NAC INTERNATIONAL

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May 23, 2017

U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

Attn: Document Control Desk

Subject: Submission of a Request to Amend the U.S. Nuclear Regulatory Commission Certificate of Compliance No. 1015 for the NAC-UMS® Cask System

Docket No. 72-1015

References:
1. U.S. Nuclear Regulatory Commission (NRC) Certificate of Compliance (CoC) No. 1015 for the NAC International Universal Storage System (UMS) Cask System, Amendment No. 5, January 12, 2009
2. NAC-UMS Cask System Final Safety Analysis Report (FSAR), Revision 11, NAC International, November 2016

NAC International (NAC) hereby submits a request to revise Reference 1, Appendix A and associated bases presented in Reference 2. The following summarizes the changes requested to Reference 1:

1. Reference 1, Section A 3.1.6, "CONCRETE CASK Heat Removal System"
   a. Revised Condition A and removed Required Action A.2 since it is a redundant requirement to what is already specified in Reference 1, Appendix B, and renumbered Required Action A.3
   b. Deleted unnecessary Surveillance Requirement (SR) 3.1.6.2 since it is bounded by the surveillance frequency presented in SR 3.1.6.1
2. Reference 1, Section A 3.2.2, "CONCRETE CASK Average Surface Dose Rates"
   a. Revised the "APPLICABILITY" section to state "Prior to..." in order to clarify that this is a one-time surveillance to be performed once the cask is in its final storage place
3. Reference 1, Section A 5.4, "Surveillance After an Off-Normal, Accident, or Natural Phenomena Event"
   a. Deleted unnecessary response surveillance since it is, in principle, covered by existing Limited Condition for Operations (LCO) surveillance requirements and frequencies
4. Reference 2, Chapter 12, page 12C3-19, LCO Bases 3.1.6 was revised to provide additional guidance for the intent of "immediate" actions (i.e., in the context of restoring the heat removal capabilities of the concrete cask).
5. Reference 2, Chapters 1, 8, 9, 11, and 12 have been revised to remove references to the deleted SR 3.1.6.2 or Section A5.4, as necessary.

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NMSS

ED20170041

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Consistent with NAC administrative practice, this proposed FSAR revision is numbered to uniquely identify the applicable changed pages. Revision bars mark the FSAR text changes on the Revision 17A pages. The included List of Effective Pages identifies the revision level of all pages in the Reference 2 FSAR with Revision 17A pages.

In order to better facilitate the review process, NAC is providing the Revision 17A change pages with appropriate backing pages. In accordance with NAC's administrative practices, upon final acceptance of this application, the 17A changed pages will be reformatted and incorporated into the next revision of the NAC-UMS FSAR.

If you have any comments or questions, please contact me on my direct line at 678-328-1236.

Sincerely,

Wren Fowler
Director, Licensing
Engineering

Enclosures:

Enclosure 1 – Proposed Changes for the NAC-UMS Technical Specifications, Amendment 6
Enclosure 2 – List of FSAR Changes for the NAC-UMS FSAR, Amendment 6
Enclosure 3 – FSAR Changed Pages and LOEP for NAC-UMS FSAR, Amendment 6

May 2017

Revision 17A

NAC-UMS

Universal MPC System

SAFETY ANALYSIS REPORT

Maine Yankee Enhancements
Amendment 6 Initial Application

Docket No. 72-1015

NAC INTERNATIONAL

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Enclosure 1

Proposed Changes for the NAC-UMS Technical Specifications Amendment 6 (Docket No 72-1015)

NAC International

May 2017

APPENDIX A

TECHNICAL SPECIFICATIONS
FOR THE NAC-UMS® SYSTEM

AMENDMENT 6

LIST OF EFFECTIVE PAGES

Appendix A

Table of Contents

A 3.1 NAC-UMS® SYSTEM

A 3.1.6 CONCRETE CASK Heat Removal System

LCO 3.1.6 The CONCRETE CASK Heat Removal System shall be OPERABLE.

APPLICABILITY: During STORAGE OPERATIONS

ACTIONS

------------------------------------NOTE------------------------------------

Separate Condition entry is allowed for each NAC-UMS® SYSTEM.

CONDITION	REQUIRED ACTION		COMPLETION TIME
A. CONCRETE CASK heat removal system inoperable	A.1	Ensure adequate heat removal to prevent exceeding short-term temperature limits	Immediately
	AND		
	A.2	Restore CONCRETE CASK Heat Removal System to OPERABLE status	25 days
B. Required Actions A.1 or A.2 and associated Completion Times not met	B.1	Perform an engineering evaluation to determine that the CONCRETE CASK Heat Removal System is OPERABLE	5 days
		OR	
	B.2	Place the NAC-UMS SYSTEM in a safe condition	5 days

(continued)

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.6.1	Verify the difference between the ISFSI ambient temperature and the average outlet air temperature is ≤ 102°F for the PWR canister or ≤ 92°F for the BWR canister OR Visually verify all four air inlet and outlet screens are unobstructed	24 hours 24 hours
SR 3.1.6.2	[DELETED]	[DELETED]

A 3.2 NAC-UMS® SYSTEM Radiation Protection

A 3.2.2 CONCRETE CASK Average Surface Dose Rates

LCO 3.2.2 The average surface dose rates of each CONCRETE CASK shall not exceed the following limits unless required ACTIONS A.1 and A.2 are met.

a. 50 mrem/hour (neutron + gamma) on the side (on the concrete surfaces);

b. 50 mrem/hour (neutron + gamma) on the top;

c. 100 mrem/hour (neutron + gamma) at air inlets and outlets.

APPLICABILITY: Prior to STORAGE OPERATIONS.

ACTIONS

-----NOTE-----

Separate Condition entry is allowed for each NAC-UMS® SYSTEM.

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. CONCRETE CASK average surface dose rate limits not met	A.1 Administratively verify correct fuel loading AND	24 hours

(continued)

PROPOSED

A 5.2 Pre-Operational Testing and Training Exercises (continued)

k. CONCRETE CASK shield plug and lid installation
l. Transport of the CONCRETE CASK to the ISFSI
m. CANISTER unloading, including reflooding and weld removal or cutting
n. CANISTER removal from the CONCRETE CASK

Appropriate mockup fixtures may be used to demonstrate and/or to qualify procedures, processes or personnel in welding, weld inspection, vacuum drying, helium backfilling, leak testing and weld removal or cutting.

A 5.3 Special Requirements for the First System Placed in Service

The heat transfer characteristics and performance of the NAC-UMS® SYSTEM will be recorded by air inlet and outlet temperature measurements of the first system placed in service with a heat load equal to or greater than 10 kW. A letter report summarizing the results of the measurements will be submitted to the NRC in accordance with 10 CFR 72.4 within 30 days of placing the loaded cask on the ISFSI pad. The report will include a comparison of the calculated temperatures of the NAC-UMS® SYSTEM heat load to the measured temperatures. A report is not required to be submitted for the NAC-UMS® SYSTEMs that are subsequently loaded, provided that the performance of the first system placed in service with a heat load ≥ 10 kW is demonstrated by the comparison of the calculated and measured temperatures.

