72-1025

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October 28, 2004

U.S. Nuclear Regulatory Commission
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Attn: Document Control Desk

Subject: Submittal of Updated NAC-MPC FSAR, Revision 5
Docket No. 72-1025

References:
1. Amendment No. 4 (CY vacuum drying enhancements) to Certificate of Compliance No. 1025 for the NAC International, Inc. Multi-Purpose Canister (NAC-MPC) System, United States Nuclear Regulatory Commission (USNRC), October 2004 (effective October 27, 2004)
2. Final Safety Analysis Report (FSAR) for the NAC International Multi-Purpose Canister (NAC-MPC) System, Revision 3, NAC International, November 24, 2003
3. Amendment No. 3 (Connecticut Yankee Fuel) to Certificate of Compliance No. 1025 for the NAC International, Inc. Multi-Purpose Canister (NAC-MPC) System, United States Nuclear Regulatory Commission (USNRC), October 8, 2003 (effective October 1, 2003)

NAC International (NAC) herewith provides five hard copies of the changed pages to update the NAC-MPC Final Safety Analysis Report (FSAR) to Revision 5 for the NAC-MPC Storage System. This FSAR update incorporates the Reference 1 amendment for Connecticut Yankee vacuum drying enhancements, as well as the changes that have been reviewed and approved by NAC under 10 CFR 72.48, and which have not been submitted previously to the NRC. The 10 CFR 72.48 Evaluation Summary Report for the NAC-MPC Storage System for the period of April 2004 – October 2004 is provided as Attachment 1. This summary report is provided in accordance with the requirements of 10 CFR 72.48(d)(2).

A detailed List of Changes for NAC-MPC FSAR, Revision 5, is provided as Attachment 2.

The NAC-MPC FSAR, Revision 5, reflects all of the requirements contained in the NAC-MPC CoC, Revision 0, Amendment 1, Amendment 2, Amendment 3 and Amendment 4.

NMSS01

If you have any comments or questions, please contact me at my direct number (678) 328-1321.

Sincerely,

T.C. Thompson

Thomas C. Thompson
Director, Licensing
Engineering

Attachment 1: 10 CFR 72.48 Evaluation Summary Report for the NAC-MPC Storage System (Period Covered: April 2004 – October 2004)

Attachment 2: List of Changes for NAC-MPC FSAR, Revision 5

Enclosures: Updated Pages for the NAC-MPC Final Safety Analysis Report, Revision 5

ATTACHMENT 1

10 CFR 72.48 Evaluation Summary Report
for the
NAC-MPC Storage System

Period Covered: April 2004 –October 2004

NAC International

October 2004

NAC-MPC FSAR, Revision 5

Summary of 10 CFR 72.48 Changes Included in Revision 5

72.48 Determination Checklist ID #NAC-04-MPC-004

Change Description

The Bases of LCO 3.1.1 (Chapter 12, C 3.1.1) are revised to provide guidance for additional time in forced air cooling in the event that forced air cooling, as required by Action A2.3 of LCO 3.1.1, is interrupted after it is initiated. Sections C 3.1.1 and C 3.1.4 are also revised to provide updated data consistent with the time limits presented in LCO 3.1.1 and 3.1.4.

Source of Change: 72.48 Determination Checklist ID #NAC-04-MPC-004

Originating Document: DCR(L) No. MPC-FSAR-4A

Note: DCR(L) MPC-FSAR-4A and 72.48 ID #NAC-04-MPC-004 were superseded by DCR(L) No. MPC-FSAR-4B and 72.48 ID #NAC-04-MPC-010.

NAC-MPC FSAR, Revision 5

Summary of 10 CFR 72.48 Changes Included in Revision 5

72.48 Determination Checklist ID #NAC-04-MPC-010

Change Description

Revises the Bases of LCO 3.1.1 and 3.1.4 (Chapter 12, C 3.1.1 and C3.1.4 of the FSAR) to make corrections to some changes incorporated via DCR(L) MPC-FSAR-4A so that the Bases are consistent with the requirements defined in LCO 3.1.1 and LCO 3.1.4.

Chapter 12, pages 12C3-11 and 12C3-12

Source of Change: 72.48 Determination Checklist ID #NAC-04-MPC-010

Originating Document: DCR(L) No. MPC-FSAR-4B

The Bases of LCO 3.1.1 (Chapter 12, C 3.1.1) are revised to provide guidance for additional time in forced air cooling in the event that forced air cooling, as required by Action A.2.3 of LCO 3.1.1, is interrupted after it is initiated.

NAC-MPC FSAR, Revision 5

Summary of 10 CFR 72.48 Changes Included in Revision 5

72.48 Determination Checklist ID #NAC-04-MPC-012

Change Description

Revises Section 1.7, License Drawings, Subsection 1.7.3, CY-MPC License Drawings, to incorporate Revision 6 of Drawing 414-860, Assembly, Transfer Cask (TFR), CY-MPC.

Chapter 1, page 1.7.3 & Revision 6 of Drawing 414-860

Source of Change: 72.48 Determination Checklist ID #NAC-04-MPC-012

Originating Document: DCR(L) No. MPC-FSAR-4C

This change revised Drawing 414-860, Assembly, Transfer Cask (TFR) to Revision 6.

Revision 6 of Drawing 414-860, Assembly, Transfer Cask (TFR), CY-MPC, contains the following changes:

- Adds Note 20: Paint/coating system may be reduced and/or removed in the area of the door-to-door rail interfaces to allow for better fit-up and operation of the doors.
- Adds chamfers to the door rails and door assemblies to facilitate insertion and operation of the doors.
- Changes Note 15 to read as follows: "Grind transition chamfers on the leading and trailing edges of the transfer cask door rail (Item 10) as required."
- Adds note: "Bottom plate of transfer cask (Item 1) may be locally ground to remove up to ¼" of material to enhance fit-up of doors, assemblies 97 and 98. Grind only at areas of interference or paint removal. Feather edges of ground areas."

All changes were made to facilitate fit-up and operation of the transfer cask doors.

NAC-MPC FSAR, Revision 5

Summary of 10 CFR 72.48 Changes Included in Revision 5

72.48 Determination Checklist ID #NAC-04-MPC-015

Change Description

Revises Chapter 8, Section 8.1.1.2, Loading and Closing the CY-MPC Transportable Storage Canister, to delete the specified time limit (15 minutes) for operating the helium leak detector.

Chapter 8, Section 8.1.1.2, Page 8.1-11, Step 45

Source of Change: 72.48 Determination Checklist ID #NAC-04-MPC-015

Originating Document: DCR(L) No. MPC-FSAR-4D

The 15-minute time frame for operation of the helium leak detector is an arbitrary number that was intended to allow enough time to purge the lines between the leak test fixture and the helium leak detector. There is no time duration for helium leak test performance in Section 9.1.3, Leak Tests, of the MPC FSAR. Once the acceptance criterion is achieved, the test is satisfactory without regard to the time duration to achieve the acceptance criteria.

In addition, the "Helium Mass Spectrometer Test – Hood Techniques" test method described in ASME Code Section V, Article 10, Appendix V, is described in ANSI N14.5-1997 as the "Evacuated Envelope" test method. Neither the ASME Code nor the ANSI Standard specifies a test performance time duration for this test method.

NAC-MPC FSAR, Revision 5

Summary of 10 CFR 72.48 Changes Included in Revision 5

72.48 Determination Checklist ID #NAC-03-MPC-022

Change Description

Revises Section 1.7, License Drawings, Subsection 1.7.3, CY-MPC License Drawings, to incorporate Revision 8 of Drawing 414-861, Weldment, Structure, Vertical Concrete Cask (VCC), CY-MPC.

Chapter 1, page 1.7.3 & Revision 8 of Drawing 414-861

Source of Change: 72.48 Determination Checklist ID #NAC-03-MPC-022

Originating Document: DCR(L) No. MPC-FSAR-4E

This change revised Drawing 414-861, Weldment, Structure, Vertical Concrete Cask (VCC), CY-MPC, to Revision 8.

Revision 8 of Drawing 414-861, Weldment, Structure, Vertical Concrete Cask (VCC), CY-MPC, contains the following change:

- Adds a hole, Ø.4 TYP, AS REQ'D, to Item 13, Inlet Side, approximately 27.0±1.0 from the outer edge and 1.75±.25 from the bottom of the bottom plate.

This change is designed to minimize water retention within the current as-built assemblies and to remove any future VCC water retention issues.

NAC-MPC FSAR, Revision 5

Summary of 10 CFR 72.48 Changes Included in Revision 5

72.48 Determination Checklist ID #NAC-03-MPC-023

Change Description

Revises Chapters 8 and 12 (Bases) to agree with the NAC-MPC CoC Amendment 4 Technical Specifications (LCOs 3.1.1, 3.1.3, 3.1.5 and 3.1.6)

Chapter 8, pages 8.1-7, 8.1-8, 8.1-10, 8.1-11, 8.1-13 & 8.1-14; Chapter 12, pages 12C3-13, 12C3-20, 12C3-22, 12C3-26, 12C3-27 & 12C3-28

Source of Change: 72.48 Determination Checklist ID #NAC-03-MPC-023

Originating Document: DCR(L) No. MPC-FSAR-4F

Chapter 8, Section 8.1.1.2, Loading and Closing the CY-MPC Transportable Storage Canister; Section 8.1.2, Loading the Vertical Concrete Cask; and Section 8.1.3, Transport and Placement of the Vertical Concrete Cask, are revised to reflect the procedures followed when loading the CY TSCs and VCCs based on the current approved NAC-MPC CoC Amendment 4 Technical Specifications (LCOs 3.1.1, 3.1.3, 3.1.5 and 3.1.6).

Chapter 12, Bases for LCOs 3.1.1, 3.1.3, 3.1.5 and 3.1.6 are revised to agree with the NRC-approved NAC-MPC CoC Amendment 4 Technical Specifications.

NAC-MPC FSAR, Revision 5

Summary of 10 CFR 72.48 Changes Included in Revision 5

72.48 Determination Checklist ID #NAC-03-MPC-024

Change Description

Identifies editorial corrections made to Chapters 3, 12 and 13 that came about during the preparation of Revision 5 as a result of combining Amendments MPC-03A & MPC-03B with Revision 4 of the MPC FSAR and incorporating DCR(L)s MPC-FSAR-4A through MPC-FSAR-4F.

Chapter 3, page 3.4.4-57; Chapter 12, pages 12C3-9, 12C3-10, 12C3-11, 12C3-12, 12C3-16, 12C3-23, 12C3-24 & 12C3-25; Chapter 13, page 13.2-9, Figure 13.2-1

Source of Change: 72.48 Determination Checklist ID #NAC-03-MPC-024

Originating Document: DCR(L) No. MPC-FSAR-4G

Chapters 3, 12 and 13 are revised to make editorial corrections that came about during the preparation of Revision 5 as a result of combining Amendments MPC-03A & MPC-03B with Revision 4 of the MPC FSAR and incorporating DCR(L)s MPC-FSAR-4A through MPC-FSAR-4F.

ATTACHMENT 2

List of Changes
for
NAC-MPC FSAR, Revision 5

NAC International

October 2004

List of Changes for the NAC-MPC FSAR, Revision 5
based on NAC-MPC FSAR, Revision 4
(incorporates Connecticut Yankee Amendments MPC-03A and MPC-03B, 10 CFR 72.48 changes for the period April 2004-October 2004

Chapter/Page/ Figure/Table	Source of Change: Amendment No./ 72.48/DCR(L) No.	Description of Change
Note: The List of Effective Pages and Chapter Tables of Contents have been revised accordingly to reflect the changes detailed below.		
Chapter 1		
Page 1-3	Amendment MPC-03A	Revised definitions of CY Fuel Inserts and Intact Fuel Assembly
Page 1.3-4	Amendment MPC-03A	Added 1st full paragraph to address Reactor Control Cluster Assemblies (RCCA)
Page 1.3-5	Amendment MPC-03A	Section 1.3.2.4 – revised section heading; 3rd sentence – changed "center" to "interior"
Page 1.3-6, Figure 1.3-1	Amendment MPC-03A	Revised figure title and deleted damaged fuel can illustration
Page 1.3-11, Table 1.3-2	Amendment MPC-03A	Revised footnote 4 and added footnote 6
Page 1.7-3	72.48/DCR(L)s MPC-FSAR-4C & -4E	Incorporated Rev. 6 of drawing no. 414-860 and Rev. 8 of drawing no. 414-861
Chapter 2		
Page 2.1-9	Amendment MPC-03A	Section 2.1.2.4 – revised section heading; 1st paragraph – revised throughout
Page 2.1-10	Amendment MPC-03A	Added 3rd full paragraph to address Reactor Control Cluster Assemblies (RCCA)
Chapter 3		
Page 3.4.3-72	Amendment MPC-03B	Added Section 3.4.3.8
Page 3.4.3-73	Amendment MPC-03B	Continuation of newly added Section 3.4.3.8
Page 3.4.4-57	72.48/DCR(L) MPC-FSAR-4G	Section 3.4.4.3.5, 1st sentence – changed "dead" to "dead weight"
Page 3.4.4-99	Amendment MPC-03A	Added Section 3.4.4.7 and Subsection 3.4.4.7.1
Page 3.4.4-100	Amendment MPC-03A	Continuation of newly added Subsection 3.4.4.7.1 and Subsection 3.4.4.7.2
Page 3.4.4-101, Figure 3.4.4.7-1	Amendment MPC-03A	Added new figure
Chapter 4		
Page 4.1-4, Table 4.1-2	Amendment MPC-03A	Revised last 2 lines of table, as well as footnotes 2 and 4
Page 4.1-5, Table 4.1-3	Amendment MPC-03A	Revised 2 rows of table; revised footnotes 1, 3, 4 and 5
Page 4.1-7, Table 4.1-5	Amendment MPC-03A	Revised 4 rows of table and added footnote 7
Page 4.5-1	Amendment MPC-03A	Section 4.5.1 – added new number 4 and subsequently renumbered following items

Chapter/Page/ Figure/Table	Source of Change: Amendment No./ 72.48/DCR(L) No.	Description of Change
Page 4.5-16	Amendment MPC-03A Amendment MPC-03B	Section 4.5.1.3, 2nd paragraph – revised throughout
	Amendment MPC-03A	Section 4.5.1.3 – added 4th paragraph to add supplemental heat option to vacuum drying process
Page 4.5-22	Amendment MPC-03A	Section 4.5.1.5, 2nd paragraph, 2nd sentence – changed "LINK31" to "MATRIX50"; 2nd paragraph, last sentence – changed "links" to "elements"
Page 4.5-24, Figure 4.5.1.5-1	Amendment MPC-03A	Revised figure title and replaced figure
Page 4.5-27	Amendment MPC-03A	Last paragraph – revised throughout
Page 4.5-29	Amendment MPC-03A	Section 4.5.3.3 – revised throughout to address vacuum drying issues
Page 4.5-30	Amendment MPC-03A	Continuation of Section 4.5.3.3 – revised throughout to address vacuum drying issues
Page 4.5-31	Amendment MPC-03A	1st paragraph – added 2nd sentence to clarify vacuum drying procedure In-Pool Cooling – revised throughout to address vacuum drying issues
Page 4.5-32	Amendment MPC-03A	Continuation of In-Pool Cooling revision Forced Air Cooling – revised throughout to address vacuum drying issues
Page 4.5-33	Amendment MPC-03A	Continuation of Forced Air Cooling revision
Page 4.5-38, Figure 4.5.3-4	Amendment MPC-03A	Inserted revised figure
Page 4.5-42, Table 4.5.3-4	Amendment MPC-03A	Table revised throughout; footnote 1 revised and footnote 4 deleted
Page 4.5-43, Table 4.5.3-5	Amendment MPC-03A	Table revised throughout; footnote 2 deleted
Page 4.5-44, Table 4.5.3-6	Amendment MPC-03A	Table revised throughout; footnote 2 deleted
Page 4.5-45, Table 4.5.3-7	Amendment MPC-03A	Table revised throughout; footnote 1 revised and footnote 2 added
Page 4.5-45, Table 4.5.3-8	Amendment MPC-03A	Table revised throughout; footnote 1 revised and footnote 2 added
Page 4.5-46, Table 4.5.3-9	Amendment MPC-03A	Table revised throughout; footnote 1 revised and footnote 2 added
Page 4.5-47, Table 4.5.3-10	Amendment MPC-03A	Revised last line of table and footnote 3
Page 4.5-52	Amendment MPC-03A	Deleted Section 4.5.7, "Maximum Allowable Fuel Rod Cladding Temperature" (including Figure 4.5.7-1 & Tables 4.5.7-1 through 4.5.7-5)
	Amendment MPC-03A	Renumbered Section titled "Evaluation of CY-MPC Performance for Normal Conditions of Storage"
Page 4.6-3	Amendment MPC-03A	Added last reference

Chapter/Page/ Figure/Table	Source of Change: Amendment No./ 72.48/DCR(L) No.	Description of Change
Chapter 8		
Page 8.1-7	Amendment MPC-03A	#12, last sentence of Note – revised throughout
	72.48/DCR(L) MPC-FSAR-4F	#12, 1st sentence of Note – revised throughout; last sentence of Note – added as a footnote to above table and revised throughout (superseded MPC-03A change)
Page 8.1-8	72.48/DCR(L) MPC-FSAR-4F	#24, 2nd Note – added "and pressure testing"
Page 8.1-9	Amendment MPC-03A	#28 – added 4th Note to allow an external heater to be used during vacuum drying #29 – added 2 Notes to allow additional vacuum drying options
Page 8.1-10	Amendment MPC-03A	#30 – added Note to allow heated forced air to be applied during vacuum drying (Note replaced; see next item)
	72.48/DCR(L) MPC-FSAR-4F	#30 – replaced Note added by Amendment MPC-03A with new Note to address forced air cooling and an interruption of the forced air cooling process #32 – deleted "(+1, -0 psig)"
Page 8.1-11	72.48/DCR(L) MPC-FSAR-4F	#34, 2nd Note – revised throughout #45 – added "(helium)"
	72.48/DCR(L) MPC-FSAR-4D	#45 – deleted "for 15 minutes"
Page 8.1-13	72.48/DCR(L) MPC-FSAR-4F	#15 – Note, 2nd sentence – revised throughout
Page 8.1-14	72.48/DCR(L) MPC-FSAR-4F	Section 8.1.3, 2nd paragraph – revised throughout
Page 8.1-18, Table 8.1-2	Amendment MPC-03A	4th row under table heading – changed "(Loaded Canister Canister (Loaded)" to "(Loaded Canister Lift)"
Chapter 12		
Page 12C3-9	72.48/DCR(L) MPC-FSAR-4G	C 3.1.1, Applicable Safety Analysis, 2nd sentence – added "per LCO 3.1.1.1.a or 3.1.1.1.b"
Page 12C3-10	Amendment MPC-03A	C 3.1.1 – added paragraph on FORCED AIR COOLING; Yankee-MPC, 1st paragraph, 1st sentence – added "Final"; deleted 4th sentence from Rev. 2, "As shown in the LCO … conservatively applied." Yankee-MPC, 2nd paragraph, 1st sentence – revised throughout; 2nd sentence – added "Final"; last sentence – changed "Section 2 of the LCO" to "LCO 3.1.1" Yankee-MPC – deleted last paragraph from Rev. 2
	72.48/DCR(L) MPC-FSAR-4G	C 3.1.1, Applicable Safety Analysis, Yankee-MPC, 1st paragraph, 3rd sentence – changed "LCO 3.1.1" to "LCO 3.1.1.1.a" 2nd paragraph, last sentence – changed "LCO 3.1.1" to "LCO 3.1.1.2.a"

Chapter/Page/ Figure/Table	Source of Change: Amendment No./ 72.48/DCR(L) No.	Description of Change
Page 12C3-11	Amendment MPC-03A	C 3.1.1, Applicable Safety Analysis, CY-MPC, 1st paragraph – revised throughout; 2nd paragraph, 1st sentence – revised throughout
	72.48/DCR(L) MPC-FSAR-4G	C 3.1.1, Applicable Safety Analysis, CY-MPC, 1st paragraph, 3rd sentence – changed “LCO 3.1.1” to “LCO 3.1.1.1.b”; 4th sentence – changed “allow commencement” to “allow for commencement” 2nd paragraph, 1st sentence – added “additional vacuum drying of”; last sentence – changed LCO 3.1.1” to LCO 3.1.1.2.b” 3rd paragraph, 1st sentence – added “during LCO 3.1.1” & changed FORCED AIR COOLING to all caps in 4 places
	72.48/DCR(L) MPC-FSAR-4B	C 3.1.1, Applicable Safety Analysis, CY-MPC, 3rd paragraph – added new text to address FORCED AIR COOLING interruption
Page 12C3-12	72.48/DCR(L) MPC-FSAR-4B	C 3.1.1, Applicable Safety Analysis, CY-MPC – added table and two following paragraphs to address FORCED AIR COOLING interruption
	72.48/DCR(L) MPC-FSAR-4G	C 3.1.1, Applicable Safety Analysis, CY-MPC, 1st paragraph – changed FORCED AIR COOLING to all caps in 3 places 2nd paragraph, 1st sentence – deleted “but less than the time limit for the CANISTER Maximum Time in the TRANSFER CASK (LCO 3.1.4),”; changed FORCED AIR COOLING to all caps in 4 places
Page 12C3-13	72.48/DCR(L) MPC-FSAR-4F	C 3.1.1, Applicability, 1st sentence – revised throughout
	Amendment MPC-03A	C 3.1.1, Actions – revised throughout
Page 12C3-14	Amendment MPC-03A	C 3.1.1., SR 3.1.1.1, last sentence – added “from the calculated times”; SR 3.1.1.2, last sentence – added “from the calculated times”
Page 12C3-15	Amendment MPC-03A	C 3.1.2, Applicable Safety Analysis, 3rd sentence – added “on removal of oxidizing gases”; 4th sentence – added “evacuating the CANISTER to a pressure of ≤ 3 mm Hg”; 5th sentence – changed “dried” to “dry”.
Page 12C3-16	Amendment MPC-03A	C 3.1.2, Applicable Safety Analysis – revised throughout
	72.48/DCR(L) MPC-FSAR-4G	C 3.1.2, Applicable Safety Analysis, 11th sentence – added “helium”; last sentence – added “helium”
Page 12C3-17	Amendment MPC-03A	C 3.1.2, Actions, B.1, 1st sentence – deleted “fuel cavity”
Page 12C3-18	Amendment MPC-03A	C 3.1.2, SR 3.1.2.1, 3rd sentence – revised for clarity; 4th sentence – deleted “(YANKEE-MPC or CY-MPC configurations)”; 5th sentence – changed “or the assumed inert atmosphere” to “or an inert atmosphere”

Chapter/Page/ Figure/Table	Source of Change: Amendment No./ 72.48/DCR(L) No.	Description of Change
Page 12C3-19	Amendment MPC-03A	C 3.1.3, Background, 2nd paragraph, 1st sentence – changed "promotes" to "provides for"; 2nd sentence – added "stored spent".
Page 12C3-20	Amendment MPC-03A	C 3.1.3, Applicable Safety Analysis, 1st partial paragraph – revised throughout; 2nd paragraph – changed "dried" to "dry".
	72.48/DCR(L) MPC-FSAR-4F	C 3.1.3, Applicable Safety Analysis, 1st partial paragraph, last sentence – revised throughout Applicability – deleted 2nd sentence
Page 12C3-22	72.48/DCR(L) MPC-FSAR-4F	C 3.1.3, Surveillance Requirements, 1st sentence – added "with helium" 2nd sentence – deleted "(YANKEE-MPC or CY-MPC configurations)" Deleted last 2 sentences
Page 12C3-23	Amendment MPC-03A	C 3.1.4, Background, 1st paragraph, 1st sentence – added "During LOADING OPERATIONS" Background, 1st paragraph, 8th sentence – changed "moving TRANSFER CASK" to "moving the TRANSFER CASK"; changed "transfer the CANISTER to the CONCRETE CASK" to "lower the CANISTER into the CONCRETE CASK" Background, 1st paragraph, 9th sentence – changed "After the CANISTER is transferred" to "After the CANISTER placement is completed" Background, 2nd & 3rd paragraphs – added new text
	72.48/DCR(L) MPC-FSAR-4G	C 3.1.4, Background, 2nd paragraph, last sentence – changed "the new" to "another"
Page 12C3-24	Amendment MPC-03A	C 3.1.4, Background, last paragraph – revised throughout Applicable Safety Analysis – revised throughout; deleted 5 paragraphs from previous revision LCO, 1st sentence – revised; deleted 2nd sentence Applicability – revised throughout
	72.48/DCR(L) MPC-FSAR-4G	C 3.1.4, Applicable Safety Analysis, 1st sentence – changed "the CONCRETE CASK" to "a CONCRETE CASK" Applicability, 1st sentence – added "per LCO 3.1.3"
Page 12C3-25	Amendment MPC-03A	C. 3.1.4, Actions -- new actions A.1 & B.1 SR 3.1.4.1 – revised throughout References – added "8.2 and 8.3"
	72.48/DCR(L) MPC-FSAR-4G	C 3.1.4, Actions, 2nd paragraph, last sentence – changed "until helium" to "until the helium"
Page 12C3-26	Amendment MPC-03A	C 3.1.5, Applicable Safety Analysis – deleted last sentence
	72.48/DCR(L) MPC-FSAR-4F	C 3.1.5, Background, last paragraph, 3rd sentence – revised throughout Applicable Safety Analysis – added new last sentence

Chapter/Page/ Figure/Table	Source of Change: Amendment No./ 72.48/DCR(L) No.	Description of Change
Page 12C3-27	72.48/DCR(L) MPC-FSAR-4F	C 3.1.5, Applicability, 1st sentence – changed "The leaktight helium leak rate verification" to "The helium leakage rate test" Actions, A.1, last sentence – changed "leak rate verification" to "leakage rate test"
Page 12C3-28	72.48/DCR(L) MPC-FSAR-4F	C 3.1.5, SR 3.1.5.1, 2nd paragraph, 1st sentence – changed "leak rate" to "leakage rate"; added "during LOADING OPERATIONS and"; 2nd sentence – changed "performs" to "perform" and "leak test" to "leakage rate test"
Page 12C3-31	Amendment MPC-03A	C 3.1.6, Added word "continued"
Page 12C3-33	Amendment MPC-03A	C 3.1.7, Background – deleted last paragraph
Page 12C3-34	Amendment MPC-03A	C 3.1.7, Applicable Safety Analysis – deleted 1st paragraph Applicability, 1st paragraph – added "per LCO 3.1.4"
Page 12C3-35	Amendment MPC-03A	C 3.1.7, Actions, 1st paragraph, 1st sentence – deleted "the time that the CANISTER is in the TRANSFER CASK is controlled by LCO 3.1.4 and" Actions – deleted 2nd paragraph and A.1; renumbered A.2 to A.1 SR 3.1.7.1 – deleted original SR and renumbered; changed "Condition A.2" to "Condition A.1"
Page 12C3-36	Amendment MPC-03A	C 3.1.7, Surveillance Requirements, 1st paragraph – changed "Nitrogen" to "nitrogen" & "longer flow allowed" to "longer flow is allowed"; 3rd paragraph – changed "flow" to "flows"
Page 12C3-37	Amendment MPC-03A	C 3.1.8 -- deleted
Page 12C3-39	Amendment MPC-03A	C 3.2.1, LCO, last paragraph – added last sentence
Page 12C3-40	Amendment MPC-03A	C 3.2.1, Actions, A.1, 2nd sentence – changed "7 days" to "25 days (600 hrs)" SR 3.2.1.2, last sentence – revised throughout
Chapter 13		
Page 13.2-9, Figure 13.2-1	72.48/DCR(L) MPC-FSAR-4G	Inserted updated organizational chart

