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July 17, 2006

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

Attn.: Document Control Desk

Subject: Request for an Amendment of Certificate of Compliance (CoC) No. 1025 for the NAC International Multi-Purpose Canister (NAC-MPC) System to Incorporate Changes to the Technical Specifications and the Final Safety Analysis Report (FSAR)

Docket No. 72-1025

References:
1. Certificate of Compliance No. 1025, Amendment 4, for the NAC-MPC System, U.S. Nuclear Regulatory Commission (NRC), October 27, 2004
2. Final Safety Analysis Report for the NAC-MPC System, Revision 6, NAC International, April 2006

NAC International (NAC) herewith submits a request for approval of an Amendment to the NAC-MPC CoC Technical Specifications (Reference 1) to incorporate changes based on cask user experience, NAC lessons learned, the 10 CFR 72.75(g) reporting requirement, and NRC guidance contained in U.S. NRC Interim Staff Guidance, ISG-22. In addition, some editorial changes are being requested to improve clarity and consistency within Reference 1 and Reference 2.

The list of proposed changes to the NAC-MPC CoC Amendment 4 Technical Specifications and the NAC-MPC FSAR (Reference 2) is provided in Attachment 1 to this letter.

This submittal includes eight copies of the proposed CoC Amendment 5 Technical Specification and Revision MPC-06A FSAR changed pages. The revised Technical Specification pages incorporate the requested amendment changes noted above. Revision bars in the margin of the affected pages indicate the proposed changes.

In accordance with the NAC licensing document control procedures, the proposed FSAR revision is numbered to uniquely identify the applicable changed pages. Revision bars mark the FSAR text changes (on Revision MPC-06A pages) that are proposed in this submittal. Upon final approval, the changed pages will be reformatted, assigned the next appropriate revision number, and incorporated into an updated NAC-MPC FSAR.

NMSS01

ED20060042

NAC INTERNATIONAL

If you have any comments or questions, please contact me on my direct number (678) 328-1274.

Sincerely,

Anthony L. Patko
Director, Licensing
Engineering

Attachment 1: List of Proposed Changes to the NAC-MPC Technical Specifications and FSAR, Revision 6

Enclosures: Changed Pages for the NAC-MPC Final Safety Analysis Report, Revision MPC-06A (eight hard copies)

Attachment 1

List of Proposed Changes to the NAC-MPC Technical Specifications and FSAR

Proposed Technical Specifications Changes – General

Revised "Amendment 4" to "Amendment 5" to reflect the correct revision indicator for the revised pages of the Technical Specifications to support incorporation of the pages into the next CoC amendment, i.e., Amendment 5.

Proposed Changes in Appendix A, Technical Specifications for the NAC-MPC System

- Pages A1-3 & A1-4 – Revised definition of "OPERABLE" to reflect the proposed Tech Spec changes.
- Page A1-4 – Deleted "SAFE CONDITION" and its definition as it is now not referenced in all capital letters anywhere in the Tech Specs or the BASES.
- Page A1-5 – Deleted "(STORAGE CASK)" from the VERTICAL CONCRETE CASK (CONCRETE CASK) term as it is not referenced in all capital letters anywhere in the Tech Specs or the BASES.
- Page A3-13 – Added "Integrity" to the title of Section A 3.1. This word had been inadvertently omitted in Amendment 4. The title now matches the Table of Contents for Appendix A.

  ACTIONS, CONDITION A – Changed "CONCRETE CASK Heat Removal System inoperable" to "LCO not met"for clarity/consistency.

  ACTIONS, CONDITION B — After "AND" in REQUIRED ACTION, changed to read as follows:

  "B.2.1 Perform an engineering evaluation to determine that the CONCRETE CASK Heat Removal System is OPERABLE"

  "OR"

  B.2.2 "Place the NAC-MPC SYSTEM in a safe condition"

  Changes/additions to these REQUIRED ACTIONS are for clarity/consistency. The COMPLETION TIME for REQUIRED ACTIONS B.2.1 and B.2.2 is 12 hours.

- Page A3-14 – SR 3.1.6.1, added:

"OR"

"Visually verify all four air inlet and outlet screens are unobstructed."

Proposed Changes in Appendix A, Technical Specifications for the NAC-MPC System (cont'd)

This action allows the licensee the operational flexibility of visually verifying that all four air inlet and outlet screens are unobstructed in order to ensure the operability of the concrete cask heat removal system. The Frequency for this action is "24 hours," which is the same as the Frequency for the temperature-monitoring activities.

- Page A3-14 – Deleted SR 3.1.6.2, as this issue is now addressed by A 5.3 of the Technical Specifications, "Surveillance After an Off-Normal, Accident, or Natural Phenomena Event."

- Page A5-2, Item A 5.3 – Revised throughout to reflect the proposed Tech Spec changes and to clarify actions required in the event of a natural phenomena event.

Proposed Changes in Appendix B, Technical Specifications for the NAC-MPC System

- Page B-2 – Revised the Table of Contents (Item B 3.2) to reflect the proposed change.

- Page B2-17, B 2.2.3 – The requirement for follow-up reporting for specific events and conditions is changed from 30 days to 60 days in accordance with 10 CFR 72.75(g).

- Page B3-1, B3.2 – An editorial change is made to the title to reflect the addition of Item B 3.2.2. The title was "Design Features Important for Criticality Control"; the revised title is "Design Features Significant to Safety."

- Page B3-1, B 3.2.1 – An editorial change is made to the title to clarify the content of a) and b) that follow. The title was "Canister – Intact Fuel Assemblies"; the revised title is "Criticality Control."

- Page B3-1 – Added new Item B 3.2.2 titled "Fuel Cladding Integrity" to comply with ISG-22 requirements.

Proposed NAC-MPC FSAR Changes Required to Support the Proposed Tech Spec Changes

Chapter 1

- Page 1.2-10, Section 1.2.1.4.9, Temperature Instrumentation – Revised throughout to reflect the addition of the operational flexibility of visually verifying that air inlet and outlet screens are unobstructed in order to ensure the operability of the concrete cask heat removal system.

- Page 1.2-11, Section 1.2.2, Operational Features – Deleted the last three sentences of the first paragraph that addressed temperature-monitoring via instrumentation only. The addition of visual verification to ensure operability of the concrete cask heat removal system makes these three sentences obsolete.

Proposed NAC-MPC FSAR Changes Required to Support the Proposed Tech Spec Changes (cont'd)

- Page 1.2-12, Section 1.2.2, Operational Features – Added the last bullet to the list of NAC-MPC operational procedures to address daily surveillance of the heat removal capability of the concrete cask per the Technical Specifications.

- Page 1.5-10, Table 1.5-1, NUREG-1536 Compliance Matrix, Chapter 2, Area 3c, Description of Compliance, 1st paragraph – Revised throughout to clarify the verification process for the concrete cask heat removal system.

- Page 1.5-11, Table 1.5-1, NUREG-1536 Compliance Matrix, Chapter 2, Area 3d, Description of Compliance – Deleted the last sentence of the fifth paragraph and paragraph six to reflect proposed Tech Spec changes.

- Page 1.5-23, Table 1.5-1, NUREG-1536 Compliance Matrix, Chapter 4, Area 3, Description of Compliance – Revised fourth paragraph to reflect the addition of the operational flexibility of visually verifying that air inlet and outlet screens are unobstructed in order to ensure the operability of the concrete cask heat removal system.

- Page 1.5-31, Table 1.5-1, NUREG-1536 Compliance Matrix, Chapter 7, Area 4, Description of Compliance – Revised throughout to state that the canister is fabricated in accordance with ASME Code and that no monitoring of the confinement system is needed. Area 5, Description of Compliance – Revised to state that no instrumentation and controls are needed.

- Page 1.5-35, Table 1.5-1, NUREG-1536 Compliance Matrix, Chapter 7, Area 5, Acceptance Criteria – Revised second sentence to remove reference to air to comply with ISG-22 requirements.

- Page 1.5-49, Table 1.5-1, NUREG-1536 Compliance Matrix, Chapter 11, Area 7, Description of Compliance – Revised first sentence to reflect proposed Tech Spec changes.

Chapter 2

Page 2.3-4, Section 2.3.3.2, Instrumentation -- Revised throughout to reflect the alternative for a daily visual inspection of the air inlet and outlet screens for blockage, as well as inspection after any natural phenomena event.

Chapter 3

Page 3.4.1-2, Section 3.4.1.1, Component Operating Environment – Revised second full sentence on page to remove reference to air to comply with ISG-22 requirements.

Proposed NAC-MPC FSAR Changes Required to Support the Proposed Tech Spec Changes (cont'd)

Chapter 7

- Page 7.1-3, Section 7.1.2, Confinement Penetrations – Revised fifth sentence to remove reference to air to comply with ISG-22 requirements.

- Page 7.2-2, Section 7.2.2, Pressurization of the Confinement Vessel – Revised first sentence of last paragraph to remove reference to air to comply with ISG-22 requirements.

Chapter 8

- Page 8.1-3, Section 8.1.1.1, Loading and Closing the Yankee-MPC Transportable Storage Canister, Item 17 – Added Note to comply with ISG-22 requirements.

- Page 8.1-4, Section 8.1.1.1, Loading and Closing the Yankee-MPC Transportable Storage Canister, Item 24 – Changed "air pressure line" to "gas pressure line" in the second sentence in compliance with ISG-22 requirements. Item 26e – Added new Note (before previous one) in compliance with ISG-22 requirements.

- Page 8.1-8, Section 8.1.1.2, Loading and Closing the CY-MPC Transportable Storage Canister, Item 19 – Added Note to comply with ISG-22 requirements. Item 26 – Changed "air pressure line" to "gas pressure line" in the second sentence in compliance with ISG-22 requirements.

- Page 8.1-9, Section 8.1.1.2, Loading and Closing the CY-MPC Transportable Storage Canister, Item 28 – Added new Note (before all previous ones) in compliance with ISG-22 requirements.

- Page 8.1-17, Table 8.1-1, List of Ancillary Equipment, Description of Vacuum Drying System – Deleted reference to air to comply with ISG-22 requirements.

- Page 8.2-1, Section 8.2, Removal of the Transportable Storage Canister from the Vertical Concrete Cask, first paragraph, last sentence – Added ", if installed," for clarity.

Chapter 9

- Page 9.1-9, Section 9.1.7, Thermal Tests – Revised second sentence to reflect the proposed Tech Spec changes.

- Page 9.2-1, Section 9.2, Maintenance Program – Revised throughout to reflect the proposed Tech Spec changes.

Proposed NAC-MPC FSAR Changes Required to Support the Proposed Tech Spec Changes (cont'd)

Chapter 10

- Page 10.1-2, Section 10.1.2, Design Considerations, last bullet – Added "optional" to reflect proposed Tech Spec changes.

- Page 10.3-2, Section 10.3, Estimated On-Site Collective Dose Assessment, first bullet of routine operations – Revised first sentence to add daily visual inspection option. Added new third sentence to clarify site-specific dose rate conditions.

Chapter 11

- Page 11.1.1-1, Section 11.1.1.1, Cause of Event, second paragraph, first sentence – Revised to add visual inspection option.

- Page 11.1.3-1, Section 11.1.3, Failure of Instrumentation, first and second sentences – Revised to reflect the proposed Tech Spec changes. Section 11.1.3.1, Cause of Accident, last paragraph – Revised for clarity. Section 11.1.3.2, Analysis of Instrumentation Failure – Revised throughout to reflect proposed Tech Spec changes.

- Page 11.1.3-2, Section 11.1.3.5, Recovery and Corrective Actions – Revised throughout to reflect the visual inspection option.

- Page 11.1.4-1, Section 11.1.4.1, Cause of Event, last paragraph – Revised for clarity.

- Page 11.2.2-15, Section 11.2.2.5, Recovery and/or Corrective Actions – Revised throughout to reflect the proposed Tech Spec changes.

- Page 11.2.3-2, Section 11.2.3.5, Recovery and/or Corrective Actions, – Revised throughout to reflect the proposed Tech Spec changes.

- Page 11.2.6-9, Section 11.2.6.5, Recovery and/or Corrective Actions – Revised throughout to reflect the proposed Tech Spec changes.

- Page 11.2.10-1, Section 11.2.10.1, Cause of Accident, last paragraph – Revised throughout for clarity.

Chapter 12

- Page 12C3-30, C 3.1.6, CONCRETE CASK Heat Removal System, ACTIONS – Made editorial change to first sentence. ACTION A.1 – Made editorial changes throughout. ACTION B.1 – Revised throughout to reflect proposed Tech Spec changes. Added "AND."

Proposed NAC-MPC FSAR Changes Required to Support the Proposed Tech Spec Changes (cont'd)

Chapter 12 (cont'd)

- Page 12C3-31, C 3.1.6, CONCRETE CASK Heat Removal System, ACTIONS – ACTION B.2.1 – Replaced with new text to reflect proposed Tech Spec changes. Added "OR." ACTION B.2.2 – Added new text to reflect proposed Tech Spec changes.
  SURVEILLANCE REQUIREMENTS, SR 3.1.6.1, first paragraph – Revised throughout to reflect proposed Tech Spec changes. Second paragraph – Added "and CANISTER" for clarity and changed "air inlets and outlets" to "air inlet and outlet screens" for consistency.

- Page 12C3-32, C 3.1.6, CONCRETE CASK Heat Removal System, SURVEILLANCE REQUIREMENTS – Deleted SR 3.1.6.2.
  REFERENCES – Revised section references.

June 2006

Tech Spec Amendment Submittal

NAC-MPC

NAC Multi-Purpose Cask

FINAL SAFETY ANALYSIS REPORT

Docket No. 72-1025

NAC INTERNATIONAL

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NAC-MPC Tech Specs – Appendix A

INTACT FUEL ROD	INTACT FUEL ROD is a fuel rod without known or suspected cladding defects greater than a pinhole leak or hairline crack.
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.
LOADING CATEGORY (LOADING CATEGORIES)	The LOADING CATEGORY defines allowable combinations of maximum total canister decay heat and maximum fuel assembly decay heat for the CY-MPC. They are used to determine operational time limits during LOADING OPERATIONS or TRANSFER OPERATIONS.
LOADING OPERATIONS	LOADING OPERATIONS include all activities on an NAC-MPC SYSTEM while it is being loaded with fuel assemblies. LOADING OPERATIONS begin when the first fuel assembly is placed in the CANISTER and end when the NAC-MPC SYSTEM is secured on the transporter. LOADING OPERATIONS do not include post-storage operations, i.e., CANISTER transfer operations between the TRANSFER CASK and the CONCRETE CASK or transport cask after STORAGE OPERATIONS.
NAC-MPC SYSTEM	NAC-MPC SYSTEM includes the components approved for loading and storage of spent fuel assemblies at the ISFSI. The NAC-MPC SYSTEM consists of a CONCRETE CASK, a TRANSFER CASK, and a CANISTER. The NAC-MPC SYSTEM is provided in two configurations: the YANKEE-MPC and the CY-MPC.
OPERABLE	An OPERABLE CONCRETE CASK heat removal system transfers sufficient heat away from the fuel assemblies such that the fuel cladding, CANISTER component and CONCRETE CASK temperatures do not exceed applicable limits. The CONCRETE CASK heat removal system is considered OPERABLE if the difference between the ISFSI ambient temperature and the average outlet air temperature is ≤ 92°F for the YANKEE-MPC or

(continued)

OPERABLE (continued)	≤ 110°F for the CY-MPC or if all four air inlet and outlet screens are visually verified to be unobstructed. Failing this, a CONCRETE CASK heat removal system may be declared OPERABLE if an engineering evaluation determines the CONCRETE CASK has adequate heat transfer capabilities to assure continued spent fuel, CANISTER and CONCRETE CASK integrity.
RETAINER	A retainer used for the Gulf United Nuclear Fuel (GUNF) lead test assemblies to retain the removable fuel rods within the fuel assembly.
STORAGE OPERATIONS	STORAGE OPERATIONS include all activities that are performed at the ISFSI, while an NAC-MPC SYSTEM containing spent fuel is located on the storage pad within the ISFSI perimeter.
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.
TRANSFER CASK	TRANSFER CASK is a shielded lifting device that holds the CANISTER during LOADING and UNLOADING OPERATIONS and during closure welding, vacuum drying, leak testing, and non-destructive examination of the CANISTER closure welds. The TRANSFER CASK is also used to transfer the CANISTER into and from the CONCRETE CASK and into the transport cask.
TRANSFER OPERATIONS	TRANSFER OPERATIONS include all activities involved in transferring a loaded CANISTER from a CONCRETE CASK to another CONCRETE CASK, to a TRANSPORT CASK, or to an appropriate location for unloading.

(continued)

TRANSPORTABLE STORAGE CANISTER (CANISTER)	TRANSPORTABLE STORAGE CANISTER is a container consisting of a tube and disk fuel basket in a cylindrical canister shell welded to a baseplate. When the shield lid with welded port covers, and structural lid are welded in place, the CANISTER provides the confinement boundary for the confined spent fuel.
TRANSPORT OPERATIONS	TRANSPORT OPERATIONS include all activities involved in moving a loaded NAC-MPC CONCRETE CASK and CANISTER to and from the ISFSI. TRANSPORT OPERATIONS begin when the NAC-MPC SYSTEM is first secured on the transporter and end when the NAC-MPC SYSTEM is at its destination and no longer secured on the transporter.
UNLOADING OPERATIONS	UNLOADING OPERATIONS include all activities on a NAC-MPC SYSTEM to be unloaded of the contained fuel assemblies. UNLOADING OPERATIONS begin when the NAC-MPC SYSTEM is no longer secured on the transporter and end when the last fuel assembly is removed from the NAC-MPC SYSTEM.
VERTICAL CONCRETE CASK (CONCRETE CASK)	VERTICAL CONCRETE CASK is the cask that receives and holds the sealed CANISTER. It provides the gamma and neutron shielding and convective cooling of the spent fuel confined in the CANISTER.
WATER COOLING	Placement of the TRANSFER CASK holding an NAC-MPC CANISTER in the spent fuel pool. The canister must be backfilled with helium. WATER COOLING shall be maintained for a minimum of 24 hours, once initiated.
YANKEE-MPC	YANKEE-MPC is a NAC-MPC SYSTEM having a fuel basket designed to accommodate Yankee Class spent fuel. The YANKEE-MPC meets the requirements designated for the NAC-MPC SYSTEM.
YANKEE-MPC DAMAGED FUEL CAN	A stainless steel container that is similar to an enlarged fuel tube and 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 end by screened openings that allow gaseous and liquid media to escape, but minimize the dispersal of gross particulate. Use of the damaged fuel can requires that four cans be used in the canister in conjunction with a special shield lid machined to accept the cans.

(continued)

A 3.1 NAC-MPC SYSTEM Integrity

A 3.1.6 CONCRETE CASK Heat Removal System

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

APPLICABILITY: During STORAGE OPERATIONS

ACTIONS

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

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. LCO not met	A.1 Restore CONCRETE CASK Heat Removal System to OPERABLE status	8 hours
B. Required Action and associated Completion Time not met	B.1 Perform SR 3.1.6.1	Immediately and every 6 hours thereafter
	AND	
	B.2.1 Perform an engineering evaluation to determine that the CONCRETE CASK Heat Removal System is OPERABLE	12 hours
	OR	
	B.2.2 Place the NAC-MPC SYSTEM in a safe condition	12 hours

(continued)

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.1.6.1	Verify the difference between the average CONCRETE CASK air outlet temperature and ISFSI ambient temperature is ≤92ºF for the YANKEE-MPC CANISTER or ≤110ºF for the CY-MPC CANISTER.	24 hours
	OR	
	Visually verify all four air inlet and outlet screens are unobstructed.	24 hours

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

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

A 5.3 Surveillance After an Off-Normal, Accident, or Natural Phenomena Event

A Response Surveillance is required following off-normal, accident or natural phenomena events. The NAC-MPC SYSTEMs in use at an ISFSI shall be inspected within 4 hours after the occurrence of an off-normal, accident or natural phenomena event in the area of the ISFSI. This inspection must specifically verify that all the CONCRETE CASK inlets and outlets are not blocked or obstructed. At least one-half of the inlets and outlets on each CONCRETE CASK must be cleared of blockage or debris within 24 hours to restore air circulation.

The CONCRETE CASK and CANISTER shall be inspected if they experience a drop or a tip-over.

Following a natural phenomena event, the ISFSI shall be inspected to determine if movement or damage to the CONCRETE CASKS has resulted in unacceptable site boundary dose rates.

(continued)

NAC-MPC Tech Specs – Appendix B

Appendix B
Table of Contents

B 1.0 [Reserved] B1-1

B 2.0 APPROVED CONTENTS B2-1
- B 2.1 Fuel Specifications and Loading Conditions B2-1
  - B 2.1 1 Fuel to be Stored in the YANKEE-MPC System B2-1
  - B 2.1 2 Fuel to be Stored in the CY-MPC System B2-1
- B 2.2 Violations B2-17

Figure B2-1 CY-MPC 24-Assembly Basket Fuel Loading Positions B2-16
Figure B2-2 CY-MPC 26-Assembly Basket Fuel Loading Positions B2-16
Table B2-1 Yankee Class Fuel Assembly Limits B2-2
Table B2-2 Yankee Class INTACT FUEL ASSEMBLY Characteristics B2-6
Table B2-3 Connecticut Yankee Fuel Assembly Limits B2-7
Table B2-4 Connecticut Yankee INTACT FUEL ASSEMBLY Characteristics B2-14
Table B2-5 Connecticut Yankee Fuel and CANISTER Heat LOADING CATEGORY Limits B2-15
Table B2-6 Heat Load Matrix used to Determine LOADING CATEGORY Limits B2-15

B 3.0 DESIGN FEATURES B3-1
- B 3.1 Site B3-1
- B 3.2 Design Features Significant to Safety B3-1
- B 3.3 Codes and Standards B3-1
- B 3.4 Site Specific Parameters and Analyses B3-7
- B 3.5 CANISTER HANDLING FACILITY (CHF) B3-9

Table B3-1 List of ASME Code Alternatives for the NAC-MPC SYSTEM B3-3
Table B3-2 Load Combinations and Service Condition Definitions for the CANISTER HANDLING FACILITY (CHF) Structure B3-11

B 2.2 Violations

If any Fuel Specification or Loading Condition of B2.1 is violated, the following actions shall be completed in accordance with the requirements of 10 CFR 72.75:

B 2.2.1 The affected fuel assemblies shall be placed in a safe condition.

B 2.2.2 Within 24 hours, notify the NRC Operations Center.

B 2.2.3 Within 60 days, submit a written report describing the cause of the violation and actions taken to restore compliance and prevent recurrence.

B 3.0 DESIGN FEATURES

B 3.1 Site

B 3.1.1 Site Location

The NAC-MPC SYSTEM is authorized for use by 10 CFR 50 license holders at various site locations under the general license provisions of 10 CFR Part 72, Subpart K.

B 3.2 Design Features Significant to Safety

B 3.2.1 CRITICALITY CONTROL

a) Minimum ^{10}B loading in the Boral neutron absorbers:
   1. YANKEE-MPC – 0.01 g/cm^2
   2. CY-MPC – 0.02 g/cm^2

b) Minimum length of INTACT FUEL ASSEMBLY internal structure and bottom end fitting and/or spacers shall ensure the minimum distance to the fuel region from the base of the CANISTER is:
   1. YANKEE-MPC – 6.7 inches
   2. CY-MPC – 3.2 inches

B 3.2.2 FUEL CLADDING INTEGRITY

The licensee shall ensure that fuel oxidation and the resultant consequences are precluded during canister loading and unloading operations.

B 3.3 Codes and Standards

The American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), 1995 Edition with Addenda through 1995, is the governing Code for the NAC-MPC SYSTEM CANISTER except that Addenda through 1997 are applied for the critical flaw evaluation of the CANISTER closure weld.

The American Concrete Institute Specifications ACI 349 (1985) and ACI 318 (1995) govern the NAC-MPC SYSTEM CONCRETE CASK design and construction, respectively.

The American National Standards Institute ANSI N14.6 (1993) and NUREG-0612 govern the NAC-MPC SYSTEM TRANSFER CASK design, operation, fabrication, testing, inspection and maintenance.

(continued)

June 2006

Revision MPC-06A

NAC-MPC

NAC Multi-Purpose Cask

FINAL SAFETY ANALYSIS REPORT

Volume 1 of 2

Docket No. 72-1025

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List of Effective Pages

List of Effective Pages

Chapter 1

1-i ..... Revision 5
1-ii ..... Revision 5
1-iii ..... Revision 3
1-1 ..... Revision 3
1-2 ..... Revision 3
1-3 ..... Revision 5
1-4 ..... Revision 5
1-5 ..... Revision 5
1-6 ..... Revision 5
1-7 ..... Revision 5
1.1-1 ..... Revision 2
1.1-2 ..... Revision 2
1.1-3 ..... Revision 2
1.1-4 ..... Revision 2
1.1-5 ..... Revision 2
1.1-6 ..... Revision 0
1.1-7 ..... Revision 2
1.2-1 ..... Revision 2
1.2-2 ..... Revision 3
1.2-3 ..... Revision 3
1.2-4 ..... Revision 3
1.2-5 ..... Revision 3
1.2-6 ..... Revision 3
1.2-7 ..... Revision 3
1.2-8 ..... Revision 3
1.2-9 ..... Revision 3
1.2-10 ..... Revision MPC-06A
1.2-11 ..... Revision MPC-06A
1.2-12 ..... Revision MPC-06A
1.2-13 ..... Revision 3
1.2-14 ..... Revision 3
1.2-15 ..... Revision 3
1.2-16 ..... Revision 3
1.2-17 ..... Revision 3
1.2-18 ..... Revision 3
1.2-19 ..... Revision 3
1.2-20 ..... Revision 3
1.2-21 ..... Revision 3
1.2-22 ..... Revision 3
1.2-23 ..... Revision 3
1.3-1 ..... Revision 3
1.3-2 ..... Revision 6
1.3-3 ..... Revision 3
1.3-4 ..... Revision 5
1.3-5 ..... Revision 5
1.3-6 ..... Revision 5
1.3-7 ..... Revision 3
1.3-8 ..... Revision 3
1.3-9 ..... Revision 3
1.3-10 ..... Revision 3
1.3-11 ..... Revision 5
1.3-12 ..... Revision 3
1.3-13 ..... Revision 3
1.3-14 ..... Revision 3
1.4-1 ..... Revision 2
1.4-2 ..... Revision 2
1.4-3 ..... Revision 2
1.5-1 ..... Revision 2
1.5-2 ..... Revision 2
1.5-3 ..... Revision 2
1.5-4 ..... Revision 2
1.5-5 ..... Revision 2
1.5-6 ..... Revision 2
1.5-7 ..... Revision 2
1.5-8 ..... Revision 2
1.5-9 ..... Revision 2
1.5-10 ..... Revision MPC-06A
1.5-11 ..... Revision MPC-06A
1.5-12 ..... Revision 2

List of Effective Pages (continued)

1.5-13 ..... Revision 2
1.5-14 ..... Revision 2
1.5-15 ..... Revision 2
1.5-16 ..... Revision 2
1.5-17 ..... Revision 2
1.5-18 ..... Revision 2
1.5-19 ..... Revision 2
1.5-20 ..... Revision 2
1.5-21 ..... Revision 2
1.5-22 ..... Revision 2
1.5-23 ..... Revision MPC-06A
1.5-24 ..... Revision 2
1.5-25 ..... Revision 2
1.5-26 ..... Revision 2
1.5-27 ..... Revision 2
1.5-28 ..... Revision 2
1.5-29 ..... Revision 2
1.5-30 ..... Revision 2
1.5-31 ..... Revision MPC-06A
1.5-32 ..... Revision 2
1.5-33 ..... Revision 2
1.5-34 ..... Revision 2
1.5-35 ..... Revision MPC-06A
1.5-36 ..... Revision 2
1.5-37 ..... Revision 2
1.5-38 ..... Revision 2
1.5-39 ..... Revision 2
1.5-40 ..... Revision 2
1.5-41 ..... Revision 2
1.5-42 ..... Revision 2
1.5-43 ..... Revision 2
1.5-44 ..... Revision 2
1.5-45 ..... Revision 2
1.5-46 ..... Revision 2
1.5-47 ..... Revision 2
1.5-48 ..... Revision 2
1.5-49 ..... Revision MPC-06A
1.5-50 ..... Revision 2
1.5-51 ..... Revision 2
1.5-52 ..... Revision 2
1.5-53 ..... Revision 2
1.5-54 ..... Revision 2
1.5-55 ..... Revision 2
1.5-56 ..... Revision 2
1.5-57 ..... Revision 2
1.5-58 ..... Revision 2
1.5-59 ..... Revision 2
1.6-1 ..... Revision 3
1.6-2 ..... Revision 2
1.7-1 ..... Revision 3
1.7-2 ..... Revision 3
1.7-3 ..... Revision 6