A 5.4 [DELETED]

(continued)

Enclosure 2

List of Changes

for the

NAC-UMS FSAR
Amendment 6
Revision 17A
(Docket No 72-1015)

NAC International

May 2017

List of Changes for the NAC-UMS FSAR, Amendment 6, Revision 17A

Chapter/Page/ Figure/Table	Description of Change
Note: The List of Effective Pages and the Chapter Table of Contents, List of Figures and List of Tables have been revised accordingly to reflect the list of changes detailed below.	
Chapter 1	
Page 1.5-9	Deleted the reference to Section A 5.4 in the last paragraph in the Description of Change column
Chapters 2 through 7 – no changes	
Chapter 8	
Page 8.1.3-2	Revised Step 12 from SR 3.1.6.2 to SR 3.1.6.1
Chapter 9	
Page 9.2-1	Deleted the fourth paragraph in Section 9.2.1
Chapter 10 – no changes	
Chapter 11	
Page 11.2.4-12	Deleted the first sentence in section 11.2.4.4
Page 11.2.6-3	Deleted the first sentence of the second paragraph in section 11.2.6.4
Page 11.2.8-11	Deleted the first sentence in section 11.2.8.3
Page 11.2.8-12	Text flow
Page 11.2.9-5	Deleted the first sentence in section 11.2.9.3
Page 11.2.10-4	Deleted the first sentence in section 11.2.10.4
Page 11.2.11-13	Deleted the first sentence in section 11.2.11.4
Page 11.2.12-71	Deleted the first sentence in section 11.2.12.5
Page 11.2.13-2	Deleted the first sentence in section 11.2.13.4
Chapter 12	
Page 12C3-29	Deleted "(typically, one operating shift)" from the second paragraph of Actions, A.1.
Page 12C3-30	Deleted Required Action A2; renumbered Required Action A3 to A2; modified text to reflect deletion of Required Action A2
Page 12C3-31	Deleted Surveillance Requirement SR 3.1.6.2
Page 12C3-35	Revised text in "APPLICABILITY SAFETY ANALYSIS"
Page 12C3-36	Revised text in "APPLICABILITY"
Page 12C3-37	Added "ACTIONS (continued)" to reflect text flow
Chapter 13 – no changes	

Enclosure 3

FSAR Changed Pages
NAC-UMS
Amendment 6
(Docket No 72-1015)

NAC International

May 2017

May 2017

Revision 17A

NAC-UMS

Universal MPC System

FINAL SAFETY ANALYSIS REPORT

for the UMS Universal Storage System

Docket No. 72-1015

NAC INTERNATIONAL

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List of Effective Pages

Chapter 1

Chapter 2

List of Effective Pages (continued)

Chapter 3

List of Effective Pages (continued)

Chapter 4

List of Effective Pages (continued)

List of Effective Pages (continued)

List of Effective Pages (continued)

Chapter 11

List of Effective Pages (continued)

Chapter 12

Chapter 13

Table 1.5-1 NUREG-1536 Compliance Matrix (continued)

Chapter 2 – Principal Design Criteria			
Area	**Requirement**	**Acceptance Criteria**	**Description of Compliance**
3. Design Criteria for Safety Protection Systems **d. Shielding/Confinement/ Radiation Protection**	The proposed DCSS design must provide radiation shielding and confinement features that are sufficient to meet the requirements of 10 CFR 72.104 and 72.106. [10 CFR 72.126(a), 72.128(a)(2), 72.128(a)(3), and 72.236(d)]	The applicant should describe those features of the cask that protect occupational workers and members of the public against direct radiation dosages and releases of radioactive material, and minimize the dose after any off-normal or accident conditions.	The confinement design features are described in Section 2.3.2.1, while the radiation shielding design features are described in Section 2.3.5.
	During normal operations and other anticipated occurrences, the annual dose equivalent to any real individual who is located beyond the controlled area must not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ as a result of exposure to (1) planned discharges to the general environment of radioactive materials except radon and its decay products, (2) direct radiation from operations of the ISFSI or monitored retrievable storage (MRS), and (3) any other radiation from uranium fuel cycle operations within the region. [10 CFR 72.24(d), 72.104(a), and 72.236(d)]		Section 10.4 presents the necessary minimum site boundary distances from an array of loaded storage systems to meet the controlled area dose limits.
	Any individual located at or beyond the nearest boundary of the controlled area shall not receive a dose greater than 5 rem to the whole body or any organ from any design-basis accident. The minimum distance from the spent fuel handling and storage facilities to the nearest boundary of the controlled area shall be 100 meters. [10 CFR 72.24(d), 72.24(m), 72.106(b), and 36(d)]		As stated in Section 10.2.2, there is no postulated accident condition that would result in a release of radioactive materials. Therefore, the accident dose limit is met.
	The DCSS must be designed to provide redundant sealing of confinement systems. [10 CFR 72.236(e)]		The redundant sealing features of the confinement system are presented in Section 2.3.2.1.
	Storage confinement systems must have the capability for continuous monitoring in a manner such that the licensee will be able to determine when corrective action needs to be taken to maintain safe storage conditions. [10 CFR 72.122(h)(4) and 72.128(a)(1)]		As described in Section 2.3.1, the system is fully welded and can operate through all postulated normal, off-normal, and accident events while confining of the stored radioactive material. Therefore, continuous monitoring is not required.
	The DCSS design must include inspections, instrumentation and/or control (I&C) systems to monitor the SSC that are important to safety over anticipated ranges for normal and off-normal operation. In addition, the applicant must identify those control systems that must remain operational under accident conditions. [10 CFR 72.122(i)]		Appendix A, Section A 3.1.6, specifies the surveillance requirements for the system. These activities are specified to ensure that the system is operated within its design parameters at all times.

Table 1.5-1 NUREG-1536 Compliance Matrix (continued)

Chapter 2 – Principal Design Criteria			
Area	**Requirement**	**Acceptance Criteria**	**Description of Compliance**
3. Design Criteria for Safety Protection Systems **e. Criticality**	Spent fuel transfer and storage systems must be designed to remain subcritical under all credible conditions. [10 CFR 72.124(a) and 72.236(c)] When practicable, the DCSS must be designed on the basis of favorable geometry, permanently fixed neutron-absorbing materials (poisons), or both. Where solid neutron-absorbing materials are used, the design shall allow for positive means to verify their continued efficacy. [10 CFR 72.124(b)]	The SAR should address the mechanisms and design features that enable the DCSS to maintain spent fuel in a subcritical condition under normal, off-normal, and accident conditions.	The criticality safety design criteria for the system are presented in Section 2.3.4.

8.1.3 Transport and Placement of the Vertical Concrete Cask

This procedure assumes that the loaded vertical concrete cask is positioned on a heavy-haul transporter and is to be positioned on the ISFSI pad using the air pad set. Alternately, the concrete cask may be lifted and moved using a mobile lifting frame. The mobile lifting frame lifts the cask using four lifting lugs at the top of the concrete cask. The lifting frame may be self-propelled or towed, and does not use the air pad set. Caution shall be observed when lifting the concrete cask using the two pairs of lifting lugs to minimize possible uneven loading on the base of the concrete cask. For lifting devices provided with load measuring equipment, the load on each lug set should be evenly maintained, but in no case shall an uneven load exceed 25,000 pounds between lug sets.

