrangements for providing information to the public.

11.3.5.17 License Condition

In accordance with the regulatory requirement in 10 CFR 72.44(f), the staff is imposing the following license condition (License Condition 12) concerning the WCS ERP:

The licensee shall follow WCS ERP-100, “Consolidated Emergency Response Plan,” Revision 02-08-2019, and as it may be further revised in accordance with 10 CFR 72.44(f).

The staff reviewed and evaluated the WCS ERP, dated February 8, 2019, and finds that the WCS ERP and the staff-imposed license condition meet the requirements of 10 CFR 72.32(a) and 10 CFR 72.44(f) and will provide reasonable assurance to adequately protect public health and safety and the environment in the event of an emergency.

11.3.6 Physical Security and Safeguards Contingency Plans

The following sections describe the staff’s review and evaluation of Revision 5 of the applicant’s PSP (nonpublic) in support of the application to license the WCS CISF. The staff based its review on Revision 5 of the WCS CISF PSP and the applicant’s responses to RAIs to determine conformance with the following regulations and additional security measures (ASM):

- 10 CFR 72.180, which requires that the licensee establish, maintain, and follow a detailed plan for physical protection as described in 10 CFR 73.51
- 10 CFR 72.182, which specifies the design requirements for physical protection
- 10 CFR 72.184, which specifies the requirements for the safeguards contingency plan
- 10 CFR 73.51, which specifies the requirements for the physical protection of SNF and high-level radioactive waste
- 10 CFR 73.71, which specifies the requirements for the reporting of safeguards events

- NRC, “Additional Security Measures for Independent Spent Fuel Storage Installations,” September 28, 2007
- NRC, “Additional Security Measures for Access Authorization and Fingerprinting at Independent Spent Fuel Storage Installations,” December 19, 2007

11.3.6.1 Facility Description

Based on its review of the WCS CISF PSP, the staff finds that the applicant provided an adequate description of the facility and site because the applicant included site maps showing the cask storage area, important supporting structures, and the boundaries of the protected area, as well as descriptions of the area adjacent to the site.

11.3.6.2 General Performance Objectives

The staff reviewed the applicant’s general objectives of the physical protection system to determine whether it provides high assurance that activities involving SNF do not constitute an unreasonable risk to public health and safety.

To achieve this objective, the physical protection system must provide for the following performance capabilities in accordance with 10 CFR 73.51(b):

- Store SNF and high-level radioactive waste only within a protected area.
- Grant access to the protected area only to individuals who are authorized to enter the protected area.
- Detect and assess unauthorized penetration of, or activities within, the protected area.
- Provide timely communication to a designated response force whenever necessary.
- Manage the physical protection organization in a manner that maintains its effectiveness.

In addition, the regulations in 10 CFR 73.51(b)(3) require that the physical protection system be designed to protect against loss of control of the facility that could be sufficient to cause a radiation exposure exceeding the dose specified in 10 CFR 72.106(b) from any design-basis accident.

Based on the staff review of the applicant’s general objectives of the physical protection system, the staff finds that the WCS CISF PSP meets the general design objective because it includes commitments that meet the requirements of 10 CFR 72.180 and 10 CFR 73.51, and because the license includes the following conditions related to the ASMs listed above:

LC13-1	The licensee shall follow the Physical Protection Plan entitled, “WCS Consolidated Interim Storage Facility (CISF) Physical Security Plan,” Revision 5, dated September 18, 2019, as well as changes made in accordance with 10 CFR 72.44(e) and 72.186(b).
LC13-2	The licensee shall follow the Training and Qualification Plan entitled, “WCS Consolidated Interim Storage Facility (CISF)

Training and Qualification Plan Appendix B to the CISF Physical Security Plan,” dated September 18, 2019, as well as changes made in accordance with 10 CFR 72.44(e) and 72.186(b).

- LC13-3 The licensee shall follow the Safeguards Contingency Plan entitled “WCS Consolidated Interim Storage Facility (CISF) Safeguards Contingency Plan Appendix C to the CISF Physical Security Plan,” dated September 18, 2019, as well as changes made in accordance with 10 CFR 72.44(e) and 72.186(b).
- LC13-4 The licensee shall follow the “Additional Security Measures for the Physical Protection of Dry Independent Spent Fuel Storage Installations,” dated September 28, 2007.
- LC13-5 The licensee shall follow the “Additional Security Measures for Access Authorization and Fingerprinting at Independent Spent Fuel Storage Installations,” dated December 19, 2007.

In addition, the staff finds that the applicant meets the requirements of 10 CFR 73.51(c) because the WCS CISF PSP includes a commitment to retain PSP Appendix B, “WCS CISF Training and Qualification Plan,” and Appendix C, “WCS CISF Safeguards Contingency Plan,” for 3 years after each is updated or superseded.

11.3.6.3 Physical Barrier Systems

The regulations in 10 CFR 73.51(d)(1) state that spent fuel must be stored only within a protected area so that access to this material requires passage through or penetration of two physical barriers—one barrier at the perimeter of the protected area and one barrier offering substantial penetration resistance.

The applicant provided for spent fuel to be stored within a protected area such that access to stored spent fuel requires passage through or penetration of at least two security barriers. The applicant described the first barrier as the protected area barrier comprising double fences that meet the definition of physical barrier in 10 CFR 73.2, “Definitions,” and 20-foot isolation zones between the outer and inner fences as well as on either side of the protected area barrier system. The applicant further described the inner isolation zone as free from clutter and provided an intrusion detection system before penetration of the inner fence of the protected area barrier system. The applicant identified the second barrier as the storage cask constructed of high-density concrete and structural steel liners that offer substantial penetration resistance.

Based on its review of the provisions described above, the staff finds that the commitments in the WCS CISF PSP for physical barriers systems meet the requirements of 10 CFR 73.51(d)(1), and the, pre-operational inspection of the facility will confirm the implementation of the barriers.

11.3.6.4 Illumination

The regulations in 10 CFR 73.51(d)(2) require that illumination must be sufficient to permit adequate assessment of unauthorized penetrations of or activities within the protected area.

Based on its review, the staff finds that the commitments in the PSP provide for enough illumination to allow surveillance and adequate assessment within the protected area. Therefore, the staff finds that the PSP meets the illumination requirements of

10 CFR 73.51(d)(2) and, once lighting is installed, pre-operational performance inspections will confirm sufficient illumination levels.

11.3.6.5 Surveillance

The regulations in 10 CFR 73.51(d)(3) require that the perimeter of the protected area must be subject to continual surveillance and be protected by an active intrusion alarm system, capable of detecting penetrations through the isolation zone, that is monitored in a continually staffed primary alarm station and in one additional continually staffed location. In addition, the regulations require the following:

- The central alarm station must be located within the protected area and have bullet-resisting walls, doors, ceiling, and floor.
- The interior of the station must not be visible from outside the protected area.
- A timely means for the assessment of alarms must also be provided.

With regard to alarm monitoring, the redundant location need only provide a summary indication that an alarm has been generated.

The applicant committed to have the capability to detect unauthorized penetrations through the isolation zones at the perimeter of the protected area, consistent with the guidance in RG 5.44, "Perimeter Intrusion Alarm Systems." The intrusion detection system covers all of the inner areas of the protected area and includes systems comparable to those described in RG 5.44.

The applicant provided a central alarm station located in the WCS CISF security building. The applicant described the central alarm station as a hardened facility within the protected area protected by the protected area intrusion detection system, access control, and barriers. The security building monitors all access control and intrusion alarms. A summary indication of alarms also annunciates in the alternate alarm station located inside the WCS CISF protected area.

Based on its review, the staff finds that the commitments in the PSP for alarm surveillance and annunciation meet the requirements of 10 CFR 73.51(d)(3), and the pre-operational inspections will confirm the installation of these surveillance systems.

11.3.6.6 Security Patrols

The regulations in 10 CFR 73.51(d)(4) require that daily random patrols monitor the protected area.

The applicant provided for security force personnel on duty at all times. Normal duties include the operation of the central and alternate alarm stations and control of personnel entry, including searches of persons who enter the protected area. Security force personnel conduct daily random patrols to monitor the protected area boundaries for the presence of unauthorized persons or activities and for physical protection system or barrier degradation.

Based on its review, the staff finds the commitments in the PSP for patrols meet the requirements of 10 CFR 73.51(d)(4), and the pre-operational inspections will confirm the implementation of these security patrols.

11.3.6.7 Security Organization

The regulations in 10 CFR 73.51(d)(5) require that the applicant establish a security organization with written procedures. The security organization must include sufficient personnel per shift to monitor detection systems and conduct surveillance, assessment, access control, and communications activities to assure adequate response. The applicant must train, equip, qualify, and requalify members of the security organization to perform assigned job duties in accordance with 10 CFR Part 73, Appendix B, "General Criteria for Security Personnel," Section I.A.1.a., "Educational development," Section I.A.1.b., "Felony convictions," Section I.B.1.a., and the applicable portions of Section II, "Training and qualifications."

The applicant committed to establishing a security organization that includes trained individuals, oversight, and written procedures to carry out security duties. The applicant described its procedures to ensure that each shift has sufficient armed individuals to meet regulatory requirements and the potential increase of shift-manning levels dependent upon planned daily activities. In addition, the applicant will provide guard training and qualification sufficient to meet the requirements of Section III, "Weapons training," of Appendix B to 10 CFR Part 73.

Based on its review, the staff finds that the commitments in the PSP for the establishment of a security organization with written procedures meet the requirements of 10 CFR 73.51(d)(5), and the pre-operational inspections will confirm the implementation of the security organization and written procedures.

11.3.6.8 Qualifications for Employment in Security

The applicant committed to perform screening for individuals, including security personnel, granted unescorted access to the protected area where spent fuel is stored before granting such access. The regulations require that security force personnel shall meet the requirements of 10 CFR Part 73, Appendix B, Sections I.A.1.a., I.A.1.b., and I.B.1.a., and the applicable portions of Section II. The WCS CISF Access Authorization Plan includes screening with a 3-year local criminal history check of counties the individual has resided in within the 3-year period before assignment as a security force member; a psychological evaluation, check of Federal Bureau of Investigations criminal history records; drug and alcohol testing; and continual behavioral observation.

Based on its review, the staff finds that the commitments in the PSP for screening and qualification for employment in security meet the requirements of 10 CFR 73.51(d)(5), and the pre-operational inspections will confirm the implementation of screening and qualification of personnel.

11.3.6.9 Security Force Training

In Appendix B to its PSP, the applicant provided the WCS CISF training and qualification plan. The plan documents how the applicant meets the applicable criteria of Appendix B to 10 CFR Part 73.

The applicant committed to implement the physical protection program to document the primary duties and responsibilities of security personnel at the WCS CISF. The applicant stated that security personnel assigned to implement the physical protection program will meet minimum training and qualification requirements, and each individual will have the knowledge, skills, and abilities to carry out assigned duties and responsibilities. The applicant further stated that the

WCS CISF security organization will not allow any individual to assume security duties and responsibilities until the individual has satisfied the minimum training requirements. To ensure individuals maintain knowledge, skills, and abilities after the initial qualification, the WCS CISF security training and qualification program provides periodic re-qualification and remedial training.

The WCS CISF training and qualification plan includes firearms training that meets the requirement of Section III in Appendix B to 10 CFR Part 73.

Based on the discussion above, the staff finds that the commitments in the plan for the security organization meet the requirements of 10 CFR 73.51(d)(5), and once the commitments are implemented, the pre-operational inspection will confirm the WCS CISF security organization and training.

11.3.6.10 Response Liaison

The regulations in 10 CFR 73.51(d)(6) require the applicant to establish a documented liaison with a designated offsite response force or local law enforcement agency (LLEA) to permit timely response to unauthorized penetration or activities. In Appendix C to the PSP, the applicant included a site safeguards contingency plan that documents liaisons with the Andrews County Sheriff's Office in Andrews, TX, and the Eunice Police Department in Eunice, NM, as the responding LLEAs. The arrangements with the LLEAs, combined with the integrated response and recovery plan in Attachment 10.1 of the PSP, provide for a timely response.

Based on its review, the staff finds that the commitments in the PSP for offsite response meet the requirements of 10 CFR 73.51(d)(6), and the pre-operational inspection will confirm their implementation.

11.3.6.11 Identification and Controlled Lock Systems

The regulations in 10 CFR 73.51(d)(7) require an applicant to establish and maintain a personnel identification system and a controlled lock system to limit access to authorized individuals.

The applicant included in its PSP an identification system to provide unique identification of individuals granted unescorted access to the protected area at the facility. In addition, the identification system will identify individuals requiring escort while within the protected area.

The applicant committed to establishing a key and lock control system to limit access to, and within, the protected area to authorized individuals.

Based on its review, the staff finds that the commitments in the PSP for identification and controlled lock systems meet the requirements of 10 CFR 73.51(d)(7), and the pre-operational inspection will confirm their implementation.

11.3.6.12 Communications Capability

The regulations in 10 CFR 73.51(d)(8) require the applicant to provide redundant communications capability between onsite security force members and the designated response force or LLEA.

In its PSP, the applicant committed to equip each security individual with a two-way radio and a cell phone as a backup capable of maintaining continuous communications with the security posts. The PSP also calls for a central alarm station with a base radio system, a commercial telephone, and a cell phone to maintain contact with the LLEA. An uninterruptible power supply provides backup power for onsite communications and, therefore, redundant communications capability between the onsite security force and the offsite response force.

Based on its review, the staff finds that the commitments in the PSP for communications capability meet the requirements in 10 CFR 73.51(d)(8), and once the commitments are implemented, the pre-operational inspection will confirm communication capability.

11.3.6.13 Access Controls at the Protected Area

The regulations in 10 CFR 73.51(d)(9) require that all individuals, vehicles, and hand-carried packages entering the protected area must be checked for proper authorization and visually searched for explosives before entry.

11.3.6.13.1 Access to Protected Areas

In the PSP, the applicant committed to establishing procedures for determining an individual's need for access to the protected area. The applicant described the procedures for limiting access to protected areas to individuals authorized to have escorted or unescorted access in order to perform job duties, and to deal with required access of emergency response personnel vehicles.

11.3.6.13.2 Access Controls at the Protected Area

The applicant committed to develop procedures for granting access to individuals and packages into the protected area and to allow only those vehicles listed on the designated vehicles list into the protected area. The applicant described the procedures to include checking authorization and searching individuals, packages, and vehicles for firearms, incendiary devices, and explosives by visual and by physical search (pat down) or with the use of a portable explosive detector.

11.3.6.13.3 Escorts and Escorted Individuals

In the PSP, the applicant identified the individuals designated and granted unescorted access into the protected area and described the requirements and procedures for escorting individuals needing access.

11.3.6.13.4 Access Controls at the Protected Area—Staff Evaluation Finding

Based on the discussions above, the staff finds that the commitments in the PSP for access control commitments meet the requirements of 10 CFR 73.51(d)(9), and once the commitments are implemented, the pre-operational inspection will confirm access control measures.

11.3.6.14 Procedures

The regulations in 10 CFR 73.51(d)(10) require that written response procedures be established and maintained for addressing unauthorized activities within the protected area, including Category 5, "Procedures," of Appendix C, "Licensee Safeguards Contingency Plans," to 10 CFR Part 73. In addition, the regulations require that the applicant retain a copy of response

procedures as a record for 3 years or until termination of the license for which the procedures were developed. The applicant must retain copies of superseded material for 3 years after each change or until termination of the license.

In the PSP, the applicant described its response procedures for dealing with the detection of unauthorized presence or activities within the protected area. It detailed the actions to be taken and decisions to be made by each member or unit of the response organization. The applicant also committed to the record retention requirements for response procedures.

Based on its review, the staff finds that the commitments in the PSP to develop security procedures meet the requirements of 10 CFR 73.51(d)(10), and once the commitments are implemented, the pre-operational inspection will confirm the security procedures.

11.3.6.15 Equipment Operability

The regulations in 10 CFR 73.51(d)(11) require that all detection systems and supporting subsystems must be tamper-indicating with line supervision and must be maintained in an operable condition, including the surveillance/assessment and illumination systems. The regulations also require the licensee to take timely compensatory measures after discovery of an inoperable condition to assure no reduction in the effectiveness of the security system.

The applicant committed to a surveillance program that combines intrusion detection systems which are protected by tamper indication with line supervision, random patrols and CCTV equipment configured to provide surveillance outside the perimeter of the PA to facilitate early detection and assessment. The applicant committed to perform testing of all security-related equipment to applicable manufacturer's specifications and to check the security systems and support equipment for operability weekly and after each use of the equipment. The applicant committed to a repair and preventive maintenance program and interim compensatory measures until restoration of the system to normal capability. The applicant committed to implementing the guidance in RG 5.44 for conducting operability tests.

Based on its review, the staff finds that the commitments in the PSP for equipment operability meet the requirements of 10 CFR 73.51(d)(11), and once the commitments are implemented, the pre-operational inspections will confirm the measures to assure equipment operability.

11.3.6.16 Audits

The regulations in 10 CFR 73.51(d)(12) require a review of the physical protection program once every 24 months by individuals independent of both physical protection program management and personnel who have direct responsibility for implementation of the physical protection program. The physical protection program review must include an evaluation of the effectiveness of the physical protection system and verification of the liaison established with the designated response force or LLEA.

The applicant committed to conduct security audits at least every 2 years by individuals independent of both security program management and personnel directly responsible for implementation of the security program. The audits will include an evaluation of the effectiveness of the physical protection system and verification of the liaison established with the LLEA. The applicant will maintain reports in a form sufficient for auditing and available for inspection for a period of 3 years.

Based on its review, the staff finds that the commitments in the PSP for the audit program meet the requirements of 10 CFR 73.51(d)(12), and the pre-operational inspection will confirm the implementation of the audit program commitments.

11.3.6.17 Documentation

The regulations in 10 CFR 73.51(d)(13) require the retention of documentation as a record for 3 years after the record is made or until termination of the license. Duplicate records to those required under 10 CFR 72.180 and 10 CFR 73.71 need not be retained under the requirements of this section.

In its contingency plan, the applicant described its response record data and committed to maintaining those records for a period of 3 years. These records include but are not limited to the following:

- a log of individuals granted access to the protected area
- a log of all patrols
- training and qualification records required by Section II.B, "Qualification requirements," of Appendix B to 10 CFR Part 73
- trustworthy and reliability checks of security force members
- current written procedures that require access control personnel to identify authorized versus unauthorized entry for the period the applicant stores spent fuel
- the record of escorted individuals for a period of 3 years from the date of the record
- written procedures for key and lock control for the period the applicant stores spent fuel
- audit reports and resolutions
- a record of assessment and response to alarms

Based on its review, the staff finds that the commitments in the PSP for recordkeeping meet the requirements of 10 CFR 73.51(d)(13), and the pre-operational inspection will confirm the implementation of the commitments.

11.4 Evaluation Findings

The staff has reviewed the SAR and has determined that WCS has established an acceptable plan to conduct the operations of the facility. The staff has determined the following:

- The SAR includes an acceptable description of the program covering the QAP, pre-operational testing, and initial operations, in compliance with 10 CFR 72.24(h), (n), and (p).
- The SAR includes a description of the detailed security measures for physical protection, including design features and the plans required by Subpart H of 10 CFR Part 72.

- The applicant has provided acceptable technical qualifications, including training and experience, for personnel who will be engaged in the proposed activities, in compliance with 10 CFR 72.28(a).
- The application includes an acceptable description of a personnel training program to comply with 10 CFR Part 72, Subpart I.
- The application includes an adequate, acceptable description of the applicant's operating organization, delegations of responsibility and authority, and the minimum skills and experience qualifications relevant to the various levels of responsibility and authority, in compliance with 10 CFR 72.28(c).
- The application includes an acceptable commitment by the applicant to have and maintain an adequate complement of trained and certified installation personnel before receipt of spent fuel or high-level radioactive waste for storage, in compliance with 10 CFR 72.28(d).
- The application includes an emergency plan in compliance with 10 CFR 72.32.
- The application provides acceptable assurance that the applicant is qualified by reason of training and experience to conduct the operations covered by the regulations in 10 CFR Part 72, in compliance with 10 CFR 72.40(a)(4).
- The application is considered to provide acceptable assurance with regard to the management, organization, and planning for pre-operational testing and initial operations that the activities authorized by the license can be conducted without endangering public health and safety, in compliance with 10 CFR 72.40(a)(13).
- The SAR includes an acceptable plan for the conduct of operations, in compliance with 10 CFR 72.24(h).

In addition, the staff finds that Revision 5 of the WCS CISF PSP, including the security training and qualification plan and safeguards contingency plan, is adequate and meets the requirements of 10 CFR 72.180, 10 CFR 73.51, the ASM for the Physical Protection of Dry Independent Spent Fuel Storage Installations, and the ASM for Access Authorization and Fingerprinting at Independent Spent Fuel Storage Installations. Further, once fully implemented and confirmed through the pre-operational inspection, the staff expects that the applicant's physical protection program will satisfy the provisions of 10 CFR 72.40(a)(14) by providing for the common defense and security and the protection of public health and safety.

11.5 References

Code of Federal Regulations, Title 10, Part 21, "Reporting of Defects and Noncompliance."

Code of Federal Regulations, Title 10, Part 71, "Packaging and Transportation of Radioactive Materials."

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

Code of Federal Regulations, Title 10, Part 73, "Physical Protection of Plants and Materials."

ISP, "Submittal of Partial Response to First RAI, Part 1, Docket 72-1050, CAC/EPID 001028/L-2017-NEW-0002," May 31, 2019. Agencywide Documents Access and Management System (ADAMS) Accession No. ML19156A048.

ISP, "WSC Consolidated Interim Storage Facility Safety Analysis Report," Revision 5, Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML21105A766.

ISP, "WCS CISF NUHOMS® Dry Run Training Exercise," Plan 1004118, Revision 0 Draft, undated, transmittal dated April 7, 2020. ADAMS Accession No. ML20105A139.

ISP, "WCS CISF NAC Systems Dry Run Training Exercise," Plan 1004119, Revision 0 Draft, undated, transmittal dated April 7, 2020. ADAMS Accession No. ML20105A139.