61 drawings (see Chapter 1)

Chapter 2

2-i ..... Revision 5
2-ii ..... Revision 3
2-iii ..... Revision 3
2-1 ..... Revision 2
2-2 ..... Revision 2
2-3 ..... Revision 3
2-4 ..... Revision 2
2-5 ..... Revision 2
2.1-1 ..... Revision 3
2.1-2 ..... Revision 3
2.1-3 ..... Revision 3
2.1-4 ..... Revision 2
2.1-5 ..... Revision 2
2.1-6 ..... Revision 2

List of Effective Pages (continued)

2.1-7 ..... Revision 2
2.1-8 ..... Revision 2
2.1-9 ..... Revision 5
2.1-10 ..... Revision 5
2.1-11 ..... Revision 5
2.1-12 ..... Revision 3
2.1-13 ..... Revision 3
2.1-14 ..... Revision 3
2.1-15 ..... Revision 3
2.1-16 ..... Revision 3
2.1-17 ..... Revision 3
2.1-18 ..... Revision 3
2.1-19 ..... Revision 3
2.1-20 ..... Revision 3
2.2-1 ..... Revision 2
2.2-2 ..... Revision 2
2.2-3 ..... Revision 0
2.2-4 ..... Revision 0
2.2-5 ..... Revision 2
2.2-6 ..... Revision 2
2.2-7 ..... Revision 2
2.2-8 ..... Revision 0
2.2-9 ..... Revision 2
2.2-10 ..... Revision 2
2.2-11 ..... Revision 2
2.3-1 ..... Revision 3
2.3-2 ..... Revision 0
2.3-3 ..... Revision 0
2.3-4 ..... Revision MPC-06A
2.3-5 ..... Revision 0
2.3-6 ..... Revision 3
2.3-7 ..... Revision 2
2.3-8 ..... Revision 0
2.3-9 ..... Revision 3
2.3-10 ..... Revision 3
2.3-11 ..... Revision 3
2.3-12 ..... Revision 3
2.3-13 ..... Revision 3
2.3-14 ..... Revision 3
2.3-15 ..... Revision 3
2.3-16 ..... Revision 3
2.3-17 ..... Revision 3
2.3-18 ..... Revision 3
2.3-19 ..... Revision 3
2.4-1 ..... Revision 2
2.4-2 ..... Revision 2
2.4-3 ..... Revision 0
2.4-4 ..... Revision 2

Chapter 3

3-i ..... Revision 5
3-ii ..... Revision 5
3-iii ..... Revision 3
3-iv ..... Revision 5
3-v ..... Revision 3
3-vi ..... Revision 3
3-vii ..... Revision 3
3.1-1 ..... Revision 3
3.1-2 ..... Revision 3
3.1-3 ..... Revision 3
3.1-4 ..... Revision 3
3.1-5 ..... Revision 3
3.1-6 ..... Revision 4
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
3.2-3 ..... Revision 2
3.3-1 ..... Revision 2

List of Effective Pages (continued)

3.3-2 ..... Revision 2
3.3-3 ..... Revision 2
3.3-4 ..... Revision 2
3.3-5 ..... Revision 2
3.3-6 ..... Revision 2
3.3-7 ..... Revision 2
3.3-8 ..... Revision 2
3.3-9 ..... Revision 2
3.3-10 ..... Amendment 1
3.3-11 ..... Revision 0
3.3-12 ..... Revision 2
3.3-13 ..... Revision 2
3.3-14 ..... Revision 2
3.4.1-1 ..... Revision 2
3.4.1-2 ..... Revision MPC-06A
3.4.1-3 ..... Revision 2
3.4.1-4 ..... Revision 2
3.4.1-5 ..... Revision 3
3.4.1-6 ..... Revision 2
3.4.1-7 ..... Revision 2
3.4.2-1 ..... Revision 2
3.4.2-2 ..... Revision 2
3.4.3-1 ..... Revision 2
3.4.3-2 ..... Revision 2
3.4.3-3 ..... Revision 2
3.4.3-4 ..... Revision 2
3.4.3-5 ..... Revision 2
3.4.3-6 ..... Revision 2
3.4.3-7 ..... Revision 2
3.4.3-8 ..... Revision 2
3.4.3-9 ..... Revision 2
3.4.3-10 ..... Revision 2
3.4.3-11 ..... Revision 2
3.4.3-12 ..... Revision 2
3.4.3-13 ..... Revision 2
3.4.3-14 ..... Revision 2
3.4.3-15 ..... Revision 2
3.4.3-16 ..... Revision 2
3.4.3-17 ..... Revision 2
3.4.3-18 ..... Revision 2
3.4.3-19 ..... Revision 2
3.4.3-20 ..... Revision 2
3.4.3-21 ..... Revision 2
3.4.3-22 ..... Revision 2
3.4.3-23 ..... Revision 2
3.4.3-24 ..... Revision 2
3.4.3-25 ..... Revision 2
3.4.3-26 ..... Revision 2
3.4.3-27 ..... Revision 2
3.4.3-28 ..... Revision 2
3.4.3-29 ..... Revision 2
3.4.3-30 ..... Revision 2
3.4.3-31 ..... Revision 2
3.4.3-32 ..... Revision 2
3.4.3-33 ..... Revision 2
3.4.3-34 ..... Revision 2
3.4.3-35 ..... Revision 2
3.4.3-36 ..... Revision 2
3.4.3-37 ..... Revision 2
3.4.3-38 ..... Revision 2
3.4.3-39 ..... Revision 2
3.4.3-40 ..... Revision 3
3.4.3-41 ..... Revision 2
3.4.3-42 ..... Revision 2
3.4.3-43 ..... Revision 2
3.4.3-44 ..... Revision 2
3.4.3-45 ..... Revision 2
3.4.3-46 ..... Revision 2
3.4.3-47 ..... Revision 2
3.4.3-48 ..... Revision 4

List of Effective Pages (continued)

3.4.3-49 ..... Revision 2
3.4.3-50 ..... Revision 2
3.4.3-51 ..... Revision 2
3.4.3-52 ..... Revision 2
3.4.3-53 ..... Revision 2
3.4.3-54 ..... Revision 2
3.4.3-55 ..... Revision 2
3.4.3-56 ..... Revision 3
3.4.3-57 ..... Revision 2
3.4.3-58 ..... Revision 2
3.4.3-59 ..... Revision 2
3.4.3-60 ..... Revision 2
3.4.3-61 ..... Revision 2
3.4.3-62 ..... Revision 2
3.4.3-63 ..... Revision 2
3.4.3-64 ..... Revision 2
3.4.3-65 ..... Revision 2
3.4.3-66 ..... Revision 2
3.4.3-67 ..... Revision 2
3.4.3-68 ..... Revision 2
3.4.3-69 ..... Revision 2
3.4.3-70 ..... Revision 2
3.4.3-71 ..... Revision 2
3.4.3-72 ..... Revision 5
3.4.3-73 ..... Revision 5
3.4.4-1 ..... Revision 2
3.4.4-2 ..... Revision 2
3.4.4-3 ..... Revision 2
3.4.4-4 ..... Revision 2
3.4.4-5 ..... Revision 2
3.4.4-6 ..... Revision 2
3.4.4-7 ..... Revision 2
3.4.4-8 ..... Revision 2
3.4.4-9 ..... Revision 2
3.4.4-10 ..... Revision 3
3.4.4-11 ..... Revision 2
3.4.4-12 ..... Revision 2
3.4.4-13 ..... Revision 2
3.4.4-14 ..... Revision 2
3.4.4-15 ..... Revision 3
3.4.4-16 ..... Revision 3
3.4.4-17 ..... Revision 3
3.4.4-18 ..... Revision 3
3.4.4-19 ..... Revision 3
3.4.4-20 ..... Revision 3
3.4.4-21 ..... Revision 3
3.4.4-22 ..... Revision 3
3.4.4-23 ..... Revision 3
3.4.4-24 ..... Revision 3
3.4.4-25 ..... Revision 3
3.4.4-26 ..... Revision 3
3.4.4-27 ..... Revision 3
3.4.4-28 ..... Revision 3
3.4.4-29 ..... Revision 3
3.4.4-30 ..... Revision 3
3.4.4-31 ..... Revision 3
3.4.4-32 ..... Revision 3
3.4.4-33 ..... Revision 3
3.4.4-34 ..... Revision 3
3.4.4-35 ..... Revision 3
3.4.4-36 ..... Revision 3
3.4.4-37 ..... Revision 3
3.4.4-38 ..... Revision 3
3.4.4-39 ..... Revision 3
3.4.4-40 ..... Revision 3
3.4.4-41 ..... Revision 3
3.4.4-42 ..... Revision 3
3.4.4-43 ..... Revision 3
3.4.4-44 ..... Revision 3
3.4.4-45 ..... Revision 3

List of Effective Pages (continued)

3.4.4-46 ..... Revision 3
3.4.4-47 ..... Revision 3
3.4.4-48 ..... Revision 3
3.4.4-49 ..... Revision 3
3.4.4-50 ..... Revision 3
3.4.4-51 ..... Revision 3
3.4.4-52 ..... Revision 3
3.4.4-53 ..... Revision 3
3.4.4-54 ..... Revision 4
3.4.4-55 ..... Revision 4
3.4.4-56 ..... Revision 4
3.4.4-57 ..... Revision 5
3.4.4-58 ..... Revision 3
3.4.4-59 ..... Revision 3
3.4.4-60 ..... Revision 3
3.4.4-61 ..... Revision 3
3.4.4-62 ..... Revision 3
3.4.4-63 ..... Revision 3
3.4.4-64 ..... Revision 3
3.4.4-65 ..... Revision 3
3.4.4-66 ..... Revision 3
3.4.4-67 ..... Revision 3
3.4.4-68 ..... Revision 3
3.4.4-69 ..... Revision 3
3.4.4-70 ..... Revision 4
3.4.4-71 ..... Revision 4
3.4.4-72 ..... Revision 4
3.4.4-73 ..... Revision 4
3.4.4-74 ..... Revision 4
3.4.4-75 ..... Revision 4
3.4.4-76 ..... Revision 4
3.4.4-77 ..... Revision 3
3.4.4-78 ..... Revision 3
3.4.4-79 ..... Revision 3
3.4.4-80 ..... Revision 3
3.4.4-81 ..... Revision 3
3.4.4-82 ..... Revision 3
3.4.4-83 ..... Revision 3
3.4.4-84 ..... Revision 3
3.4.4-85 ..... Revision 3
3.4.4-86 ..... Revision 3
3.4.4-87 ..... Revision 3
3.4.4-88 ..... Revision 3
3.4.4-89 ..... Revision 3
3.4.4-90 ..... Revision 3
3.4.4-91 ..... Revision 3
3.4.4-92 ..... Revision 3
3.4.4-93 ..... Revision 3
3.4.4-94 ..... Revision 3
3.4.4-95 ..... Revision 3
3.4.4-96 ..... Revision 3
3.4.4-97 ..... Revision 3
3.4.4-98 ..... Revision 3
3.4.4-99 ..... Revision 5
3.4.4-100 ..... Revision 5
3.4.4-101 ..... Revision 5
3.4.5-1 ..... Revision 2
3.5-1 ..... Revision 2
3.6-1 ..... Revision 2
3.6-2 ..... Revision 2
3.6-3 ..... Revision 4
3.7-1 ..... Revision 2
3.7-2 ..... Revision 2
3.8-1 ..... Revision 3
3.8.1-1 ..... Revision 0
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

List of Effective Pages (continued)

3.8.2-3 ..... Revision 0
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
3.8.5-2 ..... Revision 2

Chapter 4

4-i ..... Revision 3
4-ii ..... Revision 5
4-iii ..... Revision 3
4-iv ..... Revision 5
4-v ..... Revision 2
4-vi ..... Revision 5
4.1-1 ..... Revision 2
4.1-2 ..... Revision 2
4.1-3 ..... Revision 2
4.1-4 ..... Revision 5
4.1-5 ..... Revision 5
4.1-6 ..... Revision 2
4.1-7 ..... Revision 5
4.2-1 ..... Revision 2
4.2-2 ..... Revision 2
4.2-3 ..... Revision 0
4.2-4 ..... Revision 2
4.2-5 ..... Revision 2
4.2-6 ..... Revision 0
4.2-7 ..... Revision 0
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
4.4-7 ..... Amendment 1
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
4.4-15 ..... Revision 0
4.4-16 ..... Revision 0
4.4-17 ..... Revision 2
4.4-18 ..... Revision 2
4.4-19 ..... Revision 2
4.4-20 ..... Revision 0
4.4-21 ..... Revision 2
4.4-22 ..... Revision 2
4.4-23 ..... Amendment 1
4.4-24 ..... Revision 2
4.4-25 ..... Revision 2
4.4-26 ..... Revision 0
4.4-27 ..... Revision 0
4.4-28 ..... Revision 2
4.4-29 ..... Revision 2
4.4-30 ..... Revision 0
4.4-31 ..... Revision 2
4.4-32 ..... Revision 2
4.4-33 ..... Revision 2
4.4-34 ..... Revision 2

List of Effective Pages (continued)

4.4-35 ..... Revision 2
4.4-36 ..... Amendment 1
4.4-37 ..... Amendment 1
4.4-38 ..... Amendment 1
4.4-39 ..... Revision 2
4.4-40 ..... Revision 2
4.4-41 ..... Revision 2
4.4-42 ..... Revision 2
4.4-43 ..... Revision 2
4.4-44 ..... Revision 2
4.4-45 ..... Revision 2
4.4-46 ..... Revision 2
4.4-47 ..... Revision 2
4.4-48 ..... Revision 2
4.4-49 ..... Revision 2
4.4-50 ..... Revision 2
4.4-51 ..... Revision 2
4.4-52 ..... Revision 2
4.4-53 ..... Revision 2
4.4-54 ..... Revision 2
4.4-55 ..... Amendment 1
4.4-56 ..... Revision 3
4.4-57 ..... Revision 3
4.4-58 ..... Revision 3
4.4-59 ..... Revision 3
4.4.60 ..... Revision 3
4.4.61 ..... Revision 3
4.5-1 ..... Revision 5
4.5-2 ..... Revision 2
4.5-3 ..... Revision 2
4.5-4 ..... Revision 2
4.5-5 ..... Revision 2
4.5-6 ..... Revision 2
4.5-7 ..... Revision 3
4.5-8 ..... Revision 2
4.5-9 ..... Revision 2
4.5-10 ..... Revision 2
4.5-11 ..... Revision 2
4.5-12 ..... Revision 2
4.5-13 ..... Revision 2
4.5-14 ..... Revision 2
4.5-15 ..... Revision 2
4.5-16 ..... Revision 5
4.5-17 ..... Revision 2
4.5-18 ..... Revision 2
4.5-19 ..... Revision 2
4.5-20 ..... Revision 2
4.5-21 ..... Revision 2
4.5-22 ..... Revision 5
4.5-23 ..... Revision 2
4.5-24 ..... Revision 5
4.5-25 ..... Revision 2
4.5-26 ..... Revision 2
4.5-27 ..... Revision 5
4.5-28 ..... Revision 2
4.5-29 ..... Revision 5
4.5-30 ..... Revision 5
4.5-31 ..... Revision 5
4.5-32 ..... Revision 5
4.5-33 ..... Revision 5
4.5-34 ..... Revision 5
4.5-35 ..... Revision 2
4.5-36 ..... Revision 2
4.5-37 ..... Revision 2
4.5-38 ..... Revision 5
4.5-39 ..... Revision 2
4.5-40 ..... Revision 2
4.5-41 ..... Revision 2
4.5-42 ..... Revision 5
4.5-43 ..... Revision 5

List of Effective Pages (continued)

4.5-44 ..... Revision 5
4.5-45 ..... Revision 5
4.5-46 ..... Revision 5
4.5-47 ..... Revision 5
4.5-48 ..... Revision 2
4.5-49 ..... Revision 2
4.5-50 ..... Revision 2
4.5-51 ..... Revision 2
4.5-52 ..... Revision 5
4.6-1 ..... Revision 2
4.6-2 ..... Revision 2
4.6-3 ..... Revision 5

Chapter 5

5-i ..... Revision 3
5-ii ..... Revision 3
5-iii ..... Revision 3
5-iv ..... Revision 3
5-v ..... Revision 3
5-vi ..... Revision 3
5-vii ..... Revision 3
5-viii ..... Revision 3
5-ix ..... Revision 3
5-x ..... Revision 3
5-xi ..... Revision 3
5-xii ..... Revision 3
5.1-1 ..... Revision 2
5.1-2 ..... Revision 2
5.1.1-1 ..... Revision 3
5.1.1-2 ..... Revision 3
5.1.1-3 ..... Revision 3
5.1.1-4 ..... Revision 3
5.1.1-5 ..... Revision 3
5.1.1-6 ..... Revision 3
5.1.2-1 ..... Revision 2
5.1.2-2 ..... Revision 2
5.1.2-3 ..... Revision 2
5.1.2-4 ..... Revision 2
5.1.2-5 ..... Revision 3
5.1.2-6 ..... Revision 3
5.2-1 ..... Revision 2
5.2.1-1 ..... Revision 3
5.2.1-2 ..... Revision 3
5.2.1-3 ..... Revision 3
5.2.1-4 ..... Revision 3
5.2.1-5 ..... Revision 3
5.2.1-6 ..... Revision 3
5.2.1-7 ..... Revision 3
5.2.1-8 ..... Revision 3
5.2.1-9 ..... Revision 3
5.2.1-10 ..... Revision 3
5.2.1-11 ..... Revision 3
5.2.1-12 ..... Revision 3
5.2.1-13 ..... Revision 3
5.2.1-14 ..... Revision 3
5.2.1-15 ..... Revision 3
5.2.1-16 ..... Revision 3
5.2.1-17 ..... Revision 3
5.2.2-1 ..... Revision 3
5.2.2-2 ..... Revision 2
5.2.2-3 ..... Revision 2
5.2.2-4 ..... Revision 2
5.2.2-5 ..... Revision 2
5.2.2-6 ..... Revision 2
5.2.2-7 ..... Revision 2
5.2.2-8 ..... Revision 2
5.2.2-9 ..... Revision 2
5.2.2-10 ..... Revision 2
5.2.2-11 ..... Revision 2
5.2.2-12 ..... Revision 2

List of Effective Pages (continued)

5.2.2-13 ..... Revision 2
5.2.2-14 ..... Revision 2
5.2.2-15 ..... Revision 2
5.2.2-16 ..... Revision 2
5.2.2-17 ..... Revision 2
5.2.2-18 ..... Revision 2
5.2.2-19 ..... Revision 2
5.3-1 ..... Revision 3
5.3.1-1 ..... Revision 3
5.3.1-2 ..... Revision 3
5.3.1-3 ..... Revision 3
5.3.1-4 ..... Revision 3
5.3.1-5 ..... Revision 3
5.3.1-6 ..... Revision 3
5.3.1-7 ..... Revision 3
5.3.1-8 ..... Revision 3
5.3.1-9 ..... Revision 3
5.3.1-10 ..... Revision 3
5.3.1-11 ..... Revision 3
5.3.1-12 ..... Revision 3
5.3.1-13 ..... Revision 3
5.3.1-14 ..... Revision 3
5.3.1-15 ..... Revision 3
5.3.1-16 ..... Revision 3
5.3.1-17 ..... Revision 3
5.3.1-18 ..... Revision 3
5.3.1-19 ..... Revision 3
5.3.1-20 ..... Revision 3
5.3.1-21 ..... Revision 3
5.3.1-22 ..... Revision 3
5.3.1-23 ..... Revision 3
5.3.1-24 ..... Revision 3
5.3.1-25 ..... Revision 3
5.3.1-26 ..... Revision 3
5.3.2-1 ..... Revision 2
5.3.2-2 ..... Revision 2
5.3.2-3 ..... Revision 3
5.3.2-4 ..... Revision 2
5.3.2-5 ..... Revision 2
5.3.2-6 ..... Revision 2
5.3.2-7 ..... Revision 2
5.3.2-8 ..... Revision 2
5.3.2-9 ..... Revision 2
5.3.2-10 ..... Revision 2
5.3.2-11 ..... Revision 2
5.3.2-12 ..... Revision 2
5.3.2-13 ..... Revision 2
5.3.2-14 ..... Revision 2
5.3.2-15 ..... Revision 2
5.3.2-16 ..... Revision 2
5.4-1 ..... Revision 2
5.4.1-1 ..... Revision 3
5.4.1-2 ..... Revision 3
5.4.1-3 ..... Revision 3
5.4.1-4 ..... Revision 3
5.4.1-5 ..... Revision 3
5.4.1-6 ..... Revision 3
5.4.1-7 ..... Revision 3
5.4.1-8 ..... Revision 3
5.4.1-9 ..... Revision 3
5.4.1-10 ..... Revision 3
5.4.1-11 ..... Revision 3
5.4.1-12 ..... Revision 3
5.4.1-13 ..... Revision 3
5.4.1-14 ..... Revision 3
5.4.1-15 ..... Revision 3
5.4.1-16 ..... Revision 3
5.4.1-17 ..... Revision 3
5.4.1-18 ..... Revision 3
5.4.1-19 ..... Revision 3

List of Effective Pages (continued)

5.4.1-20 ..... Revision 3
5.4.1-21 ..... Revision 3
5.4.1-22 ..... Revision 3
5.4.1-23 ..... Revision 3
5.4.1-24 ..... Revision 3
5.4.1-25 ..... Revision 3
5.4.1-26 ..... Revision 3
5.4.1-27 ..... Revision 3
5.4.1-28 ..... Revision 3
5.4.1-29 ..... Revision 3
5.4.1-30 ..... Revision 3
5.4.1-31 ..... Revision 3
5.4.1-32 ..... Revision 3
5.4.1-33 ..... Revision 3
5.4.1-34 ..... Revision 3
5.4.2-1 ..... Revision 2
5.4.2-2 ..... Revision 2
5.4.2-3 ..... Revision 2
5.4.2-4 ..... Revision 2
5.4.2-5 ..... Revision 2
5.4.2-6 ..... Revision 2
5.4.2-7 ..... Revision 2
5.4.2-8 ..... Revision 2
5.4.2-9 ..... Revision 2
5.4.2-10 ..... Revision 2
5.4.2-11 ..... Revision 2
5.4.2-12 ..... Revision 2
5.4.2-13 ..... Revision 2
5.4.2-14 ..... Revision 2
5.4.2-15 ..... Revision 2
5.4.2-16 ..... Revision 2
5.4.2-17 ..... Revision 2
5.4.2-18 ..... Revision 2
5.4.2-19 ..... Revision 2
5.4.2-20 ..... Revision 2
5.4.2-21 ..... Revision 2
5.4.2-22 ..... Revision 2
5.4.2-23 ..... Revision 2
5.4.2-24 ..... Revision 2
5.4.2-25 ..... Revision 2
5.4.2-26 ..... Revision 2
5.4.2-27 ..... Revision 2
5.4.2-28 ..... Revision 2
5.4.2-29 ..... Revision 2
5.4.2-30 ..... Revision 2
5.4.2-31 ..... Revision 2
5.4.2-32 ..... Revision 2
5.4.2-33 ..... Revision 2
5.4.2-34 ..... Revision 2
5.4.2-35 ..... Revision 2
5.4.2-36 ..... Revision 2
5.4.2-37 ..... Revision 2
5.4.2-38 ..... Revision 2
5.4.2-39 ..... Revision 2
5.4.2-40 ..... Revision 2
5.4.2-41 ..... Revision 2
5.4.2-42 ..... Revision 2
5.4.2-43 ..... Revision 2
5.4.2-44 ..... Revision 2
5.4.2-45 ..... Revision 2
5.4.2-46 ..... Revision 2
5.4.2-47 ..... Revision 2
5.5-1 ..... Revision 2
5.5-2 ..... Revision 3
5.6.1-1 ..... Revision 3
5.6.1-2 ..... Revision 3
5.6.1-3 ..... Revision 3
5.6.1-4 ..... Revision 3
5.6.1-5 ..... Revision 3
5.6.1-6 ..... Revision 3

List of Effective Pages (continued)

5.6.1-7 ..... Revision 3
5.6.1-8 ..... Revision 3
5.6.1-9 ..... Revision 3
5.6.1-10 ..... Revision 3
5.6.1-11 ..... Revision 3
5.6.1-12 ..... Revision 3
5.6.1-13 ..... Revision 3
5.6.1-14 ..... Revision 3
5.6.1-15 ..... Revision 3
5.6.1-16 ..... Revision 3
5.6.1-17 ..... Revision 3
5.6.1-18 ..... Revision 3
5.6.1-19 ..... Revision 3
5.6.1-20 ..... Revision 3
5.6.1-21 ..... Revision 3
5.6.1-22 ..... Revision 3
5.6.1-23 ..... Revision 3
5.6.1-24 ..... Revision 3
5.6.1-25 ..... Revision 3
5.6.1-26 ..... Revision 3
5.6.1-27 ..... Revision 3
5.6.1-28 ..... Revision 3
5.6.1-29 ..... Revision 3
5.6.1-30 ..... Revision 3
5.6.1-31 ..... Revision 3
5.6.1-32 ..... Revision 3
5.6.1-33 ..... Revision 3
5.6.1-34 ..... Revision 3
5.6.1-35 ..... Revision 3
5.6.1-36 ..... Revision 3
5.6.1-37 ..... Revision 3
5.6.1-38 ..... Revision 3
5.6.1-39 ..... Revision 3
5.6.1-40 ..... Revision 3
5.6.1-41 ..... Revision 3
5.6.1-42 ..... Revision 3
5.6.1-43 ..... Revision 3
5.6.1-44 ..... Revision 3
5.6.1-45 ..... Revision 3
5.6.1-46 ..... Revision 3
5.6.1-47 ..... Revision 3
5.6.1-48 ..... Revision 3
5.6.1-49 ..... Revision 3
5.6.1-50 ..... Revision 3
5.6.1-51 ..... Revision 3
5.6.1-52 ..... Revision 3
5.6.1-53 ..... Revision 3
5.6.1-54 ..... Revision 3
5.6.1-55 ..... Revision 3
5.6.1-56 ..... Revision 3
5.6.1-57 ..... Revision 3
5.6.1-58 ..... Revision 3
5.6.1-59 ..... Revision 3
5.6.1-60 ..... Revision 3
5.6.1-61 ..... Revision 3
5.6.1-62 ..... Revision 3
5.6.1-63 ..... Revision 3
5.6.1-64 ..... Revision 3
5.6.1-65 ..... Revision 3
5.6.1-66 ..... Revision 3
5.6.1-67 ..... Revision 3
5.6.1-68 ..... Revision 3
5.6.1-69 ..... Revision 3
5.6.1-70 ..... Revision 3
5.6.1-71 ..... Revision 3
5.6.2-1 ..... Revision 3
5.6.2-2 ..... Revision 3
5.6.2-3 ..... Revision 3
5.6.2-4 ..... Revision 3
5.6.2-5 ..... Revision 3

List of Effective Pages (continued)

5.6.2-6 ..... Revision 3
5.6.2-7 ..... Revision 3
5.6.2-8 ..... Revision 3
5.6.2-9 ..... Revision 3
5.6.2-10 ..... Revision 3
5.6.2-11 ..... Revision 3
5.6.2-12 ..... Revision 3
5.6.2-13 ..... Revision 3
5.6.2-14 ..... Revision 3
5.6.2-15 ..... Revision 3
5.6.2-16 ..... Revision 3
5.6.2-17 ..... Revision 3
5.6.2-18 ..... Revision 3
5.6.2-19 ..... Revision 3
5.6.2-20 ..... Revision 3
5.6.2-21 ..... Revision 3
5.6.2-22 ..... Revision 3
5.6.2-23 ..... Revision 3
5.6.2-24 ..... Revision 3
5.6.2-25 ..... Revision 3
5.6.2-26 ..... Revision 3
5.6.2-27 ..... Revision 3
5.6.2-28 ..... Revision 3
5.6.2-29 ..... Revision 3
5.6.2-30 ..... Revision 3
5.6.2-31 ..... Revision 3
5.6.2-32 ..... Revision 3
5.6.2-33 ..... Revision 3
5.6.2-34 ..... Revision 3
5.6.2-35 ..... Revision 3
5.6.2-36 ..... Revision 3