The vertical concrete cask lift height limit is 24 inches when the cask is moved using the air pad set or the mobile lifting frame in accordance with the requirements of Section A5.6(c) and Table A5-1 of Appendix A of the CoC Number 1015 Technical Specifications. Because of lift fixture configuration, the maximum lift height of the concrete cask using the jacking arrangement is approximately 4 inches.

The concrete cask surface dose rates must be verified in accordance with the requirements of LCO 3.2.2. These measurements may be made prior to movement of the cask, at a location along the transport path, or at the ISFSI. An optional supplemental shielding fixture, shown in Drawing 790-613, may be installed in the concrete cask air inlets to reduce the radiation dose rate at the inlets.

1. Using a suitable towing vehicle, tow the heavy-haul transporter to the dry storage pad (ISFSI). Verify that the bed of the transporter is approximately at the same height as the pad surface. Install four (4) hydraulic jacks at the four (4) designated jacking points at the air inlets in the bottom of the vertical concrete cask.
2. Raise the concrete cask approximately 4 inches using the hydraulic jacks.

   Caution: Do not exceed a maximum lift height of 24 inches, in accordance with the requirements of Administrative Control A5.6(a).
3. Move the air-bearing rig set under the cask.
4. Inflate the air-bearing rig set. Remove the four (4) hydraulic jacks.
5. Using a suitable towing vehicle, move the concrete cask from the bed of the transporter to the designated location on the storage pad.

   Note: Spacing between concrete casks must not be less than 15 feet (center-to-center).
6. Turn off the air-bearing rig set, allowing it to deflate.

7. Reinstall the four (4) hydraulic jacks and raise the concrete cask approximately 4 inches. Caution: Do not exceed a maximum lift height of 24 inches, in accordance with the requirements of Administrative Control A5.6(a).
8. Remove the air-bearing rig set pads. Ensure that the surface of the dry storage pad under the concrete cask is free of foreign objects.
9. Lower the concrete cask to the surface and remove the four (4) hydraulic jacks.
10. Install the screens in the inlets and outlets.
11. Scribe/stamp concrete cask nameplate to indicate loading information.
12. Verify concrete cask operability in accordance with SR 3.1.6.1 of LCO A 3.1.6.
13. Verify continued concrete cask thermal operability in accordance with SR 3.1.6.1 of LCO A 3.1.6.

9.2 Maintenance Program

This section presents the maintenance requirements for the UMS® Universal Storage System and for the transfer cask.

9.2.1 UMS® Storage System Maintenance

The UMS® Universal Storage System is a passive system. No active components or systems are incorporated in the design. Consequently, only a minimal amount of maintenance is required over its lifetime.

The UMS® Universal Storage System has no valves, gaskets, rupture discs, seals, or accessible penetrations. Consequently, there is no maintenance associated with these types of features.

The routine thermal performance surveillance requirements for a loaded UMS® System are described in the Technical Specifications of Appendix A, Limiting Condition for Operation (LCO) 3.1.6.

Following the initial temperature measurements, the continuing operability of the concrete cask is verified on a 24-hour frequency by completion of SR 3.1.6.1, which allows verification by visual inspection of the inlet and outlet vents for blockage, or verification by measurement of the air temperature difference between ambient and outlet average. If the operable status of the concrete cask is reduced, the concrete cask will be returned to an operable status or placed in a safe condition as specified in the LCO.

In the event of any off-normal, accident or natural phenomena event, which could lead to the blockage of the concrete cask's inlets and outlets, full vent blockage shall be removed within 24 hours, and any partial blockage shall be corrected to restore the cask to operable status in accordance with LCO 3.1.6.

Annually or on a frequency established by the User based on the environmental conditions at the ISFSI (i.e., higher inspection frequency may be appropriate at ISFSIs exposed to marine environments, lower frequency for sites located in dry environments, etc.), a program of visual inspections and maintenance of the loaded UMS® systems in service shall be implemented. The Vertical Concrete Cask(s) shall be inspected as described herein.

- Visually inspect exterior concrete surfaces for chipping, spalling or other defects. Minor surface defects (i.e., approximately one cubic inch) shall be repaired by cleaning and grouting of the area in accordance with the grout manufacturer's recommendations.
- Visually inspect accessible exterior coated carbon steel surfaces including lifting lug assemblies, if installed, for loss of coating, corrosion or other damage. The maintenance and repair of corroded surfaces, or surfaces missing coating materials, shall be done by cleaning the areas and reapplying corrosion-inhibiting coatings in accordance with the coating manufacturer's recommendations. The licensee shall identify, evaluate and select acceptable coatings for use in routine maintenance of concrete cask external carbon steel surfaces.
- Visually inspect lid bolts for presence of corrosion. Excessively corroded or missing bolting shall be replaced with approved spare parts.
- Visually inspect the attachment hardware and the integrity of the inlet and outlet screens. Damaged or missing components shall be repaired or replaced with approved spare parts.
- Significant damage or defects identified during the visual inspections that exceed routine maintenance shall be processed as nonconforming items.

The schedule, results and corrective actions taken during the UMS® system inspection and maintenance program shall be documented and retained as part of the system maintenance program.

9.2.2 Transfer Cask Maintenance

The transfer cask trunnions and shield door assemblies shall be visually inspected for gross damage and proper function prior to each use.

Annually (or a period not exceeding 14 months), an inspection and testing program shall be performed on the transfer cask in accordance with the requirements of ANSI N14.6 [8]. The following actions or alternatives shall be performed:

- Visually inspect the lifting trunnions, shield doors and shield door rails for permanent deformation and cracking. Carbon steel-coated surfaces will be inspected for chipped, cracked or missing areas of coating, and repaired by reapplication of the approved coating(s) in accordance with the coating manufacturer's recommendations.
- In addition, one of the following testing/inspection methods shall be completed.

The temperatures used bound the analysis locations for all storage conditions. The actual temperatures at these locations for storage for the BWR spacer at the bottom weldment are 118°F (minimum bottom weldment temperature), and 329°F (minimum temperature of 10^{th} support disk) for the split spacer. The 10^{th} support disk is counted from bottom weldment.