Volume 1 of 2

October 2004

Revision 5

NAC-MPC

NAC Multi-Purpose Cask

FINAL SAFETY ANALYSIS REPORT

Docket No. 72-1025

NAC INTERNATIONAL

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List of Effective Pages

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1.5-10	Revision 2
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1.5-12	Revision 2

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1.5-55	Revision 2
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1.5-57	Revision 2
1.5-58	Revision 2
1.5-59	Revision 2
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2.1-19	Revision 3
2.1-20	Revision 3
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2.2-7	Revision 2
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2.2-9	Revision 2
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2.2-11	Revision 2
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2.3-3	Revision 0
2.3-4	Revision 3
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2.3-8	Revision 0
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2.3-17	Revision 3
2.3-18	Revision 3
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3.1-7	Revision 3
3.1-8	Revision 3
3.1.9	Revision 3
3.2-1	Revision 2
3.2-2	Revision 2
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3.3-1	Revision 2

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3.4.3-46	Revision 2
3.4.3-47	Revision 2
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3.4.4-98	Revision 3
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3.4.4-101	Revision 5
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3.6-1	Revision 2
3.6-2	Revision 2
3.6-3	Revision 4
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3.7-2	Revision 2
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3.8.1-2	Revision 0
3.8.1-3	Revision 0
3.8.1-4	Revision 0
3.8.2-1	Revision 0
3.8.2-2	Revision 0

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3.8.2-4	Revision 0
3.8.3-1	Revision 2
3.8.3-2	Revision 2
3.8.4-1	Revision 2
3.8.4-2	Revision 2
3.8.5-1	Revision 2
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4.2-5	Revision 2
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4.2-8	Revision 0
4.2-9	Revision 0
4.2-10	Revision 0
4.2-11	Revision 0
4.2-12	Revision 0
4.3-1	Revision 2
4.4-1	Revision 2
4.4-2	Revision 2
4.4-3	Revision 2
4.4-4	Revision 0
4.4-5	Revision 2
4.4-6	Revision 0
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4.4-8	Revision 2
4.4-9	Revision 2
4.4-10	Revision 0
4.4-11	Revision 2
4.4-12	Revision 2
4.4-13	Revision 2
4.4-14	Revision 0
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4.4-16	Revision 0
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4.4-28	Revision 2
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4.4-30	Revision 0
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4.4-37	Amendment 1
4.4-38	Amendment 1
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4.6-1	Revision 2
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Chapter 1

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Table 1-1 Terminology (continued)

Recaged Fuel Assembly	A Yankee Class Combustion Engineering fuel assembly lattice (skeleton) holding United Nuclear fuel rods with no empty fuel rod positions.
Retainer	A stainless steel component used to secure removable fuel rods in a United Nuclear assembly.
Connecticut Yankee Fuel Inserts	Reactor Control Cluster Assemblies, flow mixers or stainless steel rods that may be stored with the Connecticut Yankee spent fuel.
Intact Fuel Assembly	A fuel assembly without known or suspected cladding defects greater than pinhole leaks or a hairline cracks. Connecticut Yankee fuel assemblies with missing fuel rods, or with missing fuel rods replaced with solid filler rods, or with structural damage, are considered INTACT FUEL ASSEMBLIES, provided that they have no DAMAGED FUEL RODS. Yankee Class fuel assemblies with missing fuel rods replaced with Zircaloy or stainless steel rods, or with structural damage, are considered intact fuel assemblies provided that they have no damaged fuel rods.
Intact Fuel Rod	A fuel rod without known or suspected cladding defects greater than a pinhole leak or a hairline crack.
Yankee Damaged Fuel Assembly	A fuel assembly containing up to 20 missing or damaged fuel rods with known or suspected cladding defects greater than a hairline crack or a pinhole leak.
Connecticut Yankee Damaged Fuel Assembly	A fuel assembly with damaged fuel rods, or that cannot be handled by normal means, or both.
Damaged Fuel Rod	A fuel rod with known or suspected cladding defects greater than a hairline crack or a pinhole leak.

Table 1-1 Terminology (continued)

Damaged Fuel Can	A stainless steel container that is similar to an enlarged fuel tube that confines a Yankee Class Intact Fuel Assembly, Damaged Fuel Assembly, Recaged Fuel Assembly or a Reconfigured Fuel Assembly. A damaged fuel can is closed on its bottom end by a stainless steel bottom plate having screened openings and on its top end by a stainless steel lid that also has screened openings. The screened openings allow gaseous and liquid media to escape, but minimizes the dispersal of gross particulate. Use of the Damaged Fuel Can requires that four cans be used in the canister in conjunction with the use of a special shield lid machined to accept the cans.
Fuel Debris	Fuel in the form of particles, loose pellets and fragmented rods or assemblies.
Lattice	A fuel assembly structure that is used to hold up to 204 Intact Fuel Rods or Damaged Fuel Rods from other fuel assemblies. A Lattice is sometimes called a fuel skeleton, cage or structural cage. It is built from the same components as a standard fuel assembly, but some of those components may be modified slightly, such as relaxed grids, to accommodate the distortion that may be present in a Damaged Fuel Rod. The outside dimensions are identical to a standard fuel assembly.
Failed Rod Storage Canister	A handling container for moving up to 60 individual intact or damaged fuel rods in stainless steel tubes into a CY-MPC Damaged Fuel Can. The steel tubes are held in place by regularly spaced plates welded in an open stainless steel frame. The failed rod storage canister, which is closed at the top end by a bolted closure and at the bottom by a welded plate to capture the fuel rods in the tubes, must be loaded in a CY-MPC Damaged Fuel Can.

Table 1-1 Terminology (continued)

Structural Damage	Damage to the fuel assembly that does not prevent handling the fuel assembly by normal means. Structural damage is defined as partially torn, abraded, dented or bent grid straps, end fittings or guide tubes. The damaged grid straps or end fittings must continue to provide support to the fuel rods, as designed, and may not be completely torn or missing. Guide tubes cannot be ruptured and must be continuous between the upper and lower end fittings. Fuel assemblies with structural damage are considered to be intact fuel assemblies provided that they do not have failed or damaged fuel rods.
Canister Basket	The structure placed in the transportable storage canister to support the fuel assemblies (fuel basket).
-Support Disk	A circular stainless steel plate with square holes machined in a symmetrical pattern that provides the primary lateral load-bearing component of the canister basket.
-Heat Transfer Disk	A circular aluminum plate with square holes machined in a symmetrical pattern. The heat transfer disk enhances heat transfer in the fuel basket.
-Fuel Tube	A stainless steel tube having a square cross-section that may have BORAL neutron poison material on its exterior surfaces.
-Tie Rod	A stainless steel rod used to align the support disks and heat transfer disks in the fuel basket structure.
-Split Spacer	Spacers installed on the tie rod between the support disks to properly position, and provide axial support for, the support disks and the heat transfer disks.
Shield Lid	The primary confinement boundary for the canister. It is located directly above the canister basket and is provided in two configurations. The Damaged Fuel Can configuration may not be used interchangeably with the intact fuel configuration.
-Drain Port	A penetration located in the shield lid to permit draining of the canister cavity.

Table 1-1 Terminology (continued)

-Vent Port	A penetration located in the shield lid to aid in draining and backfilling the canister cavity.
-Port Cover	The stainless steel covers that close the vent and drain ports, which are welded in place following draining, drying, and backfilling operations.
-Quick Disconnect	The quick-disconnect valved nipple used in the vent and drain ports to facilitate operations.
Structural Lid	The secondary confinement boundary for the canister. The structural lid provides the lifting point for the loaded canister.
Vertical Concrete Cask **(Concrete Cask)** **(Storage Cask)**	A reinforced concrete cylinder closed at the top end by a shield plug and lid that holds the transportable storage canister during storage. The vertical concrete cask is formed around a steel inner liner and base.
- Shield Plug	A thick carbon steel plug installed in the top end of the storage cask to reduce skyshine radiation. The shield plug also contains a neutron shield material.
- Lid	A thick carbon steel bolted closure for the storage cask. The lid precludes access to the canister and provides additional radiation shielding.
- Liner	A thick carbon steel shell that forms the annulus of the concrete storage cask. The liner serves as the inner form during concrete pouring and provides radiation shielding of the canister contents.
- Base	A carbon steel weldment that contains the inlet air vents, the storage cask jacking points, and the pedestal that supports the canister inside the storage cask.
Transfer Cask	A shielded lifting device for the empty and loaded canister. It is used for the vertical transfer of the canister between work stations and the storage cask or the transport cask. The transfer cask incorporates bottom doors that permit the vertical loading of the storage and transport casks.
- Lifting Trunnions	Carbon steel trunnions used to lift and move the transfer cask.

Table 1-1 Terminology (continued)

Adapter Plate	A carbon steel plate that attaches to the top of the transport or storage cask to facilitate the installation and alignment of the transfer cask. It also provides the operating mechanism for the transfer cask bottom doors.
Margin of Safety	An analytically determined value defined as the "factor of safety" minus 1. Factor of safety is also analytically determined and is defined as the allowable stress of a material divided by its actual (calculated) stress.
Yankee-MPC Reconfigured Fuel Assembly	A stainless steel canister having the same external dimensions as a standard Yankee Class fuel assembly, that ensures criticality control geometry and which permits gaseous and liquid media to escape while minimizing dispersal of gross particulates. It may contain a maximum of 64 intact fuel rods or damaged fuel rods, or fuel debris from any type of Yankee Class spent fuel assembly. .

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individual fuel rods will be placed into a CY-MPC reconfigured fuel assembly for storage in the CY-MPC system. The criteria for storage of fuel assemblies in damaged fuel cans is described in Section 2.1.2.3. The criteria for storage of individual fuel rods in CY-MPC reconfigured fuel assemblies is described in Section 2.1.2.2.

1.3.2.1 Spent Fuel Assemblies

The CY-MPC is designed to store up to 26 Connecticut Yankee spent fuel assemblies. The Connecticut Yankee fuel consists of 15x15 PWR fuel assemblies manufactured by Westinghouse, Gulf Nuclear/Gulf General Atomic, NUMEC and by Babcock & Wilcox. Approximately 10% of the Connecticut Yankee spent fuel inventory is Zircaloy-clad. The remaining assemblies are stainless steel clad. The Zircaloy clad assemblies vary in initial enrichment from 2.95 to 4.61 wt % ^{235}U and have a maximum burnup of 43,000 MWD/MTU. The stainless steel clad assemblies vary in initial enrichment from 3.0 to 4.03 wt % ^{235}U and have a maximum burnup of 38,000 MWD/MTU.

The characteristics of the Connecticut Yankee spent fuels are presented in Tables 1.3-2 and 2.1-3. The Zircaloy clad Westinghouse Vantage 5H fuel assembly enriched to 4.61 wt % ^{235}U is the most reactive fuel and is the design basis fuel for the criticality evaluation. The shielding evaluation uses the Westinghouse stainless steel clad fuel assembly with a minimum enrichment of 3.65 wt % ^{235}U, a fuel mass of 432 kg U and a burnup of 38,000 MWD/MTU as the design basis stainless steel clad fuel. This fuel assembly is also the design basis for the structural and thermal evaluations, using an assembly weight of 1,350 lbs and decay heat up to 840 watts. The shielding design basis Zircaloy clad fuel uses a minimum enrichment of 3.59 wt % ^{235}U, a fuel mass of 395 kg U and a burnup of 43,000 MWD/MTU. These parameters are selected to represent the bounding mix of those that could occur in loading Zircaloy clad fuel but they do not match those of any single Connecticut Yankee fuel assembly.

Unenriched fuel assemblies are not evaluated and are not included as a proposed contents. Zircaloy clad fuel assemblies with enrichments greater than 3.93 wt % ^{235}U may only be placed in the 24-assembly basket configuration, while the remaining fuel may be placed into the 26-assembly baskets. Connecticut Yankee fuel assemblies may have a Flow Mixer/Thimble Plug assembly or a Reactor Control Cluster Assembly component inserted as described in Section 1.3.2.4.

To achieve greater flexibility in loading the Connecticut Yankee fuel assemblies, a set of parameters have been established to restrict loading of certain fuel assemblies into particular locations in the fuel basket, or into a particular basket configuration (24 or 26 assembly capacity) based on enrichment, burnup, cooling time, and cladding type. A description of the preferential fuel loading requirements is presented in Section 2.1.2.1.

Solid stainless steel rods, approximately 21 inches long, may be inserted into Connecticut Yankee intact and damaged fuel assembly Reactor Control Cluster Assemblies (RCCA) guide tubes not containing a RCCA. The stainless steel rods are intended to displace the water from the lower end of the RCCA guide tubes during draining of the canister. The height of the first drainage hole of the RCCA guide tube is over 21 inches from the bottom of the tube. The 20 RCCA guide tubes per assembly could retain significant amounts of water. This water would be required to be removed by vacuum drying. The small diameter of the RCCA guide tubes, the height of water in the tube, and the minimal decay heat in the location of the tubes would make removal of the water by the vacuum drying process extremely difficult. The rods will be installed in the assemblies prior to loading the assemblies into the canister.

1.3.2.2 Connecticut Yankee (CY-MPC) Reconfigured Fuel Assembly

The CY-MPC reconfigured fuel assembly consists of a stainless steel 10 x 10 array of tubes attached to upper and lower end fittings that are similar to those used on standard fuel assemblies. This allows handling using standard fuel assembly handling equipment. The tubes are designed to hold individual fuel rods that have been removed from fuel assemblies. The diameter of the tubes is sized to allow the insertion of individual damaged or bowed fuel rods.

The CY-MPC reconfigured fuel assembly is fabricated from stainless steel and has top and bottom closures that allow the release of gaseous products and liquids but minimizes the dispersal of particulates. The cross-section dimension restricts loading to one of the four corner "oversized fuel" basket positions.

A sketch of the CY-MPC reconfigured fuel assembly is provided in Figure 1.3-2. The major physical design parameters are presented in Table 1.3-3. The design and fabrication specification summary is provided in Table 1.3-6. A discussion of the preferential loading of the CY-MPC reconfigured fuel assembly is presented in Section 2.1.2.2.

1.3.2.3 Connecticut Yankee (CY-MPC) Damaged Fuel Cans

The damaged fuel can is designed to hold a complete (intact or damaged) fuel assembly, a fuel assembly lattice holding individual fuel rods, or a failed rod storage canister, which may hold one or more damaged fuel rods. The failed rod storage canister is shown in Figure 1.3-4. Damaged fuel includes fuel assemblies that cannot be handled with normal fuel handling equipment, or which have one or more individual fuel rods that are classified as failed. The damaged fuel can has a square cross-section that is slightly larger than a standard Connecticut Yankee fuel assembly. Consequently, loading of the damaged fuel can into the CY-MPC canister basket is restricted to one of the four corner "oversized fuel" basket positions. The damaged fuel can is fabricated from stainless steel and has top and bottom closures that allow the release of gaseous products and liquids but minimizes the dispersal of particulates.

A sketch of the CY-MPC damaged fuel can is provided in Figure 1.3-3. The major physical design parameters are presented in Table 1.3-4. The design and fabrication specification summary is provided in Table 1.3-6. A discussion of the damaged fuel can preferential loading of the CY-MPC reconfigured fuel assembly is presented in Section 2.1.2.3.

1.3.2.4 Connecticut Yankee (CY-MPC) Fuel Inserts

Some of the Connecticut Yankee fuel assemblies will be stored in the CY-MPC Storage System with Flow Mixers or with Reactor Control Cluster Assemblies installed. Flow mixers are thimble plug assemblies used during reactor operation to maintain equal coolant flow in fuel assemblies that do not contain a reactor control cluster. Loading of flow mixers is limited to fuel assemblies in the eight (8) interior positions of the CY-MPC basket. Consequently, fuel assemblies with flow mixers installed are subject to preferential loading controls. Reactor control clusters were used to control the reactivity of the Connecticut Yankee reactor during operations and shutdown. All of the spent fuel assemblies installed in a CY-MPC basket may also hold a reactor control cluster. The evaluation of this non-fuel hardware, stored with the fuel assemblies, is presented in Section 2.1.2.4.

Figure 1.3-1 Yankee-MPC Reconfigured Fuel Assembly

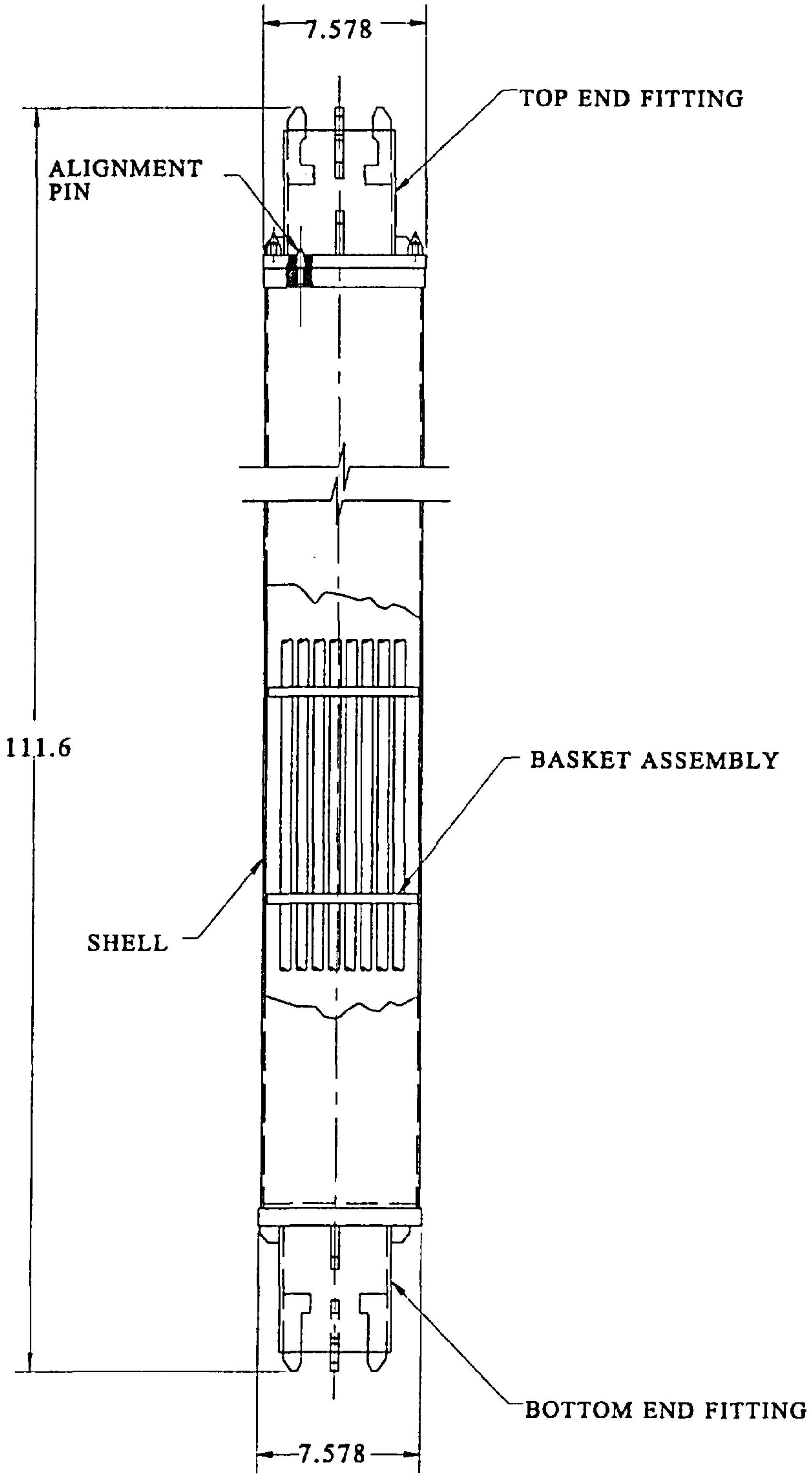

Table 1.3-2 Connecticut Yankee Design Basis Fuel Characteristics

Parameter	CY Spent Fuel[1, 2, 3, 4, 5, 6]		
	Westinghouse	Babcock and Wilcox	Westinghouse Vantage 5H
Number of Assemblies per Canister	26	26	24
Assembly Weight, lbs.	1,350	1,230	1,230
Assembly Length, in.	137.1	137.1	137.0
Active Fuel Length, in.	121.8	121.1	120.6
Fuel Rod Cladding	Stainless Steel	Zircaloy	Zircaloy
Maximum Uranium, kgU	432	395	390
Maximum Initial ^{235}U, wt %	3.65	3.59	4.61
Maximum Burnup, MWD/MTU	38,000	43,000	43,000
Maximum Assembly Decay Heat, kW			
Uniform Loading	0.674	0.674	0.674
Preferential Loading	0.840	0.840	0.840
Maximum Decay Heat, kW	17.5	17.5	17.5
Minimum Cool Time, yr	6	6	6

1. The Connecticut Yankee spent fuel includes Westinghouse Electric Company (Westinghouse), Babcock & Wilcox (B&W), Gulf General Atomic (GGA), Gulf Nuclear Fuel Co. (GNFC) and Nuclear Materials and Manufacturing Co. (NUMEC). The Westinghouse Vantage 5H is the most reactive assembly and is used as the design basis fuel for criticality analyses. The Westinghouse stainless steel fuel is the design basis fuel for shielding, thermal, and structural evaluations.

2. The CY-MPC can accommodate up to four CY-MPC Reconfigured Fuel Assemblies containing up to 100 fuel rods or rod segments classified as failed installed in the corner (oversized) fuel positions of either basket.

3. Up to four damaged fuel cans may be installed in the CY-MPC corner (oversized) fuel positions of either basket.

4. Intact fuel assemblies may have a reactor control cluster assembly (RCCA) installed and are not restricted as to loading position in the basket.

5. Intact fuel assemblies may have a flow mixer installed. Fuel assemblies with flow mixers must be loaded in one of the eight interior positions in the basket.

6. Solid stainless steel rods may be inserted into CY fuel assembly RCCA guide tubes for fuel assemblies not containing a RCCA.

Table 1.3-3 Major Physical Design Parameters of the CY-MPC Reconfigured Fuel Assembly

Parameter	**Value**
Overall Length (in.)	141.5
Fuel Rod Tube Array	10 x 10
Outside Cross Section (in.)	8.9
Tube Outside Diameter (in.)	0.56
Tube Wall Thickness (in.)	0.035
Tube Length (in.)	135.6
Empty Weight (nominal) (lbs.)	575

Table 1.3-4 Major Physical Design Parameters of the CY-MPC Damaged Fuel Can

Parameter	**Value**
Overall Length (in.)	141.5
Inside Cross Section (in.)	8.67
Outside Cross Section (in.) (1)	8.88
Can Wall Thickness	18 gauge (0.05 in)
Internal Cavity Length (in.)	138.5
Empty Weight (nominal) (lbs.)	111

1. Outside cross section of the Damaged Fuel Can upper structure is 9.08 x 9.08 in. at top (4.5 in.) for lid engagement and fuel can lifting. This upper structure is located above the top weldment plate of the fuel basket assembly.

1.7.3 CY-MPC License Drawings

Drawing Number	Title	Revision No.	No. of Sheets
414-856	Nameplate, Vertical Concrete Cask (VCC), CY-MPC	3	1
414-860	Assembly, Transfer Cask (TFR), CY-MPC	6	5
414-861	Weldment, Structure, Vertical Concrete Cask (VCC), CY-MPC	8	3
414-862	Loaded Vertical Concrete Cask (VCC), CY-MPC	4	1
414-863	Lid, Vertical Concrete Cask (VCC), CY-MPC	4	1
414-864	Shield Plug, Vertical Concrete Cask (VCC), CY-MPC	3	1
414-866	Reinforcing Bar and Concrete Placement, Vertical Concrete Cask (VCC), CY-MPC	4	4
414-870	Canister Shell, CY-MPC	3	1
414-871	Details, Canister, CY-MPC	6	2
414-872	Assembly, Transportable Storage Canister (TSC), CY-MPC	6	3
414-873	Drain Tube Assembly, CY-MPC	2	1
414-874	Shim, Canister, CY-MPC	0	1
414-875	Spacer Shim, Canister, CY-MPC	0	1
414-881	Fuel Tube, Transportable Storage Canister (TSC), CY-MPC	4	2
414-882	Oversize Fuel Tube, Transportable Storage Canister (TSC), CY-MPC	4	2
414-891	Bottom Weldment, Fuel Basket, CY-MPC	3	1
414-892	Top Weldment, Fuel Basket, CY-MPC	3	3
414-893	Support Disk and Misc. Basket Details, CY-MPC	2	2
414-894	Heat Transfer Disk, Fuel Basket, CY-MPC	0	1
414-895	Fuel Basket Assembly, CY-MPC	4	2
414-901	Assembly, Damaged Fuel Assembly Can, CY-MPC	1	1
414-902	Details, Damaged Fuel Assembly Can, CY-MPC	3	3
414-903	Reconfigured Fuel Assembly, CY-MPC	1	2
414-904	Details, Reconfigured Fuel Assembly, CY-MPC	0	3
414-917	Door Stop, CY-MPC	1	2
455-821*	Adapter Ring, Transfer Adapter to NAC-STC MPC-Yankee	0	1
455-859*	Assembly, Transfer Adapter, NAC-MPC	5	4

*Note, these drawings are also listed in Section 1.7.1 for the Yankee-MPC Drawings.