Chapter 6

6-i ..... Revision 3
6-ii ..... Revision 3
6-iii ..... Revision 3
6-iv ..... Revision 3
6-v ..... Revision 3
6-vi ..... Revision 3
6.1-1 ..... Revision 2
6.1-2 ..... Revision 2
6.1.1-1 ..... Revision 3
6.1.1-2 ..... Revision 3
6.1.2-1 ..... Revision 2
6.1.2-2 ..... Revision 2
6.2-1 ..... Revision 2
6.2.1-1 ..... Revision 3
6.2.1-2 ..... Revision 3
6.2.1-3 ..... Revision 2
6.2.1-4 ..... Revision 2
6.2.1-5 ..... Revision 2
6.2.1-6 ..... Revision 3
6.2.1-7 ..... Revision 2
6.2.2-1 ..... Revision 3
6.2.2-2 ..... Revision 2
6.2.2-3 ..... Revision 2
6.2.2-4 ..... Revision 2
6.3-1 ..... Revision 2
6.3.1-1 ..... Revision 2
6.3.1-2 ..... Revision 3
6.3.1-3 ..... Revision 2
6.3.1-4 ..... Revision 2
6.3.1-5 ..... Revision 2
6.3.1-6 ..... Revision 2
6.3.1-7 ..... Revision 2
6.3.1-8 ..... Revision 2
6.3.1-9 ..... Revision 2
6.3.1-10 ..... Revision 3
6.3.2-1 ..... Revision 3
6.3.2-2 ..... Revision 2

List of Effective Pages (continued)

6.3.2-3 ..... Revision 2
6.3.2-4 ..... Revision 2
6.3.2-5 ..... Revision 2
6.3.2-6 ..... Revision 2
6.3.2-7 ..... Revision 2
6.4-1 ..... Revision 2
6.4.1-1 ..... Revision 3
6.4.1-2 ..... Revision 3
6.4.1-3 ..... Revision 3
6.4.1-4 ..... Revision 3
6.4.1-5 ..... Revision 3
6.4.1-6 ..... Revision 3
6.4.1-7 ..... Revision 3
6.4.1-8 ..... Revision 3
6.4.1-9 ..... Revision 3
6.4.1-10 ..... Revision 3
6.4.1-11 ..... Revision 3
6.4.1-12 ..... Revision 3
6.4.1-13 ..... Revision 3
6.4.1-14 ..... Revision 3
6.4.1-15 ..... Revision 3
6.4.1-16 ..... Revision 3
6.4.1-17 ..... Revision 3
6.4.1-18 ..... Revision 3
6.4.1-19 ..... Revision 3
6.4.1-20 ..... Revision 3
6.4.1-21 ..... Revision 3
6.4.1-22 ..... Revision 3
6.4.1-23 ..... Revision 3
6.4.1-24 ..... Revision 3
6.4.1-25 ..... Revision 3
6.4.1-26 ..... Revision 3
6.4.1-27 ..... Revision 3
6.4.1-28 ..... Revision 3
6.4.1-29 ..... Revision 3
6.4.1-30 ..... Revision 3
6.4.1-31 ..... Revision 3
6.4.1-32 ..... Revision 3
6.4.1-33 ..... Revision 3
6.4.2-1 ..... Revision 2
6.4.2-2 ..... Revision 2
6.4.2-3 ..... Revision 2
6.4.2-4 ..... Revision 2
6.4.2-5 ..... Revision 2
6.4.2-6 ..... Revision 2
6.4.2-7 ..... Revision 2
6.4.2-8 ..... Revision 2
6.4.2-9 ..... Revision 2
6.4.2-10 ..... Revision 2
6.4.2-11 ..... Revision 2
6.4.2-12 ..... Revision 2
6.4.2-13 ..... Revision 3
6.4.2-14 ..... Revision 3
6.4.2-15 ..... Revision 3
6.4.2-16 ..... Revision 3
6.4.2-17 ..... Revision 3
6.4.2-18 ..... Revision 2
6.4.2-19 ..... Revision 2
6.4.2-20 ..... Revision 2
6.4.2-21 ..... Revision 2
6.4.2-22 ..... Revision 3
6.4.2-23 ..... Revision 3
6.4.2-24 ..... Revision 2
6.4.2-25 ..... Revision 2
6.4.2-26 ..... Revision 2
6.5-1 ..... Revision 2
6.5-2 ..... Revision 2
6.5.1-1 ..... Revision 2
6.5.1-2 ..... Revision 3
6.5.1-3 ..... Revision 3

List of Effective Pages (continued)

6.5.1-4 ..... Revision 2
6.5.1-5 ..... Revision 2
6.5.1-6 ..... Revision 2
6.5.1-7 ..... Revision 2
6.5.1-8 ..... Revision 2
6.5.1-9 ..... Revision 2
6.5.1-10 ..... Revision 2
6.5.1-11 ..... Revision 2
6.5.1-12 ..... Revision 2
6.5.1-13 ..... Revision 2
6.5.1-14 ..... Revision 2
6.5.1-15 ..... Revision 2
6.5.1-16 ..... Revision 2
6.5.1-17 ..... Revision 2
6.5.1-18 ..... Revision 2
6.5.1-19 ..... Revision 2
6.5.1-20 ..... Revision 3
6.5.2-1 ..... Revision 3
6.5.2-2 ..... Revision 2
6.5.2-3 ..... Revision 2
6.5.2-4 ..... Revision 2
6.5.2-5 ..... Revision 2
6.5.2-6 ..... Revision 2
6.5.2-7 ..... Revision 2
6.5.2-8 ..... Revision 2
6.5.2-9 ..... Revision 2
6.5.2-10 ..... Revision 2
6.5.2-11 ..... Revision 2
6.5.2-12 ..... Revision 2
6.5.2-13 ..... Revision 2
6.5.2-14 ..... Revision 2
6.5.2-15 ..... Revision 2
6.5.2-16 ..... Revision 2
6.5.2-17 ..... Revision 2
6.5.2-18 ..... Revision 2
6.5.2-19 ..... Revision 2
6.5.2-20 ..... Revision 2
6.6-1 ..... Revision 2
6.6-2 ..... Revision 2
6.7-1 ..... Revision 3
6.7.1-1 ..... Revision 2
6.7.1-2 ..... Revision 2
6.7.1-3 ..... Revision 2
6.7.1-4 ..... Revision 2
6.7.1-5 ..... Revision 2
6.7.1-6 ..... Revision 2
6.7.1-7 ..... Revision 2
6.7.1-8 ..... Revision 2
6.7.1-9 ..... Revision 2
6.7.1-10 ..... Revision 2
6.7.1-11 ..... Revision 2
6.7.1-12 ..... Revision 2
6.7.1-13 ..... Revision 2
6.7.1-14 ..... Revision 2
6.7.1-15 ..... Revision 2
6.7.1-16 ..... Revision 2
6.7.1-17 ..... Revision 2
6.7.1-18 ..... Revision 2
6.7.1-19 ..... Revision 2
6.7.1-20 ..... Revision 2
6.7.1-21 ..... Revision 2
6.7.1-22 ..... Revision 2
6.7.1-23 ..... Revision 2
6.7.1-24 ..... Revision 2
6.7.1-25 ..... Revision 2
6.7.1-26 ..... Revision 2
6.7.1-27 ..... Revision 2
6.7.1-28 ..... Revision 2
6.7.1-29 ..... Revision 2
6.7.1-30 ..... Revision 2

List of Effective Pages (continued)

6.7.1-31 ..... Revision 2
6.7.1-32 ..... Revision 2
6.7.1-33 ..... Revision 2
6.7.1-34 ..... Revision 2
6.7.1-35 ..... Revision 2
6.7.1-36 ..... Revision 2
6.7.1-37 ..... Revision 2
6.7.1-38 ..... Revision 2
6.7.1-39 ..... Revision 2
6.7.1-40 ..... Revision 2
6.7.1-41 ..... Revision 2
6.7.1-42 ..... Revision 2
6.7.1-43 ..... Revision 2
6.7.1-44 ..... Revision 2
6.7.1-45 ..... Revision 2
6.7.1-46 ..... Revision 2
6.7.1-47 ..... Revision 2
6.7.1-48 ..... Revision 2
6.7.1-49 ..... Revision 2
6.7.1-50 ..... Revision 2
6.7.1-51 ..... Revision 2
6.7.1-52 ..... Revision 2
6.7.1-53 ..... Revision 2
6.7.1-54 ..... Revision 2
6.7.1-55 ..... Revision 2
6.7.1-56 ..... Revision 2
6.7.1-57 ..... Revision 2
6.7.1-58 ..... Revision 2
6.7.1-59 ..... Revision 2
6.7.1-60 ..... Revision 2
6.7.1-61 ..... Revision 2
6.7.1-62 ..... Revision 2
6.7.1-63 ..... Revision 2
6.7.1-64 ..... Revision 2
6.7.1-65 ..... Revision 2
6.7.1-66 ..... Revision 2
6.7.1-67 ..... Revision 2
6.7.1-68 ..... Revision 2
6.7.1-69 ..... Revision 2
6.7.1-70 ..... Revision 2
6.7.1-71 ..... Revision 2
6.7.1-72 ..... Revision 2
6.7.1-73 ..... Revision 2
6.7.1-74 ..... Revision 2
6.7.1-75 ..... Revision 2
6.7.1-76 ..... Revision 2
6.7.1-77 ..... Revision 2
6.7.1-78 ..... Revision 2
6.7.1-79 ..... Revision 2
6.7.1-80 ..... Revision 2
6.7.1-81 ..... Revision 2
6.7.1-82 ..... Revision 2
6.7.1-83 ..... Revision 2
6.7.1-84 ..... Revision 2
6.7.1-85 ..... Revision 2
6.7.1-86 ..... Revision 2
6.7.1-87 ..... Revision 2
6.7.1-88 ..... Revision 2
6.7.1-89 ..... Revision 2
6.7.1-90 ..... Revision 2
6.7.1-91 ..... Revision 2
6.7.1-92 ..... Revision 2
6.7.1-93 ..... Revision 2
6.7.1-94 ..... Revision 2
6.7.1-95 ..... Revision 2
6.7.1-96 ..... Revision 2
6.7.1-97 ..... Revision 2
6.7.1-98 ..... Revision 2
6.7.1-99 ..... Revision 2
6.7.1-100 ..... Revision 2

List of Effective Pages (continued)

6.7.1-101 ..... Revision 2
6.7.1-102 ..... Revision 2
6.7.1-103 ..... Revision 2
6.7.1-104 ..... Revision 2
6.7.1-105 ..... Revision 2
6.7.1-106 ..... Revision 2
6.7.1-107 ..... Revision 2
6.7.1-108 ..... Revision 2
6.7.1-109 ..... Revision 2
6.7.1-110 ..... Revision 2
6.7.1-111 ..... Revision 2
6.7.1-112 ..... Revision 2
6.7.1-113 ..... Revision 2
6.7.1-114 ..... Revision 2
6.7.1-115 ..... Revision 2
6.7.1-116 ..... Revision 2
6.7.1-117 ..... Revision 2
6.7.1-118 ..... Revision 2
6.7.1-119 ..... Revision 2
6.7.1-120 ..... Revision 2
6.7.1-121 ..... Revision 2
6.7.1-122 ..... Revision 2
6.7.1-123 ..... Revision 2
6.7.1-124 ..... Revision 2
6.7.1-125 ..... Revision 2
6.7.1-126 ..... Revision 2
6.7.1-127 ..... Revision 3
6.7.1-128 ..... Revision 3
6.7.1-129 ..... Revision 3
6.7.1-130 ..... Revision 3
6.7.1-131 ..... Revision 3
6.7.1-132 ..... Revision 3
6.7.1-133 ..... Revision 3
6.7.1-134 ..... Revision 3
6.7.1-135 ..... Revision 3
6.7.1-136 ..... Revision 3
6.7.1-137 ..... Revision 3
6.7.1-138 ..... Revision 3
6.7.1-139 ..... Revision 3
6.7.1-140 ..... Revision 3
6.7.1-141 ..... Revision 3
6.7.1-142 ..... Revision 3
6.7.1-143 ..... Revision 3
6.7.1-144 ..... Revision 3
6.7.1-145 ..... Revision 3
6.7.1-146 ..... Revision 3
6.7.1-147 ..... Revision 3
6.7.1-148 ..... Revision 3
6.7.1-149 ..... Revision 3
6.7.1-150 ..... Revision 3
6.7.1-151 ..... Revision 3
6.7.1-152 ..... Revision 3
6.7.1-153 ..... Revision 3
6.7.1-154 ..... Revision 3
6.7.1-155 ..... Revision 3
6.7.1-156 ..... Revision 3
6.7.1-157 ..... Revision 3
6.7.1-158 ..... Revision 3
6.7.1-159 ..... Revision 3
6.7.1-160 ..... Revision 3
6.7.2-1 ..... Revision 2
6.7.2-2 ..... Revision 2
6.7.2-3 ..... Revision 2
6.7.2-4 ..... Revision 2
6.7.2-5 ..... Revision 2
6.7.2-6 ..... Revision 2
6.7.2-7 ..... Revision 2
6.7.2-8 ..... Revision 2
6.7.2-9 ..... Revision 2
6.7.2-10 ..... Revision 2

List of Effective Pages (continued)

6.7.2-11 ..... Revision 2
6.7.2-12 ..... Revision 2
6.7.2-13 ..... Revision 2
6.7.2-14 ..... Revision 2
6.7.2-15 ..... Revision 2
6.7.2-16 ..... Revision 2
6.7.2-17 ..... Revision 2
6.7.2-18 ..... Revision 2
6.7.2-19 ..... Revision 2
6.7.2-20 ..... Revision 2
6.7.2-21 ..... Revision 2
6.7.2-22 ..... Revision 2
6.7.2-23 ..... Revision 2
6.7.2-24 ..... Revision 2
6.7.2-25 ..... Revision 2
6.7.2-26 ..... Revision 2
6.7.2-27 ..... Revision 2
6.7.2-28 ..... Revision 2
6.7.2-29 ..... Revision 2
6.7.2-30 ..... Revision 2
6.7.2-31 ..... Revision 2
6.7.2-32 ..... Revision 2
6.7.2-33 ..... Revision 2
6.7.2-34 ..... Revision 2
6.7.2-35 ..... Revision 2
6.7.2-36 ..... Revision 2
6.7.2-37 ..... Revision 2
6.7.2-38 ..... Revision 2
6.7.2-39 ..... Revision 2
6.7.2-40 ..... Revision 2
6.7.2-41 ..... Revision 2
6.7.2-42 ..... Revision 2
6.7.2-43 ..... Revision 2
6.7.2-44 ..... Revision 2

Chapter 7

7-i ..... Revision 2
7-ii ..... Revision 2
7-1 ..... Revision 2
7.1-1 ..... Revision 3
7.1-2 ..... Revision 2
7.1-3 ..... Revision MPC-06A
7.1-4 ..... Revision 3
7.1-5 ..... Revision 2
7.1-6 ..... Revision 2
7.1-7 ..... Revision 2
7.1-8 ..... Revision 2
7.1-9 ..... Revision 2
7.1-10 ..... Revision 2
7.2-1 ..... Revision 3
7.2-2 ..... Revision MPC-06A
7.3-1 ..... Revision 2

Chapter 8

8-i ..... Revision 5
8-ii ..... Revision 5
8-1 ..... Revision 2
8-2 ..... Revision 2
8.1-1 ..... Revision 2
8.1-2 ..... Revision 2
8.1-3 ..... Revision MPC-06A
8.1-4 ..... Revision MPC-06A
8.1-5 ..... Revision MPC-06A
8.1-6 ..... Revision MPC-06A
8.1-7 ..... Revision MPC-06A
8.1-8 ..... Revision MPC-06A
8.1-9 ..... Revision MPC-06A
8.1-10 ..... Revision 6
8.1-11 ..... Revision 6

List of Effective Pages (continued)

8.1-12 ..... Revision 6
8.1-13 ..... Revision 6
8.1-14 ..... Revision 6
8.1-15 ..... Revision 6
8.1-16 ..... Revision 5
8.1-17 ..... Revision MPC-06A
8.1-18 ..... Revision 5
8.1-19 ..... Revision 5
8.2-1 ..... Revision MPC-06A
8.2-2 ..... Revision 2
8.3-1 ..... Revision 2
8.3-2 ..... Revision 3
8.3-3 ..... Revision 3
8.3-4 ..... Revision 3
8.3-5 ..... Revision 3

Chapter 9

9-i ..... Revision 3
9-1 ..... Revision 2
9.1-1 ..... Revision 2
9.1-2 ..... Revision 3
9.1-3 ..... Revision 3
9.1-4 ..... Revision 3
9.1-5 ..... Revision 3
9.1-6 ..... Revision 3
9.1-7 ..... Revision 3
9.1-8 ..... Revision 3
9.1-9 ..... Revision MPC-06A
9.1-10 ..... Revision 3
9.2-1 ..... Revision MPC-06A
9.3-1 ..... Revision 2

Chapter 10

10-i ..... Revision 2
10-ii ..... Revision 2
10-iii ..... Revision 2
10.1-1 ..... Revision 2
10.1-2 ..... Revision MPC-06A
10.2-1 ..... Revision 3
10.2-2 ..... Revision 3
10.3-1 ..... Revision 2
10.3-2 ..... Revision MPC-06A
10.3-3 ..... Revision 2
10.3-4 ..... Revision 3
10.3-5 ..... Revision 2
10.3-6 ..... Revision 2
10.3-7 ..... Revision 2
10.3-8 ..... Revision 2
10.3-9 ..... Revision 2
10.3-10 ..... Revision 2
10.3-11 ..... Revision 3
10.3-12 ..... Revision 2
10.3-13 ..... Revision 2
10.3-14 ..... Revision 2
10.4-1 ..... Revision 3
10.4-2 ..... Revision 3
10.4-3 ..... Revision 3
10.4-4 ..... Revision 3
10.4-5 ..... Revision 2
10.4-6 ..... Revision 3
10.4-7 ..... Revision 2
10.4-8 ..... Revision 2
10.4-9 ..... Revision 2
10.4-10 ..... Revision 2
10.4-11 ..... Revision 2

Chapter 11

11-i ..... Revision 2
11-ii ..... Revision 2
11-iii ..... Revision 2

List of Effective Pages (continued)

11-iv ..... Revision 3
11-v ..... Revision 3
11-vi ..... Revision 3
11-vii ..... Revision 3
11-viii ..... Revision 4
11-ix ..... Revision 3
11-x ..... Revision 3
11-xi ..... Revision 3
11-1 ..... Revision 3
11.1-1 ..... Revision 2
11.1.1-1 ..... Revision MPC-06A
11.1.1-2 ..... Revision 3
11.1.2-1 ..... Revision 2
11.1.2-2 ..... Revision 3
11.1.2-3 ..... Revision 2
11.1.2-4 ..... Revision 4
11.1.2-5 ..... Revision 2
11.1.2-6 ..... Revision 4
11.1.2-7 ..... Revision 4
11.1.3-1 ..... Revision MPC-06A
11.1.3-2 ..... Revision MPC-06A
11.1.4-1 ..... Revision MPC-06A
11.1.4-2 ..... Revision 2
11.1.4-3 ..... Revision 2
11.1.4-4 ..... Revision 2
11.1.4-5 ..... Revision 2
11.1.4-6 ..... Revision 2
11.1.4-7 ..... Revision 2
11.1.5-1 ..... Revision 2
11.1.5-2 ..... Revision 2
11.1.5-3 ..... Revision 2
11.1.5-4 ..... Revision 2
11.1.5-5 ..... Revision 2
11.1.5-6 ..... Revision 2
11.1.5-7 ..... Revision 2
11.2-1 ..... Revision 2
11.2.1-1 ..... Revision 3
11.2.1-2 ..... Revision 2
11.2.1-3 ..... Revision 2
11.2.1-4 ..... Revision 4
11.2.1-5 ..... Revision 2
11.2.1-6 ..... Revision 2
11.2.1-7 ..... Revision 2
11.2.1-8 ..... Revision 2
11.2.1-9 ..... Revision 4
11.2.1-10 ..... Revision 4
11.2.2-1 ..... Revision 2
11.2.2-2 ..... Revision 2
11.2.2-3 ..... Revision 2
11.2.2-4 ..... Revision 2
11.2.2-5 ..... Revision 2
11.2.2-6 ..... Revision 2
11.2.2-7 ..... Revision 2
11.2.2-8 ..... Revision 2
11.2.2-9 ..... Revision 2
11.2.2-10 ..... Revision 2
11.2.2-11 ..... Revision 2
11.2.2-12 ..... Revision 2
11.2.2-13 ..... Revision 2
11.2.2-14 ..... Revision 2
11.2.2-15 ..... Revision MPC-06A
11.2.3-1 ..... Revision 2
11.2.3-2 ..... Revision MPC-06A
11.2.4-1 ..... Revision 2
11.2.5-1 ..... Revision 2
11.2.5-2 ..... Revision 2
11.2.5-3 ..... Revision 2
11.2.5-4 ..... Revision 2
11.2.5-5 ..... Revision 2
11.2.6-1 ..... Revision 2

List of Effective Pages (continued)

11.2.6-2 ..... Revision 2
11.2.6-3 ..... Revision 2
11.2.6-4 ..... Revision 2
11.2.6-5 ..... Revision 2
11.2.6-6 ..... Revision 2
11.2.6-7 ..... Revision 2
11.2.6-8 ..... Revision 4
11.2.6-9 .....Revision MPC-06A
11.2.7-1 ..... Revision 2
11.2.7-2 ..... Revision 2
11.2.8-1 ..... Revision 2
11.2.8-2 ..... Revision 2
11.2.8-3 ..... Revision 3
11.2.9-1 ..... Revision 2
11.2.9-2 ..... Revision 2
11.2.9-3 ..... Revision 2
11.2.9-4 ..... Revision 2
11.2.9-5 ..... Revision 2
11.2.10-1 .....Revision MPC-06A
11.2.10-2 ..... Revision 2
11.2.10-3 ..... Revision 2
11.2.11-1 ..... Revision 2
11.2.11-2 ..... Revision 2
11.2.11-3 ..... Revision 2
11.2.11-4 ..... Revision 2
11.2.11-5 ..... Revision 2
11.2.11-6 ..... Revision 4
11.2.11-7 ..... Revision 4
11.2.11-8 ..... Revision 4
11.2.11-9 ..... Revision 2
11.2.11-10 ..... Revision 4
11.2.11-11 ..... Revision 2
11.2.12-1 ..... Revision 2
11.2.12-2 ..... Revision 2
11.2.12-3 ..... Revision 2
11.2.12-4 ..... Revision 2
11.2.12-5 ..... Revision 2
11.2.12-6 ..... Revision 2
11.2.12-7 ..... Revision 3
11.2.12-8 ..... Revision 3
11.2.12-9 ..... Revision 3
11.2.12-10 ..... Revision 3
11.2.12-11 ..... Revision 3
11.2.12-12 ..... Revision 3
11.2.12-13 ..... Revision 3
11.2.12-14 ..... Revision 3
11.2.12-15 ..... Revision 3
11.2.12-16 ..... Revision 2
11.2.12-17 ..... Revision 2
11.2.12-18 ..... Revision 2
11.2.12-19 ..... Revision 2
11.2.12-20 ..... Revision 2
11.2.12-21 ..... Revision 2
11.2.12-22 ..... Revision 2
11.2.12-23 ..... Revision 2
11.2.12-24 ..... Revision 2
11.2.12-25 ..... Revision 2
11.2.12-26 ..... Revision 3
11.2.12-27 ..... Revision 2
11.2.12-28 ..... Revision 2
11.2.12-29 ..... Revision 2
11.2.12-30 ..... Revision 3
11.2.12-31 ..... Revision 3
11.2.12-32 ..... Revision 3
11.2.12-33 ..... Revision 3
11.2.12-34 ..... Revision 3
11.2.12-35 ..... Revision 3
11.2.12-36 ..... Revision 3
11.2.12-37 ..... Revision 3
11.2.12-38 ..... Revision 3

List of Effective Pages (continued)

11.2.12-39 ..... Revision 3
11.2.12-40 ..... Revision 3
11.2.12-41 ..... Revision 3
11.2.12-42 ..... Revision 3
11.2.12-43 ..... Revision 3
11.2.12-44 ..... Revision 3
11.2.12-45 ..... Revision 3
11.2.12-46 ..... Revision 3
11.2.12-47 ..... Revision 3
11.2.12-48 ..... Revision 3
11.2.12-49 ..... Revision 3
11.2.12-50 ..... Revision 3
11.2.12-51 ..... Revision 3
11.2.12-52 ..... Revision 3
11.2.12-53 ..... Revision 3
11.2.12-54 ..... Revision 3
11.2.12-55 ..... Revision 3
11.2.12-56 ..... Revision 3
11.2.12-57 ..... Revision 3
11.2.12-58 ..... Revision 3
11.2.12-59 ..... Revision 4
11.2.12-60 ..... Revision 4
11.2.12-61 ..... Revision 3
11.2.12-62 ..... Revision 3
11.2.12-63 ..... Revision 3
11.2.12-64 ..... Revision 3
11.2.12-65 ..... Revision 3
11.2.12-66 ..... Revision 3
11.2.12-67 ..... Revision 3
11.2.12-68 ..... Revision 3
11.2.12-69 ..... Revision 4
11.2.12-70 ..... Revision 4
11.2.12-71 ..... Revision 4
11.2.12-72 ..... Revision 4
11.2.12-73 ..... Revision 3
11.2.12-74 ..... Revision 3
11.2.12-75 ..... Revision 3
11.2.12-76 ..... Revision 3
11.2.12-77 ..... Revision 3
11.2.12-78 ..... Revision 3
11.2.12-79 ..... Revision 3
11.2.12-80 ..... Revision 3
11.2.12-81 ..... Revision 3
11.2.12-82 ..... Revision 3
11.2.12-83 ..... Revision 3
11.2.12-84 ..... Revision 3
11.2.12-85 ..... Revision 3
11.2.12-86 ..... Revision 3
11.2.12-87 ..... Revision 3
11.2.12-88 ..... Revision 3
11.2.13-1 ..... Revision 2
11.2.13-2 ..... Revision 2
11.2.13-3 ..... Revision 2
11.2.13-4 ..... Revision 2
11.2.13-5 ..... Revision 2
11.2.13-6 ..... Revision 2
11.2.13-7 ..... Revision 2
11.2.13-8 ..... Revision 2
11.2.13-9 ..... Revision 2
11.2.13-10 ..... Revision 2
11.2.13-11 ..... Revision 2
11.2.13-12 ..... Revision 2
11.2.13-13 ..... Revision 2
11.2.13-14 ..... Revision 2
11.2.13-15 ..... Revision 2
11.2.13-16 ..... Revision 2
11.2.13-17 ..... Revision 2
11.2.13-18 ..... Revision 2
11.2.13-19 ..... Revision 2
11.2.13-20 ..... Revision 2

List of Effective Pages (continued)

11.2.13-21 ..... Revision 2
11.2.13-22 ..... Revision 2
11.2.13-23 ..... Revision 2
11.2.13-24 ..... Revision 3
11.2.13-25 ..... Revision 2
11.3-1 ..... Revision 2
11.3-2 ..... Revision 2
11.3-3 ..... Revision 0
11.3-4 ..... Revision 2
11.3-5 ..... Revision 2
11.3-6 ..... Revision 0
11.3-7 ..... Revision 0
11.3-8 ..... Revision 0
11.3-9 ..... Revision 2
11.3-10 ..... Revision 0
11.3-11 ..... Revision 0
11.3-12 ..... Revision 0
11.3-13 ..... Revision 0
11.3-14 ..... Revision 0
11.3-15 ..... Revision 0
11.3-16 ..... Revision 2
11.3-17 ..... Revision 2
11.3-18 ..... Revision 0
11.3-19 ..... Revision 0
11.3-20 ..... Revision 0
11.3-21 ..... Revision 2
11.3-22 ..... Revision 2
11.3-23 ..... Revision 0
11.3-24 ..... Amendment 1
11.3-25 ..... Amendment 1
11.3-26 ..... Amendment 1
11.3-27 ..... Amendment 1
11.3-28 ..... Amendment 1
11.3-29 ..... Amendment 1
11.3-30 ..... Amendment 1
11.3-31 ..... Amendment 1
11.3-32 ..... Amendment 1
11.3-33 ..... Amendment 1
11.3-34 ..... Amendment 1
11.3-35 ..... Revision 3
11.3-36 ..... Amendment 1
11.3-37 ..... Amendment 1
11.3-38 ..... Amendment 1
11.3-39 ..... Amendment 1
11.3-40 ..... Amendment 1
11.3-41 ..... Amendment 1
11.3-42 ..... Revision 3
11.3-43 ..... Revision 3
11.3-44 ..... Revision 3
11.3-45 ..... Revision 3
11.3-46 ..... Revision 3
11.4-1 ..... Revision 2
11.4.1-1 ..... Revision 2
11.4.1-2 ..... Revision 2
11.4.1-3 ..... Revision 2
11.4.1-4 ..... Revision 2
11.4.1-5 ..... Revision 2
11.4.1-6 ..... Revision 2
11.4.1-7 ..... Revision 2
11.4.1-8 ..... Revision 2
11.4.1-9 ..... Revision 2
11.4.1-10 ..... Revision 2
11.4.1-11 ..... Revision 2
11.4.1-12 ..... Revision 2
11.4.1-13 ..... Revision 2
11.4.1-14 ..... Revision 2
11.4.1-15 ..... Revision 2
11.4.1-16 ..... Revision 2
11.4.1-17 ..... Revision 2
11.4.1-18 ..... Revision 2