Fuel Tube Analysis

During the postulated 24-inch end drop of the concrete cask, fuel assemblies are supported by the canister bottom plate. The fuel assembly weight is not carried by the fuel tubes in the end drop. Therefore, evaluation of the fuel tube is performed considering the weight of the fuel tube, the canister deceleration and the minimum fuel tube cross-section. The minimum cross-section is located at the contact point of the fuel tube with the basket bottom weldment. The PWR fuel tube analysis is bounding because its weight (153 pounds/tube) is approximately twice that of the BWR fuel tube (83 pounds/tube). The minimum cross-section area of the PWR fuel tube is:

$$A = \text{(thickness)(mean perimeter)}$$

$$A = (0.048 \text{ in.})(8.80 \text{ in.} + 0.048 \text{ in.})(4) = 1.69 \text{ in}^2$$

The maximum compressive and bearing stress in the fuel tube is:

$$S_b = \frac{(60g)(153 \text{ lbs})}{1.69 \text{ in}^2} = 5{,}432 \text{ psi}$$

The Type 304 stainless steel yield strength is 17,300 psi at a conservatively high temperature of 750°F. The margin of safety is:

$$MS = \frac{S_y}{S_b} - 1 = \frac{17{,}300 \text{ psi}}{5{,}432 \text{ psi}} - 1 = +2.18 \text{ at } 750°F$$

Summary of Results

Evaluation of the UMS cask and canister during a 24-inch drop accident shows that the resulting maximum acceleration of the canister is 57.4g. The acceleration determined for the canister during the 24-inch drop is less than its design allowable g-load and, therefore, is considered bounded. This accident condition does not lead to a reduction in the cask's shielding effectiveness. The base weldment, which includes the air inlets, is crushed approximately 1-inch as the result of the 24-inch drop. The effect of the reduction of the inlet area by the drop is to reduce cooling airflow. This

condition is bounded by the consequences of the loss of one-half of the air inlets evaluated in Section 11.1.2.

11.2.4.4 Corrective Actions

Corrective actions shall be taken in accordance with the surveillance requirements to return the affected system to a safe operating condition, as applicable to the affected component(s).

11.2.4.5 Radiological Impact

There are no radiological consequences for this accident.

which shows that the component temperatures are below the allowable temperatures. The limited duration of the fire and the large thermal capacitance of the concrete cask restricted the temperatures above 244°F to a region less than 3 inches above the top surface of the air inlets. The maximum bulk concrete temperature is 138°F during and after the fire accident. This corresponds to an increase of less than 3°F compared to the bulk concrete temperature for normal condition of storage. These results confirm that the operation of the concrete cask is not adversely affected during and after the fire accident condition.

11.2.6.4 Corrective Actions

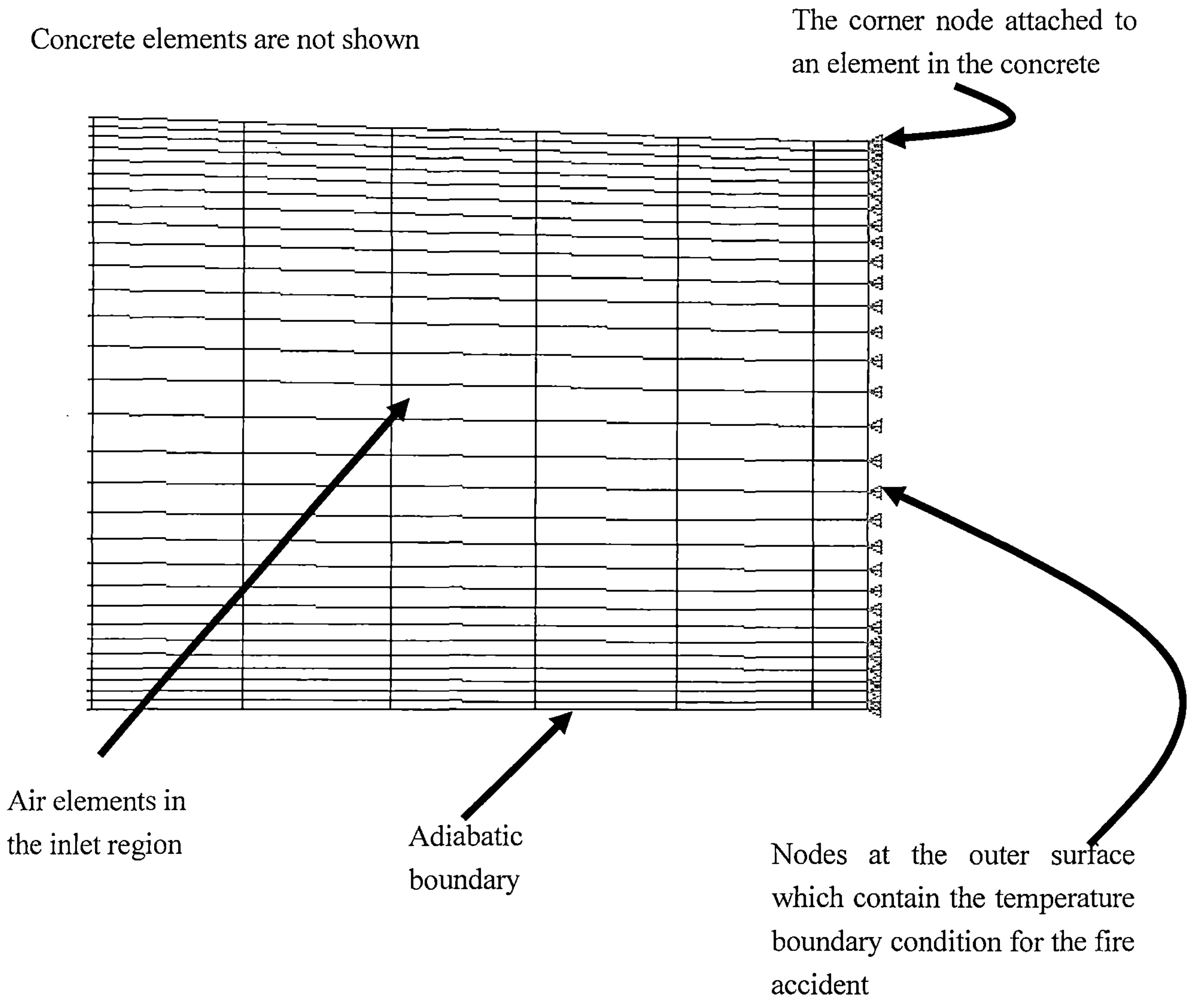
Immediately upon detection of the fire, appropriate actions should be taken by site personnel to extinguish the fire. The concrete cask should then be inspected for general deterioration of the concrete, loss of shielding (spalling of concrete), exposed reinforcing bar, and surface discoloration that could affect heat rejection. This inspection will be the basis for the determination of any repair activities necessary to return the concrete cask to its design basis configuration.

Corrective actions shall be taken in accordance with the surveillance requirements to return the affected system to a safe operating condition, as applicable to the affected component(s).

11.2.6.5 Radiological Impact

There are no significant radiological consequences for this accident. There may be local spalling of concrete during the fire event, which could lead to some minor reduction in shielding effectiveness. The principal effect would be local increases in radiation dose rate on the cask surface.

Figure 11.2.6-1 Temperature Boundary Condition Applied to the Nodes of the Inlet for the Fire Accident Condition



The D_f is computed by incrementing β from zero until the kinetic energy equals the crush energy. For the PWR and the BWR, velocities of 68 in/sec and 50 in/sec are computed, respectively. These result in the following accelerations and crush depths using the weights and heights of the five classes of the vertical concrete cask.