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REV	CHANGE
0	INITIAL ISSUE
1	INC DCR 0A, 0B, 0C
2	INC DCR 1A
3	INC DCR 2A,2B,2C,2D,2E
4	INC DCR 3A,3B,3C
5	INC DCR 4A
6	INC DCR 5A,5B,5C,5D

NOTES:

1. ALL WELDING PROCEDURES AND QUALIFICATIONS TO BE IN ACCORDANCE WITH AWS D1.1 OR ASME SECT. IX.
2. VISUALLY INSPECT (VT) ALL WELDS IN ACCORDANCE WITH ASME SECTION V, ARTICLE 9. ACCEPTANCE PER ASME SECTION III, NF-5360. AFTER LOAD TESTING, MAG. PARTICLE TEST (MT) ALL ACCESSIBLE WELDS IN ACCORDANCE WITH ASME SECTION V, ARTICLE 7. ACCEPTANCE PER ASME SECTION III, NF-5340.
3. BACKING BARS ARE OPTIONAL.
4. THE TRUNNION (ITEM 5) INNER FACE SHALL BE FLUSH WITH THE INSIDE DIAMETER OF THE INNER SHELL (ITEM 2).
5. THE TRUNNIONS (ITEM 5) SHALL BE COAXIAL TO WITHIN .100.
6. TRANSFER DRILL LOCATIONS FOR ITEM 13, DOOR LOCK BOLTS FROM ITEM 10 TO ITEMS 11 AND 12, SHIELD DOORS.
7. REMOVE ANY OIL AND/OR GREASE FROM ALL SURFACES IN ACCORDANCE WITH SSPC-SP 1. COMMERCIAL BLAST CLEAN PER SSPC-SP 10. APPLY CARBOLINE 890 OR KEELER & LONG E-SERIES EPOXY ENAMEL COATING PER MANUFACTURERS APPLICATION INSTRUCTIONS.
8. THE MATING SURFACES BETWEEN THE DOOR RAILS AND THE SHIELD DOORS SHALL BE COATED WITH A SPENT FUEL POOL COMPATIBLE LUBRICANT, SUCH AS NEOLUBE.
9. MATCH DRILL LOCATIONS FROM ITEM 14. TAP 3/4-10 UNC-2B X 1.5 DEEP.
10. 1/4" MAX GAP AT THE TOP OF NEUTRON SHIELDING. NEUTRON SHIELD TO CONTAIN 0.6 WEIGHT PERCENT B_4C MIN.
11. LOCATION FOR SEAM AND GIRTH WELDS, NUMBER AND LOCATION, OPTIONAL. ADJACENT SECTIONS WITH SEAM WELDS SHALL BE OFFSET.
12. CONTROL OVERALL HEIGHT AS SHOWN. FIRST ROW OF BRICKS SHALL BE FLAT BOTTOM WITH CHAMFERS TOWARD THE INSIDE TO ALLOW PROPER FIT-UP TO THE BASE PLATE AND SHELL. TOP ROW MAY BE FLAT IF OVERALL HEIGHT ADJUSTMENTS ARE NEEDED.
13. STEEL STAMP/ENGRAVE AS SHOWN WITH 2.0 HIGH LETTERS APPROXIMATELY .03 DEEP AND FILL WITH BLACK WEATHER RESISTANT PAINT. ACTUAL ASSEMBLED WEIGHT TO BE STAMPED IN PLACE OF X'S AT TIME OF FABRICATION. ALTERNATIVELY, INFORMATION MAY BE STEEL STAMPED/ENGRAVED ONTO AN 11 GAUGE STAINLESS STEEL SHEET AND SEAL WELDED ALL AROUND TO THE OUTER SHELL.
14. COMMERCIAL GRADE LEAD WOOL MAY BE USED TO FILL OPEN SPACES AT THE TRUNNIONS
15. ⑥ GRIND TRANSITION CHAMFERS ON THE LEADING AND TRAILING EDGES OF THE TRANSFER CASK DOOR RAIL (ITEM 10) AS REQUIRED
16. GRIND TRANSITION CHAMFERS ON THE LEADING AND TRAILING EDGES OF THE 2.25 IN. X 2.00 IN. SHOULDER 1/8 IN. X 30-45 DEGREES.
17. SEAL WELD ALL OPEN SEAMS BETWEEN ITEM 10 AND ITEM 1.
18. LOCATE AT ASSEMBLY, WITH DOORS CENTERED, FULLY CLOSED AND WITH THE DOWEL PIN IN CONTACT WITH THE TRANSFER CASK BASE/OUTER SHELL. MAINTAIN A .25 MINIMUM OUTER EDGE DISTANCE. DRILL AND REAM FOR A PRESS-FIT 1.0 DEEP INTO ITEM 11 AND 12 (2 EACH).
19. AT THE USERS OPTION EITHER: FOUR (4) OF ITEM 13, OR (2) OF ITEM 28 (ONE (1) FOR EACH DOOR) SHALL BE USED.
20. ⑥ PAINT/COATING SYSTEM MAY BE REDUCED AND/OR REMOVED IN THE AREA OF THE DOOR TO DOOR RAIL INTERFACES TO ALLOW FOR BETTER FIT UP AND OPERATION OF THE DOORS.
21. ⑥ BOTTOM PLATE OF TRANSFER CASK, ITEM 1, MAY BE LOCALLY GROUND TO REMOVE UP TO 1/4" OF MATERIAL TO ENHANCE FIT-UP OF DOORS, ASSEMBLIES 97 AND 98. GRIND ONLY AT AREAS OF INTERFERENCE OR PAINT REMOVAL. FEATHER EDGES OF GROUND AREAS.

96 ASSY	97 ASSY	98 ASSY	99 ASSY	ITEM	NAME	MATERIAL	SPEC	DRAWING No.	DESCRIPTION
			2	28	DOOR STOP			414-917-99	
			4	27	DOWEL PIN	ST. STL.	COML		ø5/8 X 2 LONG
			1	26	NAMEPLATE	ST. STL.	COML		11 GAUGE SHEET
A/R	A/R	A/R	A/R	25	COMMERCIAL GRADE LEAD WOOL		PER NOTE 14		
A/R	A/R	A/R	A/R	24	BLACK WEATHER RESISTANT PAINT		PER NOTE 13		
A/R	A/R	A/R	A/R	23	SPENT FUEL POOL COMPATIBLE LUBRICANT		PER NOTE 8		
A/R	A/R	A/R	A/R	22	COATING SYSTEM		PER NOTE 7		
1				21	FILL/DRAIN LINE PIPE	ST. STL.	COML		1 IN. SCH 40 PIPE
1				20	FILL/DRAIN LINE PLATE	ST. STL.	COML		11 GAUGE SHEET
			1	19	DOOR ASSEMBLY B			414-860-98	
			1	18	DOOR ASSEMBLY A			414-860-97	
	1	1		17	CONNECTOR	LOW ALLOY STEEL	COML		4 PLATE
			10	16	FILL/DRAIN LINE			414-860-96	
			24	15	RETAINING RING BOLT	HIGH ALLOY STEEL	ASME SA193 GR. B6		3/4-10 UNC-2A, 2.00 LG HEX HEAD BOLT
			1	14	RETAINING RING	LOW ALLOY STEEL	ASTM A588		3/4 PLATE
			4	13	DOOR LOCK BOLT	ST. STL.	COML		1 1/8 HEX BAR
		1		12	SHIELD DOOR B	LOW ALLOY STEEL	ASTM A350 LF2		FORGING
	1			11	SHIELD DOOR A	LOW ALLOY STEEL	ASTM A350 LF2		FORGING
			2	10	DOOR RAIL	LOW ALLOY STEEL	ASTM A350 LF2		FORGING
			1	9	TOP PLATE	LOW ALLOY STEEL	ASTM A588		2 PLATE
			AR	8	NEUTRON SHIELD	NS-4-FR	COML		
			2	7	SCUFF PLATE	ST. STL.	COML		11 GAUGE SHEET
			2	6	TRUNNION CAP	LOW ALLOY STEEL	COML		3/8 PLATE
			2	5	TRUNNION	LOW ALLOY STEEL	ASTM A350 LF2		FORGING
			1	4	OUTER SHELL	LOW ALLOY STEEL	ASTM A588		1 1/4 PLATE
			3285	3	GAMMA SHIELD BRICK	LEAD (PB)	ASTM B29		CHEMICAL COPPER GRADE
			1	2	INNER SHELL	LOW ALLOY STEEL	ASTM A588		3/4 PLATE
			1	1	BOTTOM PLATE	LOW ALLOY STEEL	ASTM A588		1 PLATE

QUANTITY

UNLESS OTHERWISE STATED

DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5M-94, UNSPECIFIED DIMENSIONAL TOLERANCES ARE SHOWN BELOW

ALL THREAD DEPTH CALLOUTS ARE TO BE CONSIDERED AS A MIN. DEPTH OF PERFECT THREADS. THE ACTUAL DEPTH OF THE THREADS IS NOT SUBJECT TO TOLERANCE CONTROLS

.XXX	UNDER 3	±.003	WEIGHTS ARE APPROXIMATE AND ARE TO BE USED FOR HANDLING PURPOSES ONLY
	3-12	±.005	ALL DIMENSIONS ARE IN INCHES
	OVER 12	±.010	BORDER SIZE: F (40 X 28)
.XX	UNDER 6	±.02	ALL UNSPECIFIED TOOL RADII .015 - .030
	6-18	±.03	BREAK ALL SHARP CORNERS .015 - .030
	OVER 18	±.06	MACHINED SURFACES TO BE ▽ OR BETTER
.X	ALL	±.1	NEXT ASSEMBLY: N/A
FRACTIONAL ±1/8			DRAWING TYPE: LICENSE
ANGLES ±0.5°			

GROUP	NAME	DATE
PREPARER		6-10-04
CHECKER	R. [illegible]	6-15-04
PROJECT MANAGER		6/21/04
ENGINEERING		6/21/04
LICENSING		6/21/04
QUALITY		6/22/04

NAC INTERNATIONAL

ASSEMBLY,
TRANSFER CASK (TFR)
CY-MPC

PROJECT 414 | DRAWING 860 | REV 6
SCALE 1/12 | WEIGHT NOTED | SH 1 OF 5 | 10:19AM 6-10-2004

FIGURE WITHHELD UNDER 10 CFR 2.390

NAC INTERNATIONAL

ASSEMBLY,
TRANSFER CASK (TFR)
CY-MPC

PROJECT 414		DRAWING 860	REV 6
SCALE 1/10	WEIGHT NOTED	SH 2 OF 5	10:20AM 6-10-2004

FIGURE WITHHELD UNDER 10 CFR 2.390

NAC INTERNATIONAL

ASSEMBLY,
TRANSFER CASK (TFR)
CY-MPC

PROJECT 414		DRAWING 860	REV 6
SCALE 1/10	WEIGHT NOTED	SH 3 OF 5	10:22AM 8-10-2004

FIGURE WITHHELD UNDER 10 CFR 2.390

NAC
INTERNATIONAL

ASSEMBLY,
TRANSFER CASK (TFR)
CY-MPC

PROJECT 414		DRAWING 860	REV 6
SCALE 1/8	WEIGHT NOTED	SH 4 OF 5	10:24AM 8-10-2004

FIGURE WITHHELD UNDER 10 CFR 2.390

NAC INTERNATIONAL

ASSEMBLY,
TRANSFER CASK (TFR)
CY-MPC

PROJECT 414		DRAWING 860	REV 6
SCALE 1/12	WEIGHT NOTED	SH 5 OF 5	10:37AM 8-10-2004

FIGURE WITHHELD UNDER 10 CFR 2.390

ASSY	ASSY	ASSY
QUANTITY		

UNLESS OTHERWISE STATED

DIMENSIONING AND TOLERANCING SHALL BE PER ASME Y14.5M-94, UNSPECIFIED DIMENSIONAL TOLERANCES ARE SHOWN BELOW

ALL THREAD DEPTH CALLOUTS ARE TO BE CONSIDERED AS A MIN DEPTH OF PERFECT THREADS. THE ACTUAL DEPTH OF THE THREADS IS NOT SUBJECT TO TOLERANCE CONTROLS.

.XXX	UNDER 3	±.003	WEIGHTS ARE APPROXIMATE AND ARE TO BE USED FOR HANDLING PURPOSES ONLY
	3-12	±.005	ALL DIMENSIONS ARE IN INCHES
	OVER 12	±.010	BORDER SIZE, F (40 X 28)
.XX	UNDER 6	±.02	ALL UNSPECIFIED TOOL RADII: .015 - .030
	6-18	±.03	BREAK ALL SHARP CORNERS .015 - .030
	OVER 18	±.06	MACHINED SURFACES TO BE ▽ OR BETTER
.X	ALL	±.1	NEXT ASSEMBLY: 414-866
FRACTIONAL ±1/8			DRAWING TYPE: LICENSE
ANGLES ±0.5°			

GROUP	NAME	DATE
PREPARER	R. Walton	8-18-04
CHECKER		8-19-04
PROJECT MANAGER		8-19-04
ENGINEERING		8/20/04
LICENSING		8/20/04
QUALITY		8/20/04

NAC INTERNATIONAL

WELDMENT STRUCTURE,
VERTICAL CONCRETE CASK (VCC),
CY-MPC

PROJECT 414	DRAWING 861	REV 8
SCALE 1/16	WEIGHT NOTED	SH 1 OF 3

FIGURE WITHHELD UNDER 10 CFR 2.390

NAC
INTERNATIONAL

WELDMENT, STRUCTURE,
VERTICAL CONCRETE CASK (VCC)
CY–MPC

PROJECT 414		DRAWING 861	REV 8
SCALE 1/16	EST.WT. NOTED	SH 2 OF 3	11:25AM 8-18-2004

FIGURE WITHHELD UNDER 10 CFR 2.390

NAC INTERNATIONAL

WELDMENT, STRUCTURE,
VERTICAL CONCRETE CASK (VCC)
CY–MPC

PROJECT 414
DRAWING 861
REV 8
SCALE 1/8
EST WT. NOTED
SH 3 OF 3
11:24AM
8-18-2004

Chapter 2

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Single fuel assemblies with damage to structural components that prevents handling in the normal manner, fuel assemblies that have one or more damaged fuel rods, lattices holding intact or damaged fuel rods, and the failed rod storage canister must be loaded in the Damaged Fuel Can. However, an intact, undamaged fuel assembly could also be loaded into the Damaged Fuel Can. The CY-MPC Damaged Fuel Can is shown in Drawings 414-901 and 414-902. As shown in the drawings, the can is 141.5 inches in length, and has an internal square dimension of 8.7 inches.

The can is closed on the bottom end by a 0.5-inch thick plate that is welded to the can shell. The plate has drilled holes in each corner to allow water to drain from the can. A screen covers the holes to preclude the release of gross particulate material from the fuel assembly. A lid having an overall depth dimension of 2.3 inches closes the can. The lid is not secured to the can shell, but is held in place when the shield lid is installed in the canister. The lid also has four drilled and screened holes. The damaged fuel assembly is inserted in the can and the can lid is installed. Lifting lugs in the can shell allow the loaded can to be lifted and installed in the canister basket. Alternately, the Damaged Fuel Can may be inserted in a basket corner position before the designated fuel assembly is inserted in the Damaged Fuel Can.

The CY-MPC Damaged Fuel Can design and fabrication specification summary is provided in Table 1.3-6. The major physical design parameters are provided in Table 2.1-5. The structural evaluation is provided in Sections 3.4.4.6 and 11.4.3.

2.1.2.4 Connecticut Yankee Fuel with Inserted Hardware

Connecticut Yankee fuel assemblies may have a Reactor Control Cluster Assembly (control cluster), a Flow Mixer/Thimble Plug Assembly (flow mixer) or stainless steel rods inserted in the fuel assembly. These components add weight, and the control clusters and flow mixer add gamma radiation source term to the standard fuel assembly.

The control cluster consists of 20 control rods mounted on a Type 304 stainless steel spider assembly and weighs about 140 pounds. In some fuel designs, these components are known as Control Element Assemblies (CEAs). The control rods are inserted in the fuel assembly guide tubes when the cluster is inserted in the fuel assembly. When fully inserted, the cluster spider rests on the fuel assembly upper end fitting. The rods are fabricated from Inconel 625 or stainless steel and encapsulate B_4C as the primary neutron poison material. Fuel assemblies with control clusters installed do not require preferential loading. Some fuel assemblies may have flow mixers inserted in the top of the fuel assembly for water flow control in the reactor. The mixers are an array of thimble plugs attached to a top spider assembly and weigh about 15 pounds.

Fuel assemblies with control clusters or flow mixers installed may not be loaded in a Damaged Fuel Can.

The number and positioning of control clusters and flow mixers loaded in the canister are administratively controlled to minimize external dose rates, and to maintain overall payload weights below the canister weight limit of 35,100 pounds. Flow mixers are limited to the central 8 positions in the 26-assembly basket configuration (6 positions in the 24-assembly basket configuration).

Solid stainless steel rods, approximately 21 inches long, may be inserted into Connecticut Yankee intact and damaged fuel assembly Reactor Control Cluster Assemblies (RCCA) guide tubes not containing a RCCA. The weight of the contents, including the installed stainless steel rods, will not exceed the canister weight limit of 35,100 pounds.

2.1.3 Damaged Fuel

A transportable storage canister configured for damaged fuel holds four damaged fuel cans located in the corner positions of the basket as shown in Figure 2.1-1. A damaged fuel can may contain either an intact or a damaged spent fuel assembly of the types described in Table 2.1-1, but may not contain individual fuel rods not in an assembly array. Fuel assemblies classified as damaged may have up to 20 fuel rods missing or with defects greater than pinhole leaks or hairline cracks. A canister configured for damaged fuel has a basket design that allows the damaged fuel can to be placed in the basket and a canister shield lid design that is machined on its underside to mate with the lid of the damaged fuel can. The shield lid and basket designed for the damaged fuel can cannot be used interchangeably with other canister configurations. The damaged fuel can is constructed of stainless steel and has a welded closure on its bottom end and a removable lid on the top end. The damaged fuel can lid and bottom closure are screened to allow the filling, draining and vacuum drying of the can, and to preclude the release of gross particulate to the canister during operations or storage events. The damaged fuel can has the same cross-section dimensions as the enlarged fuel tube and does not have attached neutron absorber plates on its exterior. The corner fuel positions of the basket top and bottom weldments are enlarged so that the damaged fuel can may be removed from the basket if necessary. The can is captured between the canister shield lid and bottom plate to limit axial movement. The structural, thermal, shielding, confinement, and criticality effects of the damaged fuel cans are separately evaluated in the appropriate sections.

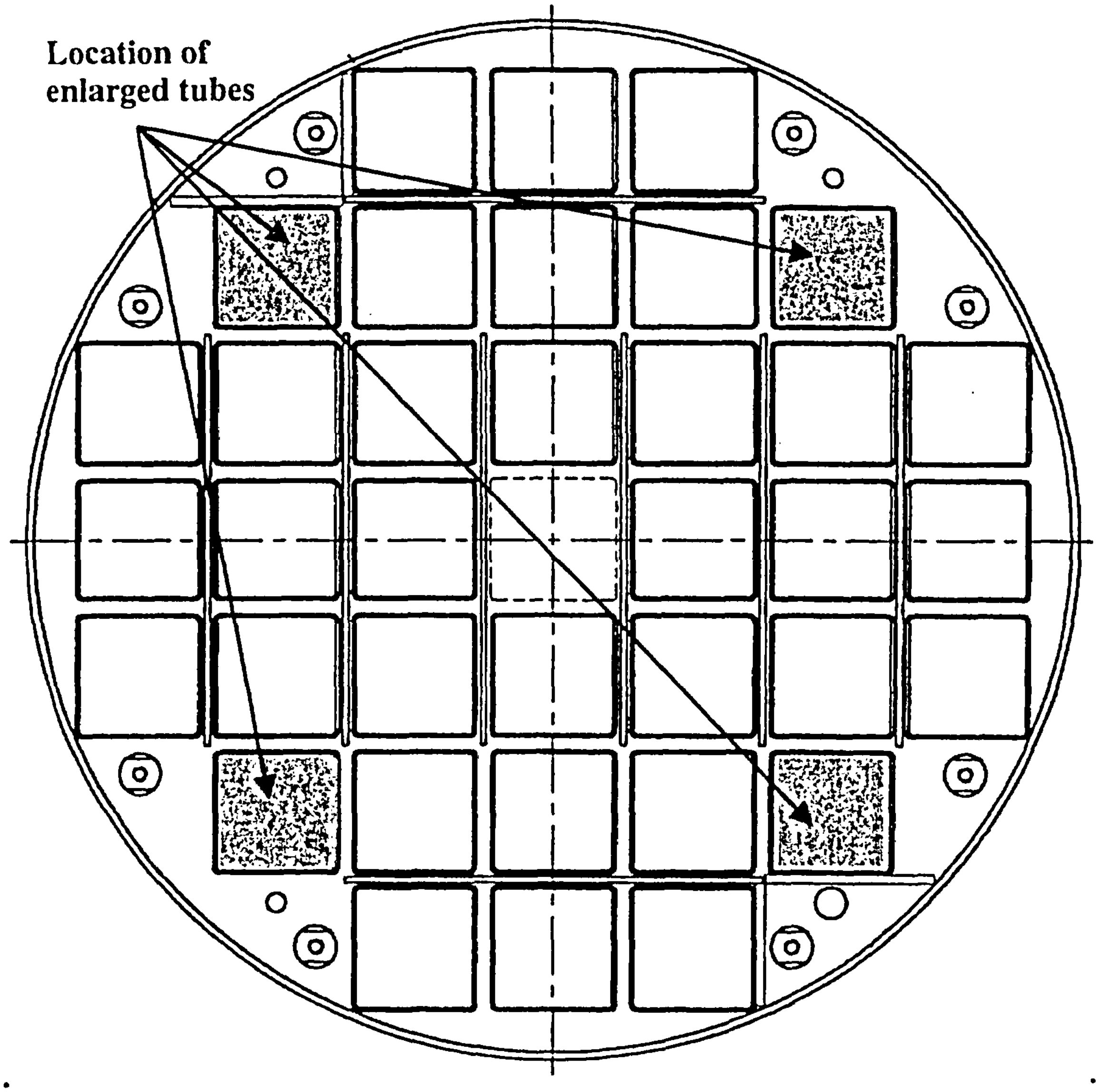
2.1.4 Recaged Fuel Assemblies

Certain United Nuclear fuel assemblies may be destructively disassembled for the purpose of inspection and testing of individual fuel rods. The United Nuclear fuel assembly lattice from which the fuel rods are removed will not likely be suitable for reuse. Consequently, the United Nuclear fuel rods may be installed in a Combustion Engineering fuel assembly lattice and placed in pool storage. The Combustion Engineering fuel assembly lattice will provide the same grid support structure as did the original United Nuclear fuel assembly lattice, but it will not have the shroud fixture used to preclude water impingement on the fuel rods. No empty fuel rod positions are permitted in the recaged Combustion Engineering fuel assembly lattice. The maximum heat load of the recaged fuel assemblies is bounded by the design basis heat load of 0.347 kW/assembly.

2.1.5 Fuel Assemblies with Removable Fuel Rods

Twelve fuel assemblies supplied by United Nuclear each have 12 fuel rods that are removable for inspection and test purposes. These fuel rods are not secured on either the top or bottom end, but are held in the grid structure of the fuel assembly lattice. The bottom end fitting prevents removal of the 12 fuel rods at the bottom end of the fuel assembly, but cutouts in the top end fitting allow the fuel rod to be grappled and removed. During loading of these United Nuclear fuel assemblies, unirradiated stainless steel retainers are used to block the cutouts in the top end fitting and prevent vertical movement of the 12 removable fuel rods in the fuel assembly grid.

Figure 2.1-1 Yankee-MPC Enlarged Fuel Tube Locations



Chapter 3

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Because the factor of safety, $FS = \frac{S_y}{\sigma_t} = \frac{18{,}600}{1{,}121} = 16.6 > 3$ (600°F), the design condition that lifting stresses have a load factor of 3 on the basis of yield strength is met.

Damaged Fuel Can Weld Evaluation

The welds joining the tube body to the bottom assembly and to the side plates are full penetration welds (Type III). The weld quality factor (n) for a Type III weld with visual surface inspection is 0.5.

The weld stress (σ_w) is:

$$\sigma_w = \frac{1.1P}{A} = \frac{1.1(1{,}800\text{ lb})}{1.766\text{ in.}^2} \cong 1{,}121\text{ psi}$$

The load (P) includes the can contents (1,590 lb design weight) and the can weldment weight (91.5 lb) for a total of 1,681.5 pounds. A load of 1,800 lb including a 10% dynamic load factor is used for the analysis. A is the cross-sectional area of the thinner member joined.

The factor of safety is, $FS = \frac{n \cdot S_y}{\sigma_w} = \frac{0.5(18{,}600)}{1{,}121} = 8.3 > 3$ (600°F)

Therefore, the design condition where lifting stresses have a load factor of 3 on the basis of yield strength is met.

Damaged Fuel Can Lifting Tool

The lifting tool employs 1.0-in. wide × 0.25-in. thick lugs that engage the lifting slots. The lugs are analyzed in shear loading with two lugs carrying the design-lifting load.

The shear stress (τ) in the lug is:

$$\tau = \frac{1.1P}{A} = \frac{1.1(858)\text{ lb}}{(1.0 \times 0.25)\text{ in.}^2} \cong 3{,}775\text{ psi}$$

where:

$P = 1/2 \times$(design contents weight [1,590 lb] + can weight [125 lb]) $\cong$ 858 lb

The factor of safety (FS) is conservatively calculated using a shear allowable of $0.6S_m$ at 300°F.

$$FS = \frac{0.6(20{,}000\text{ psi})}{3{,}775\text{ psi}} = 3.2 > 3$$

Therefore, the design condition that lifting stresses have a load factor of 3 on the basis of yield strength is met.

3.4.3.8 Evaluation of the CY-MPC Transfer Cask 6° Tilt

To enhance the removal of the water from the canister during the draining operation, the transfer cask may be tilted to a maximum of 6° from the vertical. The 6° tilt will result in a small component of the weight of the loaded transfer cask to be applied in a direction parallel to the surface on which the transfer cask rests. The stability of the transfer cask against sliding motion is maintained by the friction force acting on the bottom surface of the rails, which support the loaded transfer cask. The lateral force (F) is computed as:

$$F = 184{,}000 \times \sin(6^\circ)$$
$$F = 19{,}233\text{ lb}$$

where 184,000 pounds is the bounding weight of the loaded transfer cask.

The friction force (P) resisting the lateral force (F) is computed as:

$$P = 0.74 \times 184{,}000 \times \cos(6^\circ)$$
$$P = 135{,}414\text{ lb}$$

where:

μ = coefficient of friction between two materials comprised of mild steel
= 0.74 (Baumeister and Marks)

The Factor of Safety against the sliding motion of the transfer cask is:

$$FS = \frac{135{,}414}{19{,}233} = 7.0 > 1.1$$

The computed Factor of Safety is significantly larger than the Factor of Safety of 1.1 required by ANSI/ANS 57.9 to ensure stability against a sliding motion.

When the transfer cask is tilted, the Center of Gravity (CG) of the system will be horizontally translated by :

$$\Delta = H \times \sin(6^\circ)$$

where:

H = the vertical distance to the CG from the bottom of the transfer cask
H = 77.9 in (refer to Table 3.2-2)

therefore:

$$\Delta = 77.9 \times \sin(6^\circ) = 8.1 \text{ in}$$

In order for the transfer cask to tip over, the CG must move from the transfer cask centerline to the point of rotation, which is at the outer edge of the transfer cask door rail. This corresponds to a distance of 0.5 × (75.5 + 2 × 4.5) or 42.3 inches. The Factor of Safety for the tip-over condition is:

$$FS = \frac{42.3}{8.1} = 5.2 > 1.1$$

The computed Factor of Safety is significantly larger than the Factor of Safety of 1.1 required by ANSI/ANS 57.9 to ensure stability against an overturning motion.

Therefore, the transfer cask will be maintained in a stable condition during the 6° tilt during transfer operations.

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calculated pressure of 9.0 psig for normal conditions. The bounding pressure for normal and off-normal conditions of 15.0 psig is applied as a surface force to the elements along the internal surface of the canister shell, bottom plate, and shield lid.

The resulting maximum canister stresses for maximum internal pressure load are summarized in Tables 3.4.4.3-4 and 3.4.4.3-5 for primary membrane and primary membrane plus primary bending stresses, respectively.

3.4.4.3.4 CY-MPC Canister Handling Analysis

The canister was structurally analyzed for handling loads using the three-dimensional ANSYS finite element model. The minimum structural lid weld size is 0.75 inch and the minimum shield lid weld size is 0.375 inch. Normal handling of the canister is simulated by restraining the model at three lift points and applying a 1.1g acceleration load to the model in the axial direction, which includes a 10% dynamic load factor. The boundary conditions of the model are the same as those for the Yankee-MPC canister handling analysis, as described in Section 3.4.4.1.4.