List of Effective Pages (continued)

11.4.1-19 ..... Revision 2
11.4.1-20 ..... Revision 2
11.4.2-1 ..... Revision 2
11.4.2-2 ..... Revision 2
11.4.2-3 ..... Revision 2
11.4.2-4 ..... Revision 3
11.4.2-5 ..... Revision 3
11.4.2-6 ..... Revision 3
11.4.2-7 ..... Revision 2
11.4.2-8 ..... Revision 2
11.4.2-9 ..... Revision 2
11.4.2-10 ..... Revision 2
11.4.3-1 ..... Revision 3
11.4.3-2 ..... Revision 2
11.4.3-3 ..... Revision 2
11.4.3-4 ..... Revision 2
11.4.4-1 ..... Revision 2
11.4.4-2 ..... Revision 2
11.4.4-3 ..... Revision 2
11.4.5-1 ..... Revision 2
11.4.5-2 ..... Revision 2
11.4.5-3 ..... Revision 2
11.4.5-4 ..... Revision 2
11.4.5-5 ..... Revision 2
11.4.5-6 ..... Revision 2
11.4.5-7 ..... Revision 2
11.4.5-8 ..... Revision 2
11.4.5-9 ..... Revision 2
11.4.5-10 ..... Revision 2
11.4.5-11 ..... Revision 2
11.4.5-12 ..... Revision 2
11.5-1 ..... Revision 2
11.5-2 ..... Revision 4
11.5-3 ..... Revision 4
11.6-1 ..... Revision 0
11.6-2 ..... Revision 2
11.6-3 ..... Amendment 1
11.6-4 ..... Revision 2

Chapter 12

12-i ..... Revision 2
12-ii ..... Revision 2
12-1 ..... Revision 2
12-2 ..... Revision 2
12A-1 ..... Revision 2
12A-2 ..... Revision 2
12B-1 ..... Revision 2
12B-2 ..... Revision 2
12C-1 ..... Revision 2
12C-2 ..... Revision 5
12C1-1 ..... Revision 2
12C2-1 ..... Revision 2
12C2-2 ..... Revision 2
12C3-1 ..... Revision 2
12C3-2 ..... Revision 2
12C3-3 ..... Revision 2
12C3-4 ..... Revision 2
12C3-5 ..... Revision 2
12C3-6 ..... Revision 2
12C3-7 ..... Revision 2
12C3-8 ..... Revision 2
12C3-9 ..... Revision 5
12C3-10 ..... Revision 5
12C3-11 ..... Revision 6
12C3-12 ..... Revision 5
12C3-13 ..... Revision 5
12C3-14 ..... Revision 5
12C3-15 ..... Revision 5
12C3-16 ..... Revision 5
12C3-17 ..... Revision 5

List of Effective Pages (continued)

12C3-18 ..... Revision 5
12C3-19 ..... Revision 5
12C3-20 ..... Revision 5
12C3-21 ..... Revision 5
12C3-22 ..... Revision 5
12C3-23 ..... Revision 5
12C3-24 ..... Revision 5
12C3-25 ..... Revision 5
12C3-26 ..... Revision 5
12C3-27 ..... Revision 5
12C3-28 ..... Revision 5
12C3-29 ..... Revision 5
12C3-30 ..... Revision MPC-06A
12C3-31 ..... Revision MPC-06A
12C3-32 ..... Revision MPC-06A
12C3-33 ..... Revision 5
12C3-34 ..... Revision 5
12C3-35 ..... Revision 5
12C3-36 ..... Revision 5
12C3-37 ..... Revision 5
12C3-38 ..... Revision 5
12C3-39 ..... Revision 5
12C3-40 ..... Revision 5
12C3-41 ..... Revision 5
12C3-42 ..... Revision 5
12C3-43 ..... Revision 5

Chapter 13

13-i ..... Revision 0
13.1-1 ..... Revision 2
13.1-2 ..... Revision 0
13.2-1 ..... Revision 0
13.2-2 ..... Revision 0
13.2-3 ..... Revision 0
13.2-4 ..... Revision 0
13.2-5 ..... Revision 0
13.2-6 ..... Revision 0
13.2-7 ..... Revision 0
13.2-8 ..... Revision 0
13.2-9 ..... Revision 5

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Chapter 1

1.2.1.4.4 Draining and Drying System

The draining and drying system consists of a suction pump and a vacuum pump. The suction pump is used to remove free water from the canister cavity. The vacuum pump is a two-stage unit for drying the interior of the canister. The first stage is a large capacity or "roughing" pump intended to remove free water not removed by the suction pump. The second stage is a vacuum pump used to evacuate the canister interior of the small amounts of remaining moisture and establish the vacuum condition.

1.2.1.4.5 Helium Leak Test Equipment

A helium leak detector and leak test fixture are required to verify the integrity of the welds of the canister shield lid. The helium leak detector is the mass spectrometer type.

1.2.1.4.6 Heavy-Haul Trailer

The heavy haul trailer is used to move the vertical concrete storage cask. A special trailer has been designed for transport of the empty or loaded storage cask. However, any commercial double-drop-frame trailer having a deck height approximately matching that of the storage pad could be used.

1.2.1.4.7 Lifting Jacks

Hydraulic jacks are installed at jacking pads in the bottom air ducts to lift the storage cask so that the air pad set can be installed or removed. Four hydraulic pad jacks are provided, along with a control panel, an electric hydraulic oil pump, an oil reservoir tank and all hydraulic lines and fittings. The jacks are used to lift the cask approximately three inches. This permits installation of four air pads under the concrete cask.

1.2.1.4.8 Rigging and Slings

Load rated rigging attachments and slings are provided for major components. The rigging attachments are swivel hoist rings that allow attachment of the slings to the hook. All slings are commercially purchased to have adequate safety margin to meet the requirements of ANSI N14.6 and NUREG-0612. The slings include a concrete cask lid sling, concrete cask shield plug sling, canister shield lid sling, loaded canister transfer sling (also used to handle the structural lid), and canister retaining ring sling. The appropriate rings or eye bolts are provided to accommodate each sling and component.

The transfer cask lifting yoke is specially designed and fabricated for lifting the transfer cask. It is designed to meet the requirements of ANSI N14.6 and NUREG-0612. It is single-failure-proof by design. The transfer cask lifting yoke is initially load tested to 300 percent of the design load.

1.2.1.4.9 Temperature Instrumentation

The concrete casks may be equipped with temperature-monitoring equipment to measure the outlet air temperature. The Technical Specification requires either daily temperature measurements or daily visual inspection for inlet and outlet screen blockage to ensure the cask heat removal system remains operable.

1.2.1.5 Transport Cask

The transportable storage canister is designed to be transported in the NAC-STC. The canister is positioned in the NAC-STC cavity with two axial spacers. The spacers are required because the transport cask cavity length is 165 inches, while the length of the Yankee-MPC canister is 122.5 inches and the length of the CY-MPC canister is 151.75 inches.

The NAC-STC is licensed by the NRC pursuant to 10 CFR 71 (Certificate of Compliance No. 71-9235) for shipment of the MPC canister. The NAC-STC is designed for free interchange/rail shipment and transport by heavy-haul truck or barge. The rail transport configuration is shown in Figure 1.2-3.

1.2.2 Operational Features

This section outlines the principal handling activities of the NAC-MPC storage system. The system provides passive long-term storage of spent fuel in an inert environment.

The principal activities associated with the use of the system are closing the canister and loading the canister in the storage cask. The transfer cask is designed to meet the requirements of these operations. The transfer cask holds the canister during loading with fuel; provides biological shielding during closing of the canister; and provides the means by which the loaded canister is moved to, and installed in, the storage cask. The canister assembly consists of five principal components: the canister shell (side wall and bottom), the shield lid, the vent port, the drain port (together with the vent and drain port covers), and the structural lid. A drain tube extends from the shield lid drain port to the bottom of the canister. The location of the drain and vent ports is shown in Figure 8.1-1.

The vent and drain ports allow the draining, vacuum drying, and backfilling with helium necessary to provide a dry, inert atmosphere for the contents. The vent and drain port covers, the shield lid, the canister shell, and the joining welds form the primary confinement boundary. This boundary is shown in Figure 7.1-1. A secondary confinement boundary is formed over the shield lid by the structural lid and the weld that joins it to the canister shell. This boundary is shown in Figure 7.1-2.

The structural lid contains the drilled and tapped holes for attachment of the swivel hoist rings used to lift the loaded canister. The drilled and tapped holes are filled with bolts or plugs to avoid collecting debris, and to preclude the possibility of radiation streaming from the holes, when the hoist rings are not installed.

The step-by-step procedures for use of the NAC-MPC system are presented in Chapter 8. The following list presents a brief description of the principal activities. This list assumes that the empty canister is installed in the transfer cask for spent fuel pool loading.

- Lift the transfer cask over the pool and start the flow of water to the transfer cask annulus and canister. After the annulus and canister are filled, lower the cask to the bottom of the pool.
- Load the selected spent fuel assemblies into the canister and set the shield lid.

- Raise the transfer cask from the pool. Decontaminate the transfer cask exterior as it clears the pool surface. Drain the annulus. Place the transfer cask in the decontamination area.
- Weld the shield lid to the canister shell. Pressure test the weld. Drain the pool water from the canister. Attach the vacuum system to the drain line, and operate the system to achieve a vacuum.
- Hold the vacuum and backfill with helium to 1 atmosphere. Restart the vacuum system and remove the helium. After achieving vacuum, backfill and pressurize the canister with helium.
- Helium leak check the shield lid weld. Vent the helium pressure to 1 atmosphere (absolute). Install the vent and drain port covers and weld them to the shield lid.
- Install the structural lid and weld it to the canister shell. Install the hoist rings, and attach the canister lifting sling. Install the adapter plate on the storage cask.
- Lift the transfer cask to the top of the storage cask and set it on the adapter plate, ensuring that the bottom door hydraulic actuators are engaged.
- Attach the canister lifting slings to the crane hook and lift the canister.
- Open the bottom doors of the transfer cask.
- Lower the canister into the storage cask. Detach the canister slings from the hook.
- Remove the transfer cask and adapter plate. Remove the canister lifting slings.
- Install the shield plug and lid on the concrete cask.
- Move the loaded storage cask to the storage pad.
- Using the air pad rig set and a towing vehicle, move the storage cask to its designated location on the storage pad.
- During storage operations, the operability of the concrete cask is verified on a daily basis as specified in the Technical Specifications.

The removal operations are essentially the reverse of these steps, except that weld removal and cool down of the contents are required.

The ancillary equipment needed to operate the NAC-MPC system has been described in Section 1.2.1.4. Other items required are miscellaneous hardware, connection hose and fittings, and hand tools typically found at a reactor site.

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

Chapter 2 - Principal Design Criteria			
Area	**Requirement**	**Acceptance Criteria**	**Description of Compliance**
3. Design Criteria for Safety Protection Systems **b. Structural**	SSC that are important to safety must be designed to accommodate the combined loads of normal operations, accidents, and natural phenomena events with an adequate margin of safety. [10 CFR 72.24(c)(3), 72.122(b), and 72.122(c)] The design-basis earthquake must be equivalent to or exceed the safe shutdown earthquake of a nuclear plant at sites evaluated under 10 CFR Part 100. [10 CFR 72.102(f)] The DCSS must maintain confinement of radioactive material within the limits of 10 CFR Part 72 and Part 20, under normal, off-normal, and credible accident conditions. [10 CFR 72.236(l)] The DCSS must be designed and fabricated so that the spent fuel is maintained in a subcritical condition all under all credible normal, off-normal, and accident conditions. [10 CFR 72.124(a) and 72.236(c)] The spent fuel cladding must be protected during storage against degradation that leads to gross ruptures, or the fuel must be otherwise confined such that degradation of the fuel during storage will not pose operational safety problems with respect to its removal from storage. [10 CFR 72.122(h)(1)] Storage systems must be designed to allow ready retrieval of spent fuel waste for further processing or disposal.	The SAR should define how the DCSS structural components are designed to accommodate combined normal, off-normal, and accident loads, while protecting the DCSS contents from significant structural degradation, criticality, and loss of confinement, while preserving retrievability. This discussion is generally a summary of the analytical techniques and calculational results from the detailed analysis discussed in SAR Section 3 and should be presented in a non-proprietary forum.	A discussion of the structural design criteria are presented in Section 2.2. Combined loadings are addressed specifically in Section 2.2.5 and in Tables 2.2-1 and 2.2-2. The design-basis earthquake is specified in Section 2.2.3 in accordance with 10 CFR 72.102 criteria. Because the system maintains adequate margins of safety during normal (Section 3.4.4.1), off-normal (Section 11.1) and accident condition (Section 11.2) events, confinement of the radioactive material is assured. Because the system maintains adequate structural margins of safety during normal, off-normal and accident condition events, criticality control is assured based on the analyses presented in Chapter 6. The maximum allowable cladding temperatures are specified in Tables 2-1, 2-3, and 4.1-3. The temperature results for the fuel cladding listed in Tables 4.1-4 and 4.1-5 show that the allowable cladding temperatures are not exceeded. Therefore, the fuel cladding is protected against degradation during storage. As described in Section 1.2, the system is designed to be readily transported as necessary for further processing or disposal.

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

Chapter 2 - Principal Design Criteria			
Area	**Requirement**	**Acceptance Criteria**	**Description of Compliance**
3. Design Criteria for Safety Protection Systems **c. Thermal**	Each spent fuel storage or handling system must be designed with a heat removal capability having testability and reliability consistent with its importance to safety. [10 CFR 72.128(a)(4)] The DCSS must be designed to provide adequate heat removal capacity without active cooling systems. [10 CFR 72.236(f)]	The applicant should provide a general discussion of the proposed heat removal mechanisms, including the reliability and verifiability of such mechanisms and any associated limitations. All heat removal mechanisms should be passive and independent of intervening actions under normal and off-normal conditions.	The passive design and reliability of the NAC-MPC System heat removal capability is demonstrated by analyses presented in Chapter 4. Routine surveillance of the operability of the concrete cask heat removal system is described in Section 2.3.3.2. As shown in Table 4.1-4 and 4.1-5, the storage system provides adequate heat removal through the passive cooling design features described in Section 1.2.1.2.

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

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

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

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

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

Chapter 4 – Thermal Evaluation		
Area	**Regulatory Requirement**	**Description of Compliance**
1. Minimum Lifetime	10 CFR Part 72 requires an analysis and evaluation of DCSS thermal design and performance to demonstrate that the cask will permit safe storage of the spent fuel for a minimum of 20 years.	Section 1.1 and Tables 2-1 and 2-2 specify a 50-year design life for the system. Tables 4.1-3, 4.1-4 and 4.1-5 demonstrate that the concrete temperatures are maintained within their allowable limits.
2. Spent Fuel Cladding Protection	The spent fuel cladding must be protected against degradation that may lead to gross ruptures.	Tables 4.1-3, 4.1-4 and 4.1-5 demonstrate that the fuel cladding temperatures are maintained within allowable limits.
3. Thermal Structures, Systems, and Components	Thermal structures, systems, and components important to safety must be described in sufficient detail to permit evaluation of their effectiveness. Applicable thermal requirements are identified, in part, in 10 CFR 72.24(c)(3), 72.24(d), 72.122(h)(1), 72.122(l), 72.128(a)(4), 72.236(f), 72.236(g), and 72.236(h). 10 CFR 72.24(c)(3) Contents of Application: Descriptions of Components Important to Safety 10 CFR 72.24(d) Contents of Application: Margins of Safety / Mitigation of Accident Consequences 10 CFR 72.122(h)(1) Overall Requirements: Confinement Barriers and Systems 10 CFR 72.122(l) Overall Requirements: Retrievability 10 CFR 72.128(a)(4) Criteria for Spent Fuel Storage and Handling: Testable Heat Removal Capacity 10 CFR 72.236(f) Specific Requirements for Spent Fuel Storage Cask Approval: Passive Heat Removal 10 CFR 72.236(g) Specific Requirements for Spent Fuel Storage Cask Approval: Minimum 20-year Lifetime 10 CFR 72.236(h) Specific Requirements for Spent Fuel Storage Cask Approval: Wet/Dry Loading and Unloading Compatibility	The discussion of the thermal design features of the system is presented in Section 4.1. Tables 4.1-3, 4.1-4 and 4.1-5 demonstrate that the temperatures are maintained within allowable limits for all components of the system, including the fuel cladding. Therefore, the system is not adversely affected by normal, off-normal, or accident condition events. The temperatures of the system are maintained within allowable limits, and do not preclude retrieval of spent fuel from the system. As specified in the CofC, Section A3.1.6, the air temperatures of the outlet vents and ISFSI ambient are measured to verify operation of the heat removal system of the concrete casks or the air inlet and outlet screens are visually inspected to ensure that they are unobstructed. Section 1.1 and Tables 2-1 and 2-2 specify a 50-year design life for the system. Tables 4.1-3, 4.1-4 and 4.1-5 demonstrate that the concrete temperatures are maintained within their allowable limits. The operating procedures for the system are presented in Chapter 8. The system is compatible with wet or dry spent fuel loading and unloading facilities.

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

Chapter 4 – Thermal Evaluation		
Area	**Acceptance Criteria**	**Description of Compliance**
1. Long-term Cladding Temperatures	Fuel cladding (Zircaloy) temperature at the beginning of dry cask storage should generally be below the anticipated damage-threshold temperatures for normal conditions and a minimum of 20 years of cask storage (Refs. 13 and 14). Ref 13: UCID-21181, "Spent Fuel Cladding Integrity During Dry Storage" Ref 14: PNL-6189, "Recommended Temperature Limits for Dry Storage of Spent Light-Water Zircaloy Clad Fuel Rods in Inert Gas"	As shown in Tables 4.1-4 and 4.1-5, the fuel cladding temperatures are maintained below 644°F and below 712°F for both Zircaloy-clad and stainless steel-clad fuel for the Yankee-MPC and CY-MPC Systems, respectively. This temperature is within the recommended temperature limits for Zircaloy-clad fuel (PNL-6189) and within the limits for stainless steel-clad fuel (EPRI TR-106440) for long-term conditions.
2. Short-Term Cladding Temperatures	Fuel cladding temperature should generally be maintained below 430°C (806°F) for short-term accident conditions, short-term off-normal conditions, and fuel transfer operations (e.g., vacuum drying of the cask or dry transfer). (PNL-4835)	As shown in Tables 4.1-4 and 4.1-5, the fuel cladding temperature for both Zircaloy and stainless steel are maintained below 806°F for the Yankee-MPC System, and for the CY-MPC System, for short-term off-normal or accident condition events.
3. Maximum Internal Pressure	The maximum internal pressure of the cask should remain within its design pressures for normal, off-normal, and accident conditions assuming rupture of 1 percent, 10 percent, and 100 percent of the fuel rods, respectively. Assumptions for pressure calculations include release of 100 percent of the fill gas and 30 percent of the significant radioactive gases in the fuel rods.	The normal condition pressure calculation is presented in Sections 4.4.5 and 4.5.5. The accident condition pressure calculation is presented in Section 11.2.1. The off-normal condition is bounded by the accident condition, which assumes 100% failure of the cladding.
4. Maximum Material Temperatures	Cask and fuel materials should be maintained within their minimum and maximum temperature criteria for normal, off-normal, and accident conditions in order to enable components to perform their intended safety functions.	Tables 4.1-3, 4.1-4 and 4.1-5 demonstrate that the temperatures are maintained within allowable limits for all components of the system, including the fuel cladding. Therefore, the system is not adversely affected by normal, off-normal, or accident condition events.
5. Fuel Cladding Protection	For each fuel type proposed for storage, the DCSS should ensure a very low probability (e.g., 0.5 percent per fuel rod) of cladding breach during long-term storage.	As concluded in PNL-6189 (Zircaloy) and EPRI TR-106449 (stainless steel), the probability of cladding breech is very low when the cladding temperature is maintained below allowable limits.

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

Chapter 7 – Confinement Evaluation		
Area	**Regulatory Requirement**	**Description of Compliance**
1. Description of Structures, Systems, and Components Important to Safety	The SAR must describe the confinement structures, systems, and components (SSCs) important to safety in sufficient detail to facilitate evaluation of their effectiveness. [10 CFR 72.24(c)(3) and 10 CFR 72.24(l)]	A general description of the system is provided in Section 1.2, with a detailed description of the confinement features of the system provided in Section 7.1.
2. Protection of Spent Fuel Cladding	The design must adequately protect the spent fuel cladding against degradation that might otherwise lead to gross ruptures during storage, or the fuel must be confined through other means such that fuel degradation during storage will not pose operational safety problems with respect to removal of the fuel from storage. [10 CFR 72.122(h)(1)]	As described in Sections 7.2.1 and 7.3, the integrity of the canister is maintained under normal and accident conditions. Therefore, the inert helium atmosphere is maintained in the canister, protecting the fuel cladding against degradation.
3. Redundant Sealing	The cask design must provide redundant sealing of the confinement boundary. [10 CFR 72.236(e)]	As described in Section 7.1.3.2, the canister is sealed after loading by means of a redundant lid system.
4. Monitoring of Confinement System	Storage confinement systems must allow continuous monitoring, such that the licensee will be able to determine when to take corrective action to maintain safe storage conditions. [10 CFR 72.122(h)(4) and 10 CFR 72.128(a)(1)]	The canister is a fully welded Class I component designed and fabricated in accordance with the ASME Code, Section III, Subsection NB. It is closed by a fully welded, redundant closure system. Therefore, in accordance with regulatory guidance, monitoring of the confinement is not required.
5. Instrumentation	The design must provide instrumentation and controls to monitor systems that are important to safety over anticipated ranges for normal and off-normal operation. In addition, the applicant must identify those control systems that must remain operational under accident conditions. [10 CFR 72.122(i)]	As monitoring is not required, no instrumentation and controls are needed.
6. Release of Nuclides to the Environment	The applicant must estimate the quantity of radionuclides expected to be released annually to the environment. [10 CFR 72.24(l)(1)]	As described in Sections 7.2.1 and 7.3, the leaktight integrity of the confinement boundary is maintained during all postulated normal and accident condition events. Therefore, there is no release of radionuclides to the environment.

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

Chapter 7 – Confinement Evaluation		
Area	**Regulatory Requirement**	**Description of Compliance**
7. Evaluation of Confinement System	The applicant must evaluate the cask and its systems important to safety, using appropriate tests or other means acceptable to the Commission, to demonstrate that they will reasonably maintain confinement of radioactive material under normal, off-normal, and credible accident conditions. [10 CFR 72.236(l) and 10 CFR 72.24(d)] In addition, SSCs important to safety must be designed to withstand the effects of credible accidents and severe natural phenomena without impairing their capability to perform safety functions. [10 CFR 72.122(b)]	The confinement system is analyzed for normal conditions in Sections 3.4.3 and 3.4.4, and for off-normal, and accident conditions in Sections 11.1 and 11.2, respectively.
8. Annual Dose Limit in Effluents and Direct Radiation from an Independent Spent Fuel Storage Installation (ISFSI)	During normal operations and anticipated occurrences, the annual dose equivalent to any real individual who is located beyond the controlled area must not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ. [10 CFR 72.104(a)]	The site boundary dose calculations and minimum site boundary distances are presented in Section 10.4.

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

Chapter 7 – Confinement Evaluation		
Area	**Acceptance Criteria**	**Description of Compliance**
5. Nonreactive Environment	The cask must provide a non-reactive environment to protect fuel assemblies against fuel cladding degradation, which might otherwise lead to gross rupture. Measures for providing a nonreactive environment within the confinement cask typically include draining, vacuum drying and backfilling with a nonreactive cover gas (such as helium). For dry storage conditions, experimental data have not demonstrated an acceptably low oxidation rate for UO_2 spent fuel, over the 20-year licensing period, to permit safe storage in an air atmosphere. Therefore, to reduce the potential for fuel oxidation and subsequent cladding failure, an inert atmosphere (e.g., helium cover gas) has been used for storing UO_2 spent fuel in a dry environment (See Chapter 8 of this SRP for more detailed information on the cover gas filling process.). Note that other fuel types, such as graphite fuels for the high-temperature gas-cooled reactors (HTGRs), may not exhibit the same oxidation reactions as UO_2 fuels and, therefore, may not require an inert atmosphere. Applicants proposing to use atmospheres other than inert gas should discuss how the fuel and cladding will be protected from oxidation.	As described in Sections 7.1.1.1 and 7.1.2, the confinement system is vacuum dried and backfilled with inert helium gas during loading operations.

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

Chapter 8 – Operating Procedures		
Area	**Regulatory Requirement**	**Description of Compliance**
1. Health and Safety	The applicant must develop operating procedures that adequately protect health and minimize danger to life or property. [10 CFR 72.40(a)(5)]	Operating procedures are provided in Chapter 8. Notes and Cautions are listed among the steps provided to emphasize steps important to maintaining health and safety.
2. ALARA	The applicant must establish operational restrictions to meet the regulatory requirements of 10 CFR Part 20 and objective limits that are as low as is reasonably achievable (ALARA) for radioactive materials in effluents and direct radiation levels associated with ISFSI operations. [10 CFR 72.104(b) and 10 CFR 72.24(e)]	Section 8.0 specifies that the procedures are developed to maintain occupational dose ALARA. Automated welding systems and temporary shielding are utilized to minimize worker dose during canister loading operations. Section A3.2.2 of the CofC specifies average external dose rates to maintain reasonable dose level within a cask array for routine surveillance and inspection activities.
3. Control of Radioactive Effluents	The applicant must describe all equipment and processes used to maintain control of radioactive effluents. [10 CFR 72.24(l)(2)]	As described in Sections 7.1.1.4, 7.2.1, and 7.3, there are no radioactive effluents in routine operations other than pool water and helium gas that are removed from the canister. These effluents are routinely handled in Licensee operations.
4. Written Procedures	The general licensee shall conduct activities related to storage of spent fuel in accordance with written procedures. [10 CFR 72.212(b)(9)] Vendors seeking approval of a cask design shall ensure that written procedures and appropriate tests are established before initial use of the casks. In addition, the vendor must provide a copy of these procedures and tests to each prospective cask user. [10 CFR 72.234(f)]	Written procedures for the system are provided in Chapter 8. These procedures are intended to provide general operational guidance for use of the system. These procedures would be used by an ISFSI operator to develop detailed, site specific procedures for use of the system.
5. Wet or Dry Loading and Unloading Facilities	The cask must be compatible with wet or dry spent fuel loading and unloading facilities. [10 CFR 72.236(h)]	The operating procedures are provided in Chapter 8. The system is compatible with wet or dry spent fuel loading and unloading facilities.

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

Chapter 11 – Accident Analysis		
Area	**Regulatory Requirement**	**Description of Compliance**
7. Monitoring Systems	Instrumentation and control systems must be provided to monitor systems that are important to safety over anticipated ranges for normal operation and off-normal operation. Those instruments and control systems that must remain operational under accident conditions must be identified in the Safety Analysis Report. [10 CFR 72.122(i)]	Daily surveillance of the concrete cask is performed to verify continued thermal operability of the system. The confinement system is fully welded and is leak tested to leaktight criteria as specified in Appendix A of the CofC, LCO 3.1.5. No seal monitoring is required.
8. Surveillance	Where instrumentation and control systems are not appropriate, storage confinement systems must have the capability for continuous monitoring in a manner such that the licensee will be able to determine when corrective action needs to be taken to maintain safe storage conditions. [72.122(h)(4)]	No active, continuous monitoring systems are required. Licensee radiological monitoring programs assure ISFSI operations meet 10 CFR 72.104 and 72.106 requirements.

