72-1015

NAC
INTERNATIONAL

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August 24, 2000

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

Attn: Document Control Desk

Subject: Docket No. 72-1015

Submittal of Supplemental Information to the Response to RAI-2 for the NAC-UMS® Universal Storage System Amendment for Maine Yankee Atomic Power Company Site Specific Spent Fuel (TAC No. L22979)

References:
1. Letter, "Conference Call Concerning the Review of the NAC-UMS Maine Yankee Amendment," U.S. NRC, August 11, 2000
2. Letter, "Submittal of Responses to RAI-2 for the NAC-UMS® Universal Storage System Amendment for Maine Yankee Atomic Power Company Site Specific Spent Fuel, NAC International, July 27, 2000
3. Request for Additional Information (RAI) for the UMS Universal Storage System (TAC No. L22979), United States Nuclear Regulatory Commission, June 29, 2000

NAC International (NAC) herewith submits 10 copies of supplemental information to Reference 2, as requested in the conference call documented in Reference 1 for the NAC-UMS® Universal Storage System Amendment for Maine Yankee Atomic Power Company Site Specific Spent Fuel (UMS-MY). Included in this submittal are the response to the questions identified in Reference 1 and the changed pages for the UMS-MY Safety Analysis Report (SAR), which incorporate the response.

NAC has prepared this submittal to be fully responsive to the Reference 1 questions and in complete accordance with all NRC/NAC discussions held prior to and following the conference call. This submittal includes the NRC questions and NAC's response presented in the standard NAC response format, followed by the SAR Revision UMSS-00G changed pages. The List of Effective Pages and the Master Table of Contents for the SAR are updated to incorporate the text and page changes made in the body of the SAR.

This response and the SAR changed pages in this submittal address the thermal evaluation of the transfer cask/canister/basket for various reduced heat loads and fuel loading configurations for PWR fuel.

This submittal includes NAC Proprietary Information as a part of the response to the Reference 1 questions. Four copies of the NAC Proprietary Information are provided in appropriately marked separate packaging. The executed Proprietary Information Affidavit is enclosed. The NAC Proprietary Information included in this submittal is: NAC Calculation Package No. EA790-3206, Revision 0, "Thermal Analyses for UMS Transfer Cask/Canister for PWR Fuel with Reduced Heat Loads."

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NMSS01 Public

As previously identified, implementation of the NAC-UMS® Storage System is a critical path item for successful completion of the decommissioning of the Maine Yankee site. Therefore, NAC requests that the USNRC continue the technical review and complete the regulatory approval of the Maine Yankee Amendment of the NAC-UMS® Storage System CoC on a priority basis that will support Maine Yankee's scheduled start date for fuel loading in April 2001.

If you have any comments or questions, please contact me at (770) 447-1144, x-321, or you may call me on my direct line at (678) 328-1321.

Sincerely,

T. C. Thompson

Thomas C. Thompson
Director, Licensing
Engineering & Design Services

Enclosures

cc (w/o enclosure):	G. Zinke	(MY)
	P. Plante	(MY)
	M. Meisner	(MY)
	E. Washer	(SWEC)

ED20001224

AFFIDAVIT
IN SUPPORT OF PROPRIETARY INFORMATION CONTAINED IN THE SUPPLEMENTAL INFORMATION TO THE RAI-2 RESPONSE FOR THE NAC-UMS® UNIVERSAL STORAGE SYSTEM AMENDMENT FOR MAINE YANKEE SITE SPECIFIC SPENT FUEL

State of Georgia, County of Gwinnett

Charles W. Pennington (Affiant), Group Senior Vice President of NAC International, hereinafter referred to as NAC, at 655 Engineering Drive, Norcross, Georgia 30092, being duly sworn, deposes and says that:

1. Affiant is personally familiar with the trade secrets and privileged information contained in the Supplemental Information to the RAI-2 responses being submitted in conjunction with the request for approval of an amendment to the NAC-UMS® Universal Storage System Certificate of Compliance for Maine Yankee site specific spent fuel. Affiant requests that the Nuclear Regulatory Commission, pursuant to Chapter 10 of the Code of Federal Regulations, Part 2.790 (10 CFR 2.790) "Public Inspections, Exemptions, Request for Withholding," withhold the information contained within the Supplemental Information to the RAI-2 response, hereafter referred to as the Proprietary Material, from public disclosure.

2. This information has been and is held in confidence by NAC International Inc.

3. The information contained within the proprietary material is the result of a design calculation including component design details and critical dimensions that were developed by NAC. This type of information is held in confidence based on the significant commercial investment of time and money expended in its development.

4. The Proprietary material is transmitted to the Nuclear Regulatory Commission in confidence.

5. The information that is being claimed as trade secrets and privileged information has not been and is not available in public sources.

6. NAC has invested a considerable amount of time, engineering labor, and money in the development of the information. Public disclosure of this information would cause substantial harm to the competitive position of NAC. Others seeking to develop similar analysis would have to make similar investments to develop the information on their own as long as the information is not disclosed to the public.

Charles W. Pennington

Charles W. Pennington
Group Senior Vice President
NAC International Inc.

Subscribed and sworn to before me this 24th day of August, 2000.

Donna S Fowler

Notary Public in and for the
County of Forsyth
State of Georgia

My commission expires the 16th day of April, 2003

Notary Public, Forsyth County, Georgia
My Commission Expires April 16, 2003

NAC-UMS
Docket # 72-1015
TAC # L22979

NAC INTERNATIONAL

RESPONSE TO THE

UNITED STATES
NUCLEAR REGULATORY COMMISSION
TELECON RAI of AUGUST 10, 2000

SUPPLEMENTAL INFORMATION TO RAI-2 RESPONSE

MAINE YANKEE AMENDMENT
NAC UNIVERSAL STORAGE SYSTEM (NAC-UMS®)

(TAC NO. L22979, DOCKET NO. 72-1015)

AUGUST 2000

NAC INTERNATIONAL
SUPPLEMENTAL INFORMATION TO RAI-2 RESPONSE

1. NAC is requested to provide clarification of Response 4-6 of the NAC Responses to RAI-2 for the NAC-UMS® Universal Storage System Amendment for Maine Yankee Atomic Power Company Site Specific Spent Fuel as follows:

   - Clarify the table presented in the RAI 4-6 Response to identify the heat load distribution used for the 20 non-central basket locations, i.e. it appears to imply an averaged heat load distribution at those locations;

   - Clarify the description of the modeled application of a linear heat load distribution in the radial direction so that the staff can ascertain what heat loads have been analyzed for all of the possible spent fuel configurations; and

   - Provide adequate information to demonstrate that the heat load and fuel loading configurations analyzed bound those that will actually be loaded for UMS standard burnup fuel and Maine Yankee high burnup fuel for normal loading conditions and post-LCO ACTION (24-hour in-pool cooling) conditions.

NAC Response

Sections 4.4.1, 4.4.1.8, 4.4.3.1, LCO A3.1.1 with C3.1.1, and LCO A3.1.4 with C3.1.4 of the SAR are revised to provide additional reduced heat load and fuel loading configuration analysis cases, to clarify the analysis inputs and assumptions, and to document the bases for the Technical Specifications bounding the actual fuel loaded.

The evaluations of the reduced heat load/fuel loading configurations are performed using a new, more detailed ANSYS 3-D quarter-symmetry finite element model of the transfer cask/canister/basket. (A 2-D model was used in the previous analyses.) The specific heat load is modeled at each fuel assembly position in the basket in the 3-D model. The loading configurations evaluated consider the maximum number of design basis (0.958 kW) fuel assemblies allowed in a canister for a specific total canister heat load. The design basis fuel assemblies are considered to be loaded from the center of the basket outward for standard burnup fuel and similarly for high burnup fuel, except that the high burnup fuel assemblies are restricted to the peripheral basket locations per Technical Specification Section B 2.1.3.

NAC INTERNATIONAL
SUPPLEMENTAL INFORMATION TO RAI-2 RESPONSE

NAC Response (continued)

Two or more fuel loading configurations are considered for each canister heat load evaluated. The maximum temperature for the limiting components (fuel cladding and heat transfer disk) always occurs in the center region of the basket. Since the maximum permissible number of design basis fuel assembly heat loads are considered in the most critical basket locations (around the center), all possible fuel assembly loading configurations in accordance with the Technical Specifications are bounded. The results of the evaluations demonstrate that adequate temperature margins are provided for the limiting components (fuel cladding and heat transfer disk) and that the allowable temperature limits for those components are not exceeded.

LCO 3.1.1 and 3.1.4 in the Technical Specifications in SAR Chapter 12 are revised to incorporate the results of the detailed analysis cases presented in Chapter 4.

The applicable SAR changed pages are provided as a part of this Response.

The NAC Calculation Package, EA790-3206, "Thermal Analyses for UMS Transfer Cask/Canister for PWR Fuel with Reduced Heat Loads," is provided with this Response as NAC Proprietary Information.

12412-SAR-002

DOCKET NO. 72-1015

UMS®
UNIVERSAL MPC SYSTEM ®

SAFETY ANALYSIS REPORT

for the

UMS® UNIVERSAL STORAGE CASK

Amendment for
MAINE YANKEE ATOMIC POWER COMPANY
Site Specific Spent Fuel

August 2000 UMSS-00G

NAC INTERNATIONAL

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4.4.3-9	Revision UMSS-00G
4.4.3-10	Revision UMSS-00G
4.4.3-11	Revision UMSS-00G
4.4.3-12	Revision UMSS-00G
4.4.3-13	Revision UMSS-00G
4.4.3-14	Revision UMSS-00G
4.4.3-15	Revision UMSS-00G
4.4.4-1	Revision 1
4.4.5-1	Revision 1
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4.4.5-4	Revision 1
4.4.5-5	Revision 1
4.4.5-6	Revision 1
4.4.6-1	Revision 1
4.4.7-1	Revision 1
4.4.7-2	Revision 1
4.4.7-3	Revision 1
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4.4.7-8	Revision 1
4.4.7-9	Revision 1
4.4.7-10	Revision 1
4.4.7-11	Revision 1
4.4.8-1	Revision 1
4.5-1	Revision UMSS-00C
4.5-2	Revision UMSS-00C
4.5-3	Revision UMSS-99D
4.5-4	Revision UMSS-99D
4.5-5	Revision UMSS-00C
4.5-6	Revision UMSS-00C
4.5-7	Revision UMSS-00F
4.5-8	Revision UMSS-00F
4.5-9	Revision UMSS-00F
4.5-10	Revision UMSS-00F
4.5-11	Revision UMSS-99D
4.5-12	Revision UMSS-99D
4.5-13	Revision UMSS-99D
4.5-14	Revision UMSS-00A
4.5-15	Revision UMSS-00D
4.5-16	Revision UMSS-00D
4.5-17	Revision UMSS-00B
4.5-18	Revision UMSS-00B
4.5-19	Revision UMSS-00B
4.5-20	Revision UMSS-99D
4.5-21	Revision UMSS-00A
4.5-22	Revision UMSS-99D
4.5-23	Revision UMSS-00C
4.6-1	Revision 1
4.6-2	Revision 1
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4.6-4	Revision UMSS-00A