The resulting maximum stresses in the canister for the handling load are summarized in Tables 3.4.4.3-6 and 3.4.4.3-7 for primary membrane and primary membrane plus primary bending stresses, respectively.

3.4.4.3.5 CY-MPC Canister Load Combination

The canister was structurally analyzed for the combined thermal, dead weight, maximum internal pressure, and handling loads using the three-dimensional ANSYS model. Loads were applied to the model as discussed in Sections 3.4.4.3.1 through 3.4.4.3.4. The minimum structural lid weld size is 0.75 inch and the minimum shield lid weld size is 0.375 inch. A bounding pressure for normal and off-normal conditions of 15.0 psig was used in conjunction with a positive axial acceleration of 1.1g. Two nodes 120° apart (one node at the symmetry plane and a second node 120° from the first) were restrained along the bolt diameter at the top of the structural lid in the axial direction. Additionally, the nodes along the centerline of the lids and bottom plate were restrained in the radial direction, and the nodes along the symmetry face were restrained in the direction normal to the symmetry plane.

The resulting maximum stresses in the canister for combined loads are summarized in Tables 3.4.4.3-8, 3.4.4.3-9, and 3.4.4.3-10 for primary membrane, primary membrane plus primary bending, and primary membrane plus primary bending plus secondary stresses, respectively. As shown in Tables 3.4.4.1-8 through 3.4.4.1-10, the canister maintains positive margins of safety for the combined load condition.

3.4.4.3.6 CY-MPC Canister Fatigue Evaluation

The purpose of this section is to evaluate the effects of thermal and mechanical cyclic loading conditions on the canister during storage conditions using the criteria presented in ASME Code, Section III, Subsection NB-3222.4 for the canister and Subsection NG-3222.4 for the fuel basket.

During storage conditions, the canister is housed in the vertical concrete storage cask. The storage cask is a shielded reinforced concrete overpack designed to hold a canister during long-term storage conditions. The storage cask is constructed of a thick inner steel liner surrounded by 21 inches of reinforced concrete. Because the carbon steel inner liner will be subjected to a number of temperature/stress loading cycles (1 cycle x 365 days x 50 years = 18,250 cycles) that is less than the minimum number (20,000 cycles) specified for evaluation in Table A-K4.1 of the AISC Manual of Steel Construction, no further fatigue evaluation of the inner liner is required.

Fatigue effects on the canister are addressed using the criteria presented in ASME Code Section III, Subsection NB-3222.4 and NG-3222.4.

In accordance with these subsections, fatigue analysis need not be performed provided the conditions of six cases are met. The six cases are as follows:

1. Atmospheric to Service Pressure Cycle
2. Normal Service Pressure Fluctuation
3. Temperature Difference — Startup and Shutdown
4. Temperature Difference — Normal Service
5. Temperature Difference — Dissimilar Materials
6. Mechanical Loads

Evaluation of these conditions is presented in the following sections.

Condition 1 — Atmospheric to Service Pressure Cycle

The ASME Code requires that the specified number of times that the pressure will be cycled from atmospheric pressure to service pressure and back to atmospheric pressure during normal service does not exceed the number of allowable cycles for the material. In the case of the canister and basket, the cycle from atmospheric to service pressure happens only twice. Since

3.4.4.7 CY-MPC Transfer Cask Door Thermal Stress Evaluation

Up to a 15 kW heater may be used beneath the transfer cask doors to assist the drying of the canister for the CY-MPC system. This section presents a thermal evaluation of the transfer cask doors to determine the maximum thermal stress in the doors as a result of an applied 15 kW heat load. The analysis is divided into two parts: (1) a thermal evaluation of the doors to determine temperature gradients using various boundary conditions; (2) a structural evaluation of the doors using the temperature results from part one.

3.4.4.7.1 CY-MPC Transfer Cask Door Thermal Evaluation

A three-dimensional finite element model of a transfer cask door is used to perform the thermal evaluation, as shown in Figure 3.4.4.7-1. Due to symmetry conditions, only one-half of the door is modeled. The finite element model is constructed from ANSYS SOLID70 elements. The 15 kW heat load (18.1 BTU/hr-in^2, heat flux) is applied to the lower surface of the door. The heater, approximately 5 feet in diameter, is located at the bottom surface of the transfer cask doors. The heater is controlled such that the maximum temperature of the bottom surface of the door is limited to less than 200°F, but for the purpose of analysis, the maximum temperature was allowed to increase to 300°F. The edges of the door are conservatively assumed to be adiabatic. Two boundary conditions are considered for the upper surface of the door (next to the canister bottom plate). The first case considers the upper surface of the door to be adiabatic (the loaded canister is ignored). The second case considers the upper surface of the door to be 100°F (the loaded canister is considered to be an infinite heat sink of 100°F, based on the expected water temperature of the spent fuel pool). Note that using the lower bounding canister temperature is conservative since it would increase the thermal gradient. These two boundary conditions are conservatively used to bound the maximum thermal gradient through the thickness of the door.

The two cases analyzed are summarized in the following table:

	Calculated Maximum Door Lower Surface Temperature (°F)	**Condition Applied to Door Upper Surface**	**Condition Applied to Door Edge**
Case 1	300°F	Adiabatic	Adiabatic
Case 2	220°F (steady state condition)	100°F	Adiabatic

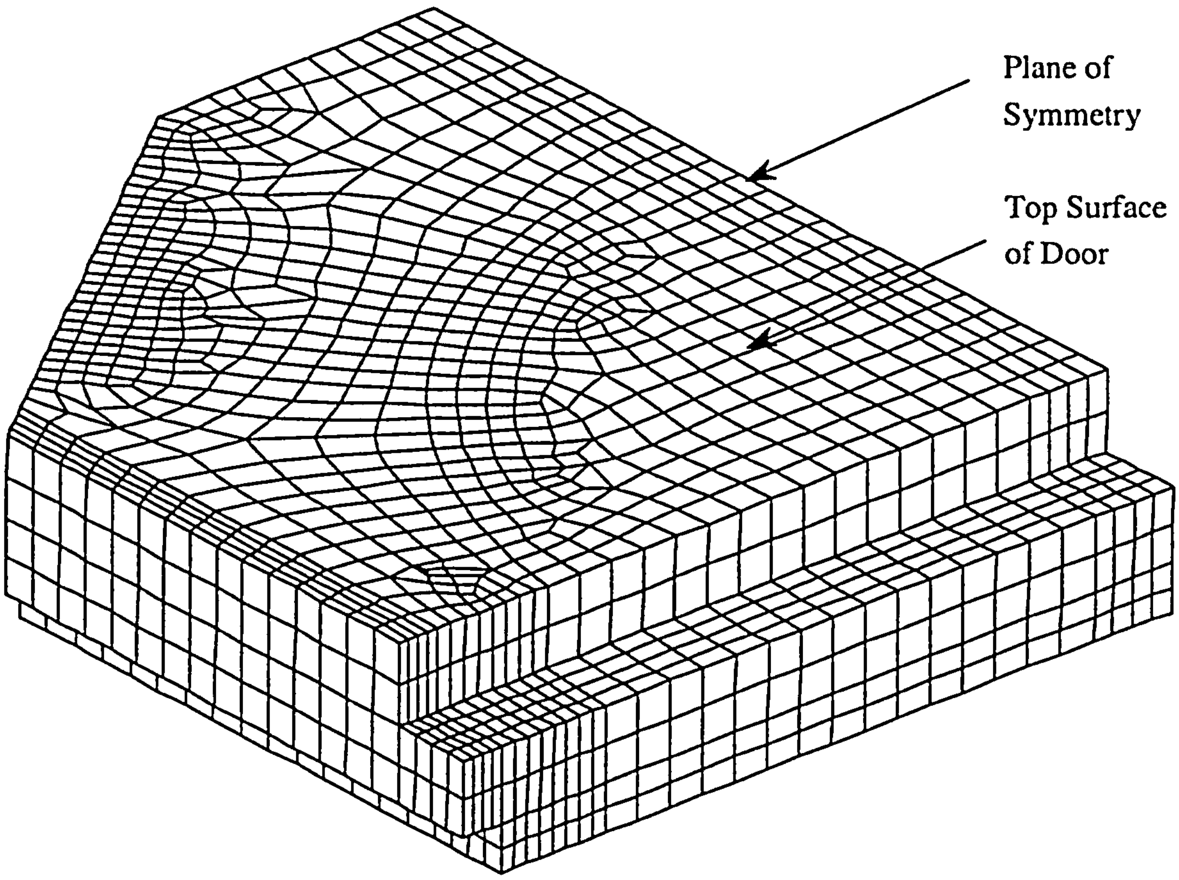
Results of the finite element thermal analysis indicate that Case 2 is the governing case with the maximum temperature gradient through the thickness of the door of 120°F. The maximum temperature gradient occurs at the center of the door for both cases.

3.4.4.7.2 CY-MPC Transfer Cask Door Thermal Stress Evaluation Results

The maximum stress intensity is evaluated using the finite element model described in Section 3.4.4.7.1, with the elements changed to SOLID45. The thermal stresses are calculated based on the temperature profile of the door from the thermal analysis. Gravity loads are ignored in the structural evaluation of the transfer cask doors. The combined weight of a loaded canister and the transfer cask door results in a compressive stress less than 100 psi in the door. This stress is negligible when compared to the thermal stresses presented in this section. The structural analysis is performed for the two cases listed in the table presented in Section 3.4.4.7.1 to determine the maximum nodal stress intensity in the door. The maximum calculated nodal stress intensities and the margins of safety (MS) are shown in the following table. The stress allowable is $3S_m$ (S_m = 21.3 ksi at 300°F for ASTM 588 Carbon Steel) for thermal (secondary) stresses. It is concluded that the use of up to a 15 kW heater under the transfer cask doors during the canister drying process will have no adverse effect on the structural performance of the doors.

Case	SI (ksi)	$S_{allowable}$ (ksi)	MS
1	14.5	63.9	+3.4
2	18.8	63.9	+2.4

Figure 3.4.4.7-1 Finite Element Model of Transfer Cask Doors for Thermal Stress Evaluation



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Chapter 4

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Table 4.1-1 Summary of Thermal Design Conditions for Storage

DESIGN CONDITION	ENVIRONMENTAL TEMPERATURE (°F)	SOLAR INSOLANCE (1)	STATUS OF INLETS AND OUTLETS
Normal	75	Yes	All open
Off-Normal	75	Yes	Two inlets blocked
Off-Normal - Severe Heat	100	Yes	All open
Off-Normal - Severe Cold	-40	No	All open
Accident - Extreme Heat	125	Yes	All open
Accident (2)	75	Yes	All blocked
Accident - Cask Burial Under Debris (3)	75	No	All blocked

(1) Solar Insolance per 10 CFR 71:
Curved Surface: 400 g cal/cm^2 (1475 Btu/ft^2) for a 12-hour period.
Flat Horizontal Surface: 800 g cal/cm^2 (2950 Btu/ft^2) for a 12-hour period.

(2) This condition bounds the case in which all inlets are blocked, with all outlets open.

(3) In the burial under debris condition, the inlets/outlets are blocked and, in addition, the debris is considered not to permit any heat transfer from the surface of the concrete. This is a highly conservative assumption.

Table 4.1-2 Summary of Thermal Design Conditions for Transfer

CONDITION[1]	DURATION (Hours)	
	Yankee-MPC	CY-MPC[3]
Design Basis Heat Load (kW)	12.5	17.5
Water Filled	22	30
Vacuum Drying	40[2]	23[4]
Canister filled with Helium	Unlimited	Unlimited

1. The canister is inside the Transfer Cask, with an ambient temperature of 75°F.
2. The canister is filled with water for a maximum of 22 hours (after removal from the spent fuel pool) before the start of the vacuum drying process. The initial water temperature is considered to be 100°F.
3. These time limits are for the design basis heat load in the preferential loading configuration. Extended time limits have been determined for lower heat loads, and are presented in Section 4.5.3.3.
4. The canister is filled with water for a maximum of 30 hours (after removal from the spent fuel pool) before the start of the vacuum drying process. The initial water temperature is considered to be 100°F.

Table 4.1-3 Maximum Allowable Temperature Limits (°F)

MATERIAL[1]	LONG TERM	SHORT TERM	REFERENCE
Concrete	150(B)/200(L)[2]	350	ACI 349
Zircaloy Fuel Cladding			
Yankee-MPC	644[3]	806[4]	PNL-6189 (long term) EPRI TR-106440 (short term)
CY-MPC	752	752[5]/1058[5]	ISG-11, Rev. 2 PNL-4835 (short term)
Stainless Steel Fuel Cladding			
Yankee-MPC	644[3]	806[4]	EPRI TR-106440 (short term)
CY-MPC	806[4]	806[4]	
Aluminum Disk	650	700	MIL-HDBK-5G
NS-4-FR or NS-3	300	300	Genden
Chemical Copper Lead	600	600	Baumeister
ASME SA 693 Type 630 Stainless Steel	650	800	ASME Code Armco
ASME SA 240 Type 304 Stainless Steel	800	800	ASME Code
ASME SA 240 Type 304L Stainless Steel	800	800	ASME Code
ASTM A588 Carbon Steel	700	700	ASME Code Case N-71-17
ASTM A36 Carbon Steel	700	700	ASME Code Case N-71-17
BORAL Composite Sheet	850	1,000	AAR Advanced Structures

1. The minimum allowable temperature limit for all materials is -40°C (-40°F).
2. B and L refer to bulk temperatures and local temperatures, respectively. The local temperature allowable applies to a restricted region where the bulk temperature allowable may be exceeded.
3. The temperature limits for 5-year and 10-year-cooled fuel are 380°C (716°F) and 340°C (644°F), respectively. The lower value (340°C) is used.
4. The temperature limit of 430°C (806°F) for stainless steel cladding is used for short-term and long-term storage conditions.
5. The temperature limit of the Zircaloy fuel cladding is 400°C (752°F) for storage (long-term) and transfer (short-term) conditions based on ISG-11, Revision 2. The temperature limit of the Zircaloy fuel cladding is 570°C (1058°F) for off-normal or accident (short-term) conditions based on PNL-4835.

Table 4.1-4 Summary of Thermal Evaluation for the Yankee-MPC Storage System

	Material Temperature (°F)									
Design Conditions	Concrete[1]	Fuel Clad	6061- T651 Al Alloy[2]	NS-4-FR[3]	Lead[3]	SA693 630 SS[2]	SA240 304 SS[4]	SA240 304L SS[4]	A36 Steel[1]	A588/A350LF2 Steel[3]
Allowable		Zr/SS								
Long-Term	150 (Bulk) 200 (Local)	644/644	650	300	600	650	800	800	700	700
Short-Term	350	806/806	700	300	600	800	800	800	700	700
Long-Term Conditions										
Normal (75°F Ambient)	133 (Bulk) 165 (Local)	563	527	129	N/A	529	183	319	165	N/A
Short-Term Conditions										
Off-Normal -Half Inlets Blocked (75°F Ambient)	168	565	529	N/A	N/A	531	192	318[5]	169	N/A
Off-Normal -Severe Heat (100°F Ambient)	196	587	552	N/A	N/A	554	213	347	196	N/A
Off-Normal -Severe Cold (-40°F Ambient)	5	453	411	N/A	N/A	412	44	187	5	N/A
Accident -Extreme Heat (125°F Ambient)	228	607	574	N/A	N/A	575	241	372	229	N/A
Transfer -Vacuum Drying	N/A	734	591	150	151	604	131	344	N/A	184
Transfer -Backfilled with Helium	N/A	734	660	225	228	659	177	498	N/A	284

1. Concrete cask components: Concrete cask and steel liner (ASTM A36).
2. Fuel basket components: Heat transfer disks (6061- T651) and support disks (ASME SA 693, Type 630 stainless steel).
3. Transfer cask components: Shells (ASTM A588); bottom doors (A350LF2), neutron shield (NS-4-FR); and, gamma shield (lead)/concrete cask lid shield.
4. Canister components: Shield lid (ASME SA 240, Type 304 stainless steel) and shell, bottom plate and structural lid (ASME SA 240 Type 304L stainless steel).
5. Although the maximum canister temperature is 1 degree lower than that of the normal condition, the overall canister temperature for the half inlet blocked condition is higher than that of the normal condition, which results in higher temperatures inside of the canister (fuel clad and disks).

Table 4.1-5 Summary of Thermal Evaluation for the CY-MPC Storage System

Design Conditions	Material Temperature (°F)[5]									
	Concrete[1]	Fuel Clad	6061-T651 Al Alloy[2]	NS-4-FR[3] or NS-3	Lead[3]	SA693 630 SS[2]	SA240 304 SS[4]	SA240 304L SS[4]	A36 Steel[1]	A588/A350LF2 Steel[3]
Allowable		Zr/SS								
Long-Term	150 (Bulk) 200 (Local)	752/806	650	300/150	600	650	800	800	700	700
Short-Term	350	1058[7]/ 752[7]/806	700	300/150	600	800	800	800	700	700
Long-Term Conditions										
Normal (75°F Ambient)	130 (Bulk) 171 (Local)	629[6]	534	N/A	N/A	538	328	312	171	N/A
Short-Term Conditions										
Off-Normal (75°F Ambient) -Half Inlets Blocked	178	632	538	N/A	N/A	541	314	315	178	N/A
Off-Normal (100°F Ambient) -Severe Heat	203	649	557	N/A	N/A	560	337	337	203	N/A
Off-Normal (-40°F Ambient) -Severe Cold	10	530	424	N/A	N/A	428	187	188	10	N/A
Accident (125°F Ambient) -Extreme Heat	235	670	579	N/A	N/A	583	362	363	235	N/A
Transfer -Vacuum Drying	N/A	730	539	185	190	542	165	282	N/A	207
Transfer -Backfilled with Helium	N/A	730	646	250	253	649	144	441	N/A	280

1. Concrete cask components: Concrete cask and steel liner (ASTM A36).
2. Fuel basket components: Heat transfer disks (6061-T651) and support disks (ASME SA 693, Type 630 stainless steel).
3. Transfer cask components: Shells (ASTM A588); bottom doors (A350LF2), neutron shield (NS-4-FR); and, gamma shield (lead)/VCC lid shield NS-4-FR or NS-3.
4. Canister components: Shield lid (ASME SA 240, Type 304 stainless steel) and shell, bottom plate and structural lid (ASME SA 240 Type 304L stainless steel)
5. This summary represents the enveloping of the two fuel loadings analyzed: (1) A uniform heat load of 674 W per fuel assembly, and (2) preferential fuel loading as shown in Figure 4.5.1.1-2. The values presented above correspond to the fuel loading condition which produced the controlling margin, i.e., the minimum margin between the allowable temperature and the maximum temperature obtained in the analyses of the two fuel loadings.
6. Maximum cladding temperature for the preferential loading configuration, which bounds the maximum temperature for the uniform loading configuration.
7. The temperature limit of the Zircaloy fuel cladding is 400°C (752°F) for storage (long-term) and transfer (short-term) conditions based on ISG-11, Revision 2. The temperature limit of the Zircaloy fuel cladding is 570°C (752°F) for off-normal or accident (short-term) conditions based on PNL-4835.

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4.5 Thermal Evaluation of the CY-MPC for Normal Conditions of Storage

This section presents the thermal evaluation of the CY-MPC storage system for normal conditions of storage. The Yankee-MPC storage system normal conditions evaluation is presented in Section 4.4.

The design basis decay heat for the CY-MPC is 17.5 kW with an axial distribution of the decay heat as shown in Figure 4.5.1.1-1. In the CY-MPC, two radial distributions of the heat load are considered. A uniform decay heat distribution is considered in which the maximum decay heat for each fuel assembly is 674 W. An additional distribution of the decay heat is also considered to permit the storage of fuel assemblies having a maximum decay heat of 840 W, which is referred to as the "preferential" fuel loading configuration. This decay heat distribution of the fuel assemblies is shown in Figure 4.5.1.1-2.

There are two basket configurations for the CY-MPC: the 26-assembly basket and the 24-assembly basket. The 24-assembly basket contains the same basket fuel loading positions as the 26-assembly basket, but the two center fuel positions are blocked to prevent fuel assemblies from being loaded in those locations. The reduction in the number of fuel assemblies represents a condition that will always maintain a reduced decay heat load compared to the 26-assembly basket. The thermal analyses in this section corresponds to the controlling, or bounding, design of the 26-fuel assembly basket and the two distributions of the decay heat (uniform and preferential fuel loading).

4.5.1 CY-MPC Thermal Models

As listed below, six finite element models, generated by the ANSYS program, are utilized for the thermal evaluation of the CY-MPC system for normal conditions of storage.

1. Two-Dimensional Axisymmetric Air Flow and Concrete Cask Model
2. Three-Dimensional Canister Model
3. Three-Dimensional Axisymmetric Transfer Cask and Canister Model
4. Three-Dimensional Periodic Model
5. Two-Dimensional Fuel Model
6. Two-Dimensional Fuel Tube Model

The two-dimensional axisymmetric air flow and concrete cask model includes: the concrete storage cask, air in the air inlets, annulus and the air outlets, the canister shell and the canister internals. The canister internals are modeled as homogeneous regions with effective thermal conductivities. The effective thermal properties for the canister internals are determined using the three-dimensional periodic canister internals model. It is used to perform computational fluid dynamic analyses to determine the mass flow rate, velocity and temperatures of the air flow, as well as the temperature distribution of the concrete, concrete cask steel liner and the canister shell. The temperatures of the canister shell from the two-dimensional axisymmetric air flow model are used as temperature boundary conditions for the three-dimensional canister model.

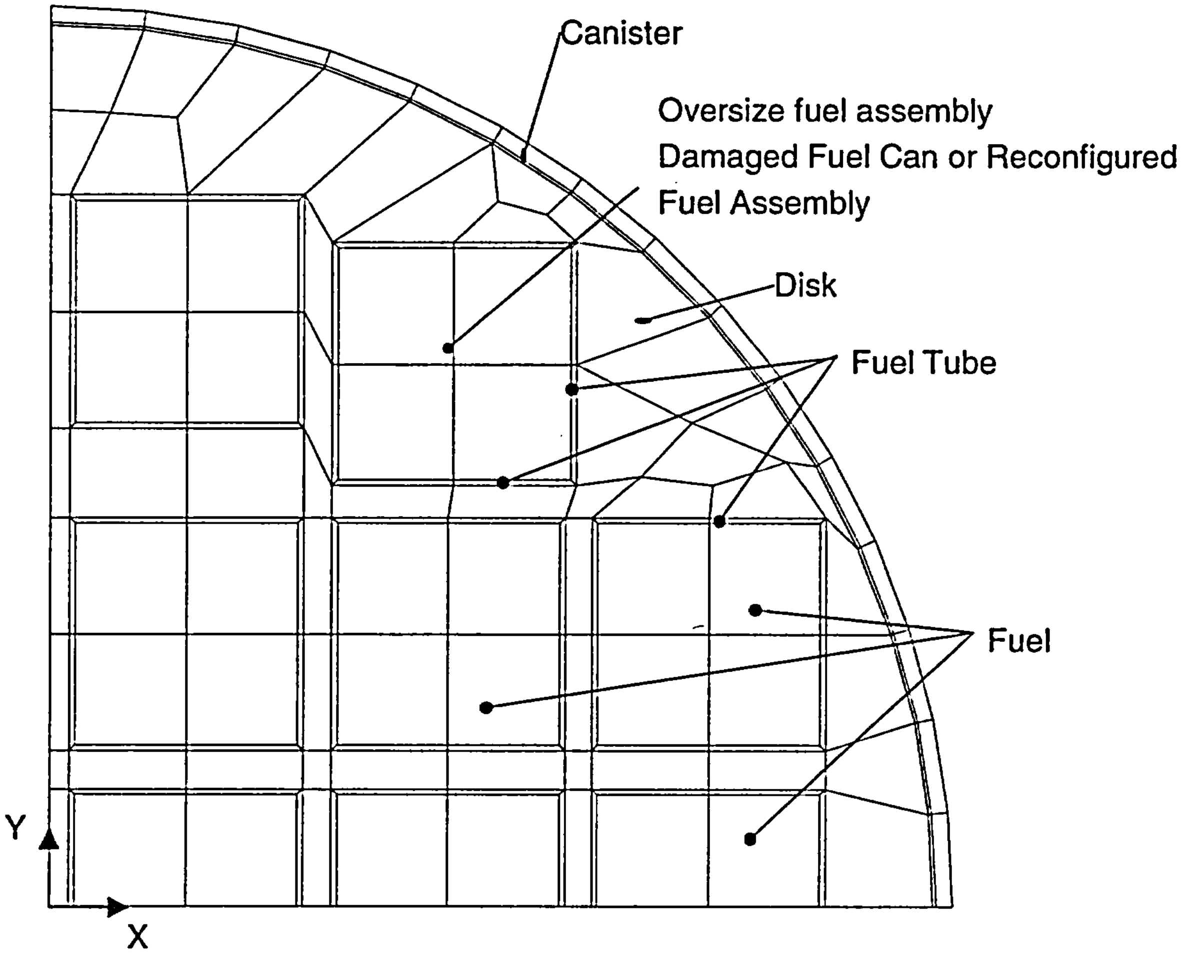
The three-dimensional canister model is comprised of the fuel assemblies, fuel tubes, stainless steel support disks, aluminum heat transfer disks, the canister shell, lids and bottom plate. The canister model is employed to evaluate the temperature distribution of the fuel cladding and components of the canister and basket. The fuel regions and the fuel tubes with the BORAL plates in the three-dimensional canister model are modeled using effective conductivities, which are determined by the two-dimensional fuel model and the two-dimensional fuel tube model.

The three-dimensional axisymmetric transfer cask and canister model comprises the transfer cask, the canister and the canister internals. The canister internals in this model are represented by effective thermal properties. The model is used to perform transient analyses for the transfer condition when the canister is in the loading, vacuum drying, helium backfill process.

The model 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. Three media are considered: helium, water and a vacuum. The fuel assemblies and fuel tubes 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 effective conductivity of the fuel is determined using the two-dimensional fuel model, which is a detailed two-dimensional thermal model of the fuel assembly. The model includes the fuel pellets, cladding, the helium gas between the fuel pellets and the fuel rod cladding and the media occupying the space between the fuel rods. For normal operational conditions, the media between the fuel rods is considered to be helium, but for the transfer operations, the media is also considered to be water or vacuum.

