PRIVATE FUEL STORAGE FACILITY

SAFETY ANALYSIS REPORT

REVISION 1 REPLACEMENT PAGE INSTRUCTIONS

SECTION/CHAPTER	INSTRUCTIONS
Document Control	Replace pages a through t with enclosed replacement pages.
Chapter 2	Replace the following pages with enclosed replacement pages: pages 2-iii, 2-iv, 2.2-3, 2.2-4-, 2.7-1, and 2.7-2. Replace Tables 2.3-7 and 2.3-8 with enclosed replacement Tables.
Chapter 3	Replace the following pages with enclosed replacement pages: pages 3-i, 3-ii, 3-iii, 3-iv, 3.1-3, 3.1-4, 3.2-3, and 3.2-4. Insert new pages 3.2-4a and 3.2-4b. Replace the following pages with enclosed replacement pages: pages 3.2-7, 3.2-8, 3.2-15 through 3.2-20, 3.2-25 through 3.2-32, 3.3-5, 3.3-6, 3.3-9, and 3.3-10. Replace the following Tables with the enclosed replacement Tables: 3.1-1, 3.1-2, 3.2-3, 3.4-1, 3.6-1(Sheet 1 of 5), and 3.6-1(Sheet 2 of 5).
Chapter 4	Replace the following pages with enclosed replacement pages: pages 4-i through 4-iv, 4.2-5, 4.2-6, 4.2-13 through 4.2-22, 4.2-25, 4.2-26, and 4.2-31 through 4.2-34. Insert new pages 4.2-34a and 4.2-34b. Replace the following pages with enclosed replacement pages: pages 4.2-39, 4.2-40, 4.3-1 through 4.3-8, and 4.7-5 through 4.7-8. Insert new pages 4.7-8a and 4.7-8b. Replace the following pages with enclosed replacement pages: pages 4.7-19 through 4.7-22, 4.7-23 through 4.7-26, 4.7-31, and 4.7-32. Replace the following tables with enclosed replacement tables: tables 4.1-1, sheets 1, 2, and 7, 4.2-1, 4.2-2, and 4.2-3.

Chapter 5	Replace the following pages with enclosed replacement pages: pages 5.1-5, 5.1-6, 5.1-9, 5.1-10, 5.2-1 through 5.2-6, 5.5-1, and 5.5-2. Replace the following Tables with the enclosed replacement Tables: 5.1-1(Sheet 1 of 2 and 2 of 2), 5.1-2 (Sheet 1 of 2 and 2 of 2). Replace Figure 5.1-1 with the enclosed replacement Figure.
Chapter 6	Replace the following pages with enclosed replacement pages: pages 6.2-1 and 6.2-2.
Chapter 7	Replace the following pages with enclosed replacement pages: pages 7.3-15, 7.3-16, 7.4-1, and 7.4-2. Replace the following tables with enclosed replacement tables: tables 7.4-1 (Pages 1 through 4) and 7.4-2 (Pages 1 through 4).
Chapter 8	Replace the following pages with enclosed replacement pages: pages 8-i, 8-ii, 8.1-17 and 8.1-18. Insert new pages 8.1-19 and 8.1-20. Replace the following pages with enclosed replacement pages: 8.2-5, 8.2-6, 8.2-39 through 8.2-44, 8.2-47, 8.2-48, 8.4-3, and 8.4-4.
Chapter 9	Replace the following pages with enclosed replacement pages: pages 9-i through 9-iv, 9.1-7, 9.1-8, 9.1-15, and 9.1-16. Insert new pages 9.1-16a and 9.1-16b. Replace the following pages with enclosed replacement pages: pages 9.1-25 through 9.1-28, 9.2-1, and 9.2-2. Insert new pages 9.2-2a and 9.2-2b. Replace the following pages with enclosed replacement pages: pages 9.2-7 and 9.2-8. Insert new pages 9.2-8a and 9.2-8b. Replace the following pages with enclosed replacement pages: pages 9.4-3 and 9.4-4. Insert new pages 9.4-4a and 9.4-4b. Replace the following pages with enclosed replacement pages: pages 9.5-1 and 9.5-2.
Chapter 10	Replace the following pages with enclosed replacement pages: pages 10.2-1 through 10.2-6. Insert new pages 10.2-6a and 10.2-6b. Replace the following pages with enclosed replacement pages: pages 10.2-11, 10.2-12, 10.2-17, and 10.2-18.

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required to exceed 1 psi overpressure for detonation of explosives transported by highway.

Michael Army Air Field is located on the Dugway Proving Ground, 15 miles south-southwest of the PFSF. This military airfield has a 13,125 foot runway, and can accommodate all operative aircraft in the Department of Defense inventory. The airspace over the Dugway Proving Ground is restricted. Military airway IR-420 passes over the PFSF site area. The methods of NUREG-0800 Section 3.5.1.6 were used to estimate the probability of an aircraft impacting the PFSF from this airway, using the equation:

$$P = C \times N \times A / w,$$ where

P = probability per year of an aircraft crashing into the PFSF
C = in-flight crash rate per mile
N = number of flights per year along the airway
A = effective area of the PFSF in square miles
w = width of airway in miles

NUREG-0800 states the in-flight crash rate as 4 E-10 per mile. Information provided by the Dugway Proving Ground states that there are approximately 414 flights annually at this airfield. The effective area of the facility (restricted area) is 99 acres x 1.562 E-3 mi^2/acre = 0.1546 mi^2. The width of the airway is 5 nautical miles (NM) according to the FAA flight map, or 5NM x 1.15 NM/mile = 5.75 miles. The probability of an aircraft impacting the PFSF is therefore 4.45 E-9 per year. This is an extremely low probability of occurrence, below the NUREG-0800 guideline of 1 E-7 per year, and is not considered a credible event. With this low probability of occurrence and the fact that the Michael Army Air Field is located 15 miles away, the PFSF is not designed to withstand the direct impact of an aircraft crash.

The Tooele Army Depot facilities, where toxic gas munitions are stored and incinerated, are located west and south, respectively, of Tooele City. The North Tooele Army Depot is 17 miles east-northeast of the PFSF and the South Tooele Army Depot is 21 miles east-southeast of the PFSF. The Stansbury Mountains, with an elevation of approximately 8,000 feet, lie between the PFSF and the Tooele Army Depots. The activities and materials at the Tooele Army Depots will therefore present no credible hazard to the PFSF, because of their relative distance and the intervening Stansbury Mountains.

2.7 SUMMARY OF SITE CONDITIONS AFFECTING CONSTRUCTION AND OPERATING REQUIREMENTS

The PFSF site is located near the middle of Skull Valley. The valley is approximately 50 miles long, 22 miles wide, and slopes gently to the north at about a 0.6% grade. The finished grade of the storage facility is sloped gently from elevation 4,475 ft at the southeastern corner to elevation 4,457 ft at the north, where a stormwater retention basin is located. The stormwater retention basin is at elevation 4,450 ft. The Canister Transfer Building, located within the restricted area, has a floor elevation of 4,475 ft. The access road is graded to match the Skull Valley road at the east end (elevation 4,487 ft) and the storage facility at the west end (elevation 4,475 ft) with a maximum slope of approximately 3%.

The entire site, including the access road, is above the 100-year flood elevation. However, diversion berms are required to deflect the anticipated flows from the PMF due to both the Stansbury Mountains and the Hickman Knolls watersheds.

A diversion berm is provided perpendicular to the access road to channel the Stansbury Mountain PMF to flow away from the PFSF. The PMF berm elevation is 4,505 ft where it intersects the access road. The berm is a maximum of 9 ft high at the access road and tapers down in height as it joins the Hickman Knolls to the south. The berm is located approximately 200 ft east of the storage facility along the access road and extends approximately 1,600 ft south and 280 ft north of the access road. The berm will divert PMF-generated flow emanating from the Stansbury Mountains, east of the site, to the north and east of the storage facility. Box culverts are provided under the access road to allow normal and 100-yr. floodwater to pass beneath the access road toward the north. PMF flows will flow over the top of the access road.

The storage facility and buildings within the restricted area are protected from the smaller Hickman Knolls PMF by a partial perimeter berm. The berm is located along the entire southern side and halfway along the western side of the storage facility. The berm is approximately 5 ft high and is designed to divert the PMF sheet flow of less than one foot deep to the west and north of the storage facility.

The largest ground motions at the site will be derived from the Stansbury fault, located about 6 miles east of the site. The DE is defined as a magnitude 6.7 event occurring on the Stansbury fault, which may result in a peak horizontal ground acceleration of 0.67 g and a peak vertical ground acceleration of 0.69 g.

Subsurface soils at the site are suitable for supporting conventional foundations under both the static and dynamic loading conditions. There is no potential for liquefaction, collapse, or excessive settlement of these soils. There are no slopes, natural or manmade, close enough to the proposed important to safety facilities that their failure could adversely affect these facilities.

Dry casks will be used to store canisters containing spent fuel. The canisters will be drained of all liquid prior to being shipped to the facility. Therefore, liquid releases cannot result from operation of the facility.

Groundwater is greater than 100 ft deep at the site. The method of storage (dry cask), the nature of the storage casks, and the depth to groundwater beneath the site preclude the possibility of groundwater contamination from operation of the facility.

TABLE 2.3-7

MEAN SEASONAL MORNING AND AFTERNOON MIXING HEIGHTS FOR SALT LAKE CITY[1]

SEASON	MEAN MIXING HEIGHT (meters)	
	MORNING	AFTERNOON
Winter	329	944
Spring	419	2,675
Summer	216	3,737
Fall	238	1,933
Annual	300	2,322

1. Period of record is 1960 - 1964.

TABLE 2.3-8

NATIONAL AMBIENT AIR QUALITY STANDARDS

POLLUTANT	AVERAGING INTERVAL	PRIMARY STANDARD		SECONDARY STANDARD	
		μg/m³	ppmv	μg/m³	ppmv
SO_2	Annual	80	0.03	-	-
	24-hr	365	0.14	-	-
	3-hr	-	-	1,300	0.50
PM10	Annual	50	-	50	-
	24-hr	150	-	150	-
CO	8-hr	10[1]	9	10[1]	9
	1-hr	40[1]	35	40[1]	35
O_3	1-hr	235	0.12	235	0.12
NO_2	Annual	100	0.053	100	0.053
Pb	3 months	1.5	-	1.5	-

1. mg/m³ (milligrams per cubic meter).

CHAPTER 3

PRINCIPAL DESIGN CRITERIA

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The PFSF design shall utilize one of two transport alternatives to haul the shipping cask from the railroad mainline to the site. The first is to haul the shipping cask by highway on a heavy haul tractor/trailer from an intermodal point to the PFSF. Using the highway alternative, the intermodal transfer point shall include the necessary components (crane, rail siding, and truck access area) to accommodate the rail to tractor/trailer transfer. The second alternative is to haul the shipping cask by rail on a railroad spur to be constructed. Using the rail spur option, the railroad spur and associated equipment shall be designed in accordance with railroad industry standards.

At the PFSF the canister shall be transferred from the shipping cask to the storage cask. The shipping cask shall be off-loaded from the transport vehicle inside the Canister Transfer Building using an overhead crane and placed in a shielded transfer cell. Once the shipping cask has been opened a transfer cask shall be placed on top of the shipping cask and the canister hoisted up and secured into the transfer cask. The transfer cask shall then be moved by crane onto the top of a concrete storage cask and the canister shall be lowered into the storage cask. The storage cask lid shall be installed and bolted. The storage cask shall then be moved to the cask storage pad using a cask transporter. Storage of the loaded concrete storage cask shall include temperature monitoring and periodic surveillance of the storage casks.

When the fuel is to be shipped offsite, the storage cask shall be moved back into the Canister Transfer Building using the cask transporter. The transfer cask shall be placed on top of the storage cask and the canister lifted up and secured into the transfer cask. The transfer cask shall then be moved by crane onto the top of a shipping cask. The canister shall be lowered into the shipping cask, which shall be closed and shipped offsite.

The PFSF shall be designed with the necessary equipment (such as, the Canister Transfer Building, cranes, cask transporter, storage area) to accommodate shipping cask receipt, canister transfer from the shipping cask to the concrete storage cask, cask transport to and from the storage pads as detailed above with provisions for security, health physics, maintenance, document control, and inventory management.

3.1.2.2 Onsite Generated Waste Processing, Packaging and Storage

The selected canister-based storage systems shall be designed to confine spent fuel within a sealed canister at the originating nuclear power plant. Therefore, handling of spent fuel is not required and no radioactive waste is generated at the PFSF.

Health physics survey material (i.e. smears, disposable clothing) shall be collected, identified, packaged in low level waste (LLW) containers, marked in accordance with 10 CFR 20 requirements, and temporarily stored in the LLW holding cell of the Canister Transfer Building while awaiting shipment to an offsite low-level radioactive disposal facility.

There shall be no other systems or facilities for processing, packaging, storing, or transporting any other type of radioactive waste at the PFSF.

3.1.2.3 Utilities

The PFSF shall be designed to include utilities necessary for facility operation. These utilities include (1) electrical power for operation of equipment, lights, monitoring equipment, communication systems, security systems; (2) backup electrical power for operation of security systems, emergency lights, monitoring equipment, and communication systems; and (3) mechanical systems for operation of fire protection equipment, building HVAC systems, compressed air systems, water supply systems, The HI-STORM and TranStor storage systems design criteria are fully described in their respective SARs. Where the storage systems design criteria do not bound the PFSF design criteria, the storage systems design shall be shown in subsequent chapters as complying with the PFSF site-specific design criteria. The storage system design parameters that require site-specific analysis and/or design and the Sections where they are addressed are as follows:

Site Specific Design Criteria	Storage System	Section Addressed
• Cask stability during a seismic event	HI-STORM TranStor	4.2.1.5.1(H) 4.2.2.5.1(H)
• Storage cask temperature monitoring verses daily inspection of vent blockage	HI-STORM TranStor	N/A 5.4.1
• Radiation doses for 4000 cask array to the RA, OCA, and nearest residence	both	7.3.3.5 and 7.6
• Off-normal contamination release event	HI-STORM TranStor	8.1.5 N/A
• Hypothetical storage cask tipover onto a PFSF concrete storage pad	both	8.2.6
• Hypothetical loss of confinement	HI-STORM TranStor	8.2.7 N/A
• Fire	both	8.2.5

3.2.1 Dead Load

Dead load is defined as the self weight of the structure, including all permanently installed equipment, and loads due to differential settlement, creep and shrinkage.

3.2.2 Live Loads

Live loads are defined as all equipment not permanently installed, lift loads, and all loads other than dead loads that might be experienced that are not separately identified and used in the applicable load combinations. These include normal and off-normal handling and impact loads from equipment. Impact loads for the cranes include equipment loads imposed on the crane through supporting members of the building and loads induced by the acceleration and deceleration of the crane bridge, gantry, or trolley.

3.2.3 Snow and Ice Loads

Snow loads, which are considered as live loads, shall be determined in accordance with ASCE-7 (Reference 3). The site is located in an area designated as CS on ASCE-7 Figure 7-1. Areas designated as CS require site-specific Case Studies to establish ground snow loads. In lieu of site-specific analysis, the ground snow load (P_g) is based on recommendations from the Tooele County Building Department for design of structures per the Uniform Building Code (UBC). UBC figure A-16-1 designates that the ground snow load for the entire State of Utah be established by the building official. The Tooele County Building Department recommends a 43 psf ground snow load for the reservation. This value is rounded up to a 45 psf ground snow load for a conservative design value. Design snow loads and placement of loads on structures shall follow the procedures outlined in ASCE-7.

3.2.4 Internal/External Pressure

Internal and external pressure loads are defined as loads resulting from the differential pressure between the helium fill gas inside the canister and the environmental pressure. The pressure may be positive (internal pressure) or negative (external pressure). The pressure must be considered for both normal and off-normal conditions,

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3.2.8.2 Determination of Forces on Structures

Forces resulting from the design basis wind and the design basis tornado shall be considered in the design. The method used to convert wind loading into forces on a structure shall be in accordance with NUREG-0800 (Section 3.3.1, Wind Loadings, and Section 3.3.2, Tornado Loadings).

3.2.8.3 Ability of Structure to Perform Despite Failure of Structure Not Designed for Tornado Load

The PFSF shall be designed to ensure that SSCs that are not designed for tornado loads do not adversely affect the safety functions of SSCs that are classified as Important to Safety.

SSCs that are classified as Important to Safety but not designed for tornado loads shall be located so as to be protected by a SSC that is classified as Important to Safety and designed for tornado loads.

The Canister Transfer Building shall be designed to withstand tornado-generated wind loadings and missiles in order to protect SSCs housed within the building that are not designed for tornado loads.

3.2.8.4 Tornado Missiles

SSCs that are classified as Important to Safety shall be designed for tornado-generated missiles except as noted in Section 3.2.8.3.

The loaded concrete storage casks shall remain stable and the confinement boundary not breached when subjected to tornado-generated missiles.

The storage pads and Canister Transfer Building shall remain stable and structurally intact when subjected to tornado-generated missiles.

Tornado-generated missiles need not be considered in the design of the canister, overhead bridge and semi-gantry cranes, or transfer cask since the canister is protected by the storage cask and the cranes and transfer cask are protected by the Canister Transfer Building.

Postulated tornado missiles shall be in accordance with NUREG-0800, Section 3.5.1.4, for Spectrum I missiles. The tornado-generated missiles shall include:

- 1800 kg automobile
- 125 kg 8" armor piercing artillery shell
- 1" solid steel sphere

As described in NUREG-0800, all missiles shall be assumed to impact at 35 percent of the maximum horizontal wind speed of the design basis tornado (240 mph x 0.35 = 84 mph). The first two missiles are assumed to impact at normal incidence; the last is assumed to impinge upon barrier openings in the most damaging directions.

The barrier design procedure associated with tornado-generated missiles shall be in accordance with NUREG-0800, Section 3.5.3.

3.2.9 Water Level (Flood) Design

The site is located in Skull Valley, an area of western Utah with a semi-arid climate, receiving low annual precipitation. Precipitation ranges from 7 to 12 inches per year. The site has no flowing or intermittent streams nearby, however, there is evidence of minor drainage channels created by infrequent thunderstorms or snow melt runoff.

3.2.10.2.6 Methods Used to Account for Torsional Effects

The storage pads and the Canister Transfer Building shall be modeled and analyzed as 3-dimensional multimass systems. Therefore, torsional effects due to eccentricities of the mass are taken into account in the analysis.

3.2.10.2.7 Methods for Seismic Analysis of Dams

There are no dams onsite or in the immediate area.

3.2.10.2.8 Methods to Determine Overturning Moments

Overturning stability shall be assured for the storage casks on the pads.

Overturning stability of loaded concrete casks located on the storage pad shall be proved by both storage system vendors with a dynamic analysis using the site-specific seismic design parameters and considering soil-structure interaction.

3.2.10.2.9 Analysis Procedure for Damping

Critical damping values shall be developed in accordance with Regulatory Guide 1.61 for a SSE.

3.2.10.2.10 Seismic Analysis of Overhead Cranes

The overhead bridge and semi-gantry cranes shall be analyzed for seismic effects in accordance with the requirements of NUREG-0554 for single-failure-proof cranes. The seismic analysis of the cranes shall include the Maximum Critical Load in the lifted position during a seismic event. The seismic analysis methods shall be in accordance with ASME NOG-1 (Reference 16). A set of amplified response spectra curves at the crane rail locations shall be developed for use in the crane seismic analysis and design.

3.2.10.2.11 Seismic Analysis of Specific Safety Features

SSCs classified as Important to Safety shall meet the requirements of 10 CFR 72.122(b)(2), which requires SSCs be designed such that a design earthquake will not result in an uncontrolled release of radioactive material or increased radiation exposure to workers or members of the general public.

3.2.11 Combined Load Criteria

The design shall consider all appropriate loads and load combinations as required by the specific SSC design code(s). Design loads shall be determined from normal, off-normal, and accident-level conditions. Design loads shall be combined to simulate the most adverse load conditions

3.2.11.1 HI-STORM Storage System Load Combinations

Loads and load combinations used in the design of the HI-STORM 100 Cask System are identified in the HI-STORM SAR, Sections 2.2.7 and 3.1.2.1.2. Exceptions to the various code criteria are shown in HI-STORM SAR, Table 2.2.15.

HI-STORM Canister

The canister shell and internals are required by the HI-STORM SAR to be designed to the applicable requirements of Subsections NB and NG of the ASME BPVC, Section III (Reference 17). The load combinations for all normal, off-normal and accident conditions and corresponding Service Levels of the canister design are as follows:

ASME Design

P_i or P_o (ASME BPVC pressure design)

Normal Conditions (ASME Service Level A)

$D + T + P_i + H$

$D + T + P_o + H$

Off-Normal Conditions (ASME Service Level B)

$D + T' + H + (P_i' \text{ or } P_o')$

Accident-Level Conditions (ASME Service Level D)

$D + T + P_i + H'$

$D + T + (P_i^* \text{ or } P_o^*)$

Where:

D	=	Dead Load
T	=	Thermal (normal operating temperature)
T′	=	Thermal (off-normal temperature)
P_i	=	Normal Internal Pressure
P_o	=	Normal External Pressure
P_i'	=	Off-normal Internal Pressure
P_o'	=	Off-normal Exterior Pressure
P_i^*	=	Accident Internal Pressure
P_o^*	=	Accident External Pressure
H	=	Normal Handling Loads
H′	=	Accident-Level Handling Load (drop)

The number of load combinations was reduced by defining the internal and external pressures (P_i and P_o) such that they bound other surface-intensive loads of snow, tornado wind, flood, and explosion.

The stress intensity limits for the canister confinement boundary (governed by Subsection NB of the ASME BPVC, Section III) and the canister internals (governed by Subsection NG of the ASME BPVC, Section III) are shown in Table 3.2-1.

The damaged fuel container is governed by Subsection NF for normal conditions of the ASME BVPC, Section III.

HI-STORM Storage Cask and HI-TRAC Transfer Cask

The load combinations for the HI-STORM storage cask and HI-TRAC transfer cask under normal, off-normal, and accident conditions are as follows:

Normal Conditions (ASME Service Level A)

D + T + H

Off-Normal Conditions (ASME Service Level B)

D + T′ + H

Accident-Level Conditions (ASME Service Level D)

D + T + H′

D + T + (E or F or W′ + M) (storage cask only)

Where:

D	=	Dead Load
T	=	Thermal (normal operating temperature)
T′	=	Thermal (off-normal temperature)
H	=	Normal Handling Loads
H′	=	Accident-Level Handling Load (drop)
E	=	Earthquake
F	=	Flood (not applicable to this site)

W' = Tornado wind

M = Tornado Missile Loads

The stress intensity limits for the steel structure of the HI-STORM storage cask and HI-TRAC transfer cask (governed by Subsection NF of the ASME BPVC, Section III for plate and shell components) are shown in Table 3.2-2. Limits for the Level D condition are obtained from Appendix F of the ASME BPVC, Section III for the steel structure of the storage cask. The storage cask concrete structure design is governed by ACI-349.

The ASME BPVC is not applicable to the HI-TRAC transfer cask for accident conditions, service level D conditions. The HI-TRAC cask shall be shown by analysis to not deform and cause an applied load to the canister, have any shell rupture, or have the top lid or transfer lid detach. The HI-TRAC lifting trunnion design is governed by ANSI N14.6.

3.2.11.2 TranStor Storage System Load Combinations

Loads and load combinations used in the design of the TranStor Storage Cask System are identified in the TranStor SAR, Section 2.2.7. The TranStor storage cask system is subjected to normal, off-normal, and accident loads and events. These loads and events are defined as follows:

Normal	Dead Weight, Pressure, Handling, Thermal, Snow, Winds, Rain.
Off-Normal	Severe Environmental Conditions, Surface Contamination, Interference During Basket Lowering From Transfer Cask to Storage Cask, Blockage of One-Half of Air Inlets, Off-Normal Handling
Accident	Complete Blockage of Air Inlets, Maximum Heat Load, Fuel Pin Rupture, Tornado (wind and missiles), Flood, Seismic, Explosion, Hypothetical Tipover

TranStor Canister

The canister shell and internals are designed to the applicable requirements of ASME BPVC, Section III, Division 1, Subsections NC and NG. The load combinations for all normal, off-normal and accident conditions and corresponding Service Levels of the canister design are as follows:

Normal Conditions (ASME Service Level A)

$D + T_1 + P$

$D + T_2 + P + H_1$

$D + T_1 + P + H_1$

Off-Normal Conditions (ASME Service Level B and C)

$D + T_3 + P$ (Service Level B)

$D + (T_1 \text{ or } T_2 \text{ or } T_3) + P + H_2$ (Service Level C)

Accident-Level Conditions (ASME Service Level D)

$D + T_1 + P + (A \text{ or } E \text{ or } F \text{ or } W_t)$

$D + (T_1 \text{ or } T_2) + P_a + H_1$

$D + T_4 + P$

Where:

D = Dead Load (Canister w/ fuel)

T_1 = Thermal (inside storage cask = 75°F)

T_2 = Thermal (inside transfer cask = 75°F)

T_3 = Thermal (inside storage cask = -40°F or 100°F)

T_4 = Thermal (inside storage cask = max heat load of 125°F)

P = Normal Pressure

P_a = Accident Pressure

H_1 = Normal Handling

H_2 = Off-normal Handling

The maximum storage pad stiffness shall be limited to 30.65 E6 lb/inch, which assures that accelerations resulting from a hypothetical tipover or vertical end drop from a height of 10 inches, for a HI-STORM storage cask, are limited to a 45 g design basis acceleration.

3.2.11.4 Canister Transfer Building Load Combinations

3.2.11.4.1 Canister Transfer Building Structure

The Canister Transfer Building is a reinforced concrete and steel structure. The design of the structure shall be in accordance with the ANSI/ANS 57.9, ACI-349, and ANSI/AISC N690 (Reference 19). Load factors and allowable stresses used in the design shall be in accordance with ACI-349 and ANSI/AISC N690.