ISP, "Revision 5 of the Physical Security Plan, Training and Qualification Plan, and Safeguards Contingency Plan with Updated Cover Sheets, Docket 72-1050 CAC/EPID 001028/L-2017-NEW-0002," transmittal letter dated September 19, 2020. ADAMS Accession No. ML20269A259.

NRC, "Additional Security Measures for Access Authorization and Fingerprinting at Independent Spent Fuel Storage Installations," December 19, 2007. ADAMS Accession No. ML080090656.

NRC, "Additional Security Measures for Independent Spent Fuel Storage Installations," September 28, 2007 (nonpublic). Safeguards LAN/Electronic Safe (SLES) Reference No. NS106675.

NRC, NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," March 2000. ADAMS Accession No. ML003686776.

NRC, Regulatory Guide 3.67, "Standard Format and Content for Emergency Plans for Fuel Cycle and Materials Facilities," Revision 1, April 2011. ADAMS Accession No. ML103360487.

NRC, SFST-ISG-16, "Emergency Planning," June 2000.

Orano, TN Americas LLC, Services Program Manual, SPM 2.1, "Systematic Approach to Training," Revision 9, August 1, 2018 (nonpublic); transmittal dated April 7, 2020. ADAMS Accession No. ML20105A134.

WCS, ERP-100, "Consolidated Emergency Response Plan," February 8, 2019. ADAMS Accession No. ML19156A045.

12 RADIATION PROTECTION EVALUATION

In Chapter 9, “Radiation Protection,” of its safety analysis report (SAR), Revision 5, Interim Storage Partners LLC (ISP or the applicant) described the radiation protection features of the proposed WCS Consolidated Interim Storage Facility (CISF) to ensure that radiation exposures to workers and members of the public meet the regulatory requirements.

12.1 Scope of Review

The U.S. Nuclear Regulatory Commission (NRC) staff evaluated the radiation protection for the WCS CISF by reviewing the SAR, documents cited in or attached to the SAR, the applicant’s responses to the staff’s requests for additional information (RAIs), and other relevant literature. The staff reviewed the information to determine whether the applicant’s radiation protection program provides sufficient assurance of the following:

- Radiation exposures and radionuclide releases will be maintained at levels that are as low as is reasonably achievable (ALARA).
- Occupational radiation doses will not exceed the limits specified in the radiation protection standards in Title 10 of the *Code of Federal Regulations* (10 CFR).
- Radiation doses to the public during normal conditions and anticipated occurrences will meet regulatory standards.

12.2 Regulatory Requirements

The NRC requirements relevant to the staff’s evaluation of establishing a radiation protection program at the proposed WCS CISF appear in the following sections of Title 10 of the *Code of Federal Regulations*:

- 10 CFR 20.1101, “Radiation protection programs”
- 10 CFR 20.1201, “Occupational dose limits for adults”
- 10 CFR 20.1301, “Dose limits for individual members of the public”
- 10 CFR 20.1302, “Compliance with dose limits for individual members of the public”
- 10 CFR 20.1406, “Minimization of contamination”
- 10 CFR 20.1501, “General”
- 10 CFR 20.1701, “Use of process or other engineering controls”
- 10 CFR 20.1702, “Use of other controls”
- 10 CFR 20.1704, “Further restrictions on the use of respiratory protection equipment”
- 10 CFR 72.24, “Contents of application: Technical information”
- 10 CFR 72.40, “Issuance of license”
- 10 CFR 72.44, “License conditions”
- 10 CFR 72.104, “Criteria for radioactive materials in effluents and direct radiation from an ISFSI or MRS”
- 10 CFR 72.106, “Controlled area of an ISFSI or MRS”
- 10 CFR 72.122, “Overall requirements”
- 10 CFR 72.126, “Criteria for radiological protection”
- 10 CFR 72.128, “Criteria for spent fuel, high-level radioactive waste, reactor-related Greater than Class C waste, and other radioactive waste storage and handling”

12.3 Staff Review and Analysis

Unless otherwise stated, the staff reviewed and evaluated the radiation protection evaluation of the proposed site discussed in Chapter 9 of SAR Revision 5, dated April 12, 2021, documents cited in or attached to the SAR, the applicant's responses to the staff's RAIs, and other relevant literature.

12.3.1 As Low As Is Reasonably Achievable Considerations

In SAR Section 9.1, "Ensuring That Occupational Radiation Exposures Are ALARA," the applicant addressed ALARA considerations. The following describes the staff's evaluation to determine whether the applicant appropriately considered the goal of maintaining doses ALARA during the operation of the facility.

In SAR Section 9.1.1, "Policy Considerations," the applicant described the ALARA policy and a program for the proposed WCS CISF. The applicant stated that the primary goal of the radiation protection program is to minimize exposure to radiation such that the individual and collective exposures to personnel in all phases of operation and maintenance are kept ALARA. The applicant described its ALARA program to maintain radiation exposures ALARA through the following methods:

- maintaining radiological releases and exposures to personnel below the applicable limits of 10 CFR Part 20, "Standards for protection against radiation"
- ensuring that all exposures are kept ALARA with technological, economic, and social factors taken into consideration
- integrating appropriate radiation protection controls and ALARA program guidelines into all work activities, including those for design, operations, maintenance, and decommissioning
- ensuring that all personnel understand and follow ALARA procedures
- restricting access to radiologically controlled areas
- tracking individual and collective doses to identify trends and causes and to take appropriate corrective actions for adverse trends
- conducting periodic training and exercises for management, radiation workers, and other site personnel in radiation protection principles and procedures, individual and group protective measures, site procedures, and emergency response
- integrating ALARA considerations into the WCS CISF design and procedure change activities, including appropriate experience gained during the loading and transfer operations at other independent spent fuel installations (ISFSIs) relative to radiation control

The applicant stated that its ALARA program will follow the requirements of 10 CFR Part 20 and the guidance of Regulatory Guide (RG) 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures as Low as Is Reasonably Achievable," Revision 2, issued August 2016, and RG 8.8, "Information Relevant to Ensuring that Occupational Radiation

Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable,” Revision 3, issued June 1978, to ensure compliance with 10 CFR 72.126 and 10 CFR 20.1101, which require radiation protection programs and systems.

The applicant stated that the facility management is committed to compliance with regulatory requirements for the control of personnel exposures; will establish and maintain a comprehensive program at the facility to keep individual and collective doses ALARA; and will ensure that each staff member integrates appropriate radiation protection controls into work activities, and that each individual understands and follows procedures to maintain their radiation dose ALARA.

The ALARA program, as described in the SAR, includes using pertinent information concerning radiation exposure of personnel in design and operation activities. The applicant stated that the program’s procedures will incorporate applicable experience gained during the operation of ISFSIs and nuclear power stations relative to radiation control to ensure that the procedures continually meet the objectives of the ALARA program. In addition, the applicant stated that the program will review trends in facility personnel and job exposures to permit corrective actions to be taken with respect to adverse trends.

Based on its review, the staff considers that the implementation of the proposed ALARA program as described in the application will provide reasonable assurance that doses to workers and members of the public will be maintained ALARA in accordance with the requirements of 10 CFR 20.1101(a) and 10 CFR 72.104(b) and (c). The staff confirmed that the proposed program contains the applicable elements in RGs 8.8 and 8.10, such as management commitment to the ALARA program and principles, written administrative procedures and instructions for operations involving potential radiation exposures, defining responsibility and authority for implementing the program, and using an effective measurement system to determine the success of the program and any trends in exposures.

12.3.2 Design Considerations

In SAR Section 9.1.2, “Design Considerations,” the applicant described the ALARA design considerations at the proposed facility. Specific features of the facility that consider ALARA include the following:

- use of thick shielding during all canister handling, transfer, and storage operations to minimize direct radiation levels
- placement of the storage pads at a sufficient distance from the protected area fence and controlled area boundary to assure doses are ALARA
- adequate spacing between storage casks to permit workers to function efficiently during placement and removal of storage casks at the pads and during performance of maintenance and surveillance
- use of metal canisters that are sealed by welding for the confinement of spent nuclear fuel (SNF) and Greater than Class C (GTCC) waste, which prevents release of radioactive effluents from inside the canister
- use of a passive system to require minimum maintenance and surveillance activities by ISP personnel

- use of a temperature monitoring system that allows for remote readout of cask temperatures
- use of temporary shielding where it is determined to be effective in reducing total dose for a task

Based on its review, the staff finds that the design of the proposed facility will provide reasonable assurance that the doses to workers and members of the public will be maintained ALARA and meet the requirements of 10 CFR 72.126(a) because of the design and operating features listed above, including adequate shielding and features that minimize the exposure of operating staff. The staff also finds that the design of the facility adequately considers the minimization of contamination and generation of radioactive waste as required by 10 CFR 20.1406. In addition, the staff also finds that 10 CFR 72.126(d) is satisfied because the facility uses welded canisters that are not opened at the facility and, therefore, no effluents are expected. The staff also finds that the facility design information provided in the SAR, as described above, provides reasonable assurance that the facility will meet the requirements for suitable shielding and confinement as set forth in 10 CFR 72.128(a)(2) and (3).

12.3.3 Operational Considerations

In SAR Section 9.1.3, "Operational Considerations," the applicant described the ALARA operational considerations at the proposed facility. The applicant stated that plans and procedures at the facility will be developed in accordance with RGs 8.8 and 8.10, and specific facility operational considerations to achieve ALARA conditions include the following:

- SNF and GTCC waste loading operations will take place at the originating sites, not at the WCS CISF, and no other handling of SNF or GTCC waste outside of canisters will take place at the WCS CISF.
- The WCS CISF will not process liquids or gases or contain, collect, store, or transport radioactive liquids.
- Canister transfer between the shipping cask and the storage cask will take place within a shielded transfer cask.
- Dry runs will be performed before canister transfer operations to train personnel on canister transfer procedures, and to refine procedures to achieve minimum probable exposures.
- Procedures and work practices will be used that reflect ALARA lessons learned from other ISFSIs that use dry cask storage.
- Cask handling and transfer equipment will require minimum personnel and allow for quick and accurate placement of the canisters.
- The storage casks and modules will be spaced on the storage pads with sufficient distance from each other to facilitate placement operations and minimize the time spent by WCS CISF personnel near the loaded casks.
- Surveys will be conducted during transportation cask receipt, inspection, and canister transfer operations to ensure that doses are maintained ALARA.

Based on its review, the staff finds that the applicant's operational plans to use RGs 8.8 and 8.10 to maintain doses ALARA are appropriate and will provide reasonable assurance that doses to workers and members of the public will be maintained ALARA. The staff finds that the applicant's use of welded-closed casks that are surveyed for surface contamination before transport to the facility, as well as helium leak tested after transportation and prior to receipt, meets the requirements of 10 CFR 20.1701 because the applicant will use engineering and process controls to prevent airborne radioactivity. The staff finds that the applicant meets the survey requirements in 10 CFR 20.1501(a)(1) to assure that personnel exposures are within 10 CFR Part 20 limits and maintained ALARA because the applicant identified surveys as an element of the ALARA program. The staff finds that the operational elements listed above, including dry runs and using lessons learned from similar operations, are accepted tools in implementing an effective ALARA program.

12.3.4 Radiation Protection Design Features

This section describes the staff's evaluation of the radiation protection design features at the proposed facility contained in SAR Section 9.3, "Radiation Protection Design Features."

12.3.4.1 Installation Design Features

In SAR Section 9.3.1, "Installation Design Features," the applicant described the radiation protection features of the installation design consistent with the applicable portions of Regulatory Position 2 of RG 8.8. The applicant described the siting of the facility far from populated areas, with the nearest town located approximately 5 miles (8 kilometers) away from the proposed facility. The storage area will be located within a protected area, far from the controlled area boundary. Storage pads will be no closer than 4,300 feet (1,310 meters) from the controlled area boundary. The Security and Administration Building will be located at least 330 feet (100 meters) from the storage area, providing separation of radioactive material handling and storage functions from other functions on the site. The Canister Transfer Building will be located within the protected area to minimize the route between the handling facility and storage pads, minimize additional traffic on the route, and maintain substantial distance from the controlled area boundary. The only sources of radiation at the WCS CISF are SNF and GTCC waste contained within the weld-sealed canisters, eliminating the potential for release. These canisters are shielded by transportation, transfer, or storage casks during operations. The canisters will not be opened, and SNF assemblies or GTCC waste will not be removed from the canisters at the WCS CISF. The spent fuel will be maintained dry so no radioactive liquid will be available for release.

The applicant stated that facility operations will generate no potential gaseous or liquid wastes. The applicant stated that the facility will generate solid low-level waste consisting of material from cask contamination surveys and decontamination activities, including paper or cloth smears, paper towels, protective clothing, and other job control wastes contaminated with low levels of radioactivity. The applicant stated that this waste will be packaged and temporarily stored in a designated radiologically controlled area until characterized and shipped to a licensed disposal facility.

The staff finds the applicant's use of Regulatory Position 2 in RG 8.8 in designing the radiation protection features of the proposed facility to be appropriate. The facility design features include controls to provide reasonable assurance that occupational and public exposures will be limited to levels that are within the limits of 10 CFR 72.104(a) and meet the ALARA

requirements of 10 CFR 20.1101(b) and satisfy 10 CFR 20.1701. For example, the use of sealed canisters at the site provides reasonable assurance that facility contamination and the generation of radioactive waste will be minimized in accordance with 10 CFR 20.1406 and will meet the allowable dose for members of the public and the ALARA requirements for effluents in 10 CFR 72.104(a), (b), and (c) and 10 CFR 72.126(d). The staff finds that the distance between the spent fuel handling and storage areas and the nearest boundary of the controlled area of the proposed facility (1,310 meters, 4,300 feet) meets the minimum distance specified in 10 CFR 72.106(b) of 100 meters (330 feet). Therefore, the staff finds the radiation protection design requirements proposed by the applicant acceptable.

12.3.4.2 Access Control

In SAR Section 9.3.2, "Access Control," the applicant described the access control to the proposed facility. The protected area is the area controlled to protect individuals from exposure to radiation or radioactive materials and to provide facility physical security. The protected area will contain all areas at the facility where the dose rate may exceed 2 millirem (mrem) per hour. The controlled area is inside the site boundary surrounded by the controlled area fence. Dose rates outside the controlled area will not exceed 25 mrem per year.

Access to the restricted area is controlled through a single access point in the Security and Administration Building (SAR Figure 1-2). This building will include provisions for donning and removing personal protective equipment, such as anticontamination clothing or respirators, in the event of an accident or off-normal event leading to an area of the site becoming contaminated. This building will also contain capabilities for personnel decontamination.

The applicant stated that under normal operations, it does not expect very high radiation, contamination, or airborne radioactivity areas at the proposed facility; however, radiation protection personnel will monitor radiation levels within the restricted area and may establish additional access requirements and area designations as needed.

The staff finds the access control at the proposed facility acceptable because it provides security fencing and limits access to a single point controlled within the Security and Administration Building to prevent unauthorized entry into radiologically controlled areas. Therefore, the staff finds the description of the access control at the proposed site acceptable and that it meets the requirements of 10 CFR 72.126(a)(3) by limiting access to radiologically controlled areas.

12.3.4.3 Shielding Design, Use, and Effectiveness

The staff evaluates the proposed facility's radiation shielding in Chapter 7, "Shielding," of this safety evaluation report (SER).

12.3.4.4 Confinement and Ventilation

The staff noted that the confinement system for the proposed facility is not vented. The staff evaluates the confinement system in SER Chapter 9, "Confinement."

12.3.4.5 Area Radiation and Airborne Radioactivity Monitoring Instrumentation

In SAR Section 9.3.5, "Area Radiation and Airborne Radioactivity Monitoring Instrumentation," and SAR Section 7.6.2.4, "Environmental Monitoring," the applicant described the area radiation and airborne radioactivity monitoring instrumentation at the proposed site. All spent fuel stored

on the site will be contained within welded-shut canisters, and there are no credible events that could result in the release of radioactive material from the canisters or unacceptable increases in direct radiation levels. Therefore, area radiation and airborne radioactivity monitors are not needed at the storage pads.

External direct radiation dose rates will be monitored inside the protected area and along the owner-controlled area fences with optically stimulated luminescence (OSL) or equivalent dosimeters. Each side of the protected area and owner-controlled area fences will have one dosimeter. The dosimeters will be used to record dose rates at these locations and provide documentation that radiation levels at these boundaries are within regulatory limits. Dosimeters will also be placed on the outside of the Cask Handling Building and Security and Administration Building, and at strategic locations inside the Cask Handling Building where personnel will normally work. The dosimeters will be retrieved and processed quarterly.

The Cask Handling Building will be equipped with stationary area radiation monitors to warn personnel of abnormal radiation levels. The area radiation monitors will have audible alarms and therefore meet the requirements of American Nuclear Society Standard 6.8.1 (1981), "Location and Design Criteria for Area Radiation Monitoring Systems for Light Water Nuclear Reactors." Stationary continuous air monitors will be used to perform airborne monitoring during canister handling operations to detect minor releases of loose contamination on the exterior of the canisters and to assess the potential release of airborne radioactivity during off-normal events. Additionally, portable airborne monitoring systems may be used during receipt and transfer operations. Continuous air monitors meet the requirements of American National Standards Institute (ANSI) N13.1 (2011), "Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities." No liquid or gaseous effluent releases are anticipated from the proposed facility during storage.

The staff finds that the description of the radiation monitoring instrumentation meets the requirements of 10 CFR 72.126(c)(2) because the areas containing radioactive materials have systems for measuring the direct radiation levels in these areas. The local area monitors include alarm systems to warn workers of unusual levels of radiation in the area. Continuous air monitoring will be performed during canister handling activities to assure that airborne radioactivity is within allowable levels as required by 10 CFR 20.1501(a)(1). The use of OSL, or equivalent, monitoring as described in SAR Section 9.3.5 provides reasonable assurance that the applicant will (1) adequately monitor actual dose rates surrounding the facility during its operation, (2) detect unexpected increases in direct radiation dose rates, and (3) verify compliance with the radiological limits in 10 CFR Part 20 and 10 CFR Part 72, "Licensing requirements for the independent storage of spent nuclear fuel, high-level radioactive waste, and reactor-related greater than Class C waste," for members of the public.

12.3.5 Dose Assessment

In Section 9 of the SAR, the applicant stated that TN Americas and NAC determined the design basis dose rates for each storage cask and associated transfer cask in the final safety analysis reports (FSARs) for the NUHOMS®-MP187 System, Standardized Advanced NUHOMS Storage System, Standardized NUHOMS Storage System, NAC-MPC System, NAC-UMS® Storage System and NAC MAGNASTOR® storage system. As part of the approval process for each cask system, the staff evaluated the shielding design and dose assessment for the system. The staff concluded that the design of the radiation shielding features in each cask system is sufficient to meet the radiation protection requirements of 10 CFR Part 20, 10 CFR 72.104, and

10 CFR 72.106. The staff evaluated the shielding features of each cask system as documented in the SER approving each cask system.

In SAR Sections 9.4 and 9.6, the applicant calculated onsite and offsite dose rates for the WCS CISF based on design-basis pressurized water- reactor (PWR) and boiling-water reactor (BWR) fuel source terms with initial enrichments, burnups, and cooling times determined to be bounding in each cask system FSAR, as discussed in SER Chapter 7. The applicant calculated dose rates separately for the NUHOMS Horizontal Storage Modules (HSMs) and the NAC vertical concrete casks (VCCs), and it combined the results for both the onsite and offsite dose calculations, as discussed in SER Chapter 7. Using the neutron and gamma surface sources calculated for the NUHOMS HSMs with SNF, and surface currents calculated for the NAC VCCs with SNF and GTCC waste, the applicant calculated a dose rate at the nearest site boundary of 8.58×10^{-6} mrem per hour for 467 casks from direct and scattered radiation exposure. This calculated dose rate is approximately 0.075 mrem/year, which is significantly less than the 25 mrem per year limit for normal operations and anticipated occurrences in 10 CFR 72.104(a). As discussed in SER Chapter 9, no release of radioactive material in effluent is expected during normal operations. However, the Fuel Only, Fuel/Control Component, and Failed Fuel Dry Shielded Canisters (FO-, FC-, and FF-DSCs) of the NUHOMS-MP187 System are tested to demonstrate no leakage using a leakage rate criterion (1×10^{-5} reference cubic centimeters per second (ref-cm³/s)) that is not considered leak tight according to ANSI N14.5, "American National Standard for Radioactive Materials—Leakage Tests on Packages for Shipment." Therefore, the applicant considered a release of radioactive material from these canisters even though they are demonstrated to have no leakage to a sensitivity of 1×10^{-5} ref-cm³/s, as discussed in SAR Section A.11, "Confinement Evaluation, NUHOMS-MP187 Cask System". The site boundary dose rate of 8.58×10^{-6} mrem per hour cited above includes the dose calculated from this postulated release. The staff notes that all canisters to be stored at the facility will be subject to a post-transport package evaluation, which include a leakage rate test of the accessible portions of the canister confinement boundary with the more sensitive 1×10^{-7} ref-cm³/s criteria, demonstrating that all canisters are leak tight prior to placement in storage. Therefore, the postulated release from the FO-, FC-, and FF-DSCs described above results in a conservative estimate of dose rates at the nearest site boundary.

The applicant extrapolated the site boundary dose rate out to approximately 4 miles (6.4 kilometers) and calculated an annual dose of 5.0×10^{-13} mrem to the nearest resident, assuming the resident is continually present for 8,760 hours per year. The applicant also calculated an annual dose of 7.52×10^{-2} mrem for a hypothetical person living at the site boundary (e.g., non-facility worker), assuming the person is at the site boundary continuously for 8,760 hours per year. This dose rate is significantly less than the 10 CFR 72.104(a) dose limit of 25 mrem per year to the whole body to a member of the public. The applicant also considered cumulative doses due to nearby operations involving radioactive material, including the existing WCS low-level waste facility and the National Enrichment Facility (NEF), demonstrating compliance with 10 CFR 72.122(e). For this calculation, the applicant assumed 40,000 metric tons uranium (MTU) of spent fuel at the WCS CISF, rather than the 5,000 MTU of spent fuel being requested for Phase 1 of the WCS CISF. The applicant determined cumulative doses at nearby businesses, including Sundance Services, Permian Basin Materials, and Lea County Landfill, as well as for the nearest actual residence. The calculation discussed in SAR Section 9.4.3.3, "Annual Dose Limits to an Individual," demonstrates that the total dose rates from the WCS CISF, the WCS low-level waste facility, and the NEF are less than the 10 CFR 72.104(a) dose limit of 25 mrem per year to the whole body to a member of the public.