Figure 4.5.1.2-2 CY-MPC Three-Dimensional Canister Model - Cross-Section



4.5.1.3 Three-Dimensional CY-MPC Transfer Cask and Canister Model

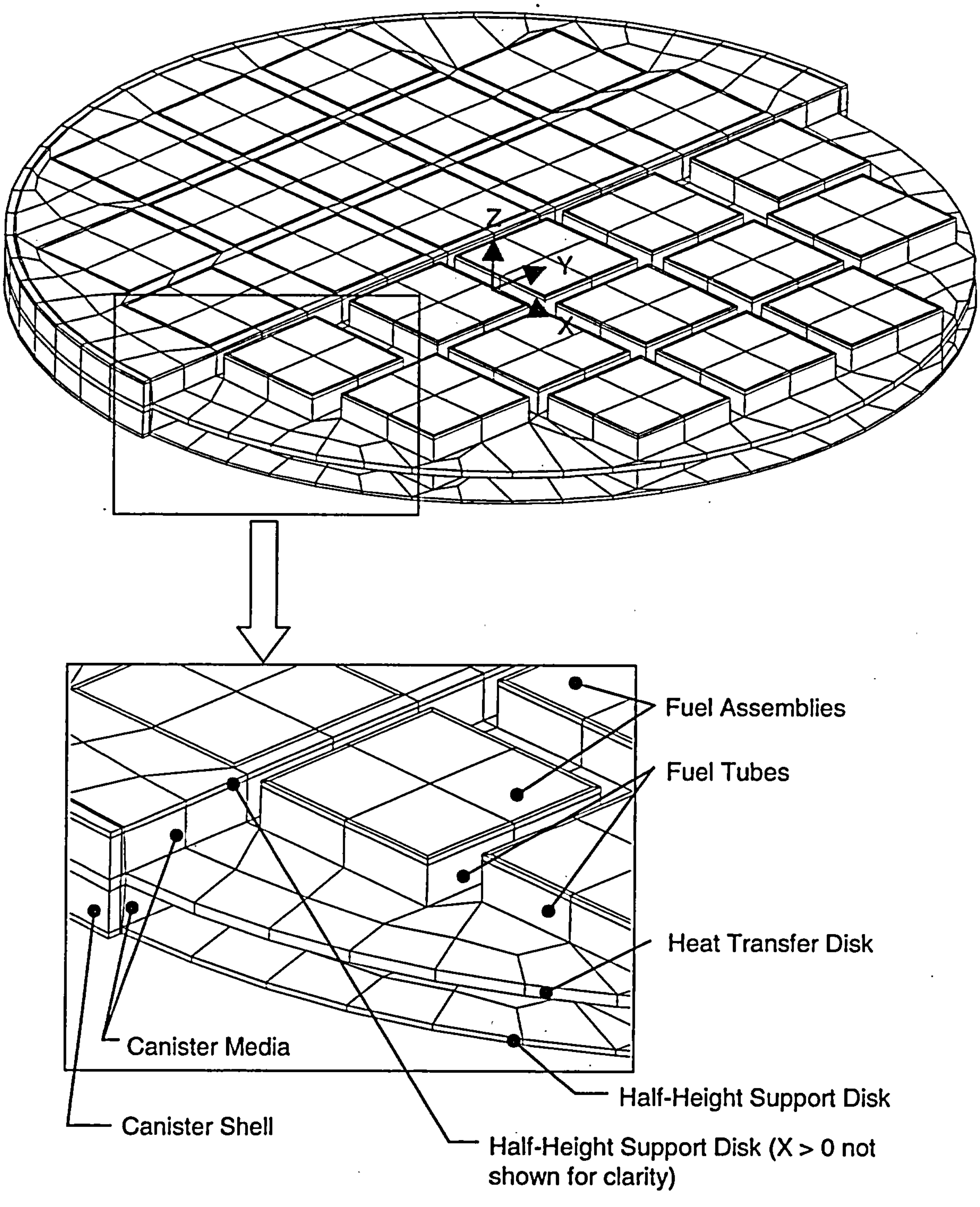
The three-dimensional CY-MPC transfer cask and canister model is shown in Figures 4.5.1.3-1 and 4.5.1.3-2. ANSYS SOLID70 three-dimensional conduction elements and MATRIX50 radiation super elements are used to construct the model. The model includes the fuel assemblies, the fuel basket (fuel tubes, support disks, heat transfer disks, and top and bottom weldment plates), the canister (shell, bottom plate, structural, and shield lids), and the transfer cask (top and bottom plates, inner and outer shells, neutron and gamma shields, and doors). Based on symmetry, only one-fourth of the transfer cask and canister are modeled, and the plane of symmetry is considered to be adiabatic.

Natural convection and radiation heat transfer modes are considered at the surfaces of the transfer cask and on the top of the canister lid. The bottom surface of the transfer cask doors is considered to be adiabatic. A 0.430-inch radial gap, based on the nominal dimensions of the canister shell and the transfer cask inner shell, is included. For normal transfer operations, when either vacuum or helium exists in the canister, only conduction and radiation are considered across the gaps inside the canister and convection is conservatively neglected. When the canister is filled with water at the start of the transfer operation, natural circulation of the water is taken into account by adjusting the effective conductivities in the fuel and water reigons based on a classical energy balance calculation of the canister content. An ambient temperature of 75°F is assumed, and no solar insolance is considered since the transfer operation occurs inside a building.

For each heat load analyzed, a volumetric heat generation (Btu/hr-in^3) is applied to each fuel assembly based on a conservatively assumed active fuel length of only 118 inches along with an axial power distribution as shown in Figure 4.5.1.1-1. The basket locations for preferential fuel loading in the CY-MPC basket ANSYS model are defined in Figure 4.5.1.1-2. Additional heat load configurations are also evaluated using the three-dimensional canister-transfer cask model, as described in Section 4.5.3.1.

To assist the vacuum drying stage of the transfer operation, supplemental heat may be applied to the canister using the following methods: (1) Apply heaters at the bottom surface of the transfer cask shield door and limit the bottom surface temperature of the shield door to 200°F; (2) Supply hot air flow of 200 CFM at 170°F to the transfer cask/canister annulus. Additional thermal transient analyses are performed to evaluate these conditions with boundary conditions modified accordingly (at the transfer cask bottom and the annulus between the canister shell and transfer cask inner shell), when the canister is in the vacuum drying stage. The use of the thermal heater may be continued during forced air cooling.

Figure 4.5.1.4-1 Three-Dimensional Periodic CY-MPC Canister Internal Model



Note: Portions of the model are not shown in order to show details of the disk and tubes.

4.5.1.5 Two-Dimensional Connecticut Yankee Fuel Model

The effective conductivity of the fuel is determined using a two-dimensional finite element model of the fuel assembly. The quarter symmetry finite element model includes: the fuel pellets, cladding, the gas between fuel pellets and the clad, and the media surrounding the fuel rod. The edge of the fuel model extends to the inside surface of the fuel tube. The model is shown in Figure 4.5.1.5-1. The fuel cladding material for this fuel can be either Zircaloy or stainless steel. The most distinguishing characteristic between the two clad materials is the emissivity (shown in Section 4.2), but minor differences also exist in the fuel clad such as the thickness of the Zircaloy clad (0.0225 inch) and the stainless steel clad (0.0150 inch). Additionally, the CY-MPC basket accommodates two sizes of fuel tubes: 22 fuel tubes with a 8.72-inch inside dimension and 4 fuel tubes with a 9.12-inch inside dimension.

Modes of heat transfer modeled include conduction and radiation between individual fuel rods for the steady-state condition, and convection is conservatively neglected. ANSYS PLANE55 conduction elements and MATRIX50 radiation elements are used in the model, which represents a 15 × 15 fuel assembly. Each fuel rod consists of the pellet, stainless steel or Zircaloy cladding, and a gap between the pellet and cladding. The gas in the gap between the pellet and cladding is considered to be helium. Three types of media between the fuel rods is considered: helium for long-term storage and backfill, water for the drain condition, and vacuum for the vacuum/drying condition. For the helium and vacuum media, radiation elements are defined between fuel rods and from the fuel rods to the boundary of the model (inside surface of the fuel tube). Radiation effects at the gap between the pellets and the cladding are conservatively ignored. Effective emissivities are determined using the formula shown in Section 4.4.1.2, and the emissivities are specified in Section 4.2. For the water condition, the radiation elements are effectively removed from the model.

A total of 12 fuel assembly models are constructed to accommodate:

1. Two clad materials (and associated dimensional differences): Zircaloy and stainless
2. The two fuel tubes inner dimensions, and
3. The three media (water, vacuum and helium)

The effective conductivity for the fuel is determined using the same method as described in Section 4.4.1.3 for the Yankee Class fuel model. The temperature-dependent effective properties are established using different boundary temperatures. The effective conductivity in the axial direction of the fuel assembly is calculated based on the material area ratio. For the thermal transient analyses, the density is computed based on a volume weighted average and the specific heat is computed on a mass weighted average as:

$$\rho_{eff} = (\Sigma \rho_i V_i)/(\Sigma V_i)$$

where:

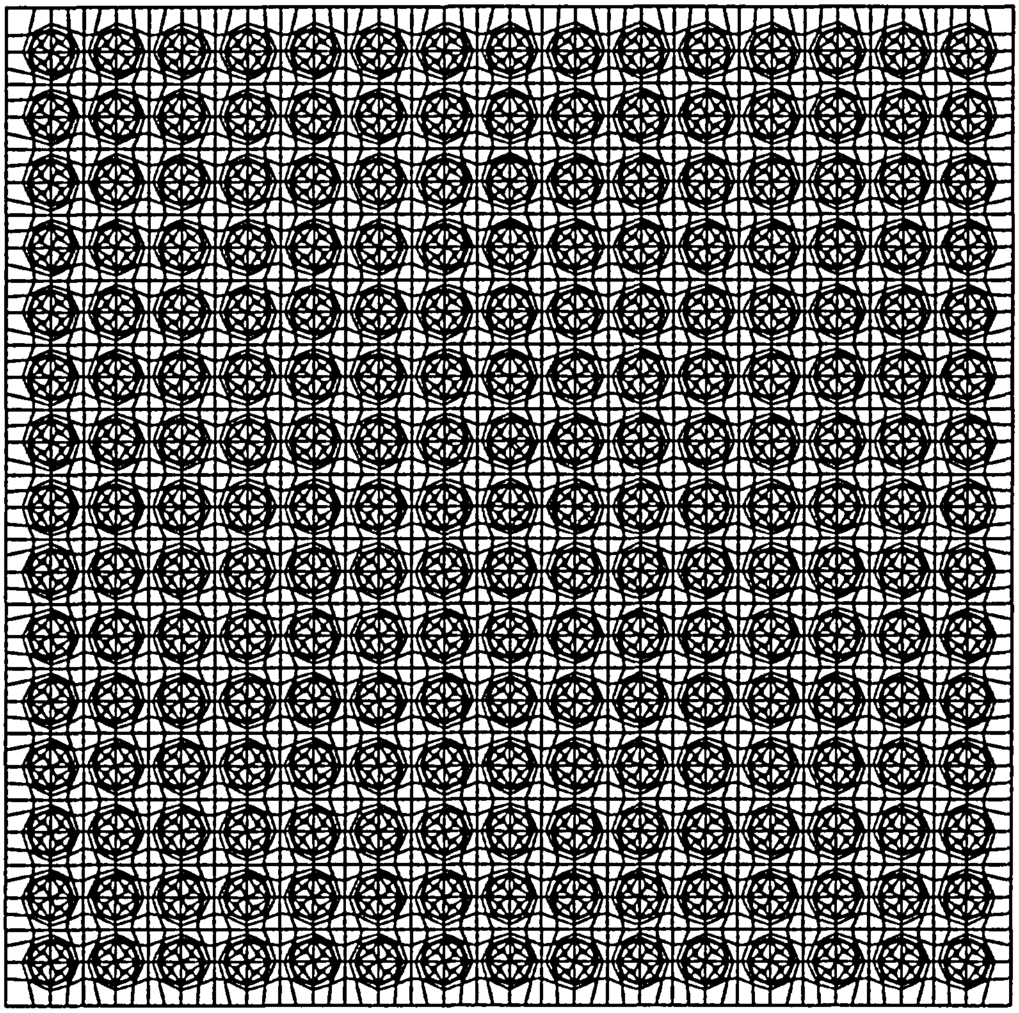
ρ_i = the density of the ith element
V_i = the volume of the ith element

$$C_{eff} = (\Sigma C_i M_i) / (\Sigma M_i)$$

where:

C_i = the specific heat of the ith element
M_i = the mass of the ith element.

Figure 4.5.1.5-1 Two-Dimensional Connecticut Yankee Fuel Model



The same three-dimensional thermal model of the loaded canister and transfer cask described in Section 4.5.1.3 is used to perform this sensitivity analysis. Several modifications are made to the model as described in the following paragraphs.

For the reduction of the material thermal emissivities sensitivity study, the material emissivities of the support disks, heat transfer disks, canister shell, canister shield lid, the top surfaces of the fuel assemblies, the transfer cask inner shell and transfer cask gamma shield (lead) are reduced by 10%. Additionally, the effective thermal conductivity values for the fuel assemblies (see Section 4.5.1.5 for model description) and for the fuel tubes (see Section 4.5.1.6 for model description) are recalculated by reducing the emissivities of the radiating surfaces by 10%.

The gaps between the support disks/heat transfer disks and the canister shell are based on nominal dimensions in the three-dimensional thermal model described in Section 4.5.1.2. For the increased gap size sensitivity study, the gap size in this model is increased to account for the maximum dimensional tolerances. Specifically, the gap between the support disks and the canister shell is increased from 0.120 inch to 0.200 inch (67% increase). The gap size between the heat transfer disks and the canister shell is increased from 0.260 inch to 0.340 inch (31% increase). The gap between the canister shell and the transfer cask inner shell is increased from 0.430 inch to 0.585 inch (36% increase). Additionally, a gap of 0.03 inch is modeled between the transfer cask inner shell and the gamma shield to account for lead shrinkage. This gap is based on the dimensional tolerances. This gap is considered in the base model presented in Section 4.5.1.3, but is not increased for the sensitivity study.

Finally, the temperature-dependent natural convection film coefficients applied to the transfer cask surfaces (the bottom remains adiabatic) and the canister structural lid are reduced by 18%.

The sensitivity study is performed using the design basis heat load of 17.5 kW with preferential fuel loading for normal transfer operations. A thermal transient analysis is performed incorporating all of the described parameter changes. The resulting maximum increase in fuel cladding temperature is 13°F. Similarly, a steady-state analysis is performed for the helium condition and the maximum increase in fuel cladding temperature is 36°F. Combining the effects from all of the sensitivity studies results in maximum fuel cladding and basket component temperatures that do not exceed the allowable temperatures established in Table 4.1-3.

4.5.2 CY-MPC Test Model

The NAC-MPC system is conservatively designed by analysis so that testing is not required.

4.5.3 Maximum Temperatures for CY-MPC Normal Conditions

Figure 4.5.3-5 shows the temperature distribution in the spent fuel, the canister and the concrete cask in long-term storage. The routine operations of loading, closing and transfer of the canister to the concrete cask are transient conditions that result in different temperature conditions, depending on the configuration of the canister. In the transient conditions, the maximum temperature of the fuel is maintained below the maximum allowable short-term temperature limit (Table 4.1-3) by implementing specific actions described in the procedures (Section 8.1.1) and in the Technical Specifications provided in Appendix A of the Certificate of Compliance. Temperature distributions for the off-normal and accident conditions are presented in Sections 11.1 and 11.2, respectively.

4.5.3.1 CY-MPC Decay Heat Loading Categories

The operational transient calculations are performed for a range of decay heat loading in the canister. In addition to the design heat load of 17.5 kW, lower heat loads are selected to allow longer operation times for canister welding, vacuum drying, and canister transfer. The range of loadings for the CY-MPC are grouped into four categories, defined as Categories A, B, C and D.

The loading categories are defined to simplify presentation in the Technical Specifications and are listed in Table 4.5.3-2. Each loading category is defined as a combination of two limits: 1) total canister decay heat; and 2) decay heat of the hottest individual fuel assembly in the canister. These fuel assembly heat loads are used in the loading cases to determine the allowable times for each operational step. The bounding cases from the analysis are identified in Table 4.5.3-1.

A matrix of loading cases, as a function of total canister decay heat and maximum fuel assembly decay heat, is presented in Table 4.5.3-3. For canister loading operations, this matrix is utilized by first determining the total heat load for all of the fuel assemblies to be loaded into a canister, then determining the maximum individual fuel assembly heat load for those assemblies. These values are then used to look up the first column ("Maximum Total Canister Heat Load"), starting at the lowest total heat load, until the condition is met, then across that row starting from the right, until the individual fuel assembly condition ("Maximum Individual Fuel Assembly Heat Load") is met. The intersection of the row and column indicates the loading category for the canister being considered. For analytical purposes, the loading categories listed in Table 4.5.3-2 have been enveloped for each loading category by considering the maximum number of hottest fuel assemblies up to the total canister decay heat limit. Therefore, the preferential loading configuration, which contains eight 840-watt fuel assemblies, bounds the uniform loading configuration which has a maximum decay heat of 674 watts per fuel assembly.

Loading Categories A and B are also constrained by the preferential loading configuration for the CY-MPC when a canister contains a fuel assembly with a decay heat greater than 674 watts.

4.5.3.2 CY-MPC Maximum Temperatures in Long-Term Storage

Figure 4.5.3-1 shows the temperature distribution of the concrete cask for the normal condition of storage for the uniform decay heat distribution of 17.5 kW. The air flow field and air temperatures in the annulus between the canister and the storage cask liner for the normal condition of storage are shown in Figures 4.5.3-2 and 4.5.3-3, respectively. The maximum component temperatures for both conditions of decay heat loading for the normal conditions of storage are shown in Table 4.5.3-4.

4.5.3.3 CY-MPC Maximum Temperatures in Transient Operations

The transfer operation will accommodate a uniformly distributed fuel load of 674 watts per assembly for the design basis preferential loading condition. As discussed in Section 4.5.3.1, the fuel cladding, fuel basket, and canister maximum temperatures calculated for the preferential fuel loading bound those for uniform loading; therefore, only the preferential fuel loading case is analyzed. Note that analyses were performed for the configuration with, and without, the supplemental heating to assist vacuum drying, as discussed in Section 4.5.1.3. The analysis results indicate that the supplemental heating has an insignificant effect on the maximum temperatures of the fuel and basket components (less than 2°F for thee transfer cask bottom heating and no effect for the air flow at the transfer cask/canister annulus). The bounding temperature results are presented in this section.

The option of purging the canister with heated nitrogen (≤ 300°F) at low flow rates was also considered. This option would not have any adverse effect on the vacuum drying times or the maximum component temperatures. Backfilling of the canister during the vacuum drying phase would increase the heat flow due to increased conductivity. The flow of relatively cool gas through the canister would keep the fuel and basket component temperature lower than the vacuum condition. The thermal transient analysis for the vacuum condition would bound the condition with nitrogen in the canister.

Transient thermal analyses are performed to establish the allowable time limits for the vacuum and helium conditions in the canister as described in the Technical Specifications for the Limiting Conditions of Operation (LCO), LCOs 3.1.1 and 3.1.4. 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 the helium condition. When the steady-state temperature calculated is less than the limiting component allowable temperature, the allowable time duration in the helium condition is defined to be 600 hours (25 days) based on the 30-day time test for abnormal regimes as described in PNL-4835.

For Loading Category A, the transient analysis is performed for the transfer operation, canister, inside the transfer cask, containing water for 30 hours, in vacuum for 23 hours and in helium for 50 hours, using the three-dimensional thermal model described in Section 4.5.1.3. A steady-state analysis is also performed for the helium condition using the same thermal model. The temperature history for Loading Category A is presented in Figure 4.5.3-4. The maximum component temperatures for the transfer conditions are shown in Table 4.5.3-5 for the helium condition and in Table 4.5.3-6 for the vacuum drying condition. The allowable temperature for the fuel cladding is 752°F for short-term conditions. The maximum calculated water temperature is 197°F at the end of 30 hours based on an initial water temperature of 100°F. Since the temperatures for the design heat load with uniform fuel loading are bounded by those for the design basis heat load with preferential fuel loading, the results presented in Tables 4.5.3-5 and 4.5.3-6, and Figure 4.5.3-4, also bound the maximum component temperatures and temperature history for uniform fuel loading. The maximum calculated steady-state temperatures (See Table 4.5.3-7) for the limiting components (706°F and 646°F for fuel cladding and heat transfer disk, respectively) are less than the allowable temperatures. Therefore, the allowable time duration in the helium condition is defined to be 600 hours (25 days).

The transient analyses are also performed for various durations of water, vacuum, and helium for Loading Categories B through D. To ensure that the bounding component temperatures are identified, the load cases identified in Table 4.5.3-1 are used to perform the transient analyses.

The transient thermal analysis results for Loading Categories B through D are shown in Table 4.5.3-7, with a comparison to the results of the design basis heat load case (Loading Category A). Note that the Time Limits in LCO 3.1.1 for the vacuum drying after the in-pool cooling are 2 hours less than those used in the analysis to account for operation time.

The Technical Specifications specify the remedial actions required to ensure that the fuel cladding and basket component temperatures do not exceed their short-term allowable temperatures. These remedial actions either include in-pool cooling or forced air cooling.

In-Pool Cooling

If the time limits of LCO 3.1.1 for the vacuum drying process are not met, the Technical Specifications require that in-pool cooling of the transfer cask be initiated and maintained for a minimum of 24 hours with the canister backfilled with helium. Using the three-dimensional ANSYS model described in Section 4.5.1.3, a transient thermal analysis is performed to simulate the vacuum drying, and in-pool cooling process followed by subsequent vacuum drying and helium backfill. The temperature at the end of the vacuum drying stage, as shown in Table 4.5.3-7, is used as the initial condition of the thermal transient analysis. A total of four (4) analyses are performed for the in-pool cooling, followed by the second vacuum drying and helium condition for Loading Category A through D, respectively. The time durations used in the analysis for the second vacuum drying after the in-pool cooling are shown in the following table. Note that the Time Limits in LCO 3.1.1 for the vacuum drying after the in-pool cooling are 2 hours less than those used in the analysis to account for operation time.

Loading Category	Heat Load (kW)	Vacuum Drying Time (hours)
A	17.5	14
B	13	17
C	13	26
D	9	68

The thermal analysis results for the in-pool cooling and subsequent vacuum drying and helium condition are shown in Table 4.5.3-8. The maximum temperatures for the fuel cladding and the heat transfer disk are below the short-term allowable temperatures. Note that the maximum component temperatures for the second vacuum drying condition are below the maximum component temperatures for the first vacuum drying condition as presented in Table 4.5.3-7.

The time limit for the helium condition after the second vacuum drying remains 600 hours (25 days).

Forced Air Cooling

Alternatively, the Technical Specifications allow forced air cooling of the transfer cask if the time limits of LCO 3.1.1 are not met. In this case, air with a maximum temperature of 75°F is supplied to the transfer cask annulus fill/drain lines at a rate of 375 CFM for a minimum of 24 hours with the canister filled with helium. Similar to the analyses discussed for in-pool cooling, transient thermal analyses are performed using the three-dimensional ANSYS model described in Section 4.5.1.3 with the design basis heat load of loading Category A, and the reduced heat loads of 13 kW, and 9 kW for loading Categories B through D.

The temperature at the end of the vacuum drying stage, as shown in Table 4.5.3-7, is used as the initial condition of the thermal transient analysis. A total of four (4) analyses are performed for the forced air cooling, followed by the second vacuum drying and helium condition for Loading Category A through D, respectively. The time durations used in the analysis for the second vacuum drying condition after the forced air cooling are shown in the following table. Note that the Time Limits in LCO 3.1.1 for the vacuum drying condition after the forced air cooling are 2 hours less than those used in the analysis to account for operation time.

Loading Category	Heat Load (kW)	Vacuum Drying Time (hours)
A	17.5	10
B	13	14
C	13	23
D	9	62

During the 24-hour forced air cooling period, a convection boundary condition is applied to the vertical surfaces of the canister shell and the transfer cask inner shell using the following correlation for flow past a concentric tube annulus (Incropera):

$$Nu_D = 0.023 Re_D^{4/5} Pr^n$$

where, Nu_D = the Nusselt Number,

$= \frac{h \times D_h}{k}$,

h = the film coefficient,

D_h = the hydraulic diameter,

k = the thermal conductivity of the media (air) at T_{film},

T_{film} = the film temperature $=(T_{surf} + T_{bulk})/2$,

T_{surf} = the surface temperature,

T_{bulk} = the media (air) temperature,

Re_D = the Reynolds Number,

$= \frac{\rho u_m D_h}{\mu}$,

ρ = the density of the media (air) at T_{film},

u_m = the mean fluid velocity (9.4 ft/sec based on 375 CFM),

μ = the dynamic viscosity of the media (air) at T_{film},

Pr = the Prandtl Number of the media (air) at T_{film}, and

n = 0.4 for heating

The thermal analysis results for the forced air cooling and subsequent vacuum drying and helium condition are shown in Table 4.5.3-9. The maximum temperatures for the fuel cladding and the heat transfer disk are below the short-term allowable temperatures. Note that the maximum component temperatures of the second vacuum drying condition are below the maximum component temperatures for the first vacuum drying condition as presented in Table 4.5.3-7. The time limit for the helium condition after the second vacuum drying condition remains 600 hours (25 days).

4.5.3.4 CY-MPC Damaged Fuel

CY-MPC damaged fuel comprises fuel assemblies that must be stored in either a reconfigured fuel assembly or inside a damaged fuel can. The maximum decay heat from either a reconfigured fuel assembly or damaged fuel can is 600 watts (Figure 4.5.1.1-2, location 8) for the preferential loading, so they are enveloped by a 674 W fuel assembly for uniform loading. It is, therefore, conservative to estimate the maximum temperature of a damaged fuel assembly in a damaged fuel can or a reconfigured fuel assembly as being equal to the maximum temperature of a 674 W fuel assembly for each thermal condition presented in Sections 4.5.3.1 and 4.5.3.2. Since the majority of the heat generated by the fuel assemblies is transferred throughout the support disks and heat transfer disks to the canister shell and since the damaged fuel cans and reconfigured fuel assemblies are restricted in loading to the corner fuel positions of the basket, placing loaded damaged fuel cans or reconfigured fuel assemblies in the four corner positions of the canister has a negligible effect on the maximum temperatures of the fuel cladding and fuel basket components. A summary of maximum component temperatures is shown in Table 4.5.3-10 for the damaged fuel condition.

For the hypothetical condition of 100% failure of the fuel rods inside the damaged fuel can, an analysis is performed to evaluate the effect this failed fuel has on the maximum fuel cladding temperatures, as well as the maximum temperature gradient through the basket support disks. Assuming 50% compaction of the debris from the failed fuel rods and fuel cladding from a 100% failure of a fuel assembly, the height of the debris is 95.67 inches. The lattice or failed rod storage canister holding damaged fuel rods are conservatively omitted, maximizing the concentration of heat within the model. Using the same model described in Section 4.5.1.2 with the 100% failed fuel debris located in the bottom 95.67 inches of the fuel assembly elements in the oversize corner basket slot (the remainder of the elements in this slot are assigned the properties of helium), thermal analyses for uniform and preferential loading for normal storage conditions are performed. For uniform fuel loading, a heat load of 674 W is applied to the fuel debris region. For preferential fuel loading, a heat load of 600 W is applied to the fuel debris region. The results of these analyses are presented in Table 4.5.3-11 and Table 4.5.3-12 for uniform and preferential fuel loadings, respectively. The increase in maximum fuel cladding temperature is 1°F, due to the effect of 100% rod failure of the damaged fuel.