The design of the reinforced concrete portions of the structure shall consider the following load combinations as included or derived from ANSI/ANS 57.9 and ACI 349:

Normal Conditions

$U_c > 1.4D + 1.7L$

$U_c > 1.4D + 1.7L + 1.7H$

Off-Normal Conditions

$U_c > 0.75\ (1.4D + 1.7L + 1.7H + 1.7T)$

$U_c > 0.75\ (1.4D + 1.7L + 1.7H + 1.7T + 1.7W)$

Accident-Level Conditions

$U_c > D + L + H + T + (E \text{ or } A \text{ or } W_t \text{ or } F)$

$U_c > D + L + H + T_a$

Where:

U_c = Minimum available strength capacity of a cross section or member calculated per the requirements and assumptions of ACI-349

D = Dead load

L = Live load

H = Lateral soil pressure

W = Wind loads

W_t = Tornado wind and missile loads

E = ISFSI Design Earthquake load

T = Thermal loads

T_a = Accident-level thermal loads

A = Accident loads

F = Flood loads (not applicable to this site)

Live load shall include crane loads in accordance with ASME NOG-1 positioned to create a worst-case loading condition. All appropriate load combinations identified in ASME NOG-1, as shown in Section 3.2.11.5 herein, shall also be considered in the building design. Live load shall also include shipping cask, transfer cask, and storage cask loads positioned with loaded canisters to create the worst-case loading on the Canister Transfer Building floor. Load combinations will account for "stacked arrangements" where the transfer cask is placed on top of the storage or shipping cask, side by side placement of the casks in a transfer cell, and when a transporter carrying a loaded storage cask moves adjacent to other loaded casks.

The design of the structural steel portions of the Canister Transfer Building shall consider the following load combinations as included or derived from ANSI/ANS 57.9 and the ANSI/AISC N690:

Normal Conditions

S and S_v > D + L or D + L + H

Off-Normal Conditions

$1.3 (S \text{ and } S_v) > D + L + H + W$

$1.5S > D + L + H + T + W$

$1.4 S_v > D + L + H + T + W$

Accident-Level Conditions

$1.6S > D + L + H + T + (E \text{ or } W_t \text{ or } F)$

$1.4 S_v > D + L + H + T + (E \text{ or } W_t \text{ or } F \text{ or } A)$

$1.7S > D + L + H + (T + A) \text{ or } T_a$

$1.4 S_v > D + L + H + T_a$

Where:

S	=	Strength of a section, member, or connection calculated in accordance with ANSI/AISC N690
S_v	=	Shear strength of a section, member, or connection calculated in accordance with ANSI/AISC N690
D	=	Dead load
L	=	Live load
W	=	Wind load
W_t	=	Tornado wind and missile loads
E	=	ISFSI Design Earthquake load
F	=	Flood loads (not applicable to this site)
T	=	Thermal load
A	=	Loads due to a drop of a heavy load (not applicable to this project)
H	=	Lateral soil pressure (not applicable to building steel)
T_a	=	Off-normal thermal (not applicable to building steel)

Live load shall include crane loads in accordance with ASME NOG-1 positioned to create a worst-case loading condition. All appropriate load combinations identified in ASME NOG-1, as shown in Section 3.2.11.5 herein, shall also be considered in the building design.

3.2.11.4.2 Canister Transfer Building Foundation

The foundation for the Canister Transfer Building shall be conventional spread footings of reinforced concrete construction. Loads and load combinations used in the design of foundations shall be in accordance with ANSI/ANS 57.9 and ACI-349.

Load factors and allowable stresses used in the design shall be in accordance with ACI-349.

Foundation design for the Canister Transfer Building shall consider the following load combinations per ANSI/ANS 57.9:

<u>Normal Conditions</u>

$U_f > 1.4D + 1.7 L + 1.7G$

$U_f > 1.4D + 1.7L + 1.7H + 1.7G$

<u>Off-Normal Conditions</u>

$U_f > 0.75 (1.4D + 1.7L + 1.7H + 1.7T + 1.7G)$

$U_f > 0.75 (1.4D + 1.7L + 1.7H + 1.7T + 1.7W + 1.7G)$

<u>Accident-Level Conditions</u>

$U_f > D + L + H + T + G +(E \text{ or } A \text{ or } W_t \text{ or } F)$

$U_f > D + L + H + T_a + G$

Where:

U_f = Minimum available strength capacity of a foundation cross section or member calculated in accordance with the requirements and assumptions of ACI-349

D = Dead load

L = Live load

G = Function of required minimum soil capacity

H = Lateral soil pressure

W = Wind loads

W_t = Tornado wind and missile loads

E = ISFSI Design Earthquake load

T = Thermal loads

T_a = Accident-level thermal loads

A = Accident loads

F = Flood loads (not applicable to this site)

Live load shall include crane loads in accordance with ASME NOG-1 positioned to create a worst-case loading condition. All appropriate load combinations identified in ASME NOG-1 shall also be considered in the foundation design. Live load shall also include shipping cask, transfer cask, and storage cask loads positioned with loaded canisters to create the worst-case loading on the Canister Transfer Building foundation. Load combinations will account for configurations where the transfer cask is placed on top of the storage or shipping cask, side by side placement of the casks in a transfer cell, and when a transporter carrying a loaded storage cask moves adjacent to other loaded casks.

Allowable soil pressure shall be determined based on the type of foundation, whether strip or square, and the size of the foundation as shown in Figures 2.6-10 and 2.6-11. Section 2.6.1.12 provides further discussion.

Foundations shall be founded at a minimum depth of 2 ft 6 inches below grade for frost protection in accordance with the PFSF Geotechnical Design Criteria (Reference 9).

3.2.11.5 Canister Transfer Crane Load Combinations

The canister transfer cranes (overhead bridge crane and the semi-gantry crane) shall be classified as Type I cranes in accordance with ASME NOG-1 since the cranes are used to handle critical loads. A Type I crane is defined as a crane that is designed and constructed to remain in place and support a critical load during and after a seismic event and has single-failure-proof features such that any credible failure of a single component will not result in the loss of capability to stop and/or hold the critical load. A critical load is defined as any lifted load whose uncontrolled movement or release could result in potential offsite radiation exposure. The single-failure-proof crane design shall meet the requirements of NUREG-0554, NUREG-0612 (Reference 20), and ASME NOG-1.

The canister transfer cranes shall be designed in accordance with the following load combinations per ASME NOG-1.

Normal Conditions

$P_c = P_{db} + P_{dt} + (P_{lr} \text{ or } P_p)$

$P_c = P_{db} + P_{dt} + P_{lr} + (P_v \text{ or } P_{ht} \text{ or } P_{hl}) + P_{wo}$

Off-Normal Conditions

$P_c = P_{db} + P_{dt} + P_a + P_{wo}$

Accident-Level Conditions

$P_c = P_{db} + P_{dt} + P_{cs} + P_e + P_{wo}$

$P_c = P_{db} + P_{dt} + P_e + P_{wo}$

$P_c = P_{db} + P_{dt} + P_{wt}$

Where:

P_c = Load combination

P_{db} = Bridge dead load

P_{dt} = Trolley dead load

P_{lr} = Design rated lift load

P_{p} = Facility operation induced loads transmitted to crane

P_{v} = Vertical impact loads

P_{ht} = Transverse horizontal load

P_{hl} = Longitudinal horizontal load

P_{wo} = Crane wind load (not applicable inside Canister Transfer Building)

P_{a} = Abnormal (off-normal) event load

P_{cs} = Credible critical load with IFSFI DE (or SSE) load

P_{e} = ISFSI DE (or SSE) load

P_{wt} = Tornado wind load (not applicable inside Canister Transfer Building)

Extreme environmental loads shall include the SSE as being equal to the ISFSI DE. The Operating Basis Earthquake (OBE) is not applicable for the PFSF design. The Maximum Critical Load, noted in NUREG-0554, shall be equal to the crane design capacity (200 tons for the overhead bridge crane and 150 for the semi-gantry crane) and shall be used as the basis for the credible critical load determined per ASME NOG-1.

The canister transfer cranes shall be designed using a response spectrum dynamic seismic analysis as described in ASME NOG-1, Section 4150. The analysis shall be performed by the crane vendor and shall include the development of amplified response spectrum (horizontal and vertical) at the crane rail elevation of the Canister Transfer Building. The amplified response spectrum shall be based on the site response spectrum (Appendix 2D, Figure 4-8) as modified by the effects of the soil-structure interaction and response of the Canister Transfer Building.

Allowable stresses used in the crane designs shall be in accordance with ASME NOG-1.

3.2.12 Lightning

The design of the SSCs, that are exposed to lightning, i.e., outdoors, shall be designed to withstand the effects of a lightning strike such that a lightning strike will not impair their capability to perform their safety function or result in a radiological release. The light poles and perimeter fences will be connected to the facility grounding system for personnel safety in the event of lightning strikes. The Canister Transfer Building shall be provided with lightning protection in accordance with NFPA 780.

Temperature monitors shall be installed to monitor the air outlet or concrete lid temperature of the loaded storage casks.

Radiation monitors shall be utilized during the canister transfer process to ensure occupational exposures are within 10 CFR 20 limits and during the storage process to ensure that doses to the public are within 10 CFR 72.104 limits.

The canister transfer cranes shall be provided with limit switches to assure bridge and trolley movements are within acceptable limits and load cells to assure the lifted load does not exceed the crane capacity.

3.3.4 Nuclear Criticality Safety

This section of the principal design criteria establishes requirements that satisfy 10 CFR 72.124(a) and (b), which identifies general design criteria that requires handling, transfer, and storage systems be designed for nuclear criticality safety. These systems shall be designed to maintain subcriticality such that K_{eff} remain below 0.95 under all conditions (i.e., normal handling, off-normal handling, storage, and postulated accidents) as recommended by NUREG-1536 (Reference 21). All canisters arriving at the PFSF shall be in the dry condition (i.e., no moderator).

3.3.4.1 Control Methods for Prevention of Criticality

Subcritical conditions shall be maintained by the canister internal geometry, which establishes fuel assembly separation. Poison plates are included in the canister basket design to meet the requirements of 10 CFR 71, however, no credit shall be taken for the poison plates since it is assumed there is no moderator (i.e. dry). The design shall assume a fuel assembly enrichment equal to or greater than the maximum initial fuel assembly enrichment that will be stored. No credit shall be taken for burnup.

3.3.4.2 Error Contingency Criteria

The values of K_{eff} shall include error contingencies and calculational and modeling biases. K_{eff} shall equal the calculated K_{eff} plus criticality code bias, plus two times sigma uncertainty to yield a 95 percent statistical confidence level.

3.3.4.3 Verification Analysis

The model used for calculating K_{eff} shall be an NRC approved computer program. Models not previously approved shall be verified by comparison to benchmark experimental data.

3.3.5 Radiological Protection

This section of the principal design criteria establishes requirements that satisfy 10 CFR 72.126(a), which identifies general design criteria that requires radiation protection systems (including SSC design, location, shielding, and testing) be provided to minimize personnel radiation exposure; 10 CFR 72.126(b), which identifies general design criteria that requires alarm systems be provided to warn personnel of abnormally high radiation concentrations; and 10 CFR 72.126(c), which identifies general design criteria that requires a means to measure and monitor radioactive effluents and direct radiation be provided.

Provisions for radiological protection by confinement barriers and systems are described in Section 3.3.2.1. Additional radiological protection design criteria is presented in the following sections.

tractor/trailer unit, if used, shall also be limited by the size of the fuel tank to minimize a potential fire duration in the Canister Transfer Building load/unload bay. If railroad transport is provided to the PFSF, either the railroad locomotive fuel tank shall be limited in size or the railroad locomotive shall not be allowed in the Canister Transfer Building to prevent the possibility of a fire in the building from the large quantity of fuel in the locomotive. The design for the SSCs shall encompass any temperature gradients resulting from a fire from these scenarios.

Determination of overpressure conditions due to explosions at the PFSF shall be in accordance with Regulatory Guide 1.91 (Reference 22). Per Regulatory Guide 1.91, a 1 psi overpressure would be produced by a detonation of the following quantities of explosives at the approximate distances shown:

Mode of Transport	Amount of Hazardous Cargo	At a Distance of
Highway Truck	50,000 lb	1660 ft
Railroad Car	132,000 lb	2290 ft
River Vessel	10,000,000 lb	10,000 ft

Since the distances from the PFSF to the nearest highway, railroad, and river exceeds the distances shown above for a 1 psi overpressure, the SSCs are not required to be designed for explosives.

3.3.7 Materials Handling and Storage

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

This section also establishes requirements that satisfy 10 CFR 72.122(l), which identifies general design criteria that requires the storage system be designed to allow ready retrieval of the spent fuel for shipping offsite.

3.3.7.1 Spent Fuel Handling and Storage

All spent fuel handling and storage at the PFSF shall be performed with the spent fuel contained in the sealed metal canister. The design for handling and storage components shall ensure that the spent fuel canister confinement integrity is maintained.

The design shall ensure that handling components can safely be used to retrieve canisters from the storage casks and load them into shipping casks for shipment offsite throughout the life of the PFSF.

3.3.7.2 Radioactive Waste Treatment

Since the spent fuel is contained in the sealed metal canister, there is expected to be negligible radioactive contamination at the PFSF. The PFSF shall include provisions to package and store health physics survey material and dry wipes used to remove contamination in the event some minor radioactive contamination is found.

3.3.7.3 Waste Storage Facilities

A low level waste (LLW) holding cell shall be provided to store health physics survey material and dry wipes used to check casks for radioactive

TABLE 3.1-1

TYPES OF PWR FUEL THAT CAN BE STORED AT THE PFSF

ASSEMBLY CLASS	CLAD	HI-STORM	TRANSTOR
B&W 15x15	Zr	✓	✓
B&W 15x15 SS	SS	✓	✓
B&W 17x17	Zr		✓
CE 14x14	Zr	✓	✓
CE 14x14 ANF	Zr		✓
CE 15x15	Zr	✓	✓
CE 15x16	Zr		✓
CE 16x16	Zr	✓	✓
WE 14x14 Std.	Zr	✓	✓
WE 14x14 OFA	Zr	✓	
WE 14x14 SS	SS	✓	✓
WE 14x14 MOX	SS	✓	✓
WE 15x15 Std.	Zr	✓	✓
WE 15x15 OFA	Zr	✓	
WE 15x15 ANF	Zr	✓	✓
WE 15x15 SS	SS	✓	✓
WE 17x17 LOPAR (Std.)	Zr	✓	✓
WE 17x17 OFA	Zr	✓	✓
WE 17x17 ANF	Zr		✓
WE 17x17 Vantage 5H	Zr	✓	
WE 17x17 ANF SPC design	Zr	✓	
WE 17x18	SS		✓
All assm. not listed w/ int. enrich. & Burnup up to 4.4% & 60 GWD	Zr, SS		✓

ANF - Advanced Nuclear Fuel (also known under Exxon and Siemens Power Corp., SPC)
B&W - Babcock & Wilcox
CE - Combustion Engineering (also known under ABB)
LOPAR - Low parasitic fuel
MOX - Mixed Oxide Fuel
OFA - Optimized Fuel Assembly
SS - Stainless Steel
WE - Westinghouse Electric
Zr - Zircaloy

TABLE 3.1-2

TYPES OF BWR FUEL THAT CAN BE STORED AT THE PFSF

ASSEMBLY CLASS	CLAD	HI-STORM	TRANSTOR
GE 6x6	Zr	✓	✓
GE 6x6 ANF	Zr	✓	✓
GE 6x6 MOX	Zr	✓	
GE 7x7	Zr	✓	✓
GE 7x7 GE-2a	Zr	✓	✓
GE 7x7 GE 2b	Zr	✓	✓
GE 7x7 GE-3 (Improved)	Zr	✓	✓
GE 8x8 GE-4	Zr	✓	✓
GE 8x8 GE-5 (Retrofit)	Zr	✓	✓
GE 8x8 GE-9	Zr	✓	✓
GE 8x8 GE-10	Zr	✓	✓
GE 8x8 ANF	Zr	✓	✓
GE 8x8 PF	Zr	✓	
GE 9x9 GE-11	Zr	✓	✓
GE 9x9 ANF	Zr	✓	✓
GE 9x9 ANF 9X	Zr		✓
AC 10x10	SS	✓	✓
AC 10x10 ANF	SS	✓	
GE 10x10 ABB SVEA-96	Zr	✓	✓
All assm. not listed w/ int. enrich. & Burnup up to 3.7% & 50 GWD	Zr or SS		✓

ABB - ABB Atom
AC - Allis Chamers
ANF - Advanced Nuclear Fuel (also known under Exxon and Siemens Power Corp., SPC)
GE - General Electric
MOX - Mixed Oxide Fuel
PF - Prototype fuel
SS - Stainless Steel
Zr - Zircaloy

TABLE 3.2-3

STRUCTURAL DESIGN CRITERIA FOR STEEL COMPONENTS USED IN THE TRANSTOR CANISTER

COMPONENT / (APPLICABLE CODE)	CRITERIA
1. Basket Normal Operation (ASME III, NC/shell/ and NG/internals/, Service Level A)	$P_m \leq S_m$ $P_m + P_b \leq 1.5\ S_m$ $P_L + P_b + Q \leq 3S_m$
Lifting Devices (ANSI N14.6 and NUREG 0612, 10% dynamic factor)	Redundant load path: max principal stress $\leq S_u/5$ or $S_y/3$ Non-redundant load path: max principal stress $\leq S_u/10$ or $S_y/6$
2. Basket Off-Normal Operation (ASME III, NC/shell/ and NG/internals/, Service Level B)	$P_m < 1.1\ S_m$ $P_L + P_b < 1.65\ S_m$ $P_L + P_b + Q < 3\ S_m$
3. Basket Off-Normal Operation (ASME III, NC/shell/ and NG/internals/, Service Level C)	$P_m < 1.2\ S_m$ (shell), $< 1.5\ S_m$ (sleeve) $P_L + P_b < 1.8\ S_m$ (shell), $< 2.25\ S_m$ (sleeves)
4. Basket Accident Conditions, (ASME III, NC/shell/ and NG/internals/, Service Level D, NUREG/CR-6322)	$P_m \leq 2.4\ S_m$ or $0.7\ S_u$ (whichever is less) $P_L + P_b \leq 3.6\ S_m$ or $1.0\ S_u$ (whichever is less) Buckling interaction ratios < 1
5. Brittle Fracture (ASME III, NC/shell/ and NG/internals/)	Selection of structural material with adequate toughness. Control by operating procedures based on minimum temperature. Carbon steel below 5/8" in thickness and stainless steel are exempt from fracture toughness testing and requirements.

TABLE 3.4-1

QUALITY ASSURANCE CLASSIFICATION OF STRUCTURES, SYSTEMS, AND COMPONENTS

IMPORTANT TO SAFETY	NOT IMPORTANT TO SAFETY
Classification Category A	Storage Facility Infrastructure
Spent Fuel Canister	Security and Heath Physics Building
	Administration Building
Classification Category B	Operations and Maintenance Building
Concrete Storage Cask	Intrusion Detection System
Transfer Cask	CCTV System
Associated Lifting Devices	Restricted Area Lighting
Canister Transfer Building	Security Alarm Stations
Canister Transfer Overhead Bridge Crane	Electrical Power - UPS
Canister Transfer Semi-gantry Crane	Electrical Power - Backup Diesel Generator
Seismic Support Struts	Electrical Power - Normal
	Yard/Building Lighting
Classification Category C	Cask Transporter
Cask Storage Pads	Radiation Monitors
	Temperature Monitoring System
	Communication Systems
	Fire Detection/Suppression
	Water Supply Systems
	Septic Systems
	Access Road
	Road Transport Alternative components
	Railroad Spur Alternative components

TABLE 3.6-1
(Sheet 1 of 5)

SUMMARY OF PFSF DESIGN CRITERIA

DESIGN PARAMETERS	DESIGN CONDITIONS	APPLICABLE CRITERIA AND CODES
GENERAL		
PFSF Design Life	40 years	PFSF Specifications
Storage Capacity	40,000 MTU of commercial spent fuel	PFSF Specifications
Number of Casks	approximately 4,000 casks	PFSF Specifications
SPENT FUEL SPECIFICATIONS		
Type of Fuel	See Tables 3.1-1 and 3.1-2	HI-STORM SAR TranStor SAR
Fuel Characteristics	See Table 3.1-3	HI-STORM SAR TranStor SAR
STORAGE SYSTEM CHARACTERISTICS		
Canister Capacity	HI-STORM 24 PWR assemblies/canister 68 BWR assemblies/canister TranStor 24 PWR assemblies/canister 61 BWR assemblies/canister	HI-STORM SAR, Section 1.1 TranStor SAR, Section 1.1
Weights (maximum)	HI-STORM Storage Cask - 267,664 lbs. Loaded Canister - 86,131 lbs. Transfer Cask - 151,963 lbs. Shipping Cask - 153,080 lbs. TranStor Storage Cask - 223,435 lbs. Loaded Canister - 84,460 lbs. Transfer Cask - 126,630 lbs. Shipping Cask - 160,900 lbs.	 HI-STORM SAR, Table 3.2.1 " HI-STORM SAR, Table 3.2.2 Shipping SAR, Table 2.2.1 TranStor SAR, Table 3.2-1 " " Shipping SAR, Table 2.2-1

TABLE 3.6-1
(Sheet 2 of 5)

SUMMARY OF PFSF DESIGN CRITERIA

DESIGN PARAMETERS	DESIGN CONDITIONS	APPLICABLE CRITERIA AND CODES
STRUCTURAL DESIGN		
Wind	90 mph, normal speed	ASCE-7
Tornado	240 mph, maximum speed 190 mph, rotational speed 50 mph, translational speed 150 ft, radius of max speed 1.5 psi, pressure drop 0.6 psi/sec rate of drop	Reg. Guide 1.76
Tornado Missiles (at 84 mph)	1800 kg automobile 125 kg 8" armor piercing artillery shell 1" solid steel sphere	NUREG-0800, Section 3.5.1.4
Flood	N/A - PFSF is not in a flood plain and is above the PMF elevation	PFSF SAR Section 2.3.2.3
Seismic	0.67g, horz.(both directions) & 0.69 g vert. max peak ground acceleration	10 CFR 72.102, 10 CFR 100, App. A
Snow & Ice	P(g) = 45 psf	ASCE-7/County
Allowable Soil Pressure	Static = 4 ksf max Dynamic = Varies by footing type/size	PFSF SAR Section 2.6.1.12
Explosion Protection	N/A - PFSF is located beyond distances from transportation routes from where cargo explosions could cause overpressures > 1 psi.	Reg. Guide 1.91
Ambient Conditions	Temperature = -35 to 110°F Humidity = 0 to 100 %	NOAA Data-Salt Lake City UT DNR Tech Pub. 18
HI-STORM 100 Cask System Load Criteria	Canister: Internals: Storage Cask: Transfer Cask: } See HI-STORM SAR, Table 2.2.6	ASME III, NB ASME III, NG ASME III NF, ACI-349 ASME III NF, ANSI N14.6

CHAPTER 4

FACILITY DESIGN

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inches of 4,000 psi concrete . The storage cask contains large penetrations near its lower and upper extremities to permit natural circulation of air to provide for the passive cooling of the canister and spent fuel. The cask has four air inlet channels located in the base of the cask and four air outlet vents located near the top of the cask. The cooling air enters the inlet channels and flows upward in the annulus between the canister and the concrete cask.

The physical characteristics of the canister and storage cask are listed in Tables 4.2-1 and 4.2-2, respectively.

4.2.1.5 Design Bases and Safety Assurance

The design bases for the HI-STORM storage system are detailed in the HI-STORM SAR. Structural, thermal, shielding, criticality, and confinement design are applicable to the HI-STORM storage system and are addressed in the following sections.

4.2.1.5.1 Structural Design

The structural evaluation for the HI-STORM storage system is contained in HI-STORM SAR Chapter 3. Analysis of the storage system components has been performed for normal, off-normal and accident/natural phenomenon conditions. The structural analyses show the structural integrity of the HI-STORM system is maintained under all credible loads with a high level of assurance to support the conclusion that the heat transfer, confinement, criticality control, radiation shielding, and retrievability criteria are met.

The following verifies that the PFSF site specific criteria are enveloped by the HI-STORM storage system design.

A. Dead and Live Loads

Dead loads are addressed in HI-STORM SAR Sections 3.4.4.3.1 and 3.4.4.3.2. The dead load of the storage cask includes the weight of the concrete and steel cask and the storage canister loaded with spent fuel. As identified in HI-STORM SAR Table 2.1.6, the dead load of the storage cask is calculated assuming the heaviest PWR assembly (B&W 15 x 15 fuel assembly type, wt = 1,680 lb) and the heaviest BWR assembly (GE 8 x 8 fuel assembly type, wt = 700 lb). The dead loads of the canister and the storage cask are shown to be within applicable code allowables and therefore meet the PFSF design criteria in Section 3.2.1 for dead loads.

The storage cask is subjected to two live loads, both of which act on the top of the storage cask: snow loads and the HI-TRAC transfer cask weight (during transfer operations) containing a fully loaded canister. The HI-STORM SAR uses a conservative worst case ground snow load of 100 psf per HI-STORM SAR Table 2.2.8, which exceeds the PFSF site snow load of 45 psf applicable to this geographic location. The live load capacity of the storage cask from the weight of the HI-TRAC transfer cask with a fully loaded canister is shown in HI-STORM SAR Section 3.4.4.3.2.1 to be adequate. Therefore, the live loads used in the HI-STORM analysis bound the PFSF design criteria specified in Sections 3.2.2 and 3.2.3 for live loads and snow loads.