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

Chapter 11 – Accident Analysis		
Area	**Acceptance Criteria**	**Description of Compliance**
1. Dose Limits for Off-Normal Events	During normal operations and anticipated occurrences, the requirements specified in 10 CFR Part 20 must be met. In addition the annual dose equivalent to any individual located beyond the controlled area must not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ as a result of exposure to the following sources: a. planned discharges to the general environment of radioactive materials (with the exception of radon and its decay products) b. direct radiation from operations of the independent spent fuel storage installation (ISFSI) c. any other cumulative radiation from uranium fuel cycle operations (i.e., nuclear power plant) in the affected area	The controlled area boundary dose calculations and minimum controlled area boundary distances under normal conditions are presented in Section 10.4. No off-normal events are postulated that would result in a controlled area boundary dose in excess of the normal condition analysis.
2. Dose Limit for Design-Basis Accidents	Any individual located at or beyond the nearest controlled area boundary must not receive a dose greater than 5 rem to the whole body or any organ from any design-basis accident.	Section 10.2.2 indicates that the controlled area boundary dose as a result of an accident will not exceed 5 rem to any organ, including skin.
3. Criticality	The spent fuel must be maintained in a subcritical condition under credible conditions (i.e., k_{eff} equal to or less than 0.95). At least two unlikely, independent, and concurrent or sequential changes must be postulated to occur in the conditions essential to nuclear criticality safety before a nuclear criticality accident is possible (double contingency).	Section 6.4 presents the results of the criticality evaluation of the storage cask for the most reactive credible conditions, including the consequences of the off-normal and accident condition events evaluated in Sections 11.1 and 11.2, respectively. As stated in Section 6.1, the criticality analyses are performed for the most reactive credible configuration of the cask, at the highest enrichment, without credit for fuel burnup, and at the most reactive internal water moderator density, even though it is stated that water intrusion is not a credible event. Therefore, criticality cannot occur unless two separate events, such as (1) misloading a higher than design-basis enrichment, unirradiated fuel assembly and (2) water intrusion, occur.

Chapter 2

is designed to withstand a postulated drop accident in a transportation cask without precluding the subsequent removal of the fuel (i.e., the fuel tubes do not deform such that they bind the fuel).

Personnel radiation exposure during handling and closure of the canister is minimized by the following steps:

1. Placing the shield lid on the canister while the transfer cask and canister are under water in the fuel pool.
2. Decontaminating the exterior of the transfer cask prior to draining the canister to preserve the shielding benefit of the water.
3. Using temporary shielding.
4. Using a retaining ring on the transfer cask to ensure that the canister is not raised out of the shield provided by the transfer cask.
5. Placing a shielding ring over the annular gap between the transfer cask and the canister.

2.3.3 Protection by Equipment and Instrumentation Selection

The NAC-MPC is a passive storage system that does not rely on equipment or instruments to preserve public health or safety and to meet its safety functions in long-term storage. The system employs support equipment and instrumentation to facilitate operations. These items and the actions taken to assure performance are described below.

2.3.3.1 Equipment

The only important-to-safety equipment employed in the use and operation of the NAC-MPC is the lifting yoke used to lift the transfer cask. The transfer cask lifting yoke is designed to meet the requirements of ANSI N14.6 and NUREG-0612. It is single failure-proof by design. The lifting yoke is proof load tested to 300 percent of design load when fabricated. The lifting yoke is inspected for visible defects prior to each use and is inspected annually.

Additional handling equipment (such as trailers, skids, air pads, portable cranes, or cask transporters) are not important to safety as the NAC-MPC system is designed to withstand the failure of any of these components.

2.3.3.2 Instrumentation

No instrumentation is required for the safe storage operations of the NAC-MPC. A remote temperature-monitoring system may be used to measure the outlet air temperature of the concrete casks in long-term storage. The outlet and ISFSI ambient air temperatures can be monitored daily as a check of the continuing thermal performance of the concrete cask. Alternately, a daily visual inspection for blockage and integrity of the air inlet and air outlet screens of all concrete casks may be performed. Following any natural phenomena event, such as an earthquake or tornado, the concrete casks shall be inspected for damage and air inlet and air outlet blockage.

2.3.4 Nuclear Criticality Safety

The primary nuclear criticality safety design criterion of the NAC-MPC is to provide features that ensure that the cask remains subcritical under normal, off-normal, and accident conditions. Neutron poison sheets (BORAL) are employed in the basket design to capture thermalized neutrons, and preclude uncontrolled fission events. BORAL sheets are attached to each side of each fuel tube, except the four enlarged fuel tubes that may be installed in the corner locations of the basket, as shown in Figure 2.1-1. The BORAL sheets are mechanically supported by the fuel tube structure to ensure that the poison sheets remain in place during the design basis normal, off-normal, and accident events. BORAL is not attached on the sides of the damaged fuel can. The absence of BORAL on the enlarged fuel tubes and the damaged fuel cans in these locations increases the system reactivity slightly, but the system reactivity remains below the criticality upper safety limit.

The efficiency of the BORAL sheets in preserving nuclear criticality safety is demonstrated by the Criticality Evaluation presented in Chapter 6.

Chapter 3

3.4 General Standards for Casks

The NAC-MPC is provided in two configurations. Both configurations, the Yankee-MPC and CY-MPC, are constructed from the same materials, are used in the same environments and are exposed to the same operating conditions. The evaluations provided in Sections 3.4.1 and 3.4.2 apply to both configurations. Separate evaluations of each configuration are provided in Sections 3.4.3 and 3.4.4, since the configurations have different weight and length dimensions, and different design basis pressures, due to the physical parameters of the contents.

3.4.1 Chemical and Galvanic Reactions

The materials used in the fabrication and operation of the NAC-MPC system have been evaluated to determine whether chemical, galvanic, or other reactions among the materials, contents, and environments can occur. All phases of operation—loading, unloading, handling, and storage—have been considered for the environments that may be encountered under normal, off-normal, or accident conditions. Based on the evaluation, there is one potential reaction that could adversely affect the overall integrity of the storage cask, the fuel basket, the transportable storage canister, or the structural integrity and retrievability of the fuel from the canister. That potential reaction, between aluminum and spent fuel pool water, which may produce hydrogen is mitigated by the specific canister loading procedures presented in Section 8.1.1.

3.4.1.1 Component Operating Environment

Most of the component materials of the NAC-MPC are exposed to two typical operating environments: 1) an open canister containing pool water or borated water with a pH of 4.5 and spent fuel or other radioactive material; or 2) a sealed canister containing helium, but with the canister in environs that include air, rain water/snow/ice, and marine (salty) water/air. The spent fuel assemblies consist of Zircaloy or stainless steel clad fuel and other fuel assembly components of stainless steel.

Each category of canister component materials is evaluated for potential reactions in each of the operating environments to which those materials are exposed. These environments may occur during fuel loading or unloading, handling or storage, and include normal, off-normal, and accident conditions.

One of the operating environments to which the canister internal component materials are exposed does not provide the conditions necessary for a reaction (corrosion); i.e., both moisture

and oxygen must be present for corrosion to occur. This long-term environment is the sealed canister, backfilled with helium. The free volume in the canister is drained, vacuum dried and backfilled with helium, effectively precluding corrosion. Galvanic corrosion (i.e., between dissimilar metals that are in contact) could occur, but only if there is water present at the point of contact and the metals are in electrical contact with each other (i.e., mechanically held together). NAC's operating procedures provide two helium backfill cycles in series separated by a vacuum-drying cycle for the canister during the preparation of the canister for storage. Therefore, the canister cavity is effectively dry and galvanic corrosion is precluded.

3.4.1.2 Component Material Categories

The component materials evaluated are categorized based on similarity of physical and chemical properties and/or on similarity of component functions. The categories of materials that are considered are stainless/nickel alloy steels, nonferrous metals, and criticality control materials. These categories are evaluated based on the environment to which they could be exposed during operation or use of the canister.

The canister component materials are not reactive among themselves, with the canister's contents, nor with the canister's operating environments, except aluminum, during any phase of normal, off-normal, or accident condition loading, unloading, handling, or storage operations. Therefore, only the potential aluminum reaction with spent fuel pool water is evaluated.

3.4.1.2.1 Stainless Steels

No reaction of the canister component stainless steel is expected in any environment, except for the marine environment, where chloride-containing salt spray might initiate pitting of the steels if the chlorides are allowed to concentrate and stay wet for extended periods of time (weeks). Only the external canister surface could be so exposed. The corrosion rate will, however, be so low that no detectable corrosion products or gases will be generated. The NAC-MPC has smooth external surfaces to minimize the collection of such materials as salts.

There is a significant electrochemical potential difference between austenitic (300 series) stainless steel and aluminum. If aluminum is in electrical contact with the austenitic stainless steel, the aluminum could be expected to exhibit corrosion driven by electrochemical EMF when immersed in water. Pressurized water reactor (PWR) pool water does provide a conductive potential. The only aluminum components that will be in contact with stainless steel and exposed to the pool water are the heat transfer disks in the fuel basket. Since the fuel basket is not welded or bolted to the canisters, poor, if any, electrical contact with the stainless steels is

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NAC-MPC

NAC Multi-Purpose Cask

FINAL SAFETY ANALYSIS REPORT

Volume 2 of 2

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List of Effective Pages

List of Effective Pages

Chapter 1

1-i ..... Revision 5
1-ii ..... Revision 5
1-iii ..... Revision 3
1-1 ..... Revision 3
1-2 ..... Revision 3
1-3 ..... Revision 5
1-4 ..... Revision 5
1-5 ..... Revision 5
1-6 ..... Revision 5
1-7 ..... Revision 5
1.1-1 ..... Revision 2
1.1-2 ..... Revision 2
1.1-3 ..... Revision 2
1.1-4 ..... Revision 2
1.1-5 ..... Revision 2
1.1-6 ..... Revision 0
1.1-7 ..... Revision 2
1.2-1 ..... Revision 2
1.2-2 ..... Revision 3
1.2-3 ..... Revision 3
1.2-4 ..... Revision 3
1.2-5 ..... Revision 3
1.2-6 ..... Revision 3
1.2-7 ..... Revision 3
1.2-8 ..... Revision 3
1.2-9 ..... Revision 3
1.2-10 ..... Revision MPC-06A
1.2-11 ..... Revision MPC-06A
1.2-12 ..... Revision MPC-06A
1.2-13 ..... Revision 3
1.2-14 ..... Revision 3
1.2-15 ..... Revision 3
1.2-16 ..... Revision 3
1.2-17 ..... Revision 3
1.2-18 ..... Revision 3
1.2-19 ..... Revision 3
1.2-20 ..... Revision 3
1.2-21 ..... Revision 3
1.2-22 ..... Revision 3
1.2-23 ..... Revision 3
1.3-1 ..... Revision 3
1.3-2 ..... Revision 6
1.3-3 ..... Revision 3
1.3-4 ..... Revision 5
1.3-5 ..... Revision 5
1.3-6 ..... Revision 5
1.3-7 ..... Revision 3
1.3-8 ..... Revision 3
1.3-9 ..... Revision 3
1.3-10 ..... Revision 3
1.3-11 ..... Revision 5
1.3-12 ..... Revision 3
1.3-13 ..... Revision 3
1.3-14 ..... Revision 3
1.4-1 ..... Revision 2
1.4-2 ..... Revision 2
1.4-3 ..... Revision 2
1.5-1 ..... Revision 2
1.5-2 ..... Revision 2
1.5-3 ..... Revision 2
1.5-4 ..... Revision 2
1.5-5 ..... Revision 2
1.5-6 ..... Revision 2
1.5-7 ..... Revision 2
1.5-8 ..... Revision 2
1.5-9 ..... Revision 2
1.5-10 ..... Revision MPC-06A
1.5-11 ..... Revision MPC-06A
1.5-12 ..... Revision 2

List of Effective Pages (continued)

1.5-13 ..... Revision 2
1.5-14 ..... Revision 2
1.5-15 ..... Revision 2
1.5-16 ..... Revision 2
1.5-17 ..... Revision 2
1.5-18 ..... Revision 2
1.5-19 ..... Revision 2
1.5-20 ..... Revision 2
1.5-21 ..... Revision 2
1.5-22 ..... Revision 2
1.5-23 ..... Revision MPC-06A
1.5-24 ..... Revision 2
1.5-25 ..... Revision 2
1.5-26 ..... Revision 2
1.5-27 ..... Revision 2
1.5-28 ..... Revision 2
1.5-29 ..... Revision 2
1.5-30 ..... Revision 2
1.5-31 ..... Revision MPC-06A
1.5-32 ..... Revision 2
1.5-33 ..... Revision 2
1.5-34 ..... Revision 2
1.5-35 ..... Revision MPC-06A
1.5-36 ..... Revision 2
1.5-37 ..... Revision 2
1.5-38 ..... Revision 2
1.5-39 ..... Revision 2
1.5-40 ..... Revision 2
1.5-41 ..... Revision 2
1.5-42 ..... Revision 2
1.5-43 ..... Revision 2
1.5-44 ..... Revision 2
1.5-45 ..... Revision 2
1.5-46 ..... Revision 2
1.5-47 ..... Revision 2
1.5-48 ..... Revision 2
1.5-49 ..... Revision MPC-06A
1.5-50 ..... Revision 2
1.5-51 ..... Revision 2
1.5-52 ..... Revision 2
1.5-53 ..... Revision 2
1.5-54 ..... Revision 2
1.5-55 ..... Revision 2
1.5-56 ..... Revision 2
1.5-57 ..... Revision 2
1.5-58 ..... Revision 2
1.5-59 ..... Revision 2
1.6-1 ..... Revision 3
1.6-2 ..... Revision 2
1.7-1 ..... Revision 3
1.7-2 ..... Revision 3
1.7-3 ..... Revision 6

61 drawings (see Chapter 1)

Chapter 2

2-i ..... Revision 5
2-ii ..... Revision 3
2-iii ..... Revision 3
2-1 ..... Revision 2
2-2 ..... Revision 2
2-3 ..... Revision 3
2-4 ..... Revision 2
2-5 ..... Revision 2
2.1-1 ..... Revision 3
2.1-2 ..... Revision 3
2.1-3 ..... Revision 3
2.1-4 ..... Revision 2
2.1-5 ..... Revision 2
2.1-6 ..... Revision 2

List of Effective Pages (continued)

2.1-7 ..... Revision 2
2.1-8 ..... Revision 2
2.1-9 ..... Revision 5
2.1-10 ..... Revision 5
2.1-11 ..... Revision 5
2.1-12 ..... Revision 3
2.1-13 ..... Revision 3
2.1-14 ..... Revision 3
2.1-15 ..... Revision 3
2.1-16 ..... Revision 3
2.1-17 ..... Revision 3
2.1-18 ..... Revision 3
2.1-19 ..... Revision 3
2.1-20 ..... Revision 3
2.2-1 ..... Revision 2
2.2-2 ..... Revision 2
2.2-3 ..... Revision 0
2.2-4 ..... Revision 0
2.2-5 ..... Revision 2
2.2-6 ..... Revision 2
2.2-7 ..... Revision 2
2.2-8 ..... Revision 0
2.2-9 ..... Revision 2
2.2-10 ..... Revision 2
2.2-11 ..... Revision 2
2.3-1 ..... Revision 3
2.3-2 ..... Revision 0
2.3-3 ..... Revision 0
2.3-4 ..... Revision MPC-06A
2.3-5 ..... Revision 0
2.3-6 ..... Revision 3
2.3-7 ..... Revision 2
2.3-8 ..... Revision 0
2.3-9 ..... Revision 3
2.3-10 ..... Revision 3
2.3-11 ..... Revision 3
2.3-12 ..... Revision 3
2.3-13 ..... Revision 3
2.3-14 ..... Revision 3
2.3-15 ..... Revision 3
2.3-16 ..... Revision 3
2.3-17 ..... Revision 3
2.3-18 ..... Revision 3
2.3-19 ..... Revision 3
2.4-1 ..... Revision 2
2.4-2 ..... Revision 2
2.4-3 ..... Revision 0
2.4-4 ..... Revision 2

Chapter 3

3-i ..... Revision 5
3-ii ..... Revision 5
3-iii ..... Revision 3
3-iv ..... Revision 5
3-v ..... Revision 3
3-vi ..... Revision 3
3-vii ..... Revision 3
3.1-1 ..... Revision 3
3.1-2 ..... Revision 3
3.1-3 ..... Revision 3
3.1-4 ..... Revision 3
3.1-5 ..... Revision 3
3.1-6 ..... Revision 4
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
3.2-3 ..... Revision 2
3.3-1 ..... Revision 2

List of Effective Pages (continued)

3.3-2 ..... Revision 2
3.3-3 ..... Revision 2
3.3-4 ..... Revision 2
3.3-5 ..... Revision 2
3.3-6 ..... Revision 2
3.3-7 ..... Revision 2
3.3-8 ..... Revision 2
3.3-9 ..... Revision 2
3.3-10 ..... Amendment 1
3.3-11 ..... Revision 0
3.3-12 ..... Revision 2
3.3-13 ..... Revision 2
3.3-14 ..... Revision 2
3.4.1-1 ..... Revision 2
3.4.1-2 ..... Revision MPC-06A
3.4.1-3 ..... Revision 2
3.4.1-4 ..... Revision 2
3.4.1-5 ..... Revision 3
3.4.1-6 ..... Revision 2
3.4.1-7 ..... Revision 2
3.4.2-1 ..... Revision 2
3.4.2-2 ..... Revision 2
3.4.3-1 ..... Revision 2
3.4.3-2 ..... Revision 2
3.4.3-3 ..... Revision 2
3.4.3-4 ..... Revision 2
3.4.3-5 ..... Revision 2
3.4.3-6 ..... Revision 2
3.4.3-7 ..... Revision 2
3.4.3-8 ..... Revision 2
3.4.3-9 ..... Revision 2
3.4.3-10 ..... Revision 2
3.4.3-11 ..... Revision 2
3.4.3-12 ..... Revision 2
3.4.3-13 ..... Revision 2
3.4.3-14 ..... Revision 2
3.4.3-15 ..... Revision 2
3.4.3-16 ..... Revision 2
3.4.3-17 ..... Revision 2
3.4.3-18 ..... Revision 2
3.4.3-19 ..... Revision 2
3.4.3-20 ..... Revision 2
3.4.3-21 ..... Revision 2
3.4.3-22 ..... Revision 2
3.4.3-23 ..... Revision 2
3.4.3-24 ..... Revision 2
3.4.3-25 ..... Revision 2
3.4.3-26 ..... Revision 2
3.4.3-27 ..... Revision 2
3.4.3-28 ..... Revision 2
3.4.3-29 ..... Revision 2
3.4.3-30 ..... Revision 2
3.4.3-31 ..... Revision 2
3.4.3-32 ..... Revision 2
3.4.3-33 ..... Revision 2
3.4.3-34 ..... Revision 2
3.4.3-35 ..... Revision 2
3.4.3-36 ..... Revision 2
3.4.3-37 ..... Revision 2
3.4.3-38 ..... Revision 2
3.4.3-39 ..... Revision 2
3.4.3-40 ..... Revision 3
3.4.3-41 ..... Revision 2
3.4.3-42 ..... Revision 2
3.4.3-43 ..... Revision 2
3.4.3-44 ..... Revision 2
3.4.3-45 ..... Revision 2
3.4.3-46 ..... Revision 2
3.4.3-47 ..... Revision 2
3.4.3-48 ..... Revision 4

List of Effective Pages (continued)

3.4.3-49 ..... Revision 2
3.4.3-50 ..... Revision 2
3.4.3-51 ..... Revision 2
3.4.3-52 ..... Revision 2
3.4.3-53 ..... Revision 2
3.4.3-54 ..... Revision 2
3.4.3-55 ..... Revision 2
3.4.3-56 ..... Revision 3
3.4.3-57 ..... Revision 2
3.4.3-58 ..... Revision 2
3.4.3-59 ..... Revision 2
3.4.3-60 ..... Revision 2
3.4.3-61 ..... Revision 2
3.4.3-62 ..... Revision 2
3.4.3-63 ..... Revision 2
3.4.3-64 ..... Revision 2
3.4.3-65 ..... Revision 2
3.4.3-66 ..... Revision 2
3.4.3-67 ..... Revision 2
3.4.3-68 ..... Revision 2
3.4.3-69 ..... Revision 2
3.4.3-70 ..... Revision 2
3.4.3-71 ..... Revision 2
3.4.3-72 ..... Revision 5
3.4.3-73 ..... Revision 5
3.4.4-1 ..... Revision 2
3.4.4-2 ..... Revision 2
3.4.4-3 ..... Revision 2
3.4.4-4 ..... Revision 2
3.4.4-5 ..... Revision 2
3.4.4-6 ..... Revision 2
3.4.4-7 ..... Revision 2
3.4.4-8 ..... Revision 2
3.4.4-9 ..... Revision 2
3.4.4-10 ..... Revision 3
3.4.4-11 ..... Revision 2
3.4.4-12 ..... Revision 2
3.4.4-13 ..... Revision 2
3.4.4-14 ..... Revision 2
3.4.4-15 ..... Revision 3
3.4.4-16 ..... Revision 3
3.4.4-17 ..... Revision 3
3.4.4-18 ..... Revision 3
3.4.4-19 ..... Revision 3
3.4.4-20 ..... Revision 3
3.4.4-21 ..... Revision 3
3.4.4-22 ..... Revision 3
3.4.4-23 ..... Revision 3
3.4.4-24 ..... Revision 3
3.4.4-25 ..... Revision 3
3.4.4-26 ..... Revision 3
3.4.4-27 ..... Revision 3
3.4.4-28 ..... Revision 3
3.4.4-29 ..... Revision 3
3.4.4-30 ..... Revision 3
3.4.4-31 ..... Revision 3
3.4.4-32 ..... Revision 3
3.4.4-33 ..... Revision 3
3.4.4-34 ..... Revision 3
3.4.4-35 ..... Revision 3
3.4.4-36 ..... Revision 3
3.4.4-37 ..... Revision 3
3.4.4-38 ..... Revision 3
3.4.4-39 ..... Revision 3
3.4.4-40 ..... Revision 3
3.4.4-41 ..... Revision 3
3.4.4-42 ..... Revision 3
3.4.4-43 ..... Revision 3
3.4.4-44 ..... Revision 3
3.4.4-45 ..... Revision 3

List of Effective Pages (continued)

3.4.4-46 ..... Revision 3
3.4.4-47 ..... Revision 3
3.4.4-48 ..... Revision 3
3.4.4-49 ..... Revision 3
3.4.4-50 ..... Revision 3
3.4.4-51 ..... Revision 3
3.4.4-52 ..... Revision 3
3.4.4-53 ..... Revision 3
3.4.4-54 ..... Revision 4
3.4.4-55 ..... Revision 4
3.4.4-56 ..... Revision 4
3.4.4-57 ..... Revision 5
3.4.4-58 ..... Revision 3
3.4.4-59 ..... Revision 3
3.4.4-60 ..... Revision 3
3.4.4-61 ..... Revision 3
3.4.4-62 ..... Revision 3
3.4.4-63 ..... Revision 3
3.4.4-64 ..... Revision 3
3.4.4-65 ..... Revision 3
3.4.4-66 ..... Revision 3
3.4.4-67 ..... Revision 3
3.4.4-68 ..... Revision 3
3.4.4-69 ..... Revision 3
3.4.4-70 ..... Revision 4
3.4.4-71 ..... Revision 4
3.4.4-72 ..... Revision 4
3.4.4-73 ..... Revision 4
3.4.4-74 ..... Revision 4
3.4.4-75 ..... Revision 4
3.4.4-76 ..... Revision 4
3.4.4-77 ..... Revision 3
3.4.4-78 ..... Revision 3
3.4.4-79 ..... Revision 3
3.4.4-80 ..... Revision 3
3.4.4-81 ..... Revision 3
3.4.4-82 ..... Revision 3
3.4.4-83 ..... Revision 3
3.4.4-84 ..... Revision 3
3.4.4-85 ..... Revision 3
3.4.4-86 ..... Revision 3
3.4.4-87 ..... Revision 3
3.4.4-88 ..... Revision 3
3.4.4-89 ..... Revision 3
3.4.4-90 ..... Revision 3
3.4.4-91 ..... Revision 3
3.4.4-92 ..... Revision 3
3.4.4-93 ..... Revision 3
3.4.4-94 ..... Revision 3
3.4.4-95 ..... Revision 3
3.4.4-96 ..... Revision 3
3.4.4-97 ..... Revision 3
3.4.4-98 ..... Revision 3
3.4.4-99 ..... Revision 5
3.4.4-100 ..... Revision 5
3.4.4-101 ..... Revision 5
3.4.5-1 ..... Revision 2
3.5-1 ..... Revision 2
3.6-1 ..... Revision 2
3.6-2 ..... Revision 2
3.6-3 ..... Revision 4
3.7-1 ..... Revision 2
3.7-2 ..... Revision 2
3.8-1 ..... Revision 3
3.8.1-1 ..... Revision 0
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

List of Effective Pages (continued)

3.8.2-3 ..... Revision 0
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
3.8.5-2 ..... Revision 2

Chapter 4

4-i ..... Revision 3
4-ii ..... Revision 5
4-iii ..... Revision 3
4-iv ..... Revision 5
4-v ..... Revision 2
4-vi ..... Revision 5
4.1-1 ..... Revision 2
4.1-2 ..... Revision 2
4.1-3 ..... Revision 2
4.1-4 ..... Revision 5
4.1-5 ..... Revision 5
4.1-6 ..... Revision 2
4.1-7 ..... Revision 5
4.2-1 ..... Revision 2
4.2-2 ..... Revision 2
4.2-3 ..... Revision 0
4.2-4 ..... Revision 2
4.2-5 ..... Revision 2
4.2-6 ..... Revision 0
4.2-7 ..... Revision 0
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
4.4-7 ..... Amendment 1
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
4.4-15 ..... Revision 0
4.4-16 ..... Revision 0
4.4-17 ..... Revision 2
4.4-18 ..... Revision 2
4.4-19 ..... Revision 2
4.4-20 ..... Revision 0
4.4-21 ..... Revision 2
4.4-22 ..... Revision 2
4.4-23 ..... Amendment 1
4.4-24 ..... Revision 2
4.4-25 ..... Revision 2
4.4-26 ..... Revision 0
4.4-27 ..... Revision 0
4.4-28 ..... Revision 2
4.4-29 ..... Revision 2
4.4-30 ..... Revision 0
4.4-31 ..... Revision 2
4.4-32 ..... Revision 2
4.4-33 ..... Revision 2
4.4-34 ..... Revision 2

List of Effective Pages (continued)

4.4-35 ..... Revision 2
4.4-36 ..... Amendment 1
4.4-37 ..... Amendment 1
4.4-38 ..... Amendment 1
4.4-39 ..... Revision 2
4.4-40 ..... Revision 2
4.4-41 ..... Revision 2
4.4-42 ..... Revision 2
4.4-43 ..... Revision 2
4.4-44 ..... Revision 2
4.4-45 ..... Revision 2
4.4-46 ..... Revision 2
4.4-47 ..... Revision 2
4.4-48 ..... Revision 2
4.4-49 ..... Revision 2
4.4-50 ..... Revision 2
4.4-51 ..... Revision 2
4.4-52 ..... Revision 2
4.4-53 ..... Revision 2
4.4-54 ..... Revision 2
4.4-55 ..... Amendment 1
4.4-56 ..... Revision 3
4.4-57 ..... Revision 3
4.4-58 ..... Revision 3
4.4-59 ..... Revision 3
4.4.60 ..... Revision 3
4.4.61 ..... Revision 3
4.5-1 ..... Revision 5
4.5-2 ..... Revision 2
4.5-3 ..... Revision 2
4.5-4 ..... Revision 2
4.5-5 ..... Revision 2
4.5-6 ..... Revision 2
4.5-7 ..... Revision 3
4.5-8 ..... Revision 2
4.5-9 ..... Revision 2
4.5-10 ..... Revision 2
4.5-11 ..... Revision 2
4.5-12 ..... Revision 2
4.5-13 ..... Revision 2
4.5-14 ..... Revision 2
4.5-15 ..... Revision 2
4.5-16 ..... Revision 5
4.5-17 ..... Revision 2
4.5-18 ..... Revision 2
4.5-19 ..... Revision 2
4.5-20 ..... Revision 2
4.5-21 ..... Revision 2
4.5-22 ..... Revision 5
4.5-23 ..... Revision 2
4.5-24 ..... Revision 5
4.5-25 ..... Revision 2
4.5-26 ..... Revision 2
4.5-27 ..... Revision 5
4.5-28 ..... Revision 2
4.5-29 ..... Revision 5
4.5-30 ..... Revision 5
4.5-31 ..... Revision 5
4.5-32 ..... Revision 5
4.5-33 ..... Revision 5
4.5-34 ..... Revision 5
4.5-35 ..... Revision 2
4.5-36 ..... Revision 2
4.5-37 ..... Revision 2
4.5-38 ..... Revision 5
4.5-39 ..... Revision 2
4.5-40 ..... Revision 2
4.5-41 ..... Revision 2
4.5-42 ..... Revision 5
4.5-43 ..... Revision 5

List of Effective Pages (continued)

4.5-44 ..... Revision 5
4.5-45 ..... Revision 5
4.5-46 ..... Revision 5
4.5-47 ..... Revision 5
4.5-48 ..... Revision 2
4.5-49 ..... Revision 2
4.5-50 ..... Revision 2
4.5-51 ..... Revision 2
4.5-52 ..... Revision 5
4.6-1 ..... Revision 2
4.6-2 ..... Revision 2
4.6-3 ..... Revision 5