The applicant calculated occupational exposures for site personnel at the WCS CISF based on design basis PWR and BWR fuel source terms with initial enrichments, burnups, and cooling times determined to be bounding in each cask system FSAR, as discussed in SER Chapter 7. The occupational exposures were calculated for activities associated with the receipt of transportation packages and the transfer of canisters into the storage configuration for the spent fuel and GTCC waste casks as discussed in SAR Appendices A through H. SER Table 12-1, "Summary of WCS CISF Cask Activities and SAR Information," summarizes the information in the SAR on the cask operations, the estimated number of personnel to complete each task, task duration, the cask dose rate in the area of the performed task, and the accumulated dose from each task. The collective doses from the receipt and transfer of GTCC waste casks, discussed in SAR Appendix H, "Introduction and General Description of Installation Canisterized GTCC Waste," are bounded by the collective doses for the associated spent fuel cask designs.

Table 12-1 Summary of WCS CISF Cask Activities and SAR Information

Activity	SAR Appendix	SAR Table
Receipt of NUHOMS-MP187 transportation package with FO-, FC-, or FF-DSC	Appendix A	A.9-2
Transfer of FO-, FC-, or FF-DSC to HSM Model 80	Appendix A	A.9-3
Receipt of NUHOMS-MP187 transportation package with 24PT1 DSC	Appendix B	B.9-2
Transfer of 24PT1 DSC to NUHOMS Advanced HSM (AHSM)	Appendix B	B.9-3
Receipt of NUHOMS-MP197HB transportation package with 61BT DSC	Appendix C	C.9-2
Transfer of 61BT DSC to NUHOMS HSM Model 102	Appendix C	C.9-3
Receipt of NUHOMS-MP197HB transportation package with 61BTH Type 1 DSC	Appendix D	D.9-2
Transfer of 61BTH Type 1 DSC to NUHOMS HSM Model 102	Appendix D	D.9-3
Receipt of NAC-Storage Transport Cask (STC) transportation package with YR-MPC, CY-MPC, or MPC-LACBWR Transportable Storage Canister (TSC) and transfer to NAC-MPC VCC	Appendix E	E.9-1
Receipt of NAC-UMS transportation package with Class 1 or 2 TSC and transfer to UMS VCC	Appendix F	F.9-1
Receipt of NAC MAGNATRAN® transportation package with MAGNASTOR TSC and transfer to MAGNASTOR VCC	Appendix G	G.9-1

The total dose from receipt of a loaded transportation package, transfer of the canister into a storage cask, movement of the storage cask to the pad, and initial surveillance varies by cask system. Based on the information in the appendix tables cited above, the collective dose for receipt and transfer operations varies from 864 to 1,097 person-mrem per cask. These calculated collective doses are consistent with those calculated for other dry storage systems and facilities previously approved by the NRC and provide reasonable assurance that the facility can be operated while maintaining occupational exposures within regulatory limits.

The staff based its evaluation of site boundary and nearest residence dose assessments on information contained in the SAR and the shielding and radiation protection evaluations in the FSARs for the NUHOMS-MP187 System, Standardized Advanced NUHOMS Storage System, Standardized NUHOMS Storage System, NAC-MPC System, NAC-UMS Storage System, and NAC MAGNASTOR storage system. As discussed in SER Chapter 9, no release of radioactive material in effluents is expected. However, since the FO-, FC-, and FF-DSCs were leak tested to a less sensitive test than all the other canisters, the applicant evaluated a non-mechanistic leak of these canisters and included the resulting dose in the offsite dose totals. The staff evaluated the shielding of direct and scattered radiation dose assessments in SER Chapter 7.

The staff finds the offsite and occupational dose assessments for the facility acceptable because they show the effects of the proposed site and facility, including effects due to operation and releases under normal and accident conditions on the regional environment and populations in the region in accordance with 10 CFR 72.100. In addition, the results of these assessments and previous evaluations in the SERs for the NUHOMS-MP187 System, Standardized Advanced NUHOMS Storage System, Standardized NUHOMS Storage System, NAC-MPC System, NAC-UMS Storage System, and NAC MAGNASTOR provide reasonable assurance that the doses to workers and to members of the public will be maintained ALARA and will meet the requirements of 10 CFR 72.104 and 10 CFR Part 20. Active and passive radiation monitoring will measure the actual dose rates during facility operation to verify compliance with the radiological limits in 10 CFR Part 20 and 10 CFR Part 72. The applicant will also operate the facility under a radiation protection program to assure that radiation fields are continually monitored and radiation doses to workers and members of the public are maintained ALARA as actual dose information is gathered during operations. The staff evaluated the radiation monitoring at the facility and the radiation protection program in SER Section 12.3.4, "Radiation Protection Design Features," and Section 12.3.6, "Health Physics Program," respectively.

12.3.6 Health Physics Program

In SAR Section 9.5, "Radiation Protection Program During Operation," the applicant provided information about its health physics program.

12.3.6.1 Organization

In SAR Section 9.5.1, "Organization and Functions," the applicant described the organization of its health physics program. The Radiation Safety Officer/Director of Health and Radiation Safety reports to the Director of Operations/Construction and is responsible for administering the radiation protection program and for radiation safety at the facility. The responsibilities of the Radiation Safety Officer/Director of Health and Radiation Safety and the radiation protection technicians are consistent with the guidance contained in RGs 8.10 and 8.8.

The staff finds that the proposed radiation protection program satisfies 10 CFR 20.1101(a) with regard to the program organization described above, since it provides for a Radiation Protection Manager who reports directly to the General Manager, and radiation protection technicians.

12.3.6.2 Equipment, Instrumentation, and Facilities

In SAR Section 9.5.2, "Equipment, Instrumentation, and Facilities," the applicant described the equipment, instrumentation, and facilities that staff in the health physics program at the proposed facility will use. A sufficient inventory and variety of operable and calibrated portable and fixed radiological instrumentation will be maintained to allow for effective measurement and control of radiation exposure and radioactive material and to provide backup capability for inoperable equipment. Equipment will be appropriate to enable the assessment of sources of gamma, neutron, beta, and alpha radiation, including the capability to measure the range of dose rates and radioactivity concentrations expected. The radiological instrumentation proposed at the facility in the radiological control program is properly selected, operated, maintained, and calibrated and includes the following:

- a proportional counter for contamination smears to define surface contamination and the need for decontamination
- hand and foot contamination monitors stationed at building exits to prevent the spread of contamination
- portable monitoring equipment to augment fixed detector systems
- personnel protective equipment and clothing
- personnel dosimetry instrumentation and equipment, including the following:
 - OSL monitoring for permanent exposure records
 - self-reading dosimeters for instantaneous readout and personnel exposure control
 - computer hardware/software to record and analyze radiological monitoring/sampling and personnel exposure data
- area radiation monitors and continuous air monitors as discussed in SER Section 12.3.4

The Security and Administration Building will provide areas for radiation instrument storage, calibration, and maintenance, as well as a low-radiation background counting room with radiation measurement equipment. The Security and Administration Building also contains the access point to the protected area, and personal dosimetry is issued and controlled at this point. This building also contains areas for putting on and removing personal protective equipment, should it be required. The radiation protection program addresses the use of respiratory protection equipment, self-reading dosimetry, dose tracking, and methods for data analysis and interpretation. All personnel operating in the Cask Handling Building during canister transfer will be issued alarming dosimeters to warn of excessively high direct radiation and to provide further assurance that occupation exposures will not exceed the limits of 10 CFR Part 20.

The staff finds that the description of the health physics equipment, instrumentation, and facilities meets the requirements of 10 CFR 20.1101(a) because the equipment, instrumentation, and facilities perform surveys of direct radiation and airborne radioactivity as one element of a health physics program.

12.3.6.3 Policies and Procedures

In SAR Section 9.5.3, "Procedures," the applicant described the health physics program policies and procedures for the proposed facility. Radiological practices used to control exposure include the following procedures:

- Take contamination swipes of potentially contaminated areas (transportation packages).
- Perform radiation surveys to define and maintain acceptable radiation dose rates in the radiation areas.
- Post areas based on surveys.
- Provide radiation work permits and perform pre-operational briefings.
- Ensure appropriate job classifications include radiation protection.
- Evaluate personnel occupational radiation doses to determine if ALARA objectives are met.
- Administer personnel dosimetry programs.
- Perform instrument calibration and testing.
- Provide ALARA review of site procedures and monitoring of operations.
- Perform radiological safety training and refresher training, as described in Section 9.5.4 of the SAR.
- Maintain records of the radiation protection program, including audit and other reviews of program content and implementation, radiation surveys, instrument calibrations, individual monitoring results, and records required for decommissioning.
- Perform, monitor, and record environmental monitoring of boundaries.

The staff finds that the description of the health physics program policies and procedures, including the elements listed above, is sufficient to provide reasonable assurance that the health physics program will be implemented in accordance with 10 CFR 20.1101(a) and (b). The use of OSLs (or equivalent) to determine dose rates at the edge of the controlled area satisfies 10 CFR 20.1302(a), which requires that surveys of radiation levels are made to assure compliance with the dose limits for individual members of the public. The radiation protection program procedures provide reasonable assurance that the applicant will minimize contamination of the facility and the environment in accordance with 10 CFR 20.1406 by the use of smear surveys to identify areas of contamination and by limiting access to contamination areas. Radiation surveys and smear swab sampling, counting, and calculation will be used as required by 10 CFR 20.1501(a)(1). Procedural controls to limit intakes of radioactive materials

are in accordance with 10 CFR 20.1702, in that access may be limited and respiratory protection may be used if engineering controls are not effective in limiting airborne radioactivity. The health physics program includes adequate radiation worker training protocols, as described in Section 9.5.4 of the SAR, consistent with the recommendations of Regulatory Guides 8.8 and 8.10. The staff notes that the SAR does not indicate the frequency for reviews of the health physics program. The provisions of 10 CFR 20.1101(c) require that the health physics program be reviewed at least annually.

12.4 Evaluation Findings

Based on its review of the information in the SAR, the staff finds the following:

- The SAR includes adequately detailed descriptions of the design and operation characteristics of the WCS CISF structures, systems, and components (SSCs), including design criteria and design bases for the radiation protection evaluation and the radioactive materials to be stored at the facility, in compliance with 10 CFR 72.24(b), (c), and (l), and 10 CFR 72.120(a) and (b). The SAR also evaluates the performance of the facility's SSCs important to safety with respect to radiation protection, in compliance with 10 CFR 72.24(d).
- The SAR includes descriptions that establish the owner-controlled area and the controlled area boundary for the WCS CISF in accordance with 10 CFR 72.106(a). The descriptions show the boundary meets the minimum distance requirements in 10 CFR 72.106(b). The SAR also describes effective and appropriate arrangements to adequately protect public health and safety and adequately control traffic on public access facilities (e.g., highways, railroads, or waterways) that traverse the controlled area in compliance with 10 CFR 72.106(c).
- The design and operating procedures of the WCS CISF provide acceptable means for controlling and limiting occupational radiation exposures within the limits given in 10 CFR Part 20 and for maintaining exposures to meet ALARA objectives, in compliance with 10 CFR 72.24(e).
- The SAR provides reasonable assurance that the activities authorized by the license can be conducted without endangering public health and safety and that the operations procedures are adequate to protect health and minimize danger to life or property in compliance with 10 CFR 72.40(a)(5) and 10 CFR 72.40(a)(13).
- The proposed WCS CISF is near other nuclear facilities, specifically the existing WCS low-level waste facility and the NEF. The cumulative effects of the combined operations of these facilities will not constitute an unreasonable risk to public health and safety, in compliance with 10 CFR 72.122(e).
- The SAR provides analyses showing that the cumulative effects of the combined operations of these facilities will be within the dose limits given in 10 CFR 72.104(a). These analyses include both direct radiation and effluent releases from the WCS CISF to the general environment during normal operations and anticipated occurrences. The SAR also includes appropriate and adequate operational restrictions and limits to meet 10 CFR 72.104(a) and ALARA objectives in compliance with 10 CFR 72.104(b) and 10 CFR 72.104(c).

- The SAR analyzes the doses from accident conditions at the facility in accordance with 10 CFR 72.24(m), and these analyses show these doses will not exceed the limits in 10 CFR 72.106(b).
- The analyses in the SAR show that the doses to members of the public will not exceed the limits in 10 CFR Part 20.
- The SAR provides adequate evaluations that show the effects of the proposed site and facility, including effects due to operation and releases under normal and accident conditions on the regional environment and populations in the region in accordance with 10 CFR 72.100.
- The SAR describes adequate measures that will preclude the transport of radioactive materials to the environment through an aquifer over which the facility is located and that serves as a major water resource in accordance with 10 CFR 72.122(b)(4).
- The design of the WCS CISF provides suitable shielding for radiation protection and confinement of radioactive materials under normal, off-normal, and accident conditions, in compliance with 10 CFR 72.128(a)(2) and 10 CFR 72.128(a)(3). This includes ventilation systems and off-gas systems, continuous monitoring capability for the storage confinement systems, and high-level waste and reactor-related GTCC waste packaging that allows handling and retrievability without releases or exposures in excess of regulatory limits in accordance with 10 CFR 72.122(h)(3)–(5).
- The facility design and operations include adequate means for controlling personnel exposures and for controlling and monitoring effluents and direct radiation, in compliance with 10 CFR 72.126.
- The facility operations include programs such as the health physics program and environmental monitoring program that are needed to ensure compliance with the requirements in 10 CFR Part 20 and 10 CFR Part 72. These programs include the necessary elements to perform their intended functions, including the policies for and management commitments to the programs and their objectives.
- The proposed license technical specifications include those items necessary to ensure adequate radiation protection in the design, fabrication, construction, and operation of the DSF SSCs in accordance with the requirements in 10 CFR 72.44(c) and to meet the requirements in 10 CFR 72.44(d).
- The facility design and operations will, to the extent practicable, minimize contamination of the facility and the environment and minimize the generation of radioactive wastes in accordance with 10 CFR 20.1406(a) and 10 CFR 20.1406(c).

The staff finds, with reasonable assurance, that the radiation protection design and program for the WCS CISF meet the requirements in 10 CFR Part 20 and 10 CFR Part 72 and that the applicable design and acceptance criteria have been satisfied. The staff also finds, with reasonable assurance, that the facility design, operations, and programs are adequate to ensure compliance with the regulatory dose limits and ALARA requirements in 10 CFR Part 20 and 10 CFR Part 72 for personnel and the public. The evaluation of the radiation protection program, facility design features, ALARA objectives, and health physics program provide

reasonable assurance that the WCS CISF will allow safe storage of SNF and reactor-related GTCC waste. The staff reached this finding based on a review that considered applicable NRC regulations and regulatory guides, codes and standards, accepted health physics practices, the statements and representations contained in the SAR, and the staff's confirmatory analyses.

12.5 References

American National Standards Institute N13.1, "Sampling and Monitoring Releases of Airborne Radioactive Substances from the Stacks and Ducts of Nuclear Facilities," 2011.

American National Standards Institute N14.5, "American National Standard for Radioactive Materials—Leakage Tests on Packages for Shipment," 2014.

American Nuclear Society 6.8.1, "Location and Design Criteria for Area Radiation Monitory Systems for Light Water Nuclear Reactors," 1981.

AREVA, Inc., "Updated Final Safety Analysis Report for the Standardized Advanced NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 6, August 2014 (nonpublic). NRC Docket No. 72-1029. Transmittal dated July 13, 2016. Agencywide Documents Access and Management System (ADAMS) Accession No. ML16200A178.

AREVA TN Americas, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 14, September 2014 (nonpublic). NRC Docket No. 72-1004. Transmittal dated July 13, 2016. ADAMS Accession No. ML16218A396.

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

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

ISP, "WSC Consolidated Interim Storage Facility Safety Analysis Report," Revision 5, Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML21105A766.

NAC International, "MAGNASTOR® Final Safety Analysis Report," Revision 7, July 2015 (nonpublic). NRC Docket No. 72-1031. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A932.

NAC International, "NAC-MPC, NAC Multi-Purpose Cask, Final Safety Analysis Report," Revision 10, January 2014 (nonpublic). NRC Docket No. 72-1025. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A556.

NAC International, "NAC-UMS Universal Storage System Final Safety Analysis Report," Revision 10, October 2012 (nonpublic). NRC Docket No. 72-1015. Transmittal dated August 3, 2016. ADAMS Accession No. ML16245A212.

NRC, RG 8.8, "Information Relevant to Ensuring That Occupational Radiation Exposures at Nuclear Power Stations Will Be As Low As Is Reasonably Achievable," Revision 3, June 1978.

NRC, RG 8.10, "Operating Philosophy for Maintaining Occupational Radiation Exposures As Low As Is Reasonably Achievable," Revision 2, August 2016.

Transnuclear, Inc., "Safety Analysis Report for the NUHOMS®-MP187 Multi-Purpose Cask,"
Revision 17, July 2003 (nonpublic). NRC Docket No. 71-9255. Transmittal dated July 15, 2016.
ADAMS Accession No. ML16203A183.

13 QUALITY ASSURANCE EVALUATION

In Chapter 6, “Quality Assurance Program,” of its application, Interim Storage Partners LLC (ISP or the applicant), described its program for the proposed WCS Consolidated Interim Storage Facility (CISF) activities affecting quality associated with the site investigation, design, licensing, procurement, construction, operation, and decommissioning that are classified as important to safety or safety related.

13.1 Scope of Review

The staff reviewed the applicant’s quality assurance program (QAP) to determine whether the applicant has a QAP that complies with the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 72, “Licensing requirements for the independent storage of spent nuclear fuel, high-level radioactive waste, and reactor-related greater than Class C waste,” Subpart G, “Quality Assurance.”

13.2 Regulatory Requirements

The U.S. Nuclear Regulatory Commission (NRC) requirements relevant to the staff’s evaluation of a description of a QAP submitted as a part of the application for the proposed WCS CISF appear in 10 CFR 72.24(n).

13.3 Staff Review and Analysis

In Chapter 13, “Conduct of Operations,” of its safety analysis report, Revision 5, and Chapter 1, “General and Financial Information,” of its license application, Revision 4, ISP describes its organizational structure in which ISP is majority-owned and controlled by Orano CIS LLC, which is 100-percent owned by Orano USA LLC. Orano USA LLC is ultimately majority-owned and controlled by Orano SA, a multinational nuclear fuel cycle company headquartered in France and majority-owned by the French government. Orano TN (also known as TN Americas LLC and TN Americas) is a subsidiary of Orano USA LLC that performs transportation and logistics of materials supporting the nuclear fuel cycle. Orano CIS LLC and Orano USA LLC are both limited liability companies formed in the State of Delaware.

ISP is responsible for managing all functional areas of the WCS CISF, to include those actions necessary to comply with the applicable requirements of 10 CFR Part 71 Subpart H, 10 CFR Part 72 Subpart G, 10 CFR Part 50, Appendix B, and ASME NQA-1.

The development of the WCS CISF is managed by ISP with support from Waste Control Specialists LLC (WCS), TN Americas, and NAC International. ISP contracted TN Americas and NAC International as the vendors to provide the canister-based storage systems at the CISF. ISP’s organization consists of TN Americas personnel, WCS corporate personnel, WCS CISF personnel, and contracted support for engineering, design and operations, public affairs, and other necessary expertise. Final responsibility for construction, preoperational testing, startup, and operation of the WCS CISF remains with ISP.

The applicant stated that the TN Quality Assurance Program Description Manual (QAPDM) applies to ISP locations. The TN Americas QAP includes this QAPDM and associated implementing procedures that are designed and administered to meet the applicable

requirements of 10 CFR Part 71, "Packaging and transportation of radioactive material," Subpart H, "Quality Assurance"; 10 CFR Part 72, Subpart G; 10 CFR Part 50, "Domestic licensing of production and utilization facilities," Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants"; and American Society of Mechanical Engineers (ASME) Nuclear Quality Assurance (NQA)-1, "Quality Assurance Requirements for Nuclear Facility Applications."

The TN Americas QAPDM states that the ISP Chief Executive Officer (CEO)/President, in deference to the President of TN Americas LLC, establishes the basic policies of the QAP, and that the ISP CEO/President is the executive in charge of managing all ISP functional areas, including those actions necessary to comply with 10 CFR Part 71, Subpart H; 10 CFR Part 72, Subpart G; 10 CFR Part 50, Appendix B; and ASME NQA-1.

The staff confirmed that the TN Americas QAP includes the QAPDM and associated implementing procedures that are designed and administered to meet the applicable requirements of 10 CFR Part 71, Subpart H; 10 CFR Part 72, Subpart G; 10 CFR Part 50, Appendix B; and ASME NQA-1. Additionally, the ISP CEO/President has the authority and reporting responsibility as Responsible Officer associated with 10 CFR Part 21, "Reporting of defects and noncompliance."

The staff noted that the QAPDM that applies to TN Americas and ISP locations was developed as a means to describe the quality assurance requirements that apply to activities affecting quality associated with the design, licensing, procurement, fabrication, handling, shipping, cleaning, assembly, inspection, modification, testing, operation, repair, maintenance, and lease of storage and transport systems for spent fuel and radioactive materials that are classified as important to safety and subject to the requirements of 10 CFR Part 71 and 10 CFR Part 72.

The staff confirmed that the complete description and specific commitments of the TN Americas QAP are contained in the QAPDM previously approved and inspected by the NRC during activities related to 10 CFR Part 71, Subpart H, and 10 CFR Part 72, Subpart G, under Docket No. 71-0250.

Based on its review, the staff finds that the applicant's QAP is acceptable because it has adopted a currently approved QAP to meet 10 CFR 72.24(n) and ensured that its organization with responsibilities related to quality assurance has been incorporated appropriately.