B. Internal and External Pressure

Internal and external pressure loads are addressed in HI-STORM SAR Section 3.4.4.3.1.2. The design pressure applied to the canister is 100 psig for internal pressures and 0 psig (ambient) for external pressures for normal and off-normal conditions per HI-STORM SAR Table 2.2.1. For accident conditions, the design pressure applied to the canister is 125 psi for internal and 60 psi for external. HI-STORM SAR Table 4.4.14 indicates pressures calculated to exist in the canister under analysis. As discussed in Section 8.2.5, a storage cask is postulated to be involved in a diesel fuel fire, involving up to 50 gallons of diesel fuel spilled from the fuel tank of the cask transporter, which is calculated to burn for 3.6 minutes. This fire would not damage the storage cask concrete, and would have a negligible effect on canister and fuel temperatures. Therefore, the HI-STORM design meets the PFSF design criteria in Section 3.2.6 for accident-level thermal loads as required per 10 CFR 72.122(c).

K. Lightning

Lightning is addressed in HI-STORM SAR Sections 2.2.3.11 and 11.2.12. The HI-STORM storage system was evaluated for the effects of lightning striking the storage cask. The evaluation determined that when hit with lightning, the lightning will discharge through the steel shell of the storage cask to the ground. The lightning current will discharge through the storage cask and will not affect the canister, which provides the confinement boundary for the spent fuel. Therefore, the HI-STORM design meets the PFSF design criteria in Section 3.2.12 for lightning protection as required in 10 CFR 72.122(b).

4.2.1.5.2 Thermal Design

Thermal performance for the HI-STORM storage system is addressed in HI-STORM SAR Chapter 4. The HI-STORM system is designed for long-term storage of spent fuel and safe thermal performance during onsite loading, unloading, and transfer operations. The HI-STORM system is also designed to minimize internal stresses from thermal expansion caused by axial and radial temperature gradients.

The HI-STORM system is designed to transfer decay heat from the spent fuel assemblies to the environment. The canister design, which includes the high structural integrity all-welded honeycomb basket structure, allows conductive heat transfer away from the canister internal region to the canister shell. The design incorporates top and bottom plenums, with interconnected downcomer paths, to accomplish corrective heat transfer. The canister is pressurized with helium, which assists in conducting heat from fuel rods to the basket and from the basket to the canister shell. Gaps exist between the basket and the canister shell to permit unrestrained axial and radial thermal expansion of the basket without contacting the shell, minimizing internal stresses. The stainless steel basket conducts heat from the individual spaces for storing fuel assemblies out to the canister shell.

The HI-STORM storage cask design provides for an annular space between the canister shell and the inner steel liner of the storage cask for airflow up the annulus. Air enters the four inlet ducts at the bottom of the storage cask, flows upward through the annulus removing heat from the canister shell and inner cask liner by convection, and exits the four outlet ducts at the top of the cask.

The thermal analysis, discussed in HI-STORM SAR Chapter 4, was performed using the ANSYS finite element modeling package (Reference 10) and an additional code discussed in the HI-STORM SAR. The thermal analysis considers the removal of decay heat from the stored spent fuel assemblies to the environment by the three modes of heat transfer: conduction, convection, and radiation. The HI-STORM PWR canister (MPC-24) and BWR canister (MPC-68) were modeled to determine the temperature distribution under long term normal storage conditions, assuming the canisters are loaded with design basis PWR and BWR fuel assemblies. Decay heat generation rates, specified in HI-STORM SAR Table 2.1.6, are 1.177 kW for a design basis PWR fuel assembly (28.25 kW per MPC-24 canister) and 0.399 kW for a design basis BWR fuel assembly (27.13 kW per MPC-68 canister). Design basis decay heat generation rates for failed and stainless steel clad fuel assemblies are considerably lower, 0.115 kW for a failed BWR assembly (design basis failed fuel assembly), 0.662 kW for a stainless steel clad PWR assembly, and 0.079 kW for a stainless steel clad

BWR assembly (HI-STORM SAR Tables 2.1.7 and 2.1.8). The analysis assumed HI-STORM storage casks are in an array, subjected to an 80° F daily average ambient temperature, with solar radiation. The results of this analysis are presented in Table 4.2-3 for MPC-24 and MPC-68 canisters. The results indicate that temperatures of all components are within maximum allowable temperatures.

Holtec considered stainless steel clad fuels in the thermal analysis, as discussed in HI-STORM SAR Section 4.3.1. Stainless steel cladding is less conductive than zircaloy clad fuel and the net thermal resistance of a basket full of stainless steel clad fuel is greater, which would result in higher cladding temperatures for stainless steel fuel assemblies having the same decay heat generation rate as zircaloy clad fuel. However, the design basis decay heat for stainless steel clad fuel is significantly lower than that of zircaloy clad fuel, as noted previously, and the allowable temperature limit for stainless steel cladding is considerably higher than for zircaloy cladding. Holtec determined that the reduction in heat duty is much more pronounced than the nominal increase in the resistance to heat transfer, and concluded that the peak cladding temperature for stainless steel clad fuel will be bounded by the results for zircaloy clad fuel and a separate analysis for stainless steel clad fuel was not required.

HI-STORM SAR Section 11.1.2 evaluates temperatures of the HI-STORM storage system for a maximum off-normal daily average ambient temperature of 100° F, an increase of 20° F from the normal conditions of storage discussed above. The maximum off-normal temperatures were calculated by adding 20° F to the maximum normal temperatures from the highest component temperature for MPC-24 and MPC-68. All the maximum off-normal temperatures are below the normal condition temperature limits except the canister shell temperature for MPC-24 (452° F). However, the off-normal high ambient temperature is of a short duration, and the resultant temperatures were evaluated against the accident condition temperature limits. The accident condition temperature limit for the canister shell is 775° F

(HI-STORM SAR Table 2.2.3). Therefore, all components are within allowable temperatures for the 100° F ambient temperature condition.

It is recognized that the PFSF site design ambient temperature of 110° F exceeds the 100° F maximum daily average ambient temperature analyzed for the HI-STORM system. The 100° F condition represents a maximum daily average temperature over a period of several days and nights required for the system to reach thermal equilibrium. While ambient temperatures at the PFSF during the day could exceed 100° F, the daily average for several consecutive days would not exceed this temperature. As shown in Section 2.3.1.2, the maximum average daily ambient temperature for cities in Utah nearest the site is 93.2° F. Therefore, it is considered that the 100° F daily average ambient temperature will envelope worst case conditions involving high ambient temperatures that a HI-STORM storage system could experience at the PFSF.

The HI-STORM storage system was analyzed for a -40° F extreme low ambient temperature condition, as discussed in HI-STORM SAR Chapter 4. Holtec conservatively assumed zero decay heat generation from spent fuel, and no solar radiation, resulting in all storage system components reaching the -40° F temperature. As stated in the HI-STORM SAR, all HI-STORM materials of construction will satisfactorily perform their intended function in the storage mode at this minimum temperature condition. The PFSF site low ambient temperature of -35° F is bounded by the temperature used for the HI-STORM storage system. Therefore, the thermal design of the HI-STORM storage system bounds the site specific design requirements.

4.2.1.5.3 Shielding Design

Shielding design and performance for the HI-STORM storage system is addressed in HI-STORM SAR Chapter 5. The HI-STORM storage system is designed to maintain radiation exposure as low as is reasonably achievable (ALARA) in accordance with 10

CFR 72.126(a). The concrete storage cask is designed to limit the average external contact dose rates (gamma and neutron) to 35 mrem/hr on the sides, 10 mrem/hr on top, and 50 mrem/hr at the air inlets and outlets based on HI-STORM design basis fuel.

The storage cask is a massive structure designed to provide gamma and neutron shielding of the spent fuel assemblies stored within the canister. Radiation shielding is provided by the 2 inch thick steel inner liner and shield plate, the 26.75 inch thick concrete shell, and the 0.75 inch thick steel outer shell. Axial shielding at the top is provided by the steel canister lid and the storage cask lid. The storage cask lid consists of an approximately 10 inches of concrete sandwiched in a steel shell, with a 4 inch thick steel top plate. The configuration of the inlet and outlet ducts prevents a direct radiation streaming path from the canister to outside the cask.

The design dose rates allow limited personnel access during canister closure operations. HI-STORM SAR Section 5.1.1 provides calculated dose rates on contact and at 1 meter for the top and side surfaces of the HI-STORM storage cask for design PWR and BWR fuel, which shows that the above design criteria are met by the HI-STORM storage system. Maximum dose rates on contact from a storage cask, calculated for design basis fuels, are shown to be approximately 29 mrem/hr on the side, 7 mrem/hr on top, 32 mrem/hr at the top vents, and 50 mrem/hr at the bottom vents.

Section 3.3.5 presents the radiological requirements for the PFSF. The requirements originate from 10 CFR 72.104, which requires that the annual dose equivalent to any real individual located beyond the OCA boundary not exceed 25 mrem to the whole body, and from 10 CFR 20.1301, which requires that the hourly dose to any member of the public in any unrestricted area not exceed 2 mrem as a result of exposure to radiation from the PFSF. As discussed in Chapter 7, the HI-STORM storage system shielding design achieves compliance with these requirements for the PFSF array, assumed to consist of 4,000 HI-STORM storage casks, configured as shown in the detail on Figure 1.2-1.

4.2.1.5.4 Criticality Design

Criticality of the HI-STORM storage system is addressed in HI-STORM SAR Chapter 6. The HI-STORM storage system is designed to maintain the spent fuel subcritical in accordance with 10 CFR 72.124(a) and (b), with canister materials and geometry. The primary criteria for the prevention of criticality is that k_{eff} remain below 0.95 for all normal, off-normal, and accident conditions.
Criticality safety of the HI-STORM system depends on the following three principal design parameters:

- An administrative limit on the maximum average enrichment acceptable for storage in the canister,
- The inherent geometry of the fuel basket designs within the canister, including the flux-traps (water gaps for loading fuel into submerged canisters), where present, and
- The incorporation of fixed neutron absorbing panels (Boral) in the fuel basket structure to assist in control of reactivity (applicable only while the canister is submerged in a nuclear plant spent fuel pool or for shipping requirements).

The criticality analysis performed for the HI-STORM system assumes only fresh fuel with no credit for burnup as a conservative bounding condition. The HI-STORM system is dry (no moderator) and the reactivity is very low (k_{eff} <0.40). At the PFSF, the fuel will always be in a dry, inert gas environment, sealed within a welded canister, and no credible accident results in water entering the canister. However, the analysis was based on a flooded system during fuel loading operations, which is limiting from a criticality standpoint, and this moderated condition determines the design. The criticality analysis assume no credit for a boron concentration in the fuel pool water during fuel loading, and both the PWR and BWR canisters are designed to assure the k_{eff} meets the design criteria when a canister is filled with unborated water.

The results of the analyses of different fuel types are shown in HI-STORM SAR Table 6.2.2 for MPC-24, and Table 6.2.4 for MPC-68, with results summarized for the PWR and BWR design basis fuels in Table 6.1.1. The results confirm that the maximum reactivities of the canisters are below the design criteria (k_{eff} <0.95) for fuels with specified maximum allowable enrichments, considering calculational uncertainties. Based on these results, the maximum allowable enrichments are specified in HI-STORM SAR Table 2.1.3 for PWR fuels and Table 2.1.4 for BWR fuels.

Stainless steel clad PWR and BWR fuel assemblies were analyzed assuming 4.0 percent enrichment. The stainless steel clad fuel assemblies showed lower reactivity than zircaloy clad fuel assemblies at 4.0 percent enrichment, and storage of stainless steel clad fuel with enrichment equal to or less than 4.0 percent was determined to be acceptable.

Accident conditions have also been considered and no credible accidents have been identified that would result in exceeding the regulatory limit on reactivity. Hypothesizing arrays of HI-STORM storage systems under flooded conditions, Holtec determined that the physical separation between overpacks due to the large diameter and cask pitch and the concrete and steel radiation shields are each adequate to preclude any significant neutronic coupling between storage systems.

HI-STORM SAR Section 6.4 discusses the results of criticality analyses on canisters storing failed fuel in a Holtec failed fuel container. Analyses were performed for three possible scenarios, assuming 3.0 percent enrichment, though the maximum enrichment of the failed fuel allowed to be stored in the MPC-68 canister is 2.7 percent. The scenarios are:

1. Lost or missing fuel rods, calculated for various numbers of missing rods in order to determine the maximum reactivity.

2. Fuel assembly broken with the upper segments falling into the lower segment creating a close-packed array. For conservatism, the array was assumed to retain the same length as the original fuel assemblies.

3. Fuel pellets lost from the assembly and forming powdered fuel dispersed through a volume equivalent to the height of the original fuel, with the flow channel and cladding material assumed to disappear.

Results of the analyses confirm that, in all cases, the maximum reactivity of the HI-STORM design base failed fuel in the most adverse post-accident condition will remain well below the regulatory limit. Therefore, the HI-STORM storage system meets the PFSF design criteria in Section 3.3.4 for criticality safety.

Since criticality control is ensured by the canister basket design, criticality monitoring addressed by 10 CFR 72.124(c) is not applicable for the PFSF.

4.2.1.5.5 Confinement Design

Confinement design for the HI-STORM storage system is addressed in HI-STORM SAR Chapter 7. The confinement vessel of the HI-STORM storage system is the canister, which provides confinement of all radionuclides under normal, off-normal, and accident conditions in accordance with 10 CFR 72.122(h). The canister consists of the canister shell, a bottom base plate, the canister lid, and the canister closure ring, which form a totally welded vessel for the storage of spent fuel assemblies. The canister requires no valves, gaskets, or mechanical seals for confinement. All components of the confinement system are classified as Important to Safety.

The canister is a totally seal-welded pressure vessel designed to meet the stress criteria of ASME BPVC Section III (Reference 11), Subsection NB. No bolts or fasteners are used for closure. All closure welds are examined using the liquid penetrant method and helium leak tested to ensure their integrity. Two penetrations are provided in the canister lid for draining, vacuum drying, and backfilling during loading operations. Following loading operations, vent and drain port cover plates are welded to the canister lid. A closure ring, which covers the penetration cover plates and welds is welded to the canister lid providing redundant closure of the canister vessel. The loading and welding operations are performed at the originating power plant, ensuring total confinement of the canister upon arrival to the PFSF. There are no confinement boundary penetrations required for canister monitoring or maintenance during storage.

The confinement features of the HI-STORM storage system meet the PFSF design criteria in Section 3.3.2 for confinement barriers and systems.

4.2.2 TranStor Storage System

The TranStor storage system is comprised of metal canisters, concrete storage casks, and associated transfer equipment. The following sections provide an analysis of the TranStor storage system canister and storage cask design relative to the storage requirements of the PFSF. Types and characteristics of fuels to be stored, site environmental conditions, support structures, and support systems are shown to be within the design criteria envelope of the TranStor SAR, thus ensuring no unanalyzed safety conditions for storage using the TranStor storage system exist at the PFSF. The TranStor canister transfer equipment, including the metal transfer cask, is described in Section 4.7.4.

4.2.2.1 Design Specifications

The design, fabrication, and construction specifications used for the TranStor storage system components are identified in the TranStor SAR Section 2.2.7 and are summarized as follows:

- Metal canister -
  - Shell (pressure boundary) — ASME BPVC Section III Subsection NC
  - Internals — ASME BPVC Section III, Subsection NG
- Concrete storage cask - ANSI/ANS 57.9, ACI-349

4.2.2.2 System Layout

The TranStor storage system consists of a metal canister placed inside of a vertical concrete storage cask. Each canister holds up to 24 PWR or 61 BWR spent fuel assemblies in an internal basket.

4.2.2.5.1 Structural Design

The structural evaluation for the TranStor storage system is contained in TranStor SAR Chapter 3. Analysis of the storage system components has been performed for normal, off-normal, and accident conditions. Structural analyses reflect the system configurations during various stages of loading, handling, and moving and have been performed for enveloping conditions representing the most conservative storage conditions.

The following verifies that the PFSF site specific criteria are enveloped by the TranStor storage system design.

A. Dead and Live Loads

The dead load of the storage cask includes the weight of the concrete cask and the metal canister loaded with spent fuel. As identified in TranStor SAR Table 2.1-1, the dead load of the storage cask is calculated assuming the heaviest PWR assembly (B&W 15 x 15 fuel assembly type, wt = 1680 lb) and the heaviest BWR assembly (GE 8 x 8 fuel assembly type, wt = 700 lb). The dead loads of the canister and the storage cask are shown in TranStor SAR Sections 3.4.4.1.2 and 3.4.4.2.1. These loads are considered in the design of the canister and storage cask and are within applicable code allowables and therefore meet the PFSF design criteria in Section 3.2.1 for dead loads.

The storage cask is subjected to two live loads, both of which act on the top of the storage cask: snow loads and the transfer cask weight (during transfer operations) with a fully loaded canister. The TranStor SAR uses a conservative worst case ground snow load of 100 psf per TranStor SAR Section 2.2.4, which exceeds the PFSF site snow load of 45 psf applicable to this geographic location. The live load capacity of the cask from the weight of a transfer cask loaded with fuel assemblies is shown in TranStor SAR Section 3.4.4.2.2 to be adequate. Therefore, the live loads used in the TranStor analysis bound the PFSF design criteria specified in Section 3.2.2 and 3.2.3 for live loads and snow loads.

B. Internal and External Pressure

The stresses resulting from the internal pressure in the canister are discussed in TranStor SAR Section 3.4.4.1.3. The helium backfill pressure is selected so that the canister will be at a slight vacuum during storage. The normal operating internal pressure is taken as -10 psig, which bounds potential heat loads and ambient conditions. The stresses resulting from the internal and external pressure loads were shown to be within code allowables and therefore meet the PFSF design criteria in Section 3.2.4 for internal and external pressures.

C. Thermal Loads

The normal thermal loads for the canister are described in TranStor SAR Section 3.4.4.1.1. The largest resulting thermal stress calculated by SNC is conservatively used in all load combinations. This stress results from the worst case temperature gradient across the canister at an ambient condition of -40° F. As shown in SAR Table 3.6-1, the design winter condition at the PFSF is -35° F. Therefore, the analysis encompasses the site specific conditions. Similarly, design summer and normal ambient temperatures fall within the other cases analyzed. Section 8.1.2 and TranStor SAR Chapter 4.0 contain a more detailed description of the thermal load evaluation.

Conservatively, the off-normal thermal stresses in the storage cask resulting from the worst case temperature gradient are used in all load combinations. This occurs when all inlet cooling vents are blocked at normal ambient conditions. The ambient basket. Although the exposed layer of concrete may lose a portion of its strength, it would not disintegrate from an exposure to flame temperatures on the order of 1,500° F as specified in 10 CFR 71. In addition, any fire would be required to burn for a long time (days) before much of the wall thickness would be affected. The cask materials and limited use of combustibles at the site minimizes the effects of fire on the storage system. As discussed in Section 8.2.5, a storage cask is postulated to be involved in a diesel fuel fire, involving up to 50 gallons of diesel fuel spilled from the fuel tank of the cask transporter, which is calculated to burn for 3.6 minutes. This fire would not damage the storage cask concrete, and would have a negligible effect on canister and fuel temperatures. Therefore, the TranStor design meets the PFSF design criteria in Section 3.2.6 for accident-level thermal loads as required per 10 CFR 72.122(c).

K. Lightning

Lightning is addressed in TranStor SAR Section 11.2.9. The TranStor storage system was evaluated for the effects of lightning striking the storage cask. The evaluation determined that even if a storage cask is hit by lightning, the primary path to ground would be from the steel concrete cask lid to the steel base plate via the steel cask liner and the steel air inlet ducts. The canister is surrounded by these steel structures and therefore, would not provide a path to ground. Therefore, a lightning strike would not affect the canister integrity. Any absorbed heat would be insignificant due to the very short duration of the event. If lightning enters or exits the cask through the concrete shell, some local spalling of concrete could occur, however, it would not be significant enough to affect the cask operation. Therefore, the TranStor design meets the PFSF design criteria in Section 3.2.12 for lightning protection as required in 10 CFR 72.122(b).

4.2.2.5.2 Thermal Design

Thermal performance for the TranStor storage system is addressed in TranStor SAR Chapter 4. The TranStor system is designed to transfer decay heat from the spent fuel assemblies to the environment. Heat generated in the fuel assemblies is transferred to the surrounding inert atmosphere and the basket sleeves by free convection and radiation. It is further conducted through the sleeves towards the exterior of the basket assembly where it conducts, convects, and radiates through the cover gas to the canister shell wall. Heat is then convected to the air in the annulus between the canister shell and the storage cask internal liner, and radiated from the canister shell to the cask liner. Cooling air enters the inlet ducts at the bottom of the TranStor storage cask, flows up the annulus by passive convection, and exits at the top of the storage cask. A small amount of heat is conducted through the concrete to the outer surfaces of the storage cask, then convected to the air.

As discussed in TranStor SAR Chapter 4, several basic models were utilized for the thermal evaluation of the TranStor storage system.

These include:

- Air flow and temperature
- Storage cask body and canister exterior heat transfer
- PWR canister interior heat transfer
- BWR canister interior heat transfer

The ANSYS finite element code was used for calculating storage cask and canister temperatures. The design basis canister heat load of 26 kW was assumed in all the thermal analyses, corresponding to 1.083 kW per PWR fuel assembly and 0.426 kW per BWR fuel assembly. Results of the thermal analyses determined that the TranStor system operates well within thermal design limits. Therefore, no degradation due to temperature effects on materials or components is expected. The analyses results represent maximum temperatures, since the heat source from the fuel assemblies decays with time. While allowable temperatures for the TranStor construction materials do not change, the fuel temperature limits decrease with time. However, SNC notes in TranStor SAR Chapter 4 that the heat load decays faster than the corresponding maximum allowable cladding temperatures, and margins between actual and allowable fuel cladding temperatures increase with time.

Off-normal and accident cases are described in TranStor SAR Chapter 11. The following steady state conditions have been analyzed:

1. Normal condition, average ambient temperature = 75° F, no solar radiation.
2. Off-normal condition, ambient temperature = 100° F, solar radiation.
3. Off-normal condition, ambient temperature = -40° F, no solar radiation.
4. Off-normal condition, ambient temperature = 75° F, no solar radiation, 1/2 of air inlets blocked.
5. Accident condition, ambient temperature = 125° F, solar radiation.
6. Accident condition, ambient temperature = 75° F, no solar radiation, all air inlets blocked.

The TranStor thermal analysis performed for the concrete storage cask verifies that material temperature limits are not exceeded for normal, off-normal, and accident conditions. The TranStor thermal analysis verifies that fuel cladding allowable temperature limits are not exceeded. The minimum temperatures for the TranStor system correspond to the coldest environmental conditions of -40° F and no heat load in the cask. However, even at these extreme conditions the components are above their minimum material temperature limits. The TranStor cask does not employ any temperature-sensitive features such as gaskets, packing, or O-rings.

The results of the thermal analysis for normal, off-normal, and accident conditions is shown in TranStor SAR Table 4.1-1. These results are summarized in Table 4.2-6.

The PFSF site ambient temperatures of -35° F to110° F to are bounded by temperatures used for the TranStor storage system. The heat generation of the fuel to be stored at the PFSF is bounded by the heat generation of the TranStor design basis fuel. Therefore, the thermal design of the TranStor storage system bounds the site specific design requirements.

4.2.2.5.3 Shielding Design

Shielding for the TranStor storage system is addressed in TranStor SAR Chapter 5. The TranStor storage system is designed to maintain ALARA radiation exposure in accordance with 10 CFR 72.126(a). The concrete storage cask is designed to limit the average external dose rate (gamma and neutron) one meter from the cask to less than 15 mrem/hr on the sides (30 mrem/hr for stainless steel clad fuel) and 200 mrem/hr on top at the cover lid centerline based on TranStor design basis fuel. The design dose rates allow limited personnel access during canister closure operations.

Radiation shielding of the TranStor storage system is provided by the 0.75 inch thick steel canister shell, the 2 inch thick steel storage cask liner, and the 29 inch thick reinforced concrete cask wall. Axial shielding at the top is provided primarily by the steel canister shield and structural lids, which have a combined thickness of 11 inches. The 0.75 inch thick steel storage cask lid also provides axial shielding. The inlet and outlet ducts are configured to prevent direct radiation streaming from the spent fuel assemblies to the outside of the cask.

TranStor SAR Section 5.1 provides calculated dose rates on contact and at 1 meter for the top and side surfaces of the TranStor storage cask for design PWR and BWR fuel, which show that the above criteria are met by the TranStor Storage System. Maximum dose rates for TranStor design basis fuels are shown to be approximately 19 mrem/hr on contact with the side and 10 mrem/hr at 1 meter from the side of the TranStor storage cask; 157 mrem/hr on contact with the center of the lid and 135 mrem/hr at 1 meter from the top of the cask; and 7.5 mrem/hr on contact with the top vent and 14 mrem/hr on contact with the bottom vent.

Section 3.3.5 presents the radiological requirements for the PFSF. The requirements originate from 10 CFR 72.104, which requires that the annual dose equivalent to any real individual located beyond the OCA boundary not exceed 25 mrem to the whole body, and from 10 CFR 20.1301, which requires that the hourly dose to any member of the public in any unrestricted area not exceed 2 mrem as a result of exposure to radiation from the PFSF. As discussed in Chapter 7, the TranStor storage system shielding design achieves compliance with this requirement for the PFSF array, assumed to consist of 4,000 TranStor storage casks, configured as shown in the detail on Figure 1.2-1.

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4.2.3 Cask Storage Pads

The design criteria for the cask storage pads are described in Chapter 3. The analysis methods and resulting design of the pads are described below.

4.2.3.1 Design Specifications

The design of the cask storage pads is in accordance with ANSI/ANS-57.9 (Reference 14) and ACI 349 (Reference 15) as identified in Chapter 3.