Vertical Concrete Cask Acceleration/Crush Summary

	Class 1	Class 2	Class 3	Class 4	Class 5
VCC Side Impact Acceleration (g)	32.5	32.6	32.7	26.3	26.3
Design Basis Tip-over Acceleration (A_d) in (g)	40	40	40	30	30
Dynamic Load Factor (DLF) for the Tip-over Evaluation	1.19	1.11	1.2	1.05	1.04
A_d/DLF	33.6	36.0	33.3	28.6	28.8
Crush (in)	.3	.3	.3	.2	.2

As indicated in the preceding table, the accelerations resulting from the impact are less than the factored accelerations (A_d/DLF) of the basket used in the PWR and BWR basket and canister evaluations. Therefore, the stresses and displacements of the basket and canister resulting from the tip-over evaluation bound the stresses and displacements resulting from a side impact of two vertical concrete casks.

While the 15-foot center-to-center cask spacing was evaluated in the criticality analysis documented in Chapter 6, the calculations in Chapter 6, combined with minimal cask surface neutron fluxes shown in Chapter 5, clearly demonstrate that there is no neutronic interaction between casks in the array. Therefore, variations in cask spacing as a result of cask movement (including cask-to-cask contact) during abnormal/accident conditions will have no effect on system reactivity.

11.2.8.3 Corrective Actions

Corrective actions shall be taken in accordance with the surveillance requirements to return the affected system to a safe operating condition, as applicable to the affected component(s). Concrete casks shall be restored to operable status in accordance with LCO A 3.1.6 of the Technical Specifications. Optional temperature-monitoring equipment, if used, should be verified as operable, or repaired and returned to service. As sliding may occur, the positions of the concrete casks should be verified or the casks shall be repositioned to ensure they maintain the 15-foot center-to-center spacing on the ISFSI pad established in Section 8.1.3.

11.2.8.4 Radiological Impact

Minor radiological consequences may result if the concrete casks are required to be repositioned on the ISFSI pad.

Maximum stresses at the base surface:

$\sigma_v = M / S_{outer} \approx 20$ psi (tension or compression)

The compressive stresses are included in load combination No. 7 in Table 3.4.4.2–1. As shown in Table 3.4.4.2–1, the maximum combined stresses for the load combination due to dead, live, thermal and flood loading, are less than the allowable stress.

11.2.9.3 Corrective Actions

Corrective actions shall be taken in accordance with the surveillance requirements to return the affected system to a safe operating condition, as applicable to the affected component(s). Concrete casks shall be restored to operable status in accordance with LCO A 3.1.6 of the Technical Specifications. Optional temperature-monitoring equipment, if used, should be verified as operable, or repaired and returned to service.

11.2.9.4 Radiological Impact

There are no dose consequences associated with the design basis flood event.

Table 11.2.9-1 Canister Increased External Pressure (22 psi) with No Internal Pressure (0 psi) Primary Membrane (P_m) Stresses (ksi)

Section No. [1]	Sx	Sy	Sz	Sxy	Syz	Sxz	Stress Intensity	Stress Allowable[2]	Margin of Safety
1	-0.17	-0.86	-2.17	0.06	0.03	0.31	2.10	40.08	18.1
2	-1.46	1.76	1.37	-0.24	0.03	0.30	3.29	40.08	11.2
3	0.24	2.71	-0.64	-0.23	-0.05	-0.61	3.69	40.08	9.9
4	-0.02	-1.18	-0.60	0.10	0.00	0.00	1.18	38.77	31.8
5	-0.02	-1.17	-0.60	0.10	0.00	0.00	1.17	35.86	29.7
6	-0.02	-1.17	-0.60	0.10	0.00	0.00	1.17	35.55	29.4
7	-0.02	-1.17	-0.60	0.10	0.00	0.00	1.17	38.23	31.7
8	-0.01	-1.13	-0.54	0.10	0.00	0.00	1.13	40.08	34.3
9	-0.28	-0.34	-0.16	0.02	-0.01	-0.12	0.27	40.08	145.6
10	0.32	-0.13	-0.08	0.03	-0.01	-0.07	0.46	40.08	85.5
11	-0.27	-0.13	0.09	-0.01	-0.01	-0.06	0.37	40.08	106.1
12	0.07	-0.23	-0.17	0.03	-0.01	0.02	0.32	40.08	125.6
13	0.06	-0.16	-0.30	0.02	-0.01	-0.06	0.38	40.08	103.4
14	-0.38	-0.38	-0.01	0.00	-0.16	0.02	0.49	40.08	81.5
15	0.02	0.02	-0.01	0.00	0.00	0.00	0.03	40.08	1235.3
16	-0.03	-0.03	-0.02	0.00	0.00	0.00	0.02	40.08	2524.5

(1) See Figure 3.4.4.1-4 for definition of locations of stress sections.

(2) ASME Service Level D is used for material allowable stress.

The pulse is represented conservatively as a half sine form, so that the equivalent $f = 1/2\tau$, where τ is the referenced pulse duration. Two skin depths, corresponding to different pulse duration, are computed. The larger effective frequency will result in a smaller effective area to conduct the current. The effective resistance is computed as:

$$R = \frac{\rho\, l}{a}$$

where:

R	= resistance (ohms)
ρ	= resistivity = 9.78×10^{-8} (ohm-m)
l	= length of conductor path
a	= area of conductor (m^2)

Using the current level of the pulse and the duration in conjunction with the carbon steel liner, the resulting energy into the shell is computed using Equation 11.2.10.1.

This thermal energy dissipation is conservatively assumed to occur in the localized volume of the carbon steel involved in the current flow path through the flange to the inner liner. Assuming no heat loss or thermal diffusion beyond the current flow boundary, the maximum temperature increase in the flange due to this thermal energy dissipation is calculated [28] as:

$$\Delta T = \frac{Q}{mc}$$

where:

ΔT	= temperature change (°F)
Q	= thermal energy (BTU)
C	= 0.113 Btu/lbs °F
m	= mass (lbm)

The ΔT_1 for the peak current (250KA, 260 µsec) is found to be 4.7°F.

The ΔT_2 for the continuous current (2 kA, 2 sec) is found to be negligible (0.0006°F).

The ΔT_1 corresponds to the increase in the maximum temperature of the steel within the current path. For the concrete to experience an increase in temperature, the heat must disperse from the steel surface throughout the steel. Using the total thickness of the steel, over the 90-degree section, the increase in temperature would be proportional to the volume of steel in this sector resulting in a temperature rise of less than 1°F.

Therefore the increase in concrete temperature attributed to Joulean heating is not significant.

11.2.10.4 Corrective Actions

Corrective actions shall be taken in accordance with the surveillance requirements to return the affected system to a safe operating condition, as applicable to the affected component(s).

11.2.10.5 Radiological Impact

There are no dose implications due to the lightning event.

Tornado Effects on the Canister

The postulated tornado wind loading and missile impacts are not capable of overturning the cask, or penetrating the boundary established by the concrete cask. Consequently, there is no effect on the canister. Stresses resulting from the tornado-induced decreased external pressure are bounded by the stresses due to the accident internal pressure discussed in Section 11.2.1.