Figure 4.5.3-3 Air Temperature Field (°F) in the CY-MPC Storage Cask - Normal Storage

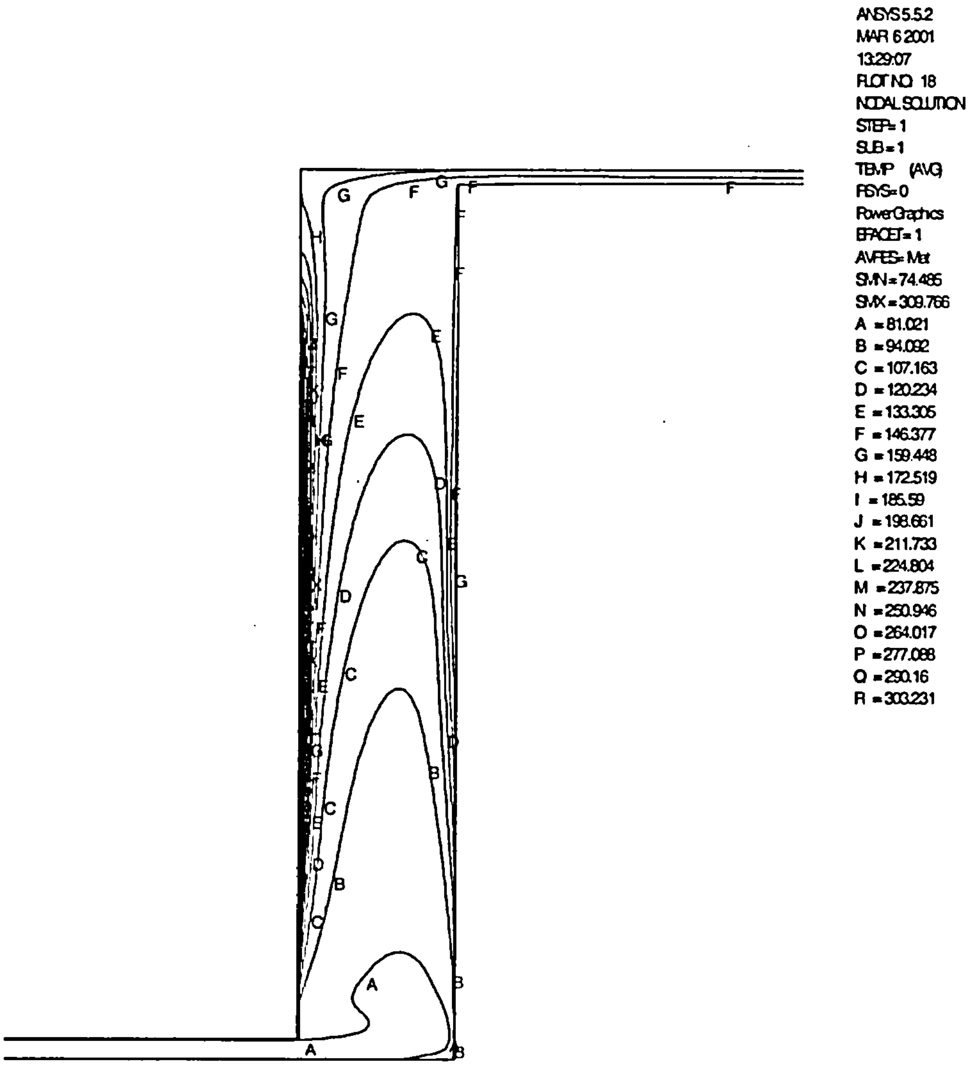


Figure 4.5.3-4 CY-MPC Component Temperature History for the Normal Transfer Condition for the Design Basis Heat Load

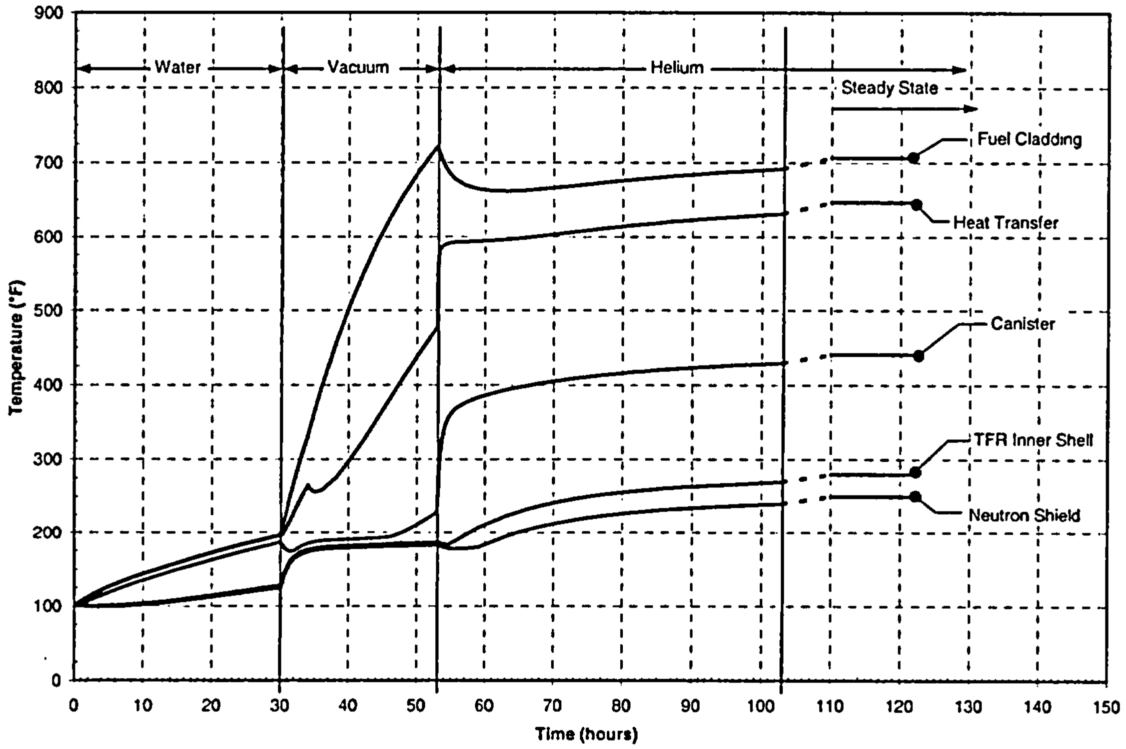


Table 4.5.3-2 CY-MPC Canister Loading Categories

Loading Category	**Maximum Canister Decay Heat**	**Maximum Fuel Assembly Decay Heat**
A	17.5 kW	840 Watts
B	13 kW	840 Watts
C	13 kW	674 Watts
D	9 kW	500 Watts

Table 4.5.3-3 CY-MPC Canister Loading Category Determination Matrix

Maximum Total Canister Heat Load (kW)	**Maximum Individual Fuel Assembly Heat Load (Watts)**		
	840	**674**	**500**
≤ 17.5	A	A	A
≤ 13	B	C	C
≤ 9	B	C	D

Table 4.5.3-4 CY-MPC Maximum Component Temperatures for the Normal Conditions of Storage

Component		Uniform Loading		Preferential Loading (17.5 kW)	
		Maximum Temperature (°F)	**Allowable Temperature (°F)**[1]	**Maximum Temperature (°F)**	**Allowable Temperature (°F)**[1]
Fuel Cladding	Loc. 1[2]	592	752	629	752
	Loc. 2[2]	566	752	596	752
	Loc. 3[2]	508	752	500	752
	Loc. 4[2]	571	752	604	752
	Loc. 5[2]	545	752	541	752
	Loc. 6[2]	492	752	482	752
	Loc. 7[2]	508	752	500	752
	Loc. 8[2]	506	752	496	752
Aluminum Disk		515	700	534	700
Support Disk		517	650	538	650
Canister		312	800	312	800
Concrete Liner (steel)		171	700	171	700
Concrete		171 (local) 130 (bulk)[3]	200 (local) 150 (bulk)	171 (local) 130 (bulk)[3]	200 (local) 150 (bulk)

1. The allowable temperatures are defined and referenced in Table 4.1-3.
2. See Figure 4.5.1.1-2 for basket locations.
3. The average temperature of the concrete region is used as the bulk concrete temperature.

Table 4.5.3-5 CY-MPC Maximum Component Temperatures for the Transfer Condition—Helium in Canister, Design Basis Heat Load with Preferential Fuel Loading

Component	**Maximum Temperature (°F)**	**Allowable Temperature (°F)[1]**
Fuel Cladding	722	752
Gamma Shield (Lead)	253	600
Neutron Shield	250	300
Heat Transfer Disk (Aluminum)	646	700
Support Disk	649	800
Canister	441	800
Transfer Cask Inner Shell	280	700

1. The allowable temperatures are defined and referenced in Table 4.1-3.

Table 4.5.3-6 CY-MPC Maximum Component Temperatures for the Transfer Condition - Vacuum Drying for Preferential Fuel Loading (Design Basis Heat Load)

Component	**Maximum Temperature (°F)**	**Allowable Temperature (°F)[1]**
Fuel Cladding	722	752
Gamma Shield (Lead)	186	600
Neutron Shield	182	300
Heat Transfer Disk (Aluminum)	477	700
Support Disk	480	800
Canister	229	800
Transfer Cask Inner Shell	186	700

1. The allowable temperatures are defined and referenced in Table 4.1-3.

Table 4.5.3-7 CY-MPC Maximum Component Temperatures for the Transfer Condition

Loading Category	Water			Vacuum[2]			Helium		
	Duration (hours)	Maximum Temperature (°F)		Duration (hours)	Maximum Temperature (°F)		Duration (hours)	Max. Temp. / Steady-State Temperature (°F)	
		Fuel	Heat Transfer Disk		Fuel	Heat Transfer Disk		Fuel	Heat Transfer Disk
A	30	197	195	23	722	477	600[1]	722/706	631/646
B	43	195	194	25	729	449	600[1]	729/628	573/560
C	45	195	194	35	730	511	600[1]	730/597	609/541
D	82	195	194	74	728	539	600[1]	728/475	619/426

1. Duration (25 days) is defined based on a test time of 30 days for abnormal regimes as described in PNL-4835.
2. Bottom heating of the transfer cask doors is considered for this condition.

Table 4.5.3-8 CY-MPC Maximum Component Temperatures for the Transfer Condition – Transfer Cask In-Pool Cooling

Loading Category	Canister Total Heat Load (kW)	Helium (In-Pool)			Vacuum[2]			Helium		
		Duration (hours)	Temperature at End of Duration (°F)		Duration (hours)	Temperature at End of Duration (°F)		Duration (hours)	Max. Temp. / Steady-State Temperature (°F)	
			Fuel	Heat Transfer Disk		Fuel	Heat Transfer Disk		Fuel	Heat Transfer Disk
A	17.5	24	493	396	14	714	440	600[1]	714/706	621/646
B	13	24	465	365	17	722	422	600[1]	722/628	552/560
C	13	24	440	353	26	715	479	600[1]	715/597	582/541
D	9	24	378	303	68	718	524	600[1]	718/475	605/426

1. Duration (25 days) is defined based on a test time of 30 days for abnormal regimes as described in PNL-4835.
2. Bottom heating of the transfer cask doors is not considered for the in-pool cooling option.

Table 4.5.3-9 CY-MPC Maximum Component Temperatures for the Transfer Condition – Transfer Cask Forced Air Cooling

Loading Category	Canister Total Heat Load (kW)	Helium (Air Cooling)[2]			Vacuum[2]			Helium		
		Duration (hours)	Temperature at End of Duration (°F)		Duration (hours)	Temperature at End of Duration (°F)		Duration (hours)	Max. Temp. / Steady-State Temperature (°F)	
			Fuel	Heat Transfer Disk		Fuel	Heat Transfer Disk		Fuel	Heat Transfer Disk
A	17.5	24	552	466	10	713	455	600[1]	713 / 706	626 / 646
B	13	24	509	417	14	723	437	600[1]	723 / 628	562 / 560
C	13	24	494	414	23	727	500	600[1]	727 / 597	599 / 541
D	9	24	431	359	62	724	534	600[1]	724 / 475	614 / 426

1. Duration (25 days) is defined based on a test time of 30 days for abnormal regimes as described in PNL-4835.
2. Bottom heating of the transfer cask doors is considered for this condition.

Table 4.5.3-10 Maximum Component Temperatures for Damaged Fuel

	Maximum Temperatures (°F)[1]		
Design Condition	**Damaged Fuel Can** [2,4]	**Reconfigured Fuel Assembly Tube** [2,5]	**Fuel Rod Cladding**[3]
Normal	506	592	592
Off-Normal and Accident Conditions	548	634	634
Transfer	596	722	722

1. Bounding temperatures are taken from the maximum fuel clad temperature for uniform heat condition of 17.5 kW per canister or 674 W per assembly.
2. Material allowable temperature: 800°F.
3. Fuel cladding allowable temperatures:
   Normal conditions: 752°F
   Off-normal and accident conditions: 806°F
   Transfer conditions: 752°F
4. Temperature of fuel in basket location 8 (see Table 4.5.3-4).
5. Conservative temperature taken from the fuel temperature in the center of the basket.

Table 4.5.3-11 Maximum Component Temperatures for 100% Damaged Fuel, Uniform Fuel Loading

Case	Maximum Temperature of Intact Fuel, 674 W (°F)	Maximum Temperature of Damaged Fuel, 674 W (°F)
100% Failed Fuel With 50% Compaction (17.5 kW, uniform)	593	521
Base (17.5 kW, uniform)	592	---

Table 4.5.3-12 Maximum Component Temperatures for 100% Damaged Fuel, Preferential Fuel Loading

Case	Maximum Temperature of Intact Fuel, 840 W (°F)	Maximum Temperature of Damaged Fuel, 600 W (°F)
100% Failed Fuel With 50% Compaction (17.5 kW, zone)	630	509
Base (17.5 kW, zone)	629	---

The bounding total mass of hardware, 38 kg, is then combined with the RCCA mass and converted to a volume. The volume is then converted to moles based on the assumed backfill temperature of 150°F (339K) and the 1 atmosphere backfill pressure.

Region	SS Clad Assemblies	Zr Clad Assemblies
Active Core (kg)	12.458	19.415
Gas Plenum (kg)	3.879	5.137
Lower End-Fitting (kg)	8.850	5.440
Upper End-Fitting (kg)	11.240	11.840
Plenum Spring (kg)	-3.200	-4.100
Total (kg)	33.227	37.732

$$V_{\text{Payload}} = \frac{\left[\left(\frac{38\text{kg}}{\text{Assembly}}\times\frac{2.2046\text{lb}}{\text{kg}}\right)+\frac{156\text{lb}}{\text{Assembly}}\right]\times\frac{26\text{ Assemblies}}{\text{Cask}}}{0.291\frac{\text{lb}}{\text{in}^3}} = 22{,}000\frac{\text{in}^3}{\text{Cask}}$$

$$V_{\text{Rods}} = \pi\times\left(\frac{0.4325\text{ in}}{2}\right)^2\times\frac{126.7\text{ in}}{\text{Rod}}\times\frac{204\text{ Rods}}{\text{Assembly}}\times\frac{26\text{ Assemblies}}{\text{Cask}} \cong 99{,}000\frac{\text{in}^3}{\text{Cask}}$$

$$V_{\text{Cavity Volume}} = 536{,}000\frac{\text{in}^3}{\text{Cask}}$$

$$V^{\text{26 Fuel Assembly}}_{\text{Basket Componet Volume}} = 68{,}000\frac{\text{in}^3}{\text{Cask}}$$

Note: Free volume is rounded down to the nearest 100 liter.

$$N_{\text{TSC Back-Fill}} = \frac{1\text{atm}\times 5{,}700\frac{\text{liter}}{\text{Cask}}}{0.08205\frac{\text{atm liter}}{\text{Mole K}}\times 339\text{ K}} = 210\frac{\text{Moles of Canister Fill Gas}}{\text{Cask}}$$

The total gas quantity available for pressurizing the canister, normal conditions, is:

$$N = N_{\text{TSC Back-Fill}} + (x_{\text{RF}})(N_{\text{Rod Back-Fill}}) + (x_{\text{gs}})(x_{\text{RF}})(N_{\text{Fission Gas}})$$

$$N = N_{\text{TSC Back-Fill}} + 0.03(N_{\text{Rod Back-Fill}}) + 0.3(0.03)(N_{\text{Fission Gas}})$$

$$N = 210\frac{\text{Moles}}{\text{Cask}} + 0.03\left(140\frac{\text{Moles}}{\text{Cask}}\right) + 0.3\ (0.03)\left(610\frac{\text{Moles}}{\text{Cask}}\right) = 220\frac{\text{Moles}}{\text{Cask}}$$

$$P = \frac{\left(220\ \frac{\text{Moles}}{\text{Cask}}\right) \times \left(0.08205\frac{\text{atm liter}}{\text{mole K}}\right) \times 506\ \text{K}}{\left(5{,}700\frac{\text{liter}}{\text{Cask}}\right)} \approx 24\ \text{psia} \approx 9\ \text{psig}$$

4.5.6 Maximum CY-MPC Thermal Stresses for Normal Conditions

The canister and concrete storage cask thermal stresses are evaluated in Section 3.4.4.3.

4.5.7 Evaluation of CY-MPC Performance for Normal Conditions of Storage

As shown in the preceding sections, the CY-MPC system operates within the thermal design limits. Therefore, no degradation due to temperature effects on material or components is expected over the lifetime of the cask.

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Siegel, R. and Howell, J.R., Thermal Radiation Heat Transfer, Third Edition, Hemisphere Publishing Company, 1992.

Reg. Guide 1.25, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors (Safety Guide 25)," March 1972.

PNL-6364, "Control of Degradation of Spent LWR Fuel During Dry Storage in an Inert Atmosphere," October 1987.

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Revision 5

NAC-MPC

NAC Multi-Purpose Cask

FINAL SAFETY ANALYSIS REPORT

Docket No. 72-1025

NAC
INTERNATIONAL

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Chapter 8

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8. Disengage the transfer cask lifting yoke to provide clear access to the canister.
9. Load the previously designated fuel assemblies into the canister.

   Note: Contents must be selected and loaded in accordance with the Approved Contents provisions of Appendix B, Section B2.0, of the Certificate of Compliance.
10. Attach a three-legged sling to the shield lid using the swivel hoist rings.
11. Using the cask handling crane, or auxiliary hook, lower the shield lid until it rests in the top of the canister.

    Note: Ensure that the shield lid key slot aligns with the key welded to the canister shell.
12. Raise the transfer cask until its top just clears the pool surface. Hold at that position, and using a suction pump, drain the pool water from above the shield lid. After the water is removed, continue to raise the cask. Note the time that the transfer cask is removed from the pool. Operations through Step 28 must be completed within 30 hours; or for the CY-MPC configuration with less than the design basis heat load, the time limits shown in Table 8.1-3 are applied.

    Note: In the event that the drain time limit will not be met, forced air cooling or in-pool cooling of the canister is required to be initiated prior to exceeding the allowable time in water established for the canister heat load. Forced air cooling is implemented by supplying 375 CFM air with a maximum temperature of 75°F to the 8 transfer cask lower inlets. Forced air or in-pool cooling of the canister shall be maintained for a minimum of 24 hours. After 24 hours, the cooling may be discontinued based on heat load as follows:

    Time Periods for Discontinued Cooling after 24 Hours[1]

Heat Load (kW)	For Forced Air Cooling (hrs)	For In-Pool Cooling (hrs)
$13 < Q \leq 17.5$	7	7
$9 < Q \leq 13$	16	14
$Q \leq 9$	48	47

    [1] Interruption of forced air cooling, as described in the Note of Step 30, is not applicable to the forced air cooling required during canister time in water evolutions.
13. As the cask is raised, spray the transfer cask outer surface with clean or filtered water to wash off any gross contamination.
14. When the transfer cask is clear of the pool surface, but still over the pool, turn off the clean or filtered water flow to the annulus, remove the hoses and allow the annulus water to drain to the pool. Move the transfer cask to the decontamination area or other suitable work station.

    Note: Access to the top of the transfer cask is required. A suitable work platform may need to be erected.
15. Verify that the shield lid is level and centered.

    Note: Supplemental shielding may be used for activities around the shield lid.

16. Attach the suction pump to the suction pump fitting on the drain port. Operate the suction pump to remove free water from the shield lid surface. Disconnect the suction pump and suction pump fitting. Remove any free standing water from the shield lid surface and from the vent and drain ports.
17. Decontaminate the top of the transfer cask and shield lid as required to allow welding and inspection activities.
18. Insert the drain tube through the drain port of the shield lid into the basket drain tube sleeve. Install the drain tube assembly by hand until metal-to-metal contact is achieved; then torque to 135 ± 15 ft-lbs for Furon metal seals or 115 ± 5 ft-lbs for elastomer seals (EPDM or Viton). Install a mating quick-disconnect fitting in the vent line to open the vent. Remove the shield lid hoist rings and replace with threaded plugs.
19. Verify that the vent port is open. Connect the suction pump to the drain port. Remove approximately 65 gallons of water from the canister. Disconnect and remove the pump. Caution: Radiation level may increase as water is removed from the canister.
20. Install the semiautomated welding equipment.
21. Attach the hydrogen gas detector to the vent port. Verify that the concentration of any detectable hydrogen gas is below 2.4%.

    Note: If the concentration exceeds 2.4%, operate the vacuum system to remove gases from the under side of the shield lid and re-verify hydrogen gas concentration. Disconnect and remove the vacuum system.
22. Operate the welding equipment to complete the root weld joining the shield lid to the canister shell following approved procedures.
23. Prepare the weld and perform a liquid penetrant weld examination of the root pass. Record the results of the weld examination.

    Note: The hydrogen detector may be removed from the vent port, if necessary.
24. Complete welding of the shield lid to the canister wall. Prepare the weld and perform a liquid penetrant weld examination of the final pass. Record the results of the weld examination.

    Note: At the discretion of the user, the weld examination may be deferred until completion of the pressure test.

    Note: Re-rounding, if required, shall be performed prior to final weld examinations and pressure testing.
25. Remove the weld equipment and the hydrogen gas detector.
26. Remove any lines attached to the drain port. Attach an air pressure line to the vent port. Pressurize the canister to 20 psig and isolate the air supply. There must be no loss of pressure for 10 minutes.

27. Release the pressure. Visually inspect the shield lid to canister shell weld for indications of defects. Record the results of the inspection.

28. Drain the remaining water from the canister cavity. Draining of the canister may be performed by suction, by a blow-down gas pressure of 15-18 psig, or by a combination of suction and a blow-down gas pressure of 15-18 psig. After removal of the water from the canister, disconnect the equipment from the canister. Note the time that the last free water is removed from the canister cavity. If not already installed, install a quick-disconnect to open the vent port.

    Note: The time duration from completion of draining through the completion of helium backfill (Step 34) shall be monitored in accordance with LCO 3.1.1.

    Note: The transfer cask (with the canister inside) may be tilted up to 6° from vertical to assist in canister water removal and draining.

    Note: A temporary full-length siphon/drain tube may be used in place of the permanent drain tube to facilitate removal of remaining free water from the canister cavity. If the temporary full-length siphon/drain tube is used, following completion of the canister water removal process, it shall be removed and replaced by the permanent drain tube prior to initiating Step 29.

    Note: At the completion of draining operations, an external heater may be used to add heat to the transfer cask shield doors during vacuum drying and during forced air cooling operations implemented per LCO 3.1.1 until the dryness verification of LCO 3.1.2 is completed. The heater will be sized and operated to limit the peak temperature of the bottom of the shield doors to < 200°F. The addition of heat will assist vacuum drying operations.

    Caution: The user shall ensure the stability of the transfer cask and canister during all operations.

    Caution: Radiation levels at the top and sides of the transfer cask may rise as water is removed.

29. Attach the vacuum equipment to the vent and drain ports. Dry any free standing water in the vent and drain port recesses.

    Note: At the option of the user, dry nitrogen (ambient temperature up to 300°F) may be purged or bled into the cavity during vacuum drying at a low flow rate (i.e., ≤ 10 CFM).

    Note: At the option of the user, dry nitrogen or helium may be used during the vacuum drying cycle to backfill the cavity to ≤ 1 atmosphere to allow canister internals to thermally stabilize.

30. Operate the vacuum equipment, until a vacuum of ≤ 10 mm of mercury exists in the canister. Vacuum drying pressure must conform to the requirements of LCO 3.1.2.

    Note: If the vacuum drying operations are not completed within the allowable vacuum drying cycle time periods established in LCO 3.1.1.1.b or LCO 3.1.1.2.b, the canister shall be backfilled with helium and either forced air cooling or water cooling operations shall be initiated and maintained for a minimum of 24 hours prior to the restart of loading operations.

    In the event of an interruption of the forced air cooling process during the required minimum 24 hours of operation, remedial actions to extend the forced air cooling time to account for interruptions is required. The period of the required additional forced air cooling is based on the duration of the interruption(s) as follows:

Duration of Interruption(s) T (hr)	Additional Forced Air Cooling Time (hr)
$T \leq 0.5$	0
$0.5 < T \leq 1$	2
$1 < T \leq 2$	4
$2 < T \leq 3$	6
$3 < T \leq 4$	8

    The duration of the interruption(s) corresponds to the cumulative time of interruption events. The additional forced air cooling time is required to be added to the remaining time of the original minimum 24 hours of cooling prior to the first interruption. If the duration of the interruption(s) exceeds 4 hours, a minimum duration of 30 hours of forced air cooling is required from the end of the interruption(s).

31. Verify that no water remains in the canister by holding the vacuum for 10 minutes. If water is present in the cavity, the pressure will rise as the water vaporizes. Continue the vacuum/hold cycle until the conditions of LCO 3.1.2 are met.

32. Evacuate the canister to ≤ 3 mm of mercury and backfill the canister cavity with helium, having a minimum purity of 99.9%, to a pressure of one atmosphere.

    Note: As an option, an informational helium leak test may be conducted at this point using the following steps (the record leak test is performed at Step 49):

    32a. Backfill the canister cavity with helium having a minimum purity of 99.9% to a pressure of 15 psig.

    32b. Using a helium leak detector ("sniffer" detector) with a test sensitivity of 5×10^{-6} cm^3/sec (helium), survey the weld joining the shield lid and canister shell.

32c. At the completion of the survey, vent the canister helium pressure to one atmosphere (0 psig).

33. Restart the vacuum equipment and evacuate the canister to ≤ 3 mm of mercury.
34. Backfill the canister cavity with helium having a minimum purity of 99.9% to a pressure of one atmosphere (+1, -0 psig).

    Note: Canister vacuum and helium backfill pressure must conform to the requirements of LCO 3.1.3.

    Note: Step 34 through Step 19 of the concrete cask loading procedure (Section 8.1.2) must be completed within 25 days in accordance with LCO 3.1.4.
35. Disconnect the vacuum and helium supply lines from the vent and drain ports. Dry any residual water that may be present in the vent and drain port cavities.
36. Install the vent and drain port covers.
37. Weld the drain port cover to the shield lid.
38. Prepare the weld and perform a liquid penetrant examination of the root pass. Record the results of the weld examination.

    Note: If the drain port cover weld is completed in a single pass, the weld final surface is examined in accordance with this step.
39. Weld the vent port cover to the shield lid.
40. Prepare the weld and perform a liquid penetrant examination of the root pass. Record the results.