The cask storage pads are independent structural units constructed of reinforced concrete. Each pad is 30 ft wide by 64 ft long and 3 ft thick. The size of the pad is based on a center to center spacing of 15 ft for the storage casks. The ends of the storage pad are provided with an additional 2 ft in length to support both tracks of the cask transporter on the pad. The pads are nearly flush with grade for direct access by the cask transporter. Each cask storage pad is capable of supporting 8 loaded HI-STORM or TranStor storage casks.

An independent modular pad design was chosen to simplify the pad analysis (i.e. minimize the number of cask placement combinations) and to minimize the effects of thermal expansion. The modular pad design also provides for ease of construction by limiting the number of concrete pad construction and/or expansion joints required and allows for staged construction of the facility.

The cask storage pad design is based on a maximum loaded storage cask weight of 356,521 lbs. This maximum weight is associated with the HI-STORM storage cask loaded with an MPC-32 (32 fuel assembly capacity PWR canister) and envelopes the maximum loaded weight of both the TranStor and HI-STORM concrete storage casks proposed for use at the PFSF. The TranStor storage cask has a maximum loaded weight of 309,130 lb. as shown on TranStor SAR Table 3.2-1. The HI-STORM storage cask has a maximum loaded weight of 356,521 lb. (MPC-32) as shown on HI-STORM SAR Table 3.2.1. The Holtec MPC-32 has the maximum weight of all of the HI-STORM series canisters and is conservatively used in the design, even though it is not proposed for use at the PFSF. The HI-STORM canisters proposed for use at the PFSF are the MPC-24 and the MPC-68 with maximum weights of 346,495 lb. and 353,796 lb., respectively, when in the HI-STORM storage cask, both of which are bounded by the weight of the MPC-32, when in the HI-STORM storage cask.

The cask storage pad design also considers the weight of the loaded concrete storage casks in combination with the seismic loads due to the Design Earthquake (DE) for the site.

4.2.3.2 Plans and Sections

The site plan, which shows the locations of the concrete storage pads, is shown in Figure 1.2-1. A typical concrete storage pad plan, cross section, and details are shown in Figure 4.2-7.

4.2.3.3 Function

The function of the cask storage pads is to provide a level and stable surface for placement and storage of the TranStor and HI-STORM concrete storage casks containing the spent fuel canisters.

4.3 AUXILIARY SYSTEMS

4.3.1 Ventilation and Offgas Systems

The canister-based storage technologies use a sealed (welded) canister design that precludes the need for ventilation or off-gas systems. No canisters will be opened at the site, therefore no ventilation system is required.

4.3.2 Electrical Systems

4.3.2.1 Major Components and Operating Characteristics

Normal electrical power is provided at the PFSF by an existing 12.5 kV offsite distribution power line, which runs parallel to Skull Valley Road. A new line will provide power from the 12.5 kV distribution power line to a 480 volt site transformer. Normal power is provided to the PFSF for lighting, general utilities, security system, HVAC loads, crane loads, and miscellaneous equipment.

Emergency backup power is provided at the PFSF by a 480 volt diesel-generator. The emergency power supply is limited to the security system, emergency lighting loads, storage cask temperature monitoring system, and the site communications system. The diesel generator fuel supply is sized to provide continuous operation for a minimum 24 hour period. The diesel generator is located in the Security and Health Physics Building. A battery charger is provided with automatic and manual charge control to maintain fully charged diesel generator starting batteries when the unit is stopped.

An Uninterruptible Power Source (UPS) is utilized to support the security loads until the diesel starts and comes up to speed. The UPS system is a 120 volt, single phase system with integral batteries and battery charger. The UPS system is designed for a minimum of 1 hour operation without replacing or recharging batteries. The UPS system is located in the Security and Health Physics Building.

4.3.2.2 Safety Considerations and Controls

In the event of a loss of offsite power, the UPS system is designed to automatically switch over to the battery source without loss of output voltage. When the diesel generator comes up to speed, the UPS automatically switches back to its normal source (which is then from the diesel generator) without loss of output voltage or battery recharge.

The diesel generator is provided with starting batteries maintained to supply sufficient capacity to consecutively crank the engine a minimum of five times. When the diesel generator starts, an automatic transfer switch transfers the security, emergency, and temperature monitoring loads to the generator when the diesel comes up to speed. Transfer back to normal offsite power takes place after the normal power is restored for a minimum of 30 minutes.

Electrical power is not classified as Important to Safety since the storage systems do not require electrical power for operation. In addition the cranes and operating equipment have been designed to maintain adequate safety provisions for handling spent fuel canisters in the event of a loss of power as discussed in Section 8.1.1.

In the event of a lightning strike, the most probable target is the 120 foot tall light poles that provide the lighting for the storage area. The light poles are metal and therefore act as a conductor. The poles are grounded to ensure that the current from a lightning strike is properly conducted to ground.

4.3.3 Air Supply Systems

An air supply system is provided at the PFSF in the Canister Transfer Building and Operation and Maintenance Building for maintenance purposes. There are no SSCs classified as being Important to Safety that require compressed air for operation.

4.3.4 Steam Supply and Distribution System

A steam supply system is not provided at the PFSF. There are no SSCs classified as being Important to Safety that require steam for operation.

4.3.5 Water Supply System

A water supply system is provided at the PFSF for normal facility services and operation and maintenance functions. There are no safety related SSCs classified as being Important to Safety that require water for operation.

4.3.6 Sewage Treatment System

A sewage (septic) system is provided at the PFSF for normal facility services.

4.3.7 Communications and Alarm Systems

The communication systems consist of normal telephone service in all the buildings, a site public address system, and a short-wave radio system for security. The communication systems provide a means to contact the local law enforcement authorities for security purposes and for emergency responses on site in the event of an "ALERT", with notifications and follow-up communications.

In the event of an emergency, facility personnel and visitors on site are notified by an announcement over the onsite communications system (intercom). Offsite emergency response personnel are notified by means of personal pagers and/or using the notification list of telephone numbers located in the Emergency Plan implementing procedures. Alarms at the PFSF are only used on area radiation monitors to notify nearby personnel of doses that exceed the alarm setpoint.

Portable two-way radios are used by security personnel to maintain continuous communications with the Security and Health Physics Building while on patrol. The communication system is in accordance with proposed rule 10 CFR 73.51 (Reference 23).

4.3.8 Fire Protection System

4.3.8.1 Design Basis

Fires that could affect SSCs classified as Important to Safety are postulated to result from diesel fuel sources originating from the cask transporter or shipping cask transport vehicles (heavy haul tractor/trailer or railroad locomotive). SSCs affected include the storage casks in the yard and the shipping and storage system components and cranes in the Canister Transfer Building. Scenarios for a fire in both locations considering fire location, intensity, and duration have been analyzed in Section 8.2.5. The analysis determined that the fires will not compromise the safety provisions of the SSCs.

No other major fire fuel sources are located in areas near SSCs classified as Important to Safety. The Canister Transfer Building is constructed of noncombustible materials and is designed to limit the potential effects from a diesel fuel fire with curbs, raised thresholds, and sloped floors located to contain spilled diesel fuel away from SSCs.

The Canister Transfer Building is designed with a fire detection system and a fire suppression system to aid in the mitigation of fires. Portable fire extinguishers are located in the building and yard areas to facilitate fire suppression. The fire detection system is designed in accordance with NFPA 72E (Reference 24). The fire suppression system consists of a sprinkler system designed, installed, and tested in accordance with the Uniform Building Code (Reference 25) and NFPA 13 (Reference 26) and 13A (Reference 27). The fire pumps and water supply tanks are provided in accordance with NFPA 20 (Reference 28) and NFPA 22 (Reference 29) respectively. The portable fire extinguishers are provided in accordance with NFPA 10 (Reference 30).

4.3.8.2 System Description

A sprinkler type fire suppression system is provided in the Canister Transfer Building to mitigate potential fires. The sprinkler system is supplied water by fire pumps located outside of the RA. Water for the pumps is supplied by a primary and a backup water tank. One pump is powered by an electric motor, the other by a diesel engine in the event of a loss of electrical power.

Fire hydrants are located near the buildings to support fire suppression of the buildings. The PFSF is served by at least one fire truck located at the site and one truck located at the Goshute Village 3.5 miles from the site to suppress fires that may occur around the site such as brush fires.

The fire detection system consists of photo-sensitive smoke detectors located in all the facility buildings. The smoke detectors are interconnected within each building and are connected to a central alarm panel located in the Security and Health Physics Building. Annunciation of the smoke alarms occurs within both the building where the detector is located and the central alarm panel. A trip of the fire detection system in the Canister Transfer Building will automatically set off the building's fire sprinkler system.

Smoke from a fire in the Canister Transfer Building will be removed by the building's ventilation exhaust fans.

4.3.8.3 System Evaluation

An evaluation of potential fires affecting SSCs classified as Important to Safety is shown in Section 8.2.5. The analysis concludes that these fires will not produce an unsafe condition or preclude the ability of SSCs from performing their safety related function. The sprinkler system ensures that fires that could occur in the Canister Transfer Building will be extinguished within minutes.

4.3.8.4 Inspection and Testing Requirements

Preoperational and periodic operational testing and inspection of the fire detection and fire suppression systems will be performed in accordance with requirements of Section 9.2.

4.3.8.5 Personnel Qualification and Training

Training and qualification requirements associated with the testing, inspection, and operation of the fire systems will be in accordance with the requirements of Section 9.3.

4.3.9 Maintenance System

4.3.9.1 Major Components and Operating Characteristics

The PFSF has relatively few maintenance requirements because of the passive nature of the storage system's design. Major components at the PFSF that require routine periodic maintenance include the overhead bridge crane, semi-gantry crane, transfer equipment, and fire suppression system located in the Canister Transfer Building, the rail cars or heavy haul tractor/trailer units, the cask transporters, the backup diesel generator located in the Security and Health Physics Building, and the temperature monitoring equipment, fire pumps, and fire engine.

Periodic inspection and maintenance is also required to ensure the storage cask air ducts are not blocked from snow, dirt, debris, or small animal nesting per the operation controls and limits given in Chapter 10.

4.3.9.2 Safety Considerations and Controls

Routine maintenance procedures ensure that timely maintenance is performed according to equipment manufacturer's standards. The Operations and Maintenance Building is designed to facilitate activities performed on equipment and provide a safe environment. Ladders and platforms mounted on the walls and cranes in the Canister Transfer Building are used to access the cranes for maintenance and inspection activities. PFSF procedures prevent maintenance of the cranes or transfer equipment near casks loaded with spent fuel to minimize personnel radiation doses. Maintenance and inspection of the temperature monitoring system at the storage casks or the storage cask air vents are controlled by PFSF procedures to ensure that the work is performed ALARA.

4.3.10 Cold Chemical Systems

There are no chemical systems required or provided at the PFSF.

4.3.11 Air Sampling Systems

Since the spent fuel is totally contained within the canisters, there is no need for air sampling systems or airborne monitors except for the hand held monitor use to analyze the air sample taken from the shipping cask prior to being opened.

walls and doors, equipment lay-down areas, storage cask delivery and staging platform, mechanical and electrical equipment areas, and personnel offices and restroom areas.

4.7.1.4.1 Seismic Support Struts

The seismic support struts are rigid strut assemblies that secure the shipping and transfer casks to the Canister Transfer Building transfer cell walls during transfer operations. The struts ensure that the casks will remain stable and will not topple in the event of an earthquake. The struts are connected to the shipping cask after it is moved into the transfer cell. The struts are attached to the transfer cask when it is placed on top of the shipping cask or storage cask. Each cask utilizes two struts that provide restraint in the x and y directions.

The support struts are procured as standard sway strut assemblies that conform to ASME III, NF requirements for Class 2 nuclear grade supports. The struts consist of a rigid tubular body with threaded eye rods on both ends. Each strut is pinned to a bracket that is secured to the cask and to the building transfer cell wall.

4.7.1.5 Design Bases and Safety Assurance

The Canister Transfer Building is classified as being Important to Safety to provide the safety assurance commensurate with canister transfer activities. The design bases for the Canister Transfer Building are described in Chapter 3.

4.7.1.5.1 Structural Design

The design of the Canister Transfer Building will be performed during the detailed design phase of the project. The building structure and components will be analyzed and designed to envelope the worst case loading conditions for all possible operating and canister transfer conditions for the design basis loads as identified in Chapter 3.

The following provides verification that the site specific and operational criteria of the PFSF are enveloped by the Canister Transfer Building analysis and design.

A. Dead Loads

The Canister Transfer Building will be designed for the self weight of the structure and all permanently attached equipment.

B. Live Load

The Canister Transfer Building will be designed for the following live loads:

- Snow and ice loads
- Bridge crane and semi-gantry crane loads
- Normal crane handling loads and transfer operations
- Normal wind load
- Concrete storage cask, transfer cask, and shipping cask loads
- Vehicle loads

Crane loads will be increased to account for lateral and longitudinal impact forces.

C. Lateral Soil Pressure

Below grade portions of the Canister Transfer Building will be designed for loads from lateral soil pressure, including loads in excess of geostatic pressures resulting from the presence of adjacent surcharges or vehicular traffic.

D. Thermal Loads

The Canister Transfer Building will be designed to accommodate the site-specific extreme temperatures. Expansion joints will be provided as required to accommodate thermally induced movements in the structure.

E. Tornado Winds and Missiles

The Canister Transfer Building will be designed to protect all SSCs housed within the building from the effects of tornado winds and tornado-generated missiles. The Canister Transfer Building will be designed for the 240 mph wind speed and 1.5 psi pressure drop site specific design basis tornado event. The tornado wind speed will be converted to wind pressures in accordance with the provisions of ASCE-7 (Reference 31). Tornado wind and tornado pressure drop will be considered to act simultaneously. The worst case wind and pressure distribution acting on the structure as a whole and on individual building elements will be determined based on the physical size of the structure in relation to the size and characteristics of the design basis tornado. The structure will be designed to withstand the tornado wind and pressure drop by means of its static strength without the need to resort to venting of the structure.

The Canister Transfer Building will be designed to resist the effects of both horizontal and vertical impacts of the design basis tornado-generated missiles. Building components will be of sufficient strength and size to withstand the missile impact without compromising the strength and stability of the structure as a whole and to prevent penetration of the missile and spalling of the concrete face interior to the point of impact. The building layout and specifically designed labyrinths will prevent tornado missiles entering through door or ventilation openings in the walls and roof from impacting or damaging the fuel canisters, single failure proof cranes and their supports, or other SSC's housed within the building.

F. Earthquake

The Canister Transfer Building will be designed for the Design Earthquake loads for the site. The structure will be modeled and analyzed using three-dimensional modal seismic analysis. The dead loads from the bridge and semi-gantry cranes will be located so as to produce the highest design loads and member stresses within the structure. Lifted loads from the cranes will be included in the seismic analysis.

G. Fire

The postulated fire accident for the Canister Transfer Building is discussed in SAR Section 8.2.5. Since the Canister Transfer Building will be equipped with fire detection and suppression systems and be constructed of reinforced concrete, which has both a high thermal inertia and is inherently noncombustible, the postulated fire accident will have no effect on the structural strength or stability of the Canister Transfer Building structure as required per 10 CFR 72.122(c).

H. Lightning

The Canister Transfer Building is approximately 77 feet tall and is a possible lightning target. The Canister Transfer Building is designed with lightning protection features in accordance with NFPA 780.

4.7.1.5.2 Shielding Design

The Canister Transfer Building is designed to provide radiological shielding during the transfer operations. A portion of the building is divided into canister transfer cells where the transfer operations are performed. The cells are surrounded by concrete shield walls that are designed to limit the radiation doses from the canister transfer operations to personnel outside of the cell to 2 mrem/hr, which is below the 5 mrem/hr dose level that establishes a "radiation area" per 10 CFR 20.1003. Large sliding doors for moving shipping and storage casks in and out of the cell are made of steel with a sandwich layer of neutron shielding. Personnel access openings into the cells are designed with a labyrinth of concrete to mitigate streaming of radiation.

A shielding analysis will be performed assuming canisters containing design basis fuel involved in canister transfer operations to determine transfer cell wall and cell door thickness requirements. The analysis will consider attenuation of the radiation doses through the shield walls and doors to locations outside the cell.

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in HI-STORM SAR Table 4.5.4. The table shows a summary of temperature differences in the basket periphery and canister shell between the top and bottom of the canister. The table indicated temperature differences between the top and bottom section of the basket periphery of approximately 238° F, and approximately 166° F between top and bottom sections of the canister shell. The temperature gradients were evaluated to determine the cask and canister thermal growths and shown to be minimal. The temperature gradients were also used to calculate thermal stresses in the canister, which were shown to be within code allowables and therefore meet the PFSF design criteria in Section 3.2.6 for thermal loads.

C. Tornado Winds and Missiles

Evaluation of the transfer cask for tornado wind or missile is not required since the canister transfer operations are conducted within the Canister Transfer Building.

D. Earthquake

The transfer cask has been evaluated for stability during a seismic event when in the stacked cask arrangement. The stacked cask arrangement occurs when the transfer cask is resting on top of the storage cask. It was concluded that during transfer operations, it is necessary to ensure the transfer cask is supported throughout the transfer operation to prevent the cask from toppling during a seismic event. Therefore, facility procedures will ensure that the transfer cask be secured to the cell walls with struts when in the stacked arrangement to preclude a cask toppling accident.

E. Fire

Fires concerning the HI-TRAC transfer cask are addressed in HI-STORM SAR Section 11.2.4. The HI-TRAC was analyzed for a fire around the cask of 50 gallons of combustible fuel. The fire had a duration of less than 5 minutes. A bounding cask temperature rise of less than 16° F per minute was determined from the combined radiant and convection heat input to the cask. As a result, the fuel cladding was shown not to exceed the accident condition fuel cladding temperature limits. As shown in Section 8.2.5, the only fuel source near a loaded HI-TRAC transfer cask would be diesel fuel from the cask transporter, whose fuel tanks have a capacity of 50 gallons, which would fuel a fire for a duration of less than 5 minutes, as analyzed. In addition, it is anticipated any fires would be put out by the Canister Transfer Building sprinkler system.

The elevated temperatures from a fire could cause the pressure in the transfer cask water jacket to increase and cause the overpressure relief valve to vent steam to the atmosphere. However, this would not have any adverse affect on systems classified as Important to Safety and would vent less water and cause less disruption than the sprinkler system. Therefore the HI-TRAC design and building provisions meet the PFSF design criteria in Section 3.2.6 for accident-level thermal loads in accordance with 10 CFR 72.122(c).

4.7.3.5.2 Thermal Design

The thermal analysis for the HI-TRAC transfer cask is described in HI-STORM SAR Section 4.5.1. The analysis uses the same approach as the HI-STORM storage cask/canister thermal analysis (Section 4.2.1.5.2) and was performed using the ANSYS finite element computer code (Reference 10).

Heat generated in the fuel assemblies is transported to the shell of the canister, in the manner described in Section 4.2.1.5.2. From the outer surface of the canister, heat is transported across a total of six concentric layers, representing the air gap, the HI-TRAC inner steel shell, the lead shielding, the outer steel shell, the water jacket, and the enclosure shell from which heat is rejected to atmosphere. Heat is transferred across the air gap between the canister and the transfer cask by parallel mechanisms of conduction and radiation. Heat is transported through the cylindrical wall of the transfer cask by conduction through successive layers of steel, lead, and steel. Conduction through the water jacket occurs through both the water cavities and the steel channels.

A bounding steady-state analysis of the HI-TRAC transfer cask was performed using the least favorable canister basket thermal conductivity, the highest design basis decay heat load (28.25 kW), and assuming solar radiation. Maximum fuel cladding temperatures and temperatures in different parts of the transfer cask and canister are summarized in Table 4.7-2. Temperatures of all components are shown to be within allowable temperature limits.

The minimum ambient temperature condition required to be considered for the HI-TRAC design is specified as 0° F. Provided an antifreeze is added to the water in the transfer cask jacket, all HI-TRAC materials will satisfactorily perform their intended functions at the 0° F minimum postulated temperature condition. The minimum design temperature for the Canister Transfer Building is 40° F. Movement of the transfer cask at temperatures above 40° F eliminates the potential for approaching the minimum HI-TRAC design condition.

4.7.3.5.3 Shielding Design

The transfer cask provides shielding of the canister during transfer operations. Radial shielding is provided by steel shells that enclose a lead gamma shield with radial neutron shielding provided by 24 water-filled steel channels on the outside of the transfer cask. The bottom lid consists of a lead gamma shield and a solid neutron shield material sandwiched between steel liners. Shielding in the axial-up direction relies primarily on the canister's thick steel lid. Results of the dose rate analysis and determination of the dose rates at the bottom, sides, and top of the loaded HI-TRAC transfer cask are shown in HI-STORM SAR Section 5.1 and summarized in Table 7.3-3. Chapter 7 discusses the shielding analysis.

Temporary shielding will be provided as needed during the transfer operation as well as measures implemented to maintain ALARA doses. Doses will be maintained within occupational dose limits required in 10 CFR 20 in accordance with Section 3.3.5.2 for shielding.

4.7.4 TranStor Transfer Equipment

The TranStor transfer equipment consists of a metal transfer cask, transfer cask lifting trunnions, shipping cask and transfer cask lifting yokes, canister hoist rings, and storage cask lifting lugs.

4.7.4.1 Design Specifications

The TranStor transfer cask, trunnions, lifting yokes, and canister hoist rings are designed as special lifting devices in accordance with ANSI N14.6 (Reference 34) and NUREG-0612 (Reference 35).

4.7.4.2 Plans and Sections

The transfer cask assembly is shown in Figure 4.7-3.

4.7.4.3 Function

The function of the TranStor transfer cask is to provide a shielded lifting mechanism for transfer of the loaded canister between the shipping cask and the storage cask. The function of the lifting yokes is to provide a lifting interface between the crane and shipping cask or transfer cask. The function of the canister hoist rings is to provide a means to lift the canister. The function of the storage cask lifting lugs is to provide a means to lift the storage cask.

4.7.4.4 Components

4.7.4.4.1 Transfer Cask

The TranStor transfer cask is a cylindrical vessel, with walls that consist of multiple layers of material. The outer wall is steel, followed by a layer of neutron absorbing material, a layer of lead, and an inner wall of steel. There is a layer of lead inside the inner wall with an adjacent layer of neutron absorbing material. The base of the transfer cask consists of movable steel plates that are hydraulically operated to permit opening and closing of the cask bottom for transfer of the canister. The steel plates travel along rails located on each side of the cask. Two steel pins in each plate are provided to prevent inadvertent opening of the plates while the canister is contained within the transfer cask. The top of the transfer cask consists of a steel ring with an inner diameter smaller than that of the canister to prevent the canister from being lifted through the top of the cask.

Physical characteristics of the TranStor transfer cask are listed in Table 4.7-3.

4.7.4.4.2 Transfer Cask Trunnions

The transfer cask is lifted from above via two trunnions located near the top of the outer shell. The trunnions are steel forgings that extend radially from the transfer cask body. Each trunnion is welded to the inner and outer steel shells of the transfer cask wall with full penetration circumferential welds. The two trunnions are capable of accommodating the combined weight of the transfer cask and a fully loaded, water filled canister (at the originating power plant) while meeting NUREG-0612, Section 5.1.6(3) requirements for interfacing lift points.

4.7.4.4.3 Shipping and Transfer Cask Lifting Yokes

The shipping cask lifting yoke is a specialty lift rig that attaches between the crane hook and the two trunnions of the shipping cask. The transfer cask lifting yoke is a specialty lift rig that attaches between the crane hook and the two trunnions of the transfer cask. The lifting yokes consist of two armed steel hooks joined by two steel beams.

4.7.4.4.4 Canister Hoist Rings

The canister hoist rings consist of eight steel rings that are threaded into the top of the canister. The rings are used to provide a lift attachment for the crane in order to lift the canister up and out of either the shipping cask or storage cask and into the transfer cask.

4.7.4.4.5 TranStor Storage Cask Lifting Attachments

The TranStor storage cask is lifted from the top by use of four lifting attachments. The lifting attachments consist of steel plates, two plates located on either side of the cask. The plates are integrally welded to the cask concrete reinforcing bars. The four plates allow for direct lifting by the cask transporter or crane hook. The lifting attachments are not Important to Safety since the cask is not allowed to be lifted more than 10 inches per the operating conditions and limits given in Chapter 10.

4.7.4.5 Design Bases and Safety Assurance

4.7.4.5.1 Structural Design

A. Dead and Live Loads

The structural analysis for the TranStor transfer cask is described in TranStor SAR Section 3.4.3.3. The transfer cask is designed to lift the required load within the allowable safety factors to provide single-failure-proof lift capability in accordance with Section 3.2. The transfer cask, including the shell, bottom plates, trunnions, and associated welds are evaluated for loading conditions imposed by the weight of the transfer cask including the weight of a loaded canister. The transfer cask lid has been evaluated for the full weight of the transfer cask should inadvertent lifting of the transfer cask by the canister occur.

Structural adequacy of the transfer cask trunnions was evaluated by modeling the trunnions as cantilevers and applying the weight of the loaded transfer cask. The resulting bending and shear stresses in the trunnions were combined to calculate the maximum principal stress and determine the corresponding safety factors.

The shipping cask and transfer cask lifting yokes are designed as non-redundant lifting devices with a factor of safety of ten or greater on material ultimate strength and six or greater on material yield strength and includes the dynamic load increase factor of 10 percent. The lifting yokes therefore meet the NUREG-0612 requirements for a single-failure-proof device.

The canister hoist rings are designed with a minimum factor of safety of three on material yield strength and five on material ultimate strength, as well as a dynamic load increase factor of 10 percent. Eight rings provide redundant capability since only four

4.7.5 Cask Transporter

A cask transporter is used to move the loaded storage cask between the Canister Transfer Building and the storage pad.

4.7.5.1 Design Specifications

The cask transporter is a commercial grade system that has no specific code or specification criteria.

4.7.5.2 Plans and Sections

A drawing of a typical cask transporter is shown on Figure 4.7-4.