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5-iv	Revision 1
5-v	Revision UMSS-99D
5-vi	Revision 1
5-vii	Revision UMSS-99D
5-viii	Revision UMSS-99D
5.1-1	Revision 1

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5.1-4	Revision UMSS-99D
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5.1-7	Revision 1
5.1-8	Revision 1
5.1-9	Revision 1
5.1-10	Revision 1
5.1-11	Revision 1
5.2-1	Revision 1
5.2-2	Revision 1
5.2-3	Revision 1
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5.2-5	Revision 1
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5.2-7	Revision 1
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5.2-11	Revision 1
5.2-12	Revision 1
5.2-13	Revision 1
5.2-14	Revision 1
5.2-15	Revision 1
5.2-16	Revision 1
5.2-17	Revision 1
5.2-18	Revision 1
5.2-19	Revision 1
5.2-20	Revision 1
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5.2-22	Revision 1
5.2-23	Revision 1
5.2-24	Revision 1
5.2-25	Revision 1
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5.2-27	Revision 1
5.2-28	Revision 1
5.2-29	Revision 1
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5.2-31	Revision 1
5.3-1	Revision 1
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5.3-3	Revision 1
5.3-4	Revision 1
5.3-5	Revision 1
5.3-6	Revision 1
5.3-7	Revision 1
5.3-8	Revision 1
5.3-9	Revision 1
5.3-10	Revision 1
5.3-11	Revision 1
5.3-12	Revision 1
5.3-13	Revision 1
5.3-14	Revision 1
5.3-15	Revision 1
5.3-16	Revision 1
5.3-17	Revision 1
5.3-18	Revision 1
5.3-19	Revision 1
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5.3-21	Revision 1
5.3-22	Revision 1
5.3-23	Revision 1
5.4-1	Revision 1
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5.4-17	Revision 1
5.4-18	Revision 1
5.4-19	Revision 1
5.4-20	Revision 1
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5.4-22	Revision 1
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5.5-6	Revision 1
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5.5-10	Revision 1
5.6-1	Revision UMSS-99D
5.6.1-1	Revision UMSS-00A
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5.6.1-3	Revision UMSS-99D
5.6.1-4	Revision UMSS-99D
5.6.1-5	Revision UMSS-99D
5.6.1-6	Revision UMSS-00A
5.6.1-7	Revision UMSS-99D
5.6.1-8	Revision UMSS-99D
5.6.1-9	Revision UMSS-99D
5.6.1-10	Revision UMSS-99D
5.6.1-11	Revision UMSS-99D
5.6.1-12	Revision UMSS-00B
5.6.1-13	Revision UMSS-99D
5.6.1-14	Revision UMSS-99D
5.6.1-15	Revision UMSS-99D
5.6.1-16	Revision UMSS-99D
5.6.1-17	Revision UMSS-99D
5.6.1-18	Revision UMSS-99D
5.6.1-19	Revision UMSS-99D
5.6.1-20	Revision UMSS-99D
5.6.1-21	Revision UMSS-00C
5.6.1-22	Revision UMSS-00C
5.6.1-23	Revision UMSS-99D
5.6.1-24	Revision UMSS-00C
5.6.1-25	Revision UMSS-99D
5.6.1-26	Revision UMSS-99D
5.7-1	Revision 1
5.7-2	Revision 1
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6-iv	Revision 1
6-v	Revision 1
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6.3-1	Revision 1
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6.5-20	Revision 1
6.5-21	Revision 1
6.5-22	Revision 1
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6.5-25	Revision 1
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6.6.1-1	Revision UMSS-00C
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6.6.1-4	Revision UMSS-99D
6.6.1-5	Revision UMSS-00C
6.6.1-6	Revision UMSS-00C
6.6.1-7	Revision UMSS-00C
6.6.1-8	Revision UMSS-00C
6.6.1-9	Revision UMSS-00C
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6.6.1-13	Revision UMSS-00C
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6.6.1-15	Revision UMSS-00C
6.6.1-16	Revision UMSS-00C
6.6.1-17	Revision UMSS-00C
6.6.1-18	Revision UMSS-00C
6.6.1-19	Revision UMSS-00C
6.6.1-20	Revision UMSS-00C
6.6.1-21	Revision UMSS-00C
6.7-1	Revision 1
6.7-2	Revision 1
6.8-1	Revision 1
6.8-2	Revision 1
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6.8-10	Revision 1
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6.8-17	Revision 1
6.8-18	Revision 1
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6.8-27	Revision 1
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7.1-9	Revision 1
7.1-10	Revision 1
7.1-11	Revision 1
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7.2-2	Revision 1
7.3-1	Revision 1
7.4-1	Revision UMSS-00D
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8-ii	Revision UMSS-00F
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8-2	Revision UMSS-99D
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8.1.1-5	Revision UMSS-99D
8.1.1-6	Revision UMSS-99D
8.1.1-7	Revision UMSS-99D
8.1.1-8	Revision UMSS-99D
8.1.2-1	Revision UMSS-99D
8.1.2-2	Revision UMSS-99D
8.1.3-1	Revision UMSS-99D
8.1.3-2	Revision UMSS-99D
8.2-1	Revision 1
8.2.2	Revision 1
8.3-1	Revision UMSS-00F
8.3-2	Revision UMSS-00F
8.3-3	Revision UMSS-00F
8.3-4	Revision UMSS-00F
8.4-1	Revision 1

Chapter 9

9-i	Revision UMSS-00E
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9.1-10	Revision 1
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9.2-2	Revision UMSS-00E
9.3-1	Revision 1

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10.2-2	Revision 1
10.3-1	Revision 1
10.3-2	Revision UMSS-00C
10.3-3	Revision UMSS-00C
10.3-4	Revision 1
10.3-5	Revision 1
10.3-6	Revision 1
10.3-7	Revision 1
10.3-8	Revision UMSS-00C
10.3-9	Revision UMSS-00C
10.4-1	Revision 1
10.4-2	Revision 1
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10.4-4	Revision 1
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11-vii	Revision 1
11-viii	Revision 1
11-ix	Revision UMSS-99D
11-x	Revision UMSS-00A
11-1	Revision 1
11.1.1-1	Revision 1
11.1.1-2	Revision 1
11.1.1-3	Revision 1
11.1.1-4	Revision 1
11.1.1-5	Revision 1
11.1.1-6	Revision 1
11.1.2-1	Revision 1
11.1.2-2	Revision 1
11.1.2-3	Revision 1
11.1.3-1	Revision 1
11.1.3-2	Revision 1
11.1.3-3	Revision 1
11.1.3-4	Revision 1
11.1.3-5	Revision 1
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11.1.3-7	Revision 1
11.1.3-8	Revision 1
11.1.3-9	Revision 1
11.1.3-10	Revision 1

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11.1.3-13	Revision 1
11.1.3-14	Revision 1
11.1.3-15	Revision 1
11.1.3-16	Revision 1
11.1.4-1	Revision UMSS-00D
11.1.4-2	Revision 1
11.1.5-1	Revision 1
11.1.5-2	Revision 1
11.1.6-1	Revision UMSS-00B
11.2-1	Revision UMSS-00B
11.2.1-1	Revision 1
11.2.1-2	Revision 1
11.2.1-3	Revision 1
11.2.1-4	Revision 1
11.2.1-5	Revision 1
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11.2.1-8	Revision 1
11.2.2-1	Revision 1
11.2.3-1	Revision 1
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11.2.4-4	Revision 1
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11.2.4-16	Revision 1
11.2.4-17	Revision 1
11.2.4-18	Revision 1
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11.2.4-21	Revision 1
11.2.4-22	Revision 1
11.2.4-23	Revision UMSS-00C
11.2.4-24	Revision 1
11.2.4-25	Revision UMSS-00C
11.2.4-26	Revision 1
11.2.4-27	Revision 1
11.2.4-28	Revision 1
11.2.4-29	Revision 1
11.2.4-30	Revision 1
11.2.5-1	Revision 1
11.2.6-1	Revision 1
11.2.6-2	Revision 1
11.2.6-3	Revision 1
11.2.6-4	Revision 1
11.2.6-5	Revision 1
11.2.7-1	Revision 1
11.2.7-2	Revision 1
11.2.8-1	Revision 1
11.2.8-2	Revision 1
11.2.8-3	Revision 1
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11.2.8-5	Revision 1
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11.2.8-7	Revision 1

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11.2.12-3	Revision UMSS-00E
11.2.12-4	Revision UMSS-00E
11.2.12-5	Revision UMSS-00E
11.2.12-6	Revision UMSS-00E
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11.2.12-37	Revision 1
11.2.12-38	Revision 1
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11.2.13-3	Revision 1
11.2.14-1	Revision 1
11.2.14-2	Revision 1
11.2.15-1	Revision UMSS-00B
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11.2.15-11	Revision UMSS-00A
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11.2.15-14	Revision UMSS-00A
11.2.15-15	Revision UMSS-00A
11.2.15-16	Revision UMSS-00A
11.2.15-17	Revision UMSS-00A
11.2.15-18	Revision UMSS-00A
11.2.15-19	Revision UMSS-00A
11.2.15-20	Revision UMSS-00A
11.2.15-21	Revision UMSS-00A
11.2.15-22	Revision UMSS-00B
11.2.15-23	Revision UMSS-00C
11.2.15-24	Revision UMSS-00C
11.2.15-25	Revision UMSS-00D
11.2.15-26	Revision UMSS-00B
11.2.15-27	Revision UMSS-00C
11.2.16-1	Revision UMSS-00D
11.2.16-2	Revision UMSS-00D
11.2.16-3	Revision UMSS-00D
11.2.16-4	Revision UMSS-00D
11.2.16-5	Revision UMSS-00D
11.2.16-6	Revision UMSS-00E
11.2.16-7	Revision UMSS-00E
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4.4.1 Thermal Models

Finite element models are utilized for the thermal evaluation of the Universal Storage System, as shown below. These models are used separately to evaluate the system for the storage of PWR or BWR fuel.

1. Two-Dimensional Axisymmetric Air Flow and Concrete Cask Models
2. Three-Dimensional Canister Models
3. Two-Dimensional Axisymmetric Transfer Cask and Canister Models
4. Three-Dimensional Periodic Canister Internal Models
5. Two-Dimensional Fuel Models
6. Two-Dimensional Fuel Tube Models
7. Two-Dimensional Forced Air Flow Model for Transfer Cask Cooling
8. Three-Dimensional Transfer Cask and Canister Model

The two-dimensional axisymmetric air flow and concrete cask model includes the concrete cask, air in the air inlets, annulus and the air outlets, the canister and the canister internals, which are modeled as homogeneous regions with effective thermal conductivities. The effective thermal conductivities for the canister internals in the radial direction are determined using the three-dimensional periodic canister internal models. The effective conductivities in the canister axial direction are calculated using classical methods. The two-dimensional axisymmetric air flow and concrete cask model is used to perform computational fluid dynamic analyses to determine the mass flow rate, velocity and temperature of the air flow, as well as the temperature distribution of the concrete, concrete cask steel liner and the canister. Two models are generated for the evaluations of the PWR and the BWR systems, respectively. These models are essentially identical, but have slight differences in dimensions and the effective properties of the canister internals.