    Note: If the vent port cover weld is completed in a single pass, the weld final surface is examined in accordance with this step.
41. Remove any supplemental shielding used during shield lid closure activities.
42. Install the helium leak test fixture.
43. Attach the vacuum line and leak detector to the leak test fixture fitting.
44. Operate the vacuum system to establish a vacuum in the leak test fixture.
45. Operate the helium leak detector to verify that there is no indication of a helium leak exceeding 2×10^{-7} cm^3/second (helium) in accordance with the requirements of LCO 3.1.5.
46. Release the vacuum and disconnect the vacuum and leak detector line from the fixture.
47. Remove the leak test fixture.
48. Attach a three-legged sling to the structural lid using the swivel hoist rings.

    Caution: Ensure that the hoist rings are fully seated against the structural lid. Torque the hoist rings in accordance with Table 8.1-2. Verify that the structural lid weld spacer ring is in place on the structural lid.

    Note: Verify that the structural lid is stamped, or otherwise marked, to provide traceability of the canister contents.

49. Using the cask handling or the auxiliary crane, install the structural lid in the top of the canister. Verify that the structural lid is even with or slightly above the canister shell and is approximately centered in the canister shell. Verify that the gap in the spacer ring is not aligned with the shield lid alignment key. Remove the lifting sling and the hoist rings.
50. Install the automated welding equipment on the structural lid.
51. Operate the welding equipment to complete the root weld pass joining the structural lid to the canister shell, following approved procedures.
52. Prepare the weld and perform a liquid penetrant examination of the weld root pass and record the results of the weld examination.
53. Complete the remainder of the weld, examining the weld at 3/8-inch intervals and the final weld surface using the liquid penetrant method. Record the results of each intermediate examination.

    Note: If ultrasonic testing of the weld is used, testing is performed after the weld is completed.
54. Remove the welding equipment.
55. Perform a smear survey of the accessible area at the top of the canister to ensure that the surface contamination is less than the limits established for the site. Smear survey results shall meet the requirements of LCO 3.2.1.
56. Install the transfer cask retaining ring. Torque bolts as required by Table 8.1-2.
57. Decontaminate the external surface of the transfer cask to the limits established for the site.

8.1.2 Loading the Vertical Concrete Cask

This section of the loading procedure assumes that the vertical concrete cask (concrete cask) is located on the bed of a heavy-haul trailer, or on the floor of the work area, under the site approved crane and that the concrete cask shield plug and lid are not in place and that the bottom pedestal plate cover is installed.

1. Using a site approved crane, place the transfer adapter on the top of the concrete cask.
2. Using the transfer adapter bolt hole pattern, align the adapter to the concrete cask. Bolt the adapter to the cask using four (4) socket head cap screws. (Note: Bolting of the transfer adapter to the cask is optional, if the transfer adapter centering segments/guides are installed.)
3. Verify that the bottom door connectors on the adapter plate are in the fully extended position.
4. If not already done, attach the transfer cask lifting yoke to the site approved crane. Verify that the transfer cask retaining ring is installed.

5. Install six (6) swivel hoist rings in the structural lid of the canister. Verify that the hoist ring threads are fully engaged, and attach two (2) three-legged slings. Stack the slings on the top of the canister so they are available for use in lowering the canister into the concrete cask.
6. Engage the transfer cask trunnions with the transfer cask lifting yoke. Ensure that all lines are disconnected from the transfer cask.
7. Raise the transfer cask and move it over the concrete cask. Lower the transfer cask, ensuring that the bottom door rails and connector tees align with the adapter plate rails and door connectors. Prior to final set down, remove transfer cask door lock bolts/lock pins.

   Note: The minimum temperature of the surrounding air must be verified to be higher than 0°F prior to lifting in accordance with Appendix B, Section B3.4(8).
8. Ensure that the bottom door connector tees are engaged with the adapter plate door connectors.
9. Disengage the transfer cask yoke from the transfer cask and from the site approved crane hook.
10. Return the cask site approved crane hook to the top of the transfer cask and engage the two (2) three-legged slings attached to the canister. Lift the canister slightly (about 1/2 inch) to take the canister weight off of the transfer cask bottom doors.

    Note: A load cell may be used to determine when the canister is supported by the crane. Avoid raising the canister to the point that the structural lid engages the transfer cask retaining ring, as this could result in lifting the transfer cask.

    Caution: The top connection of the three-legged slings must be at least 67 inches above the Yankee-MPC canister lid, and at least 53 inches above the CY-MPC lid.
11. Using the hydraulic system, open the bottom doors to access the concrete cask cavity.
12. Lower the canister into the concrete cask, using a slow crane speed as the canister nears the bottom of the concrete cask.
13. Disconnect the slings from the crane hook and lower them to the top of the canister. Close the transfer cask bottom doors.
14. Retrieve the transfer cask lifting yoke and attach the yoke to the transfer cask.
15. Lift the transfer cask off the concrete cask and return it to the decontamination area or designated work station.

    Note: For the YR-MPC, ensure that a visible gap exists between the canister and the concrete cask liner (i.e., the canister is not in contact with the concrete cask liner). For the CY-MPC, visually verify that the canister is located within the cylinder of the projection of the support ring.
16. Using the site approved crane, remove the adapter plate from the top of the concrete cask.
17. Remove the swivel hoist rings from the structural lid and replace them with threaded plugs.

18. Using the site approved crane, retrieve the shield plug and install the shield plug in the top of the concrete cask.
19. Using the site approved crane, retrieve the concrete cask lid and install the lid in the top of the concrete cask using six stainless steel bolts.
20. Ensure that there is no foreign material left at the top of the concrete cask. Install the tamper-indicating seal wire and seal.
21. If used, install a supplemental shielding fixture in each of the four air inlets.
    Note: The supplemental shielding fixtures may also be shop installed.

8.1.3 Transport and Placement of the Vertical Concrete Cask

This section of the procedure assumes that the loaded concrete cask is positioned on a heavy-haul trailer.

After placement on the ISFSI pad, the concrete cask surface dose rates must be verified in accordance with the requirements of LCO 3.2.2. The dose rate measurements may be made prior to movement of the concrete cask, at a location along the transport path, or at the ISFSI. Following placement of the concrete cask at the ISFSI, the operability of the concrete cask heat removal system shall be verified in accordance with LCO 3.1.6.

1. Using a suitable towing vehicle, tow the heavy-haul trailer to the dry storage pad (ISFSI). Verify that the bed of the trailer is approximately at the same height as the pad surface.
2. Install four (4) hydraulic jacks at the four (4) designated jacking points at the bottom cooling air vents.
3. Raise the concrete cask approximately 4 inches.
   Caution: Do not exceed a maximum lift height of 6 inches, in accordance with the requirements of Section A 5.5(d) of the Certificate of Compliance.
4. Move the air-bearing rig set under the cask, if not already in place.
   Note: A hydraulic skid may also be used to move the concrete cask. The height the concrete cask is raised depends upon the height of the skid or air pad set used, but may not exceed 6 inches.
5. Remove the four (4) hydraulic jacks. Inflate the air-bearing rig set.
6. Using a suitable towing vehicle, move the concrete cask from the bed of the transporter to the designated location on the storage pad.
7. Turn off the air-bearing rig set, allowing it to deflate.
8. Reinstall the four (4) hydraulic jacks and raise the concrete cask approximately 4 inches.
   Caution: Do not exceed a maximum lift height of 6 inches.

9. Remove the air-bearing rig set pads. Ensure that the surface of the dry storage pad under the cask is free of foreign objects.
10. Lower the concrete cask to the surface.

    Note: Ensure that the centerline spacing between concrete casks is 15 feet minimum.
11. Remove the four (4) hydraulic jacks.
12. Install screens in the inlets and outlets.
13. Install/connect the temperature monitoring equipment and verify operation.
14. Scribe/stamp the concrete cask name plate to indicate loading date.

Figure 8.1-1 Vent and Drain Port Locations

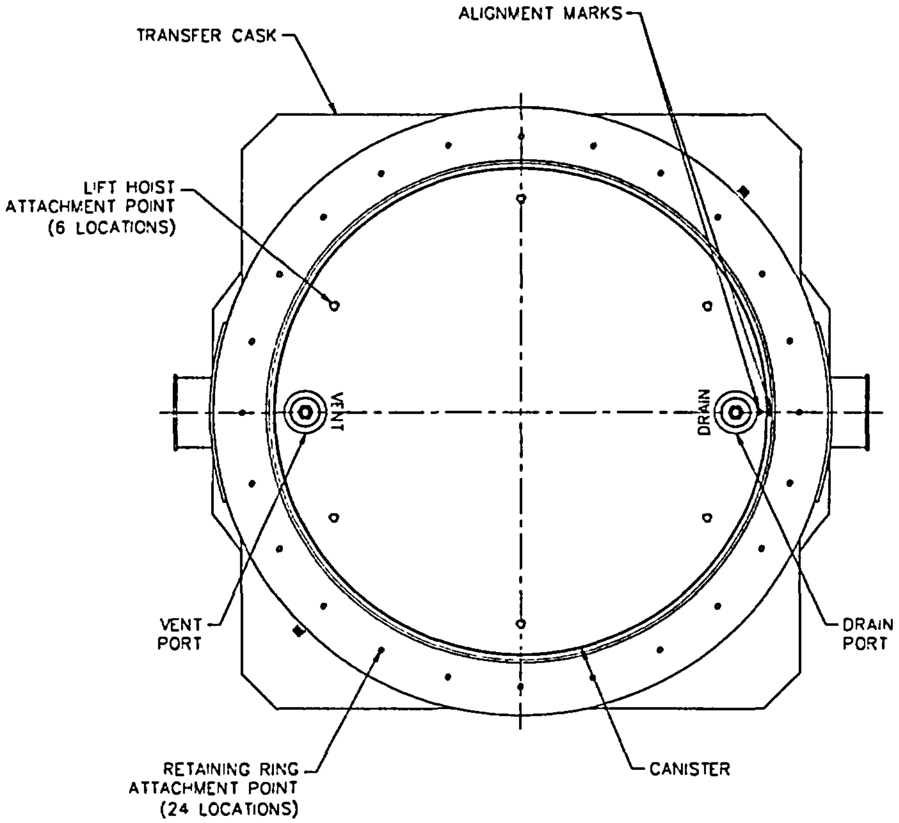

Table 8.1-1 List of Ancillary Equipment

Item	Description
Transfer Cask Lifting Yoke	Required for lifting and moving the transfer cask.
Transport Trailer (Optional)	Heavy-haul (double drop frame) trailer required for moving the loaded and empty concrete cask to and from the ISFSI pad.
Helium Supply System	Supplies helium to the canister for helium backfill and purging operations.
Vacuum Drying System	Used for evacuating the canister. Used to remove residual water, air and initial helium backfill.
Automated Welding System	Used for welding the shield lid and structural lid to the canister shell.
Self-Priming Pump	Used to remove water from the canister.
Shield Lid Sling	Used to make a three-point lift of the shield lid and the concrete cask shield plug and lid.
Canister Sling	Used to make a six-point lift of the loaded canister. These slings are also used to make a three-point lift of the structural lid.
Transfer Adapter	Used to align the transfer cask to the concrete cask or transport cask. Provides the platform for the operation of the transfer cask bottom doors.
Hydraulic Unit	Operates the bottom doors of the transfer cask.
Lift Pump Unit	Jacking system for raising and lowering the concrete cask.
Air Pad Rig Set	Air cushion system used for moving the concrete cask.
Supplemental Shielding Fixture	An optional carbon steel fixture inserted in the Yankee-MPC vertical concrete cask air inlets to reduce radiation dose rates at the inlets.

Table 8.1-2 Torque Values

Fastener	Torque Value (ft-lbs)	Torque Pattern
Transfer Adapter Bolts (Optional)	40 ± 5	None
Transfer Cask Retaining Ring Bolts	100 ±10	None
Vertical Concrete Cask Lid Bolts	40 ± 5	None
Lifting Hoist Rings* (Loaded Canister Lift) * Threads must be fully engaged	800 + 80, - 0	None
Lifting Hoist Rings* (Components)		
Vertical Concrete Cask Lid	60 + 5, - 0	None
Transfer Cask Retaining Ring	100 + 10, - 0	None
GTCC Canister (Empty)	230 + 25, - 0	None
Vertical Concrete Cask Shield Plug	230 + 25, - 0	None
Fuel Canister (Empty)	230 +25, - 0	None
Canister Shield Lid Welding Plate	230 +25, - 0	None
Canister Shield Lid	470 +50, - 0	None
Canister Structural Lid	Hand Tight	None
* Threads must be fully engaged		
Canister and Lid Plug Bolts	Hand Tight	None
Transfer Cask Door Lock Bolts/ Lock Pins	Hand Tight	None
Canister Drain Tube	135 ± 15 (Furon metal seals) 115 ± 5 (elastomer seals, EPDM or Viton)	None
Canister Vent Valve	135 ± 15 (Furon metal seals) 115 ± 5 (elastomer seals, EPDM or Viton)	None

Table 8.1-3 Time Limits for Removing Water from the CY-MPC Canister

Total Heat Load (L) kW	Time Limit (Hours)
$13 < L \leq 17.5$	30
$9 < L \leq 13$	43
$L \leq 9$	82

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Chapter 12

APPENDIX 12C

TECHNICAL SPECIFICATION BASES FOR THE NAC-MPC SYSTEM

Appendix 12C
Table of Contents

C 3.1 NAC-MPC 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 Analysis 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, per LCO 3.1.1.1.a or 3.1.1.1.b, the CANISTER is backfilled with helium and either WATER COOLING or FORCED AIR COOLING is initiated. The WATER COOLING or FORCED AIR COOLING of the loaded CANISTER is maintained for a minimum of 24 hours.

(continued)

APPLICABLE SAFETY ANALYSIS (continued)

FORCED AIR COOLING

The basis for FORCED AIR COOLING is the application of forced convection cooling of the CANISTER with cool air at flow rates exceeding the CONCRETE CASK natural convection cooling flow rate. Because of the small annulus between the TRANSFER CASK and CANISTER, this results in a high flow velocity. The high flow velocity results in improved heat transfer from the CANISTER compared to normal storage conditions in the CONCRETE CASK. For the Yankee-MPC the time limits for FORCED AIR COOLING are conservatively applied to the WATER COOLING condition, as the FORCED AIR COOLING evaluation bounds that for WATER COOLING.

YANKEE-MPC

Analyses reported in the Final Safety Analysis Report conclude that spent fuel cladding and CANISTER material short-term temperature limits will not be exceeded for total elapsed times less than 40 hours in vacuum drying and for an unlimited time with the CANISTER filled with helium in the TRANSFER CASK. Since the rate of heat-up is lower for lower total heat loads, the time required to reach component temperature limits is longer than for the design basis heat load. Consequently, longer time limits are specified for heat loads below the design basis heat load, as shown in LCO 3.1.1.1.a. The times specified in the LCO are reduced by 2 hours to allow commencement of the REQUIRED ACTIONS should the LCO time limits not be met.

After a minimum of 24 hours of WATER COOLING or FORCED AIR COOLING operations, the spent fuel cladding temperature will be below 552°F. Analyses in the Final Safety Analysis Report show that short-term limits will not be reached for a minimum of 10 hours under vacuum drying conditions for the design basis heat load. For reduced heat loads, the time duration is longer, as shown in LCO 3.1.1.2.a.

(continued)

APPLICABLE SAFETY ANALYSIS (continued)

CY-MPC

Analyses reported in the Final Safety Analysis Report conclude that spent fuel cladding and CANISTER material short-term temperature limits will not be exceeded for total elapsed time less than 23 hours in vacuum drying and for 25 days (600 hrs) with the CANISTER filled with helium in the TRANSFER CASK. Since the rate of heat-up is lower for the lower total heat loads (LOADING CATEGORIES B through D), the time required to reach component limits is longer. Consequently, longer time limits are specified for these categories as shown in LCO 3.1.1.1.b. The times specified in the LCO are reduced by 2 hours from the calculated times to allow for commencement of the REQUIRED ACTIONS should the LCO time limits not be met.

After 24 hours of WATER COOLING or FORCED AIR COOLING, the time limits for additional vacuum drying of the CY-MPC are 12 hours following WATER COOLING and 8 hours following FORCED AIR COOLING for the design basis heat load of LOADING CATEGORY A. Since the rate of heat-up is lower for the lower total heat loads (LOADING CATEGORIES B through D), the time required to reach component limits is longer than for the design basis heat load. Consequently, longer time limits are specified for these categories for the CY-MPC configuration as shown in LCO 3.1.1.2.b.

In the event of a FORCED AIR COOLING interruption(s) during LCO 3.1.1, remedial action to extend the FORCED AIR COOLING time to account for the interruption in air cooling is required. The extension of FORCED AIR COOLING assures that the temperatures of the fuel cladding and critical fuel basket components evaluated in the thermal analysis for the restart of the vacuum drying are achieved. The period of additional FORCED AIR COOLING required is based on the duration of the interruption as shown in the following table.

(continued)

APPLICABLE SAFETY ANALYSIS (continued)

Duration of Interruption(s) T (hr)	Additional FORCED AIR COOLING Time (hr)
$T \leq 0.5$	0
$0.5 < T \leq 1$	2
$1 < T \leq 2$	4
$2 < T \leq 3$	6
$3 < T \leq 4$	8

Note that the preceding table is established for short periods (up to 4 hours) of interruption. The "Duration of Interruption(s)" corresponds to the cumulative time of interruption events. The "Additional FORCED AIR COOLING Time" is to be added to the time remaining in the LCO action prior to the first interruption (i.e., the original 24 hours of cooling must be completed plus the additional cooling time corresponding to the duration of the interruption). Additional FORCED AIR COOLING time is not required if the duration of interruption(s) is 30 minutes or less. The additional FORCED AIR COOLING time determinations are based on the design heat load for the CY-MPC system and, consequently, all other heat loads are bounded.

For an interruption(s) with a duration greater than 4 hours, a minimum duration of 30 hours of FORCED AIR COOLING is required following the end of the last interruption event. (Note: the original 24 hours of FORCED AIR COOLING does not need to be completed.) The minimum duration of 30 hours of FORCED AIR COOLING is conservatively determined based on the required cooling time to ensure that the fuel clad and component temperatures are acceptable for the restart of the vacuum drying for the durations listed in the LCO for all heat load cases following FORCED AIR COOLING.

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 in the FSAR for the NAC-MPC SYSTEM.

(continued)

APPLICABILITY

The 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 and the backfilling of the CANISTER with helium for long-term STORAGE OPERATIONS. 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-MPC SYSTEM. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each NAC-MPC SYSTEM not meeting the LCO. Subsequent NAC-MPC SYSTEMS that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1 Commence filling CANISTER with helium to a pressure of 0 (+1, -0) psig.

<u>AND</u> Commence WATER COOLING.

A.2.1 <u>AND</u>

Maintain WATER COOLING for a minimum of 24 hours.

A.2.2

<u>OR</u>

A.2.3 Commence FORCED AIR COOLING.

<u>AND</u>

A.2.4 Maintain FORCED AIR COOLING for a minimum of 24 hours.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.1.1.1

The elapsed time shall be monitored from completion of CANISTER draining through completion of the CANISTER vacuum dryness verification testing. Monitoring the elapsed time ensures that helium backfill and cooling operations can be initiated in a timely manner during LOADING OPERATIONS to prevent fuel cladding and CANISTER materials from exceeding short-term temperature limits. The times specified in the LCO are reduced by 2 hours from the calculated times to allow commencement of the REQUIRED ACTIONS should the LCO time limits not be met.

SR 3.1.1.2

The elapsed time shall be monitored from the end of WATER COOLING or FORCED AIR COOLING through completion of the CANISTER vacuum dryness verification testing. Monitoring the elapsed time ensures that helium backfill and cooling operations can be initiated in a timely manner during LOADING OPERATIONS to prevent fuel cladding and CANISTER materials from exceeding short-term temperature limits. The times specified in the LCO are reduced by 2 hours from the calculated times to allow commencement of the REQUIRED ACTIONS should the LCO time limits not be met.

REFERENCES

1. FSAR Sections 4.4, 4.5 and 8.1.

C 3.1 NAC-MPC SYSTEM Integrity

C 3.1.2 CANISTER Vacuum Drying Pressure

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. CANISTER cavity vacuum drying is utilized to remove residual moisture from the CANISTER cavity after the water is drained from the CANISTER. Any water not drained from the CANISTER cavity evaporates due to the vacuum. This is aided by the temperature increase, due to the heat generation of the fuel.
APPLICABLE SAFETY ANALYSIS	The confinement of radioactivity (including fission product gases, fuel fines, volatiles, and crud) during the storage of design basis spent fuel in the CANISTER is ensured by the multiple confinement boundaries and systems. The barriers relied on are: the fuel pellet matrix, the metallic fuel cladding tubes where the fuel pellets are contained, and the CANISTER where the fuel assemblies are stored. Long-term integrity of the fuel cladding depends on removal of oxidizing gases and on storage in an inert atmosphere. This is accomplished by removing water from the CANISTER, evacuating the CANISTER to a pressure of ≤ 3mm Hg and backfilling the cavity with helium. The thermal analysis assumes that the CANISTER cavity is dry and filled with helium.

(continued)

APPLICABLE SAFETY ANALYSIS (continued)

The heat-up of the CANISTER and contents will occur during CANISTER vacuum drying, but is controlled by LCO 3.1.1. Dryness of the CANISTER (e.g., no free water) is verified by holding a vacuum of ≤ 10 mm Hg for a period of not less than 10 minutes. The vapor pressure of water at 70°F is approximately 30 mm Hg. Selecting a maximum pressure (10 mm Hg) that is 1/3 of the vapor pressure at 70°F ensures that all of the free water in the CANISTER is removed. The actual temperatures in the loaded CANISTER are expected to be above 70°F, which would result in a higher vapor pressure. Consequently, the maximum vacuum pressure of 10 mm Hg is conservatively selected. Holding the vacuum pressure for 10 minutes demonstrates that there is no free water since the presence of any free water will result in a pressure exceeding 10 mm Hg within the CANISTER. The removal of oxidizing gases that could lead to fuel cladding deterioration is assured by evacuation to ≤ 3 mm Hg (minimum). After this vacuum condition is achieved, the CANISTER is backfilled with helium to approximately one atmosphere. After the first backfill, the CANISTER is evacuated again to a ≤ 3 mm Hg and backfilled with helium to approximate atmospheric pressure and sealed. The removal of oxidizing gases and the establishment of an inert helium atmosphere in the CANISTER is controlled by LCO 3.1.3. These vacuum and helium backfill cycles ensure that the CANISTER contents are dry and that the atmosphere in the canister is essentially free (< one mole) of any oxidizing gases that could affect the fuel cladding, as recommended by PNL-6365.

LCO

A vacuum pressure of ≤ 10 mm Hg indicates that liquid water has evaporated and been removed from the CANISTER cavity. Removing water from the CANISTER cavity helps to ensure the long-term maintenance of fuel cladding integrity.

APPLICABILITY

Cavity vacuum drying is performed during LOADING OPERATIONS before the TRANSFER CASK holding the CANISTER is moved to transfer the CANISTER into the CONCRETE CASK. Therefore, the vacuum requirements do not apply after the CANISTER is backfilled with helium and leak tested prior to TRANSPORT OPERATIONS and STORAGE OPERATIONS.

(continued)

ACTIONS

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

A.1

If the CANISTER cavity vacuum drying pressure limit cannot be met, actions must be taken to meet the LCO. Failure to successfully complete cavity vacuum drying could have many causes, such as failure of the vacuum drying system, inadequate draining, ice clogging of the drain lines, or leaking CANISTER welds. The Completion Time is sufficient to determine and correct most failure mechanisms. Excessive heat-up of the CANISTER and contents is precluded by LCO 3.1.1.

B.1

If the CANISTER cannot be successfully vacuum dried, the fuel must be placed in a safe condition. Corrective actions may be taken after the fuel is placed in a safe condition to perform the A.1 action provided that the initial conditions for performing A.1 are met. A.1 may be repeated as necessary prior to performing B.1. The time frame for completing B.1 can not be extended by re-performing A.1. The Completion Time is reasonable, based on the time required to reflood the CANISTER, perform fuel cooldown operations, cut the shield lid weld, move the TRANSFER CASK into the spent fuel pool, and remove the CANISTER shield lid in an orderly manner and without challenging personnel.

(continued)

SURVEILLANCE REQUIREMENTS

SR 3.1.2.1

The long-term integrity of the stored fuel is dependent on storage in a dry, inert environment. Cavity dryness is demonstrated by evacuating the cavity to a very low absolute pressure and verifying that the pressure is held over a specified period of time. The maintenance of low vacuum pressure for the specified time indicates that the cavity is dry. The surveillance must be performed prior to TRANSPORT OPERATIONS, as the vacuum drying pressure must be achieved before the CANISTER is sealed. This allows sufficient time to backfill the CANISTER cavity with helium, while minimizing the time the fuel is in the CANISTER without water or an inert atmosphere in the cavity. In addition, the CANISTER can be maintained in a safe condition based on the use of FORCED AIR COOLING or WATER COOLING.

REFERENCES

1. FSAR Sections 4.4, 4.5, 7.1 and 8.1 and PNL-6365.

C 3.1 NAC-MPC SYSTEM Integrity

C 3.1.3 CANISTER Helium Backfill Pressures

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 of the CANISTER cavity with helium provides for heat transfer from the spent fuel to the CANISTER structure and the inert atmosphere protects the fuel cladding. Providing a helium pressure equal to atmospheric pressure ensures that there will be no in-leakage of air over the life of the CANISTER, which might be harmful to the heat transfer features of the NAC-MPC SYSTEM and to the stored spent fuel.

APPLICABLE SAFETY ANALYSIS

The confinement of radioactivity (including fission product gases, fuel fines, volatiles, and crud) during the storage of spent fuel in the CANISTER is ensured by the multiple confinement boundaries and systems. The barriers relied on are: the fuel pellet matrix, the metallic fuel cladding tubes where the fuel pellets are contained, and the CANISTER where the fuel assemblies are stored. Long-term integrity of the fuel and cladding depends on the ability of the NAC-MPC SYSTEM to remove heat from the CANISTER and reject it to the

(continued)

APPLICABLE SAFETY ANALYSIS (continued)

environment. This is accomplished by removing water from the CANISTER cavity and backfilling the cavity with an inert gas. Removal of free water from the CANISTER is verified by LCO 3.1.2. The removal of oxidizing gases that could lead to fuel cladding deterioration is by evacuation of the CANISTER to a a pressure of ≤ 3 mm Hg. After this vacuum condition is achieved, the CANISTER is backfilled with helium to one atmosphere. After the backfill, the CANISTER is evacuated again to ≤ 3 mm Hg and the CANISTER is then backfilled with helium to approximately one atmosphere (0 [+1, -0] psig) and sealed. These vacuum cycles ensure that the canister contents are dry and that the atmosphere in the canister is essentially free (< one mole) of any oxidizing gases, as recommended by PNL-6365. The duration that the CANISTER and contents may remain in the TRANSFER CASK following backfilling with helium is controlled by LCO 3.1.4.

The thermal analyses of the CANISTER assume that the CANISTER cavity is dry and filled with dry helium.

LCO

Backfilling the CANISTER cavity with helium at a pressure equal to atmospheric pressure ensures that there is no air in-leakage into the CANISTER, which could decrease the heat transfer properties and result in increased cladding temperatures and damage to the fuel cladding over the storage period. The helium backfill pressure of one atmosphere (0 [+1, 0] psig) was selected based on a minimum helium purity of 99.9% to ensure that the CANISTER internal pressure and heat transfer from the CANISTER to the environment are maintained consistent with the design and analysis basis of the CANISTER.