4.7.5.3 Function

The function of the cask transporter is to enable transfer of the loaded concrete casks between the canister transfer facility and the concrete storage pads.

4.7.5.4 Components

The cask transporter is a large tracked vehicle designed to straddle a concrete storage cask and lift it for transport between the Canister Transfer Building and the storage pads. The transporter lifting mechanism consists of a lift beam supported on either end by two hydraulic lift rams. The lift beam is designed with lift connections to attach to the lifting eyes in the storage cask. The transporter is controlled by a driver who is located on the back corner of the vehicle. The braking system is designed to automatically set when the vehicle operating levers are in neutral or the parking brake is set.

The transporter travels up to 2 mph, has a capacity of 200 tons, and weighs approximately 135,000 lb (Reference 21).

4.7.5.5 Design Bases and Safety Assurance

The cask transporter is classified as not Important to Safety. A failure of any cask transporter components will not result in any safety concerns since the cask would only lower 4 inches back to the ground. Drops this small are within analyzed accident conditions presented in Section 8.2.6. The transporter is designed to mechanically limit the lifting height of a canister to a maximum of 10 inches. The hydraulic lift cylinders are equipped with double locking valves and a cam locking system engages and holds the load in the event a cylinder looses holding power. Indicator lights on the operating console tell if the cams are disengaged or engaged. Markings on the lift boom and a meter on the operating console give indication of the lifted height.

TABLE 4.1-1
(Sheet 1 of 7)

PFSF COMPLIANCE WITH GENERAL DESIGN CRITERIA (10 CFR 72, SUBPART F)

10 CFR 72 REQUIREMENT	REQUIREMENT SUMMARY	SAR SECTION WHERE COMPLIANCE IS DEMONSTRATED
72.122 (a) Quality standards	Structures, systems, and components Important to Safety must be designed, fabricated, erected, and tested to quality standards commensurate with the importance to safety of the function.	• Section 3.4 provides the QA classifications for SSCs Important to Safety. • Chapter 4 describes the design of SSCs Important to Safety. • Section 9.2.2 describes the Preoperational Test Plan • Section 9.4.1.1.5 describes the QA procedures req'mts. • Chapter 11 shows that the QA Program is in accordance with 10 CFR 72.140.
72.122 (b) Protection against environmental conditions and natural phenomena	Structures, systems, and components Important to Safety must be designed to accommodate the effects of and be compatible with site characteristics and environmental conditions and to withstand postulated accidents.	• Sections 3.2 and 3.2.10.2.11 provide req'mts for environmental and site design criteria for SSCs Important to Safety. • Sections 4.2 and 4.7 describe the design to mitigate environmental effects. • Chapter 8 and Sections 8.2.1.1, 8.2.1.2, and 8.2.2.2 demonstrate the capability of SSCs Important to Safety to withstand postulated accidents.
72.122 (c) Protection against fires and explosions	Structures, systems, and components Important to Safety must be designed and located so that they can continue to perform their safety functions under credible fire and explosion exposure conditions.	• Section 3.3.6 provides fire and explosion protection req'mts. • Sections 4.2.1.5.1 (I) and (J), 4.2.2.5.1 (I) and (J), 4.7.3.5.1(E), and 4.7.4.5.1(D) describe the design that provides fire and explosion protection. • Sections 8.2.4.2 and 8.2.5.2 show the capability of SSCs Important to Safety to withstand postulated fire and explosion accidents.

TABLE 4.1-1
(Sheet 2 of 7)

PFSF COMPLIANCE WITH GENERAL DESIGN CRITERIA (10 CFR 72, SUBPART F)

10 CFR 72 REQUIREMENT	REQUIREMENT SUMMARY	SAR SECTION WHERE COMPLIANCE IS DEMONSTRATED
72.122 (d) Sharing of structures, systems, and components	Structures, systems, and components Important to Safety must not be shared between the PFSF and other facilities unless it is shown that such sharing will not impair the capability of either facility to perform its safety functions.	• Section 1.2 verifies that the PFSF does not share SSCs with other facilities.
72.122 (e) Proximity of sites	An ISFSI located near other nuclear facilities must be designed and operated to ensure that the cumulative effects of their combined operations will not constitute an unreasonable risk to the health and safety of the public.	• Section 7.6.2 verifies that no other nuclear facilities are located within 5 miles of the PFSF.
72.122 (f) Testing and maintenance of systems and components	Systems and components that are Important to Safety must be designed to permit inspection, maintenance, and testing.	• Sections 4.2, 4.7, 5.1.4.7, 4.7.2.1, and 5.1.6.5 describe the capability of SSC's to permit inspection, maintenance, and testing.

TABLE 4.1-1
(Sheet 7 of 7)

PFSF COMPLIANCE WITH GENERAL DESIGN CRITERIA (10 CFR 72, SUBPART F)

10 CFR 72 REQUIREMENT	REQUIREMENT SUMMARY	SAR SECTION WHERE COMPLIANCE IS DEMONSTRATED
72.128 (a) Spent fuel storage and handling systems	Spent fuel storage and other systems that might contain or handle radioactive materials associated with spent fuel must be designed to ensure adequate safety under normal and accident conditions.	• Section 3.3.7 provides the requirements for ensuring the safe design of the spent fuel storage and handling systems. • Sections 4.2 and 4.7 describe the design features of the storage and handling systems to provide adequate shielding, confinement, and heat removal capability. • Section 10.2.3 addresses the surveillance specifications for testing and monitoring some components Important to Safely.
72.128 (b) Waste treatment	Radioactive waste treatment facilities must be provided.	• Section 3.3.7 addresses radioactive waste provisions. • Chapter 6 addresses the generation of radioactive wastes.
72.130 Criteria for decommissioning	The ISFSI must be designed for decommissioning.	• Section 3.5 provides the requirements for decommissioning the site. • Section 9.6.3 describes the design considerations to facilitate decommissioning. • Decommissioning Plan (License Application, Appendix B) presents an overall description of the decommissioning requirements.

TABLE 4.2-1

PHYSICAL CHARACTERISTICS OF THE HI-STORM CANISTER

PARAMETER	VALUE
Outside Diameter	68.38 inches
Length, maximum	190.5 inches
Capacity	24 PWR assemblies 68 BWR assemblies
Maximum Heat Load	28.25 kW for PWR canister (MPC-24) 27.13 kW for BWR canister (MPC-68)
Material of Construction	Stainless steel
Weight, maximum (loaded with spent fuel)	78,831 lb (MPC-24) 86,131 lb (MPC-68)
Internal Atmosphere	Helium

TABLE 4.2-2

PHYSICAL CHARACTERISTICS OF THE HI-STORM STORAGE CASK

PARAMETER	VALUE
Height	231.25 inches
Outside Diameter	132.5 inches
Capacity	1 loaded canister
Max. Radiation Dose[1]	
1 meter from surface:	
Side	14 mrem/hr
Top	2 mrem/hr
On contact with surface:	
Side	29 mrem/hr
Top	7 mrem/hr
Top vents	32 mrem/hr
Bottom vents	50 mrem/hr
Material of Construction	Concrete (core and lid) Steel (liner and shell)
Weight, maximum	267,664 lb (empty) 346,495 lb (with loaded MPC-24) 353,796 lb (with loaded MPC-68)
Service Life	>100 years

1. Dose rate is based on HI-STORM design basis fuel.

TABLE 4.2-3

HI-STORM STORAGE SYSTEM STEADY STATE TEMPERATURE EVALUATION UNDER NORMAL CONDITIONS OF STORAGE

COMPONENT	MPC-24 TEMPERATURE (°F)	MPC-68 TEMPERATURE (°F)	NORMAL CONDITION TEMPERATURE LIMITS (°F)
Ambient Air	80	80	N.A.
Storage Cask Outer Shell	146	146	350
Air Outlet	205	202	N.A.
Storage Cask Inner Liner	264	264	300 *
Canister Shell	432	416	450
Helium Gas	630	625	N.A.
Fuel Cladding	632	627	716

* 300°F is Holtec's normal condition temperature limit on the concrete. The storage cask steel structure has a normal condition limit of 350°F (HI-STORM SAR Table 2.2.3).

the cradle, lifted off the transport vehicle, and moved into one of three canister transfer cells. The shipping cask is secured in place by attaching support struts between the cask and the transfer cell walls. The shipping cask lid is unbolted and removed. The canister is then accessible through the top of the shipping cask where the canister lifting attachments and hoist slings are installed on the canister lid. Temporary shielding is positioned as required to maintain worker doses as-low-as-is-reasonably-achievable (ALARA).

The transfer cask is placed onto the shipping cask by the overhead bridge crane or semi-gantry crane. The seismic support struts are attached between the transfer cask and the transfer cell walls. Shield doors installed on the bottom of the transfer cask are opened. The hoist slings are pulled up through the transfer cask and the canister is lifted up into the transfer cask just above the shield doors. The shield doors are closed and the canister is lowered onto the doors, which support the weight of the canister. The support struts are disconnect from the transfer cask. The transfer cask is lifted from the shipping cask by the crane and placed on top of the concrete storage cask. Support struts are again attached between the transfer cask and transfer cell walls. The canister is lifted slightly to remove its weight from the transfer cask shield doors. The shield doors are opened and the canister is lowered into the storage cask. The transfer cask is removed from the top of the storage cask and the storage cask lid is installed. Temporary shielding is removed from the cask transfer area. During the transfer process, radiation levels are measured to assure doses to workers are ALARA.

5.1.4.3 Placement of the Storage Cask on the Storage Pad

The concrete storage cask loading is now complete and ready for transport to a storage pad. The storage cask is moved out of the canister transfer cell by the cask transporter. The cask transporter lifts the storage cask approximately 4 inches high. The cask is then moved to the appropriate storage pad by the cask transporter. At the storage pad, the storage cask is positioned and lowered onto the storage pad. The temperature at the air outlet vents is taken after the cask is placed on the pad in accordance with Technical Specification requirements to confirm proper operation of the storage system.

5.1.4.4 Surveillance of the Storage Casks

While in storage, the proper operation of the storage casks is verified by surveillance procedures. Cask temperatures are measured by a continuous monitoring system to verify temperatures do not exceed temperature limits in the Technical Specifications. In addition, the cask air vents are inspected for blockage on a periodic basis in accordance with the Technical Specifications. An overall site observation surveillance is also performed on a periodic basis to detect any cask damage or accumulation of site debris. Surveillance requirements are discussed in Chapter 10.

Radiation doses emitted from the storage casks are measured by thermoluminecent dosimeters (TLDs) located at the restricted area (RA) and owner controlled area (OCA) fences to ensure doses are within 10 CFR 20.1301 and 10 CFR 72.104 or 40 CFR 191 limits.

STORM storage system and on Figures 5.1-3 and 5-1-4 for the TranStor storage system.

A flow diagram showing the sequence of operations required to remove the storage casks from the PFSF and ship them offsite is shown on Figure in 5.1-5.

The number of personnel and the time required for the various operations are given in Table 5.1-1 for the HI-STORM system and Table 5.1-2 for the TranStor system. These tables are used to develop the occupational exposures in Chapter 7.

5.1.6 Identification of Subjects for Safety Analysis

5.1.6.1 Criticality Prevention

As discussed in Section 4.2.1.5.4 (HI-STORM) and 4.2.2.5.4 (TranStor), criticality is controlled at the PFSF by utilizing fuel assembly geometry. Poison materials are primarily for underwater canister loading in the originating nuclear plant spent fuel pool. During storage, with the canister dry and sealed from the environment, no further criticality control measures within the storage installation are necessary.

5.1.6.2 Chemical Safety

There are no chemical hazards associated with the operation of the PFSF.

5.1.6.3 Operation Shutdown Modes

During storage, there are no operational shutdown modes associated with the HI-STORM or TranStor Storage Systems since the systems are passive and rely on natural air circulation for cooling. During canister transfer, the transfer process may be shut down at the end of the day until the next day because of the transfer duration. Operation procedures ensure that no shutdown can occur in the middle of an operational step. Operational shutdown steps following emergency or accident events are also addressed by the PFSF operational procedures. All operational shutdown modes at the PFSF are safe shutdown modes due to the design features of the facility.

5.1.6.4 Instrumentation

Due to the totally passive nature of the storage casks, there is no need for any instrumentation to perform safety functions. Temperature monitors are utilized as a means to monitor the cask temperature during storage. Area radiation monitors are used to measure radiation levels in the Canister Transfer Building during canister transfer operations and in the LLW storage room. Portable radiation monitors are used to measure radiation levels of casks following canister transfer. PFSF personnel are equipped with personnel dosimeters whenever they are in the RA. The radiation dose will be monitored at the perimeters of the RA and OCA. The temperature and radiation monitors are classified as Not Important to Safety.

5.1.6.5 Maintenance Techniques

No special maintenance techniques are necessary that would require a safety analysis.

There is preventative maintenance performed on a regular basis on the overhead transfer crane, canister lifting equipment, cask transporter, heavy haul tractor/trailers, radiation detection and monitoring equipment, cask temperature monitoring equipment, security equipment, fire detection and suppression equipment, etc. Maintenance is performed in accordance with 10 CFR 72.122(f) and manufacturer's requirements.

5.2 SPENT FUEL CANISTER HANDLING SYSTEMS

5.2.1 Spent Fuel Canister Receipt, Handling, and Transfer

An operational description for the systems used for the receipt and transfer of spent fuel canisters is provided in the following paragraphs. Special features of these systems to ensure safe handling of the spent fuel canisters are also described.

5.2.1.1 Spent Fuel Canister Receipt

5.2.1.1.1 Functional Description

The shipping casks and impact limiters comprise the system in which the spent nuclear fuel canisters are contained when they arrive at the PFSF. The shipping cask system protects the enclosed spent fuel canister from physical damage, provides shielding, and allows sufficient cooling of the canister while enroute to the PFSF.

5.2.1.1.2 Safety Features

Safety features of the system include the impact limiters, which help protect the spent fuel shipping cask during transportation, and the design, materials, and construction of the shipping casks, which provide gamma and neutron shielding, conductive and radiant cooling, criticality control, and structural strength to protect the spent fuel canister. A tamperproof device on the cask provides indication of an unauthorized attempt to obtain access to the cask. These safety features are fully described in the HI-STAR and TranStor shipping SARs.

5.2.1.2 Spent Fuel Canister Handling

5.2.1.2.1 Functional Description

The overhead bridge and semi-gantry cranes perform handling functions inside the Canister Transfer Building for the shipping cask, the transfer cask, and the TranStor canister. The canister downloader, bolted on top of the HI-TRAC transfer cask is used to raise and lower the HI-STORM canister.

Shipping and transfer cask handling components include the shipping cask and transfer cask lifting yokes, trunnions, and seismic support struts.

The storage cask handling component consists of the storage cask lifting attachments, cask transporter, and the overhead bridge crane, if needed.

The canister handling components consist of the lifting slings, HI-STORM canister lifting cleats, and TranStor canister hoist rings.

5.2.1.2.2 Safety Features

Safety features of the overhead bridge and semi-gantry cranes include single-failure-proof designs for sustaining the load upon failure of any single component, limit switches for prevention of hook travel beyond safe operating positions, and provisions for lowering a load in the event of an overload trip.

Safety features of the HI-TRAC downloader, used to raise and lower the HI-STORM canister during canister transfer operations, include a single-failure-proof design for sustaining the load upon failure of any single component and/or loss of hydraulic pressure as described in the HI-STORM SAR.

Safety features of the shipping and transfer cask handling components include single-failure-proof lift capacity or equivalent safety factor as described in the HI-STORM and TranStor SARs. Use of seismic support struts ensure the shipping and transfer cask do not topple over during an earthquake.

There are no safety features associated with the cask transporter since the storage cask is designed to withstand drops that could result from a failure associated with the transporter lift components. The transporter is designed such that the lift mechanism can only lift the storage cask within lift heights specified by the Technical Specifications.

The safety features of the canister handling components, slings, canister lifting cleats, and canister hoist rings, are their redundancy and the required stress safety margins as described in the HI-STORM and TranStor SARs.

5.2.1.3 Spent Fuel Canister Transfer

5.2.1.3.1 Functional Description

The transfer cask is used for transfer of the spent fuel canister between the shipping cask and the storage cask. The transfer cask protects the spent fuel canister from physical damage and provides radiation shielding.

5.2.1.3.2 Safety Features

The transfer casks provide radiation shielding and act as special lifting devices when carrying a canister loaded with spent fuel. The transfer cask lifting trunnions are designed and tested to the single-failure-proof requirements of NUREG-0612 (Reference 6) and ANSI N14.6 (Reference 7) so that canisters can be lifted by the transfer cask without the requirement to analyze a transfer cask drop. However, annual testing requirements per ANSI N14.6 of the transfer cask trunnion welds is not performed since the welds cannot be accessed for testing and NDE.

The transfer casks consist of cylindrical steel liners with a lead gamma shield and a neutron shield. Two trunnions are provided for transfer cask handling. The transfer cask has movable shield doors at the bottom to allow raising the canister into the transfer cask, lowering of the canister into the storage or shipping cask, or to support the canister weight and provide shielding while in the transfer cask. The doors slide in steel guides along each side of the transfer cask. Steel pins or bolts are used to prevent inadvertent opening of the doors. Roller bearings on the HI-TRAC transfer cask enable the cask doors to be manually operated. Hydraulic cylinders are used to open the TranStor transfer cask doors.

The transfer casks are designed to prevent the canister from being lifted beyond the top of the cask, which would expose the canister and cause high radiation doses. On the HI-TRAC transfer cask, the canister downloader, which raises the canister, is bolted on top of the cask. The canister can only be lifted up to the downloader hoist mechanical stops and is prevented from being raised beyond the top of the HI-TRAC cask. On the TranStor transfer cask, the top cover of the transfer cask is designed to stop the canister and prevent the crane from inadvertently lifting the canister up and out of the transfer cask while being raised.

The lifting yokes provided with the transfer casks are used to interface with the crane.

The safety features of the transfer casks are described in greater detail in the HI-STORM and TranStor SARs.

5.2.2 Spent Fuel Canister Storage

Spent fuel storage consists of the HI-STORM and the TranStor storage systems, which includes spent fuel canisters placed in the concrete storage casks located on the storage pads. The storage systems are a passive design and require no support systems for operation. The storage systems perform their functions under normal conditions as discussed in Chapter 4 and off-normal and accident level conditions as discussed in Chapter 8. Limits of operation associated with various normal and off-normal conditions are contained in Chapter 10. Surveillance requirements are also contained in Chapter 10.

5.2.2.1 Safety Features

Safety features include a passive dry cask design and administrative controls. The canister is enclosed in the cavity of the concrete storage cask, which protects the canister from severe natural phenomena (such as tornado-driven missiles), provides required shielding of the canister, and flow paths for natural convection cooling. The results of analyses of hypothetical storage cask tipover events are described in Section 8.2.6, where it is concluded that the canister will remain intact inside the storage cask and canister internals will not be damaged. Safety features are discussed in greater detail in Chapter 4, Chapter 8, and the HI-STORM and TranStor SARs.

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5.5 CONTROL ROOM AND CONTROL AREAS

Regulation 10 CFR 72.122(j) requires the control room or control area to be designed to ensure that the PFSF is safely operated, monitored, and controlled for off-normal or accident conditions. This requirement is not applicable to the PFSF because the spent fuel storage system is a passive system and requires no control room to ensure safe operation at the PFSF.

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TABLE 5.1-1
(Sheet 1 of 2)

ANTICIPATED TIME AND PERSONNEL REQUIREMENTS FOR HI-STORM CANISTER TRANSFER OPERATIONS

OPERATION	NO. OF PERSONNEL[1]	TASK DURATION (HOURS)
1. Receive and inspect shipment. Measure dose rates.	3	0.5
2. Move shipment into Canister Transfer Building.	4	0.5
3. Remove personnel barrier, measure cask dose rates, and perform contamination survey.	3	1.6
4. Remove impact limiters and tiedowns.	3	1.5
5. Attach lifting yoke to crane and HI-STAR shipping cask. Upright HI-STAR cask and move to transfer cell. Connect support struts.	3	1.0
6. Sample enclosed cask gas and vent.	2	0.5
7. Remove HI-STAR closure plate bolts.	3	1.0
8. Remove HI-STAR closure plate (lid).	3	0.2
9. Prep HI-STAR to mate with HI-TRAC transfer cask.	3	0.2
10. Install canister lift cleats and attach slings.	3	1.0
11. Attach lifting yoke to crane and HI-TRAC.	3	0.5
12. Mount HI-TRAC on top of HI-STAR. Connect support struts to HI-TRAC	3	0.5
13. Open HI-TRAC transfer cask doors.	3	0.2
14. Attach slings to canister downloader hoist and raise canister.	3	0.5
15. Close HI-TRAC doors and install pins.	3	0.2
16. Lower canister onto HI-TRAC doors.	3	0.2
17. Prep HI-STORM storage cask to mate with HI-TRAC transfer cask. Disconnect support struts.	3	0.2
18. Move HI-TRAC from HI-STAR to HI-STORM. Attach support struts to HI-TRAC	3	0.7
19. Raise canister and open HI-TRAC doors.	3	0.5
20. Lower canister into HI-STORM storage cask.	3	0.5

TABLE 5.1-1
(Sheet 2 of 2)

ANTICIPATED TIME AND PERSONNEL REQUIREMENTS FOR HI-STORM CANISTER TRANSFER OPERATIONS

OPERATION	NO. OF PERSONNEL[1]	TASK DURATION (HOURS)
21. Disconnect lifting slings.	3	0.2
22. Close transfer cask doors.	3	0.2
23. Disconnect support struts. Remove HI-TRAC from HI-STORM	3	0.5
24. Remove canister lift cleats.	3	0.5
25. Install HI-STORM lid and lid bolts.	3	1.0
26. Perform dose survey and install HI-STORM lifting eyes.	3	0.5
27. Drive cask transporter in transfer cell.	2	0.3
28. Connect HI-STORM to cask transporter.	3	0.5
29. Raise HI-STORM storage cask.	3	0.2
30. Transport HI-STORM cask to storage pad.	3	2.0
31. Position and lower HI-STORM cask on pad.	3	0.5
32. Disconnect HI-STORM cask from transporter and remove cask lifting eyes.	3	1.0
33. Connect cask temperature instrumentation.	3	0.5
34. Perform cask operability tests.	2	48
Total Hours	-	19.9[2]

Notes

1. Number of personnel typically includes 2 to 3 operators and 1 HP technician.
2. Total does not reflect 48 hour duration in Step 34, which is time required for cask temperature to reach equilibrium. Personnel time required to monitor temperatures during the equilibrium phase is minimal.

TABLE 5.1-2
(Sheet 1 of 2)

ANTICIPATED TIME AND PERSONNEL REQUIREMENTS FOR TRANSTOR CANISTER TRANSFER OPERATIONS

OPERATION	NO. OF PERSONNEL[1]	TASK DURATION (HOURS)
1. Receive and inspect shipment. Measure dose rates.	3	0.5
2. Move shipment into Canister Transfer Building.	4	0.5
3. Remove personnel barrier, measure cask dose rates, and perform contamination survey.	3	1.6
4. Remove impact limiters and tiedowns and install cask rotation trunnions.	3	1.5
5. Attach lifting yoke to crane and TranStor shipping cask. Upright shipping cask and move to transfer cell. Connect support struts.	3	1.0
6 Sample enclosed cask gas and vent.	2	0.5
7. Remove shipping cask closure lid bolts.	3	1.0
8. Remove shipping cask closure lid.	3	0.2
9. Prep shipping cask to mate with TranStor transfer cask.	3	0.2
10. Install canister lift eyes and attach slings.	3	1.0
11. Attach lifting yoke to crane and transfer cask.	3	0.5
12. Mount transfer cask on top of shipping cask, connect support struts, and disengage crane.	3	0.7
13. Open transfer cask doors.	3	0.2
14. Attach slings to crane and raise canister.	3	0.5
15. Close transfer cask doors and install pins.	3	0.2
16. Lower canister onto transfer cask doors and disconnect canister slings from crane hook.	3	0.2
17. Attach lifting yoke to crane hook and engage transfer cask. Disconnect support struts.	3	0.5
18. Move transfer cask from shipping cask to storage cask. Attach support struts to transfer cask and disengage crane.	3	1.0

TABLE 5.1-2
(Sheet 2 of 2)

ANTICIPATED TIME AND PERSONNEL REQUIREMENTS FOR TRANSTOR CANISTER TRANSFER OPERATIONS

OPERATION	NO. OF PERSONNEL[1]	TASK DURATION (HOURS)
19. Engage crane to canister, raise canister, and open transfer cask doors.	2	0.5
20. Lower canister into TranStor storage cask.	3	0.5
21. Disconnect lifting slings.	3	0.2
22. Close transfer cask doors.	2	0.2
23. Attach lifting yoke to crane and engage to transfer cask. Disconnect support struts. Remove transfer cask from storage cask	3	0.8
24. Remove canister lifting eyes.	3	0.5
25. Install storage cask lid and lid bolts.	3	1.0
26. Perform dose survey.	1	0.5
27. Drive cask transporter in transfer cell.	2	0.3
28. Connect storage cask to cask transporter.	3	0.5
29. Raise storage cask.	3	0.2
30. Transport storage cask to storage pad.	3	2.0
31. Position and lower storage cask on pad.	3	0.5
32. Disconnect storage cask from transporter.	3	0.2
33. Connect cask temperature instrumentation.	3	0.5
34. Perform cask operability tests.	2	48
Total Hours	-	20.2[2]

Notes

1. Number of personnel typically includes 2 to 3 operators and 1 HP technician.
2. Total does not reflect 48 hour duration in Step 34, which is time required for cask temperature to reach equilibrium. Personnel time required to monitor temperatures during the equilibrium phase is minimal.