13.4 Evaluation Findings

Based upon its review and evaluation of the QAP description contained in the application, the staff concludes the following:

- The QAP describes requirements, procedures, and controls that, when properly implemented, comply with the requirements of 10 CFR Part 72, Subpart G.
- The QAP provides control over activities affecting quality to an extent commensurate with the importance to safety as defined in the safety analysis report.
- The QAP assures conformance to the approved design of structures, systems, and components.

- The QAP assures management review of the QAP to determine program status and adequacy.
- The QAP provides for indoctrination and training of personnel performing activities affecting quality.
- The QAP establishes and delineates the authority and duties of persons and organizations performing activities affecting quality.
- The QAP provides for approved procedures or instructions to document the QAP and requires that these procedures and instructions be followed.
- The licensee's description of the QAP complies with applicable NRC regulations and industry standards, and the QAP can be implemented for the design, construction, operation, and decommissioning phases of the installation's life cycle.

13.5 References

10 CFR Part 21, "Reporting of defects and noncompliance."

10 CFR Part 71, Subpart H, "Quality Assurance."

10 CFR Part 72, Subpart G, "Quality Assurance."

10 CFR Part 50, Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

ASME NQA-1, "Quality Assurance Requirements for Nuclear Facility Application."

ISP, "License Application, Interim Storage Partners LLC," Revision 4, April 12, 2021. Agencywide Documents Access and Management System (ADAMS) Accession No. ML21105A785.

ISP, "WSC Consolidated Interim Storage Facility Safety Analysis Report," Revision 5, Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML21105A766.

TN Americas, "TN Americas LLC Quality Assurance Program Description Manual for 10 CFR Part 71, Subpart H and 10 CFR Part 72, Subpart G," Revision 16, October 8, 2018 (nonpublic). Docket No. 71-0250. ADAMS Accession No. ML18225A074. Amended by Revision 23, dated October 11, 2018. ADAMS Accession No. ML18270A114.

14 FINANCIAL QUALIFICATIONS AND DECOMMISSIONING EVALUATION

In Chapter 1, “General and Financial Information,” of its application, Interim Storage Partners LLC (ISP or the applicant) described its financial qualifications to demonstrate it can carry out the activities for which the license is sought in accordance with the applicable regulations and to meet other financial assurance requirements regarding the proposed WCS Consolidated Interim Storage Facility (CISF).

In Chapter 10, “Decommissioning Plan,” Appendix B, “Preliminary Decommissioning Plan,” and Appendix D, “Decommissioning Funding Plan,” of its application, and Section 3.5, “Decommissioning Considerations,” of the Safety Analysis Report (SAR), the applicant described its decontamination and decommissioning (D&D) cost estimate and its decommissioning funding plan describing how funds will be available to decommission the WCS CISF.

14.1 Scope of Review

The staff reviewed the applicant’s description of its financial qualifications to demonstrate its current and continuing access to the financial resources necessary to engage in the proposed activity. The staff reviewed this information to determine whether the applicant demonstrated that it possesses the adequate financial capabilities to construct and operate the proposed facility.

For decommissioning, the staff reviewed the information in the application to determine whether the applicant provided appropriate detail in describing how decontamination and decommissioning of the facility will be addressed.

14.2 Regulatory Requirements

The U.S. Nuclear Regulatory Commission (NRC) requirements relevant to the staff’s evaluation of the financial qualifications of the applicant for the proposed WCS CISF appear in the following sections of Title 10 of the *Code of Federal Regulations*:

- 10 CFR 72.22, “Contents of application: General and financial information”
- 10 CFR 72.30, “Financial assurance and recordkeeping for decommissioning”
- 10 CFR 72.54, “Expiration and termination of licenses and decommissioning of sites and separate buildings, or outdoor areas”
- 10 CFR 72.130, “Criteria for decommissioning”

An applicant must address provisions for site-specific insurance, as needed, on a case-specific basis. While financial protection requirements are not identified by NRC regulation for applicants for a license under 10 CFR Part 72, such insurance and indemnity coverage are required of NRC power reactor licensees transitioning to decommissioning. Moreover, the NRC has previously exercised its discretion on a case-specific basis to condition the approval of a spent nuclear fuel (SNF) storage license on provision of onsite and offsite financial protection provided by the applicant.

14.3 Staff Review and Evaluation

Unless otherwise stated, the staff reviewed and evaluated the financial qualifications and preliminary decommissioning plan (DP) provided by the applicant in Revision 4 of its application, documents cited in or attached to its application, and the applicant's responses to the staff's requests for additional information.

The staff also considered information in technical and legal analyses performed in support of the NRC's review of the Private Fuel Storage (PFS) facility application, received on June 20, 1997, for a license to build and operate a temporary SNF storage facility in Utah. The PFS Special Nuclear Materials license number 2513 (SNM-2513), was issued on February 21, 2006.

The staff's evaluation of the ISP application considered financial, technical, licensing, environmental, and safety related information in the safety evaluation of the PFS license application and addressed at evidentiary hearings held before the NRC's Atomic Safety and Licensing Board (ASLB) in 2000, 2002, and 2004. In its review of the ISP application, the staff considered final adjudicatory decisions issued for PFS. In particular, the staff noted the following selected quotes, and Commission decisions, in that licensing case:

In Commission Order CL-00-13, under Section III, "Financial Assurance Through License Conditions, A. Use of License Conditions to Provide Financial Assurance Under Part 72," the Commission stated:

- "We agree with the [ASLB] that license conditions can be an acceptable method for providing reasonable assurance of financial qualifications under 10 CFR Part 72;"
- "... while both Part 72 and Part 50 call for "financial assurance" showings, the two parts differ considerably on what must be shown. Part 50 prescribes in detail precisely what a reactor license applicant must demonstrate. See 10 CFR § 50.33(f); 10 C.F.R. Part 50, Appendix C. Part 72, by contrast, contains no equivalent detail; it simply sets out a broad "financial assurance" command. See 10 CFR Paragraph 72.22(e). Part 72, in other words, provides flexibility that Part 50 does not;" and
- "Our flexible approach to financial assurance in non-reactor cases appropriately reflects differing levels of risk. Utah, though, argues that the Board erroneously found that an ISFSI presents safety risks more closely comparable to an uranium enrichment plant, like the one at issue in Claiborne, than to a nuclear power reactor. According to Utah, the risks of an ISFSI are as great as those of a reactor, and therefore PFS should make the same type of detailed financial showing required of reactor license applicants under Part 50. We disagree with Utah and find the Board's risk calculus reasonable."

In its conclusion in Commission Order CL-00-13, the Commission directed the staff and PFS to include license conditions reflecting promises made by PFS during the licensing process and in support of its motion for summary judgment, addressing, among other things, adequate

financing prior to start of construction and operations. Like PFS, ISP proposed several license conditions in its application to address construction and operations funding.

For its evaluation of the applicant's decommissioning funding plan, the staff conducted its review consistent with the guidance in NUREG-1757, "Consolidated Decommissioning Guidance – Financial Assurance, Recordkeeping, and Timeliness", Volume 3, Revision 1, states the following:

- The DFP must contain a detailed decommissioning cost estimate (DCE), in an amount reflecting: (1) the cost of an independent contractor to perform all decommissioning activities, (2) an adequate contingency factor, and (3) the cost of meeting the 10 CFR 20.1402 unrestricted use criteria (or the cost of meeting the 10 CFR 20.1403 restricted use criteria, provided the licensee can demonstrate its ability to meet these criteria).
- The licensee's DFP must also identify and justify using the key assumptions contained in the DCE.
- The DFP must describe the method of assuring funds for ISFSI decommissioning, including means for adjusting cost estimates and associated funding levels periodically over the life of the ISFSI.
- The DFP must specify the volume of onsite subsurface material containing residual radioactivity that will require remediation to meet the criteria for license termination, and must contain a certification that financial assurance for ISFSI decommissioning has been provided in the amount of the DCE.

14.3.1 Financial Qualifications for ISFSI

The regulation at 10 CFR 72.22, "Contents of application: General and Financial Information," Section (e), requires, in part, that the applicant must provide information as to the cost of construction and operation of the proposed facility, and provide information showing it meets financial qualifications for funding construction and operation at the site. Specifically, the requirement states the applicant is to provide:

... information sufficient to demonstrate to the Commission the financial qualifications of the applicant to carry out, in accordance with the regulations in this chapter, the activities for which the license is sought. ...The information must show that the applicant **either possesses the necessary funds, or that the applicant has reasonable assurance of obtaining** the necessary funds or that by a combination of the two, the applicant will have the necessary funds available to cover..." estimated construction costs and estimated operating costs over the planned life of the ISFSI.

Moreover, the regulation in 10 CFR 72.40, "Issuance of license," states: (a) "... the Commission will issue a license under this part upon a determination that the application for a license meets the standards and requirements of the Act and the regulations of the Commission, and upon finding that... the applicant for an ISFSI or MRS is financially qualified to engage in the proposed activities in accordance with the regulations in this part."

The staff reviewed the reasonableness of estimated construction and operations costs provided by the applicant and evaluated the applicant's qualifications as to its ability to fund the construction and operation of the facility. The following sections present the staff's analyses.

14.3.1.1 Estimated Construction Costs

In Section 1.6, "Financial Qualifications and Financial Assurance," of its application, the applicant described the location of the CISF on land previously characterized in the submitted Environmental Report and with access roads, electricity, and water. The applicant stated that existing administration buildings, warehouses and other facilities currently used for non-CISF operations at the WCS facilities can supplement the CISF buildings and construction projects as needed. The applicant described new construction to include a rail side track, a Cask Handling Building, a Security and Administration Building, and the construction of storage pads and related storage systems. Only as needed, these structures would be constructed to reduce the initial construction costs.

The application stated that the cost to construct the facility is [REDACTED]. The following table provides a breakdown of cost:

Table 14-1: Engineering, Procurement and Construction Estimate (Millions USD)

Item	Materials	Labor	Total
Equipment for Cask Handling Building & Security Building	[REDACTED]		[REDACTED]
Initial Buildings, Infrastructure and Security Features	[REDACTED]	[REDACTED]	[REDACTED]
Construction of First Pad	[REDACTED]	[REDACTED]	[REDACTED]
Construction - Heavy lifting equipment and heavy haul equipment	[REDACTED]		[REDACTED]
Access Road Improvements	[REDACTED]	[REDACTED]	[REDACTED]
Rail Spur / Rail Siding Construction		[REDACTED]	[REDACTED]
Land Improvements		[REDACTED]	[REDACTED]
Engineering		[REDACTED]	[REDACTED]
Dry Fuel Storage specific equipment	[REDACTED]		[REDACTED]
Total Phase I	[REDACTED]	[REDACTED]	[REDACTED]
Contingency (30%)			[REDACTED]
TOTAL			[REDACTED]

In order to evaluate the reasonableness of this estimate, staff reviewed estimated ISFSI construction costs presented in a 2009 study performed by the Electric Power Research Institute (EPRI) for a generic, away-from-reactor ISFSI (GISF). The study entitled, "Cost Estimate for an Away-From-Reactor Generic Interim Storage Facility (GISF) for Spent Nuclear Fuel," provided detailed evaluations of capital costs required to construct a GISC, including those for establishing the necessary transportation infrastructure required to serve the GISC; GISC buildings, equipment, and infrastructure; and equipment needed to load and transport SNF from nuclear power plants. The study presented costs that are representative of capital costs associated with the design, engineering and licensing of a GISC.

Based on the study, EPRI estimated capital expenditure costs of \$270 million (2009 dollars) for a facility designed to store 20,000 MTU. In order to scale this estimate to reflect ISP's plan for an initial license to store 5,000 MTU, the staff included the start-up and engineering costs (fixed at ~ \$67 million), reduced the EPRI estimate of variable costs by 75-percent, and applied a 19-percent increase to that cost estimate to account for inflation between January 2009 (the year of the report's publication) and March 2020 (when ISP's RAI response was received). Based on this information and the EPRI report data, staff estimated the cost to construct the proposed WCS CISF would equal approximately \$141 million (2019 dollars).

Based on its evaluation, the staff finds the applicant's construction cost estimate of

reasonable because

14.3.1.2 Estimated Operation Costs

In Section 1.6 of its application, the applicant stated that WCS currently operates a facility that treats, stores and disposes of hazardous wastes and low-level radioactive waste (LLRW) licensed by the Texas Commission on Environmental Quality. The applicant also stated that the existing facility has existing operations and administrative personnel, licensing, environmental monitoring and compliance programs, health and safety programs, health physics, insurance policies and financial assurance mechanisms and other programs approved by cognizant regulatory authorities as would be required of any similar facility. The applicant noted that many of these same activities and related costs would also be required of a CISF and will be available to ISP.

The applicant provided five years of projected operating costs, detailed in the table below:

Table 14-2: ISP CISF Operating Costs (\$millions)

Year	1	2	3	4	5
Labor Costs					
Administrative					
Security					
Engineering and Technical					
Maintenance and Equipment operations					
Other Operating Costs					
State Inspection Fees					
Equipment and Maintenance					
Licensing and Regulatory Fees					
Overpacks					
Licensing Amendments					
Utilities					
LLW Disposal					
Office Expenses					
Decommissioning Bond Interest					
Lease Expense					

Year	1	2	3	4	5
State/County Fee Sharing					
Decommissioning Expense					
Total Operating Cost					

In order to evaluate the reasonableness of this estimate, staff reviewed estimated ISFSI operations costs identified in two GAO reports:

- “Nuclear Waste Management; Key Attributes, Challenges, and Costs for the Yucca Mountain Repository and Two Potential Alternatives,” January 2009, provided annual operations and maintenance costs for a centralized storage facility.
- “Spent Nuclear Fuel Management; Outreach Needed to Help Gain Public Acceptance for Federal Activities That Address Liability,” October 2014, provided safety and security system and annual operational costs for dry storage at a shutdown reactor site.

The 2009 GAO publication (page 54) estimated \$8.8 million in operations costs for a CISF. The staff applied a 19-percent increase in the operations cost for a CISF to account for inflation which resulted in an approximate \$10.5 million annual cost, in 2019 dollars. The 2014 GAO publication (page 52) estimated \$2.5 to \$6.5 million in annual operations and other related costs with negligible inflation from 2014 through 2018, at approximately 5-percent during that time period.

Based on its review of the application, the staff finds that the ISP operations cost estimate of [REDACTED] reasonable because [REDACTED]

14.3.1.3 Funding Construction and Operations

The staff reviewed portions of the PFS SE germane to financial qualifications and considered Commission decisions supporting the licensing of PFS. The staff notes that the Commission found, in the PFS licensing proceeding, that an ISFSI presents lesser risks than a reactor, and that a 10 CFR Part 72 applicant need not meet the detailed financial qualifications requirements found in 10 CFR Part 50. Furthermore, the Commission found that a precisely drawn license condition, so that verification of compliance is a largely ministerial act, is an appropriate way of meeting the financial qualifications requirements found in 10 CFR Part 72.

14.3.1.3.1 Construction Funding

In Section 1.6 of its application, [REDACTED]

[REDACTED] The applicant stated in proposed License Condition 14 that, “Construction of the WCS CISF shall not commence before funding (equity, revenue, and debt) is fully committed, that is adequate to

construct a facility with the initial capacity as specified by the Licensee to the NRC. Construction of any additional capacity beyond the initial capacity amount shall commence only after funding is fully committed that is adequate to construct such additional capacity.” The amount of funding needed to meet this license condition is identified in Table 14-1 as ‘TOTAL’. The staff finds that, based on the funding plan and the license condition, there is reasonable assurance that the applicant will obtain the funds necessary to construct the facility prior to commencing construction.

14.3.1.3.2 Operations Funding

In Section 1.6 of its application, the applicant stated that funding of the operating costs will be through contracts with the customers of ISP, whether the U.S. Department of Energy (DOE) or SNF title holders. Also, the applicant proposed License Condition 19 which states that, prior to commencement of operations, the Licensee shall have an executed contract with DOE or other SNF title holder(s) stipulating responsibility for funding operations required for storing the material identified in License Conditions 6.A, 6.B, 7.A, or 7.B at the CISF. The projected amount of funds needed is listed in Table 14-2. License Condition 19 may be met with a single executed contract or multiple executed contracts.

Additionally, the applicant proposed License Condition 15, which specifies provisions that must be included in its contracts with clients. The provisions include: a requirement that clients retain title to the material identified in License Conditions 6.A, 6.B, 7.A or 7.B; provisions allocating legal and financial liability among the Licensee and the client(s); provisions requiring clients to periodically provide credit information and, when necessary, additional financial assurances such as guarantees, prepayment, or payment bond(s); and a provision requiring the Licensee not to terminate the license prior to furnishing storage services covered by the contract. These conditions are consistent with conditions previously found acceptable (including by the Commission or Licensing Board) to ensure compliance with the financial assurance requirements of 10 CFR Part 72, “Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste.”

The staff finds that, based on the projected amount of funds needed for operation and the license conditions described above, there is reasonable assurance that the applicant will obtain the funds necessary for operating the facility.

14.3.1.3.3 Financial Qualifications Summary

Based on its evaluation discussed above, the staff finds that the applicant provided a reasonable construction cost estimate and an operations cost estimate for the proposed CISF and therefore meets the requirements in 10 CFR 72.22 and the guidance in NUREG-1757. Therefore, the staff concludes that the applicant has reasonable assurance of obtaining the funds necessary to cover estimated construction and operation costs associated with the proposed CISF, based on proposed license conditions set forth in the license application.

14.3.2 Decommissioning Plan

The staff reviewed the WCS CISF preliminary decommissioning plan (DP) provided by the applicant to determine whether the provisions for decommissioning the facility give reasonable assurance that decontamination and decommissioning of the facility at the end of its useful life will provide adequate protection of public health and safety.

The staff's focus was on the overall adequacy and completeness of the preliminary DP, including proposed decontamination and decommissioning activities. The applicant stated that the objectives of its decommissioning activities at the WCS CISF are to verify that any potential radioactive contamination is below release limits and if there is any contamination, to identify and remove radioactive contamination that is above NRC release limits so that the site may be released for unrestricted use and the NRC license terminated. Upon completion of operations at the WCS CISF, the applicant proposed to submit a final DP addressing any spills, leaks or other occurrences during operations.

The applicant noted its plans to implement measures to minimize the potential for contamination, thereby facilitating decontamination and decommissioning. The applicant stated that these measures depend upon the use of multipurpose canisters to ship and store the SNF and reactor-related Greater than Class C (GTCC) waste from commercial nuclear power plants. The applicant proposed to use canisters welded shut and sealed at the reactor facilities to prevent leaks, surveyed before shipment to the WCS CISF, and upon arrival at the WCS CISF, to determine the acceptability into the WCS CISF. The applicant noted that the canisters will not be opened during handling or storage at the WCS CISF and health physics technicians will be involved in all parts of canister movement and transfer operations. The applicant stated that technicians will perform surveys of all applicable components during and after the transfer process to verify that any contamination is below acceptable limits, and to identify and control the spread of contamination should an unexpected event occur. The applicant stated that the canisters are readily removable from the CISF regardless of the vertical or horizontal storage configuration.

The applicant stated in its preliminary DP that its DP will include initial characterization surveys to identify any areas of contamination requiring decontamination and/or disassembly and that it will use the following records to plan final decommissioning efforts:

- Records of spills or unplanned occurrences involving the spread of radiation.
- As-built drawings of structures, components and equipment used in the storage of radioactive material.
- Documentation of all areas designated at any time as restricted area and all other areas involved in the spread of contamination.
- Decommissioning cost estimates and funding method used.

The applicant also stated that the DP will include Derived Concentration Guidelines as clean-up criteria and a Final Status Survey plan. Contaminated components will be disassembled as necessary and sent to a licensed facility for disposal. The applicant committed to maintain records until the facility is released for unrestricted use. SER Sections 14.3.2.1 through 14.3.2.3 discuss the staff review of the design and operating features and general provisions discussed in the preliminary DP and how that information meets the applicable requirements of 10 CFR 72.30 and 10 CFR 72.130. SER Section 14.3.2.4 discusses the staff review of the decommissioning funding plan and DCE, and SER Section 14.3.2.5 discusses the staff review of the financial assurance mechanism.

14.3.2.1 Design Features

The staff reviewed the information in the application related to the design of the WCS CISF. The applicant described the WCS CISF as a facility designed to accept commercial SNF and GTCC waste contained in dual-purpose (transportation/storage) cask and canister-based cask systems previously certified by the NRC. As part of the certification process, the NRC evaluated the casks and canister systems for the ability to withstand normal use and design basis accidents, to confine SNF within the casks, to prevent leaks, and to support retrievability. The applicant proposed to use six previously certified cask systems including three NUHOMS® storage systems along with the NAC-MPC, NAC-UMS®, and MAGNASTOR® storage systems.

The applicant described the transfer of the canister-based dry storage systems from the transportation cask to the storage overpack in either the Cask Handling Building or the Storage Area, depending on the canister system design. The applicant further stated that all transfer and handling activities will be accomplished in a dry mode using canister transfer equipment and CISF structures, systems, and components (SSCs) because the WCS CISF design does not employ a SNF pool or other bare fuel handling capability. The applicant asserted that these factors lessen the chance of contamination and facilitate decontamination and decommissioning.

In its application, the applicant stated that small volumes of solid radioactive waste may be produced from routine operations involving contamination surveys and decontamination activities for incoming and outgoing transportation dry storage systems and equipment. The applicant included plans for collecting and temporarily storing potential solid waste streams on site until authorization under WCS LLRW License RML R04100 allows for processing and disposal. SER Section 15.3.4, "Solid Wastes," discusses the staff's review of the applicant's LLRW collection and temporary storage plans. Any waste generated will be temporarily stored onsite and sent to a licensed facility for disposal. The applicant stated that it does not expect the generation of gaseous and liquid wastes at the WCS CISF. The staff finds that temporarily storing small volumes of solid waste and transfer to a licensed disposal facility should ensure that workers and the public are protected.