The three-dimensional canister model comprises the fuel assemblies, fuel tubes, stainless steel or carbon steel support disks, aluminum heat transfer disks, top and bottom weldments, the canister shell, lids and bottom plate. The canister model is employed to evaluate the temperature distribution of the fuel cladding and basket components. The fuel assemblies and the fuel tubes in the three-dimensional canister model are modeled using effective conductivities. The effective conductivities for the fuel assemblies are determined using the two-dimensional fuel models. The effective conductivities for the fuel tubes are determined using the two-dimensional fuel tube models. Two three-dimensional canister models are generated for the PWR and BWR canisters, respectively.

The two-dimensional axisymmetric transfer cask model includes the transfer cask and the canister with its internals modeled as homogeneous regions with effective thermal properties. This model is used to perform transient analyses for the transfer condition, starting from removing the transfer cask/canister from the spent fuel pool, vacuum drying and finally back-filling the canister with helium. Separate transfer cask models are required for PWR and BWR systems.

The three-dimensional canister internal model consists of a periodic section of the canister internals. For the PWR canister, the model contains one support disk with two heat transfer disks (half thickness) on its top and bottom, fuel assemblies, fuel tubes and the media in the canister. For the BWR canister, two models are required. The first model, for the central region of the BWR canister, contains one heat transfer disk with two support disks (half thickness) on its top and bottom, fuel assemblies, fuel tubes and the media in the canister. The other model, for the region without heat transfer disks, contains two support disks (half thickness), fuel assemblies, fuel tubes and the media in the canister. The purpose of the three-dimensional periodic canister internal model is to determine the effective thermal conductivity of the canister internals in the canister radial direction. The effective conductivities are used in the two-dimensional axisymmetric air flow and concrete cask models and two-dimensional axisymmetric transfer cask and canister models. Three types of media are considered: helium, water and a vacuum. The fuel assemblies and fuel tubes in this model are modeled as homogeneous regions with effective thermal properties, which are determined by the two-dimensional fuel models and the two-dimensional fuel tube models.

The two-dimensional fuel model includes the fuel pellets, cladding and the media occupying the space between fuel rods. The media is considered to be helium for storage conditions and water, vacuum or helium for transfer conditions. The model is used to determine the effective thermal conductivities of the fuel assembly. In order to account for various types of fuel assemblies, a total of seven fuel models are generated: Four models for the 14x14, 15x15, 16x16 and 17x17PWR fuel assemblies and three models for the 7x7, 8x8 and 9x9 BWR fuel assemblies. The effective properties are used in the three-dimensional canister models and the three-dimensional periodic canister internal models.

The two-dimensional fuel tube model is used to determine the effective conductivities of the fuel tube wall and BORAL plate. The effective properties are used in the three-dimensional canister models and the three-dimensional periodic canister internal models.

The two-dimensional axisymmetric air flow model is used to determine the air flow rate needed for the forced air cooling of the canister inside the transfer cask.

The three-dimensional transfer cask and canister model is used to evaluate the transfer operation for PWR fuel heat load cases with less than the design basis heat load of 23 kW.

Descriptions of the finite element models are presented in Sections 4.4.1.1 through 4.4.1.8.

4.4.1.1 Two-Dimensional Axisymmetric Air Flow and Concrete Cask Models

This section describes the finite element models used to evaluate the thermal performance of the vertical concrete cask for the PWR and BWR configurations. The model includes the concrete cask, the air in the air inlets, the annulus and the air outlets, the canister and the canister internals, which are modeled as homogeneous regions with effective thermal conductivities. Two separate two-dimensional axisymmetric models are used for the PWR and BWR configurations, respectively. The PWR model is shown in Figures 4.4.1.1-1 and 4.4.1.1-2. The BWR model is essentially identical to the PWR model, but it incorporates different effective thermal properties of the canister internals, and slight differences in dimensions.

The fuel canister is cooled by (1) natural/free convection of air through the lower vents (the air inlets), the vertical air annulus, and the upper vents (the air outlets); and (2) radiation heat transfer between the surfaces of the canister shell and the steel liner. The heat transferred to the liner is rejected by air convection in the annulus and by conduction through the concrete. The heat flow through the concrete is dissipated to the surroundings by natural convection and radiation heat transfer. The temperature in the concrete region is controlled by radiation heat transfer between the vertical annulus surfaces (the canister shell outer surface and the steel liner inner surface), natural convection of air in the annulus, and boundary conditions applicable to the concrete cask outer surfaces—e.g., natural convection and radiation heat transfer between the outer surfaces and the environment, including consideration of incident solar energy. These heat transfer modes are combined in the air flow and concrete cask model. The entire thermal system, including mass, momentum, and energy, is analyzed using the two-dimensional axisymmetric air flow and concrete cask models. The temperature distributions of the concrete cask, the air region and the canister are determined by these models. Detailed thermal evaluations for the canister internals (fuel cladding, basket, etc.) are performed using the three-dimensional canister models as described in Section 4.4.1.2.

The concrete cask has four air inlets at the bottom and four air outlets at the top that extend through the concrete. Since the configuration is symmetrical, it can be simplified into a two-dimensional axisymmetric model by using equivalent dimensions for the air inlets and outlets, which are assumed to extend around the concrete cask periphery. The canister internals are modeled as three homogeneous regions using effective thermal conductivities - the active fuel region and the regions above and below the active fuel region. The two-dimensional axisymmetric model is shown schematically in Figure 4.4.1.1-1. Determination of the effective properties is described in Section 4.4.1.4.

ANSYS FLOTRAN FLUID141 fluid thermal elements are used to construct the two-dimensional axisymmetric finite element models, as shown in Figure 4.4.1.1-2. In the air region (including the air inlet, outlet and annulus regions), only quadrilateral elements are used and the element sizes are nonuniform with much smaller element sizes close to the walls. In other regions, to simulate conduction, a mix of quadrilateral elements and triangular elements are used. Radiation heat transfer that occurs in the following regions is included in the model:

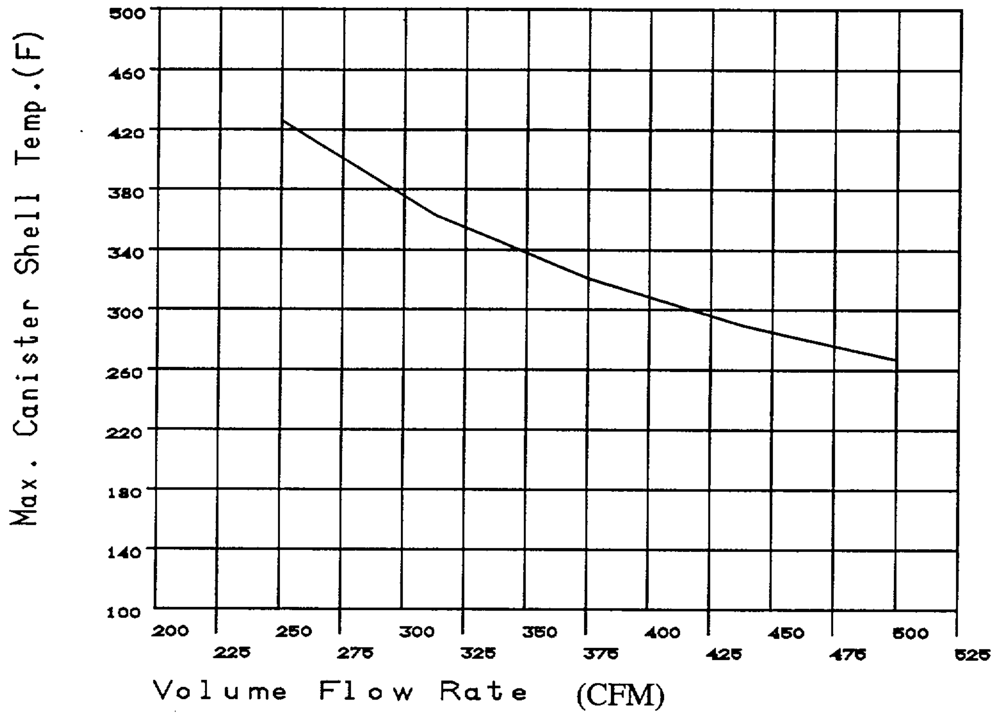
1. From the concrete outer surfaces to the ambient
2. Across the vertical air annulus (from the canister shell to the concrete cask liner)
3. From the top of the active fuel region to the bottom of the canister shield lid
4. From the bottom of the active fuel region to the top of the canister bottom plate
5. From the canister structural lid to the shield plug
6. From the shield plug to the concrete cask lid

Loads and Boundary Conditions

1. Heat generation in the active fuel region.

The distribution of the heat generation is based on the axial power distribution shown in Figure 4.4.1.1-3 and 4.4.1.1-4 for PWR and BWR fuels, respectively (see description in Chapter 5, Section 5.2.6, for the design-basis fuel).