SHIPMENT RECEIPT AND INSPECTION

1. Visually inspect the shipping cask, impact limiters, and cradle for any physical damage. Measure shipment dose rates. Verify security seal is in place.
2. Move the shipping cask, which is loaded on a heavy haul trailer or rail car into the Canister Transfer Building.
3. Remove the personnel barrier, measure shipping cask (HI-STAR) surface dose rates, and perform contamination surveys.

TRANSFER PREPARATION

4. Remove security seal, impact limiters, and shipment tiedowns.
5. Attach the HI-STAR lifting yoke to the overhead bridge crane. Engage the lifting yoke with the cask trunnions. Upright the HI-STAR shipping cask on the shipping cradle in the vertical position, raise cask from the transport vehicle, and move the cask into a canister transfer cell. Attach support struts between the shipping cask and transfer cell walls. Remove the removable shear ring segments from the HI-STAR shipping cask.
6. Remove cask vent port cover plate and attach backfill tool and sample bottle. Sample gas in the annulus and evaluate. Vent the cask annulus to atmosphere by removing the vent port seal plug if results from sample are acceptable. Vent the cask annulus through backfill tool HEPA filter if results from sample are not acceptable. Remove sample equipment.
7. Remove the HI-STAR cask closure plate (cask lid) bolts.
8. Remove the HI-STAR closure plate.
9. Install the transfer collar on HI-STAR shipping cask.
10. Install canister lift cleats on top of the canister. Attach lifting slings to the canister lift cleats.

CANISTER TRANSFER

11. Attach the transfer cask lifting yoke to the overhead bridge or semi-gantry crane and engage lifting yoke to the transfer cask (HI-TRAC) trunnions.
12. Mount the HI-TRAC transfer cask on top of the HI-STAR shipping cask. Connect the support struts to the HI-TRAC.
13. Remove the HI-TRAC transfer cask shield door locking pins and open the shield doors. Install the radiation shielding (trim plates).
14. Attach hoist slings to canister downloader (canister lifting hoist) hook and lift the canister into the HI-TRAC transfer cask by extending the downloader.
15. Remove trim plates, close HI-TRAC shield doors, and install locking pins.
16. Lower the canister onto the HI-TRAC shield doors.
17. Install vent duct shield inserts in the HI-STORM upper vents, install alignment pins in the HI-STORM lifting eye holes, and disconnect support struts.
18. Move the HI-TRAC transfer cask from on top of the HI-STAR shipping cask and mount on top of the HI-STORM storage cask. Attach support struts to HI-TRAC.
19. Extend the canister downloader to the full position to raise the canister off of the transfer lid shield doors, remove the shield door locking pins and open the shield doors.
20. Install the radiation shielding (trim plates). Retract the canister downloader to lower the canister into the HI-STORM storage cask.
21. Disconnect the canister from the downloader.
22. Remove the trim plates, close the shield doors, and install the door locking pins.
23. Disconnect the support struts. Remove the HI-TRAC transfer cask from the HI-STORM storage cask and place the HI-TRAC cask back into its storage area.

CASK STORAGE

24. Remove the canister lift cleats and lifting slings.
25. Remove the HI-STORM vent duct shield inserts and alignment pins. Install upper vent screens, HI-STORM lid, and lid bolts.
26. Perform a health physics survey for radiation doses and install the HI-STORM lifting eyes.
27. Open the transfer cell door and drive the cask transporter into the cell straddling the HI-STORM storage cask.
28. Attach the cask transporter lift hoist to the HI-STORM lifting eyes.
29. Raise the HI-STORM storage cask approximately 4 inches.
30. Transport the HI-STORM storage cask from the Canister Transfer Building to the appropriate storage pad with the cask transporter.
31. Position the HI-STORM storage cask in its designated storage location and lower the cask to the pad.
32. Disconnect the cask transporter lift hoist from the HI-STORM storage cask and remove the lifting eyes.
33. Connect the storage cask temperature monitoring instrumentation.
34. Perform natural convection cooling operability testing.

(Reference 1, Section 8.5)
(Note: The exact operational sequence is controlled by PFSF procedures.)

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Figure 5.1-1

HI-STORM CANISTER TRANSFER OPERATIONAL SEQUENCE

PRIVATE FUEL STORAGE FACILITY SAFETY ANALYSIS REPORT

6.2 OFFGAS TREATMENT AND VENTILATION

There are no gaseous releases from the storage systems utilized at the PFSF. After the canisters are loaded with spent fuel at the originating nuclear power plants, the canisters are vacuum dried, backfilled with helium, welded closed, and tested to verify leak tightness. Potentially contaminated gases that are purged from the canisters during the closure process are handled by the gaseous radioactive waste system at the originating nuclear power plant shipping the fuel. The canisters are ASME Boiler and Pressure Vessel Code Section III vessels designed to remain leak-tight for long-term storage at the PFSF. Under all normal, off-normal, and credible accident conditions of transport, handling, and storage, the potential does not exist for breach of the canister and release of radioactive material associated with spent fuel from inside the canister.

There are no special ventilation systems installed in the PFSF facilities. There are no credible scenarios that would require installation of special ventilation systems to protect against offgas or particulate release.

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west ends of the front row are much further from the dose receptor point than the nearest casks in the center of the row.

The results of the dose rate vs. distance analysis for the PFSF array full of TranStor storage casks are given in Table 7.3-8. Total dose rates at the RA fence at the north side of the array (highest doses) are calculated to be 0.45 mrem/hr. This is less than the 2 mrem/hour criteria for unrestricted areas specified in 10 CFR 20.1301 and is therefore acceptable. The total dose rate at the OCA boundary 600 meters north of the RA fence was calculated to be 1.21 E-3 mrem/hour. It was determined that the dose rates at the north OCA boundary were higher than those along the other sides, even though the west OCA boundary is the same distance from the storage pads (646 meters) as the north boundary. Conservatively assuming a hypothetical individual spends 2,000 hours per year at the portion of the OCA boundary fence with the highest calculated dose rate from the storage cask array results in an annual dose of 2.42 mrem. This is less than the 25 mrem criteria specified in 10 CFR 72.104 for maximum permissible annual whole body dose to any real individual located beyond the controlled area boundary and is therefore acceptable.

Dose at Nearest Residence

The approximate distance to the nearest residence is 2 miles east-southeast of the PFSF. At distances greater than several thousand feet, the accuracy of computer code calculational techniques becomes questionable. The error bands in statistical codes like MCNP become large and for deterministic codes like Skyshine, the conditions may be beyond the range of the codes data. However, both Holtec and SNC estimated dose rates that could occur at long distances from the PFSF, assuming the PFSF array of 4,000 HI-STORM storage casks loaded with 40 GWd/MTU, 10-year cooled PWR fuel, and conservatively taking no credit for any intervening shielding from berms, natural terrain or buildings at the PFSF. Holtec estimated the dose rate at 2.0 miles from the PFSF by extrapolating the maximum dose rate at the OCA boundary (1.94 E-3 mrem/hr) out to a distance of 2.0 miles using a power curve. The result was 2.7 E-6 mrem/hr, which would result in an annual dose of 0.024 mrem at a distance of 2.0 miles from the OCA boundary, assuming a person continually present (8,760 hrs/yr) at this location.

SNC made an estimate of the dose rate at 10,000 ft from the PFSF using the following approach: Based on data from Table 7.3-8, the dose per year at 2,000 ft is about 11 mrem/yr, assuming an occupancy factor of 8,760 hrs/yr. Table 7.3-8 also indicates that the dose rate decreases by at least a factor of five for every 1,000 ft of distance from the PFSF, for distances greater than 1,000 ft. Therefore an estimate for the 10,000 ft annual accrued dose is 11 mrem/yr divided by 5 to the eighth power, or 3 E-5 mrem/yr. Although this approximation has large uncertainty because of the long distance involved, SNC considered that the maximum dose rate at 10,000 ft would be far less than 0.1 mrem/yr.

7.3.4 Ventilation

10 CFR 72.122(h)(3) requires that ventilation systems and off-gas systems be provided where necessary to ensure the confinement of airborne radioactive particulate materials during normal or off-normal conditions. However, there are no special ventilation systems installed in the PFSF facilities. There are no credible scenarios that would require installation of ventilation systems to protect against off-gas or particulate filtration.

7.3.5 Area Radiation and Airborne Radioactivity Monitoring Instrumentation

10 CFR 72.122(h)(4) requires the capability for continuous monitoring of the storage system to enable the licensee to determine when corrective action needs to be taken to maintain safe storage conditions. This is not applicable to the PFSF because the

7.4 ESTIMATED ONSITE COLLECTIVE DOSE ASSESSMENT

The shipping, transfer and storage casks are designed to limit dose rates to ALARA levels for operators, inspectors, maintenance, and radiation protection personnel when the canisters are being transferred from the shipping to the storage casks, when the storage casks are being moved to the storage pads, and while the storage casks are being stored on the pads.

Table 7.4-1 shows the estimated occupational exposures to PFSF personnel during receipt of the HI-STAR shipping cask, transfer of the canister from the shipping cask to the HI-STORM storage cask using the HI-TRAC transfer cask, movement of the storage cask to the pad, and emplacement on the pad. Table 7.4-2 shows the estimated occupational exposures to PFSF personnel for these operations involving the TranStor shipping, transfer, and storage systems. Dose rate values include both gamma and neutron flux components, and are based on PWR fuel with 35 GWd/MTU burnup and 20-year cooling time. Fuel with these characteristics is considered to be representative of typical fuel that will be contained in canisters handled at the PFSF and dose estimates based on fuel with these characteristics are considered to be realistic. The operational sequence for these operations is also described in Chapter 5.

From Table 7.4-1, the total dose from receipt of a loaded shipping cask, transfer of the canister into a storage cask, movement of the storage cask to the pad, and performance of initial surveillances is estimated to be about 205 person-mrem for both HI-STORM and TranStor systems. Assuming a storage cask loading rate of 200 casks per year, the total annual dose to operations and Radiation Protection personnel involved in these operations is estimated to be approximately 41 person-rem. Occupational doses to individuals will be administratively controlled to ensure that they are maintained below 10 CFR 20.1201 limits and ALARA.

Temporarily positioned shielding will be used during transfer operations to reduce dose rates from streaming paths or relatively high radiation areas where its use will result in a net reduction in worker exposures. The effects of temporarily positioned shielding are considered in the Table 7.4-1 and 7.4-2 dose estimates for canister transfer operations.

Occupational exposures are also estimated to security personnel and PFSF personnel that conduct inspections, surveillances, and maintain the storage systems. These estimates are based on the assumption that the PFSF is at its 4,000 storage cask capacity. It is estimated that security personnel that conduct security inspections will accrue approximately 1.3 person-rem annually, based on one inspection per shift (3 shifts per day, 365 days per year) along the RA fence, using the highest dose rate at the fence discussed in Section 7.3.3.5. It is considered that dose rates inside the Security and Health Physics Building are negligible due to shielding provided by the building structure. One visual inspection per quarter is required to be performed for each storage cask to check for the buildup of debris at the inlet ducts and to inspect the cask exterior. Assuming one person spends 1.0 minute inspecting each cask, in an average dose field of 15 mrem/hr during the inspection, this surveillance will result in approximately 1.0 person-rem per quarter to PFSF personnel conducting the inspections, for a total of 4.0 person-rem annually. Conservatively assuming that 5 percent of the 4,000 casks require clearing of debris from the inlet ducts once a year at 10 minutes each, in a dose field of 15 mrem/hr, an additional annual dose of 0.5 person-rem is estimated. Monitoring of temperatures representative of the thermal performance of the casks will be performed remotely with a data acquisition system and will not result in significant exposure. Based on the above, the total dose to personnel involved in security inspections, surveillance, and storage cask maintenance operations is estimated to be 5.8 person-rem annually.

A combination of building location and shielding will minimize the dose to staff personnel working in the PFSF facilities. The west sides of the Canister Transfer

TABLE 7.4-1
(Page 1 of 4)
ESTIMATED PERSONNEL EXPOSURES FOR HI-STORM CANISTER TRANSFER OPERATIONS

Operation	No. of Personnel[1]	Task Duration[2] (hours)	Time in Dose Area[3] (hours)	Dose Rate in Area[4] (mrem/hr)	Dose[5] (person-mrem)
1. Receive and inspect shipment, and measure dose rates.	2 Ops 1 HP	0.5	0.5 0.5	4.0 4.0	4.0 2.0
2. Move shipment into Canister Transfer Building.	3 Ops 1 HP	0.5	0.5 0.5	0 0	0 0
3. Remove personnel barrier, measure dose rates, and perform contamination survey.	2 Ops 1 HP	1.6	1.0 1.6	4.0 6.0	8.0 9.6
4. Remove impact limiters and tiedowns.	2 Ops 1 HP	1.5	1.5 1.5	5.0 1.0	15.0 1.5
5. Attach lifting yoke to crane and HI-STAR shipping cask. Upright HI-STAR cask and move to transfer cell.	2 Ops 1 HP	1.0	0.5 1.0	5.0 1.0	5.0 1.0
6. Sample enclosed cask gas and vent.	1 Op 1 HP	0.5	0.5 0.5	12.5 / 2.0 1.0	6.3 /1.0 0.5
7. Remove HI-STAR closure plate (lid) bolts.	2 Ops 1 HP	1.0	1.0 1.0	12.5 / 2.0 1.0	25.0 / 4.0 1.0
8. Remove HI-STAR closure plate (lid).	2 Ops 1 HP	0.2	0.2 0.2	12.5 1.0	5.0 0.2
9. Prep HI-STAR to mate with HI-TRAC transfer cask.	2 Ops 1 HP	0.2	0.2 0.2	12.5 1.0	5.0 0.2
10. Install canister lift cleats and attach slings.	2 Ops 1 HP	1.0	1.0 1.0	12.5 / 7.1 1.0	25.0 /14.2 1.0

TABLE 7.4-1 (Page 2 of 4)

Operation	No. of Personnel [1]	Task Duration[2] (hours)	Time in Dose Area[3] (hours)	Dose Rate in Area[4] (mrem/hr)	Dose[5] (person-mrem)
11. Attach lifting yoke to crane and HI-TRAC.	2 Ops 1 HP	0.5	0.5 0.5	2.0 1.0	2.0 0.5
12. Mount HI-TRAC on top of HI-STAR.	2 Ops 1 HP	0.5	0.5 0.5	2.0 1.0	2.0 0.5
13. Open HI-TRAC transfer cask doors.	2 Ops 1 HP	0.2	0.2 0.2	5.0 1.0	2.0 0.2
14. Attach slings to canister downloader hoist and raise canister.	2 Ops 1 HP	0.5	0.5 0.5	2.0 1.0	2.0 0.5
15. Close HI-TRAC doors and install pins.	2 Ops 1 HP	0.2	0.2 0.2	10.0 1.0	4.0 0.2
16. Lower canister onto HI-TRAC doors.	2 Ops 1 HP	0.2	0.2 0.2	1.0 1.0	0.4 0.2
17. Prep HI-STORM storage cask to mate with HI-TRAC transfer cask (including installation of HI-STORM shielding inserts).	2 Ops 1 HP	0.2	0.2 0.2	5.0 1.0	2.0 0.2
18. Move HI-TRAC from HI-STAR to HI-STORM.	2 Ops 1 HP	0.7	0.7 0.7	1.0 1.0	1.4 0.7
19. Raise canister and open HI-TRAC doors.	2 Ops 1 HP	0.5	0.2 0.5	10.0 1.0	4.0 0.5
20. Lower canister into HI-STORM storage cask.	2 Ops 1 HP	0.5	0.5 0.5	1.0 1.0	1.0 0.5
21. Disconnect lifting slings.	2 Ops 1 HP	0.2	0.2 0.2	7.5 1.0	3.0 0.2

TABLE 7.4-1 (Page 3 of 4)

Operation	No. of Personnel[1]	Task Duration[2] (hours)	Time in Dose Area[3] (hours)	Dose Rate in Area[4] (mrem/hr)	Dose[5] (person-mrem)
22. Close transfer cask doors.	2 Ops 1 HP	0.2	0.2 0.2	5.0 1.0	2.0 0.2
23. Remove HI-TRAC from HI-STORM.	2 Ops 1 HP	0.5	0.5 0.5	1.0 1.0	1.0 0.5
24. Remove canister lift cleats and HI-STORM shield inserts.	2 Ops 1 HP	0.5	0.5 0.5	12.5 / 7.1 1.0	12.5 / 7.1 0.5
25. Install HI-STORM lid and lid bolts.	2 Ops 1 HP	1.0	1.0 1.0	2.0 1.0	4.0 1.0
26. Perform dose survey and install HI-STORM lifting eyes.	2 Ops 1 HP	0.5	0.5 0.5	2.0 1.0	2.0 0.5
27. Drive cask transporter in transfer cell.	1 Op 1 HP	0.3	0.3 0.3	1.0 1.0	0.3 0.3
28. Connect HI-STORM to cask transporter.	2 Ops 1 HP	0.5	0.5 0.5	1.0 1.0	1.0 0.5
29. Raise HI-STORM storage cask.	2 Ops 1 HP	0.2	0.2 0.2	1.0 1.0	0.4 0.2
30. Transport HI-STORM cask to storage pad.	2 Ops 1 HP	2.0	2.0 2.0	1.0 1.0	4.0 2.0
31. Position and lower HI-STORM cask on pad.	2 Ops 1 HP	0.5	0.5 0.5	10.0 5.0	10.0 2.5
32. Disconnect HI-STORM cask from transporter and remove cask lifting eyes.	2 Ops 1 HP	1.0	1.0 1.0	10.0 5.0	20.0 5.0

TABLE 7.4-1 (Page 4 of 4)

Operation	No. of Personnel[1]	Task Duration[2] (hours)	Time in Dose Area[3] (hours)	Dose Rate in Area[4] (mrem/hr)	Dose[5] (person-mrem)
33. Connect cask temperature instrumentation.	2 Ops 1 HP	0.5	0.5 0.5	10.0 5.0	10.0 2.5
34. Perform cask operability tests.	1 Op 1 HP	48	1.0 1.0	10.0 5.0	10.0 5.0
TOTAL					241.2 / 198.7 [5]

1. Number of personnel typically includes 2 to 4 operators and 1 HP technician.
2. Task duration includes total estimated time required to perform task.
3. Time in dose area includes only that time personnel are in a significant dose field.
4. The values in this column represent estimated average dose rates in the area where personnel will be working to perform the associated task. For operations where it is considered that temporary shielding will be effective in keeping dose rates ALARA, two values are presented (e.g., 50 / 5). The first value (50 mrem/hr) is the projected dose rate assuming no credit for temporary shielding. The second value (5 mrem/hr) takes credit for radiation attenuation by the use of temporary shielding.
5. Doses are calculated for times in dose fields without temporary shielding and with temporary shielding, such as 50 / 5, where the first value (50 mrem) is calculated based on the time spent in an area with the dose rate in the preceding column without temporary shielding, and the second value (5 mrem) is calculated based on the dose rate in the preceding column that takes credit for temporary shielding.

TABLE 7.4-2
(Page 1 of 4)

ESTIMATED PERSONNEL EXPOSURES FOR TRANSTOR CANISTER TRANSFER OPERATIONS

Operation	No. of Personnel[1]	Task Duration[2] (hours)	Time in Dose Area[3] (hours)	Dose Rate in Area[4] (mrem/hr)	Dose[5] (person-mrem)
1. Receive and inspect shipment, and measure dose rates.	2 Ops 1 HP	0.5	0.5 0.5	5.0 5.0	5.0 2.5
2. Move shipment into Canister Transfer Building.	3 Ops 1 HP	0.5	0.5 0.5	0 0	0 0
3. Remove personnel barrier, measure dose rates, and perform contamination survey.	2 Ops 1 HP	1.6	1.0 1.6	5.0 5.0	10.0 8.0
4. Remove impact limiters and tiedowns and install cask rotation trunnions.	2 Ops 1 HP	1.5	1.5 1.5	3.8 1.0	11.4 1.5
5. Attach lifting yoke to crane and TranStor shipping cask. Upright shipping cask and move to transfer cell.	2 Ops 1 HP	1.0	0.5 1.0	2.0 1.0	2.0 1.0
6. Sample enclosed cask gas and vent.	1 Op 1 HP	0.5	0.5 0.5	17.6 / 2.0 1.0	8.8 / 2.0 0.5
7. Remove shipping cask closure lid bolts.	2 Ops 1 HP	1.0	1.0 1.0	17.6 / 2.0 1.0	35.2 / 4.0 1.0
8. Remove shipping cask closure lid.	2 Ops 1 HP	0.2	0.2 0.2	17.6 1.0	7.0 0.2
9. Prep shipping cask to mate with TranStor transfer cask.	2 Ops 1 HP	0.2	0.2 0.2	16.8 1.0	6.7 0.2

TABLE 7.4-2 (Page 2 of 4)

Operation	No. of Personnel[1]	Task Duration[2] (hours)	Time in Dose Area[3] (hours)	Dose Rate in Area[4] (mrem/hr)	Dose[5] (person-mrem)
10. Install canister lift eyes and attach slings.	2 Ops 1 HP	1.0	1.0 1.0	16.8 / 4.5 1.0	33.6 / 9.0 1.0
11. Attach lifting yoke to crane and transfer cask.	2 Ops 1 HP	0.5	0.5 0.5	2.0 1.0	2.0 0.5
12. Mount transfer cask on top of shipping cask, connect support struts, and disengage crane.	2 Ops 1 HP	0.7	0.7 0.7	2.0 1.0	2.8 0.7
13. Open transfer cask doors.	2 Ops 1 HP	0.2	0.2 0.2	4.6 1.0	1.8 0.2
14. Attach slings to crane and raise canister.	2 Ops 1 HP	0.5	0.5 0.5	2.0 1.0	2.0 0.5
15. Close transfer cask doors and install pins.	2 Ops 1 HP	0.2	0.2 0.2	13.1 1.0	5.2 0.2
16. Lower canister onto transfer cask doors and disconnect canister slings from crane hook.	2 Ops 1 HP	0.2	0.2 0.2	13.1 1.0	5.2 0.2
17. Attach lifting yoke to crane hook and engage transfer cask. Disconnect support struts.	2 Ops 1 HP	0.5	0.2 0.5	13.1 1.0	5.2 0.5
18. Move transfer cask from shipping cask to storage cask. Attach support struts to transfer cask and disengage crane.	2 Ops 1 HP	1.0	0.3 1.0	13.1 1.0	7.9 1.0
19. Engage crane to canister lifting slings, raise canister, and open transfer cask doors.	1 Op 1 HP	0.5	0.3 0.5	13.1 1.0	3.9 0.5

TABLE 7.4-2 (Page 3 of 4)

Operation	No. of Personnel[1]	Task Duration[2] (hours)	Time in Dose Area[3] (hours)	Dose Rate in Area[4] (mrem/hr)	Dose[5] (person-mrem)
20. Lower canister into TranStor storage cask.	2 Ops 1 HP	0.5	0.5 0.5	1.0 1.0	1.0 0.5
21. Disconnect canister lifting slings.	2 Ops 1 HP	0.2	0.2 0.2	1.0 1.0	0.4 0.2
22. Close transfer cask doors.	1 Op 1 HP	0.2	0.2 0.2	4.6 1.0	0.9 0.2
23. Attach lifting yoke to crane and engage to transfer cask. Remove transfer cask from storage cask.	2 Ops 1 HP	0.8	0.8 0.8	2.0 1.0	3.2 0.8
24. Remove canister lifting eyes.	2 Ops 1 HP	0.5	0.5 0.5	16.8 / 4.5 1.0	16.8 / 4.5 0.5
25. Install storage cask shield ring, lid, and lid bolts.	2 Ops 1 HP	1.0	1.0 1.0	3.0 1.0	6.0 1.0
26. Perform dose survey and install storage cask lifting eyes.	2 Ops 1 HP	0.5	0.5 0.5	3.0 1.0	3.0 0.5
27. Drive cask transporter in transfer cell.	1 Op 1 HP	0.3	0.3 0.3	1.0 1.0	0.3 0.3
28. Connect storage cask to cask transporter.	2 Ops 1 HP	0.5	0.5 0.5	1.0 1.0	1.0 0.5
29. Raise storage cask.	2 Ops 1 HP	0.2	0.2 0.2	1.0 1.0	0.4 0.2
30. Transport storage cask to storage pad.	2 Ops 1 HP	2.0	2.0 2.0	1.0 1.0	4.0 2.0

TABLE 7.4-2 (Page 4 of 4)

Operation	No. of Personnel[1]	Task Duration[2] (hours)	Time in Dose Area[3] (hours)	Dose Rate in Area[4] (mrem/hr)	Dose[5] (person-mrem)
31. Position and lower storage cask on pad.	2 Ops 1 HP	0.5	0.5 0.5	10.0 5.0	10.0 2.5
32. Disconnect storage cask from transporter and remove storage cask lifting eyes.	2 Ops 1 HP	1.0	1.0 1.0	10.0 5.0	20.0 5.0
33. Connect cask temperature instrumentation.	2 Ops 1 HP	0.5	0.5 0.5	10.0 5.0	10.0 2.5
34. Perform cask operability tests.	1 Op 1 HP	48	1.0 1.0	10.0 5.0	10.0 5.0
TOTAL					284.8 / 208.9 [5]

1. Number of personnel typically includes 2 operators and 1 HP technician.
2. Task duration includes total estimated time required to perform task.
3. Time in dose area includes only that time personnel are in a significant dose field.
4. The values in this column represent estimated average dose rates in the area where personnel will be working to perform the associated task. For operations where it is considered that temporary shielding will be effective in keeping dose rates ALARA, two values are presented (e.g., 50 / 5). The first value (50 mrem/hr) is the projected dose rate assuming no credit for temporary shielding. The second value (5 mrem/hr) takes credit for radiation attenuation by the use of temporary shielding.
5. Doses are calculated for times in dose fields without temporary shielding and with temporary shielding, such as 50 / 5, where the first value (50 mrem) is calculated based on the time spent in an area with the dose rate in the preceding column without temporary shielding, and the second value (5 mrem) is calculated based on the dose rate in the preceding column that takes credit for temporary shielding.