The applicant stated in the preliminary DP and in Chapters 1 and 10 of the license application that waste containers (i.e., canisters containing SNF or GTCC waste) will not be opened at the WCS CISF, so the SNF will not be exposed to the CISF facilities, water, air or the surrounding environment and, therefore, the likelihood of a contamination event is considered very low and unlikely. The licensee will operate the WCS CISF as a "start-clean/stay-clean" facility, and the WCS CISF will operate in a manner that supports decommissioning activities throughout the life of the facility. Continual radiological surveillance during the operational period will ensure that any contamination is promptly discovered, identified, and removed in a timely manner before the decommissioning period begins. The applicant stated that contamination controls will minimize the possibility that storage modules will have radioactive contamination above the release limits and that, in the unlikely event the characterization surveys identify contamination levels above the NRC limits for unrestricted release, conventional decontamination techniques will be used which minimize the volume of waste.

Based on its review of the information discussed above, the staff finds that the WCS CISF design features described in the application satisfactorily facilitate decontamination, minimize the quantity of radioactive waste, and contaminated equipment, and facilitate removal of radioactive wastes and contaminated material when the CISF is decommissioned consistent with the requirements in 10 CFR 72.30 and 10 CFR 72.130.

14.3.2.2 Operational Features

In the preliminary DP, the applicant stated that the WCS CISF will be operated as a clean facility, and only sealed canisters that have been surveyed and determined to be free from contamination will be accepted for storage at the WCS CISF. Because the canisters will remain sealed at the WCS CISF, the applicant stated that contamination of the storage modules, storage pads, and the Cask Handling Building is not anticipated.

The applicant stated that health physics technicians will be involved in all parts of the canister movement and transfer to survey all applicable components during and after the transfer process, and to identify and control the spread of contamination from the transfer facility to the storage pads. As described in the SAR, the applicant stated that the storage pads will be conventional cast-in-place concrete mat structures designed to provide a level and stable surface for placement of storage overpacks and not relied on for any confinement.

The SAR noted that the canisters are licensed and maintained for off-site transportation. The SAR also noted that loaded canisters will be stored at the WCS CISF until their transfer to a geologic repository for ultimate disposal or other site as directed by the DOE or other title holder of SNF or GTCC waste.

In SAR Section 3.5, "Decontamination Considerations", the applicant stated that because contamination of the outer surface of the canisters is minimized, it does not expect contamination of any CISF equipment or on the internal passages of the storage overpacks. However, the applicant stated that the storage overpacks could become slightly radioactive due to neutron activation; therefore, the overpacks will remain at the CISF until dismantled and disposed of using commercial demolition and disposal techniques. The applicant acknowledged that small quantities of radioactive material could be generated during routine operations, primarily from radiological surveys conducted at the CISF. To be conservative, the applicant assumed in the preliminary DP that some contamination will exist during decommissioning for its DCE.

In the preliminary DP, the applicant committed to maintaining records that will be used to plan final decommissioning efforts throughout operations and until the CISF is released for unrestricted use. These records include:

- Spills or unplanned occurrences involving the spread of radiation.
- As built drawing of structures, components and equipment used in the storage of radioactive materials.
- Documentation of all areas designated at any time as restricted and all other areas involved in the spread of contamination.
- DCEs and funding method used.

Based on its review of the information described above, the staff finds that the information in the preliminary DP satisfies the requirements of 10 CFR 72.30 and 10 CFR 72.130 because the operational features minimize the quantity of radioactive waste and contaminated equipment and facilitate decontamination and the removal of contaminated material, and the applicant

committed to maintain records of spills or other unplanned occurrences that will be addressed in the DP.

14.3.2.3 General Provisions

The staff reviewed the applicant's preliminary DP which identified design features such as the use of sealed canisters to prevent contamination and readily removable canisters to avoid spills and facilitate decommissioning. The preliminary DP also identified operational features such as maintaining a clean in/clean out facility to avoid contamination and conducting in-process surveys by health physics technicians in all canister movement and transfer operations to minimize and identify any contamination early. In addition, the preliminary DP discussed a decommissioning funding plan, cost estimate and financial assurance mechanism.

Based on its review of the information described above, the staff concludes that the preliminary DP provides an acceptable level of detail to satisfy the requirement in 10 CFR 72.30(c) because throughout operations and until the CISF is released for unrestricted use, the applicant will be maintaining records of spills or unplanned occurrences, as built drawing of structures, components and equipment used in the storage of radioactive materials and documentation of all restricted areas. This information is critical in the development of the DP that will be submitted after operations cease. The applicant also committed to include the Derived Concentration Guidelines as clean-up criteria and a Final Status Survey plan in the DP.

14.3.2.4 Cost Estimate

In Section 1.6, "Financial Qualifications and Financial Assurance," of its application, the applicant stated that the decommissioning costs will be kept to a minimum by designing and operating the CISF in a manner that minimizes contamination pursuant to 10 CFR 20.1406 and 10 CFR 72.130. The applicant described in the SAR that the likelihood of a contamination event is considered very low and unlikely because the waste canisters will not be opened while stored at the site and it plans to operate the facility as a "start-clean/stay-clean" facility which supports decommissioning activities throughout the life of the facility.

In the decommissioning funding information submitted by the applicant in Chapter 10 of the application and in the preliminary DP, the applicant estimated the total cost to decommission the WCS CISF for unrestricted use at \$12,643,596 (2018 dollars), which includes a 25-percent contingency. The applicant identified key decommissioning cost element expenditures as follows:

- Planning and Preparation \$444,300
- Decontamination or Dismantling of Radioactive Facility Components \$489,000
- Packaging, Shipping, and Disposal of Radioactive Waste \$74,400
- Final Radiation Survey \$5,755,400
- Packing Materials \$61,805
- Shipping Costs \$11,160
- Waste Disposal \$24,579
- Equipment/Supply \$397,825
- Laboratory \$915,408
- Miscellaneous \$441,000
- Contractor Overhead/Profit \$1,500,000
- Contingency (25%) \$2,528,719

Staff found the detailed estimate provided by ISP followed the guidance of NUREG-1757 and contained all the required information. Moreover, based on its analysis of ISP's application, the staff determined that the submitted DCE was based on reasonable costs of a third-party contractor; included an adequate contingency factor; and was based on reasonable and documented assumptions, in accordance with the requirements for decommissioning funding plans in 10 CFR 72.30(b). Therefore, the staff finds that the DCE adequately estimates the cost, at this time, to carry out required CISF decommissioning activities prior to license termination, and that the DCE is acceptable.

14.3.2.5 Financial Assurance Mechanism

The Commission's regulations require that financial assurance for decommissioning a 10 CFR Part 72 facility, such as proposed by ISP, must be provided by one or more of the following methods, pursuant to 10 CFR 72.30(e):

- Prepayment prior to the start of operations in the form of a trust;
- A surety method, insurance, or other guarantee method. These methods guarantee that decommissioning costs will be paid;
- An external sinking fund in which deposits are made at least annually, coupled with a surety method, insurance, or other guarantee method, the value of which may decrease by the amount being accumulated in the sinking fund.

In Section 1.6 of its application, the applicant stated that it will use a surety bond combined with an external sinking fund as authorized by 10 CFR 72.30(e)(3), and payments from storage operations will be deposited into the external sinking fund as waste is received. The applicant described that a surety bond will be used to assure the difference in the DCE and the value of the sinking fund until the sinking fund is fully funded. The applicant also proposed License Condition 20 to ensure that it will have funding in place before SNF is received on site.

In consideration of the above, the staff determined that the applicant, per requirements at 10 CFR 72.30, has provided a thorough and reasonable DCE for decommissioning the proposed CISF. The staff determined that the applicant's plan to provide a decommissioning financial assurance instrument provides reasonable assurance that the proposed CISF facility will be decommissioned.

14.3.3 ISP Onsite and Offsite Nuclear Insurance

In Section 1.6 of the application, the applicant committed to obtain and to maintain nuclear liability insurance in the amount of \$100 million to address offsite liability and \$450 million for onsite liability. The NRC does not have specific insurance and indemnity requirements for 10 CFR Part 72 facilities. Therefore, the staff finds the applicant's commitment to provide nuclear liability insurance per proposed License Condition 16 acceptable.

14.4 Evaluation Findings

Based on information in the application, the staff concludes that:

- The SAR includes an adequate description to demonstrate the financial capabilities to construct, operate, and decommission the installation, as required by 10 CFR 72.22(e).
- The applicant's preliminary DP provides reasonable assurance that decommissioning issues for the ISFSI facility have been adequately characterized, so that the site will ultimately be available for unrestricted use for any private or public purpose and therefore, meets the requirements in 10 CFR 72.30(a).
- The applicant's decommissioning funding plan documentation for the ISFSI facility is sufficient to provide reasonable assurance that costs related to decommissioning, as characterized by the preliminary DP, have been adequately estimated and therefore, meets the requirements in 10 CFR 72.30(b).
- The applicant's financial assurance mechanisms are sufficient to provide reasonable assurance that adequate funds will be available to decommission the facility so that the site will ultimately be available for unrestricted use for any private or public purpose and, therefore, meets the requirements in 10 CFR Part 72.

14.5 References

Code of Federal Regulations, Title 10, Part 21, "Reporting of Defects and Noncompliance."

Code of Federal Regulations, Title 10, Part 50, "Domestic Licensing of Production and Utilization Facilities."

Code of Federal Regulations, Title 10, Part 71, "Packaging and Transportation of Radioactive Materials."

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

Electric Power Research Institute, "Cost Estimate for an Away-from-Reactor Generic Interim Storage Facility (GISF) for Spent Nuclear Fuel," 2009.

ISP, "WSC Consolidated Interim Storage Facility Safety Analysis Report," Revision 5, Docket No. 72-1050, April 12, 2021. Agencywide Documents Access and Management System (ADAMS) Accession No. ML21105A766.

NRC, NUREG-1757, "Consolidated Decommissioning Guidance," Volume 3, Revision 1, "Financial Assurance, Recordkeeping, and Timeliness," February 2012. ADAMS Accession No. ML12048A683.

NRC, Memorandum and Order CLI-00-13, Docket No. 72-22, August 1, 2000. ADAMS Accession No. ML003737270.

NRC, License for Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste, License No. SNM-2513, issued to Private Fuel Storage LLC, for the Private Fuel Storage Facility, issued February 21, 2006. ADAMS Accession No. ML060450438.

NRC, Regulatory Guide 3.65, "Standard Format and Content of Decommissioning Plans for Materials Licensees," Revision 1, May 2008. ADAMS Accession No. ML081130703.

NRC, "Consolidated Safety Evaluation Report Concerning the Private Fuel Storage Facility, Chapter 17, Financial Qualifications and Decommissioning Funding Assurance, March 2002, Docket No. 72-22. ADAMS Accession No. ML020660749.

U.S. Government Accountability Office, "Nuclear Waste Management: Key Attributes, Challenges, and Costs for the Yucca Mountain Repository and Two Potential Alternatives," November 2009.

U.S. Government Accountability Office, "Spent Nuclear Fuel Management: Outreach Needed to Help Gain Public Acceptance for Federal Activities that Address Liability," October 2014.

15 WASTE CONFINEMENT AND MANAGEMENT EVALUATION

In Chapter 6, “Waste Confinement and Management,” of the safety analysis report (SAR), Revision 5, Interim Storage Partners LLC (ISP or the applicant) described its analysis of the waste management systems for the proposed WCS Consolidated Interim Storage Facility (CISF).

15.1 Scope of Review

The staff reviewed the applicant’s waste management analysis to determine whether the facility provides safe confinement and management of radioactive waste generated at the facility, and whether the generation of radioactive waste and release of the radioactive material to the environment meet regulatory requirements.

15.2 Regulatory Requirements

The U.S. Nuclear Regulatory Commission requirements relevant to the waste confinement and management systems evaluation of the proposed WCS CISF appear in the following parts and sections of Title 10 of the *Code of Federal Regulations* (10 CFR):

- 10 CFR Part 20, “Standards for protection against radiation”
- 10 CFR Part 61, “Licensing Requirements for Land Disposal of Radioactive Waste”
- 10 CFR 72.40, “Issuance of license”
- 10 CFR 72.104, “Criteria for radioactive materials in effluents and direct radiation from an ISFSI or MRS”
- 10 CFR 72.122, “Overall requirements”
- 10 CFR 72.126, “Criteria for radiological protection”
- 10 CFR 72.128, “Criteria for spent fuel, high-level radioactive waste, reactor-related Greater than Class C waste, and other radioactive waste storage and handling”

15.3 Staff Review and Analysis

Unless otherwise stated, the staff reviewed and evaluated the waste management systems analysis provided by the applicant in Revision 4 of its application, documents cited in or attached to its application, and the applicant’s responses to the staff’s requests for supplemental and additional information.

15.3.1 Waste Sources

The staff reviewed the sources of radioactive waste described in SAR Section 6.1, “On-Site Waste Sources,” that included consideration of dry solid radioactive waste produced during operation of the facility.

The applicant described the radioactive waste sources, which are limited to wastes produced during the operation of the facility. The applicant stated that the solid waste will consist of anticontamination clothing, rags, and associated health physics materials that will be packaged and temporarily stored in a designated radiologically controlled area until the waste is characterized and shipped to a licensed disposal facility. The applicant stated that the canisters arriving at the facility are expected to have minimal, if any, external surface contamination because the external surfaces of the transportation casks are surveyed and decontaminated, as

necessary, before the cask leaves the originating site for the WCS CISF. The applicant stated that a canister would not be transported to the facility if surveys performed at the originating power plant indicated that the surface contamination levels exceed the acceptable limits for the specific canister design. In addition, the applicant noted that a canister would not be accepted at the facility if surveys conducted upon receipt indicated that surface contamination exceeds the acceptable limits. As described in the application, the canisters are sealed by welding and would not be opened at the facility. Because the welded canisters are designed not to be breached under normal and off-normal conditions of transfer, handling, and storage, the applicant stated that no release of radioactive materials from inside the canister is expected under these conditions.

Based on its review, the staff finds that the applicant adequately described the waste sources at the facility and that there are no routine effluents discharged to the environment due to the operation of the facility, including during normal and off-normal conditions. Since there are no liquid or gaseous effluents, the staff finds that the application meets the requirements of 10 CFR 72.122(b)(4) precluding transport of radioactivity to an aquifer and the dose limits of 10 CFR 72.104(a) with respect to the release of effluents. Lastly, the staff finds that the application meets the requirements of 10 CFR 72.128(a)(5) to limit the generation of radioactive waste because the canisters are surveyed for surface contamination before transport to the facility and upon arrival at the facility, the canisters are designed with a welded closure, and the canisters are not opened at the facility.

15.3.2 Off-Gas Treatment and Ventilation

In SAR Section 6.2, "Off-Gas Treatment and Ventilation," the applicant discussed off-gas treatment and ventilation. The applicant stated that the facility will handle only sealed canisters; therefore, the applicant does not expect gaseous releases from the storage systems at the facility.

Based on its review, the staff finds that under normal operations, no radioactive materials will be released to the environment as gaseous effluents; therefore, no special off-gas or ventilation systems are needed. Thus, the staff concludes that the application meets the requirements of 10 CFR 72.122(h)(3), 10 CFR 72.126(c)(1), 10 CFR 72.126(d), 10 CFR 72.128(a)(5), and 10 CFR 72.128(b). Since there are no gaseous effluents, the staff finds that the design and operation of the facility meet the requirements in 10 CFR 72.104(a), (b), and (c) for offsite doses from effluents.

15.3.3 Liquid Waste Treatment and Retention

In SAR Section 6.3, "Liquid Waste Treatment and Retention," the applicant discussed the facility's liquid waste treatment and retention program. The applicant stated that no liquid radioactive wastes are generated by the receipt and transfer of canisters containing spent nuclear fuel or greater-than-Class-C waste at the WCS CISF.

Based on its review, the staff finds that special liquid radioactive waste treatment and retention systems are not needed at the facility because no liquid radioactive effluents will be discharged to the environment under normal operations. Thus, the staff concludes that the facility meets the requirements in 10 CFR 20.2001, "General requirements"; 10 CFR 20.2003, "Disposal by release into sanitary sewerage"; 10 CFR 72.122(b)(4); and 10 CFR 72.126(c)(1) and (d) with respect to the possible release of radioactive material in liquid effluents. Since there are no

liquid effluents, the staff finds that the design and operation of the facility meet the requirements in 10 CFR 72.104(a), (b), and (c) for doses from liquid effluents.

15.3.4 Solid Wastes

In SAR Section 6.4, “Solid Wastes,” the applicant discussed the facility’s solid waste generation, collection, handling, and disposal program. The applicant described that decontamination activities will generate solid waste at the facility, including a small amount in the form of smears, disposable clothing, tape, blotter paper, rags, and related health physics materials. The applicant further described that solid waste will be identified and packaged in suitable low-level waste containers, temporarily stored in a designated radiologically controlled area, and then transferred to an offsite low-level waste disposal facility. The applicant stated that it expects independent spent fuel storage installation operations to generate a minimal volume of solid waste.

Based on its review, the staff finds that the applicant’s provisions for handling solid wastes are appropriate and meet the requirements of 10 CFR 72.128(b). Because the applicant’s method would not be expected to produce radioactive effluents, the staff finds that the application meets the requirements of 10 CFR 72.104(a), (b), and (c) with respect to doses from effluents, and of 10 CFR 72.122(h)(3) with respect to releases of effluents. Any waste generated at the facility is required to be classified and managed in accordance with 10 CFR Part 61 for disposal.

15.3.5 Radiological Impact of Normal Operations

In SAR Section 6.5, “Radiological Impact of Normal Operations Summary,” the applicant discussed the radiological impact of the facility’s activities during normal operations. The applicant summarized the radiological impact of normal operations and stated that under all normal and off-normal conditions of transfer, handling, and storage, the welded canisters will remain sealed and no radioactive material will be released from inside the canister. Additionally, the applicant proposed practices and procedures to limit and control contamination at the facility to assure that radiological impacts are minimized and that the principles of “as low as reasonably achievable” are maintained. The applicant stated that no release of radioactive material to the environment is expected during normal facility operations, and no liquid or gaseous effluents are anticipated from the facility. Thus, the applicant concluded that the radiological impacts to the environment from normal operations at the facility will be minimal.

Because the canisters are sealed and the impacts were found to be minimal, based on its review, the staff determined that the radiological impact of the facility under normal operations has been adequately and appropriately described, and that the radiological impacts from releases will be minimal and will not endanger public health and safety. Based on these considerations, the staff finds that the application meets the requirements of 10 CFR 20.1101, “Radiation protection programs,” with respect to potential releases of radioactive materials under normal operations, and 10 CFR 72.40(a)(13)(i); 10 CFR 20.1301, “Dose limits for individual members of the public”; and 10 CFR 20.1302, “Compliance with dose limits for individual members of the public,” with respect to doses to members of the public from potential releases of radioactive materials under normal operations. Any waste generated at the facility is required to be classified and managed in accordance with 10 CFR Part 61 for disposal. The staff reviewed and evaluated the dose to members of the public in Chapter 7, “Shielding Evaluation”; Chapter 9, “Confinement Evaluation”; and Chapter 12, “Radiation Protection Evaluation,” of this safety evaluation report.

15.4 Evaluation Findings

Based on its review, the staff finds that the waste confinement and management program of the proposed facility does the following:

- meets the requirements in 10 CFR 20.2001, 10 CFR 20.2003, 10 CFR 72.104(b), 10 CFR 72.104(c), 10 CFR 72.122(b)(4), 10 CFR 72.122(h)(3), 10 CFR 72.126(c)(1), and 10 CFR 72.126(d) with respect to the potential release of effluents to the environment
- meets the radioactive waste management and minimization requirements in 10 CFR 72.128(a)(5) and 10 CFR 72.128(b)
- meets the dose limits for members of the public in 10 CFR 20.1101, 10 CFR 20.1301, 10 CFR 20.1302, and 10 CFR 72.104(a) with respect to radioactive materials released as effluents
- will not endanger public health and safety as required by 10 CFR 72.40, with respect to radioactive materials released as effluents

15.5 References

Code of Federal Regulations, Title 10, Part 20, “Standards for Protection Against Radiation.”

Code of Federal Regulations, Title 10, Part 61, “Licensing Requirements for Land Disposal of Radioactive Waste.”

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

Interim Storage Partners LLC, “Submission of Revision 5 of the Safety Analysis Report and Revision 4 of the License Application for the WCS CISF,” Docket No. 72-1050, April 12, 2021. Agencywide Documents Access and Management System Accession No. ML21105A766.

16 ACCIDENT ANALYSIS

In Chapter 12, “Accident Analysis,” of the safety analysis report (SAR), Interim Storage Partners LLC (the applicant) described its engineering analyses to qualify the storage and transportation systems received at the proposed WCS Consolidated Interim Storage Facility (CISF) for off-normal operating conditions and for a range of credible and hypothetical accident conditions. Consistent with the guidance in Regulatory Guide (RG) 3.48, “Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage),” Revision 1, issued August 1989, the applicant used the design events identified by the American National Standards Institute (ANSI) and the American Nuclear Society (ANS) in ANSI/ANS 57.9-1984, “Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type),” to form the basis for the accident analyses for the WCS CISF storage and transportation systems.

16.1 Scope of Review

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed and evaluated the accident analysis of the proposed facility discussed in Chapter 12 of Revision 5 of the SAR, dated April 12, 2021, documents cited in or attached to the SAR, and the applicant’s responses to the staff’s requests for additional and supplemental information. In SAR Section 1.1, “Introduction,” the applicant stated that the WCS CISF will store spent nuclear fuel (SNF) in cask systems that the NRC has previously approved. The applicant described its analysis of off-normal and accident conditions for the approved storage systems in SAR Chapter 12 and the cask design-specific appendices to the SAR. The applicant referenced the associated systems’ storage final safety analysis reports (FSARs) and transportation system SARs; these provide design-basis information about radiological hazards for the individual systems to be used at the WCS CISF.