Chapter 5

5-i ..... Revision 3
5-ii ..... Revision 3
5-iii ..... Revision 3
5-iv ..... Revision 3
5-v ..... Revision 3
5-vi ..... Revision 3
5-vii ..... Revision 3
5-viii ..... Revision 3
5-ix ..... Revision 3
5-x ..... Revision 3
5-xi ..... Revision 3
5-xii ..... Revision 3
5.1-1 ..... Revision 2
5.1-2 ..... Revision 2
5.1.1-1 ..... Revision 3
5.1.1-2 ..... Revision 3
5.1.1-3 ..... Revision 3
5.1.1-4 ..... Revision 3
5.1.1-5 ..... Revision 3
5.1.1-6 ..... Revision 3
5.1.2-1 ..... Revision 2
5.1.2-2 ..... Revision 2
5.1.2-3 ..... Revision 2
5.1.2-4 ..... Revision 2
5.1.2-5 ..... Revision 3
5.1.2-6 ..... Revision 3
5.2-1 ..... Revision 2
5.2.1-1 ..... Revision 3
5.2.1-2 ..... Revision 3
5.2.1-3 ..... Revision 3
5.2.1-4 ..... Revision 3
5.2.1-5 ..... Revision 3
5.2.1-6 ..... Revision 3
5.2.1-7 ..... Revision 3
5.2.1-8 ..... Revision 3
5.2.1-9 ..... Revision 3
5.2.1-10 ..... Revision 3
5.2.1-11 ..... Revision 3
5.2.1-12 ..... Revision 3
5.2.1-13 ..... Revision 3
5.2.1-14 ..... Revision 3
5.2.1-15 ..... Revision 3
5.2.1-16 ..... Revision 3
5.2.1-17 ..... Revision 3
5.2.2-1 ..... Revision 3
5.2.2-2 ..... Revision 2
5.2.2-3 ..... Revision 2
5.2.2-4 ..... Revision 2
5.2.2-5 ..... Revision 2
5.2.2-6 ..... Revision 2
5.2.2-7 ..... Revision 2
5.2.2-8 ..... Revision 2
5.2.2-9 ..... Revision 2
5.2.2-10 ..... Revision 2
5.2.2-11 ..... Revision 2
5.2.2-12 ..... Revision 2

List of Effective Pages (continued)

5.2.2-13 ..... Revision 2
5.2.2-14 ..... Revision 2
5.2.2-15 ..... Revision 2
5.2.2-16 ..... Revision 2
5.2.2-17 ..... Revision 2
5.2.2-18 ..... Revision 2
5.2.2-19 ..... Revision 2
5.3-1 ..... Revision 3
5.3.1-1 ..... Revision 3
5.3.1-2 ..... Revision 3
5.3.1-3 ..... Revision 3
5.3.1-4 ..... Revision 3
5.3.1-5 ..... Revision 3
5.3.1-6 ..... Revision 3
5.3.1-7 ..... Revision 3
5.3.1-8 ..... Revision 3
5.3.1-9 ..... Revision 3
5.3.1-10 ..... Revision 3
5.3.1-11 ..... Revision 3
5.3.1-12 ..... Revision 3
5.3.1-13 ..... Revision 3
5.3.1-14 ..... Revision 3
5.3.1-15 ..... Revision 3
5.3.1-16 ..... Revision 3
5.3.1-17 ..... Revision 3
5.3.1-18 ..... Revision 3
5.3.1-19 ..... Revision 3
5.3.1-20 ..... Revision 3
5.3.1-21 ..... Revision 3
5.3.1-22 ..... Revision 3
5.3.1-23 ..... Revision 3
5.3.1-24 ..... Revision 3
5.3.1-25 ..... Revision 3
5.3.1-26 ..... Revision 3
5.3.2-1 ..... Revision 2
5.3.2-2 ..... Revision 2
5.3.2-3 ..... Revision 3
5.3.2-4 ..... Revision 2
5.3.2-5 ..... Revision 2
5.3.2-6 ..... Revision 2
5.3.2-7 ..... Revision 2
5.3.2-8 ..... Revision 2
5.3.2-9 ..... Revision 2
5.3.2-10 ..... Revision 2
5.3.2-11 ..... Revision 2
5.3.2-12 ..... Revision 2
5.3.2-13 ..... Revision 2
5.3.2-14 ..... Revision 2
5.3.2-15 ..... Revision 2
5.3.2-16 ..... Revision 2
5.4-1 ..... Revision 2
5.4.1-1 ..... Revision 3
5.4.1-2 ..... Revision 3
5.4.1-3 ..... Revision 3
5.4.1-4 ..... Revision 3
5.4.1-5 ..... Revision 3
5.4.1-6 ..... Revision 3
5.4.1-7 ..... Revision 3
5.4.1-8 ..... Revision 3
5.4.1-9 ..... Revision 3
5.4.1-10 ..... Revision 3
5.4.1-11 ..... Revision 3
5.4.1-12 ..... Revision 3
5.4.1-13 ..... Revision 3
5.4.1-14 ..... Revision 3
5.4.1-15 ..... Revision 3
5.4.1-16 ..... Revision 3
5.4.1-17 ..... Revision 3
5.4.1-18 ..... Revision 3
5.4.1-19 ..... Revision 3

List of Effective Pages (continued)

5.4.1-20 ..... Revision 3
5.4.1-21 ..... Revision 3
5.4.1-22 ..... Revision 3
5.4.1-23 ..... Revision 3
5.4.1-24 ..... Revision 3
5.4.1-25 ..... Revision 3
5.4.1-26 ..... Revision 3
5.4.1-27 ..... Revision 3
5.4.1-28 ..... Revision 3
5.4.1-29 ..... Revision 3
5.4.1-30 ..... Revision 3
5.4.1-31 ..... Revision 3
5.4.1-32 ..... Revision 3
5.4.1-33 ..... Revision 3
5.4.1-34 ..... Revision 3
5.4.2-1 ..... Revision 2
5.4.2-2 ..... Revision 2
5.4.2-3 ..... Revision 2
5.4.2-4 ..... Revision 2
5.4.2-5 ..... Revision 2
5.4.2-6 ..... Revision 2
5.4.2-7 ..... Revision 2
5.4.2-8 ..... Revision 2
5.4.2-9 ..... Revision 2
5.4.2-10 ..... Revision 2
5.4.2-11 ..... Revision 2
5.4.2-12 ..... Revision 2
5.4.2-13 ..... Revision 2
5.4.2-14 ..... Revision 2
5.4.2-15 ..... Revision 2
5.4.2-16 ..... Revision 2
5.4.2-17 ..... Revision 2
5.4.2-18 ..... Revision 2
5.4.2-19 ..... Revision 2
5.4.2-20 ..... Revision 2
5.4.2-21 ..... Revision 2
5.4.2-22 ..... Revision 2
5.4.2-23 ..... Revision 2
5.4.2-24 ..... Revision 2
5.4.2-25 ..... Revision 2
5.4.2-26 ..... Revision 2
5.4.2-27 ..... Revision 2
5.4.2-28 ..... Revision 2
5.4.2-29 ..... Revision 2
5.4.2-30 ..... Revision 2
5.4.2-31 ..... Revision 2
5.4.2-32 ..... Revision 2
5.4.2-33 ..... Revision 2
5.4.2-34 ..... Revision 2
5.4.2-35 ..... Revision 2
5.4.2-36 ..... Revision 2
5.4.2-37 ..... Revision 2
5.4.2-38 ..... Revision 2
5.4.2-39 ..... Revision 2
5.4.2-40 ..... Revision 2
5.4.2-41 ..... Revision 2
5.4.2-42 ..... Revision 2
5.4.2-43 ..... Revision 2
5.4.2-44 ..... Revision 2
5.4.2-45 ..... Revision 2
5.4.2-46 ..... Revision 2
5.4.2-47 ..... Revision 2
5.5-1 ..... Revision 2
5.5-2 ..... Revision 3
5.6.1-1 ..... Revision 3
5.6.1-2 ..... Revision 3
5.6.1-3 ..... Revision 3
5.6.1-4 ..... Revision 3
5.6.1-5 ..... Revision 3
5.6.1-6 ..... Revision 3

List of Effective Pages (continued)

5.6.1-7 ..... Revision 3
5.6.1-8 ..... Revision 3
5.6.1-9 ..... Revision 3
5.6.1-10 ..... Revision 3
5.6.1-11 ..... Revision 3
5.6.1-12 ..... Revision 3
5.6.1-13 ..... Revision 3
5.6.1-14 ..... Revision 3
5.6.1-15 ..... Revision 3
5.6.1-16 ..... Revision 3
5.6.1-17 ..... Revision 3
5.6.1-18 ..... Revision 3
5.6.1-19 ..... Revision 3
5.6.1-20 ..... Revision 3
5.6.1-21 ..... Revision 3
5.6.1-22 ..... Revision 3
5.6.1-23 ..... Revision 3
5.6.1-24 ..... Revision 3
5.6.1-25 ..... Revision 3
5.6.1-26 ..... Revision 3
5.6.1-27 ..... Revision 3
5.6.1-28 ..... Revision 3
5.6.1-29 ..... Revision 3
5.6.1-30 ..... Revision 3
5.6.1-31 ..... Revision 3
5.6.1-32 ..... Revision 3
5.6.1-33 ..... Revision 3
5.6.1-34 ..... Revision 3
5.6.1-35 ..... Revision 3
5.6.1-36 ..... Revision 3
5.6.1-37 ..... Revision 3
5.6.1-38 ..... Revision 3
5.6.1-39 ..... Revision 3
5.6.1-40 ..... Revision 3
5.6.1-41 ..... Revision 3
5.6.1-42 ..... Revision 3
5.6.1-43 ..... Revision 3
5.6.1-44 ..... Revision 3
5.6.1-45 ..... Revision 3
5.6.1-46 ..... Revision 3
5.6.1-47 ..... Revision 3
5.6.1-48 ..... Revision 3
5.6.1-49 ..... Revision 3
5.6.1-50 ..... Revision 3
5.6.1-51 ..... Revision 3
5.6.1-52 ..... Revision 3
5.6.1-53 ..... Revision 3
5.6.1-54 ..... Revision 3
5.6.1-55 ..... Revision 3
5.6.1-56 ..... Revision 3
5.6.1-57 ..... Revision 3
5.6.1-58 ..... Revision 3
5.6.1-59 ..... Revision 3
5.6.1-60 ..... Revision 3
5.6.1-61 ..... Revision 3
5.6.1-62 ..... Revision 3
5.6.1-63 ..... Revision 3
5.6.1-64 ..... Revision 3
5.6.1-65 ..... Revision 3
5.6.1-66 ..... Revision 3
5.6.1-67 ..... Revision 3
5.6.1-68 ..... Revision 3
5.6.1-69 ..... Revision 3
5.6.1-70 ..... Revision 3
5.6.1-71 ..... Revision 3
5.6.2-1 ..... Revision 3
5.6.2-2 ..... Revision 3
5.6.2-3 ..... Revision 3
5.6.2-4 ..... Revision 3
5.6.2-5 ..... Revision 3

List of Effective Pages (continued)

5.6.2-6 ..... Revision 3
5.6.2-7 ..... Revision 3
5.6.2-8 ..... Revision 3
5.6.2-9 ..... Revision 3
5.6.2-10 ..... Revision 3
5.6.2-11 ..... Revision 3
5.6.2-12 ..... Revision 3
5.6.2-13 ..... Revision 3
5.6.2-14 ..... Revision 3
5.6.2-15 ..... Revision 3
5.6.2-16 ..... Revision 3
5.6.2-17 ..... Revision 3
5.6.2-18 ..... Revision 3
5.6.2-19 ..... Revision 3
5.6.2-20 ..... Revision 3
5.6.2-21 ..... Revision 3
5.6.2-22 ..... Revision 3
5.6.2-23 ..... Revision 3
5.6.2-24 ..... Revision 3
5.6.2-25 ..... Revision 3
5.6.2-26 ..... Revision 3
5.6.2-27 ..... Revision 3
5.6.2-28 ..... Revision 3
5.6.2-29 ..... Revision 3
5.6.2-30 ..... Revision 3
5.6.2-31 ..... Revision 3
5.6.2-32 ..... Revision 3
5.6.2-33 ..... Revision 3
5.6.2-34 ..... Revision 3
5.6.2-35 ..... Revision 3
5.6.2-36 ..... Revision 3

Chapter 6

6-i ..... Revision 3
6-ii ..... Revision 3
6-iii ..... Revision 3
6-iv ..... Revision 3
6-v ..... Revision 3
6-vi ..... Revision 3
6.1-1 ..... Revision 2
6.1-2 ..... Revision 2
6.1.1-1 ..... Revision 3
6.1.1-2 ..... Revision 3
6.1.2-1 ..... Revision 2
6.1.2-2 ..... Revision 2
6.2-1 ..... Revision 2
6.2.1-1 ..... Revision 3
6.2.1-2 ..... Revision 3
6.2.1-3 ..... Revision 2
6.2.1-4 ..... Revision 2
6.2.1-5 ..... Revision 2
6.2.1-6 ..... Revision 3
6.2.1-7 ..... Revision 2
6.2.2-1 ..... Revision 3
6.2.2-2 ..... Revision 2
6.2.2-3 ..... Revision 2
6.2.2-4 ..... Revision 2
6.3-1 ..... Revision 2
6.3.1-1 ..... Revision 2
6.3.1-2 ..... Revision 3
6.3.1-3 ..... Revision 2
6.3.1-4 ..... Revision 2
6.3.1-5 ..... Revision 2
6.3.1-6 ..... Revision 2
6.3.1-7 ..... Revision 2
6.3.1-8 ..... Revision 2
6.3.1-9 ..... Revision 2
6.3.1-10 ..... Revision 3
6.3.2-1 ..... Revision 3
6.3.2-2 ..... Revision 2

List of Effective Pages (continued)

6.3.2-3 ..... Revision 2
6.3.2-4 ..... Revision 2
6.3.2-5 ..... Revision 2
6.3.2-6 ..... Revision 2
6.3.2-7 ..... Revision 2
6.4-1 ..... Revision 2
6.4.1-1 ..... Revision 3
6.4.1-2 ..... Revision 3
6.4.1-3 ..... Revision 3
6.4.1-4 ..... Revision 3
6.4.1-5 ..... Revision 3
6.4.1-6 ..... Revision 3
6.4.1-7 ..... Revision 3
6.4.1-8 ..... Revision 3
6.4.1-9 ..... Revision 3
6.4.1-10 ..... Revision 3
6.4.1-11 ..... Revision 3
6.4.1-12 ..... Revision 3
6.4.1-13 ..... Revision 3
6.4.1-14 ..... Revision 3
6.4.1-15 ..... Revision 3
6.4.1-16 ..... Revision 3
6.4.1-17 ..... Revision 3
6.4.1-18 ..... Revision 3
6.4.1-19 ..... Revision 3
6.4.1-20 ..... Revision 3
6.4.1-21 ..... Revision 3
6.4.1-22 ..... Revision 3
6.4.1-23 ..... Revision 3
6.4.1-24 ..... Revision 3
6.4.1-25 ..... Revision 3
6.4.1-26 ..... Revision 3
6.4.1-27 ..... Revision 3
6.4.1-28 ..... Revision 3
6.4.1-29 ..... Revision 3
6.4.1-30 ..... Revision 3
6.4.1-31 ..... Revision 3
6.4.1-32 ..... Revision 3
6.4.1-33 ..... Revision 3
6.4.2-1 ..... Revision 2
6.4.2-2 ..... Revision 2
6.4.2-3 ..... Revision 2
6.4.2-4 ..... Revision 2
6.4.2-5 ..... Revision 2
6.4.2-6 ..... Revision 2
6.4.2-7 ..... Revision 2
6.4.2-8 ..... Revision 2
6.4.2-9 ..... Revision 2
6.4.2-10 ..... Revision 2
6.4.2-11 ..... Revision 2
6.4.2-12 ..... Revision 2
6.4.2-13 ..... Revision 3
6.4.2-14 ..... Revision 3
6.4.2-15 ..... Revision 3
6.4.2-16 ..... Revision 3
6.4.2-17 ..... Revision 3
6.4.2-18 ..... Revision 2
6.4.2-19 ..... Revision 2
6.4.2-20 ..... Revision 2
6.4.2-21 ..... Revision 2
6.4.2-22 ..... Revision 3
6.4.2-23 ..... Revision 3
6.4.2-24 ..... Revision 2
6.4.2-25 ..... Revision 2
6.4.2-26 ..... Revision 2
6.5-1 ..... Revision 2
6.5-2 ..... Revision 2
6.5.1-1 ..... Revision 2
6.5.1-2 ..... Revision 3
6.5.1-3 ..... Revision 3

List of Effective Pages (continued)

6.5.1-4 ..... Revision 2
6.5.1-5 ..... Revision 2
6.5.1-6 ..... Revision 2
6.5.1-7 ..... Revision 2
6.5.1-8 ..... Revision 2
6.5.1-9 ..... Revision 2
6.5.1-10 ..... Revision 2
6.5.1-11 ..... Revision 2
6.5.1-12 ..... Revision 2
6.5.1-13 ..... Revision 2
6.5.1-14 ..... Revision 2
6.5.1-15 ..... Revision 2
6.5.1-16 ..... Revision 2
6.5.1-17 ..... Revision 2
6.5.1-18 ..... Revision 2
6.5.1-19 ..... Revision 2
6.5.1-20 ..... Revision 3
6.5.2-1 ..... Revision 3
6.5.2-2 ..... Revision 2
6.5.2-3 ..... Revision 2
6.5.2-4 ..... Revision 2
6.5.2-5 ..... Revision 2
6.5.2-6 ..... Revision 2
6.5.2-7 ..... Revision 2
6.5.2-8 ..... Revision 2
6.5.2-9 ..... Revision 2
6.5.2-10 ..... Revision 2
6.5.2-11 ..... Revision 2
6.5.2-12 ..... Revision 2
6.5.2-13 ..... Revision 2
6.5.2-14 ..... Revision 2
6.5.2-15 ..... Revision 2
6.5.2-16 ..... Revision 2
6.5.2-17 ..... Revision 2
6.5.2-18 ..... Revision 2
6.5.2-19 ..... Revision 2
6.5.2-20 ..... Revision 2
6.6-1 ..... Revision 2
6.6-2 ..... Revision 2
6.7-1 ..... Revision 3
6.7.1-1 ..... Revision 2
6.7.1-2 ..... Revision 2
6.7.1-3 ..... Revision 2
6.7.1-4 ..... Revision 2
6.7.1-5 ..... Revision 2
6.7.1-6 ..... Revision 2
6.7.1-7 ..... Revision 2
6.7.1-8 ..... Revision 2
6.7.1-9 ..... Revision 2
6.7.1-10 ..... Revision 2
6.7.1-11 ..... Revision 2
6.7.1-12 ..... Revision 2
6.7.1-13 ..... Revision 2
6.7.1-14 ..... Revision 2
6.7.1-15 ..... Revision 2
6.7.1-16 ..... Revision 2
6.7.1-17 ..... Revision 2
6.7.1-18 ..... Revision 2
6.7.1-19 ..... Revision 2
6.7.1-20 ..... Revision 2
6.7.1-21 ..... Revision 2
6.7.1-22 ..... Revision 2
6.7.1-23 ..... Revision 2
6.7.1-24 ..... Revision 2
6.7.1-25 ..... Revision 2
6.7.1-26 ..... Revision 2
6.7.1-27 ..... Revision 2
6.7.1-28 ..... Revision 2
6.7.1-29 ..... Revision 2
6.7.1-30 ..... Revision 2

List of Effective Pages (continued)

6.7.1-31 ..... Revision 2
6.7.1-32 ..... Revision 2
6.7.1-33 ..... Revision 2
6.7.1-34 ..... Revision 2
6.7.1-35 ..... Revision 2
6.7.1-36 ..... Revision 2
6.7.1-37 ..... Revision 2
6.7.1-38 ..... Revision 2
6.7.1-39 ..... Revision 2
6.7.1-40 ..... Revision 2
6.7.1-41 ..... Revision 2
6.7.1-42 ..... Revision 2
6.7.1-43 ..... Revision 2
6.7.1-44 ..... Revision 2
6.7.1-45 ..... Revision 2
6.7.1-46 ..... Revision 2
6.7.1-47 ..... Revision 2
6.7.1-48 ..... Revision 2
6.7.1-49 ..... Revision 2
6.7.1-50 ..... Revision 2
6.7.1-51 ..... Revision 2
6.7.1-52 ..... Revision 2
6.7.1-53 ..... Revision 2
6.7.1-54 ..... Revision 2
6.7.1-55 ..... Revision 2
6.7.1-56 ..... Revision 2
6.7.1-57 ..... Revision 2
6.7.1-58 ..... Revision 2
6.7.1-59 ..... Revision 2
6.7.1-60 ..... Revision 2
6.7.1-61 ..... Revision 2
6.7.1-62 ..... Revision 2
6.7.1-63 ..... Revision 2
6.7.1-64 ..... Revision 2
6.7.1-65 ..... Revision 2
6.7.1-66 ..... Revision 2
6.7.1-67 ..... Revision 2
6.7.1-68 ..... Revision 2
6.7.1-69 ..... Revision 2
6.7.1-70 ..... Revision 2
6.7.1-71 ..... Revision 2
6.7.1-72 ..... Revision 2
6.7.1-73 ..... Revision 2
6.7.1-74 ..... Revision 2
6.7.1-75 ..... Revision 2
6.7.1-76 ..... Revision 2
6.7.1-77 ..... Revision 2
6.7.1-78 ..... Revision 2
6.7.1-79 ..... Revision 2
6.7.1-80 ..... Revision 2
6.7.1-81 ..... Revision 2
6.7.1-82 ..... Revision 2
6.7.1-83 ..... Revision 2
6.7.1-84 ..... Revision 2
6.7.1-85 ..... Revision 2
6.7.1-86 ..... Revision 2
6.7.1-87 ..... Revision 2
6.7.1-88 ..... Revision 2
6.7.1-89 ..... Revision 2
6.7.1-90 ..... Revision 2
6.7.1-91 ..... Revision 2
6.7.1-92 ..... Revision 2
6.7.1-93 ..... Revision 2
6.7.1-94 ..... Revision 2
6.7.1-95 ..... Revision 2
6.7.1-96 ..... Revision 2
6.7.1-97 ..... Revision 2
6.7.1-98 ..... Revision 2
6.7.1-99 ..... Revision 2
6.7.1-100 ..... Revision 2

List of Effective Pages (continued)

6.7.1-101 ..... Revision 2
6.7.1-102 ..... Revision 2
6.7.1-103 ..... Revision 2
6.7.1-104 ..... Revision 2
6.7.1-105 ..... Revision 2
6.7.1-106 ..... Revision 2
6.7.1-107 ..... Revision 2
6.7.1-108 ..... Revision 2
6.7.1-109 ..... Revision 2
6.7.1-110 ..... Revision 2
6.7.1-111 ..... Revision 2
6.7.1-112 ..... Revision 2
6.7.1-113 ..... Revision 2
6.7.1-114 ..... Revision 2
6.7.1-115 ..... Revision 2
6.7.1-116 ..... Revision 2
6.7.1-117 ..... Revision 2
6.7.1-118 ..... Revision 2
6.7.1-119 ..... Revision 2
6.7.1-120 ..... Revision 2
6.7.1-121 ..... Revision 2
6.7.1-122 ..... Revision 2
6.7.1-123 ..... Revision 2
6.7.1-124 ..... Revision 2
6.7.1-125 ..... Revision 2
6.7.1-126 ..... Revision 2
6.7.1-127 ..... Revision 3
6.7.1-128 ..... Revision 3
6.7.1-129 ..... Revision 3
6.7.1-130 ..... Revision 3
6.7.1-131 ..... Revision 3
6.7.1-132 ..... Revision 3
6.7.1-133 ..... Revision 3
6.7.1-134 ..... Revision 3
6.7.1-135 ..... Revision 3
6.7.1-136 ..... Revision 3
6.7.1-137 ..... Revision 3
6.7.1-138 ..... Revision 3
6.7.1-139 ..... Revision 3
6.7.1-140 ..... Revision 3
6.7.1-141 ..... Revision 3
6.7.1-142 ..... Revision 3
6.7.1-143 ..... Revision 3
6.7.1-144 ..... Revision 3
6.7.1-145 ..... Revision 3
6.7.1-146 ..... Revision 3
6.7.1-147 ..... Revision 3
6.7.1-148 ..... Revision 3
6.7.1-149 ..... Revision 3
6.7.1-150 ..... Revision 3
6.7.1-151 ..... Revision 3
6.7.1-152 ..... Revision 3
6.7.1-153 ..... Revision 3
6.7.1-154 ..... Revision 3
6.7.1-155 ..... Revision 3
6.7.1-156 ..... Revision 3
6.7.1-157 ..... Revision 3
6.7.1-158 ..... Revision 3
6.7.1-159 ..... Revision 3
6.7.1-160 ..... Revision 3
6.7.2-1 ..... Revision 2
6.7.2-2 ..... Revision 2
6.7.2-3 ..... Revision 2
6.7.2-4 ..... Revision 2
6.7.2-5 ..... Revision 2
6.7.2-6 ..... Revision 2
6.7.2-7 ..... Revision 2
6.7.2-8 ..... Revision 2
6.7.2-9 ..... Revision 2
6.7.2-10 ..... Revision 2

List of Effective Pages (continued)

6.7.2-11 ..... Revision 2
6.7.2-12 ..... Revision 2
6.7.2-13 ..... Revision 2
6.7.2-14 ..... Revision 2
6.7.2-15 ..... Revision 2
6.7.2-16 ..... Revision 2
6.7.2-17 ..... Revision 2
6.7.2-18 ..... Revision 2
6.7.2-19 ..... Revision 2
6.7.2-20 ..... Revision 2
6.7.2-21 ..... Revision 2
6.7.2-22 ..... Revision 2
6.7.2-23 ..... Revision 2
6.7.2-24 ..... Revision 2
6.7.2-25 ..... Revision 2
6.7.2-26 ..... Revision 2
6.7.2-27 ..... Revision 2
6.7.2-28 ..... Revision 2
6.7.2-29 ..... Revision 2
6.7.2-30 ..... Revision 2
6.7.2-31 ..... Revision 2
6.7.2-32 ..... Revision 2
6.7.2-33 ..... Revision 2
6.7.2-34 ..... Revision 2
6.7.2-35 ..... Revision 2
6.7.2-36 ..... Revision 2
6.7.2-37 ..... Revision 2
6.7.2-38 ..... Revision 2
6.7.2-39 ..... Revision 2
6.7.2-40 ..... Revision 2
6.7.2-41 ..... Revision 2
6.7.2-42 ..... Revision 2
6.7.2-43 ..... Revision 2
6.7.2-44 ..... Revision 2

Chapter 7

7-i ..... Revision 2
7-ii ..... Revision 2
7-1 ..... Revision 2
7.1-1 ..... Revision 3
7.1-2 ..... Revision 2
7.1-3 ..... Revision MPC-06A
7.1-4 ..... Revision 3
7.1-5 ..... Revision 2
7.1-6 ..... Revision 2
7.1-7 ..... Revision 2
7.1-8 ..... Revision 2
7.1-9 ..... Revision 2
7.1-10 ..... Revision 2
7.2-1 ..... Revision 3
7.2-2 ..... Revision MPC-06A
7.3-1 ..... Revision 2

Chapter 8

8-i ..... Revision 5
8-ii ..... Revision 5
8-1 ..... Revision 2
8-2 ..... Revision 2
8.1-1 ..... Revision 2
8.1-2 ..... Revision 2
8.1-3 ..... Revision MPC-06A
8.1-4 ..... Revision MPC-06A
8.1-5 ..... Revision MPC-06A
8.1-6 ..... Revision MPC-06A
8.1-7 ..... Revision MPC-06A
8.1-8 ..... Revision MPC-06A
8.1-9 ..... Revision MPC-06A
8.1-10 ..... Revision 6
8.1-11 ..... Revision 6

List of Effective Pages (continued)

8.1-12 ..... Revision 6
8.1-13 ..... Revision 6
8.1-14 ..... Revision 6
8.1-15 ..... Revision 6
8.1-16 ..... Revision 5
8.1-17 ..... Revision MPC-06A
8.1-18 ..... Revision 5
8.1-19 ..... Revision 5
8.2-1 ..... Revision MPC-06A
8.2-2 ..... Revision 2
8.3-1 ..... Revision 2
8.3-2 ..... Revision 3
8.3-3 ..... Revision 3
8.3-4 ..... Revision 3
8.3-5 ..... Revision 3