Figure 4.4.1.7-5 Maximum Canister Temperature Versus Air Volume Flow Rate



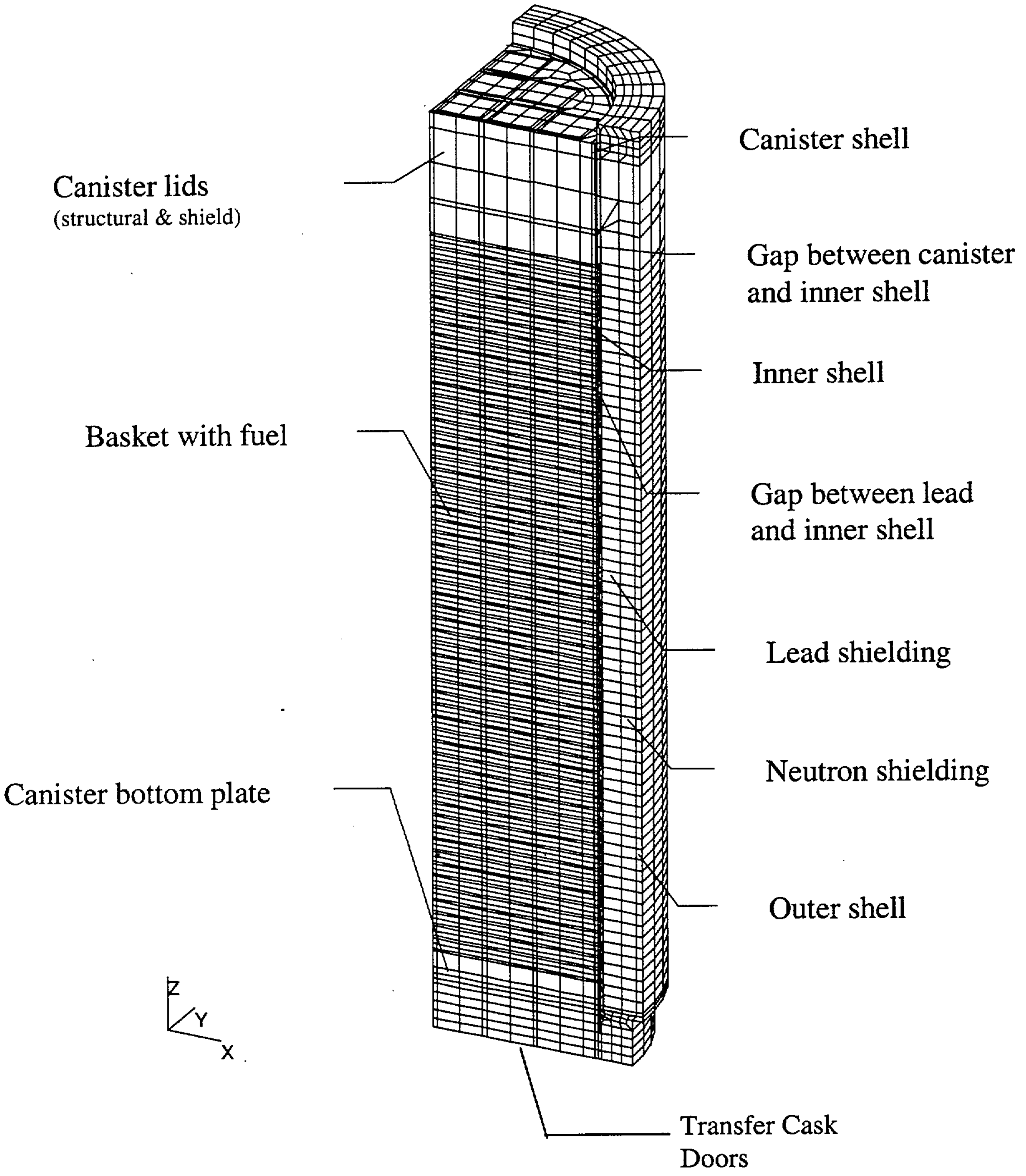
4.4.1.8 Three-Dimensional Transfer Cask and Canister Model

A three-dimensional finite element model is generated for the transfer cask with the loaded canister for the PWR fuel configuration, as shown in Figure 4.4.1.8-1. The model is used in Section 4.4.3.1 to evaluate the transfer operation for PWR fuel heat load cases with less than the design basis heat load of 23 kW (evaluated in Section 4.4.3). A quarter of the transfer cask, basket and canister is modeled due to the symmetry of the components and thermal loads. The planes of symmetry are considered to be adiabatic. The finite element model is comprised of SOLID70 and LINK31 radiation elements. The canister and its contents are modeled using the methodology described for the three-dimensional canister model for PWR fuel in Section 4.4.1.2.

The canister contents includes the fuel assemblies, fuel tubes, support and heat transfer disks, top and bottom weldments, the canister shell, lids and bottom plate, and the media (water, vacuum and helium) inside the canister. The effective properties for the fuel assembly region and the fuel tube are determined using the two-dimensional fuel models (Section 4.4.1.5) and the two-dimensional fuel tube models (Section 4.4.1.6), respectively. The effective properties take into account the different types of media (water, vacuum and helium) in the canister.

The transfer cask in the model consists of the inner shell, lead, neutron shield and outer shell. Convection and radiation are considered at the side and top surfaces of the transfer cask and the top surface of the canister. The ambient temperature is considered to be 76°F. For the transient analysis for transfer operations, an initial temperature of 100°F is considered in the model on the basis of the typical average water temperature in the spent fuel pool. Two air gaps (radial) outside of the canister are considered: a gap of 0.345 inch between the canister and transfer cask inner shell and a gap of 0.03 inch (based on tolerance) between the transfer cask inner shell and lead. Only conduction and radiation are considered across the gaps (no convection). The bottom of the transfer cask is conservatively modeled as adiabatic.

Figure 4.4.1.8-1 Three-Dimensional Transfer Cask and Canister Model



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4.4.3 Maximum Temperatures for PWR and BWR Fuel

Temperature distribution and maximum component temperatures for the Universal Storage System under the normal conditions of storage and transfer conditions are provided in this section. Components of the Universal Storage System containing PWR and BWR fuels are addressed separately. Temperature distributions for the evaluated off-normal and accident conditions are presented in Sections 11.1 and 11.2.

Figure 4.4.3-1 shows the temperature distribution of the Vertical Concrete Cask and the canister containing the PWR design basis fuel for the normal, long-term storage condition. The air flow pattern and air temperatures in the annulus between the PWR canister and the concrete cask liner for the normal condition of storage are shown in Figures 4.4.3-2 and 4.4.3-3, respectively. The temperature distribution in the concrete portion of the concrete cask for the PWR assembly is shown in Figure 4.4.3-4. The temperature distribution for the BWR design basis fuel is similar to that of the PWR fuel and is, therefore, not presented. Table 4.4.3-1 shows the maximum component temperatures for the normal condition of storage for the PWR design basis fuel. The maximum component temperatures for the normal condition of storage for the BWR design basis fuel are shown in Table 4.4.3-2.

As shown in Figure 4.4.3-3, a high-temperature gradient exists near the wall of the canister and the liner of the concrete cask, while the air in the center of the annulus exhibits a much lower temperature gradient, indicating significant boundary layer features of the air flow. The temperatures at the concrete cask steel liner surface are higher than the air temperature, which indicates that salient radiation heat transfer occurs across the annulus. As shown in Figure 4.4.3-4, the local temperature in the concrete, directly affected by the radiation heat transfer across the annulus, can reach 186°F (less than the 200°F allowable temperature). The bulk temperature in the concrete, as determined using volume average of the temperatures in the concrete region, is 135°F, less than the allowable value of 150°F.

Under typical operations, the transient history of maximum component temperatures for the transfer conditions (canister, inside the transfer cask, containing water for 17 hours, vacuum for 10 hours and helium for 16 hours for PWR fuel and for 24 hours for BWR fuel) is shown in Figures 4.4.3-5 and 4.4.3-6 for PWR and BWR fuels, respectively. The maximum component temperatures for the transfer conditions (vacuum and helium conditions) are shown in Tables 4.4.3-3 and 4.4.3-4, for PWR and BWR fuels, respectively. The maximum calculated water temperature is 195°F and 204°F for PWR and BWR fuels, respectively, at the end of 17 hours based on an initial water temperature of 100°F. For the maximum temperatures shown in Tables 4.4.3-3 and 4.4.3-4 for the transfer conditions of vacuum and helium, the maximum basket temperatures (support disk and aluminum disk) are conservatively determined by using the maximum temperature in the canister content region of the two-dimensional axisymmetric transfer cask and canister models.

4.4.3.1 Maximum Temperatures at Reduced Total Heat Loads

This section provides the evaluation of component temperatures for PWR fuel heat loads less than the design basis heat load of 23 kW. Transient thermal analyses are performed for heat loads of 20, 17.6, 14, 11 and 8 kW to establish the allowable time limits for the vacuum and helium conditions in the canister as described in the Technical Specifications (Chapter 12) for the Limiting Conditions of Operation (LCO), LCOs 3.1.1 and 3.1.4. These LCOs control the length of time that the loaded canister in the transfer cask can remain in a vacuum condition and the length of time the loaded canister can remain in the transfer cask after being filled with helium. The time limits ensure that the allowable temperatures of the limiting components – the heat transfer disks and the fuel cladding - are not exceeded. A steady state evaluation is also performed for heat loads of 14, 11 and 8 kW in the helium condition. If the steady state temperature calculated is less than the limiting component allowable temperature, then the allowable time duration in the helium condition is not limited.

The three-dimensional transfer cask and canister model for the PWR fuel configuration, described in Section 4.4.1.8, is used for the transient and steady state thermal analysis for the reduced heat load cases. To obtain the bounding temperatures for all possible loading configurations, thermal analyses are performed for a total of fourteen (14) cases as tabulated below. The basket locations are shown in Figure 4.4.3-7. Since the maximum temperature for the limiting components (fuel cladding and heat transfer disk) always occurs at the central region of the basket, hotter fuels (maximum allowable heat load for 5-year cooled fuel: 0.958 kW = 23 kW/24) are specified at the central basket locations. The bounding cases for each heat load condition are noted with an asterisk (*) in the tabulation which follows. Six cases (cases 3 through 8) are evaluated for the 17.6 kW heat load condition. The first four cases (cases 3 through 6) represent standard UMS system fuel loadings. The remaining two cases (cases 7 and 8) account for the preferential loading configuration for Maine Yankee site specific high burnup fuel (Section 4.5.1.2.2), with case 8 being the bounding case for the Maine Yankee high burnup fuel. Based on the analysis results of the 17.6 kW heat load cases, only two loading cases are required to establish the bounding condition for the 20, 14, 11 and 8 kW heat loads.

Canister Heat Load (kW)	Heat Load Case	Heat Load (kW) Evaluated in Each Basket Location (See Figure 4.4.3-7)					
		1	2	3	4	5	6
20	1	0.958	0.958	0.709	0.958	0.709	0.709
20*	2	0.958	0.958	0.958	0.958	0.958	0.210
17.6	3	0.958	0.958	0.509	0.958	0.509	0.509
17.6*	4	0.958	0.958	0.568	0.958	0.958	0.000
17.6	5	0.958	0.958	0.958	0.958	0.568	0.000
17.6	6	0.958	0.958	0.284	0.958	0.958	0.284
17.6	7	0.958	0.146	1.050	0.146	1.050	1.050
17.6	8	0.958	0.958	1.050	0.384	1.050	0.000
14	9	0.958	0.958	0.209	0.958	0.209	0.209
14*	10	0.958	0.958	0.000	0.958	0.626	0.000
11	11	0.958	0.896	0.000	0.896	0.000	0.000
11*	12	0.958	0.958	0.000	0.834	0.000	0.000
8	13	0.958	0.521	0.000	0.521	0.000	0.000
8*	14	0.958	0.958	0.000	0.084	0.000	0.000

The heat load (23 kW/24 kW) at the four (4) central basket locations corresponds to the maximum allowable canister heat load for 5-year cooled fuel (Table 4.4.7-8). The non-uniform heat loads evaluated in this section bound the equivalent uniform heat loads, since they result in higher maximum temperatures of the fuel cladding and heat transfer disk.

Volumetric heat generation (Btu/hr-in^3) is applied to the active fuel region in each fuel assembly location of the model using the axial power distribution for PWR fuel (Figure 4.4.1.1-3) in the axial direction.