16.2 Regulatory Requirements

The regulatory requirements relevant to accident analysis for the proposed WCS CISF appear in the following sections of Title 10 of the *Code of Federal Regulations* (10 CFR):

- 10 CFR 72.24, “Contents of application: Technical information”
- 10 CFR 72.90, “General considerations”
- 10 CFR 72.92, “Design basis external natural events”
- 10 CFR 72.94, “Design basis external man-induced events”
- 10 CFR 72.104, “Criteria for radioactive materials in effluents and direct radiation from an ISFSI or MRS”
- 10 CFR 72.106, “Controlled area of an ISFSI or MRS”
- 10 CFR 72.122, “Overall requirements”
- 10 CFR 72.124, “Criteria for nuclear criticality safety”
- 10 CFR 72.126, “Criteria for radiological protection”
- 10 CFR 72.128, “Criteria for spent fuel, high-level radioactive waste, reactor-related Greater than Class C waste, and other radioactive waste storage and handling”

These requirements ensure that an applicant identifies and evaluates the hazards for off-normal and accident or design-basis events involving systems, structures, and components (SSCs) that are important to safety (ITS).

16.3 Staff Review and Analysis

The NRC staff evaluated the applicant's analysis of off-normal events and postulated accident events for the WCS CISF by reviewing the information in the SAR. The staff reviewed this information to establish whether the WCS CISF system designs satisfy the applicable operational and safety requirements.

The applicant stated that the FSARs for the referenced storage systems identify design-basis events that are classified as either normal, off-normal, or accidents for each approved system. The applicant described normal, off-normal, and accident conditions in SAR Section 1.4.3.2, "Safety Analysis Methodology," as follows:

- Normal events include such operations as transportation package receipt, inspection, transfer of the canisters to the storage overpack, and storage at the WCS CISF until ready to be transported off site.
- Off-normal events are those events that are expected to occur with moderate frequency during transfer and storage operations.
- Accident conditions are those events that occur infrequently and could reasonably be expected to occur during the lifetime of the WCS CISF. These events include low-probability design-basis accidents, which establish a conservative design basis for ITS SSCs. These events include natural phenomena such as earthquakes and tornadoes, and human-made events such as cask drop.

16.3.1 Off-Normal Events

In SAR Section 12.1, "Off-Normal Events," the applicant provided information about off-normal events for the NUHOMS® and NAC storage systems.

16.3.1.1 NUHOMS Systems

For the NUHOMS systems to be used at the WCS CISF, the applicant stated that off-normal events could occur during cask handling, transfer vehicle moving, canister transfer, and other operational events. The applicant stated that two off-normal events bound the range of off-normal conditions: (1) a jammed canister during loading or unloading from the horizontal storage module (HSM), and (2) the extreme ambient temperatures in SAR Table 1-2, "Summary of WCS CISF Principal Design Criteria." The applicant stated that these events envelop the range of expected off-normal structural loads and temperatures acting on the canister, transfer cask, and HSM. For the NUHOMS systems, the applicant stated that it considered the following to be off-normal conditions:

- off-normal transfer loads
- extreme temperatures
- postulated release of radionuclides

In SAR Appendices A through D, Sections A.12.1, B.12.1, C.12.1, and D12.1, each entitled, "Off-Normal Operations," respectively, the applicant discussed the postulated causes and analyses of effects and consequences for off-normal conditions for the NUHOMS systems that the applicant plans to use at the WCS CISF. The applicant's discussions identified the FSAR

for each corresponding storage system that the applicant incorporated by reference in SAR Section 1.6.

For the off-normal transfer loads condition for the NUHOMS systems, the applicant referenced specific sections of the FSAR for each NUHOMS system for the causes of, detection of, evaluation of, and corrective actions for this condition.

For the extreme temperature off-normal condition for the NUHOMS systems, the applicant referenced specific sections of the FSAR for each NUHOMS system for the causes of, detection of, evaluation of, and corrective actions for this condition. In SAR Appendices A through D, Sections A.8.4, B.8.4, C.8.4, and D.8.4, respectively, the applicant referenced analyses that concluded that the WCS CISF extreme temperature conditions were enveloped by the conditions analyzed in the system-specific FSARs incorporated by reference.

For the postulated release of radionuclides off-normal condition, the applicant stated in SAR Section 11.1 that, except for the NUHOMS-MP187 fuel only-, fuel/control component-, and “failed” fuel-dry shielded canisters (DSCs), all of the canisters to be stored at the WCS CISF are designed to be leak tight under all normal, off-normal, and accident conditions. Additionally, the applicant’s proposed Technical Specification 2.1, “Functional and Operating Limits,” limits the canisters received at the WCS CISF to those that were loaded and stored in accordance with the listed Site Specific and General Licenses that correspond to the FSARs incorporated by reference into the SAR. Therefore, the confinement of the SNF or GTCC waste is maintained under all conditions.

For the NUHOMS-MP187 system, the applicant provided an analysis in SAR Section A.11 showing that, using a conservative assumption of 10-percent failed fuel, calculated doses at the facility boundary were less than 1 percent of the applicable regulatory limits in 10 CFR 72.104(a). SAR Table A.11-8 presents the results of the applicant’s analysis. The staff’s review of this analysis appears in SER Section 9.3.2.2. For the NUHOMS Standardized Advanced, Standardized 61BT, and 61BTH Type 1 systems, the applicant stated that the canisters are designed, fabricated, and tested to be leak-tight; therefore, there is no possibility for release of radionuclides from the canister under normal, off-normal, and accident conditions.

The staff found the applicant’s evaluation of the off-normal conditions involving the NUHOMS systems acceptable because the applicant relied on analyses previously accepted by the NRC for these systems, and those analyses apply to or bound the off-normal conditions of the WCS CISF. Specifically, the staff found that the off-normal transfer loads condition and the postulated release of radionuclides off-normal condition apply to the WCS CISF and the applicant incorporated by reference the FSARs that previously analyzed those conditions. Additionally, for the extreme temperature off-normal condition, the staff found that the site-specific off-normal extreme temperatures are enveloped by the conditions analyzed in the system-specific FSARs incorporated by reference.

16.3.1.2 NAC Systems

For the NAC-MPC System and NAC-UMS Storage System, the applicant stated in SAR Appendices E and F, Sections E.12.1.1, E.12.2.1, and F.12.1.1, that it considered the off-normal conditions at the WCS CISF to include the following:

- blockage of half the storage cask air inlets
- canister off-normal handling load
- failure of instrumentation

- severe environmental conditions (shown in SAR Table 1-2)
- small release of radioactive particulate from the canister exterior

For the NAC MAGNASTOR® storage system, the applicant stated in SAR Appendix G, Section G.12.1.1, that it considered the off-normal conditions listed above and the following additional off-normal conditions at the WCS CISF:

- crane failure during loaded transfer cask movements
- crane/hoist failure during transfer of a transportable storage canister (TSC) to a vertical concrete cask (VCC)

In SAR Appendices E, F, and G, Sections E.12.1.1, E.12.2.1, F.12.1.1, and G.12.1.1, the applicant identified the FSAR of each corresponding storage system that the applicant incorporated by reference in SAR Section 1.6, including all NAC systems that the applicant plans to use at the WCS CISF, and the FSAR's discussion of the postulated causes and analyses of effects and consequences for off-normal conditions.

For the Yankee Rowe and Connecticut Yankee configurations of the NAC-MPC System, SAR Section E.12.1.1 references Sections 11.1.1 through 11.1.5 of the NAC-MPC FSAR, incorporated by reference, to address the five off-normal conditions indicated above. For the La Crosse configuration of the NAC-MPC System (NAC-LACBWR), SAR Section E.12.2.1 references NAC-MPC FSAR Sections 11.A.1.1 through 11.A.1.5, which the applicant incorporated by reference to address the five off-normal conditions indicated above. The conditions discussed in the referenced FSAR apply to the WCS CISF, including the severe environmental conditions. SAR Table E.3-1, "Summary of WCS CISF Principal Design Criteria," compares the off-normal temperature conditions analyzed in the FSAR and incorporated by reference with the off-normal temperature conditions of the WCS CISF and shows that the previously analyzed temperature conditions bound the off-normal conditions of the WCS CISF.

For the NAC-UMS Storage System, SAR Section F.12.1.1 references Sections 11.1.1 through 11.1.5 of the NAC-UMS FSAR, which the applicant incorporated by reference to address the five off-normal conditions indicated above as they apply to Maine Yankee SNF stored in the NAC-UMS system. The conditions discussed in the referenced FSAR apply to the WCS CISF, including the severe environmental conditions. SAR Table F.3-1, "Summary of WCS CISF Principal Design Criteria," compares the off-normal temperature conditions analyzed in the NAC-UMS FSAR that is incorporated by reference with the off-normal temperature conditions of the WCS CISF and shows that the previously analyzed temperature conditions bound the off-normal conditions of the WCS CISF.

For the NAC MAGNASTOR storage system, SAR Appendix G, Section G.12.1.1, references Sections 12.1.1 through 12.1.7 of the NAC MAGNASTOR FSAR, which the applicant incorporated by reference to address the seven off-normal conditions indicated above. The conditions discussed in the referenced FSAR apply to the WCS CISF, including the severe environmental conditions. Table G.3-1, "Summary of WCS CISF Principal Design Criteria," compares the off-normal temperature conditions analyzed in the NAC MAGNASTOR FSAR that is incorporated by reference with the off-normal conditions of the WCS CISF and shows that the previously analyzed temperature conditions bound the off-normal conditions of the WCS CISF.

The staff found the applicant's evaluation of off-normal conditions involving the NAC systems acceptable because the applicant relied on analyses previously accepted by the NRC for these

systems, the applicant incorporated by reference those analyses, and those analyses apply to or bound the off-normal conditions of the WCS CISF.

16.3.1.3 Greater-than-Class C Waste Canisters

The applicant discussed off-normal operations for greater-than-Class C (GTCC) waste canisters in SAR Appendix H, Section H.8.1, "Normal and Off-Normal Operations." The applicant stated that GTCC waste canisters are comparable to SNF canisters in the thickness of canister shells and cover plates, the material chemical and physical properties, and the thickness of canister shell welds. The applicant stated that the GTCC waste canisters have insignificant heat load, with internal pressures not significantly greater than backfill pressures. Therefore, the material temperatures are only slightly greater than ambient, the temperature variations at any point in the shells are approximately equal to the variation in ambient temperature, and these small temperature cycles do not result in damage to or failure of the various GTCC waste canister shell assemblies. The staff found the applicant's evaluation of off-normal conditions for the GTCC waste canisters acceptable because the off-normal conditions for the canisters containing SNF envelop the corresponding conditions for the GTCC waste canisters. .

16.3.1.4 Off-Normal Events Summary

For the reasons stated above, the applicant's identification and assessment of off-normal events meets the requirements of 10 CFR 72.122 to protect public health and safety, 10 CFR 72.124 to maintain SNF in a subcritical condition, 10 CFR 72.126 for radiological protection, and 10 CFR 72.128 for SNF and GTCC waste handling, storage, and retrievability.

16.3.2 Accidents

The applicant stated in SAR Section 12.2, "Accidents," that the following postulated accident conditions are addressed, as applicable to each system in the WCS CISF SAR appendices:

- adiabatic heatup/blockage of air inlets/outlets (also see SAR Section 12.2.3, "Adiabatic Heat Up/Blockage of Air Inlets/Outlets")
- drop accidents
- earthquakes
- lightning
- fire/explosion
- flood
- tornado wind and missiles
- tip-over/overturning (NAC vertical systems)

The applicant provided details of the accident analyses in SAR Appendices A through G, in Section 12, "Accident Analysis," of each appendix for the SNF storage systems and Section H.8, "Analysis of Design," of SAR Appendix H for the GTCC systems. For each SNF storage system FSAR incorporated by reference, the applicant compared the WCS CISF design criteria to the storage system design criteria in SAR Appendices A through G, Tables A.3-1, B.3-1, C.3-1, D.3-1, E.3-1, F.3-1, and G.3-1, each titled, "Summary of WCS CISF Principal Design Criteria." In SAR Section H.3, the applicant clarified that (1) the structural design criteria for the GTCC storage systems proposed for use at the WCS CISF are the same as the structural design criteria used for the storage systems listed in WCS CISF SAR Table 1-1, "Storage Systems at the WCS CISF," and (2) the results of the accident analyses for the

storage systems, which include drop accidents, floods, lightning, tornadoes and wind missiles, and tip-over, bound the results for the same accidents involving the GTCC storage systems.

For the NAC SNF storage systems, the applicant provided tip-over analyses for these systems in SAR Appendices E, F, and G, Sections E.12.1.3, E.12.2.3, F.12.1.3 and G.12.1.3, "Concrete Cask Non-Mechanistic Tip-Over Analysis."

16.3.2.1 Cask Tip-Over

The applicant considered tip-over of the NAC concrete casks a non-mechanistic, hypothetical accident condition. The applicant stated that existing postulated design-basis accidents do not result in the tip-over of the concrete casks. For each NAC cask system, the applicant referenced a bounding cask evaluation appearing in the corresponding NRC-approved FSAR for the cask system in order to demonstrate that the storage cask system does not suffer significant adverse consequences due to this event because the concrete cask, TSC, and basket maintain design-basis shielding, geometry control of contents, and content confinement performance requirements. The applicant incorporated by reference these FSARs.

In SAR Appendices E, F, and G, Sections E.12.1.3, E.12.2.3, F.12.1.3 and G.12.1.3, the applicant described site-specific tip-over analyses of the Yankee MPC and Connecticut Yankee MPC configurations of the NAC-MPC System, and the NAC-LACBWR, NAC-UMS, and MAGNASTOR cask systems, respectively, considering the WCS CISF site-specific soil properties and concrete pads and relevant design attributes of individual casks. The objective of those tip-over analyses was to confirm that the maximum amplified accelerations of the top of the basket and the canister for the five systems at the WCS CISF are bounded by the accelerations used in the structural evaluations of the five systems as original licensing bases.

The staff evaluated the applicant's site-specific tip-over analyses for the five systems in Sections 5.3.1.4.4 through 5.3.1.4.6 of this SER. The staff noted that the applicant used an LS-DYNA finite element analysis to perform tip-over analysis by following the common modeling approach in the individual FSARs for the design-basis analysis, with the exception that the cask- and site-specific pad design features and soil properties are taken into account. For the five systems analyzed, the applicant noted that the design-basis accelerations used in qualifying the basket and canister evaluations in the individual FSARs bound those for the casks deployed at the WCS CISF site. The staff verified the applicant's evaluation. The staff finds the applicant's assessment acceptable that (1) the previous analyses of canister and basket evaluations are bounding and (2) no further cask tip-over evaluations are required for the WCS CISF.

16.3.2.2 Cask Drop

The application incorporates by reference the following NRC-approved SNF storage cask system FSARs: NUHOMS-MP187 System discussed in the Rancho Seco ISFSI FSAR, Standardized Advanced NUHOMS Storage System, Standardized NUHOMS Storage System, NAC-MPC System, NAC-UMS Storage System, and NAC MAGNASTOR storage system. The respective FSARs for each system addressed the cask-drop accident.

In SAR Appendix A, Section A.12.2, "Postulated Accident," the applicant discussed an accident analysis of the NUHOMS MP187 cask in the transfer configuration. The applicant incorporated by reference the evaluation of the structural, thermal, and radiological consequences and the recovery measures required to mitigate the effects of a drop accident which appear in

Section 8.2.1.3, "Analysis of Effects and Consequences," of Volume I of the Rancho Seco independent spent fuel storage installation (ISFSI) FSAR.

In SAR Appendix B, Section B.12.2, "Postulated Accident," the applicant discussed an accident analysis of the NUHOMS-MP187 cask in the 24PT1 DSC transfer configuration as described in the Standardized Advanced NUHOMS Storage System FSAR, which the applicant incorporated by reference. For the identical NUHOMS-MP187 cask also using the Standardized Advanced NUHOMS Storage System, the accident analysis referenced Section 8.2.1.3 "Analysis of Effects and Consequences," of Volume I of the Rancho Seco ISFSI FSAR.

In SAR Appendix C, Section C.12.2, "Postulated Accident," the applicant discussed an accident analysis of the MP197HB cask in the transfer configuration, referencing the structural and thermal consequences for the effect of a drop accident addressed in Section K.11.2.5.2, "Accident Analysis," of the Standardized NUHOMS Storage System FSAR for the canister and in SAR Appendix C, Section C.8, "Thermal Evaluation." This analysis, which the applicant incorporated by reference, demonstrates that the canister remains leak tight and the basket maintains its configuration following the drop event.

In SAR Appendix D, Section D.12.2, "Postulated Accident," the applicant discussed an accident analysis of the MP197HB cask in the transfer configuration for the structural thermal consequences for the effects of a drop accident addressed in Section T.11.2.5.2, "Accident Analysis," of the Standardized NUHOMS Storage System FSAR for the canister and in SAR Appendix D, Section D.8, "Thermal Evaluation," for the NUHOMS-MP197HB cask. This analysis, which the applicant incorporated by reference, demonstrates that the canister remains leak tight and the basket maintains its configuration following the drop event.

In SAR Appendix E, Section E.12.1.2, "Accidents," and Section E.12.2.2, "Accidents," the applicant discussed an accident analysis of the NAC-MPC and NAC-LACBWR casks in the transfer configuration. The applicant incorporated by reference the structural consequences evaluated in Sections 11.2.11 and 11.A.2.11, both entitled, "Storage Cask 6-Inch Drop," of the NAC-MPC FSAR, which demonstrate adequate structural performance of the cask undergoing a 6-inch cask drop accident for the NAC-MPC and NAC-LACBWR cask systems, respectively.

In SAR Appendix F, Section F.12.1.2, "Accidents," the applicant discussed an accident analysis of the NAC-UMS cask in the transfer configuration. The applicant incorporated by reference the structural consequences evaluated in Section 11.2.4, "24-Inch Drop of Vertical Concrete Cask," of the NAC-UMS FSAR, which demonstrate adequate structural performance of the vertical concrete cask undergoing a 24-inch cask drop accident for the NAC-UMS cask systems.

In SAR Appendix G, Section G.12.1.2, "Accidents and Natural Phenomena," the applicant discussed an accident analysis of the NAC MAGNASTOR cask in the transfer configuration. The applicant referred to the structural consequences evaluated in Section 12.2.4, "24-Inch Drop of the Concrete Cask," of the NAC MAGNASTOR FSAR, which the applicant incorporated by reference and which demonstrates adequate structural performance of the concrete cask undergoing a 24-inch cask drop accident for the NAC MAGNASTOR storage system.

The staff reviewed and verified the information incorporated by reference, discussed above, and determined that it was properly evaluated and is applicable to the WCS CISF. As a result, the staff has reasonable assurance to conclude that cask components are structurally adequate for the postulated cask-drop accidents.

16.3.2.3 Flood

The staff reviewed and evaluated the potential for events due to flooding in SER Section 2.3.4, "Surface Hydrology."

In SAR Section 2.4.2.2, "Flood Design Considerations," and Section 3.2.2, "Water Level (Flood) Design," the applicant noted that the WCS CISF is not in a floodplain and is above the probable maximum flood elevation. Because the cask systems deployed on the concrete pads will remain dry in the event of a flood, the staff finds the applicant's assessment acceptable that no further flood analysis is required of the cask systems.

16.3.2.4 Fire and Explosions

The application incorporated by reference the following NRC-approved SNF storage cask system FSARs: NUHOMS-MP187 Cask System discussed in the Rancho Seco ISFSI FSAR, Standardized Advanced NUHOMS Storage System, Standardized NUHOMS Storage System, NAC-MPC System, NAC-UMS Storage System, and NAC MAGNASTOR storage system. The respective FSARs for each system address a fire accident. The previous evaluations of each system concerning a fire accident continue to be acceptable because the site limits the amount of combustible materials to the amounts described in the respective FSARs incorporated by reference and therefore the analyzed fires in these FSARs bound the site. A fire event is postulated to occur for the canister transfer system which has not been analyzed in the FSARs, as described below.

SAR Section 12.2.1, "Canister Transfer System Fire Accident," described the analysis of a fire event assuming 50 gallons of flammable liquid, which is the only flammable material in the vicinity of the canister transfer system during transfer operations. This event is specific to the WCS CISF site because the transfer casks are located inside a building and have not been considered previously in the FSARs for the respective systems incorporated by reference. The applicant's analysis results showed that none of the allowable temperature limits are exceeded.

In SAR Section 3.3.6, "Fire and Explosion Protection," the applicant stated that WCS CISF-initiated explosions are not considered credible because no explosive materials are present. The applicant also stated that the effects of externally initiated explosions are bounded by the design-basis tornado-generated missile load analysis performed for the authorized storage systems.

Based on its review, the staff finds that the applicant's analysis for fire and explosions is acceptable because the analyses incorporated by reference bound the design criteria of the site, except for the postulated fire inside the cask handling building which was analyzed in the SAR, and the allowable temperature limits are not exceeded for a fire in the canister transfer system.

16.3.2.5 Lightning

The application incorporated by reference the following NRC-approved SNF storage cask system FSARs: NUHOMS-MP187 System discussed in the Rancho Seco ISFSI FSAR, Standardized Advanced NUHOMS Storage System, Standardized NUHOMS Storage System, NAC-MPC System, NAC-UMS Storage System, and NAC MAGNASTOR storage system. Because the respective FSARs for each system address a lightning accident and the previous evaluations continue to be acceptable, the staff finds that further evaluation is not required.

16.3.2.6 Earthquakes

In SAR Section 2.6.2, "Vibratory Ground Motion," the applicant evaluated site-specific vibratory ground motion and selected the ground-surface uniform hazard response spectra with 1×10^{-4} annual frequency of exceedance having a peak ground acceleration of 0.250g horizontal and 0.175g vertical. The site-specific response spectra shown in SAR Table 1-5, "Ground Surface DRS," and Figure 1-5, "10,000-Year Return Period Response Spectra (5% Damped)," are used in the soil-structure interaction (SSI) analyses in SAR Section 7.6.1, "Storage Pads for VCCs," and Section 7.6.5, "NUHOMS NITS Storage Pad Design," to obtain the enveloped acceleration spectra at the center of gravity and at the base of the NAC vertical concrete casks and NUHOMS HSM, respectively.

In SER Section 5.3.4.3, "NUHOMS Horizontal Storage Module Storage Pad," the staff evaluated the applicant's SSI analysis of the NUHOMS HSM storage pad. The staff finds that the resulting enveloping response spectra presented in SAR Appendices A through D, Sections A.7.5, B.7.5, C.7.3, and D.7.3, respectively, demonstrate that the enveloping WCS CISF site-specific seismic forces remain below their applicable capacities for the structural components of the NUHOMS-MP187 cask with the Rancho Seco DSCs, the NUHOMS-MP187 cask and Standardized Advanced NUHOMS System, the MP197HB cask and Standardized NUHOMS with the 61BT DSC, and the MP197HB cask and Standardized NUHOMS with the 61BTH Type 1 DSC, respectively.