11.2.11.4 Corrective Actions

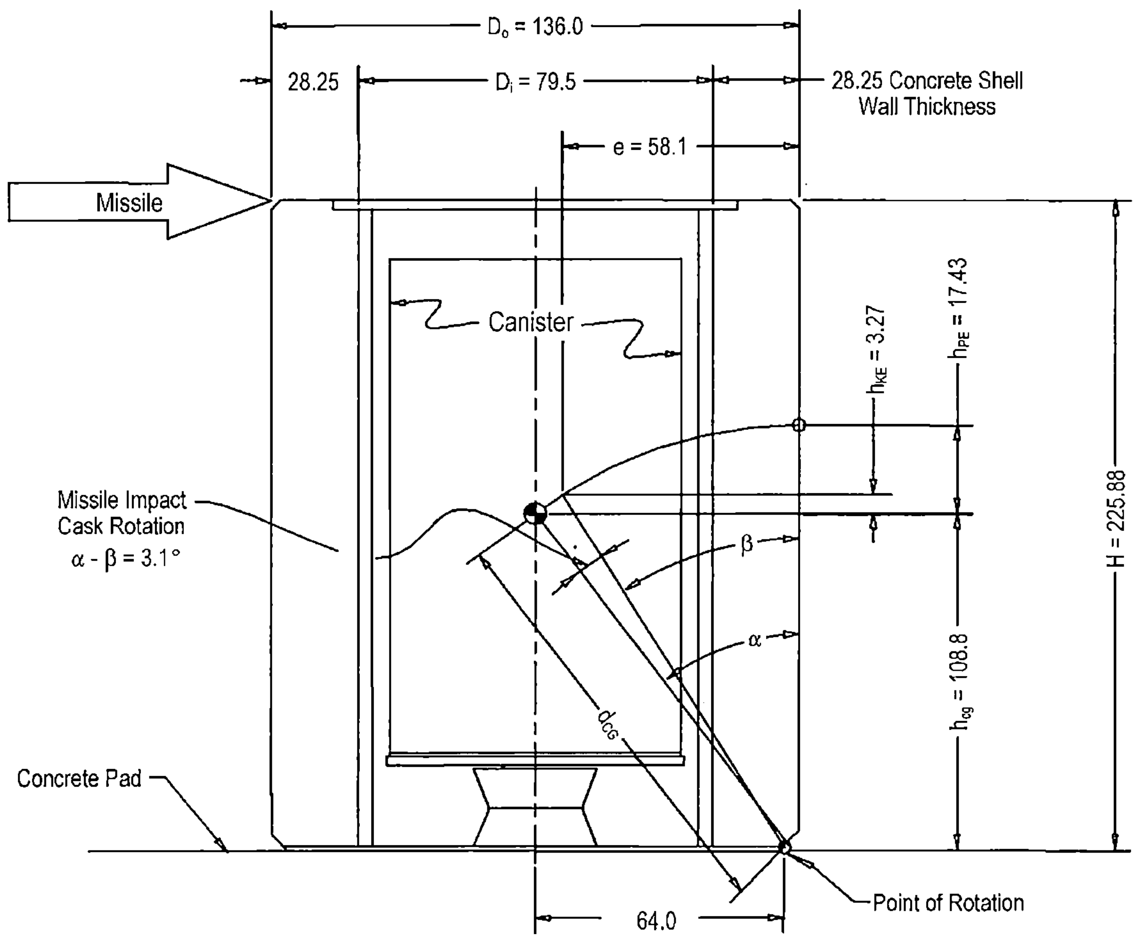
Corrective actions shall be taken in accordance with the surveillance requirements to return the affected system to a safe operating condition, as applicable to the affected component(s).

Concrete casks shall be restored to operable status in accordance with LCO A 3.1.6 of the Technical Specifications. Optional temperature-monitoring equipment, if used, should be verified as operable, or repaired and returned to service.

11.2.11.5 Radiological Impact

Damage to the vertical concrete cask after a design basis accident does not result in a radiation exposure at the controlled area boundary in excess of 5 rem to the whole body or any organ. The penetrating missile impact is estimated to reduce the concrete shielding thickness, locally at the point of impact, by approximately 6 inches. Localized cask surface dose rates for the removal of 6 inches of concrete are estimated to be less than 250 mrem/hr for the PWR and BWR configurations.

Figure 11.2.11-1 Principal Dimensions and Moment Arms Used in Tornado Evaluation



11.2.12.5 Corrective Actions

Corrective actions shall be taken in accordance with the surveillance requirements to return the affected system to a safe operating condition, as applicable to the affected component(s).

The most important recovery action required following a concrete cask tip-over is the uprighting of the cask to minimize the dose rate from the exposed bottom end. The uprighting operation will require a heavy lift capability and rigging expertise. The concrete cask must be returned to the vertical position by rotation around a convenient bottom edge, and by using a method and rigging that controls the rotation to the vertical position.

Surface and top and bottom edges of the concrete cask are expected to exhibit cracking and possibly loss of concrete down to the layer of reinforcing bar. If only minor damage occurs, the concrete may be repairable by using grout. Otherwise, it may be necessary to remove the canister for installation in a new concrete cask. If the canister remains in the cask, it should be returned to its centered storage position within the cask, in accordance with Section 8.1.2, Item 17, Note 1.

The storage pad, if damaged, must be repaired to preclude the intrusion of water that could cause further deterioration of the pad in freeze-thaw cycles.

11.2.12.6 Radiological Impact

There is an adverse radiological consequence in the hypothetical tip-over event since the bottom end of the concrete cask and the canister have significantly less shielding than the sides and tops of these same components. The dose rate at 1 meter is calculated, using a 1–D analysis, to be approximately 34 rem/hour, and the dose at 4 meters is estimated to be approximately 4 rem/hour. Consequently, following a tip-over event, supplemental shielding should be used until the concrete cask can be uprighted. Stringent access controls must be applied to ensure that personnel do not enter the area of radiation shine from the exposed bottom of the tipped-over concrete cask.

Damage to the edges or surface of the concrete cask may occur following a tip-over, which could result in marginally higher dose rates at the bottom edge or at surface cracks in the concrete. This increased dose rate is not expected to be significant, and would be dependent on the specific damage incurred.

11.2.13 Full Blockage of Vertical Concrete Cask Air Inlets and Outlets

This section evaluates the Vertical Concrete Cask for the steady state effects of full blockage of the air inlets and outlets at the normal ambient temperature (76°F). It estimates the duration of the event that results in the fuel cladding, the fuel basket and the concrete reaching their design basis limiting temperatures (See Table 4.1-3 for the allowable temperatures for short-term conditions).

The evaluation demonstrates that there are no adverse consequences due to this accident, provided that the full blockage of the concrete cask inlets and outlets is cleared within 24 hours.

11.2.13.1 Cause of Full Blockage

The likely cause of complete cask air inlet and outlet blockage is the covering of the cask with earth in a catastrophic event that is significantly greater than the design basis earthquake or a landslide. This event is a bounding accident and is not credible.

11.2.13.2 Detection of Full Blockage

Blockage of the cask air inlets and outlets will be visually detected during the general site inspection following an earthquake, land slide, or other events with a potential for such blockage. In addition, a daily surveillance of the concrete cask to verify operability limits the potential for a full blockage event to go undetected.