CHAPTER 8

ACCIDENT ANALYSES

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8.1.5.2 Detection of Event

A release of some removable activity from the exterior surface of the canister could possibly occur as the result of impacts during the canister transfer operation. Significant impact of the canister during transfer operations would be observed by personnel associated with the transfer operation, which includes health physics coverage that would detect an activity release.

8.1.5.3 Analysis of Effects and Consequences

The following assesses the effects of postulated release of contamination from the external surfaces of a canister, conservatively assuming removable contamination levels of 1 E-4 μCi/cm^2 (22,200 dpm/100 cm^2) over the entire external surface area of a canister, much higher than is anticipated for canisters received at the PFSF and slightly above the removable surface contamination limit for accessible canister surfaces specified in Section 10.2.2.1 (22,000 dpm/100 cm^2) for beta/gamma activity. It is conservatively assumed that an event causes 100 percent of the canister external surface contamination to be released to the atmosphere.

Assuming the contamination is Co-60 particulate activity evenly distributed at a concentration of 1 E-4 μCi/cm^2 over the entire external surface of a HI-STORM canister (TranStor canister has a smaller area), with a surface area of approximately 312,000 cm^2 there would be a total activity inventory of approximately 31.2 μCi. The nearest distance from a storage pad to the OCA fence (site area boundary) is 646 meters, and the nearest distance from the Canister Transfer Building to the OCA fence is 500 meters. A χ/Q of 1.94 E-3 sec/cubic meter was calculated in accordance with Regulatory Guide 1.145 (Reference 6), assuming a distance of 500 meters to the dose receptor, a wind speed of 1 meter/sec, atmospheric stability class F, with no consideration for plume meander.

The dose conversion factor for intake of Co-60 is specified in EPA Federal Guidance Report No. 11 (Reference 7) as a committed effective dose equivalent (CEDE) of 5.91 E-8 Sv/Bq, equal to 219 mrem/μCi. The highest dose conversion factor for committed dose equivalent (CDE) to any organ from Co-60 is that for the lungs, 3.45 E-7 Sv/Bq, equal to 1,277 mrem/μCi. An adult breathing rate of 3.3 E-4 cubic meters per second is assumed in accordance with Reference 7. Based on Table XX of Reference 25, it is considered that 95 percent of Co-60 particulates are greater than 10 microns aerodynamic diameter and are non-respirable. Therefore, a respirable factor of 0.05 was applied to these particulates to account for inhalation of those particulates having an aerodynamic diameter less than 10 microns. Assuming an individual is located within the plume 500 meters from the release point for the duration of the release, the individual would receive a CEDE of 2.18 E-4 mrem and a CDE to the lungs of 1.28 E-3 mrem. The dose to an individual at the OCA boundary from external exposure to radiation emitted by the plume (submersion dose) was also calculated, using the equation presented in Regulatory Guide 1.3 (Reference 28) for determining the gamma dose rate in air from submersion in a semi-infinite cloud of radioactive material. The submersion dose from external exposure to Co-60 in the plume was calculated to be 3.78 E-5 mrem. Adding the external dose from submersion to the internal CEDE results in a total effective dose equivalent (TEDE) of 2.56 E-4 mrem. These doses are well below the 10 CFR 72.106 criteria of 5 rem TEDE for accidents. Assuming an off-normal condition resulting in release of contamination to the atmosphere occurs on the order of once per year, total annual dose consequences at the OCA boundary from this event and radiation emanating from storage casks (Section 7.6) will not exceed 25 mrem, in accordance with 10 CFR 72.104.

The dose was also calculated to onsite personnel assumed to be located 150 meters from the release point using the same methodology and assumptions discussed above, with a calculated χ/Q of 1.40 E-2 sec/cubic meter. Onsite personnel 150 meters from the release point would receive a CEDE of 1.58 E-3 mrem, a CDE to the lungs of 9.20 E-3 mrem, and an external dose due to submersion of 2.73 E-4 mrem. Adding the external dose from submersion to the internal CEDE results in a TEDE of 1.85 E-3 mrem.

8.1.5.4 Corrective Actions

Even if relatively high levels of contamination are encountered on the external surfaces of a canister, which is not anticipated, no corrective action is necessary. Doses at the OCA fence resulting from release of activity from a contaminated canister would be negligible.

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The casks are modeled as a two body system with each overpack described by six degrees of freedom which captures the inertial rigid body motion of the overpack. Within each overpack the internal MPC is modeled by an additional five degree of freedom mass which is sufficient to define all but the rotational motion of the MPC about its own longitudinal axis, a motion which is of no significance in this analysis. Spring constants are developed to simulate the contact stiffness between the MPC and the overpack cavity. Interface spring constants are developed for the overpack-to-concrete pad linear compression only contact springs and for the associated friction springs at each of the 36 contact locations for each overpack on the pad.

Soil-structure interaction is incorporated into the model by the development of soil springs to reflect the characteristics of the underlying soil mass beneath the pad. Horizontal, vertical, rocking and torsional spring rates were calculated along with appropriate soil mass and damping values and applied at the pad-soil interface.

The cask stability analysis was performed by computer methods using cask-to-pad coefficients of friction equal to 0.2 (emphasizes sliding potential) and 0.8 (emphasizes tipping potential) to bound the maximum sliding and tipping behavior of the cask. The results of the site-specific analysis show that the storage casks will not tip over or slide to the extent of impacting adjacent casks during the site-specific DE.

For the limiting case with a 0.8 coefficient of friction (maximum tip), there is minimal rotation of the cask vertical centerline, except the case with a single cask on the pad. For this case, there is evidence the cask edges and rolls to a new position approximately 5 inches from its original position during the seismic event. The maximum tip, identified as the lateral motion of the cask top center point from its initial position, is approximately 13 inches for the single cask case and considerably less for all other cases. For the limiting case bounded by a 0.2 coefficient of friction (maximum slide), the maximum distance in which a cask will slide is shown to be 10.25 inches.

For both coefficients of friction considered, cask motions are generally in-phase with each other. The casks are spaced on the storage pad at 15 ft center-to-center which provides 47.5 inches clear between casks (cask diameter is 132.5 inches) and provides a considerable margin of safety against impacts between casks during a seismic event. The analysis also shows that for those cases where the cask(s) tip up slightly and then "slap" back down on their base, vertical deceleration forces, up to 8.41 g, are developed, but these values are well below the design basis deceleration forces for the HI-STORM 100 system.

The site specific cask stability analysis performed by the cask vendor demonstrates that the HI-STORM storage cask will not tip over in a seismic event. The calculated cask movements are much less than the cask spacing on the storage pad and as such, the storage casks are shown not to impact one another or move off of the storage pad in a seismic event. Therefore, no radioactive material would be released from the storage system when subjected to the DE. The HI-STORM storage system thus meets the general design criteria of 10CFR 72.122(b), as it relates to earthquakes.

<u>TranStor Cask Stability Analysis</u>

The TranStor generic cask stability analysis is described in Section 11.2.5 of the TranStor SAR. The analysis demonstrates the storage cask will not tip over when subjected to a seismic event characterized by Regulatory Guide 1.60 response spectra curves with a zero period acceleration of 0.75 g in two horizontal directions and 0.50 g in the vertical direction. The generic cask stability analysis is performed using a two-dimensional analysis, and as such, utilizes a horizontal response spectrum with a resultant zero period acceleration of 0.8 g and a vertical response spectrum with a zero period acceleration of 0.5 g. The horizontal response spectrum is the resultant of both 0.75 g horizontal accelerations combined using the 100-40 rule allowed by NUREG/CR-0098 (Reference 9). The analysis also concludes that with a maximum ground within the breached canister following release from the fuel assemblies, and do not escape to the atmosphere. Ten percent of these radionuclides and 100 percent of the H-3 and Kr-85 are assumed to escape from the canister breach to the atmosphere.

The radionuclides postulated to be released from the hypothetical breached canister are dispersed in the atmosphere, reaching the downwind dose point and resulting in a dose to a hypothetical individual standing at the nearest point of the OCA boundary for the duration of the release.

8.2.7.3 Accident Dose Calculations

The nearest distance from a PFSF storage pad to the OCA fence (site area boundary) is 646 meters, and the nearest distance from the Canister Transfer Building to the OCA fence is 500 meters. A χ/Q of 1.94 E-3 sec/cubic meter was calculated in accordance with Regulatory Guide 1.145 (Reference 6), assuming a distance of 500 meters from the release source to the dose receptor, a wind speed of 1 meter/sec, and atmospheric stability class F, with no consideration for plume meander.

The dose conversion factors for Committed Effective Dose Equivalent (CEDE) and Committed Dose Equivalent (CDE - organ) due to inhalation are specified in Reference 7. An adult breathing rate of 3.3 E-4 cubic meters per second is assumed (Reference 7). Based on Table XX of Reference 25, 95 percent of Co-60 and Sr-90 particulates are greater than 10 microns aerodynamic diameter and are non-respirable. Therefore, a respirable factor of 0.05 was applied to these particulates to account for inhalation of those particulates having an aerodynamic diameter less than 10 microns. In addition to inhalation dose equivalents, immersion doses were also calculated that result from exposure to radiation emitted by the radionuclides in the plume. These immersion doses were calculated using the Passive/Evolutionary Regulatory Consequence Code ("PERC2" - Reference 26) based on radionuclide concentrations calculated at the OCA boundary. Gamma exposures resulting from immersion in the plume were added to the inhalation dose equivalents to arrive at total dose equivalents. Assuming an individual is located within the plume 500 meters (at the closest point of the OCA boundary to the Canister Transfer Building) from the breached canister for the duration of the release, it is calculated that the individual would receive a CEDE (internal dose) of 504 mrem, a CDE to the lungs (the maximally exposed organ) of 2,430 mrem, and a total external dose due to submersion in the plume of 42.7 mrem from hypothetical breach of a PWR canister containing 24 design fuel assemblies. Adding the external dose to the internal CEDE results in a TEDE of 547 mrem from the breached PWR canister. The maximum organ dose is the CDE to the lungs plus the submersion dose, or approximately 2,470 mrem to the lungs from the breached PWR canister. For hypothetical breach of a BWR canister containing 68 design fuel assemblies, it is calculated that the individual would receive a CEDE (internal dose) of 677 mrem, a CDE to the lungs (the maximally exposed organ) of 3,400 mrem, and a total external dose due to submersion in the plume of 75.1 mrem. Adding the external dose to the internal CEDE results in a TEDE of 752 mrem from the breached BWR canister. The maximum organ dose is the CDE to the lungs plus the submersion dose, or approximately 3,480 mrem to the lungs from the breached BWR canister.

The above doses at the OCA boundary calculated to result from a hypothetical canister breach accident are below the 5 rem to the whole body or any organ criteria specified in 10 CFR 72.106 (b). Note that although the consequences have been evaluated, this is not considered to be a credible event for the PFSF.

8.2.7.4 Recovery Plan for a Hypothetical Canister Breach

As discussed in Section 8.2.7 above, the breach of a canister is not considered credible. However, for a hypothetical canister breach, a plan has been developed to recover from such an event.

The primary method of recovery from a breached canister would be to return the canister via shipping cask to the originating nuclear power plant or another facility having the capability to handle individual spent fuel assemblies. Transport of a breached canister would be in a licensed spent fuel shipping configuration in which the shipping cask provides the confinement boundary, with no reliance on the canister for fission product confinement. Since radioactive material that could potentially escape from the breached canister would be confined within the shipping cask, which is qualified to maintain its integrity under normal conditions of transport as well as accident conditions, transport of a breached canister would have no adverse environmental impacts.

The additional method of recovery from a breached canister would be to enclose the breached canister inside of another confinement vessel. This action can be accomplished onsite without the need to handle individual spent fuel assemblies inside the canister.

Holtec has designed and is licensing the HI-STAR shipping cask for both transportation and storage of spent fuel. The cask is metal and is designed to provide the confinement boundary in the shipping configuration. For the hypothetical breach of a Holtec canister, the canister would be transferred to a HI-STAR metal storage cask to re-establish the storage confinement boundary. The HI-STAR cask would be vacuum-dried, backfilled with helium, sealed closed, and shipped or placed in storage at the PFSF for shipment offsite at a later date. The procedure is addressed in HI-STORM SAR, Section 8.4. This recovery method would use steel storage casks with mechanical closure and would require a site specific seismic analysis, equipment to vacuum dry and backfill the HI-STAR cask with helium, and a pressure monitoring system to ensure the integrity of the mechanical seal.

Sierra Nuclear Corporation (SNC) has designed a canister overpack, a second metal canister that a breached TranStor canister can be inserted into, which functions as the confinement barrier. Once the leaking canister is placed in the canister overpack, the lid of the canister overpack would be welded to the shell and the overpack system would be vacuum dried and helium backfilled. The backfill port would then be welded closed and the welds would be tested. The sealed canister overpack, now loaded with the breached canister, would be transferred into a TranStor storage cask and moved to the storage pad. When the canister is shipped offsite, it would be necessary to cut the canister overpack open to remove the breached canister and transfer it into a TranStor shipping cask where it could be sealed (shipping cask provides the confinement barrier) and shipped offsite. Appropriate radiological controls and airborne surveys would be taken during the transfer process to ensure protection of PFSF workers. This procedure is addressed in Reference 27, Section 5.1.1.5 for the TranStor storage system. This recovery method would require equipment to weld, vacuum dry and backfill the canister overpack with helium, perform required tests, and a pressure monitoring system to ensure the integrity of the single closure canister overpack.

As an alternative to placing a breached TranStor canister inside of the overpack, the breached canister could be sealed in a TranStor shipping cask and stored at the PFSF for shipment offsite at a later date, as with the HI-STAR cask recovery method. This would require an amendment to the TranStor SAR Certificate of Compliance. This recovery method would use a steel storage cask with mechanical closure and would require a site specific seismic analysis, equipment to vacuum dry and backfill the shipping cask with helium, and a pressure monitoring system to ensure the integrity of the mechanical seal.

Another method of recovery from a breached canister would be to utilize a portable dry transfer system at the PFSF site. A dry transfer system is not part of the PFSF design, however, several portable dry transfer system units are expected to be in operation by the Private Fuel Storage L.L.C. (PFSLLC) for use at power plants with restrictions on lifting heights or crane capacity. One of these dry transfer system units could be brought to the PFSF as needed to recover from a hypothetical canister breach at the PFSF. The dry transfer system would enable onsite transfer of individual fuel assemblies from a breached canister to a new canister.

The portable dry transfer system consists of a transfer vessel, canister shield adapter, and load/unload frame. The transfer vessel would be an upright steel cylindrical vessel that provides complete confinement for a limited number of spent fuel assemblies. The transfer vessel contains a single-failure-proof hoist and grapple within its confinement boundary that are used to lift or lower the fuel assemblies. The transfer vessel is mounted on top of the canister shield adapter, which is mounted on top of the cask. A shield door is located on the bottom end of the transfer vessel to enable fuel assemblies to be moved between the transfer cask and canister. The canister shield adapter is a cover that encloses the top of the canister in lieu of the canister lid, which is removed. The adapter also provides a shield barrier to limit the radiation doses out the top of the canister. A load/unload platform frame provides support for the canister shield adapter and transfer vessel and allows personnel access to operate the equipment. This recovery method would require the dry transfer system, equipment to weld the new canister, vacuum dry and backfill the canister with helium, perform tests, monitor for airborne contamination, and dispose of the opened canister.

Although a canister breach is a non-credible, hypothetical event at the PFSF, this recovery plan provides several reasonable alternatives of recovery from such a hypothetical event with negligible impacts on public health and safety.

8.2.8 100% Blockage of Air Inlet Ducts

Complete blockage of the air inlet ducts is classified as Design Event IV as defined by ANSI/ANS-57.9.

8.2.8.1 Cause of Accident

This event involves postulated complete blockage of all four storage cask air inlet ducts. Heat is normally removed from the canister shell by natural convection, and the heated air flows up the annulus by natural convection to four top outlet ducts, where the hot air exits the storage cask.

Since the HI-STORM storage casks have four air inlet ducts 90° apart and the TranStor storage casks have four air inlet ducts, with two located on opposing sides of the cask, it is highly unlikely that all air inlet ducts could become blocked by blowing debris, snow, rodents, or other material. A severe windstorm could possibly blow debris against the bottom of the storage casks and possibly clog one or two of the inlet screens exposed to the wind, but the inlets on the leeward side of the cask would be expected to remain relatively free of dirt and debris. If a large sheet of plastic or a tarpaulin were to blow against a storage cask (which is unlikely since the RA is surrounded by two 8-ft high chain link fences that would be expected to catch such items), it could wrap partially around the storage cask and block, or partially block, the air inlet ducts on the windward side, but ducts on the opposite side would be expected to remain open.

One means of cutting off normal convection airflow would be a flood in which the height of the water exceeded the tops of the air inlet ducts. However, since the PFSF location and design assures that the upper surfaces of the storage pads are at an elevation above the elevation of the probable maximum flood in this area, blockage of the inlet ducts by flooding is not credible.

8.2.9 Lightning

Lightning is classified as a natural phenomenon Design Event III as defined in ANSI/ANS-57.9.

8.2.9.1 Cause of Accident

This event would be caused by meteorological conditions at the site. Lightning striking one of the storage casks is not a likely event, because there are grounded metal light fixtures/poles in the vicinity of the storage pads that are substantially higher than the storage casks (approximately 120 ft high).

8.2.9.2 Accident Analysis

If a storage cask were hit by lightning, the likely path to ground would be from the steel cask lid to the steel base plate via the steel cask liner(s) and the steel air inlet ducts. The canister is surrounded by these steel structures and would not provide a likely ground path. Therefore, a lightning strike would not affect canister integrity. The absorbed heat would be insignificant due to the very short duration of the event. If the lightning entered or exited the cask via the concrete shell, some local spalling of concrete might occur. Storage cask operation would not be adversely affected.

8.2.9.3 Accident Dose Calculations

The canister would retain its confinement integrity, and there would be no releases of radioactivity. Therefore, no offsite doses would result from this accident. The effects of localized shielding loss due to spalling of storage cask concrete would be bounded by dose rates discussed in Section 8.2.2.3 for worst case tornado missile penetration.

8.2.10 Hypothetical Accident Pressurization

Accident pressurization is classified as a hypothetical Design Event IV as defined by ANSI/ANS-57.9. This is not a credible accident.

8.2.10.1 Cause of Accident

The spent fuel is stored in a manner that complies with the general design criteria 10 CFR 72.122(h), in that the spent fuel cladding is protected during storage against degradation that could lead to gross ruptures. The space internal to the confinement boundary is filled with an inert gas (helium) without the presence of air or moisture that might produce the potential for long term degradation of the spent fuel cladding. The spent fuel storage systems are designed to assure that fuel is maintained at temperatures below those at which fuel cladding degradation occurs, under normal, off-normal, and accident conditions. It is therefore highly unlikely that a spent fuel assembly with intact fuel cladding will undergo cladding failure during storage, and the assumption of complete cladding failure of all rods in a canister is extremely conservative. Failure of the cladding of all fuel rods contained in a canister is considered to be a non-credible event. Nevertheless, a hypothetical breach of all fuel rods in the canister and subsequent release of their fission and fill gases to the canister interior is analyzed. This would pressurize the canister shell and lids.

8.2.10.2 Accident Analysis

The analysis of this accident entails calculation of the free volume in the canister as well as the quantities of fill and fission gases in the fuel assemblies. The canister pressure is then determined based on the addition of 100 percent of the fuel rod fill gas and a conservative fraction of the fission gases to the helium already present in the canister. The fuel rods are initially assumed to be at a bounding fill pressure.

17. Regulatory Guide 1.91, Evaluations of Explosions Postulated to Occur on Transportation Routes Near Nuclear Power Plants, Revision 1, U.S. NRC, February 1978.

18. IAEA Safety Standards, Regulations for the Safe Transport of Radioactive Material, IAEA Safety Series No. 6, 1985.

19. Gregory, J.J., et. al., Thermal Measurements in a Series of Large Pool Fires, SAND 85-1096, Sandia National Laboratories, August, 1987.

20. Topical Safety Analysis Report for the Holtec International Storage, Transport, and Repository Cask System, (HI-STAR 100 Cask System), Holtec Report HI-951251, Docket 71-9261, Revision 4, September 1996.

21. UCID-21246, Dynamic Impact Effects on Spent Fuel Assemblies, Lawrence Livermore National Laboratory, Chun, Witte, Schwartz, October 20, 1987.

22. ACI-349, Code Requirements for Nuclear Safety-Related Concrete Structures, American Concrete Institute, September 1985.

23. TranStor Basket Handling and Dead Weight Load Analysis, Sierra Nuclear Corporation Design Calculation No. TSL-1.10.06.60, Rev. 1; March 6, 1997.

24. NUREG-1536, Standard Review Plan for Dry Cask Storage Systems, Final Report, January 1997.

25. SAND80-2124, Transportation Accident Scenarios for Commercial Spent Fuel, Sandia National Laboratories, February 1981.

26. Passive/Evolutionary Regulatory Consequence Code (PERC2), Version 0, Level 1; Computer Code Designator NU-226.

27. Trojan ISFSI Safety Analysis Report, Trojan Nuclear Plant, Portland General Electric Company, Revision 0, Docket No. 72-17.

28. Regulatory Guide 1.3, Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Boiling Water Reactors, Revision 2, U.S. NRC, June 1974.

CHAPTER 9

CONDUCT OF OPERATIONS

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Board of Managers on issues Important to Safety and is responsible for reviewing modifications, plans, procedures and other activities that have elements that are Important-to-Safety. The ORC, consisting of the leaders of the various departments, will support the General Manager/Chief Operating Officer (who will serve as Chairman of the ORC) in the review/assessment of site operations. The ORC will consist of the lead persons from each department as indicated on Figure 9.1-3. A quorum consisting of a majority of ORC members will be required for the ORC to perform its function of operational assessment and safety oversight. Offsite nuclear engineering support during PFSF operations is discussed in Section 9.1.2.1.8.

Storage cask vendors will be inspected by PFSLLC representatives to ensure compliance with the 10 CFR 71 and/or 10 CFR 72 Certificates of Compliance and approved Quality Assurance Programs. Spent fuel shipment preparation at individual nuclear power plant sites will be overseen by the PFSLLC nuclear engineering staff.

9.1.1.3 Interrelationships with Contractors and Suppliers

As shown in Figures 9.1-1 and 9.1-2, the A/E reports to the PFSLLC Project Manager, who in turn reports to the Board of Managers, for the pre-licensing, and licensing and construction phases. The PFSLLC Project Manager is responsible to the Board for managing technical work activities and ensuring that engineering and design tasks, as well as licensing support tasks, are completed on schedule.

The PFSLLC and its A/E work under a contractual relationship which requires that all appropriate work by the A/E be performed in accordance with the A/E's approved Quality Assurance Program. Any subcontractor's support analysis or design work is required to have an approved Quality Assurance Program or to be directly supervised by the A/E.

The A/E Project Manager reports to the Project Manager of the PFSLLC, who is responsible for contractual compliance. The PFSLLC Quality Assurance and Technical Committees review and audit the work of the A/E. These committees consist of staff members from PFSLLC member utilities with specific expertise in the area of oversight. They are appointed by the Chairman of the Board. In addition, routine telephone conferences between the PFSLLC and the A/E are utilized to monitor progress and communicate issues.

The entire process of canister and storage cask selection in the pre-license phase of the project will be overseen by staff provided from PFSLLC member utilities. This mechanism will bring close industry scrutiny from a variety of potential users and reinforces the normal quality assurance oversight on this important function. Storage cask vendors are required by the contract with the PFSLLC to perform work under the approved Quality Assurance Program with oversight by the PFSLLC's Quality Assurance and Technical Committees.

Other suppliers contract with the A/E or the PFSLLC directly. All PFSLLC contracts and purchase orders relating to the License are reviewed for quality assurance applicability and standards by a member of the Quality Assurance Committee. Contracts and purchase orders are signed by the Chairman of the Board.

9.1.1.4 Technical Staff

The PFSLLC technical staff is provided by the member utilities. These staff members support the review of activities performed by the A/E and storage cask vendors. They also provide review for "Requests for Proposal" specifications to ensure transportation, dry transfer equipment, and on-site transfer equipment properly interface with the position has the authority and responsibility for providing staff resources (or contract support, as needed) and management direction to ensure the safe and efficient operation and maintenance of the facility. This position is responsible for document control and storage, training, security and the licensing interface with the NRC. This position is also responsible for the liaison between the PFSLLC and local governments in accordance with the Emergency Plan. The General Manager/Chief Operating Officer reviews proposed facility modifications, procedural changes, and tests, and has the authority to approve them for implementation, unless it is determined that the proposed modifications, changes or tests may involve an unreviewed safety question. The General Manager/Chief Operating Officer provides final approval of procedures for facility operations, maintenance, equipment inspections, administration and security, after all other required approvals have been obtained. The General Manager/Chief Operating Officer ensures that all subordinate or delegated responsibilities, assignments, authorities and relationships are understood and implemented by his/her lead people, engineers, and other staff members. The General Manager/Chief Operating Officer is familiar with all pertinent rules, regulations, codes, and procedures and ensures compliance as applicable.

The General Manager/Chief Operating Officer coordinates the activities of the facility with the Board of Managers and outside support services, and keeps the Board advised of facility performance. All unusual occurrences, incidents, or abnormalities in facility operation are reported to this position. The General Manager/Chief Operating Officer has the authority to shut down the facility operation and initiate emergency procedures or curtail operations in any emergency situation which should arise.

The General Manager/Chief Operating Officer is responsible for the scheduling and procurement of all equipment and materials (including special nuclear and source materials) necessary for the operation of the facility; the development of plans and procedures for facility administration, operation, and maintenance; the selection and hiring of facility personnel; and the development of appropriate training programs to ensure facility personnel are qualified.