In SAR Appendix A, Section A.12.2.3, "Earthquakes," the applicant refers to SAR Section A.7.5, "Seismic Reconciliation of the MP187 Cask, Canisters, and HSM Model 80," for a discussion of how the site-specific response spectra were used to obtain the enveloped acceleration spectra at the HSM center of gravity (CG) and base. In Section A.7.5, the applicant presents a seismic reconciliation evaluation between the site-specific seismic forces and the capacities of the NUHOMS-MP187 Cask System components to demonstrate structural performance. The staff reviewed this seismic reconciliation in SER Section 5.3.1.4.1. The applicant incorporated by reference the structural, thermal, and radiological consequences and the recovery measures required to mitigate an earthquake addressed in relevant sections of Volume II and Volume III of the Rancho Seco ISFSI FSAR.

In SAR Appendix B, Section B.12.2.3, "Earthquakes," the applicant refers to SAR Section B.7.5, "Seismic Reconciliation of the Advanced NUHOMS 24PT1 DSC and AHSM Storage Components and the MP187 Transfer Cask," for a discussion of how the site-specific response spectra were used to obtain the enveloped acceleration spectra at the advanced HSM (AHSM) CG and base. In Section B.7.5, the applicant presents a seismic reconciliation between the site-specific seismic forces and the capacities of the NUHOMS-MP187 cask and Standardized Advanced NUHOMS System components to demonstrate structural performance. The staff reviewed this seismic reconciliation in SER Section 5.3.1.4.2. The applicant discussed the design-basis earthquake analysis of the NUHOMS-MP187 System and Standardized Advanced NUHOMS Storage System by noting that the structural and thermal consequences of an earthquake are addressed in Section 11.2.1.2, "Accident Analysis," of the Standardized Advanced NUHOMS Storage System FSAR, which the applicant incorporated by reference. The applicant stated that the NUHOMS-MP187 cask, when mounted on the transfer vehicle during an earthquake, is subjected to stresses that are bounded by the 80-inch cask-drop analysis.

In SAR Appendix C, Section C.12.2.3, "Earthquakes," the applicant refers to SAR Section C.7.3, "Seismic Reconciliation of the 61BT DSC, HSM Model 102, and MP197HB Cask," for a

discussion of how the site-specific response spectra were used to obtain the enveloped acceleration spectra at the HSM CG and base. In Section C.7.3, the applicant presents a seismic reconciliation between the site-specific seismic forces and the capacities of the MP197HB cask and Standardized NUHOMS System components to demonstrate structural performance. The staff reviewed this seismic reconciliation in SER Section 5.3.1.4.3. The applicant discussed the design-basis earthquake analysis of the NUHOMS-MP197HB cask and Standardized NUHOMS system with the 61BT DSC by noting that the structural and thermal consequences of an earthquake are addressed in Sections K.11.2.2.2, 8.2.3.2, and K.3.7 of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. The applicant noted that SAR Appendix C.7 evaluates the NUHOMS-MP197HB cask when mounted on the transfer vehicle during an earthquake.

In SAR Appendix D, Section D.12.2.3, "Earthquakes," the applicant refers to SAR Section D.7.3, "Seismic Reconciliation of the 61BT DSC, HSM Model 102, and MP197HB Cask," for a discussion of how the site-specific response spectra were used to obtain the enveloped acceleration spectra at the HSM CG and base. The applicant further discussed a seismic reconciliation between the site-specific seismic forces and the capacities of the MP197HB cask and Standardized NUHOMS System components to demonstrate structural performance. The staff reviewed this seismic reconciliation in SER Section 5.3.1.4.3. The applicant discussed the design-basis earthquake analysis of the NUHOMS-MP197HB cask and Standardized NUHOMS system with the 61BTH Type 1 DSC by noting that the structural and thermal consequences of an earthquake are addressed in Sections T.11.2.2.2, 8.2.3.2, and T.3.7.2 of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. SAR Appendix D.7, "Structural Evaluation," evaluates the NUHOMS-MP197HB cask when mounted on the transfer vehicle during an earthquake.

In SER Section 5.3.2.5, the staff evaluated the applicant's SSI analysis of the NAC VCC storage pad and finds that the resulting enveloping response spectra in SAR Section 7.6.1 demonstrate that the enveloping WCS CISF site-specific seismic forces remain below their applicable capacities for the structural components of the NAC-MPC, NAC-LACBWR, NAC-UMS, and NAC MAGNASTOR cask systems. The applicant used the bounding MAGNASTOR storage cask for the sliding and overturning calculation.

In SAR Sections E.12.1.2, E.12.2.2, F.12.1.2, and G.12.1.2, each titled, "Accidents," the applicant discussed the design-basis earthquake analysis of the NAC-MPC, NAC-UMS and NAC MAGNASTOR cask systems. Those sections further reference the structural consequences evaluated in each cask system's FSAR, each titled, "Earthquake Events." The staff verified the respective sections of the referenced FSARs and finds that the analyses discussed in those FSAR sections continue to remain valid for the WCS site because the designs remain similar and the FSAR sections are incorporated by reference. In addition, the seismic performance of the NAC cask systems is further discussed in SAR Section 7.6.3 where the applicant analyzed the structural performance of each cask system under site-specific conditions. The staff discusses and finds the seismic analyses acceptable in SER Section 5.3.2.5.

In summary, the staff reviewed and verified the information incorporated by reference, discussed above, and determined that it was properly evaluated. The staff's review of the seismic reconciliation for the aforementioned casks, as applicable, is further discussed in SER Sections 5.3.1 and 5.3.2. As a result, the staff has reasonable assurance to conclude that storage casks and cask components will remain structurally adequate during the design-basis earthquake events at the WCS CISF site.

16.3.2.7 Loss of Shielding

Chapter 12 of the SAR discusses the dose consequences for the identified design-basis accidents and natural phenomena events. Additionally, the FSARs for the following facilities and systems incorporated by reference consider the dose consequences of design-basis accidents and natural phenomena events: Rancho Seco ISFSI, Standardized Advanced NUHOMS Storage System, Standardized NUHOMS Storage System, NAC-MPC System, NAC-UMS Storage System, and NAC MAGNASTOR storage system. The applicant determined in Chapter 12.2 of the SAR that the confinement system is not adversely affected during a design-basis accident and that no design-basis accident would significantly degrade the shielding capability of the storage cask or the cask handling building (CHB). Based on its review, the staff finds that there is reasonable assurance that the dose to any individual beyond the owner-controlled area will not exceed the limits in 10 CFR 72.106(b) and that occupational exposures from accident recovery will not exceed the limits in 10 CFR Part 20, "Standards for protection against radiation," because (1) the analyses incorporated by reference bound the design criteria of the proposed site and (2) the staff's detailed analysis in SER Chapter 7 supports the applicant's analysis.

16.3.2.8 Adiabatic Heatup

The applicant stated in SAR Section 12.2.3, "Adiabatic Heat Up/Blockage of Air Inlets/Outlets," that no credible accident scenarios at the WCS CISF site would result in a full adiabatic condition for the storage systems (e.g., entombment of the storage overpacks from volcanic or seismic activity, landslides). The applicant stated in SAR Section 12.2.3 that the accident evaluated in each Section 12 of the SAR Appendices (e.g., SAR Sections A.12, B.12) for each system that considers adiabatic heatup is the "Blockage of Air Inlets/Outlets." The application incorporated by reference the NRC-approved SNF storage cask system and facility FSARs for the Rancho Seco ISFSI, Standardized Advanced NUHOMS Storage System, Standardized NUHOMS Storage System, NAC-MPC System, NAC-UMS Storage System, and NAC MAGNASTOR storage system. The respective FSARs for each system address blocked air inlet/outlet vents. Because the NRC previously evaluated these systems and the previous evaluations continue to be acceptable, the staff finds that further evaluation is not required.

16.3.2.9 Tornadoes and Missiles Generated by Natural Phenomena

In SAR Section 3.2.1, "Tornado and Wind Loadings," the applicant stated that the cask storage systems are designed to withstand the loads resulting from tornado and extreme wind. The design-basis tornado is from Region II, as defined by RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants." SAR Table 1-2 lists the design-basis tornado characteristics for Region II. Tornado missile load conditions are based on the design-basis tornado addressed in SAR Section 3.2.1.1, "Applicable Design Parameters," and are listed in SAR Table 1-2. The loaded storage overpacks are designed to remain stable and to maintain the confinement boundary when subjected to tornado-generated missiles.

In SAR Appendix A, Section A.3.3.1, "Tornado Wind and Tornado Missiles," the applicant discussed a tornado wind and tornado missiles analysis for the NUHOMS-MP187 cask system, from Section 3.2.1, "Tornado and Wind Loadings," of Volume 1 of the Rancho Seco ISFSI FSAR, which the applicant incorporated by reference. The applicant stated that the NUHOMS-MP187 System components are designed and conservatively evaluated for the most severe tornadoes and missiles anywhere within the United States (Region I as defined in NRC

RG 1.76), while the WCS CISF is in Region II, a location with less severe tornadoes and tornado missiles.

The NUHOMS HSM protects the DSC from adverse environmental effects and is the principal structure exposed to tornado wind and missile loads. The applicant stated that all components of the HSM (regardless of their safety classification) are designed to withstand tornadoes and tornado-based missiles. The applicant further stated that the MP187 cask protects the DSC during transit to the storage pad from adverse environmental effects such as tornado winds and missiles.

In SAR Appendix A, Section A.7.3.2, "Accident Conditions," the applicant discussed the structural analysis of the MP187 cask and the canisters for postulated accidents, including extreme wind and tornado missiles during transfer operations, and identified the relevant volumes and sections of the Rancho Seco ISFSI FSAR, which the applicant incorporated by reference.

Since the NUHOMS-MP187 cask operates in a horizontal configuration, which is different from the vertical configuration analyzed in the Rancho Seco ISFSI FSAR, the applicant performed a WCS CISF-specific tornado missile impact stability analysis of the NUHOMS-MP187 cask in transfer configuration.

As noted in SAR Appendices A and B, Sections A.3.4.2 and B.3.4.2, both entitled, "Structural," the applicant will use the MP187 cask for onsite transfer of the DSC for its storage in the HSM and AHSM. As such, the tornado missile impact stability analysis of the MP187, which the staff reviewed in Section 5.3.3.4.4, "Structural Analysis for NUHOMS Transfer Casks," of this SER, applies to both cask systems previously approved for the Rancho Seco ISFSI and the Standardized Advanced NUHOMS HSM.

In SAR Appendix B, Section B.12.2.7, "Tornado Wind and Missiles," the applicant noted that the Standardized Advanced NUHOMS system components are designed for tornado and tornado wind effects. In addition, the AHSM and MP187 cask in the transfer configuration are also designed for tornado missile effects. The Standardized Advanced NUHOMS system components are designed and conservatively evaluated for the most severe tornadoes and missiles anywhere within the United States (Region I as defined in NRC RG 1.76), while the WCS CISF is in Region II, a location with less severe tornadoes and tornado missiles.

The applicant incorporated by reference the structural and thermal consequences of the effect of tornado wind and missile loads on the AHSM from Section 11.2.2.2, "Accident Analysis," of the Standardized Advanced NUHOMS Storage System FSAR. As noted in preceding paragraphs, the tornado missile impact stability analysis of the MP187 cask to demonstrate structural adequacy, which the NRC staff reviewed in Section 5.3.3.4.4 of this SER, applies to the Standardized Advanced NUHOMS HSM.

In SAR Appendix C, Section C.12.2.7, "Tornado Wind and Missiles," the applicant discussed the structural consequences of the effects of tornado wind and missile loads on the HSM and canister, referencing the relevant information in Sections 8.2.2, K.3.7.2, and K.11.2.3.2 of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. The applicant noted that the Standardized NUHOMS system components are designed for tornado and tornado wind effects for the most severe tornadoes and missiles anywhere within the United States (Region I as defined in NRC RG 1.76), while the WCS CISF is in Region II, a location with less severe tornadoes and tornado missiles. In addition, the HSM and MP197HB cask in the transfer configuration are designed for tornado missile effects.

In SAR Appendix C, Section C.7.7.4, “MP197HB Cask Stability and Missile Penetration Analyses,” the applicant discussed cask stability and penetration analyses of the MP197HB cask loaded with the 61BT DSC for the design-basis tornado wind and tornado-generated missiles. The analysis, which the staff reviewed in Section 5.3.3.4.4 of this SER, demonstrates that the MP197HB cask loaded with the 61BT DSC is structurally acceptable for the canister transfer at the WCS CISF.

In SAR Appendix D, Section D.12.2.7, “Tornado Wind and Missiles,” the applicant discussed the structural and thermal consequences of the effects of tornado wind and missile loads on the HSM and canister, referencing information provided in Sections 8.2.2, T.3.7.1, and T.11.2.3.2 of the Standardized NUHOMS Storage System FSAR, which the applicant incorporated by reference. The applicant noted that the Standardized NUHOMS Storage System components are designed for tornado and tornado wind effects for the most severe tornadoes and missiles anywhere within the United States (Region I as defined in NRC RG 1.76), while the WCS CISF is in Region II, a location with less severe tornadoes and tornado missiles. In addition, the HSM and MP197HB cask in the transfer configuration are designed for tornado missile effects.

In SAR Appendix D, Section D.7.7, “Structural Analysis of MP197HB Cask as On-Site Transfer Cask,” the applicant described cask stability and penetration analyses of the MP197HB cask loaded with the 61BTH Type 1 DSC for the design-basis tornado wind and tornado-generated missiles. The analysis, which the staff reviewed in Section 5.3.3.4.4 of this SER, demonstrates that the MP197HB cask loaded with the 61BTH Type 1 DSC is structurally acceptable for the canister transfer at the WCS CISF.

In SAR Section 7.5.3.2.1, “Load Definitions,” the applicant proposed to administratively manage protection from tornado missiles for the short period of time that individual loaded canisters are transferred in certain configurations between the transportation and storage casks. The handling systems (i.e., the CHB crane, the VCT during transfer of the loaded NAC canisters within the CHB, and the CTS, which includes the NAC transfer casks) used during the transfer of the canisters have not been evaluated to withstand the effect of tornadoes.

In SAR Section 7.5.3.2.1, “Load Definitions,” and Section 7.6.6, “Transport Cask Stability,” the applicant stated that the transportation casks would not be moved into the CHB to begin the railcar unloading process unless the current and forecasted weather indicates safe weather conditions, as defined in Section 7.5.3.2.1. The tornado protection design basis for the loaded storage canisters is risk-informed, in that there is a low potential of a tornado strike in general, the applicant will consider the forecasted condition at the time of starting the transfer process, and the transfer process will be completed in a limited period of time. In addition, there is significant partial protection against tornado effects provided by the CHB framing design (as evaluated in SER Section 5.3.3.1), there is additional protection against direct missile strike provided by the sealed canister and the surrounding cask (i.e., transportation cask, transfer cask, or VCC), and the crane is ITS and therefore robustly designed. Therefore, the staff concluded that there is adequate defense in depth to protect SSCs during transfer operations.

In SAR Appendices E, F, and G, Sections E.12.1.2, E.12.2.2, F.12.1.2, and G.12.1.2, the applicant discussed the site-specific tornado and tornado-driven missile analyses for the NAC-MPC System, NAC-LACBWR, NAC-UMS Storage System, and NAC MAGNASTOR storage system, respectively, referencing the relevant information in the FSARs that the applicant incorporated by reference. The staff verified the information incorporated by reference and finds that the applicant provided sufficient information to demonstrate adequate structural

performance of the NAC cask systems for this accident. The tornado and tornado-driven missile analyses for the individual cask systems appear in the FSAR sections as follows:

- NAC-MPC FSAR Section 11.2.13
- NAC-MPC FSAR Section 11.A.2.13
- NAC-UMS FSAR Section 11.2.11
- NAC MAGNASTOR FSAR Section 12.2.11

Because the components of the various cask systems discussed above have been demonstrated structurally adequate in the design-basis tornado and tornado-driven missile analyses previously for approved casks, the staff finds the applicant's assessment acceptable.

16.3.2.10 Accidents at Nearby Sites

The applicant's evaluation in SAR Section 12.2.2, "Offsite Accident Analysis," which is referenced in SAR Section 2.2, "Nearby Industrial, Transportation and Military Facilities," indicates that there are no facilities that could contribute to the potential for significant explosions located within 5 miles of the CISF facility.

The staff reviewed and evaluated potential accidents due to nearby facilities in SER Section 2.3.2. In that section, the staff finds that the applicant appropriately identified and analyzed the potential hazards associated with nearby facilities and transportation routes. Based on the staff's review of the information provided by the applicant, and the staff's independent confirmatory calculations described, the staff finds in Section 2.3.2 that the potential hazards from an explosion at a nearby facility or transportation route, or an aircraft crash at the site, present a low risk to public health and safety.

16.3.2.11 Building Structural Failure onto Structures, Systems, and Components

Section 7.5, "Cask Handling Building," and Section 7.5.3, "Cask Handling Building Structural Design," of the SAR provide the description and design-basis information for the CHB. The CHB and its foundations are Category B ITS structures used to transfer canisters from the transportation casks to the storage overpacks. In SAR Section 7.5.3, the applicant stated that it designed the CHB to meet the requirements of 10 CFR 72.122, which states, in part, that ITS structures must be designed to withstand loads associated with normal conditions and postulated accidents, including natural phenomena events. Natural phenomena events incorporated in the design basis of the CHB included events such as earthquake, high winds and tornado missiles. The licensee designed the CHB to withstand applicable loads and to ensure structural integrity and stability of the primary framing systems, therefore preventing CHB structural failure into other ITS SSCs. The staff's review of the design of the CHB to meet the requirements of 10 CFR 72.122 appears in SER Section 5.3.3.1.

16.3.2.12 Accidents Summary

For the reasons stated above, the applicant's identification and assessment of accidents meets the requirements of 10 CFR 72.122 to protect public health and safety, 10 CFR 72.124 to maintain SNF in a subcritical condition, 10 CFR 72.126 for radiological protection, and 10 CFR 72.128 for SNF and GTCC waste handling, storage, and retrievability.

16.3.3 Other Non-Specified Accidents (None to be Discussed)

The applicant did not identify additional accident scenarios applicable to the WCS CISF. Based on its review in other SER chapters, the staff finds that the design characteristics of the WCS CISF do not pose potential accidents that the applicant has not identified.

16.4 Evaluation Findings

The applicant identified and provided complete analyses of the credible off-normal and accident events for operations at the site. Based on the information in the application, the staff concludes the following:

- The SAR includes acceptable analyses of the design and performance of ITS SSCs under off-normal and accident scenarios. For NUHOMS systems, applicable off-normal accidents analyzed in the SAR or incorporated by reference include off-normal transfer loads, extreme temperatures, and postulated release of radionuclides. For NAC systems, applicable off-normal accidents analyzed in the SAR or incorporated by reference include blockage of half the storage cask air inlets, canister off-normal handling load, failure of instrumentation, severe environmental conditions, and small release of radioactive particulate from the canister exterior. For the NAC MAGNASTOR storage system, additional applicable off-normal accidents analyzed in the SAR or incorporated by reference include crane failure during loaded transfer cask movements, and crane/hoist failure during transfer of a TSC to a VCC. Applicable accident events analyzed in the SAR include adiabatic heatup/blockage of air inlets/outlets, drop accidents, earthquakes, lightning, fire/explosion, flood, tornado wind and missiles, and (for NAC vertical systems) tip-over/overtipping.
- The analyses of off-normal and accident events and conditions show that the design of the CISF will acceptably meet the requirements without endangering public health and safety, in compliance with the overall requirements of 10 CFR 72.122.
- The analyses of off-normal and accident events and conditions and reasonable combinations of these and normal conditions show that the design of the CISF will acceptably meet the requirements of 10 CFR 72.124 for the maintenance of the SNF in a subcritical condition.
- The analyses of off-normal and accident events and conditions and reasonable combinations of these and normal conditions show that the design of the CISF will acceptably meet the requirements of 10 CFR 72.126 for criteria for radiological protection.
- The analyses of off-normal and accident events and conditions and reasonable combinations of these and normal conditions show that the design of the CISF will acceptably meet the requirements of 10 CFR 72.128 for handling, storage, and retrievability of the SNF and other radioactive material.

16.5 References

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

AREVA, Inc., "NUHOMS®-MP197 Transport Packaging Safety Analysis Report," Revision 17, April 2001 (nonpublic). NRC Docket No. 71-9302. Transmittal dated July 20, 2016. Agencywide Documents Access and Management System (ADAMS) Accession No. ML16207A498.

AREVA, Inc., "Updated Final Safety Analysis Report for the Standardized Advanced NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 6, August 2014 (nonpublic). NRC Docket No. 72-1029. Transmittal dated July 13, 2016. ADAMS Accession No. ML16200A178.

AREVA TN Americas, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 14, September 2014 (nonpublic). NRC Docket No. 72-1004. Transmittal dated July 13, 2016. ADAMS Accession No. ML16218A396.

Code of Federal Regulations, Title 10, Part 20, "Standards for protection against radiation."

Code of Federal Regulations, Title 10, Part 72, "Licensing requirements for the independent storage of spent nuclear fuel, high-level radioactive waste, and reactor-related Greater than Class C waste."

Interim Storage Partners LLC, "WSC Consolidated Interim Storage Facility Safety Analysis Report," Revision 5, Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML21105A766.

NAC International, "MAGNASTOR® Final Safety Analysis Report," Revision 7, July 2015 (nonpublic). NRC Docket No. 72-1031. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A932.

NAC International, "NAC-MPC, NAC Multi-Purpose Cask, Final Safety Analysis Report," Revision 10, January 2014 (nonpublic). NRC Docket No. 72-1025. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A556.

NAC International, "NAC-UMS Universal Storage System Final Safety Analysis Report," Revision 10, October 2012 (nonpublic). NRC Docket No. 72-1015. Transmittal dated August 3, 2016. ADAMS Accession No. ML16245A212.