11.2.13.3 Analysis of Full Blockage

The accident temperature conditions are evaluated using the thermal models described in Section 4.4.1. The analysis assumes initial normal storage conditions, with the sudden loss of convective cooling of the canister. Heat is then rejected from the canister to the Vertical Concrete Cask liner by radiation and conduction. The loss of convective cooling results in the fairly rapid and sustained heat-up of the canister and the concrete cask. To account for the loss of convective cooling in the ANSYS air flow model (Section 4.4.1.1), the elements in the model are replaced with thermal conduction elements. This model is used to evaluate the thermal transient resulting from the postulated boundary conditions. The analysis indicates that the maximum basket temperature (support disk and heat transfer disk) remain less than the allowable temperature for 24 hours after the initiation of the event. The maximum fuel cladding temperature and the maximum concrete bulk temperature remain less than the allowable temperatures for about 6

days (150 hours) after the initiation of the event. The heat-up of the fuel cladding, canister shell and concrete (bulk temperature) is shown in Figures 11.2.13-1 and 11.2.13-2, for the PWR and BWR configurations, respectively.

11.2.13.4 Corrective Actions

Corrective actions shall be taken in accordance with the surveillance requirements to return the affected system to a safe operating condition, as applicable to the affected component(s).

Following any event that could cause blockage of the concrete cask inlets and outlets, concrete casks shall be restored to operable status in accordance with LCO A 3.1.6 of the Technical Specifications. Optional temperature-monitoring equipment, if used, should be verified as operable, or repaired and returned to service.

11.2.13.5 Radiological Impact

There are no significant radiological consequences for this event, as the Vertical Concrete Cask retains its shielding performance. Dose is incurred as a consequence of uncovering the concrete cask and vent system. Since the dose rates at the air inlets and outlets are higher than the nominal rate (35 mrem/hr) at the cask wall, personnel will be subject to an estimated maximum dose rate of 100 mrem/hr when clearing the inlets and outlets. If it is assumed that a worker kneeling with his hands on the inlets or outlets requires 15 minutes to clear each inlet or outlet, the estimated extremity dose is 200 mrem for the 8 openings. The whole body dose will be slightly less. In addition, some dose is incurred clearing debris away from the cask body. This dose is estimated at 50 mrem, assuming 2 hours is spent near the cask exterior surface.

LCO (continued)	Operability of the heat removal system ensures that the decay heat generated by the stored fuel assemblies is transferred to the environment at a sufficient rate to maintain fuel cladding and CANISTER component temperatures within design limits.
APPLICABILITY	The LCO is applicable during STORAGE OPERATIONS. Once a CONCRETE CASK containing a CANISTER loaded with spent fuel has been placed in storage, the heat removal system must be OPERABLE to ensure adequate heat transfer of the decay heat away from the fuel assemblies.
ACTIONS	A note has been added to ACTIONS that states for this LCO, separate Condition entry is allowed for each CONCRETE CASK. This is acceptable since the Required Actions for each Condition provide appropriate compensatory measures for each CONCRETE CASK not meeting the LCO. Subsequent CONCRETE CASKs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions. <u>A.1</u> If the CONCRETE CASK heat removal system has been determined to not be OPERABLE, it must be restored to an analyzed safe status immediately, with adequate heat removal capability. Immediately, defined as the required action to be pursued without delay and in a controlled manner, provides a reasonable period of time (i.e., within the design basis time limit as presented in Section 11.2.13 or within the time limit for a less than design basis heat load case, as evaluated) to take action to remove the obstructions in the air flow path. In order to meet A.1, adequate heat removal capability must be verified to exist, either by visual observation of at least two unobstructed air inlet and outlet screens or by physically clearing any blockage from two air inlet and outlet screens, to prevent exceeding the short-term temperature limits. Thermal analysis of a fully blocked CONCRETE CASK shows that without adequate heat removal, the fuel cladding accident temperature limit could be exceeded over time. As a result, requiring immediate verification of adequate heat removal capability will ensure that the CONCRETE CASK and CANISTER components and the fuel cladding do not exceed their short-term temperature limits. The thermal analysis also shows that complete blockage of two air inlet and outlet screens results in no potential for exceeding accident fuel cladding, CONCRETE CASK or CANISTER component temperature limits. As a result, verifying that there are at least two unobstructed

(continued)

ACTIONS (continued)

air inlet and outlet screens will ensure that the accident temperature limits are not exceeded during the time that the remainder of the air inlet and outlet screens are returned to OPERABLE status.

AND

A.2

In addition to Required Action A.1 that ensures adequate heat removal capability, restoring the CONCRETE CASK Heat Removal System to OPERABLE is not an immediate concern. Therefore, restoring it within 25 days is considered a reasonable period of time.

B.1

If Required Action A.1 or A.2 cannot be met, an engineering evaluation is performed to verify that the CONCRETE CASK heat removal system is OPERABLE.

The Completion Time for this Required Action of 5 days will ensure that the CANISTER remains in a safe, analyzed condition.

OR

B.2

Place the affected NAC-UMS SYSTEM in a safe condition.

The Completion Time for this Required Action is 5 days. Requiring B.2 action completion within 5 days will ensure that the NAC-UMS SYSTEM is maintained in a safe condition.

(continued)

SURVEILLANCE REQUIREMENTS	SR 3.1.6.1 The long-term integrity of the stored fuel is dependent on the ability of the CONCRETE CASK to reject heat from the CANISTER to the environment. Visual observation that all four air inlet and outlet screens are unobstructed and intact ensures that air flow past the CANISTER is occurring and heat transfer is taking place. However, partial blockage of less than two air inlet or outlet screens or the equivalent effective screen area does not result in the heat removal system being unable to provide adequate heat removal. Corrective actions should be taken promptly to remove the obstruction and restore full flow through the affected air inlet and outlet screens. Alternatively, based on the analyses, if the air temperature rise is less than the limits stated in the SR, adequate air flow and, therefore, adequate heat transfer is occurring to provide assurance of long-term fuel cladding integrity. The reference ambient temperature used to perform this Surveillance shall be measured at the ISFSI facility. The Frequency of 24 hours is reasonable based on the time necessary for CONCRETE CASK and CANISTER components to heat up to unacceptable temperatures assuming design basis heat loads, and allowing for corrective actions to take place upon discovery of the blockage of the air inlet and outlet screens. SR 3.1.6.2 [DELETED]
REFERENCES	1. FSAR Chapter 4 and Chapter 11, Section 11.1.2 and Section 11.2.13.

C 3.2 NAC-UMS® SYSTEM Radiation Protection

C 3.2.1 CANISTER Surface Contamination

BASES

BACKGROUND	A TRANSFER CASK containing an empty CANISTER is immersed in the spent fuel pool in order to load the spent fuel assemblies. The external surfaces of the CANISTER are maintained clean by the application of clean water to the annulus of the TRANSFER CASK. However, there is potential for the surface of the CANISTER to become contaminated with the radioactive material in the spent fuel pool water. Contamination exceeding LCO limits is removed prior to moving the CONCRETE CASK containing the CANISTER to the ISFSI in order to minimize the radioactive contamination to personnel or the environment. This allows the ISFSI to be entered without additional radiological controls to prevent the spread of contamination and reduces personnel dose due to the spread of loose contamination or airborne contamination. This is consistent with ALARA practices.
APPLICABLE SAFETY ANALYSIS	The radiation protection measures implemented at the ISFSI are based on the assumption that the exterior surfaces of the CANISTER are not significantly contaminated. Failure to decontaminate the surfaces of the CANISTER to below the LCO limits could lead to higher-than-projected occupational dose and potential site contamination.
LCO	Removable surface contamination on the exterior surfaces of the CANISTER is limited to 10,000 dpm/100 cm^2 from beta and gamma sources and 100 dpm/100 cm^2 from alpha sources. Only loose contamination is controlled, as fixed contamination will not result from the CANISTER loading process. Experience has shown that these limits are low enough to prevent the spread of contamination to clean areas and are significantly less than the levels that could cause significant personnel skin dose.