9.1.2.2.2 Radiation Protection Manager

The Radiation Protection Manager is responsible to the General Manager/Chief Operating Officer for radiation safety at the PFSF, including the planning and direction of the facility radiation protection and ALARA programs and procedures, the operation of the health physics laboratory, and the technical and functional supervision of the Radiation Protection Technicians. The Radiation Protection Manager is responsible for all routine and special radiation monitoring for the protection of personnel and ensures that packaging, storage, and shipment of solid radioactive waste complies with applicable regulations. The Radiation Protection Manager advises and informs the General Manager/Chief Operating Officer on all matters pertaining to radiological safety, including the status of radiological health aspects of facility operation and maintenance and identification of potential radiological concerns. The Radiation Protection Manager is responsible for maintaining and monitoring all radiation protection related records for any trends which may affect facility operation.
The Radiation Protection Manager has the authority and responsibility to order cessation of hazardous work involving radiological materials until the General Manager/Chief Operating Officer is appraised of the situation and the appropriate precautions are taken. The Radiation Protection Manager has the authority to initiate and direct facility emergency procedures if required to protect personnel or the general public. The Radiation Protection Manager is also responsible for industrial safety at the PFSF.

9.1.2.2.3 Radiation Protection Technicians

The Radiation Protection Technicians are responsible for the actual monitoring of

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9.1.3.1.5 Mechanics

Mechanics shall hold a high school diploma or equivalent and a minimum of four years experience in mechanical maintenance. All mechanics shall become certified facility operators prior to operating cask handling equipment, and shall become licensed locomotive operators if a rail spur is developed to the site. One mechanic must become a certified welder to provide backup for the Lead Mechanic/Operator. Mechanics should possess a high degree of manual dexterity and the ability to learn and apply new skills in maintenance operations as they are developed and incorporated into facility operations.

9.1.3.1.6 Lead Instrument and Electrical Technician

At the time of appointment to the active position this person shall have a high school diploma or equivalent and a minimum of six years of experience in instrumentation and electrical work. This person should possess a two-year associate degree in the instrumentation, control and electrical field.

9.1.3.1.7 Instrument and Electrical Technicians

Technicians shall have a high school diploma or equivalent and a minimum of four years of working experience in this field. They should have minimum of one year of related technical training in addition to their experience.

9.1.3.1.8 Lead Quality Assurance Technician

This person shall have a high school diploma or equivalent and a minimum of six years experience within the nuclear power industry in a quality assurance position. This person should also have two years technical education in this area.

9.1.3.1.9 Quality Assurance Technician and Quality Assurance Auditor

The Quality Assurance Technicians shall have a high school diploma or equivalent and a minimum of four years experience in the quality assurance field within the nuclear power industry.

9.1.3.1.10 Lead Nuclear Engineer

This person shall have a minimum of a Bachelor degree in nuclear engineering and four years experience in the nuclear power industry.

9.1.3.1.11 Nuclear Engineers

This person shall have a Bachelor degree in Nuclear Engineering.

9.1.3.1.12 Security Captain

This person shall be a High School graduate, a qualified weapons instructor (NRA or equivalent), and have received supervisory skills training. Should have 6 years experience in security at least three of which must be at a nuclear facility.

9.1.3.1.13 Emergency Preparedness Coordinator

This person shall have a high school diploma or equivalent and a minimum of two years experience in emergency preparedness. This individual shall also have a minimum of four years of working experience in radiation protection. In addition, this person should have experience in providing training.

9.1.3.2 Personal Qualification Requirements

Each member of the site staff involved with important safety activities will be required to meet the minimum qualifications of the License. Programs for additional site familiarization training and ongoing training and retraining will be maintained to provide a continuously qualified staff. The training program as coordinated by the Emergency Preparedness Coordinator is under the overall direction of the General Manager/Chief Operating Officer.

9.1.4 Liaison with Outside Organizations

During the pre-licensing phase, most of the outside technical support for the PFSF engineering and licensing was employed through the A/E. Oversight was provided by a nuclear engineer on the Technical Committee. The outside organizations providing technical expertise on site selection were directed by the Project Manager; the Chairman of the Board monitored the interface.

The outside organizations supplying the cask storage systems are directed by the Technical Committee and the PFSLLC Project Manager. Their review is performed in accordance with the Quality Assurance Program and is audited by the Quality Assurance Committee.

During construction, the outside organization for installation and construction and the A/E are overseen by the PFSLLC Project Manager. The system to monitor the design includes Technical Committee review and Quality Assurance Committee audits as well as routine telephone conferences.

During the operational phase, the General Manager/Chief Operating Officer shall be responsible for day-to-day contacts with the U.S. Nuclear Regulatory Commission and other regulatory bodies. The authority to hire necessary consulting staff within the guidelines approved by the Board will rest with the General Manager/Chief Operating Officer after consulting the Board Chairman. The acquisition of outside consulting expertise or services will be done in full accordance with the standards outlined in the Quality Assurance Program. All work performed on SSCs that are Important-to-Safety, will be strictly governed by the Quality Assurance Program.

Oversight of the outside organizations which manufacture canisters is provided by the General Manager/Chief Operating Officer and the Nuclear Engineering staff, who will conduct oversight activities in accordance with the Quality Assurance Program. Fabrication of canisters to appropriate standards and storage, transfer and transportation technology is monitored by the nuclear engineering staff. The oversight of outside organizations is audited periodically by the Quality Assurance staff."

9.2 PREOPERATIONAL TESTING AND OPERATION

Prior to loading the PFSF with spent fuel canisters, preoperational, startup, and performance tests will be developed and implemented. The tests will verify the functional operation of structures, systems and components important to safety, including spent fuel shipping and receipt, canister transfer, onsite transport, and storage operations as well as the performance of the storage system components. The tests will verify that the PFSF shipping, transfer, onsite transport and storage systems operate safely and effectively. The results of the tests will be reported as a supplement to this section.

9.2.1 Administrative Procedures for Conducting Test Program

Test procedures will be developed for conducting the tests at the PFSF to ensure that structures, systems, and components satisfactorily perform their required functions. These test procedures will further ensure that the PFSF has been properly designed and constructed and is ready to operate in a manner that will not endanger the health and safety of the public.

The test procedures will include the elements in Section 9.4.1.2 and will detail the type of test, the response expected and the validation method for each component or system tested. Review and approval of test procedures by the responsible line manager is required before submission for final approval or ORC review (if required). Procedures involving structures, systems or components important to safety will be reviewed and approved by the site Operations Review Committee (ORC). Revisions necessitated by operational experience, changes to systems or components, new requirements, clerical errors, etc., will be reviewed and approved in the same manner as the original procedure. The test results will be documented by the individuals performing the test and will be reviewed and evaluated by the appropriate line organization. Test results for structures, systems and components important to safety will be approved by the ORC.

9.2.2 Preoperational Test Plan

The preoperational test plan will ensure that preoperational tests and dry runs are performed on all PFSF operations involving spent fuel prior to operation and that preoperational tests continue to be conducted on new structures, systems, and components that handle spent fuel to verify performance throughout the life of the facility.

The preoperational test plan will ensure that preoperational test procedures address all aspects of the PFSF, including testing specified in the technical specifications, construction testing, physical facilities testing and operatioal testing. The preoperational test plan will clearly define test objectives, methods for accomplishing the objectives, prerequisites for performing the tests, and acceptance criteria used to evaluate test results. The results of preoperational testing will be used to make necessary changes or modifications to equipment and procedures.

Preoperational tests will be performed in accordance with approved procedures, which will be developed and implemented in accordance with the QA Program described in Chapter 11. The QA Program meets the requirements of 10 CFR 72, Subpart G. Thus, the PFSF meets the general design criteria of 10 CFR 72.122(a), as it relates to testing.

9.2.2.1 Construction Testing

Construction testing will verify requirements for configuration, materials, performance, and quality for structures, systems and components important to safety at the PFSF.

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into document control system, no personnel concerns outstanding, operator aids posted, preoperational testing completed, equipment functional and calibrated.

- Training - Training procedures written and approved, all personnel trained to procedures as required, and training material revised to latest PFSF procedures and drawings.
- Radiological Controls - Radiation protection procedures written and approved, health physics personnel trained, radiation postings completed, and radiological monitoring equipment tested and operational.
- Security Controls - Security procedures written and approved, security personnel trained, security equipment tested and operational, and security drills to detect and assess intrusion performed.
- Maintenance and Surveillance - Maintenance and surveillance procedures written and approved, spare parts itentified and available on site, post-maintenance testing completed as required, surveillance inspections and testing completed or ready as required, and startup test plan actions completed.
- Organization and Management - Procedures affecting organization and management are written and approved, management available, fitness for duty requirements completed, staffing adequate, personnel trained and qualified, and security program and personnel in place.
- Fire Protection - Fire protection procedures written and approved, fire detection systems tested and operational, fire protection systems tested and operational including fire truck, fire pumps, and sprinkler systems, fire personnel trained and available, and fire drills performed and determined acceptable.

- Nuclear Safety - There exist no unresolved safety questions regarding the facility or facility operation. All criticality controls and fuel accountability controls will be approved and distributed in an appropriate procedural form. All procedures for the loading of fuel into canisters at the originating power plants will be ready and approved by the steps prescribed in the Quality Assurance Program."

The ORR team will consist of a team leader and safety and technical experts representing the areas of operations, engineering and technical support, maintenance and surveillance, and organization and management. The ORR team is expected to conduct internal meetings with the applicable organizations as required to ensure that all activites reviewed in the ORR are accomplished prior to operation. The ORR team will prepare and issue a report addressing the scope of the ORR and all conclusions, findings, and observations of each review item. The report will be signed off by the ORR Team Leader, PFSF General Manager, and other appropriate managers and made available to the NRC.

9.2.4 Operating Startup Plan

An operating startup plan will be initiated to prepare and implement procedures necessary for the initial arrival of spent fuel and operations to transfer the fuel to storage. The plan will identify specific actions unique to the initial spent fuel loading. The operating startup plan will include tests and reviews of the operating procedures, radiation exposure times and received doses, measured radiation levels of the casks and shielding methods, verification of heat removing features in accordance with the technical specifications, and notification to the NRC of the first loaded cask placed in storage.

The operating startup plan will be implemented for the initial loading of both the HI-STORM storage system and TranStor storage system. Upon completion of the plan, procedures, actions, and equipment will be evaluated for improved operations of subsequent spent fuel shipments.

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9.4.1.1.4 Operating Procedures

The operating procedures will provide instructions for all routine and projected contingency (off-normal) operations, including handling, loading, transporting, and storing of spent fuel, and for all other operations important to safety. Operating procedures will include chemical safety, off-normal occurrences, operation of the cask temperature monitoring system and all operations identified in the technical specifications. The requirements for certification of personnel operating equipment and controls important to safety will be specified in the operating procedures.

9.4.1.1.5 Quality Assurance Procedures

Quality assurance procedures will prescribe the necessary elements of quality oversight to ensure activities important to safety are conducted in a controlled manner, in accordance with 10 CFR 72.122 (a) and all applicable regulations, the PFSF license and technical specifications, the radiation protection program, and approved procedures. The quality assurance procedures will clearly communicate that the responsibility for quality rests with each individual, employee or visitor, who enters the facility.

9.4.1.2 Procedure Preparation

Procedures will be generated for all activities important to safety, and will include the following format and depth of coverage:

- Purpose and role in broader scope function
- Personnel required per shift by staff position and general function (e.g., function performance, QA, radiation monitoring)
- Continuous or single (or double) shift operation

- Prerequisites for readiness, such as
  - calibrations to be performed or checked
  - instrumentation to be on hand
  - tools and special equipment to be on hand
  - notifications (with lead times)
  - check/set equipment controls (e.g., physical travel limits for overhead crane)
  - check environmental or other monitors for acceptable range
  - identification of subject(s) of function (e.g., canister to be transferred, cask to be retrieved)
  - log and forms to be completed on hand
  - preceding function
- Series of operations, including results, projected times, projected instrument and gauge readings, controls to be used in performance (e.g., torque, time at pressure, and threshold limits requiring contingency actions (such as hold, initiating a contingency sequence, notification))
- Records to be completed during operation and distribution
- Record and notification upon Completion
- Identification of following function

9.4.1.3 Training On Procedures

All personnel involved in activities important to safety will be trained on the associated procedures prior to conducting the activity. Formal training of personnel on facility procedures will be substantially complete prior to the receipt of radioactive materials at the PFSF. Personnel performing activities important to safety will be certified to perform such functions and will undergo refresher training and testing a minimum of every two years.

9.4.2 Records

9.4.2.1 Records Management System

Records relating to the historical operation of the facility will be maintained by the Administrative organization, under the responsibility of the Administrative Assistant. Records will be stored in the Administration Building, with copies of records required to be maintained in duplicate, as noted below, maintained in the Security and Health Physics Building. Unless otherwise noted, records will be maintained until termination of the facility license by the NRC.

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9.5 EMERGENCY PLANNING

An Emergency Plan (EP) has been prepared for the PFSF with an outline and content that complies with the requirements of 10 CFR 72.32(a). The PFSF EP applies specifically to emergencies that could occur at the site.

All accidents and off-normal events evaluated in Chapter 8 of this SAR were considered in the planning basis for development of the PFSF EP. The planning basis includes credible events as well as hypothetical accidents whose occurrence is not considered credible, so as not to limit the scope of emergency planning. Evaluation of the consequences of credible and hypothetical accidents postulated to occur at the PFSF determined that releases of radioactivity would not require response by an off-site organization to protect persons beyond the boundary of the PFSF owner-controlled area. There is a single emergency classification level for events at the PFSF, the Alert classification, which is based on the worst case consequences of potential accidents which are postulated to occur at the PFSF.

Should an off-normal event or accident occur, the PFSF EP requires personnel stationed at the PFSF to notify appropriate emergency response personnel. The emergency response personnel are then responsible for classifying the event in accordance with classification procedures in the PFSF EP and notifying the NRC and local authorities, as stated in the PFSF EP. The emergency response personnel are also responsible for calling out personnel, as necessary, who assemble at the PFSF site to take actions to mitigate the consequences of the emergency, assess radiation and radioactivity levels in the vicinity of the PFSF, and return the PFSF to a safe and stable condition. The design of the PFSF provides for accessibility to equipment on-site and availability of off-site emergency facilities and services in accordance with 10 CFR 72.122(g). The Administration Building at the southeast corner of the PFSF site serves as the emergency response facility, from which emergency response actions are coordinated.

As detailed in the EP, should an emergency event occur, the General Manager (during normal working hours) or the Security Sergeant (at all other times) assumes the position of Emergency Response Leader. The Emergency Response Leader assumes responsibilities for declaring an Alert, as appropriate, and activation of the Emergency Response Organization (ERO), as well as communicating with on-site emergency response personnel and appraising them of the situation at the PFSF. The EP identifies responsibilities and staffing of the on-site ERO and for requesting off-site assistance. Members of the PFSF ERO will be trained on how to respond to various emergencies at the site, as established in the EP.

In order to expedite response to a fire, a fire pumper truck is stationed at the PFSF site, and members of the on-site fire brigade are trained in its operation. An additional fire truck is stationed at the Goshute Skull Valley Reservation and is available for use at the PFSF, if needed. An ambulance is also located at the PFSF to expedite the transport of any seriously injured individuals.

Off-site assistance may be requested as necessary from the Tooele Regional Medical Center, Tooele County Fire Department, and Tooele County Sheriff, all of which are located in Tooele, Utah. Other off-site assistance may be requested from industry or the NRC, as specified in the EP.

The Tooele County Emergency Operations Plan was consulted in the development of the PFSF EP, and meetings were held with PFSF personnel and Tooele County officials responsible for emergency response operations to discuss accidents that could possibly occur at the PFSF and gain input in the development of the PFSF EP. The EP

10.2 DEVELOPMENT OF OPERATING CONTROLS AND LIMITS

10.2.1 Functional and Operating Limits, Monitoring Instruments, and Limiting Control Settings

This section provides requirements for the controls or limits, which apply to operating variables classified as Important to Safety that are observable and measurable. The operating variables required for the safe operation of the PFSF are:

- Fuel characteristics
- Canisters authorized for use at the PFSF
- Maximum concrete storage cask lift height
- Temperature restrictions for lifting transfer casks
- Placement of concrete storage casks on the storage pads

The specifications for these operating variables are shown on the following pages.

10.2.1.1 Fuel Characteristics

Specification: The spent fuel selected for storage must comply with the specifications below and be independently verified and documented at the originating power plant prior to shipping. Documentation will be maintained at the PFSF identifying each cask, canister, and the fuel assemblies stored in the canister.

Type/Condition: PWR or BWR fuel assemblies listed in tables 3.1-1 and 3.1-2, including MOX fuel and failed fuel confined in approved containers within the canisters, as specified by the storage cask vendors. See section 12.3.1.4 of reference 1 for specifications for damaged BWR fuel.

Fuel Cladding: HI-STORM 100 System:

Zircaloy or Stainless Steel

TranStor Storage System:

Zircaloy or Stainless Steel

Initial Enrichment: HI-STORM 100 System:

PWR: See HI-STORM SAR Table 2.1.6 (Zircaloy) or Table 2.1.8 (stainless steel)

BWR: See HI-STORM SAR Table 2.1.6 (Zircaloy) or Table 2.1.8 (stainless steel)

TranStor Storage System:

PWR: See TranStor SAR Tables 12.2-2 and 12.2-3 (Reference 2).

BWR: See TranStor SAR Tables 12.2-4 and 12.2-5.

Burnup:	HI-STORM 100 System: See HI-STORM SAR Figure 2.1.6 (Zircaloy) or Table 2.1.8 (stainless steel) for the allowable burnup based on assembly cooling time. TranStor Storage System: PWR: See TranStor SAR Tables 12.2-2 and 12.2-3. BWR: See TranStor SAR Tables 12.2-4 and 12.2-5.
Cooling Time: (Post Irradiation)	HI-STORM 100 System: PWR: See HI-STORM SAR Table 2.1.6 (Zircaloy) and Table 2.1.8 (Stainless steel) BWR: See HI-STORM SAR Table 2.1.6 (Zircaloy) and Table 2.1.8 (Stainless steel) TranStor Storage System: ≥ 5 years - Cooling times for a given fuel assembly must be adequate to assure the decay heat of the assembly does not exceed the limits specified in the following paragraph. Representative minimum cooling times (for specified burnups) are provided in TranStor SAR Chapter 5, Table 5.1-1.
Decay Heat:	Decay heat is estimated based on DOE/RW-0184-R1, July, 1992 (or equivalent spent fuel database), using the characteristics of the spent fuel assemblies. HI-STORM 100 System: PWR: Zircaloy ≤ 1.177 kW per assembly (See Table 2.1.6 of HI-STORM SAR)

Stainless steel ≤ 0.662 kW per assembly (See Table 2.1.8 of HI-STORM SAR)

BWR: Zircaloy ≤ 0.3989 kW per assembly (See Table 2.1.6 of HI-STORM SAR)

Stainless steel ≤ 0.079 kW per assembly (See Table 2.1.8 of HI-STORM SAR)

TranStor Storage System:

PWR: ≤ 1.083 kW per assembly (See Table 12.2-1 of TranStor SAR)

BWR: ≤ 0.426 KW per assembly (See Table 12.2-1 of TranStor SAR)

Fuel Assembly Weights: (incl. Control components)	PWR: ≤ 1680 lb BWR: ≤ 700 lb

Applicability: All PWR and BWR spent fuel to be stored at the PFSF.

Objective: To ensure the maximum fuel cladding temperatures, cask dose rates, and criticality conditions are within the vendors' design values.

Action: Fuel not meeting this specification shall not be accepted at the PFSF.

Basis: This specification is based on the design criteria and associated SARs of the PFSF and storage systems (References 1 and 2). It assures that the design basis remain valid by defining the type/condition of the spent fuel and limits on maximum initial enrichment, irradiation history, minimum post irradiation cooling time, and maximum decay heat. These limits protect the integrity of the spent fuel and the storage systems by ensuring that the storage system thermal, shielding, and criticality analyses are valid for fuel stored at the PFSF.

The limits therefore assure that dose rates associated with the transfer and storage casks do not exceed those analyzed. The maximum fuel assembly weights ensure that structural condition assumptions in the vendors' SARs bound those of the actual fuel being stored.

10.2.1.2 Canisters Authorized for Use at the PFSF

Specification: Two types of canisters are authorized for use at the PFSF, the HI-STORM canister and the TranStor canister. Canister designs will accommodate PWR or BWR fuel, including MOX fuel and failed fuel. The canisters are sealed by welding, vacuum dried, backfilled and pressurized with helium, and leak tested at the originating nuclear power plant, prior to shipment to the PFSF. This limitation assures that only canisters that comply with requirements specified by the vendors of these two spent fuel storage systems are transported to the PFSF. A PFSF receipt inspection procedure will be utilized to verify that the as-received fuel and the storage canisters meet the PFSF technical specifications. This procedure will be part of the overall receipt inspection plan for incoming shipping casks and canisters and will be performed in addition to the security inspection and the survey for dose rates and surface contamination.

The purpose of the PFSF receipt inspection procedure will be to provide a list of specific documentation attributes which must be reviewed and verified, and provide a list of items that require visual inspection/verification at the PFSF to ensure the as-received fuel and the storage canisters meet the PFSF technical specifications. The receipt inspection procedure will contain a check list of specific attributes which must be reviewed and verified. The exact information required will be determined by the conditions imposed on the cask vendor Certificate of Compliance and the PFSF license/technical specifications. Receipt inspection forms will be provided with appropriate signature blocks for operations personnel to sign after verification of each attribute."

Canisters received at the PFSF shall meet the following requirements, as confirmed by documentation accompanying the canister shipments:

1. Only canisters designed and fabricated in compliance with vendor specifications for Holtec's HI-STORM spent fuel storage system and SNC's TranStor spent fuel storage system are authorized for use at the PFSF. The steel canisters shall be designed and fabricated in accordance with Section III of the ASME code, as specified by the vendors in their storage system SARs (References 1 and 2).

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10.2.1.5 Ambient Temperature Limits for Handling a Loaded HI-TRAC Transfer Cask

Specification: The loaded HI-TRAC cask shall not be handled in an environment where the ambient temperature is below 32° F, except as noted below under action item a, or above 100° F.

Applicability: All loaded HI-TRAC transfer casks.

Objective: To avoid the potential for brittle failure and damage resulting from freezing of the neutron water jacket and to avoid exceeding the upper ambient temperature used in the thermal analysis.

Action:

a. If the HI-TRAC transfer cask is exposed to an ambient temperature below 32° F, the neutron shield water jacket shall be drained and replaced with a 25 percent solution of ethylene glycol and demineralized water.

b. In the event that the ambient temperature is expected to reach or exceed 100° F, do not handle the loaded HI-TRAC.

c. In the event that the ambient temperature is expected to reach or go below 0° F, do not handle the loaded HI-TRAC.

Basis: The HI-TRAC thermal analysis is based on an upper ambient temperature of 100°F. Operating the HI-TRAC at or below 32°F may lead to freezing and subsequent damage to the neutron shield jacket. Handling the HI-TRAC below an ambient temperature of 0°F may present a risk of brittle fracture as discussed in the HI-STORM SAR (Reference 1), Chapter 12, Section 12.3.12.

10.2.1.6 Placement of Concrete Storage Casks on the Storage Pad

Specification: All loaded concrete storage casks shall be placed in a storage array with a minimum center-to-center spacing of 15 ft. The cask centerline shall also be a minimum of 7 ft, 6 in from any edge of the storage pad.

Applicability: All loaded concrete storage casks.

Objective: a. To ensure the storage casks thermal margins are not exceeded.
b. To ensure the cask remains on the pad and does not collide with another cask during a seismic event.

Action: The center-to-center and distance to edge of pad spacing shall be measured upon initial storage cask placement. After a seismic event of magnitude greater than 5.0 Richter at the PFSF, as determined by the National Earthquake Information Center, Golden, CO., verify spacing specified above. If required, restore center-to-center and distance to edge of pad spacing.

Basis: The thermal analysis for the storage cask system utilizes the above specified spacing. Additionally, seismic analysis shows that this spacing will prevent any storage cask impact during a seismic event.

10.2.2.3 Concrete Storage Cask Air Outlet Temperature-Initial Installation

Specification: The equilibrium air temperature, after initial installation, at the outlet of a loaded storage cask shall not exceed ambient by more than 125° F for the HI-STORM (Reference 1, Chapter 12, Section 12.3.17) storage cask and 100° F for the TranStor (Reference 2, Chapter 12, Section 12.2.1.2) storage cask.

Applicability: All storage casks loaded with spent fuel at the PFSF.

Objective: To ensure that the air vents are operable and that the temperatures of the fuel cladding, canisters, and the storage cask concrete do not exceed their specified limits.

Action: If the cask outlet temperature is greater than the values specified above, the first action is to check all inlet and outlet ducts for airflow blockage. If environmental factors are ruled out as the cause of the excessive air temperature, and if the correct fuel loading has been verified, then this condition is not addressed in the SAR and will require additional temperature measurements and/or analysis to justify acceptability of the actual cask performance.

Surveillance: TranStor Storage System:
To verify proper operation of the loaded storage cask, temperature measurements shall be conducted at intervals not to exceed 26 hours until the cask has reached equilibrium. The air temperature shall be the average of measurements at all four outlets.

HI-STORM System 100:

Temperature measurements shall be conducted at the intervals listed below:

1. Immediately following the installation of the lid.
2. 24 hours after the installation of the lid.
3. 7 days after installation of the lid.

Basis: The vendors' storage cask thermal analyses are described in their respective storage cask system SARs (References 1 and 2). These analyses ensure that the fuel cladding, canister, and cask concrete will be maintained at temperatures below material degradation levels.