The thermal analysis results for the closure and transfer of a loaded PWR fuel canister in the transfer cask for the reduced heat load cases are shown in Table 4.4.3-5. The temperatures shown are the maximum temperatures for the limiting components (fuel cladding and heat transfer disk). The maximum temperatures of the fuel cladding and the heat transfer disk are less than the allowable temperatures (Table 4.1-3) of these components for the short-term conditions of vacuum drying and helium backfill. As shown in Table 4.4.3-5, there is no time limit for movement of the canister out of the transfer cask for the cases with a heat load less than 14 kW, after the canister is filled with helium. For heat loads equal to or less than 14 kW, the maximum fuel cladding/heat transfer disk temperatures for the steady state condition are well below the short term allowable temperatures of the fuel cladding and the heat transfer disk. Note that the maximum water temperature at the end of the "water period" is considered to be the volumetric average temperature of the calculated cladding temperatures in the active fuel region of the hottest fuel assembly. The results indicate that the volumetric average water temperature is below 212°F for all cases evaluated. This is consistent with the thermal model that only considers conduction in the fuel assembly region and between the disks. This approach does not include consideration of convection of the water or the energy absorbed by latent heat of vaporization.

The Technical Specifications specify the remedial actions, either in-pool or forced air cooling, required to ensure that the fuel cladding and basket component temperatures do not exceed their short-term allowable temperatures, if the time limits are not met. LCOs 3.1.1 and 3.1.4 incorporate the operating times for heat loads that are less than the design basis heat loads as evaluated in this section.

Using the same three-dimensional transfer cask/canister model, analysis is performed for the conditions of in-pool cooling followed by the vacuum drying and helium backfill operation (LCO 3.1.1). The condition at the end of the vacuum drying as shown in Table 4.4.3-5 is used as the initial condition of the analysis. The LCO 3.1.1 "Action" analysis results are shown in Table 4.4.3-6. The maximum temperatures for the fuel cladding and the heat transfer disk are below the short term allowable temperatures.

The in-pool cooling followed by the helium backfill operation in LCO 3.1.4 is also evaluated. The condition at the end of the helium condition as shown in Table 4.4.3-5 is used as the initial condition. Based on the in-pool cooling analysis for LCO 3.1.1, the minimum temperature reduction due to in-pool cooling is 216°F (706-490) for the 20 kW heat load case. The evaluation for LCO 3.1.4 in-pool cooling conservatively considers a temperature reduction of 150°F for in-pool cooling and a heat up rate of 6°F/hour (helium condition) for an additional 16 hours and 20 hours for 20 kW and 17.6 kW heat load cases, respectively. The maximum fuel temperature and heat transfer disk temperatures at the end of the helium condition for the governing case of 17.6 kW are determined to be 668°F ((698-150)+(20×6)) and 612°F ((642-150)+(20×6)), respectively, which are well below the short-term allowable temperatures.

Figure 4.4.3-1 Temperature Distribution (°F) for the Normal Storage Condition: PWR Fuel

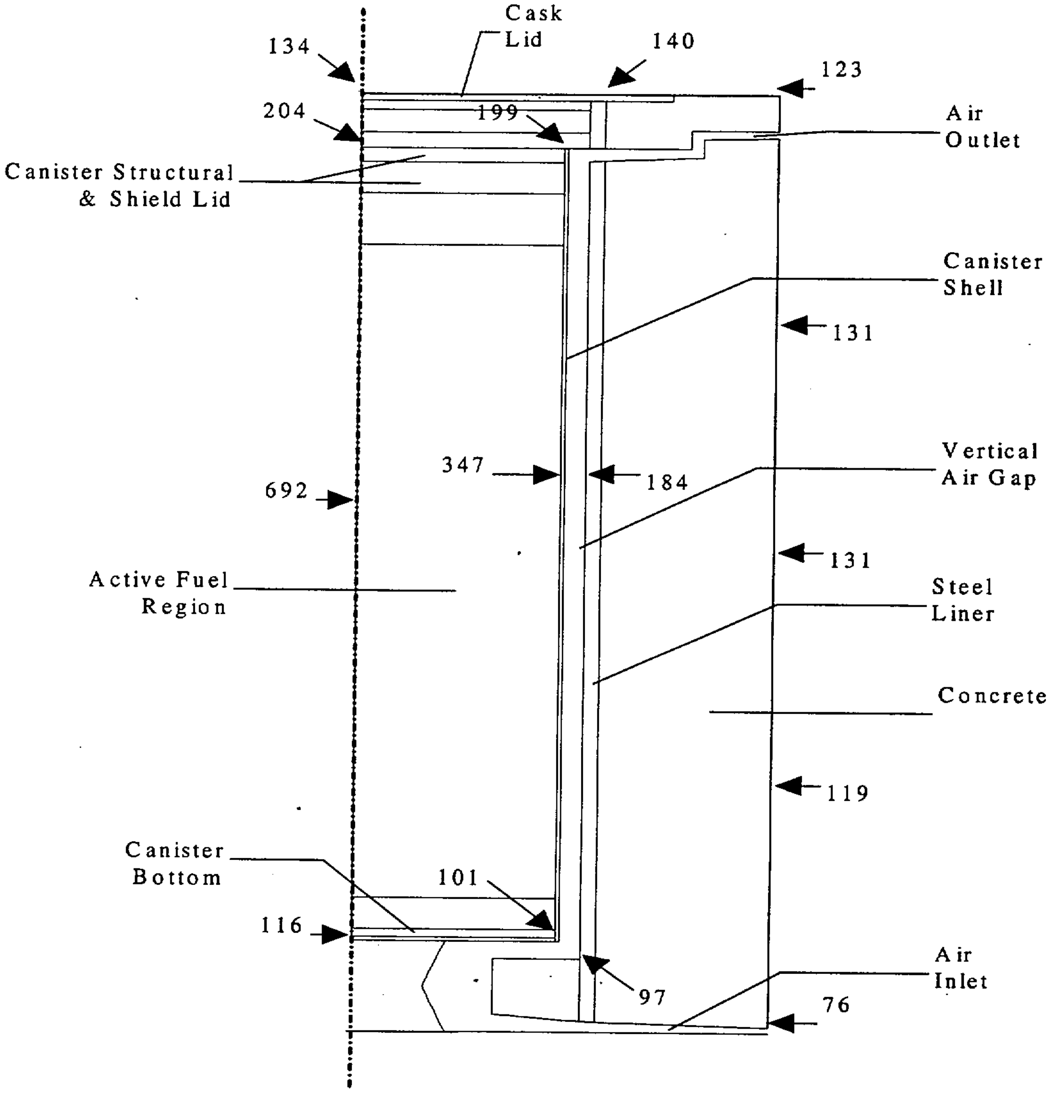


Figure 4.4.3-2 Air Flow Pattern in the Concrete Cask in the Normal Storage Condition: PWR Fuel

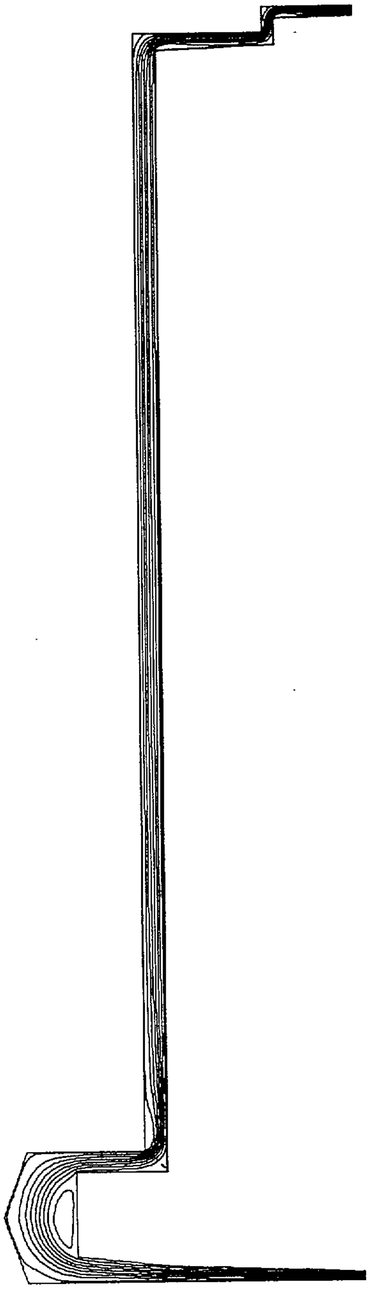


Figure 4.4.3-3 Air Temperature (°F) Distribution in the Concrete Cask During the Normal Storage Condition: PWR Fuel

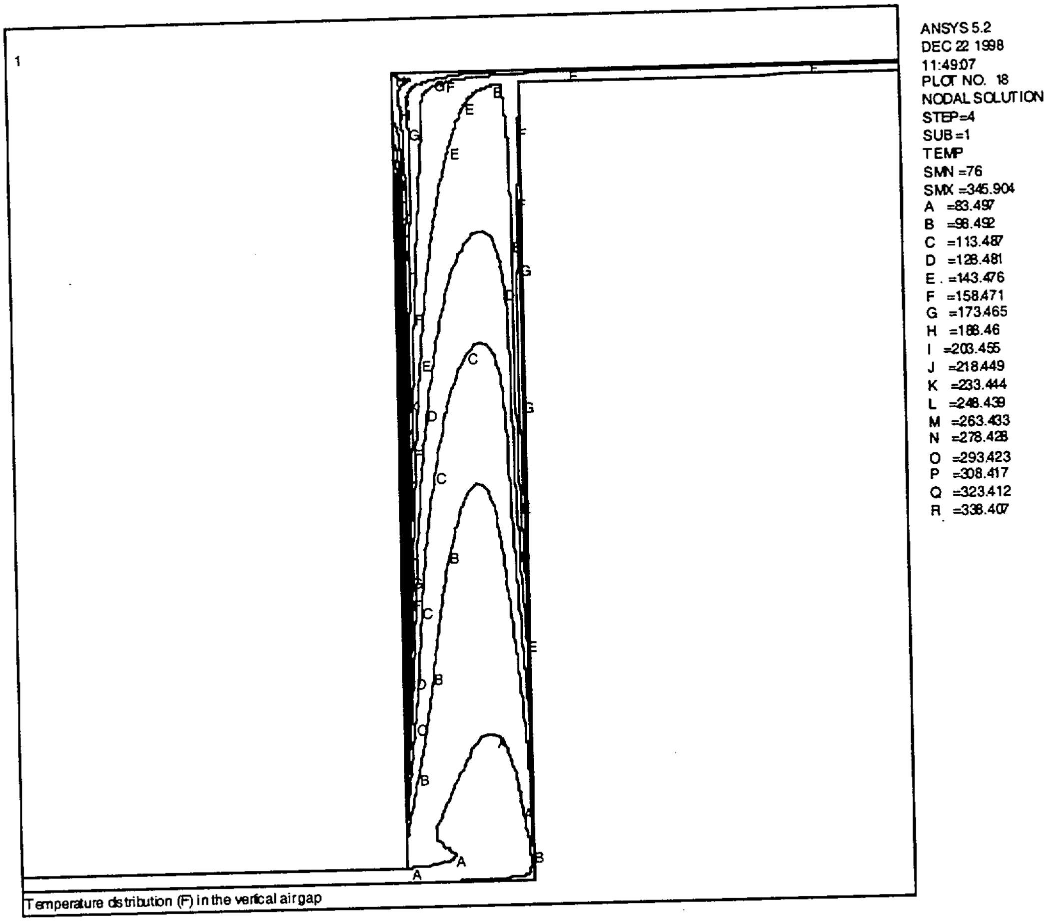


Figure 4.4.3-4 Concrete Temperature (°F) Distribution During the Normal Storage Condition: PWR Fuel