APPLICABILITY

Helium backfill is performed during LOADING OPERATIONS, before the TRANSFER CASK and CANISTER are moved to the CONCRETE CASK for transfer of the CANISTER.

(continued)

ACTIONS

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

A.1

If the backfill pressure cannot be established within limits, actions must be taken to meet the LCO. The Completion Time is sufficient to determine and correct most failures, which would prevent backfilling of the CANISTER cavity with helium. These actions include identification and repair of helium leak paths or replacement of the helium backfill equipment.

B.1

If the CANISTER cavity cannot be backfilled with helium to the specified pressure, the fuel must be placed in a safe condition. Corrective actions may be taken after the fuel is placed in a safe condition to perform the A.1 action provided that the initial conditions for performing A.1 are met. A.1 may be repeated as necessary prior to performing B.1. The time frame for completing B.1 can not be extended by reperforming A.1. The Completion Time is reasonable based on the time required to re-flood the CANISTER, perform cooldown operations, cut the CANISTER shield lid weld, move the TRANSFER CASK and CANISTER into the spent fuel pool, remove the CANISTER shield lid, and remove the spent fuel assemblies in an orderly manner and without challenging personnel.

SURVEILLANCE REQUIREMENTS

SR 3.1.3.1

The long-term integrity of the stored fuel is dependent on storage in a dry, inert atmosphere and maintenance of adequate heat transfer mechanisms. Filling the CANISTER cavity with helium at a pressure of one atmosphere will ensure that there will be no air in-leakage, which could potentially damage the fuel. This pressure of helium gas is sufficient to maintain fuel cladding temperatures within acceptable levels.

(continued)

SURVEILLANCE REQUIREMENTS (continued)	Backfilling of the CANISTER cavity with helium must be performed successfully on each CANISTER before placing it in storage. The surveillance must be performed prior to TRANSPORT OPERATIONS, as the helium atmosphere must be established before the CANISTER can be moved to storage.
REFERENCES	1. FSAR Sections 4.5, 7.1 and 8.1.

C 3.1 NAC-MPC SYSTEM Integrity

C 3.1.4 CANISTER Maximum Time in the TRANSFER CASK

BASES

BACKGROUND

During LOADING OPERATIONS, 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 lower the CANISTER into the CONCRETE CASK. After the CANISTER placement is completed, the CONCRETE CASK is then moved to the ISFSI. Average CONCRETE CASK dose rates are measured at the ISFSI pad.

During TRANSFER OPERATIONS, a loaded CANISTER is transferred from one CONCRETE CASK to another CONCRETE CASK (or a TRANSPORT CASK) using the TRANSFER CASK. The TRANSFER CASK is placed on the CONCRETE CASK, the bottom doors are opened, the loaded CANISTER is lifted into the TRANSFER CASK cavity, the bottom shield doors are closed and the CANISTER is lowered until it rests on the bottom doors. Subsequently, the loaded TRANSFER CASK is placed on another CONCRETE CASK (or TRANSPORT CASK) and the procedure is reversed, lowering the loaded CANISTER into another CONCRETE CASK (or TRANSPORT CASK).

During UNLOADING OPERATIONS, a loaded CANISTER is removed from a CONCRETE CASK (or TRANSPORT CASK) using the same procedure used during TRANSFER OPERATONS. After removal from the CONCRETE CASK, the loaded CANISTER is moved to a cask handling area, unsealed, cooled and unloaded.

(continued)

BACKGROUND (continued)

Backfilling the CANISTER cavity with helium provides sufficient heat transfer from the fuel and ensures that the short-term temperature limits for the fuel cladding and CANIISTER components are not exceeded. The LCO limits the total time a CANISTER can be maintained in the TRANSFER CASK to 25 days (600 hrs).

APPLICABLE SAFETY ANALYSIS

Limiting the total time that a loaded CANISTER backfilled with helium may be in the TRANSFER CASK, prior to placement in a CONCRETE CASK, TRANSPORT CASK, or returned for UNLOADING OPERATIONS, precludes the inappropriate use of the TRANSFER CASK as a storage component. The thermal analyses in the Final Safety Analysis Report show that the short-term temperature limits for the spent fuel cladding are not exceeded for an unlimited period of time (steady state analysis). The duration of 25 days (600 hrs) is defined based on a test time of 30 days for abnormal regimes as described in PNL-4835.

LCO

Limiting the length of time that the loaded CANISTER backfilled with helium is allowed to remain in the TRANSFER CASK ensures that the TRANSFER CASK is not inappropriately used as a storage component.

APPLICABILITY

The elapsed time restrictions on a loaded CANISTER in the TRANSFER CASK apply during: LOADING OPERATIONS (beginning with backfilling of the CANISTER with helium per LCO 3.1.3); TRANSFER OPERATIONS (beginning with closure of the bottom doors of the TRANSFER CASK containing a loaded CANISTER); and UNLOADING OPERATIONS (beginning with closure of the bottom doors of the TRANSFER CASK containing a loaded CANISTER).

(continued)

ACTIONS	A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each NAC-MPC SYSTEM. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each NAC-MPC SYSTEM not meeting the LCO. Subsequent NAC-MPC SYSTEMS that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions. The CANISTER is backfilled with helium to 0 (+1, -0) psig in accordance with the conditions and requirements of LCO 3.1.3. The ACTIONS and SURVEILLANCES of LCO 3.1.3 apply until the helium backfill activity is complete. A.1 Complete CANISTER transfer. B.1 Remove all fuel assemblies from the CANISTER.
SURVEILLANCE REQUIREMENTS	SR 3.1.4.1 Verify CANISTER transfer complete.
REFERENCES	1. FSAR Sections 4.4, 4.5, 8.1, 8.2, and 8.3.

C 3.1 NAC-MPC SYSTEM Integrity

C 3.1.5 CANISTER Helium Leak Rate

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 to the CANISTER shell. The inert atmosphere protects the fuel cladding. Prior to transferring the CANISTER to the CONCRETE CASK, the CANISTER shield lid closure welds are helium leakage rate tested to verify the closure meets leaktight requirements. Successful test performance ensures that the fuel and helium backfill gas are confined during STORAGE OPERATIONS.

APPLICABLE SAFETY ANALYSIS

The confinement of radioactivity (including fission product gases, fuel fines, volatiles, and crud) during the storage of spent fuel in the CANISTER is ensured by the multiple confinement boundaries and systems. The barriers relied on are: the fuel pellet matrix, the metallic fuel cladding tubes where the fuel pellets are contained, and the CANISTER where the fuel assemblies are stored. Long-term integrity of the fuel and cladding depends on maintaining an inert atmosphere, and maintaining the cladding temperatures below established long-term limits. This is accomplished by removing water from the CANISTER, backfilling the CANISTER cavity with helium, and leakage rate testing the CANISTER shield lid closure welds.

(continued)

APPLICABLE SAFETY ANALYSIS (continued)

Verification of the leaktight condition is achieved for the CY-MPC System based on demonstrating a helium leak rate less than 2×10^{-7} cm^3/sec (helium) using a leak test sensitivity of 1×10^{-7} cm^3/sec (helium). Verification of the leaktight condition is achieved for the Yankee-MPC System based on demonstrating a helium leak rate less than 4×10^{-8} cm^3/sec (helium) using a leak test sensitivity of 8×10^{-8} cm^3/sec (helium). Both test conditions result in a leaktight configuration of the CANISTER.

LCO

Verifying that the CANISTER cavity helium leak rate is below the leaktight limit ensures that the CANISTER shield lid is sealed. Verifying that the helium leak rate is below leaktight levels will also ensure that the assumptions in the accident analyses and radiological evaluations are maintained.

APPLICABILITY

The helium leakage rate test is performed during LOADING OPERATIONS before the TRANSFER CASK and integral CANISTER are moved for transfer operations to the CONCRETE CASK. TRANSPORT OPERATIONS would not commence if the CANISTER helium leak rate was not below the test sensitivity. Therefore, CANISTER leak rate testing is not required during 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 CANISTER. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each CANISTER not meeting the LCO. Subsequent CANISTERs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1

If the helium leak rate limit is not met, actions must be taken to meet the LCO. The Completion Time is sufficient to determine and correct most failures, which could cause a helium leak rate in excess of the limit. Actions to correct a failure to meet the helium leak rate limit would include, in ascending order of performance, 1) verification of helium leak test system performance; 2) inspection of weld surfaces to locate helium leakage paths using a helium sniffer probe; and 3) weld repairs, as required, to eliminate the helium leakage. Following corrective actions, the helium leakage rate test shall be reperformed.

(continued)

ACTIONS (continued) <u>B.1</u>

If the CANISTER leak rate cannot be brought within the limit, the fuel must be placed in a safe condition. Corrective actions may be taken after the fuel is placed in a safe condition to perform the A.1 action provided that the initial conditions for performing A.1 are met. A.1 may be repeated as necessary prior to performing B.1. The time frame for completing B.1 cannot be extended by re-performing A.1. The Completion Time is reasonable based on the time required to re-flood the CANISTER, perform fuel cooldown operations, cut the CANISTER shield lid weld, move the TRANSFER CASK into the spent fuel pool, remove the CANISTER shield lid, and remove the spent fuel assemblies in an orderly manner and without challenging personnel.

SURVEILLANCE REQUIREMENTS SR 3.1.5.1

The primary design consideration of the CANISTER is that it is leaktight to ensure that off-site dose limits are not exceeded and to ensure that the helium remains in the CANISTER during long-term storage. Long-term integrity of the stored fuel is dependent on storage in a dry, inert environment.

Verifying that the helium leakage rate meets leaktight requirements must be performed successfully on each CANISTER during LOADING OPERATIONS and prior to TRANSPORT OPERATIONS. The Surveillance Frequency allows sufficient time to backfill the CANISTER cavity with helium and perform the leakage rate test, while minimizing the time the fuel is in the CANISTER and loaded in the TRANSFER CASK.

REFERENCES 1. FSAR Sections 7.1 and 8.1.

C 3.1 NAC-MPC SYSTEM Integrity

C 3.1.6 CONCRETE CASK Heat Removal System

BASES

BACKGROUND

The CONCRETE CASK Heat Removal System is a passive, air-cooled convective heat transfer system, which ensures that heat from the CANISTER is transferred to the environment by the upward flow of air through the CONCRETE CASK. Relatively cool air is drawn into the annulus between the CONCRETE CASK and the CANISTER through the four air inlets at the bottom of the CONCRETE CASK. The CANISTER transfers its heat from the CANISTER surface to the air via natural convection. The buoyancy created by the heating of the air creates a chimney effect and the air flows back into the environment through the four air outlets at the top of the CONCRETE CASK.

APPLICABLE SAFETY ANALYSIS

The thermal analyses of the CONCRETE CASK take credit for the decay heat from the spent fuel assemblies being ultimately transferred to the ambient environment surrounding the CONCRETE CASK. Transfer of heat away from the fuel assemblies ensures that the fuel cladding and CANISTER component temperatures do not exceed applicable limits. Under normal storage conditions, the four air inlets and four air outlets are unobstructed and full air flow (i.e., maximum heat transfer for the given ambient temperature) occurs.

Analyses have been performed for the complete obstruction of all of the air inlets and outlets. The complete blockage of all air inlets and outlets stops air cooling of the CANISTER. The CANISTER will continue to radiate heat to the relatively cooler inner shell of the CONCRETE CASK. With the loss of air cooling, the CANISTER component temperatures will increase toward their respective short-term temperature limits. The limiting component is the CANISTER basket support and heat transfer disks, which, by analysis, approach their temperature limits in 24 hours, if no action is taken to restore air flow to the heat removal system.

LCO

The CONCRETE CASK Heat Removal System must be verified to be OPERABLE to preserve the assumptions of the thermal analyses.

(continued)

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 which states that, 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.

A.1

If the heat removal system has been determined to be inoperable, it must be restored to OPERABLE status within 8 hours. Eight hours is reasonable based on the accident analysis which shows that the limiting CONCRETE CASK component temperatures will not reach their temperature limits for 24 hours after a complete blockage of all inlet air ducts. This time frame allows for the 4 hour Response Surveillance required following an off-normal, accident, or natural phenomena event established in Section A.5.3 of the Certificate of Compliance, plus eight hours (typically, one operating shift) to take action to remove the obstructions in the air flow path.

B.1

SR 3.1.6.1 or SR 3.1.6.2 are performed to document the continuing status of the operability of the CONCRETE CASK Heat Removal System.

B.2.1

Efforts must continue to restore the heat removal system to OPERABLE status by removing the air flow obstruction(s).

(continued)

ACTIONS (continued)

B.2.1 (continued)

This Required Action must be completed in 12 hours. The Completion Time reflects a conservative total time period without any cooling of 24 hours, assuming all of the air inlets and outlets become blocked 4 hours prior to the Response Surveillance. The results of the thermal analysis of this accident show that the fuel cladding temperature does not reach its short-term temperature limit for more than 24 hours. It is also unlikely that an unforeseen event could cause complete blockage of all four air inlets and outlets immediately after the last successful Surveillance.

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. The temperature rise between ambient and the CONCRETE CASK air outlets shall be monitored to verify operability of the heat removal system. Blocked air inlets or outlets will reduce air flow and increase the temperature rise experienced by the air as it removes heat from the CANISTER. Based on the analyses, provided 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 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 inlets and outlets.

SR 3.1.6.2

The long-term integrity of the stored fuel depends on the ability of the CONCRETE CASK to reject heat from the CANISTER to the environment. The temperature rise between the ambient temperature

(continued)

SURVEILLANCE REQUIREMENTS (continued)

and the average CONCRETE CASK air outlet temperature shall be monitored to verify operability of the heat removal system. Blocked air inlets or outlets will reduce air flow and increase the temperature rise experienced by the air as it removes heat from the CANISTER. Based on the analyses, provided 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 4 hours after an off-normal, accident, or natural phenomena event in the vicinity of the ISFSI that might result in the complete blockage of the air inlets and outlets is reasonable based on the time necessary for CONCRETE CASK components to heat up to unacceptable temperatures and allowing for corrective actions.

REFERENCES

1. FSAR Chapter 4 and Chapter 11, Section 11.2.13.

C 3.1 NAC-MPC SYSTEM Integrity

C 3.1.7 Fuel Cooldown Requirements

BASES

BACKGROUND

In the event that a CANISTER must be unloaded, the CONCRETE CASK with its enclosed CANISTER is returned to the fuel building or similar facility, the CANISTER is removed from the CONCRETE CASK using the TRANSFER CASK, and the TRANSFER CASK and CANISTER are placed in the cask preparation area to begin the process of fuel unloading. The structural lid and vent and drain port cover welds are removed. The CANISTER cavity gas is sampled to determine the level of radioactive gases in the cavity. A flow of nitrogen gas is established to flush radioactive gases from the cavity. A cooldown system is attached to the drain connection (inlet) and vent connection (outlet). A controlled water flow rate with a specified minimum water temperature is established to the drain connection with the steam and water being discharged from the vent to the spent fuel pool or radioactive water treatment system. Cooling water flow is maintained until the CANISTER is filled and the contents sufficiently cooled down to allow placement of the TRANSFER CASK and CANISTER in the spent fuel pool, or similar water filled space.

Following cooldown, the shield lid weld is removed and the TRANSFER CASK and CANISTER are placed in the fuel pool. The shield lid is removed and the fuel assemblies are removed and placed in storage rack locations. The TRANSFER CASK and CANISTER are removed from the spent fuel pool and decontaminated.

During the time that the CANISTER is in the TRANSFER CASK prior to the start of internal cooldown of the CANISTER cavity, the CANISTER begins to heat up due to the decay heat of the contents and the reduced heat transfer provided by the TRANSFER CASK compared to the CONCRETE CASK. Note that the conditions of LCO 3.1.4 also apply.

(continued)

APPLICABLE SAFETY ANALYSIS

The use of a controlled cooldown process allows the reflooding of the CANISTER and cooling of the stored fuel assemblies in a manner which precludes the creation of excessive thermal stresses in the fuel cladding, which could result in cladding rupture and steam pressures in the cavity that could exceed the CANISTER's design pressure.

LCO

Controlling the inlet water flow rate and temperature ensures that there is no excessive thermally induced stress in the fuel cladding leading to failure, and that the steam pressure will be maintained below analyzed design values. The exit water temperature is monitored to ensure that the CANISTER contents are sufficiently cooled down to allow return of the CANISTER to the spent fuel pool for fuel assembly unloading.

APPLICABILITY

The elapsed time restrictions on the sealed, loaded CANISTER in the TRANSFER CASK apply during UNLOADING OPERATIONS from the completion point of the closing of the TRANSFER CASK shield doors through the initiation of internal cooling of the CANISTER per LCO 3.1.4.

The inlet water flow rate and temperature and water/steam outlet temperatures are controlled and measured during UNLOADING OPERATIONS after the CANISTER has been transferred to the TRANSFER CASK from the CONCRETE CASK. Therefore, the CANISTER fuel cooldown LCO does not apply during TRANSPORT OPERATIONS and STORAGE OPERATIONS. A note has been added to the Applicability for LCO 3.1.7, which states that the APPLICABILITY is only applicable to wet UNLOADING OPERATIONS. This is acceptable, since the intent of the LCO is to avoid uncontrolled CANISTER pressurization due to steam creation during CANISTER reflooding, which is not a concern for dry UNLOADING OPERATIONS.

(continued)

ACTIONS

A note has been added to the ACTIONS that states that separate Condition entry is allowed for each NAC-MPC SYSTEM. Separate condition entry is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each CANISTER not meeting the LCO. Subsequent CANISTERs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

A.1

If the inlet water flow rate and minimum temperature requirements are not met, actions must be taken to restore the parameters to within the limits. If any of the required cooldown parameters are not met (e.g., minimum water temperature, flow rate, or maximum pressure), appropriate actions, including changing of water supply source, and repositioning of inlet and outlet flow valves on the cooldown system, shall be taken to restore the cooldown parameters to be within the limits. The Completion Time for verification of water temperature and flow rate is short to ensure actions are taken to correct the LCO before fuel cladding damage or overpressurization of the CANISTER has occurred. No additional actions are appropriate, since this LCO applies during UNLOADING OPERATIONS, which cannot proceed until the LCO is met.

SURVEILLANCE REQUIREMENTS

SR 3.1.7.1

These SURVEILLANCE REQUIREMENTS apply to Condition A.1. This SR ensures that short-term temperature limits of the spent fuel cladding and CANISTER components are not exceeded by limiting sudden changes in temperature in the CANISTER and fuel components and by limiting the pressure excursion within the CANISTER that may occur due to the formation of steam.

(continued)

SURVEILLANCE REQUIREMENTS (continued)

The time duration for the flow of nitrogen is specified as a minimum of 10 minutes, but longer flow is allowed since it provides for heat removal and is not reactive with the spent fuel or CANISTER components.

Cooling water temperature is determined prior to the start of flow. Flow rate is determined soon after water flow starts to limit the thermal shock and pressure excursion that could occur as a result of higher than evaluated water flow.

CANISTER pressure is monitored continuously until water flows out of the CANISTER to ensure that the evaluated conditions of pressure are not exceeded.

Water discharge temperature is monitored to determine when adequate cooling of the spent fuel has been achieved so that opening of the CANISTER for fuel removal can continue.

REFERENCES

1. FSAR Sections 4.4, 4.5, 8.2 and 8.3, and Chapter 3.

C 3.1 NAC-MPC SYSTEM Integrity

C 3.1.8 CANISTER Removal from the CONCRETE CASK

BASES

[Deleted]

C 3.2 NAC-MPC 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. This contamination is reduced to acceptable levels on accessible exterior surfaces 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 within acceptable contamination levels on accessible surfaces. Failure to decontaminate the surfaces of the CANISTER could lead to higher-than-projected occupational dose and potential site contamination.

LCO

Removable surface contamination on accessible exterior surfaces of the CANISTER and accessible interior surfaces of the TRANSFER CASK are limited to 10,000 dpm/100 cm^2 from beta and gamma sources and 100 dpm/100 cm^2 from alpha sources. These limits are one-half of the values shown in Section 11.1.5 to produce a minimum site boundary dose of less than 1 mrem annually. Only removable 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, which would cause significant personnel skin dose.

(continued)

LCO (continued)

LCO 3.2.1 requires removable contamination to be within the specified limits for the accessible exterior surfaces of the CANISTER and accessible interior surfaces of the TRANSFER CASK. The location and number of CANISTER and TRANSFER CASK surface swipes used to determine compliance with this LCO are determined based on standard industry practice and the user's plant-specific contamination measurement program for objects of this size. Accessible portions of the CANISTER are the upper portion of the CANISTER external shell wall accessible after draining of the TRANSFER CASK annulus and the top surface of the structural lid. The user shall determine a reasonable number and location of swipes for the accessible portion of the CANISTER. The objective is to determine a removable contamination value representative of the entire upper circumference of the CANISTER and the structural lid, while implementing sound ALARA practices.

Verification swipes and measurements of removable surface contamination levels on the accessible interior surfaces of the TRANSFER CASK shall be performed following transfer of the CANISTER to the CONCRETE CASK. These measurements will provide indirect evidence that the inaccessible surfaces of the CANISTER have acceptable contamination levels. If high contamination levels are detected on the TRANSFER CASK internals, additional smears of the CANISTER surfaces can be performed with the CANISTER in the CONCRETE CASK to verify that actual CANISTER contamination levels meet the LCO limits.

APPLICABILITY

Verification that the accessible exterior surface contamination of the CANISTER and accessible interior surface contamination of the TRANSFER CASK are less than the LCO limits is performed during LOADING OPERATIONS. This occurs before TRANSPORT OPERATIONS and STORAGE OPERATIONS. Measurement of the CANISTER and TRANSFER CASK surface contamination is unnecessary during UNLOADING OPERATIONS as surface contamination would have been measured prior to moving the subject CANISTER to the ISFSI.

ACTIONS

A note has been added to the ACTIONS, which states that, for this LCO, separate Condition entry is allowed for each CANISTER LOADING OPERATION. This is acceptable, since the Required Actions for each Condition provide appropriate compensatory measures for each CANISTER and TRANSFER CASK not meeting the LCO. Subsequent CANISTERs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions.

(continued)

ACTIONS
(continued)

A.1

If the removable surface contamination of the CANISTER that has been loaded with spent fuel or the TRANSFER CASK is not within the LCO limits, action must be initiated to decontaminate the CANISTER and TRANSFER CASK, and bring the removable surface contamination to within limits. The Completion Time of 25 days (600 hours) is appropriate, given that the time needed to complete the decontamination varies with the extent of the contamination and surface contamination does not affect temperatures or otherwise affect the spent fuel assemblies.

SURVEILLANCE
REQUIREMENTS

SR 3.2.1.1

This SR verifies that the removable surface contamination on the accessible exterior surfaces of the CANISTER is less than the limits in the LCO. The Surveillance is performed using smear surveys to detect removable surface contamination. The Frequency requires performing the verification prior to initiating TRANSPORT OPERATIONS in order to confirm that the CANISTER can be moved to the ISFSI without spreading loose contamination.

SR 3.2.1.2

This SR verifies that the removable surface contamination on the accessible interior surfaces of the TRANSFER CASK is less than the limits, thereby providing indirect confirmation that the removable surface contamination on the inaccessible surfaces of the CANISTER are within the limits. It also confirms the proper functioning of the annulus clean water fill system. The Surveillance is performed using smear surveys to detect removable surface contamination. The Frequency requires performing the verification once, prior to TRANSPORT OPERATIONS.

REFERENCES

1. FSAR Section 8.1.
2. FSAR Section 11.1.5.

C 3.2 NAC-MPC 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.

LCO

The limits on CONCRETE CASK average surface dose rates are based on the Safety Analysis Report shielding analysis of the NAC-MPC 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-MPC 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.

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. Radiation doses during STORAGE OPERATIONS are monitored by the NAC-MPC 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-MPC

(continued)

ACTIONS (continued) 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 of the Certificate of Compliance 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.

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.

SURVEILLALNCE 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 12A3-1, 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.

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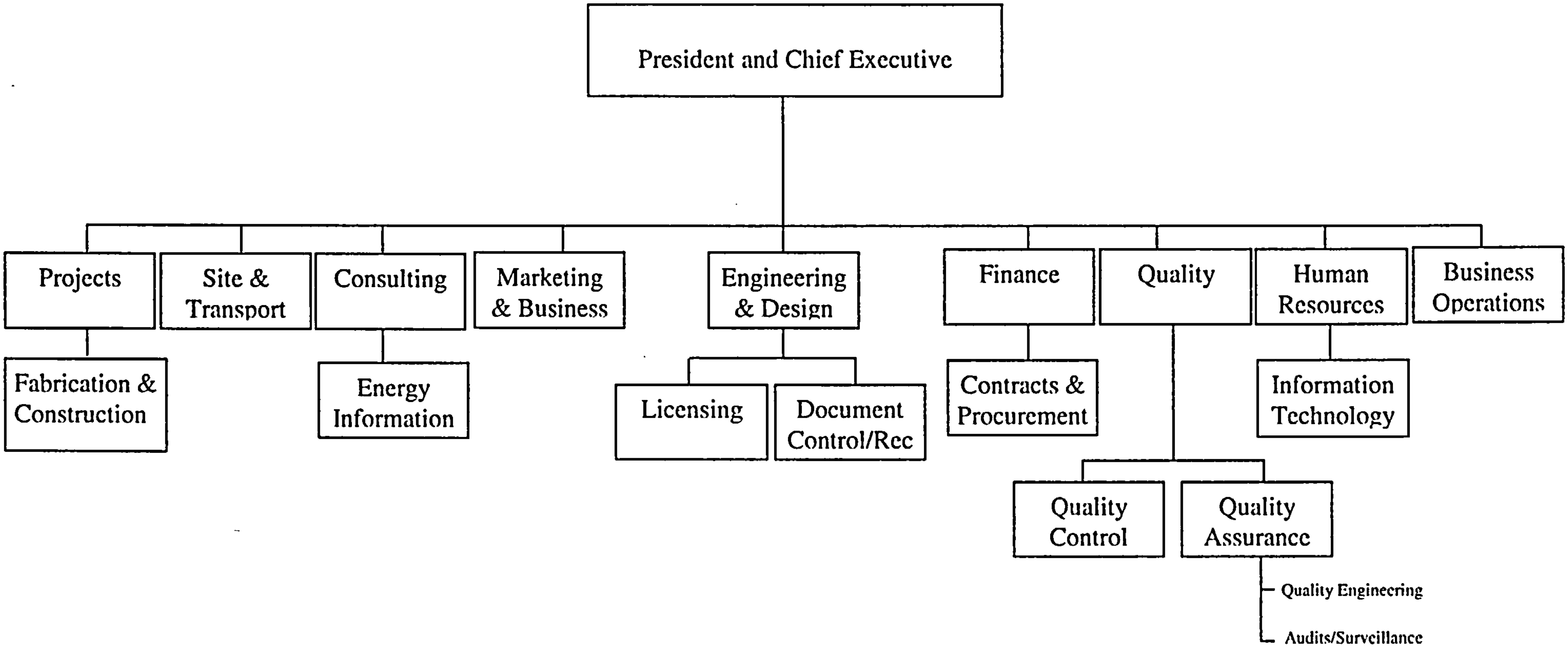
Chapter 13

Figure 13.2-1 NAC International Organization Chart



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