(continued)

C 3.2 NAC-UMS® SYSTEM Radiation Protection

C 3.2.2 CONCRETE CASK Average Surface Dose Rates

BASES

BACKGROUND	The regulations governing the operation of an ISFSI set limits on the control of occupational radiation exposure and radiation doses to the general public (Ref. 1). Occupational radiation exposure should be kept as low as reasonably achievable (ALARA) and within the limits of 10 CFR Part 20. Radiation doses to the public are limited for both normal and accident conditions in accordance with 10 CFR 72.
APPLICABLE SAFETY ANALYSIS	The CONCRETE CASK average surface dose rates are not an assumption in any accident analysis, but are used to ensure compliance with regulatory limits on occupational dose and dose to the public. FSAR Section 10.2.1 defines the maximum average surface dose rate limits as the design basis limits for normal storage conditions. As stated in FSAR Table 1.5-1, these limits maintain a reasonable dose level within a cask array for routine surveillance and inspection activities.
LCO	The limits on CONCRETE CASK average surface dose rates are based on the Safety Analysis Report shielding analysis of the NAC-UMS® SYSTEM (Ref. 2). The limits are selected to minimize radiation exposure to the public and to maintain occupational dose ALARA to personnel working in the vicinity of the NAC-UMS® SYSTEM. The LCO specifies sufficient locations for taking dose rate measurements to ensure the dose rates measured are indicative of the effectiveness of the shielding materials.

(continued)

APPLICABILITY

The CONCRETE CASK average surface dose rates apply during STORAGE OPERATIONS. These limits ensure that the CONCRETE CASK average surface dose rates during STORAGE OPERATIONS are bounded by the shielding safety analyses. This is established once for each cask by ensuring that the limits are met prior to STORAGE OPERATION in accordance with SR 3.2.2.1. Radiation doses during STORAGE OPERATIONS are monitored by the NAC-UMS® SYSTEM user in accordance with the plant-specific radiation protection program as required by 10 CFR 72.212(b)(6) and 10 CFR 20 (Reference 1).

ACTIONS

A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each loaded CONCRETE CASK. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each CONCRETE CASK not meeting the LCO. Subsequent NAC-UMS® SYSTEMs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1

If the CONCRETE CASK average surface dose rates are not within limits, it could be an indication that a fuel assembly that did not meet the Approved Contents Limits in Section B2.0 of Appendix B was inadvertently loaded into the CANISTER. Administrative verification of the CANISTER fuel loading, by means such as review of video recordings and records of the loaded fuel assembly serial numbers, can establish whether a misloaded fuel assembly is the cause of the out-of-limit condition. The Completion time is based on the time required to perform such a verification.

A.2

If the CONCRETE CASK average surface dose rates are not within limits and it is determined that the CONCRETE CASK was loaded with the correct fuel assemblies, an analysis may be performed. This analysis will determine if the CONCRETE CASK would result in the ISFSI offsite or occupational calculated doses exceeding regulatory limits in 10 CFR Part 72 or 10 CFR Part 20, respectively. If it is determined that the measured average surface dose rates do not result in the regulatory limits being exceeded, STORAGE OPERATIONS may continue.

(continued)

ACTIONS (continued)

B.1

If it is verified that the fuel was misloaded, or that the ISFSI offsite radiation protection requirements of 10 CFR Part 20 or 10 CFR Part 72 will not be met with the CONCRETE CASK average surface dose rates above the LCO limit, the fuel assemblies must be placed in a safe condition in the spent fuel pool. The Completion Time is reasonable, based on the time required to transport the CONCRETE CASK, transfer the CANISTER to the TRANSFER CASK, remove the structural lid and vent and drain port cover welds, perform fuel cooldown operations, cut the shield lid weld, move the TRANSFER CASK and CANISTER into the spent fuel pool, remove the shield lid, and remove the spent fuel assemblies in an orderly manner and without challenging personnel.

SURVEILLANCE REQUIREMENTS

SR 3.2.2.1

This SR ensures that the CONCRETE CASK average surface dose rates are within the LCO limits after transfer of the CANISTER into the CONCRETE CASK and prior to the beginning of STORAGE OPERATIONS. This Frequency is acceptable as corrective actions can be taken before off-site dose limits are compromised. The surface dose rates are measured approximately at the locations indicated on Figure A3-1 of Appendix A of the CoC Number 1015 Technical Specifications, following standard industry practices for determining average surface dose rates for large containers.

REFERENCES

1. 10 CFR Parts 20 and 72.
2. FSAR Sections 5.1 and 8.2.

C 3.3 NAC-UMS® SYSTEM Criticality Control

C 3.3.1 Dissolved Boron Concentration

BASES

BACKGROUND	A TRANSFER CASK with an empty CANISTER is placed into a PWR spent fuel pool and loaded with fuel assemblies meeting the requirements of the Approved Contents Limits shown in Table B2-2. A shield lid is then placed on the CANISTER. The TRANSFER CASK and CANISTER are raised out of the spent fuel pool. The TRANSFER CASK and CANISTER are then moved into the cask decontamination area, where dose rates are measured and the CANISTER shield lid is welded to the CANISTER shell and the lid weld is examined, pressure tested, and leak tested. The water is drained from the CANISTER, and CANISTER cavity vacuum drying is performed. The CANISTER cavity is then backfilled with helium. Additional dose rates are measured, and the CANISTER vent port and drain port covers and structural lid are installed and welded. Non-destructive examinations are performed on the welds. Contamination measurements are completed prior to moving the TRANSFER CASK and CANISTER in position to transfer the CANISTER to the CONCRETE CASK. After the CANISTER is transferred, the CONCRETE CASK is then moved to the ISFSI. Average CONCRETE CASK dose rates are measured at the ISFSI pad.
APPLICABLE SAFETY ANALYSIS	During loading into, or unloading from, the CANISTER, criticality control of certain PWR fuel requires that the water in the CANISTER contains dissolved boron in a concentration of 1,000 parts per million, or greater. As shown in Table B2-2, spent fuel with the enrichments shown in the "without (w/o) boron" column may be loaded with no assured level of boron in the water in the CANISTER. However, spent fuel with the enrichments shown in the "with boron" column must be loaded or unloaded from the CANISTER when the water in the CANISTER has a boron concentration of 1,000 parts per million or greater. Since boron concentration varies with water temperature, water temperature must be considered in measuring the boron concentration.

(continued)