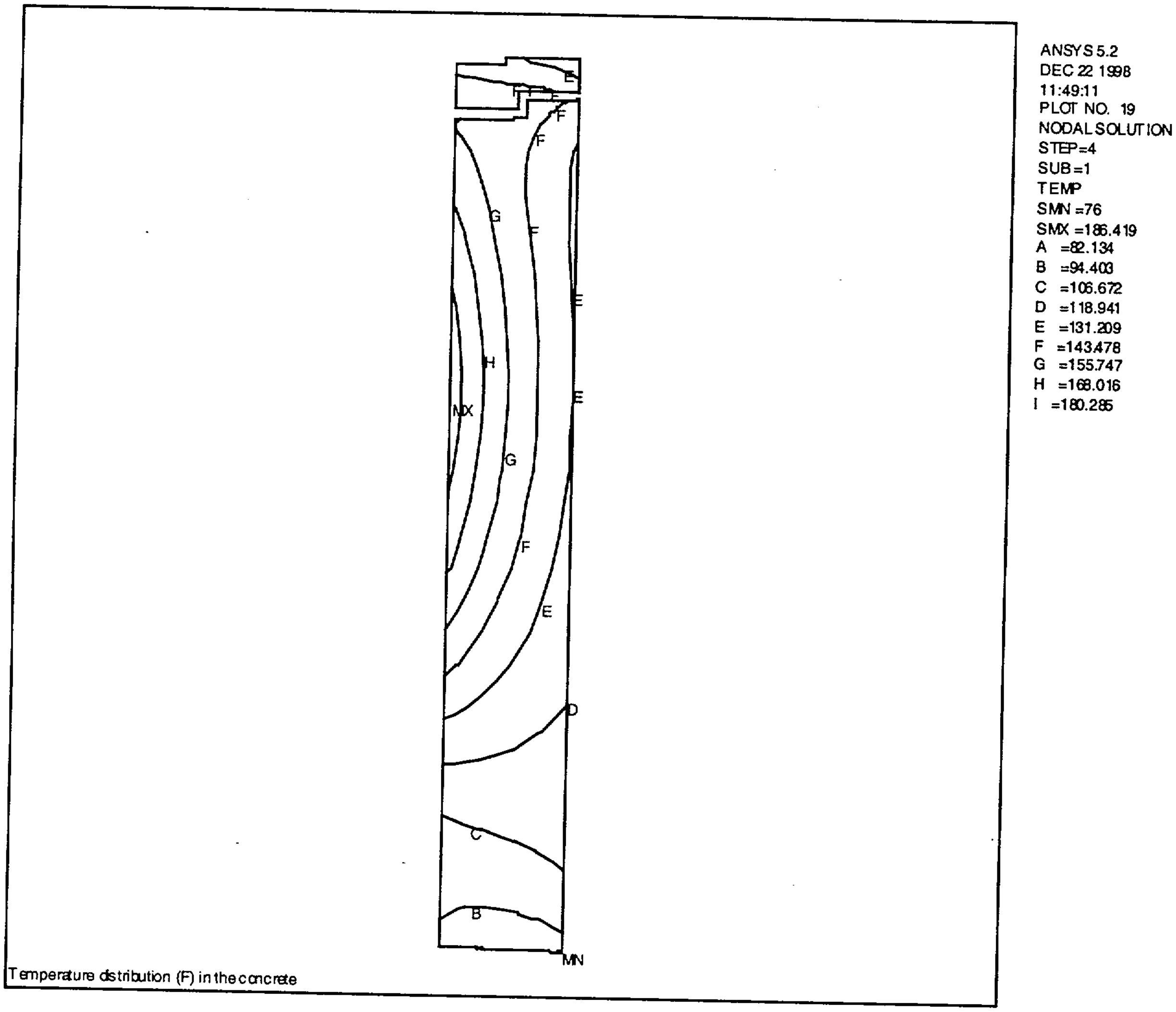
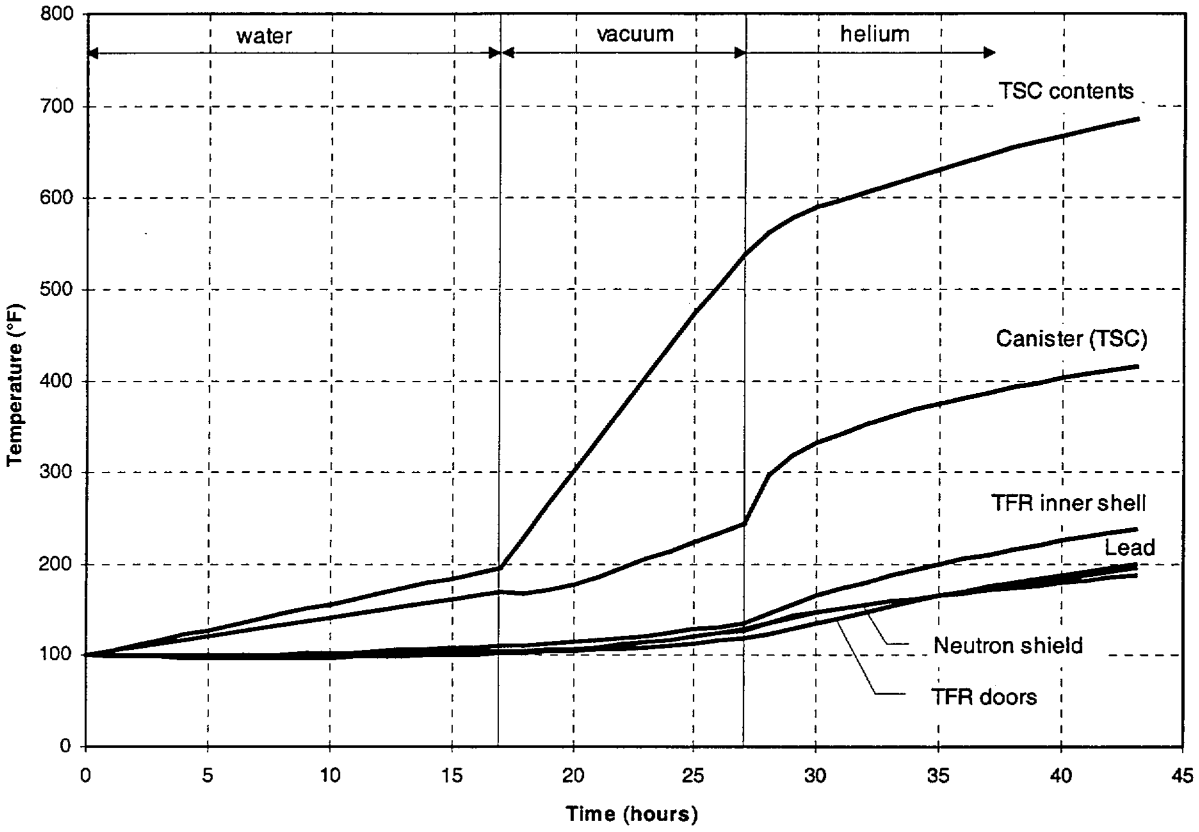


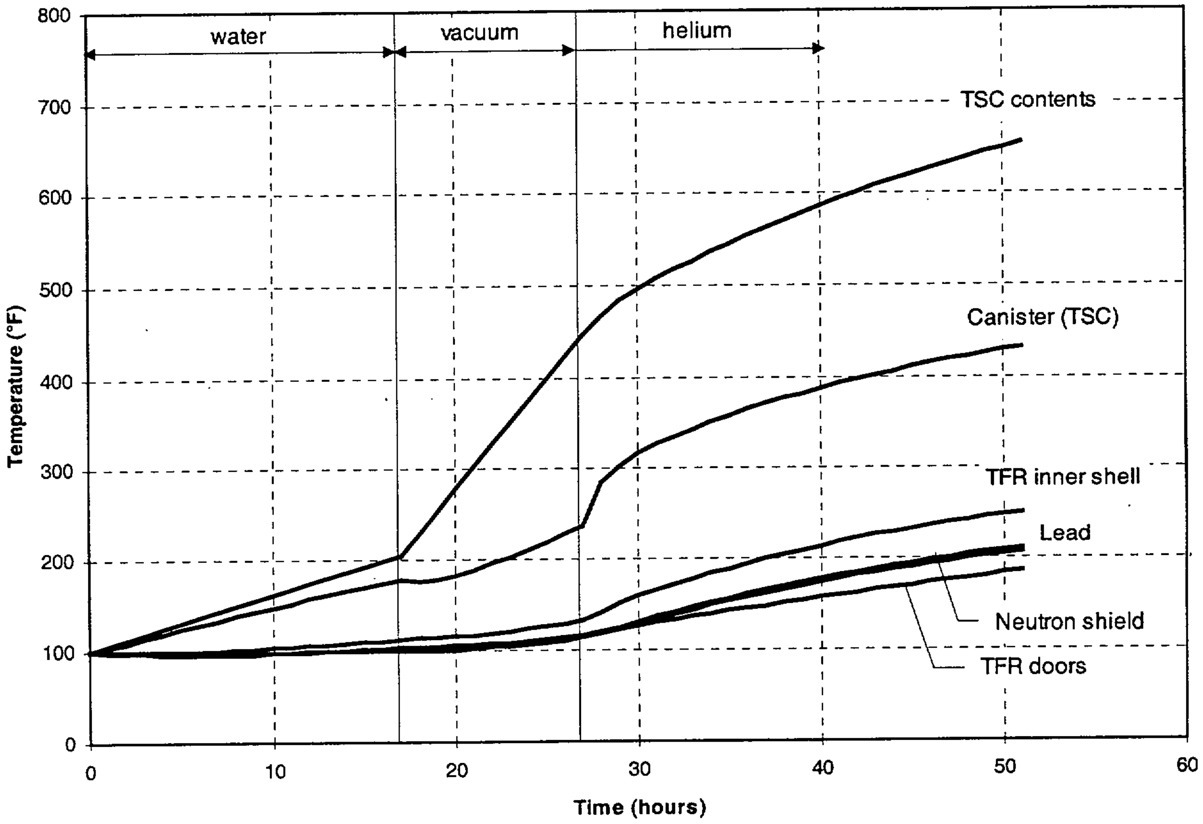
Figure 4.4.3-5 History of Maximum Component Temperature (°F) for Transfer Conditions for PWR Fuel with Design Basis 23 kW Uniformly Distributed Heat Load



Notes:

1. This graph corresponds to a canister containing water for 17 hours, vacuum for 10 hours and helium for 16 hours - normal operations, with a uniformly distributed decay heat load of 23 kW.
2. The temperature of "TSC contents" represents the maximum fuel cladding temperature. The maximum basket component (heat transfer disk and support disk) temperatures are conservatively assumed to be the same as the maximum fuel cladding temperature (see Table 4.4.3-3).