Chapter 9

9-i ..... Revision 3
9-1 ..... Revision 2
9.1-1 ..... Revision 2
9.1-2 ..... Revision 3
9.1-3 ..... Revision 3
9.1-4 ..... Revision 3
9.1-5 ..... Revision 3
9.1-6 ..... Revision 3
9.1-7 ..... Revision 3
9.1-8 ..... Revision 3
9.1-9 ..... Revision MPC-06A
9.1-10 ..... Revision 3
9.2-1 ..... Revision MPC-06A
9.3-1 ..... Revision 2

Chapter 10

10-i ..... Revision 2
10-ii ..... Revision 2
10-iii ..... Revision 2
10.1-1 ..... Revision 2
10.1-2 ..... Revision MPC-06A
10.2-1 ..... Revision 3
10.2-2 ..... Revision 3
10.3-1 ..... Revision 2
10.3-2 ..... Revision MPC-06A
10.3-3 ..... Revision 2
10.3-4 ..... Revision 3
10.3-5 ..... Revision 2
10.3-6 ..... Revision 2
10.3-7 ..... Revision 2
10.3-8 ..... Revision 2
10.3-9 ..... Revision 2
10.3-10 ..... Revision 2
10.3-11 ..... Revision 3
10.3-12 ..... Revision 2
10.3-13 ..... Revision 2
10.3-14 ..... Revision 2
10.4-1 ..... Revision 3
10.4-2 ..... Revision 3
10.4-3 ..... Revision 3
10.4-4 ..... Revision 3
10.4-5 ..... Revision 2
10.4-6 ..... Revision 3
10.4-7 ..... Revision 2
10.4-8 ..... Revision 2
10.4-9 ..... Revision 2
10.4-10 ..... Revision 2
10.4-11 ..... Revision 2

Chapter 11

11-i ..... Revision 2
11-ii ..... Revision 2
11-iii ..... Revision 2

List of Effective Pages (continued)

11-iv ..... Revision 3
11-v ..... Revision 3
11-vi ..... Revision 3
11-vii ..... Revision 3
11-viii ..... Revision 4
11-ix ..... Revision 3
11-x ..... Revision 3
11-xi ..... Revision 3
11-1 ..... Revision 3
11.1-1 ..... Revision 2
11.1.1-1 ..... Revision MPC-06A
11.1.1-2 ..... Revision 3
11.1.2-1 ..... Revision 2
11.1.2-2 ..... Revision 3
11.1.2-3 ..... Revision 2
11.1.2-4 ..... Revision 4
11.1.2-5 ..... Revision 2
11.1.2-6 ..... Revision 4
11.1.2-7 ..... Revision 4
11.1.3-1 ..... Revision MPC-06A
11.1.3-2 ..... Revision MPC-06A
11.1.4-1 ..... Revision MPC-06A
11.1.4-2 ..... Revision 2
11.1.4-3 ..... Revision 2
11.1.4-4 ..... Revision 2
11.1.4-5 ..... Revision 2
11.1.4-6 ..... Revision 2
11.1.4-7 ..... Revision 2
11.1.5-1 ..... Revision 2
11.1.5-2 ..... Revision 2
11.1.5-3 ..... Revision 2
11.1.5-4 ..... Revision 2
11.1.5-5 ..... Revision 2
11.1.5-6 ..... Revision 2
11.1.5-7 ..... Revision 2
11.2-1 ..... Revision 2
11.2.1-1 ..... Revision 3
11.2.1-2 ..... Revision 2
11.2.1-3 ..... Revision 2
11.2.1-4 ..... Revision 4
11.2.1-5 ..... Revision 2
11.2.1-6 ..... Revision 2
11.2.1-7 ..... Revision 2
11.2.1-8 ..... Revision 2
11.2.1-9 ..... Revision 4
11.2.1-10 ..... Revision 4
11.2.2-1 ..... Revision 2
11.2.2-2 ..... Revision 2
11.2.2-3 ..... Revision 2
11.2.2-4 ..... Revision 2
11.2.2-5 ..... Revision 2
11.2.2-6 ..... Revision 2
11.2.2-7 ..... Revision 2
11.2.2-8 ..... Revision 2
11.2.2-9 ..... Revision 2
11.2.2-10 ..... Revision 2
11.2.2-11 ..... Revision 2
11.2.2-12 ..... Revision 2
11.2.2-13 ..... Revision 2
11.2.2-14 ..... Revision 2
11.2.2-15 ..... Revision MPC-06A
11.2.3-1 ..... Revision 2
11.2.3-2 ..... Revision MPC-06A
11.2.4-1 ..... Revision 2
11.2.5-1 ..... Revision 2
11.2.5-2 ..... Revision 2
11.2.5-3 ..... Revision 2
11.2.5-4 ..... Revision 2
11.2.5-5 ..... Revision 2
11.2.6-1 ..... Revision 2

List of Effective Pages (continued)

11.2.6-2 ..... Revision 2
11.2.6-3 ..... Revision 2
11.2.6-4 ..... Revision 2
11.2.6-5 ..... Revision 2
11.2.6-6 ..... Revision 2
11.2.6-7 ..... Revision 2
11.2.6-8 ..... Revision 4
11.2.6-9 .....Revision MPC-06A
11.2.7-1 ..... Revision 2
11.2.7-2 ..... Revision 2
11.2.8-1 ..... Revision 2
11.2.8-2 ..... Revision 2
11.2.8-3 ..... Revision 3
11.2.9-1 ..... Revision 2
11.2.9-2 ..... Revision 2
11.2.9-3 ..... Revision 2
11.2.9-4 ..... Revision 2
11.2.9-5 ..... Revision 2
11.2.10-1 .....Revision MPC-06A
11.2.10-2 ..... Revision 2
11.2.10-3 ..... Revision 2
11.2.11-1 ..... Revision 2
11.2.11-2 ..... Revision 2
11.2.11-3 ..... Revision 2
11.2.11-4 ..... Revision 2
11.2.11-5 ..... Revision 2
11.2.11-6 ..... Revision 4
11.2.11-7 ..... Revision 4
11.2.11-8 ..... Revision 4
11.2.11-9 ..... Revision 2
11.2.11-10 ..... Revision 4
11.2.11-11 ..... Revision 2
11.2.12-1 ..... Revision 2
11.2.12-2 ..... Revision 2
11.2.12-3 ..... Revision 2
11.2.12-4 ..... Revision 2
11.2.12-5 ..... Revision 2
11.2.12-6 ..... Revision 2
11.2.12-7 ..... Revision 3
11.2.12-8 ..... Revision 3
11.2.12-9 ..... Revision 3
11.2.12-10 ..... Revision 3
11.2.12-11 ..... Revision 3
11.2.12-12 ..... Revision 3
11.2.12-13 ..... Revision 3
11.2.12-14 ..... Revision 3
11.2.12-15 ..... Revision 3
11.2.12-16 ..... Revision 2
11.2.12-17 ..... Revision 2
11.2.12-18 ..... Revision 2
11.2.12-19 ..... Revision 2
11.2.12-20 ..... Revision 2
11.2.12-21 ..... Revision 2
11.2.12-22 ..... Revision 2
11.2.12-23 ..... Revision 2
11.2.12-24 ..... Revision 2
11.2.12-25 ..... Revision 2
11.2.12-26 ..... Revision 3
11.2.12-27 ..... Revision 2
11.2.12-28 ..... Revision 2
11.2.12-29 ..... Revision 2
11.2.12-30 ..... Revision 3
11.2.12-31 ..... Revision 3
11.2.12-32 ..... Revision 3
11.2.12-33 ..... Revision 3
11.2.12-34 ..... Revision 3
11.2.12-35 ..... Revision 3
11.2.12-36 ..... Revision 3
11.2.12-37 ..... Revision 3
11.2.12-38 ..... Revision 3

List of Effective Pages (continued)

11.2.12-39 ..... Revision 3
11.2.12-40 ..... Revision 3
11.2.12-41 ..... Revision 3
11.2.12-42 ..... Revision 3
11.2.12-43 ..... Revision 3
11.2.12-44 ..... Revision 3
11.2.12-45 ..... Revision 3
11.2.12-46 ..... Revision 3
11.2.12-47 ..... Revision 3
11.2.12-48 ..... Revision 3
11.2.12-49 ..... Revision 3
11.2.12-50 ..... Revision 3
11.2.12-51 ..... Revision 3
11.2.12-52 ..... Revision 3
11.2.12-53 ..... Revision 3
11.2.12-54 ..... Revision 3
11.2.12-55 ..... Revision 3
11.2.12-56 ..... Revision 3
11.2.12-57 ..... Revision 3
11.2.12-58 ..... Revision 3
11.2.12-59 ..... Revision 4
11.2.12-60 ..... Revision 4
11.2.12-61 ..... Revision 3
11.2.12-62 ..... Revision 3
11.2.12-63 ..... Revision 3
11.2.12-64 ..... Revision 3
11.2.12-65 ..... Revision 3
11.2.12-66 ..... Revision 3
11.2.12-67 ..... Revision 3
11.2.12-68 ..... Revision 3
11.2.12-69 ..... Revision 4
11.2.12-70 ..... Revision 4
11.2.12-71 ..... Revision 4
11.2.12-72 ..... Revision 4
11.2.12-73 ..... Revision 3
11.2.12-74 ..... Revision 3
11.2.12-75 ..... Revision 3
11.2.12-76 ..... Revision 3
11.2.12-77 ..... Revision 3
11.2.12-78 ..... Revision 3
11.2.12-79 ..... Revision 3
11.2.12-80 ..... Revision 3
11.2.12-81 ..... Revision 3
11.2.12-82 ..... Revision 3
11.2.12-83 ..... Revision 3
11.2.12-84 ..... Revision 3
11.2.12-85 ..... Revision 3
11.2.12-86 ..... Revision 3
11.2.12-87 ..... Revision 3
11.2.12-88 ..... Revision 3
11.2.13-1 ..... Revision 2
11.2.13-2 ..... Revision 2
11.2.13-3 ..... Revision 2
11.2.13-4 ..... Revision 2
11.2.13-5 ..... Revision 2
11.2.13-6 ..... Revision 2
11.2.13-7 ..... Revision 2
11.2.13-8 ..... Revision 2
11.2.13-9 ..... Revision 2
11.2.13-10 ..... Revision 2
11.2.13-11 ..... Revision 2
11.2.13-12 ..... Revision 2
11.2.13-13 ..... Revision 2
11.2.13-14 ..... Revision 2
11.2.13-15 ..... Revision 2
11.2.13-16 ..... Revision 2
11.2.13-17 ..... Revision 2
11.2.13-18 ..... Revision 2
11.2.13-19 ..... Revision 2
11.2.13-20 ..... Revision 2

List of Effective Pages (continued)

11.2.13-21 ..... Revision 2
11.2.13-22 ..... Revision 2
11.2.13-23 ..... Revision 2
11.2.13-24 ..... Revision 3
11.2.13-25 ..... Revision 2
11.3-1 ..... Revision 2
11.3-2 ..... Revision 2
11.3-3 ..... Revision 0
11.3-4 ..... Revision 2
11.3-5 ..... Revision 2
11.3-6 ..... Revision 0
11.3-7 ..... Revision 0
11.3-8 ..... Revision 0
11.3-9 ..... Revision 2
11.3-10 ..... Revision 0
11.3-11 ..... Revision 0
11.3-12 ..... Revision 0
11.3-13 ..... Revision 0
11.3-14 ..... Revision 0
11.3-15 ..... Revision 0
11.3-16 ..... Revision 2
11.3-17 ..... Revision 2
11.3-18 ..... Revision 0
11.3-19 ..... Revision 0
11.3-20 ..... Revision 0
11.3-21 ..... Revision 2
11.3-22 ..... Revision 2
11.3-23 ..... Revision 0
11.3-24 ..... Amendment 1
11.3-25 ..... Amendment 1
11.3-26 ..... Amendment 1
11.3-27 ..... Amendment 1
11.3-28 ..... Amendment 1
11.3-29 ..... Amendment 1
11.3-30 ..... Amendment 1
11.3-31 ..... Amendment 1
11.3-32 ..... Amendment 1
11.3-33 ..... Amendment 1
11.3-34 ..... Amendment 1
11.3-35 ..... Revision 3
11.3-36 ..... Amendment 1
11.3-37 ..... Amendment 1
11.3-38 ..... Amendment 1
11.3-39 ..... Amendment 1
11.3-40 ..... Amendment 1
11.3-41 ..... Amendment 1
11.3-42 ..... Revision 3
11.3-43 ..... Revision 3
11.3-44 ..... Revision 3
11.3-45 ..... Revision 3
11.3-46 ..... Revision 3
11.4-1 ..... Revision 2
11.4.1-1 ..... Revision 2
11.4.1-2 ..... Revision 2
11.4.1-3 ..... Revision 2
11.4.1-4 ..... Revision 2
11.4.1-5 ..... Revision 2
11.4.1-6 ..... Revision 2
11.4.1-7 ..... Revision 2
11.4.1-8 ..... Revision 2
11.4.1-9 ..... Revision 2
11.4.1-10 ..... Revision 2
11.4.1-11 ..... Revision 2
11.4.1-12 ..... Revision 2
11.4.1-13 ..... Revision 2
11.4.1-14 ..... Revision 2
11.4.1-15 ..... Revision 2
11.4.1-16 ..... Revision 2
11.4.1-17 ..... Revision 2
11.4.1-18 ..... Revision 2

List of Effective Pages (continued)

11.4.1-19 ..... Revision 2
11.4.1-20 ..... Revision 2
11.4.2-1 ..... Revision 2
11.4.2-2 ..... Revision 2
11.4.2-3 ..... Revision 2
11.4.2-4 ..... Revision 3
11.4.2-5 ..... Revision 3
11.4.2-6 ..... Revision 3
11.4.2-7 ..... Revision 2
11.4.2-8 ..... Revision 2
11.4.2-9 ..... Revision 2
11.4.2-10 ..... Revision 2
11.4.3-1 ..... Revision 3
11.4.3-2 ..... Revision 2
11.4.3-3 ..... Revision 2
11.4.3-4 ..... Revision 2
11.4.4-1 ..... Revision 2
11.4.4-2 ..... Revision 2
11.4.4-3 ..... Revision 2
11.4.5-1 ..... Revision 2
11.4.5-2 ..... Revision 2
11.4.5-3 ..... Revision 2
11.4.5-4 ..... Revision 2
11.4.5-5 ..... Revision 2
11.4.5-6 ..... Revision 2
11.4.5-7 ..... Revision 2
11.4.5-8 ..... Revision 2
11.4.5-9 ..... Revision 2
11.4.5-10 ..... Revision 2
11.4.5-11 ..... Revision 2
11.4.5-12 ..... Revision 2
11.5-1 ..... Revision 2
11.5-2 ..... Revision 4
11.5-3 ..... Revision 4
11.6-1 ..... Revision 0
11.6-2 ..... Revision 2
11.6-3 ..... Amendment 1
11.6-4 ..... Revision 2

Chapter 12

12-i ..... Revision 2
12-ii ..... Revision 2
12-1 ..... Revision 2
12-2 ..... Revision 2
12A-1 ..... Revision 2
12A-2 ..... Revision 2
12B-1 ..... Revision 2
12B-2 ..... Revision 2
12C-1 ..... Revision 2
12C-2 ..... Revision 5
12C1-1 ..... Revision 2
12C2-1 ..... Revision 2
12C2-2 ..... Revision 2
12C3-1 ..... Revision 2
12C3-2 ..... Revision 2
12C3-3 ..... Revision 2
12C3-4 ..... Revision 2
12C3-5 ..... Revision 2
12C3-6 ..... Revision 2
12C3-7 ..... Revision 2
12C3-8 ..... Revision 2
12C3-9 ..... Revision 5
12C3-10 ..... Revision 5
12C3-11 ..... Revision 6
12C3-12 ..... Revision 5
12C3-13 ..... Revision 5
12C3-14 ..... Revision 5
12C3-15 ..... Revision 5
12C3-16 ..... Revision 5
12C3-17 ..... Revision 5

List of Effective Pages (continued)

12C3-18 ..... Revision 5
12C3-19 ..... Revision 5
12C3-20 ..... Revision 5
12C3-21 ..... Revision 5
12C3-22 ..... Revision 5
12C3-23 ..... Revision 5
12C3-24 ..... Revision 5
12C3-25 ..... Revision 5
12C3-26 ..... Revision 5
12C3-27 ..... Revision 5
12C3-28 ..... Revision 5
12C3-29 ..... Revision 5
12C3-30 ..... Revision MPC-06A
12C3-31 ..... Revision MPC-06A
12C3-32 ..... Revision MPC-06A
12C3-33 ..... Revision 5
12C3-34 ..... Revision 5
12C3-35 ..... Revision 5
12C3-36 ..... Revision 5
12C3-37 ..... Revision 5
12C3-38 ..... Revision 5
12C3-39 ..... Revision 5
12C3-40 ..... Revision 5
12C3-41 ..... Revision 5
12C3-42 ..... Revision 5
12C3-43 ..... Revision 5

Chapter 13

13-i ..... Revision 0
13.1-1 ..... Revision 2
13.1-2 ..... Revision 0
13.2-1 ..... Revision 0
13.2-2 ..... Revision 0
13.2-3 ..... Revision 0
13.2-4 ..... Revision 0
13.2-5 ..... Revision 0
13.2-6 ..... Revision 0
13.2-7 ..... Revision 0
13.2-8 ..... Revision 0
13.2-9 ..... Revision 5

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Chapter 7

NB, ensures that the canister maintains confinement in all of the evaluated normal, off-normal, and accident conditions.

The design of the canister allows the recovery of stored spent fuel, should that become necessary.

The canister has no exposed penetrations, no mechanical closures, and does not employ seals to maintain confinement. There is no requirement for continuous monitoring.

The design basis parameters for the Yankee Class and Connecticut Yankee fuel are presented in Sections 1.3.1 and 1.3.2, respectively. The design parameters that apply to the two canister configurations, as an element of the NAC-MPC dry storage system, are presented in Table 1.2-1.

7.1.1.4 Release Rate

A stainless steel plate, joined to the canister shell by welding, forms the primary confinement boundary. The welds are visually inspected, nondestructively examined, pressure tested, and leak tested to confirm integrity. There is no maximum allowable leak rate specified for the NAC-MPC canister, as leakage to any degree up to the level of sensitivity of the leak test, is not acceptable. To demonstrate leaktightness of the shield lid weld, a leak test is performed based on the leaktight condition of 1×10^{-7} ref cm^3/sec, as defined by the American National Standard for Leakage Tests on Packages for Shipment of Radioactive Materials, ANSI N14.5-1997, issued by the American National Standards Institute in December 1997.

Based on the leaktight configuration, the calculation of radionuclide inventories is not required.

7.1.2 Confinement Penetrations

Two penetrations (with quick disconnect fittings) are provided in the canister shield lid for operator use. One penetration is used for draining residual water from the canister. It connects to a drain tube that extends to the bottom of the canister. The other penetration extends only to the underside of the shield lid. It is used to introduce gas into the top of the canister. Once draining is completed, either penetration (or both) may be used for vacuum drying and backfilling with helium. Following backfilling, both penetrations are closed with port covers that are welded to the shield lid. When the port covers are in place, the penetrations are not accessible. These port covers are subsequently enclosed and covered by the structural lid, which is also welded in place. The structural lid and the remainder of the canister have no penetrations.

7.1.3 Seals and Welds

This section describes the process used to properly assemble the confinement vessel. Weld specification, examination and acceptance criteria are described in Sections 7.1.3.2 and 7.1.3.3. There are no elastomer or metallic seals used in the confinement boundary of the canister.

7.1.3.1 Fabrication

All cutting, machining, welding, and forming is in accordance with Section III, Article NB-4000 of the ASME Code, unless otherwise specified in the approved fabrication drawings and specifications consistent with the alternatives to the Code described in Section 7.1.1.1 and in Table B3-1 of the Certificate of Compliance. License drawings are provided in Section 1.7. ASME Code stamping of the canister is not required.

7.1.3.2 Welding Specifications

The canister body is assembled using longitudinal welded joints in the shell and circumferential welded joints at the bottom plate/shell juncture. The canister body may also require a circumferential weld, depending on the overall length of the canister shell.

These welds are performed in accordance with ASME Code Section III, NB-4000. The full penetration longitudinal weld and the circumferential weld (if used), joining the canister shell are radiographed in accordance with ASME Code Section V, Article 2. The weld joining the bottom plate to the canister shell is ultrasonically inspected in accordance with ASME Code Section V, Article 5. The acceptance criteria for these welds is as specified in ASME Code Section III, NB-5320 and NB-5330, respectively. The finished surface of each weld is liquid penetrant examined in accordance with ASME Code Section V, Article 6, and accepted in accordance with Section III, NB-5350.

After loading, the canister is closed by a shield lid and a structural lid using field installed bevel welds.

After the shield lid is welded in place, the canister is pnuematically (air over water) pressure tested. Following draining, drying and inerting operations, the vent and drain ports are closed with port covers that are welded in place with bevel welds. The shield lid and port cover welds

7.2 Requirements for Normal Conditions of Storage

The canister is transferred to the vertical concrete storage cask using the transfer cask. During this transfer, the canister is subject to handling loads. The evaluation of the canister for normal handling loads is provided in Section 3.4.4. The principal design criteria for the NAC-MPC system are provided in Chapter 2.0.

Once the canister is placed inside of the concrete storage cask, it is effectively protected from direct loading due to natural phenomena, such as wind, snow and ice loading. The principal direct loading for normal operating conditions arises from increased internal pressure caused by decay heat, solar insolation, and ambient temperature. The normal operating internal pressure is evaluated in Section 3.4.4, as described in Section 7.2.2.

7.2.1 Release of Radioactive Material

The structural analysis of the canister for normal conditions of storage that is presented in Section 3.4.4 shows that the canister is not breached in any of the normal operating events. Consequently, there is no release of radioactive material during normal conditions of storage.

7.2.2 Pressurization of the Confinement Vessel

The canister is vacuum dried and backfilled with helium at approximately one (1) atmosphere prior to installing and welding the penetration port covers. In service, the internal pressure increases due to an increase in temperature of the helium and due to the postulated failure of fuel rod cladding of 3% of the fuel rods, which releases 30% of the available fission gases in those rods.

The temperature of the helium increases due to the fuel decay heat, high ambient temperature, and the effect of full solar insolation on the concrete cask surface. Fuel cladding failure is assumed to release a fraction of the available fission gas and other radionuclides that are assumed to be releasable and all of the charge gas installed in the fuel rods at the time of manufacture of the rod. The evaluation conservatively adds the fission gas and volatile radionuclide releasable inventory of the reconfigured fuel rods classified as damaged to the inventory of the intact fuel that is assumed to fail in normal conditions. For fuel classified as damaged and loaded in a damaged fuel can, this inventory is considered to be previously released and it does not contribute to the pressurization of the canister.

The canister, shield lid, fittings, and the canister basket are fabricated from materials that do not react with ordinary or borated spent fuel pool water to generate gases. The aluminum heat transfer disks, fuel tubes, and BORAL plates used for criticality control are protected by an oxide film that forms shortly after fabrication. This oxide layer effectively precludes further oxidation of the aluminum components or other reaction with water in the canister at temperatures less than 200°F, which is higher than the typical spent fuel pool water temperature. No steels requiring protective coatings or paints are used in the canister, shield lid, fittings, or basket. Therefore, there are no protective coatings or paints present that could interact with water to release gases.

The calculation of the Yankee-MPC canister pressure, based on normal storage conditions, is presented in Section 4.4.5 and is 7.9 psig. This pressure is well within the Yankee-MPC design internal pressure value of 11.5 psig for normal condition of storage. Similarly, for the CY-MPC, the normal conditions canister pressure is 9.0 psig, and the bounding pressure for normal and off-normal conditions is 15.0 psig. There are no adverse consequences for either configuration due to the respective internal pressures that result from normal storage conditions.

Since the canister is vacuum dried and backfilled with helium prior to sealing, no significant moisture or gases remain in the canister. Consequently, there is no potential that radiolytic decomposition could cause an increase in canister internal pressure or result in a buildup of explosive gases in the canister.

Chapter 8

14. When the cask is clear of the pool surface, but still over the pool, turn off the water flow to the annulus and allow the annulus water to drain to the pool. Move the cask to the decontamination area or other suitable work station. Note the time the transfer cask is removed from the pool. Operations through 26a must be completed within the time shown for the applicable heat load (L):

Total Total Heat Load (L) (kW)	Allowable Time (Hours)
$10.5 < L \leq 12.5$	22
$8.5 < L \leq 10.5$	32
$6.5 < L \leq 8.5$	48
$4.5 < L \leq 6.5$	60
$L \leq 4.5$	90

Note: In the event a time limit is not met, cooling of the canister is required. Forced air cooling may be implemented by supplying 250 cfm air with a maximum temperature of 75°F to the inlets on the transfer cask. Forced air cooling must be continuously maintained for heat loads greater than 8.5 kW. Forced air cooling may be discontinued for 8 hours after 24 hours of continuous cooling for heat loads less than 8.5 kW. In-pool cooling may be used for heat loads less than 8.5 kW. In-pool cooling may be discontinued for 14 hours after 48 hours of continuous in-pool cooling. In-pool or forced air cooling may be repeated as necessary.

Note: Access to the top of the transfer cask is required. A suitable work platform may need to be erected.

15. Visually verify that the shield lid is level. Decontaminate the top of the transfer cask and shield lid as required to allow welding and inspection activities.

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

16. Install mating female quick-disconnect to drain tube quick-disconnect. Insert the drain tube through the drain port of the shield lid into the basket drain tube sleeve. Remove the female quick-disconnect. Torque the drain tube to 135 ± 15 ft-lbs for Furon metal seals or 115 ± 5 ft-lbs for elastomer seals (EPDM or Viton). Remove the hoist rings. Connect a female quick-disconnect to the valve installed in the vent port.
17. Connect the suction pump to the drain port. Remove approximately 50 gallons of water from the canister. Disconnect and remove the pump.

    Note: Fuel rods shall not be exposed to air during the 50-gallon pump-down.

18. Install the semiautomated welding equipment with secondary shield plate.
19. 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%, connect and operate the vacuum system to remove gases from the under side of the shield lid and re-verify hydrogen gas concentration.

20. Operate the welding equipment to complete the root weld joining the shield lid to the canister shell following approved procedures.

    Note: Stop welding if the hydrogen detector indicates a hydrogen concentration above 2.4% and clear hydrogen gas buildup.

21. 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. Leave the connector and vent tube installed to vent the canister.

22. Complete welding of the shield lid to the canister wall.
23. Prepare the weld and perform a liquid penetrant weld examination of the final pass. Record the results of the weld examination.

    Note: Re-rounding, if required, shall be performed prior to weld examination.

24. Remove any lines attached to the drain port. Attach a gas pressure line to the vent port. Pressurize the canister to 15 psig and hold the pressure. There shall be no loss of pressure for 10 minutes.
25. Release the pressure and visually inspect the shield lid to canister shell weld for indications of leaks and defects. Perform a liquid penetrant examination of the final weld surface. Record the results of the inspection.
26. Drain the Canister.

    26a. Attach the suction pump to the drain line. Ensure that the vent line is open. Using the pump, remove the remaining free water from the canister cavity.

    26b. Remove the suction pump from the drain line and close the drain line. Attach a nitrogen supply to the vent port.

    26c. Using the vent port, pressurize the canister with nitrogen to 15 (+0, -3) psig.

    26d. Open the drain line to blow any remaining free water from the canister. Remove any free water in the drain port cavity. Install the drain port cover.

    26e. Repeat Steps 26b-26d until water no longer discharges from the drain line. Stop the flow of nitrogen, vent the remaining pressure and remove the nitrogen supply line. Remove the drain line from the drain port.

    Note: Fuel rods shall not be exposed to air during canister draining operations.

    Note: Steps 26b through 32 must be completed within the time limits of LCO 3.1.1.

27. Attach the vacuum equipment to the vent and/or drain line as needed.
28. Operate the vacuum equipment, until a vacuum ≤ 3 mm of mercury exists in the canister.

29. Verify that no water remains in the canister by holding the vacuum ≤ 3 mm for a minimum of 30 minutes. If water is present in the cavity, the pressure will rise as the water vaporizes. Pressure should not continuously rise during the period of the test.
30. Backfill the canister cavity with helium to 1.0 ATM (+1, -0 psig) with helium having a minimum purity of 99.9%.
31. Restart the vacuum equipment and evacuate the canister to 3 mm of mercury.
32. Backfill the canister cavity with helium to 1.0 ATM (+1, -0 psig).

    Note: Step 32 through Step 12 of the concrete cask loading procedure (Section 8.1.2) must be completed within 30 days.
33. Remove any attachments to the vent ports.
34. Remove any free water in the drain port cavity. Install the drain port cover.
35. Weld the drain port cover to the shield lid.
36. Prepare the weld to perform a liquid penetrant examination of the drain port cover weld. Record the result 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.
37. Install the vent port cover and weld the vent port cover to the shield lid.
38. Prepare the weld and perform a liquid penetrant examination of the vent port cover weld. Record the results of the weld examination.