NRC, RG 3.48, "Standard Format and Content for the Safety Analysis Report for an Independent Spent Fuel Storage Installation or Monitored Retrievable Storage Installation (Dry Storage)," Revision 1, August 1989. ADAMS Accession No. ML003739163.

NRC, RG 1.76, "Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants," Revision 1, March 2007. ADAMS Accession No. ML070360253.

NRC, NUREG-1567, "Standard Review Plan for Spent Fuel Dry Storage Facilities," March 2000. ADAMS Accession No. ML003686776.

Sacramento Municipal Utility District, "Rancho Seco Independent Spent Fuel Storage Installation, Final Safety Analysis Report, Volume 1, ISFSI System," Revision 4, June 2010 (nonpublic). NRC Docket No. 72-11. Transmittal dated August 11, 2016. ADAMS Accession No. ML16236A115.

Transnuclear, Inc., "Safety Analysis Report for the NUHOMS®-MP187 Multi-Purpose Cask,"
Revision 17, July 2003 (nonpublic). NRC Docket No. 71-9255. Transmittal dated July 15, 2016.
ADAMS Accession No. ML16203A183.

17 TECHNICAL SPECIFICATIONS

In Appendix A, “Proposed Technical Specifications,” to its application, Interim Storage Partners LLC (the applicant) submitted the technical specifications (TS) that are applicable to the important-to-safety storage systems and other operational components at the proposed WCS Consolidated Interim Storage Facility (CISF). The proposed TS include functional and operating limits, monitoring instruments, limiting control settings, limiting conditions for operation (LCOs), surveillance requirements (SRs), design features, and administrative controls. The applicant identified the proposed TS necessary to maintain subcriticality, confinement, shielding, heat removal, and structural integrity under normal, off-normal, and accident conditions.

17.1 Scope of Review

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the proposed TS to ensure that those conditions and limits necessary for the design and operations of the WCS CISF meet the requirements in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 72, “Licensing requirements for the independent storage of spent nuclear fuel, high-level radioactive waste, and reactor-related greater than Class C [GTCC] waste.” The staff reviewed the proposed specifications to assess compliance with the regulatory requirements including the following areas: functional and operating limits, LCOs and SRs, design features, and administrative controls.

17.2 Regulatory Requirements

The NRC requirements relevant to the overall function of an independent spent fuel storage installation (ISFSI) and the design criteria and operation of certain separate functional subsystems at the proposed WCS CISF appear in the following and sections of Title 10 of the *Code of Federal Regulations* (10 CFR):

The NRC details the regulatory requirements for the overall function of an independent spent fuel storage installation (ISFSI) and the design criteria and operation of certain separate functional subsystems in the following sections of Title 10 of the *Code of Federal Regulations*:

- 10 CFR 72.24, “Contents of application: Technical information”
- 10 CFR 72.26, “Contents of application: Technical specifications”
- 10 CFR 72.44, “License conditions”

17.3 Staff Review and Analysis

Unless otherwise stated, the staff reviewed and evaluated the TS proposed by the applicant in Revision 4 of its application, documents cited in or attached to its application, and the applicant’s responses to the staff’s requests for additional information.

17.3.1 Functional and Operating Limits

The staff reviewed the functional and operating limits specified by the applicant in Sections 2.1 and 2.2 of the proposed WCS CISF TS. The staff lists this information and the associated safety evaluation report (SER) sections in SER Table 17-1.

Table 17-1 WCS CISF TS Functional and Operating Limits and Associated SER Sections

TS Item	Functional and Operating Limit	Associated SER Sections
2.1.1	Fuel to be stored at the ISFSI as specified in NRC Materials License SNM-2510, Amendment 4	1.3.1, 4.3.1
2.1.2	Fuel to be stored at the ISFSI in NUHOMS® 61BT dry shielded canisters (DSCs) as specified in NRC Certificate of Compliance (CoC) 1004, Amendments 3 through 13	1.3.1, 4.3.1
2.1.3	Fuel to be stored at the ISFSI in NUHOMS 61BTH DSCs as specified in NRC CoC 1004, Amendments 10 through 13	1.3.1, 4.3.1
2.1.4	Fuel to be stored at the ISFSI in NUHOMS 24PT1 DSCs as specified in NRC CoC 1029, Amendments 0, 1, and 3	1.3.1, 4.3.1
2.1.5	Fuel to be stored at the ISFSI in the NAC-MPC System as specified in CoC 1025, Amendments 0 through 6	1.3.1, 4.3.1
2.1.6	Fuel to be stored at the ISFSI in the NAC-UMS® System as specified in CoC 1015, Amendments 0 through 5	1.3.1, 4.3.1
2.1.7	Fuel to be stored at the ISFSI in the NAC-MAGNASTOR® System as specified in CoC 1031, Amendments 0 through 3, Revision 1, and Amendments 4 and 5	1.3.1, 4.3.1
2.2.1	Functional and Operating Limits Violation—Canister shall be placed in a safe condition	1.3.1, 1.3.3, 9.3.4.2, 11.3.3.1
2.2.2	Functional and Operating Limits Violation—Notify the NRC Operations Center	1.3.1, 1.3.3, 9.3.4.2, 11.3.3.1
2.2.3	Functional and Operating Limits Violation—Submit a special report that describes the cause of the violation and the actions taken to restore compliance and prevent recurrence	1.3.1, 1.3.3, 9.3.4.2, 11.3.3.1

The staff confirmed that the functional and operating limits proposed by the applicant are consistent with corresponding limits in CoC TS previously approved by the NRC. The staff finds that the functional and operating limits listed in SER Table 17-1 apply to the fuel proposed for storage at the WCS CISF and are necessary to protect the integrity of the stored fuel, to protect employees against occupational exposure, and to guard against the uncontrolled release of radioactive materials. Therefore, the staff concludes that the WCS CISF TS meet the requirements in 10 CFR 72.44(c)(1)(i).

17.3.2 Limiting Conditions for Operation and Surveillance Requirements

The staff reviewed the LCOs and SRs proposed by the applicant. SER Table 17-2 lists the proposed LCOs and SRs included in the WCS CISF TS and the associated SER sections.

Table 17-2 WCS CISF TS LCOs and SRs and Associated SER Sections

TS Item	LCO	Associated SR	Associated SER Sections
LCO 3.1.1	Shipping/Transfer Cask Exterior Surface Contamination	SR 3.1.1.1	12.3.3, 12.3.6.3
LCO 3.2.1	NAC-MPC Canister Maximum Time in the Transfer Cask	SR 3.2.1.1	6.3.1
LCO 3.2.2	NAC-MPC Vertical Concrete Cask (VCC) Heat Removal System	SR 3.2.2.1	6.3.1
LCO 3.3.1	NAC-UMS Canister Maximum Time in the Transfer Cask	SR 3.3.1.1	6.3.1
LCO 3.3.2	NAC-UMS VCC Heat Removal System	SR 3.3.2.1 and SR 3.3.2.2	6.3.1
LCO 3.4.1	NAC-MAGNASTOR Canister Maximum Time in the Transfer Cask	SR 3.4.1.1	6.3.1
LCO 3.4.2	NAC-MAGNASTOR VCC Heat Removal System	SR 3.4.2.1	6.3.1

The staff confirmed that the LCOs listed in SER Table 17-2 specify the lowest functional capability for the equipment required for safe operation and are consistent with corresponding LCOs in CoC TS previously approved by the NRC. In addition, the staff confirmed that the SRs listed in Table 17-2 provide for the necessary inspection and testing, confirm operation within appropriate functional and operating limits, and confirm that LCOs for safe storage are met. Therefore, the staff concludes that the WCS CISF TS meet the requirements in 10 CFR 72.44(c)(2) and (c)(3).

17.3.3 Design Features

The staff reviewed the design features portion of the TS, which includes items that could have a significant effect on safety if altered or modified, such as materials of construction or geometric arrangements. SER Table 17-3 lists the design features included in the WCS CISF TS and the associated SER sections.

Table 17-3 WCS CISF TS Design Features and Associated SER Sections

TS Item	Design Feature	Associated SER Sections
4.1	Site	2.3.1
4.2.1	Storage Systems	1.3.1
4.2.2	Storage Capacity	1.3.1
4.3.1	Storage Configuration	1.3.1
4.3.2	Concrete Storage Pad Properties to Limit Canister Gravitational Loadings Due to Postulated Drops	5.4.2.4, 5.3.2.5
4.4.1	Lifting	3.3.8.2, 4.3.3.4

Table 17-3 WCS CISF TS Design Features and Associated SER Sections

TS Item	Design Feature	Associated SER Sections
4.4.2	Post-Transportation Verification	9.3.3.1
4.5	Design-Basis Site-Specific Parameters and Analyses	6.3.5, 16.3.2.4

The design features and other specifications contained in TS Item 4.4.1 prescribe the design and operational standards applicable to the Canister Transfer System (CTS), Vertical Cask Transporter (VCT), and associated lifting devices. Lifting systems meeting these standards ensure these structures, systems, and components have and maintain the necessary quality and integrity to act as single-failure-proof handling systems. The scope of the standards includes design, fabrication, operation, testing, inspection, and maintenance, consistent with the guidelines of NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants: Resolution of Generic Technical Activity A-36," issued July 1980.

The staff confirmed that the design features listed in SER Table 17-3 are features that if altered could have a significant effect on safety. Therefore, the staff concludes that the WCS CISF TS meet the requirements in 10 CFR 72.44(c)(4).

17.3.4 Administrative Controls

The staff reviewed the administrative controls proposed in the WCS CISF TS. SER Table 17-4 lists the administrative controls and the associated SER sections.

Table 17-4 WCS CISF TS Administrative Controls and Associated SER Sections

TS Item	Administrative Controls	Associated SER Sections
5.1.1	Radiological Environmental Monitoring Program	12.3.4.5
5.1.2	Radiation Protection Program	12.3.6
5.1.3	Horizontal Storage Module (HSM) Thermal Monitoring Program	6.3.1
5.1.4	Corrective Action Program	9.3.4.2
5.2.1	Lifting Height and Temperature Limits	5.3.3.4, 5.3.4, 6.3.2
5.2.2	Cask Drop	5.3.1.4
5.3	Concrete Testing	10.3.13
5.4	Severe Weather	5.3.3.1.2.1

The administrative controls on lift height and temperatures of applicable outer cask structures (including the shipping/transfer casks (STCs) and VCCs) during operations contained in TS Item 5.2.1 prescribe the initial conditions defining material properties and accident loads considered in drop analyses. Adherence to these administrative controls ensures that loads imposed on these casks by failure of the not-important-to-safety handling systems would remain

within analyzed conditions determined to be acceptable. These administrative controls are consistent with the guidelines of NUREG-0612.

The staff confirmed that the administrative controls listed in SER Table 17-4 are necessary to assure that the operations involved in the storage of spent fuel at the facility are performed in a safe manner. Therefore, the staff concludes that the WCS CISF TS meet the requirements in 10 CFR 72.44(c)(5) and (d).

17.3.5 License Conditions

The regulations in 10 CFR 72.44 require that each license issued under 10 CFR Part 72 include license conditions that pertain to design, construction, and operation, or that the Commission may include as it deems appropriate, and specify certain license conditions that apply to each license issued under 10 CFR Part 72, whether or not the license explicitly states the license conditions. The staff noted that the conditions specified in 10 CFR 72.44(b)(1) through (b)(6) are binding on the WCS CISF license but are not explicitly restated in the WCS CISF license.

SER Table 17-5 lists the license conditions that the staff identified during its review of the WCS CISF application and associated documents, and the associated SER chapter detailing the staff's evaluation.

Table 17-5 WCS CISF License Conditions and Associated SER Chapters

License Condition Description	Associated SER Chapter
Aging Management Program	10
Startup Plan	11
Physical Security Plan	11
Funding Operations	14
Financial Assurance	14

17.4 Evaluation Findings

Based on its review of the application, the staff concludes that the conditions for the WCS CISF identify the necessary TS to satisfy the requirements of 10 CFR 72.44(c) and (d). The proposed TS provide reasonable assurance that the ISFSI will allow for the safe storage of spent fuel. This finding is based on the regulation itself, appropriate regulatory guides, and accepted practices.

17.5 References

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

Interim Storage Partners LLC, Proposed Materials License No. SNM-1050, Revision 4, Appendix A, "WCS Consolidated Interim Storage Facility Technical Specifications," April 12, 2021. Agencywide Documents Access and Management System (ADAMS) Accession No. ML21105A785.

NRC, SNM-2510, License for Independent Storage of Spent Nuclear Fuel and High Level Radioactive Waste, Amendment 4. Enclosure 2, Technical Specifications Changed Page, Section 2.1, "Functional and Operating Limits," August 11, 2009. ADAMS Accession No. ML092240427.

NRC, Certificate of Compliance for Spent Fuel Storage Casks, Certificate No. 1004, Model No. Standardized NUHOMS-24P, -52B, -61BT, -32PT, -24PHB, -24PTH, -32PTH1, -37PTH, -61BTH, and -69BTH, Amendment 13, Appendix A, "Technical Specifications for the Standardized NUHOMS® Horizontal Modular Storage System," May 23, 2014. ADAMS Accession No. ML14153A578.

NRC, Certificate of Compliance for Spent Fuel Storage Casks, Certificate No. 1029, Model No. Standardized Advanced NUHOMS System, Amendment 3, Appendix A, "Technical Specifications for the Standardized Advanced NUHOMS® System Operating Controls and Limits," February 20, 2015. ADAMS Accession No. ML15054A513.

NRC, Certificate of Compliance for Spent Fuel Storage Casks, Certificate No. 1025, Model No. NAC-MPC, Amendment 6, Appendix B, "Approved Contents and Designs Features for the NAC-MPC® System," October 18, 2010. ADAMS Accession No. ML102980019.

NRC, Certificate of Compliance for Spent Fuel Storage Casks, Certificate No. 1015, Model No. NAC-UMS System, Amendment 5, Appendix B, "Approved Contents and Designs Features for the NAC-UMS® System," January 12, 2009. ADAMS Accession No. ML090120473.

NRC, Certificate of Compliance for Spent Fuel Storage Casks, Certificate No. 1031, Model No. MAGNASTOR System, Amendment 5, Appendix B, "Approved Contents for the MAGNASTOR® System," June 29, 2015. ADAMS Accession No. ML15180A379.

18 CONCLUSION

The staff has reviewed the design, testing, operations, maintenance, and other safety-related activities and features for the WCS Consolidated Interim Storage Facility (CISF), as described in the following documents submitted by the applicant:

- the License Application, which contains general and financial information, the applicant's technical qualifications, technical specifications, and a preliminary decommissioning plan;
- the Safety Analysis Report for the WCS CISF;
- the Emergency Plan for the WCS CISF; and
- the Physical Security Plan for the WCS CISF, which includes the safeguards contingency plan.

Based on the information provided in the above documents, the conditions specified in the proposed Technical Specifications and the license conditions identified in this SER, and the use of previously approved spent nuclear fuel storage systems (NUHOMS®-MP187, Standardized Advanced NUHOMS System, Standardized NUHOMS System, NAC-MPC, NAC-UMS®, and MAGNASTOR®) and transportation systems (NUHOMS-MP187, NUHOMS-MP197, NAC-STC, NAC-UMS, and MAGNATRAN®) and the respective final safety analysis reports that the applicant incorporated by reference, the staff concludes that the WCS CISF meets the requirements of 10 CFR Part 72. Pursuant to 10 CFR 72.40(a), the staff has made the following findings:

- 10 CFR 72.40(a)(1) - Based on the evaluation throughout this SER, the staff finds that the applicant's proposed ISFSI design complies with Subpart F of 10 CFR Part 72.
- 10 CFR 72.40(a)(2) - Based on the evaluation in Chapters 2, 4, 7, 12, and 15 of this SER, the staff finds that the proposed site complies with the criteria in Subpart E of 10 CFR Part 72.
- 10 CFR 72.40(a)(3) - Based on the evaluation throughout this SER, the staff finds that the proposed ISFSI would not pose an undue risk to the safe operation of the WCS radioactive material disposal facilities.
- 10 CFR 72.40(a)(4) - Based on the evaluation in Chapter 11 of this SER, the staff has made the finding that the applicant is qualified by reason of training and experience to conduct the operation covered by the regulations in this part.
- 10 CFR 72.40(a)(5) - Based on the evaluation in Chapter 3 of this SER, the staff finds that the applicant's description of its proposed operating procedures to protect health and to minimize danger to life or property are adequate.
- 10 CFR 72.40(a)(6) - Based on the evaluation in Chapter 14 of this SER, the staff finds that the applicant for the ISFSI is financially qualified to engage in the proposed activities in accordance with the regulations in this part.

- 10 CFR 72.40(a)(7) - Based on the evaluation in Chapter 13 of this SER, the staff finds that the applicant's quality assurance plan complies with Subpart G of 10 CFR Part 72.
- 10 CFR 72.40(a)(8) - Based on the evaluation in Chapter 11 of this SER, the staff finds that the applicant's physical protection provisions comply with Subpart H of 10 CFR Part 72.
- 10 CFR 72.40(a)(9) - Based on the evaluation in Chapter 11 of this SER, the staff finds that the applicant's personnel training program complies with Subpart I of 10 CFR Part 72.
- 10 CFR 72.40(a)(10) - Based on the evaluation in Chapter 14 of this SER, the staff finds that the applicant's preliminary decommissioning plan, pursuant to 10 CFR 72.30, provides reasonable assurance that decontamination and decommissioning of the ISFSI at the end of its useful life will provide adequate protection to the health and safety of the public.
- 10 CFR 72.40(a)(11) - Based on the evaluation in Chapter 11 of this SER, the staff finds that the applicant's emergency plan complies with 10 CFR 72.32.
- 10 CFR 72.40(a)(12) - This regulatory requirement is outside the scope of this SER.
- 10 CFR 72.40(a)(13) - Based on the evaluation throughout this SER, the staff finds that there is reasonable assurance that: (i) The activities authorized by the license can be conducted without endangering the health and safety of the public and (ii) these activities will be conducted in compliance with the applicable regulations of Chapter 10 of the Code of Federal Regulations.
- 10 CFR 72.40(a)(14) - Based on the evaluation in Chapter 11 of this SER, the staff finds that the issuance of a license for the WCS CISF will not be inimical to the common defense and security.

18.1 References

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

AREVA, Inc., "NUHOMS®-MP197 Transport Packaging Safety Analysis Report," Revision 17, April 2001 (nonpublic). NRC Docket No. 71-9302. Transmittal dated July 20, 2016. Agencywide Documents Access and Management System (ADAMS) Accession No. ML16207A498.

AREVA, Inc., "Updated Final Safety Analysis Report for the Standardized Advanced NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 6, August 2014 (nonpublic). NRC Docket No. 72-1029. Transmittal dated July 13, 2016. ADAMS Accession No. ML16200A178.

AREVA TN Americas, "Updated Final Safety Analysis Report for the Standardized NUHOMS® Horizontal Modular Storage System for Irradiated Nuclear Fuel," Revision 14, September 2014

(nonpublic). NRC Docket No. 72-1004. Transmittal dated July 13, 2016. ADAMS Accession No. ML16218A396.

Interim Storage Partners LLC, "Submission of Revision 5 of the Safety Analysis Report and Revision 4 of the License Application for the WCS CISF," Docket No. 72-1050, April 12, 2021. ADAMS Package Accession No. ML21105A766.

Interim Storage Partners LLC, "Revision 5 of the Physical Security Plan, Training and Qualification Plan, and Safeguards Contingency Plan with Updated Cover Sheets, Docket 72-1050 CAC/EPID 001028/L-2017-NEW-0002," transmittal letter dated September 19, 2020. ADAMS Accession No. ML20269A259.

NAC International, "Safety Analysis Report for the UMS® Universal Transport Cask," Revision 2, November 2005. NRC Docket No. 71-9270. ADAMS Accession No. ML16252A309.

NAC International, "NAC-STC, NAC Storage Transport Cask Safety Analysis Report," Revision 17, April 2011 (nonpublic). NRC Docket No. 71-9235. Transmittal dated May 25, 2011. ADAMS Accession No. ML11152A179.

NAC International, "MAGNATRAN Safety Analysis Report," Revision 12A, October 2012. NRC Docket No. 71-9356. ADAMS Accession Nos. ML13024A258 and ML13010A092.

NAC International, "MAGNATRAN® Safety Analysis Report," Revision 14A, October 2014. NRC Docket No. 71-9356. ADAMS Accession No. ML14356A377.

NAC International, "MAGNATRAN Safety Analysis Report," Revision 15A, October 2015 (nonpublic). NRC Docket No. 71-9356. Transmittal dated October 15, 2015. ADAMS Accession No. ML15296A084.

NAC International, "MAGNASTOR® Final Safety Analysis Report," Revision 7, July 2015 (nonpublic). NRC Docket No. 72-1031. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A932.

NAC International, "NAC-MPC, NAC Multi-Purpose Cask, Final Safety Analysis Report," Revision 10, January 2014 (nonpublic). NRC Docket No. 72-1025. Transmittal dated August 3, 2016. ADAMS Accession No. ML16223A556.

NAC International, "NAC-UMS Universal Storage System Final Safety Analysis Report," Revision 10, October 2012 (nonpublic). NRC Docket No. 72-1015. Transmittal dated August 3, 2016. ADAMS Accession No. ML16245A212.

Sacramento Municipal Utility District, "Rancho Seco Independent Spent Fuel Storage Installation, Final Safety Analysis Report, Volume 1, ISFSI System," Revision 4, June 2010 (nonpublic). NRC Docket No. 72-11. Transmittal dated August 11, 2016. ADAMS Accession No. ML16236A115.

Transnuclear, Inc., "Safety Analysis Report for the NUHOMS®-MP187 Multi-Purpose Cask," Revision 17, July 2003 (nonpublic). NRC Docket No. 71-9255. Transmittal dated July 15, 2016. ADAMS Accession No. ML16203A183.

Waste Control Specialists LLC, ERP-100, "Consolidated Emergency Response Plan," February 8, 2019. ADAMS Accession No. ML19156A045.