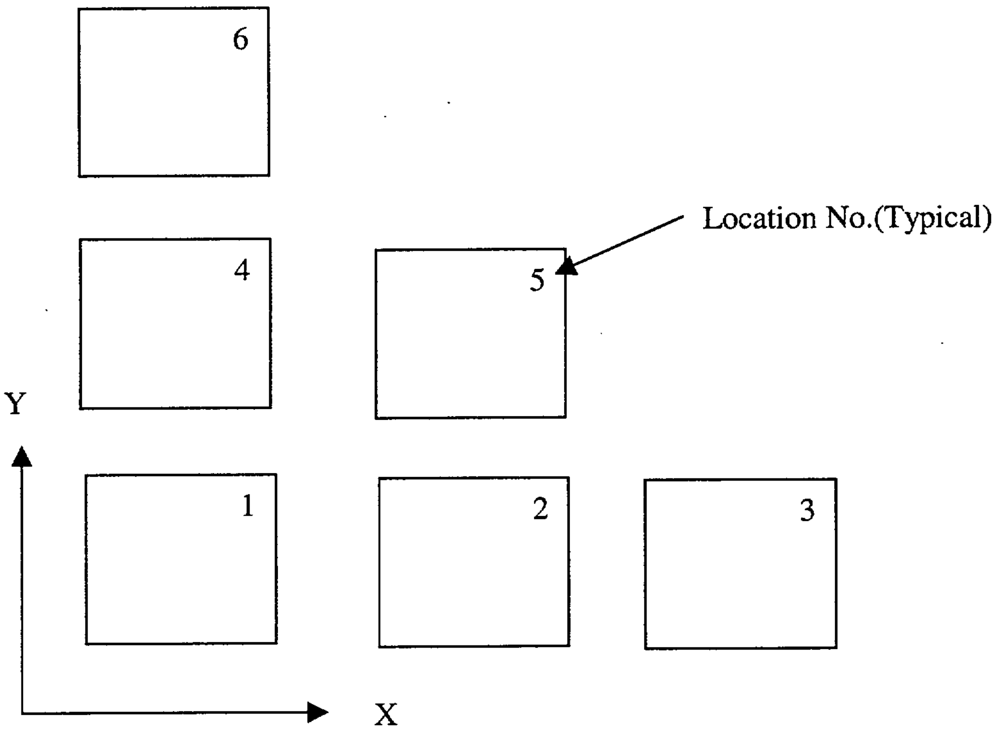
Figure 4.4.3-6 History of Maximum Component Temperature (°F) for Transfer Conditions for BWR Fuel with Design Basis 23 kW Uniformly Distributed Heat Load



Notes:

1. This graph corresponds to a canister containing water for 17 hours, vacuum for 10 hours and helium for 24 hours - normal operations, with a decay heat load of 23 kW.
2. The temperature of "TSC contents" represents the maximum fuel cladding temperature. The maximum basket component (heat transfer disk and support disk) temperatures are conservatively assumed to be the same as the maximum fuel cladding temperature (see Table 4.4.3-4).

Figure 4.4.3-7 Basket Location for the Thermal Analysis for Reduced Heat Load Cases



Basket locations correspond to the quarter symmetry model (Figure 4.4.1.8-1). X and Y axes are at the centerlines of the basket.

Table 4.4.3-1 Maximum Component Temperatures for the Normal Storage Condition - PWR

Component	**Maximum Temperature (°F)**	**Allowable Temperatures (°F)**
Fuel Cladding	670	716
Heat Transfer Disk	612	650
Support Disk	615	650
Top Weldment	419	800
Bottom Weldment	151	800
Canister Shell	351	800
Canister Structural Lid	212	800
Canister Shield Lid	202	800
Concrete	186 (local) 135 (bulk*)	200 (local) 150 (bulk)

*The volume average temperature of the concrete region is used as the bulk concrete temperature.

Table 4.4.3-2 Maximum Component Temperatures for the Normal Storage Condition - BWR

Component	**Maximum Temperature (°F)**	**Allowable Temperatures (°F)**
Fuel Cladding	651	716
Heat Transfer Disk	622	650
Support Disk	624	700
Top Weldment	360	800
Bottom Weldment	272	800
Canister Shell	376	800
Canister Structural Lid	212	800
Canister Shield Lid	202	800
Concrete	192 (local) 136 (bulk*)	200 (local) 150 (bulk)

* The volume average temperature of the concrete region is used as the bulk concrete temperature.

Table 4.4.3-3 Maximum Component Temperatures for the Transfer Condition – PWR Fuel with Design Basis 23 kW Uniformly Distributed Heat Load

Component	Maximum Temperature (°F)		Allowable Temperature (°F)
	Vacuum[1]	Helium[1]	
Fuel	538	686	1,058
Lead	119	199	600
Neutron Shield	128	195	300
Heat Transfer Disk	538[2]	686[2]	700
Support Disk	538[2]	686[2]	800
Canister	244	416	800
Transfer Cask Shells	136	237	700

1 Maximum temperatures at the end of 10 hours vacuum condition and 16 hours helium condition, respectively (see Figure 4.4.3-5).
2 Conservatively, the maximum fuel cladding temperature is used.

Table 4.4.3-4 Maximum Component Temperatures for the Transfer Condition – BWR Fuel with Design Basis 23 kW Uniformly Distributed Heat Load

Component	Maximum Temperature (°F)		Allowable Temperature (°F)
	Vacuum[1]	Helium[1]	
Fuel	447	654	1,058
Lead	117	210	600
Neutron Shield	116	206	300
Heat Transfer Disk	447[2]	654[2]	700
Support Disk	447[2]	654[2]	700
Canister	235	432	800
Transfer Cask Shells	133	251	700

1 Maximum temperatures at the end of 10 hours vacuum condition and 24 hours helium condition, respectively (see Figure 4.4.3-6).
2 Conservatively, the maximum fuel cladding temperature is used.

Table 4.4.3-5 Maximum Limiting Component Temperatures in Transient Operations for the Reduced Heat Load Cases for PWR Fuel

Canister Total Heat Load (kW)	Water			Vacuum			Helium		
	Duration (hours)	Maximum Temperature (°F)		Duration (hours)	Maximum Temperature (°F)		Duration (hours)	Max. Temp./ Temp. at End of Duration (°F)	
		Fuel	Heat Transfer Disk		Fuel	Heat Transfer Disk		Fuel	Heat Transfer Disk
20	18	233	210	15	707	547	20	707/705[1]	651/651[1]
17.6	20	240	215	19	760	587	48	760/698[1]	674/642[1]
17.6[3]	20	233	210	19	761	575	48	761/683[1]	658/625[1]
14	22	242	216	23	776	577	No Limit[2]	776/645[2]	676/583[2]
11	24	239	212	30	792	569	No Limit[2]	792/586[2]	673/518[2]
8	26	226	198	34	758	489	No Limit[2]	758/509[2]	602/431[2]

Notes:

1. Temperature at the end of helium duration.
2. Based on the steady state analysis performed for the 14 kW, 11 kW and 8 kW cases for the helium condition, the maximum calculated steady state fuel cladding temperatures are 645°F, 586°F and 509°F, respectively. The maximum calculated steady state heat transfer disk temperatures are 583°F, 518°F and 431°F, respectively. Since these temperatures are well below the allowable material temperatures, there is no time limit for the helium condition for these load cases.
3. Bounding case for the Maine Yankee Site Specific high burnup fuel.

Table 4.4.3-6 Maximum Limiting Component Temperatures in Transient Operations for the Reduced Heat Load Cases for PWR Fuel after In-Pool Cooling

Canister Total Heat Load (kW)	Helium (In-Pool)			Vacuum			Helium		
		Temperature at End of Duration in Pool (°F)			Maximum Temperature (°F)			Max. Temp./ Temp. at End of Duration (°F)	
	Duration (hours)	Fuel	Heat Transfer Disk	Duration (hours)	Fuel	Heat Transfer Disk	Duration (hours)	Fuel	Heat Transfer Disk
20	24	490	407	10	714	543	20	714/703[1]	650/650[1]
17.6	24	478	392	10	700	509	48	700/693[1]	637/637[1]
14	24	456	365	14	731	521	No Limit[2]	731/645[2]	622/583[2]
11	24	431	337	14	706	465	No Limit[2]	706/586[2]	577/518[2]
8	24	391	296	14	675	390	No Limit[2]	675/509[2]	509/431[2]

Notes:

1. Temperature at the end of helium duration.
2. Based on the steady state analysis performed for the 14 kW, 11 kW and 8 kW cases for the helium condition, the maximum calculated steady state fuel cladding temperatures are 645°F, 586°F and 509°F, respectively. The maximum calculated steady state heat transfer disk temperatures are 583°F, 518°F and 431°F, respectively. Since these temperatures are well below the allowable material temperatures, there is no time limit for the helium condition for these load cases.

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SR 3.0.3 (continued)	When the Surveillance is performed within the delay period and the Surveillance is not met, the LCO must immediately be declared not met, and the applicable Condition(s) must be entered.
SR 3.0.4	Entry into a specified Condition in the Applicability of an LCO shall not be made, unless the LCO's Surveillances have been met within their specified Frequency. This provision shall not prevent entry into specified conditions in the Applicability that are required to comply with Actions or that are related to the unloading of a NAC-UMS® SYSTEM.

A 3.1 NAC-UMS® SYSTEM Integrity

A 3.1.1 CANISTER Maximum Time in Vacuum Drying

LCO 3.1.1 The following limits for vacuum drying time shall be met, as appropriate:

1. The time duration from completion of draining the CANISTER through completion of vacuum dryness testing and the introduction of helium backfill shall not exceed 10 hours for BWR fuel with the design basis 23 kW heat load or the time shown for PWR fuel with the specified heat load:

Total Heat Load (L) (kW)	Time Limit (Hours)	Total Heat Load (L) (kW)	Time Limit (Hours)
$20 < L \leq 23$	10	$11 < L \leq 14$	23
$17.6 < L \leq 20$	15	$8 < L \leq 11$	30
$14 < L \leq 17.6$	19	$L \leq 8$	34

2. The time duration from the end of 24 hours of in-pool cooling or of forced air cooling of the CANISTER through completion of vacuum dryness testing and the introduction of helium backfill shall not exceed 6 hours for the BWR configuration or the time shown for a specified PWR heat load:

Total Heat Load (L) (kW)	Time Limit (Hours)
$20 < L \leq 23$	6
$14 < L \leq 20$	10
$L \leq 14$	14

APPLICABILITY: During LOADING OPERATIONS

(continued)

ACTIONS

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

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

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. LCO time limits not met	A.1 Commence filling CANISTER with helium	2 hours
	<u>AND</u>	
	A.2.1 Submerge TRANSFER CASK with helium filled loaded CANISTER in spent fuel pool.	2 hours
	<u>AND</u>	
	A.2.2 Maintain TRANSFER CASK and CANISTER in spent fuel pool for a minimum of 24 hours	Prior to restart of LOADING OPERATIONS
	<u>OR</u>	
	A.3.1 Commence supplying air to the TRANSFER CASK annulus fill/drain lines at a rate of 375 CFM and a maximum temperature of 75°F	2 hours
	<u>AND</u>	
	A.3.2 Maintain airflow for a minimum of 24 hours	Prior to restart of LOADING OPERATIONS

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.1.1	Monitor elapsed time from completion of CANISTER draining operations until start of helium backfill	Once after completion of CANISTER draining <u>AND</u> As required to meet time limit.
SR 3.1.1.2	Monitor elapsed time from the end of in-pool cooling or of forced-air cooling until restart of helium backfill	Once at end of in-pool cooling or of forced-air cooling <u>AND</u> As required to meet time limit.

A 3.1 NAC-UMS® SYSTEM Integrity

A 3.1.2 CANISTER Vacuum Drying Pressure

LCO 3.1.2 The CANISTER vacuum drying pressure shall be less than or equal to 3 mm of Mercury. Pressure shall be held for not less than 30 minutes.

APPLICABILITY: During LOADING OPERATIONS

ACTIONS

---NOTE---

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

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. CANISTER vacuum drying pressure limit not met	A.1 Establish CANISTER cavity vacuum drying pressure within limit	25 days
B. Required Action and associated Completion Time not met	B.1 Remove all fuel assemblies from the NAC-UMS® SYSTEM	5 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.2.1	Verify CANISTER cavity vacuum drying pressure is within limit	Once within 10 hours (PWR or BWR configuration) after completion of CANISTER draining

A 3.1 NAC-UMS® SYSTEM Integrity

A 3.1.3 CANISTER Helium Backfill Pressure

LCO 3.1.3 The CANISTER helium backfill pressure shall be 0 (+1, -0) psig.

APPLICABILITY: During LOADING OPERATIONS

ACTIONS

-----NOTE-----

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

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. CANISTER helium backfill pressure limit not met	A.1 Establish CANISTER helium backfill pressure within limit	25 days
B. Required Action and associated Completion Time not met	B.1 Remove all fuel assemblies from the NAC-UMS® SYSTEM	5 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.3.1	Verify CANISTER helium backfill pressure is within limit	Once within 10 hours (PWR or BWR configuration) after completion of CANISTER draining.

A 3.1 NAC-UMS® SYSTEM Integrity

A 3.1.4 CANISTER Maximum Time in TRANSFER CASK

LCO 3.1.4

The following limits for CANISTER time in TRANSFER CASK shall be met, as appropriate:

1. The time duration from completion of backfilling the CANISTER with helium through completion of the CANISTER transfer operation from the TRANSFER CASK to the CONCRETE CASK shall not exceed 24 hours for the design basis BWR heat load of 23 kW or the time shown below for a specific PWR heat load:

Total PWR Heat Load (L) (kW)	Time Limit (Hours)
20 < L ≤ 23	16
17.6 < L ≤ 20	20
14 < L ≤ 17.6	48
L ≤ 14	Not Limited

2. The time duration from completion of in-pool or external forced air cooling of the CANISTER through completion of the CANISTER transfer operation from the TRANSFER CASK to the CONCRETE CASK shall not exceed 15 hours for the BWR configuration or the time shown below for a specific PWR heat load:

Total PWR Heat Load (L) (kW)	Time Limit (Hours)
20 < L ≤ 23	6
17.6 < L ≤ 20	16
14 < L ≤ 17.6	20
L ≤ 14	Not Limited

The LCO time limits are also applicable if SR 3.1.5.1 was not met during vacuum drying operations.

APPLICABILITY: During LOADING OPERATIONS

(continued)

ACTIONS

--NOTE--

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

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. LCO time limits not met	A.1.1 Place TRANSFER CASK with helium filled loaded CANISTER in spent fuel pool	2 hours
	<u>AND</u> A.1.2 Maintain TRANSFER CASK and CANISTER in spent fuel pool for a minimum of 24 hours	Prior to restart of LOADING OPERATIONS
	<u>OR</u> A.2.1 Commence supplying air to the TRANSFER CASK annulus fill/drain lines at a rate of 375 CFM and a maximum temperature of 75°F	2 hours
	<u>AND</u> A.2.2 Maintain airflow for a minimum of 24 hours	Prior to restart of LOADING OPERATIONS

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.4.1	Monitor elapsed time from completion of helium backfill until completion of transfer of loaded CANISTER into CONCRETE CASK	Once at completion of helium backfill <u>AND</u> 4 hours thereafter
SR 3.1.4.2	Monitor elapsed time from completion of in-pool or forced-air cooling until completion of transfer of loaded CANISTER into CONCRETE CASK	Once at completion of cooling operations <u>AND</u> 4 hours thereafter

A 3.1 NAC-UMS® SYSTEM Integrity

A 3.1.5 CANISTER Helium Leak Rate

LCO 3.1.5 There shall be no indication of a helium leak at a test sensitivity of 1 x 10^{-7} cm^3/sec (helium) through the CANISTER shield lid to CANISTER shell confinement weld to demonstrate a helium leak rate equal to or less than 2 x 10^{-7} cm^3/sec (helium).

APPLICABILITY: During LOADING OPERATIONS

ACTIONS

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

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. CANISTER helium leak rate limit not met	A.1 Establish CANISTER helium leak rate within limit	25 days
B. Required Action and associated Completion Time not met	B.1 Remove all fuel assemblies from the NAC-UMS® SYSTEM	5 days

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.5.1	Verify CANISTER helium leak rate is within limit	Once prior to TRANSPORT OPERATIONS.

C 3.1 NAC-UMS® SYSTEM Integrity

C 3.1.1 CANISTER Maximum Time in Vacuum Drying

BASES

BACKGROUND

A TRANSFER CASK with an empty CANISTER is placed into the spent fuel pool and loaded with fuel assemblies meeting the requirements of the Approved Contents limits. 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.

Limiting the elapsed time from the end of CANISTER draining operations through dryness verification testing and subsequent backfilling of the CANISTER with helium ensures that the short-term temperature limits established in the Safety Analyses Report for the spent fuel cladding and CANISTER materials are not exceeded.

APPLICABLE SAFETY ANALYSIS

Limiting the total time for loaded CANISTER vacuum drying operations ensures that the short-term temperature limits for the fuel cladding and CANISTER materials are not exceeded. If vacuum drying operations are not completed in the required time period, the CANISTER is backfilled with helium, the TRANSFER CASK and loaded CANISTER are submerged in the spent fuel pool, and the TRANSFER CASK and loaded CANISTER are kept in the pool for a minimum of 24 hours.

(continued)

APPLICABLE SAFETY ANALYSIS (continued)

Analyses reported in the Safety Analysis Report conclude that spent fuel cladding and CANISTER material short-term temperature limits will not be exceeded for total elapsed time in the vacuum drying operation and in the TRANSFER CASK with the CANISTER filled with helium. Since the rate of heat up is slower for lower total heat loads, the time required to reach component limits is longer than for the design basis heat load. Consequently, longer time limits are specified for heat loads below the design basis for the PWR fuel configuration as shown in LCO 3.1.1. As shown in the LCO, for total heat loads not specified, the time limit for the next higher specified heat load is conservatively applied. Analysis also shows that the fuel cladding and CANISTER component temperatures are well below the allowable temperatures for the time durations specified from the end of in-pool cooling, or end of forced air cooling, of the CANISTER through the completion of the vacuum drying and for the time specified in LCO 3.1.4 for the CANISTER in the TRANSFER CASK when backfilled with helium.

LCO

Limiting the length of time for vacuum drying operations for the CANISTER ensures that the spent fuel cladding and CANISTER material temperatures remain below the short-term temperature limits for the NAC-UMS® SYSTEM.

APPLICABILITY

The elapsed time restrictions for vacuum drying operations on a loaded CANISTER apply during LOADING OPERATIONS from the completion point of CANISTER draining operations through the completion point of the CANISTER dryness verification testing. The LCO is not applicable to TRANSPORT OPERATIONS or STORAGE OPERATIONS.

ACTIONS

A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each NAC-UMS® SYSTEM. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each NAC-UMS® SYSTEM 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.

(continued)

C 3.1 NAC-UMS® SYSTEM Integrity

C 3.1.4 CANISTER Maximum Time in the TRANSFER CASK

BASES

BACKGROUND

A TRANSFER CASK with an empty CANISTER is placed into the spent fuel pool and loaded with fuel assemblies meeting the requirements of the Approved Contents limits. 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 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.

Backfilling the CANISTER cavity with helium promotes heat transfer from the fuel and the inert atmosphere protects the fuel cladding. Limiting the total time the loaded CANISTER is in the TRANSFER CASK, prior to its placement in the CONCRETE CASK, ensures that the short-term temperature limits established in the Safety Analysis Report for the spent fuel cladding and CANISTER materials are not exceeded.

APPLICABLE SAFETY ANALYSIS

Limiting the total time that a loaded CANISTER backfilled with helium may be in the TRANSFER CASK, prior to placement in the CONCRETE CASK, ensures that the short-term temperature limits for the spent fuel cladding and CANISTER materials are not exceeded. Upon placement of the loaded CANISTER in the CONCRETE CASK, the temperatures of the CANISTER and stored spent fuel will return to normal storage condition values due to the more efficient passive heat transfer characteristics of the CONCRETE

(continued)

APPLICABLE SAFETY ANALYSIS (continued)

CASK. Ensuring temperatures are maintained below short-term limits for a limited time period and returning them to values below long-term limits will prevent damage to the spent fuel cladding and the CANISTER materials.

Analyses reported in the Safety Analysis Report conclude that spent fuel cladding and CANISTER material short-term temperature limits will not be exceeded for the total elapsed times specified in LCO 3.1.4, in the TRANSFER CASK. Since the rate of heat up is slower for lower total heat loads, the time required to reach component limits is longer than for the design basis heat load. Consequently, longer time limits are specified for heat loads below the design basis for the PWR fuel configurations as shown in LCO 3.1.4. As shown in the LCO, for total heat loads not specified, the time limit for the next higher specified heat load is conservatively applied. Analysis also shows that the fuel cladding and CANISTER component temperatures are below their allowable temperatures for the time durations specified with the CANISTER in the TRANSFER CASK and backfilled with helium when the CANISTER is cooled in-pool or using forced air.

The basis for forced air cooling is an inlet maximum air temperature of 76°F which is the maximum normal ambient air temperature in the thermal analysis. The specified 375 CFM air flow rate exceeds the CONCRETE CASK natural convective cooling flow rate by a minimum of 10 percent. This comparative analysis conservatively excludes the higher flow velocity resulting from the smaller annulus between the TRANSFER CASK and CANISTER which would result in improved heat transfer from the CANISTER.

LCO

Limiting the length of time that the loaded CANISTER backfilled with helium is allowed to remain in the TRANSFER CASK ensures that the spent fuel cladding and CANISTER material temperatures remain below the short-term temperature limits established in the SAR for the NAC-UMS® SYSTEM. The time duration is a function of the design of the TRANSFER CASK and the NAC-UMS® SYSTEM.

(continued)