    Note: If the vent port cover weld is completed in a single pass, the weld final surface is examined in accordance with this step.
39. Remove weld machine and supplemental shield plate.
40. Install leak test cover and attach helium Mass Spectrometer Leak Detector (MSLD) and vacuum pump. Evacuate leak test cover volume to ≤ 2mm and perform helium leak test of shield lid welds to verify helium leakage of $\leq 8 \times 10^{-8}$ cm^3/sec at the test sensitivity of $\leq 4 \times 10^{-8}$ cm^3/sec.
41. Vent and remove leak test cover and helium MSLD.
42. Attach a three-legged sling to the structural lid using the swivel hoist rings.

    Note: Verify that the structural lid is stamped, or otherwise marked, to provide traceability of the canister contents. Verify that the structural lid weld spacer ring is in place on the structural lid.
43. Using the site approved crane, install the structural lid in the top of the canister. Verify that the structural lid 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.
44. Install the automated welding equipment on the structural lid.
45. Complete the root weld pass joining the structural lid to the canister shell.

46. Prepare the weld and perform a liquid penetrant examination of the weld root pass and record the results of the weld examination.
47. Complete the remainder of the weld, performing NDE (progressive liquid penetrant or ultrasonic testing) examination. Record the results of each weld examination.
48. Remove the welding equipment.
49. Prepare the weld and perform an ultrasonic inspection of the weld, if required, then perform a liquid penetrant examination of the final weld pass. Record the results of the weld examinations.
50. 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 by Technical Specification LCO 3.2.1.
51. Install the transfer cask retaining ring.
52. Decontaminate the external surface of the transfer cask.

8.1.1.2 Loading and Closing the CY-MPC Transportable Storage Canister

1. Visually inspect the basket fuel tubes to ensure they are unobstructed and free of debris. Ensure that the welding zones on the canister, shield and structural lids, and the port covers are prepared for welding. Ensure transfer cask door lock bolts/lock pins are installed and secure.
2. Flood the canister with clean water until the water is about 4 inches from the top of the canister.

   Note: Do not fill the canister completely in order to avoid spilling water during the transfer to the spent fuel pool.
3. Attach a clean water line(s) to the transfer cask. Install threaded pipe plugs on unused fill/drain lines on the transfer cask.
4. If it is not already attached, attach the transfer cask lifting yoke to the cask handling crane, and engage the transfer cask lifting trunnions.

   Note: The minimum external ambient air temperature must be verified to be higher than 0°F prior to lifting, in accordance with Appendix B, Section B3.4(8).
5. Raise the transfer cask and move it over the pool, following the prescribed travel path. If not already installed, attach clean water line(s) to the transfer cask.
6. Lower the transfer cask to the pool surface and turn on the clean or filtered water line to flood the annulus between the transfer cask and canister.
7. Lower the transfer cask as the annulus fills with clean water until the top of the cask is approximately 1 to 4 inches above the surface and hold that position until clean water fills the remainder of the canister and overflows through the upper fill lines or annulus of the transfer cask. Then lower the transfer cask to the bottom of the pool cask loading area.

Note: If an intermediate shelf is used to avoid wetting the cask handling crane hook, follow the plant procedure for use of the extension piece.

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.
    Note: Fuel rods shall not be exposed to air during the 65-gallon pump-down.
    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 a gas pressure line to the vent port. Pressurize the canister to 20 psig and isolate the gas 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. Draining is a continuous process, which should not exceed 2 hours (i.e., allowable drain down time) under normal operations. Completion of draining occurs when the pump loses suction, or when gas becomes evident, if gas is being used for assistance for draining the canister cavity. Note the time draining is completed. After removal of the water from the canister, disconnect the equipment from the canister. If not already installed, install a quick-disconnect to open the vent valve.

    Note: Fuel rods shall not be exposed to air during canister draining operations.

    Note: Should draining be interrupted, or exceed 2 hours, end the drain down time clock and start the vacuum drying time clock of LCO 3.1.1.

    Note: The time duration from completion of draining, or termination of the drain down time clock, through the completion of helium backfill (Step 34) shall be 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. To ensure that sufficient helium is introduced into the canister cavity for adequate heat transfer, reduce the canister cavity pressure to less than 75 mm Hg and backfill with minimum 99.9% pure helium to the pressure specified in LCO 3.1.1, Action A.1. Alternatively, backfill the canister cavity through the vent port with 99.9% pure helium to a pressure of 15-18 psig and vent through the drain line. Repeat the process a minimum of 4 times (approximately 24 to 30 m^3 of helium at standard pressure) and adjust cavity pressure to the pressure specified in LCO 3.1.1, Action A.1.

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).

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, gas 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 Transfer Cask Retaining Ring GTCC Canister (Empty) Vertical Concrete Cask Shield Plug Fuel Canister (Empty) Canister Shield Lid Welding Plate Canister Shield Lid Canister Structural Lid * Threads must be fully engaged	 60 + 5, - 0 100 + 10, - 0 230 + 25, - 0 230 + 25, - 0 230 +25, - 0 230 +25, - 0 470 +50, - 0 Hand Tight	 None None None None None None None None
Canister and Lid Plug Bolts	Hand Tight	None
Transfer Cask Door Lock Bolts/ Lock Pins	Hand Tight	None
Canister Drain Tube Canister Vent Valve	135 ± 15 (Furon metal seals) 115 ± 5 (elastomer seals, EPDM or Viton) 135 ± 15 (Furon metal seals) 115 ± 5 (elastomer seals, EPDM or Viton)	None None

8.2 Removal of the Transportable Storage Canister from the Vertical Concrete Cask

Removal of the loaded canister from the concrete cask is expected to occur at the time of shipment of the canistered fuel off site. Alternately, removal could be required in the unlikely event of an accident condition that rendered the concrete cask or canister unsuitable for continued long-term storage or for transport. This procedure identifies the general steps to return the loaded canister to the transfer cask and return the transfer cask to the decontamination station, or other designated work area. Since these steps are the reverse of those undertaken to place the canister in the concrete cask, as described in Section 8.1.2, they are summarized here. The procedure assumes that the inlet and outlet screens and the temperature-sensing instrumentation, if installed, have been removed.

Mechanical operation steps of the procedure may be performed in an appropriate sequence to allow for operational efficiency. Changing the order of these steps, within the intent of the procedures, has no effect on the safety of the canister removal process and does not violate any requirements stated in the Technical Specifications.

At the option of the user, the canister may be removed from the concrete cask and transferred to another concrete cask or to the NAC-STC transport cask at the ISFSI site. This transfer is done using the transfer cask, which provides shielding for the canister contents during the transfer.

1. Using the hydraulic jacking system and the air pad set, move the concrete cask from the ISFSI pad to the heavy-haul trailer. The bed of the trailer must be approximately level with the surface of the pad.

   Caution: Do not exceed a maximum lift height of 6 inches when raising the concrete cask in accordance with the requirements of Section A 5.5(d) of the Certificate of Compliance.
2. Tow the transporter to the cask receiving area or other designated work station.
3. Remove the concrete cask shield plug and lid. Install the hoist rings in the canister structural lid. Verify that the hoist ring threads are fully engaged and torque the hoist rings as required in Table 8.1-2. Attach the lift slings. Install the transfer adapter.
4. Retrieve the transfer cask and position it on the transfer adapter on the top of the concrete cask.

   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) of the Certificate of Compliance.

5. Open the shield doors. Attach the canister lift slings to the site approved crane hook.
   Caution: The top connection of the three-legged sling must be at least 67 inches above the Yankee-MPC canister lid and at least 53 inches above the CY-MPC canister lid.
6. Raise the canister into the transfer cask. Use caution to avoid contacting the transfer cask retaining ring with the canister.
7. Close the shield doors. Lower the canister to rest on the bottom doors. Disconnect the canister slings from the crane hook.
8. Retrieve the transfer cask lifting yoke. Engage the transfer cask trunnions and move the transfer cask to the decontamination area or designated work station.
   Note: Prior to moving transfer cask, install and secure door lock bolts/ lock pins.

After the transfer cask containing the canister is in the decontamination area or other suitable work station, additional operations may be performed on the canister. It may be opened, transferred to another concrete cask, or placed in the NAC-STC transport cask. The length of time that the loaded canister is in the transfer cask and spent fuel cooldown operations must be monitored in accordance with LCO 3.1.4 and LCO 3.1.7 of the Certificate of Compliance.

Chapter 9

material thickness and boron content.

Typical test equipment will consist of thermal neutron source equipment, a neutron detector and a counting instrument. The test equipment is calibrated using BORAL standards, whose ^{10}B content has been checked and verified by an independent method such as chemical analysis. The highest permissible counting rate is determined from the neutron counting rates of the reference sheet(s), which should be ground to the minimum allowable plate thickness. This calibration process shall be repeated daily (every 24 hours) while tests are being performed.

9.1.6.4 Acceptance Criteria

The wet chemistry test results shall be considered acceptable if the ^{10}B areal density is determined to be equal to, or greater than, that specified on the fuel tube drawings. The neutron absorption test shall be considered acceptable if the neutron count determined for each test specimen is less than or equal to the highest permissible neutron count rate determined from the BORAL standard, which is based on the ^{10}B areal density specified on the fuel tube drawings. Any specimen not meeting the acceptance criteria for either test method shall be rejected and all of the sheets from that batch shall be similarly rejected.

9.1.7 Thermal Tests

No thermal acceptance testing of the NAC-MPC system is required during construction. The continued operability of the concrete cask's heat removal system is verified by the performance of Surveillance 3.1.6.1 of Technical Specification LCO 3.1.6

9.1.8 Cask Identification

A stamped stainless steel nameplate, as shown on Drawing No. 455-856 for the Yankee-MPC and on Drawing No. 414-856 for the CY-MPC, is permanently attached on the outer surface of the storage cask.

The nameplate includes the following information:

	Yankee-MPC	CY-MPC
Owner	(Utility Name)	(Utility Name)
Designer	NAC International	NAC International
Fabricator	(Vendor Name)	(Vendor Name)
Date of Manufacture	(mm/dd/yy)	(mm/dd/yy)
Model Number	YR-MPC	CY-MPC
Cask Number	(XXX)	(XXXX)
Date of Loading	(mm/dd/yy)	(mm/dd/yy)
Empty Weight	(Pounds [kilograms])	(Pounds [kilograms])

9.2 Maintenance Program

The NAC-MPC storage system is a passive system. There are no active components or systems incorporated in the design. Consequently, there is a minimal amount of maintenance that is required over its lifetime.

The system has no valves, gaskets, rupture discs or seals, and there are no accessible penetrations. Consequently, there is no maintenance associated with these types of features.

The routine thermal performance surveillance requirements for a loaded NAC-MPC system are described in the Technical Specifications of Appendix A, LCO 3.1.6 of the Certificate of Compliance.

The continuing operability of the concrete cask is verified on a 24-hour frequency by completion of SR 3.1.6.1, which allows verification by visual inspection of the inlet and outlet vents for blockage, or verification by measurement of the air temperature difference between ambient and outlet average. If the operable status of the concrete cask is reduced, the concrete cask will be returned to an operable status as specified in LCO 3.1.6.

Following an off-normal, accident or natural phenomena event, the user shall perform a Response Surveillance of the NAC-MPC systems in use at the ISFSI and take corrective actions, as required, in accordance with the requirements of Section A 5.3 of the Technical Specifications.

An annual inspection of the vertical concrete cask exterior is required, and includes:

- Visual inspection of concrete surfaces for chipping, spalling or other surface defects. Any defects larger than one inch in diameter (or width) and deeper than one inch shall be regrouted, according to the grout manufacturer's recommendations.
- Reapplication of corrosion-inhibiting (external) coatings on accessible surfaces.

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Chapter 10

10.0 RADIATION PROTECTION

The NAC-MPC is provided in two configurations. The Yankee Class MPC (Yankee-MPC) is designed to store up to 36 Yankee Class spent fuel assemblies. The Connecticut Yankee MPC (CY-MPC) is designed to store up to 26 Connecticut Yankee spent fuel assemblies. The radiation protection features and analysis presented in this chapter apply to both NAC-MPC configurations, except as noted in the appropriate sections.

10.1 Ensuring that Occupational Radiation Exposures Are As Low As Reasonably Achievable (ALARA)

The NAC-MPC provides radiation protection for all areas and systems that may expose personnel to radiation or radioactive materials. The components of the NAC-MPC system that require operation, maintenance and inspection are designed, fabricated, located, and shielded to minimize radiation exposure to personnel.

10.1.1 Policy Considerations

It is the policy of NAC to ensure that the NAC-MPC system is designed so that operation, inspection, repair and maintenance can be carried out while maintaining occupational exposure as low as reasonably achievable (ALARA).

10.1.2 Design Considerations

The design of the NAC-MPC system complies with the requirement of 10 CFR 72.3 concerning ALARA and meets the requirements of 10 CFR 72.126(a) and 10 CFR 20.1101 with regard to maintaining occupational radiation exposures ALARA. Specific design features that demonstrate the ALARA philosophy are:

- Material selection and surface preparation that facilitate decontamination.
- A basket configuration that allows spent fuel loading using accepted standard practice and current experience.
- Positive clean water flow in the transfer cask/canister annulus to minimize the potential for contamination of the canister surface during in-pool loading.

- Passive confinement, thermal, criticality, and shielding systems that require no maintenance.
- Thick steel and concrete walls to reduce the average side surface dose rate to 40 mrem/hr (average) for the Yankee-MPC and 108 mrem/hr for the CY-MPC.
- Nonplanar cooling air pathways to minimize radiation streaming at the inlets and outlets of the concrete cask.
- Optional use of remote, automated outlet air temperature measurement to reduce surveillance time.

10.1.3 Operational Considerations

The ALARA philosophy has been incorporated into the procedural steps necessary to operate the NAC-MPC in accordance with its design. The following features or actions, which comprise a baseline radiological controls approach, have been incorporated in the design or procedures to minimize occupational radiation exposure:

- Use of prefabricated, shaped temporary shielding during automated welding equipment set up and removal, manual welding, and weld inspection of the shielding and structural lids and for use during all of the canister closing and sealing operations.
- Use of automatic equipment for welding the shield lid and structural lid to the canister shell.
- Decontamination of the exterior surface of the transfer cask, welding of the shield lid, and pressure testing of the canister while the canister remains filled with water.
- Use of quick-disconnect fittings at penetrations to facilitate required service connections.
- Use of remote handling equipment, where practical, to reduce radiation exposure.

The operational procedures at a particular facility will be determined by the user's operational conditions and facilities.

10.3 Estimated On-Site Collective Dose Assessment

Occupational radiation exposures (person-mrem) resulting from the use of the NAC-MPC storage system are calculated using estimated exposure rates presented in Chapter 5.0 and Section 10.2.1. Exposure was evaluated by identifying the tasks and estimating the duration and number of personnel performing those tasks based on industry experience. The tasks identified were based on the design basis operating procedures, as presented in Chapter 8.0.

An estimated collective dose assessment is made for loading a single NAC-MPC, for dose related to routine storage operations and for unloading a single NAC-MPC. The collective dose assessments for the Yankee-MPC configuration is provided in Section 10.3.1. The collective dose assessment for the CY-MPC configuration is provided in Section 10.3.2.

Estimated Dose Due to Loading

The estimated dose due to loading considers the collective dose due to the loading, sealing, transfer and placement of a single NAC-MPC containing design basis fuel. This analysis assumes that the exposure incurred by the operators is independent of background radiation, as background will vary with site specificity. The number of persons allocated to task completion is generally the minimum number required for the task.

Working area exposure rates are assigned based on the orientation of the worker with respect to the source and take into account the use of temporary shielding.

The calculated exposures differ significantly between the Yankee-MPC and CY-MPC. The CY-MPC evaluation considers the increased use of automated equipment to off-set the elevated cask surface dose rates. The use of automated equipment is expected to reduce exposure time during transfer and welding operations. The CY-MPC evaluation also employs dose rates determined by three-dimensional profiling, rather than the average or one-dimensional dose rates used for the Yankee-MPC evaluations. Combining these effects results in lower occupational exposures for the CY-MPC loading and unloading operations compared to the Yankee-MPC system, even though the cask surface dose rates are higher for the CY-MPC system.

Estimated Dose Due to Routine Operations

Once in place, the ISFSI will require limited ongoing maintenance and surveillance throughout its design life. The annual dose evaluation considers the combination of the requirements specified in the NAC-MPC Technical Specifications and tasks that are anticipated to be representative of an operational facility. Typically, no maintenance of the storage system is expected to be required annually. Collective dose due to certain events, such as clearing the blockage of air vents, is accounted for in Chapter 11.0.

Routine operations are expected to include:

- The daily electronic measurement of ambient air and outlet air temperatures for each NAC-MPC in service, or the daily visual inspection of the concrete cask inlet and outlet screens to verify they are intact and unobstructed. Outlet temperature indicators are located away from the cask array and the operator is not expected to incur dose as a result of the temperature measurement. The time required to perform the visual inspection, and the expected dose, will be site specific due to ISFSI pad dimensions and configurations, concrete cask array, distance of the inspector to the casks, etc.
- A daily visual security inspection of the security fence and equipment surrounding the storage area. This surveillance is assumed to require 1 minute per cask for the Yankee-MPC array and a total of 10 minutes for the CY-MPC array and 1 security officer.
- Grounds maintenance performed no less than twice a month by 1 maintenance technician. Grounds maintenance is assumed to require 0.5 hour for the Yankee-MPC array and 1 hour for the CY-MPC array.
- Quarterly radiological surveillance. The surveillance consists of a radiological survey comprised of a surface radiation measurement on each cask, the determination and/or verification of general area exposure rates and radiological postings. This surveillance is assumed to require 1 person and 1 hour for the Yankee-MPC array and 2 hours for the CY-MPC array.
- Annual inspection of the general condition of the storage casks. This inspection is estimated to require 3-15 minutes per cask and 2 technicians.

For the Yankee-MPC evaluation, the storage array is conservatively assumed to have a fuel population having cooling times ranging from 8 to 20 years. To account for the different ages of the fuel, weighting factors are applied to the single cask dose rates. The application of these factors permits a more accurate representation of the exposure commitment necessary for the routine operation of the ISFSI. The weighting factors applied are based on the decayed spectra of the fuel neutron and fuel gamma components of the source term. Table 10.3-2 presents the

Chapter 11

11.1.1 Blockage of Half of the Air Inlets

This section evaluates the NAC-MPC storage cask for the steady state effects of a blockage of one-half of the air inlets at the normal ambient temperature (75°F).

11.1.1.1 Cause of Event

The likely cause of air inlet blockage is debris deposited in the inlets by wind or by intrusion of a burrowing animal. It is expected that screens over the inlets would preclude such animals and would exclude debris from the inlet channels.

This event would be detected by the daily concrete cask operability inspection, which is performed either by outlet air temperature measurements or by visual inspection of the inlet and outlet screens for blockage and integrity. It could also be detected by security forces, or other operations personnel engaged in other routine activities, such as fence inspection or grounds maintenance.

11.1.1.2 Analysis of the Blockage Event

Off-normal temperature conditions are evaluated using the thermal models described in Section 4.4.1 for the Yankee-MPC and in Section 4.5.1 for the CY-MPC. Air mass flow and air carried heat are calculated using the airflow models described in Sections 4.4.1 and 4.5.1 for the Yankee-MPC and CY-MPC configurations, respectively. The maximum component temperatures due to one-half of the air inlets being blocked are compared to the allowable component temperatures for the off-normal event as shown:

Component	Yankee-MPC 1/2 Inlets Blocked Max Temp. (°F)	Yankee-MPC Allowable Temp. (°F)	CY-MPC 1/2 Inlets Blocked Max Temp. (°F)	CY-MPC Allowable Temp. (°F)
Fuel Cladding	565	806	632	806
Support Disks	531	800	541	800
Heat Transfer Disks	529	700	538	700
Canister Shell	318	800	315	800
Concrete	168	350	178	350

These evaluations show that the component temperatures are within the allowable temperature range for the one-half of the inlets blocked condition for both configurations.

11.1.1.3 Radiological Consequences

There are no significant radiological consequences for this event. It is assumed that a worker kneeling with his hands on the inlets would require 15 minutes to clear the inlets.

For the Yankee-MPC, personnel will be subject to an estimated maximum contact dose rate of 219 mrem/hr. The estimated maximum extremity dose is 55 mrem. The whole body dose would be significantly less.

For the CY-MPC, personnel will be subject to an estimated maximum contact dose rate of 105 mrem/hr. The estimated maximum extremity dose is 25 mrem. The whole body dose would be significantly less.

11.1.1.4 NAC-MPC Performance

There are no adverse consequences for this off-normal condition. The maximum component temperatures are less than the allowable temperatures. The NAC-MPC storage cask continues to perform its function with one-half of the air inlets blocked.

11.1.1.5 Recovery and/or Corrective Actions

The debris blocking the inlets must be manually removed. The nature of the debris may indicate that other actions are required to prevent recurrence of the blockage.

11.1.3 Failure of Instrumentation

The NAC-MPC system may use a temperature-sensing system to measure the outlet air temperature at each of the four air outlets on each storage cask. The air temperatures at the outlets may be measured and reviewed daily in lieu of performing daily visual verification that all four inlet and outlet screens are unobstructed.

11.1.3.1 Cause of Accident

Failure of the temperature measuring instrumentation could occur as a result of component failure, or as a result of another accident condition that interrupted power or damaged the sensing or reader terminals.

The failure may be identified by the lack of a reading, or an inappropriate reading, at the temperature reader terminal. The event could also be identified by disparities between outlet temperatures in a cask or between similar storage casks.

11.1.3.2 Analysis of Instrumentation Failure

For concrete casks incorporating daily temperature-monitoring programs, the maximum time period during which an increase in outlet air temperatures may go undetected is 24 hours. The principal condition that could cause an increase in temperature is the blockage of the air inlets and/or outlets. Section 11.2.8 shows that even if all of the inlets and outlets of a single cask are blocked immediately after a temperature measurement, it would take longer than 24 hours before any component approaches its allowable temperature limit. Therefore, there would be sufficient time to identify and correct temperature instrumentation failure events prior to critical system components reaching their temperature limits. During the period of loss of instrumentation, no significant change in canister temperature will occur under normal conditions. Therefore, instrument failure would be of no consequence when the affected storage cask continues to operate in a normal storage condition.

Because the canister and the concrete cask are a large heat sink, and because there are few conditions that could result in a cooling air temperature increase, the temporary loss of remote sensing and monitoring of the outlet air temperature is not a major concern. No applicable regulatory criteria are violated by the failure of the temperature instrumentation system.

11.1.3.3 Radiological Consequences

There are no radiological consequences for this event.

11.1.3.4 NAC-MPC Performance

The NAC-MPC canister and storage casks are a large thermal sink. During the period of loss of instrumentation, no significant change in canister temperature will occur under normal conditions.

11.1.3.5 Recovery and Corrective Actions

Following the loss of instrumentation, the temperature instrumentation shall be replaced or repaired and returned to service to allow the surveillance requirements and frequency of LCO 3.1.6 to be met. Alternatively, the surveillance requirement may be met by the daily visual inspection of the inlet and outlet screens of each concrete cask to verify they are not blocked and are intact.

11.1.4 Severe Environmental Conditions (100°F and -40°F)

This section evaluates the NAC-MPC for the steady state effects of high and low ambient temperature conditions.

11.1.4.1 Cause of Event

Large geographical areas of the United States are subjected to sustained summer temperatures in the 90°F to 100°F range and winter temperatures that are significantly below zero. To bound the expected steady state temperatures of the canister and storage cask during these severe ambient conditions, analyses were performed to calculate the steady state storage cask, canister, and fuel cladding temperatures for a 100°F ambient temperature and 24-hour average solar loads. Similarly, winter weather analyses were performed for a -40°F ambient temperature with no solar load. The maximum thermal load of 12.5 kW was applied for the evaluation of the Yankee-MPC. The maximum thermal load of 17.5 kW was applied for the evaluation of the CY-MPC. Neither ambient temperature condition is expected to last more than several days.

Detection of off-normal ambient temperatures would occur during measurement of site ambient temperatures.

11.1.4.2 Analysis of the Off-Normal Ambient Temperature Event

The Yankee-MPC and CY-MPC configurations are evaluated separately.

11.1.4.2.1 Yankee-MPC Off-Normal Ambient Temperature Event

Off-normal temperature conditions are evaluated using the thermal models described in Section 4.4.1. The temperature profile for the concrete cask and for the air flow for the steady state conditions associated with a 100°F ambient condition are shown in Figures 11.1.4-1 and 11.1.4-2, respectively. Similar profiles for the -40°F ambient temperature condition are shown in Figures 11.1.4-3 and 11.1.4-4. The principal component temperatures for each of these ambient temperature conditions are summarized below.

This evaluation shows that the component temperatures are within the allowable values for the off-normal ambient conditions.

Yankee-MPC Component	100°F Ambient Max Temp. (°F)	-40°F Ambient Max Temp. (°F)	Allowable Temp. (°F)
Fuel Cladding	587	453	806
Support Disks	554	412	800
Heat Transfer Disks	552	411	700
Canister Shell	347	187	800
Concrete	196	5	350

The thermal stress evaluation for the Yankee-MPC concrete cask for these off-normal conditions are bounded by that for the accident condition with 125°F ambient temperature (Section 11.2.10), since the accident condition has the maximum temperature gradient through the storage cask concrete wall.

The thermal stresses for the Yankee-MPC canister the support disks and weldments due to these off-normal conditions are bounded in the thermal stress analysis presented in Section 3.4.4.1.

11.1.4.2.2 Analysis of the CY-MPC for the Off-Normal Ambient Temperature Event

Off-normal temperature conditions are evaluated using the thermal models described in Section 4.5.1. The temperature profile for the concrete cask and for the air flow for the steady state conditions associated with these off-normal conditions for the CY-MPC system are similar to those for the Yankee-MPC system as shown in Figures 11.1.4-1 through 11.1.4-4. The principal component temperatures for each of these ambient temperature conditions are summarized as:

CY-MPC Component	100°F Ambient Max Temp. (°F)	-40°F Ambient Max Temp. (°F)	Allowable Temp. (°F)
Fuel Cladding	649	530	806
Support Disks	560	428	800
Heat Transfer Disks	557	424	700
Canister Shell	337	188	800
Concrete	203	10	350

11.2.2.4 NAC-MPC Performance

This analysis shows that the design basis earthquake does not affect the NAC-MPC vertical concrete cask performance. The vertical concrete cask does not tip over for the design-basis earthquake having ground accelerations of 0.25g.

11.2.2.5 Recovery and/or Corrective Actions

Response Surveillance of the storage casks at the ISFSI is required following an earthquake accident in accordance with Section A 5.3 of the Technical Specifications to verify the heat removal systems of the casks are operable. While the cask does not tip over, there is a potential for movement of a cask relative to other casks and for superficial damage at the bottom edge due to that movement.

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11.2.3 Explosion

The flood analysis presented in Section 11.2.6 shows that the NAC-MPC system would not experience adverse effects due to a pressure of 22 psig applied to the canister. The vertical concrete cask will also be unaffected. This pressure is considered to bound any explosions occurring in the vicinity of the ISFSI.

11.2.3.1 Cause of Accident

An explosion is an unlikely event because administrative controls will exclude explosive substances in the vicinity of the ISFSI. No flammable or explosive substances are stored or used at the storage facility; therefore, an explosion affecting the site is extremely unlikely. This evaluation is provided in order to provide a bounding pressure that could be used in the event that the potential of an explosion must be considered at a given site.

11.2.3.2 Evaluation of the Explosion Event

The NAC-MPC canister shell was evaluated in Section 11.2.6 for the effects of a flood having a depth of 50 feet. The water exerts an external hydrostatic pressure of 22 psig on the canister, which results in stress in the canister shell.

The concrete cask is a monolithic structure that is not affected by the explosion overpressure.

11.2.3.2.1 Yankee-MPC Canister Stress Due to the Explosion Event

The maximum primary membrane stress calculated in the canister is 8.82 ksi. The allowable stress for accident conditions is 40.08 ksi. The margin of safety for primary membrane stress is + 3.54.

The maximum primary membrane plus bending stress calculated in the canister is 19.18 ksi. The allowable primary membrane plus bending stress for accident conditions is 60.12 ksi. The margin of safety for primary membrane plus bending stress is + 2.13.

Consequently, there is no adverse consequence to the canister as a result of the 22 psig external pressure. This pressure conservatively bounds an explosion event.

11.2.3.2.2 CY-MPC Canister Stress Due to the Explosion Event

The maximum primary membrane stress calculated in the canister is 3.91 ksi. The allowable stress for accident conditions is 40.08 ksi. The margin of safety for primary membrane stress is +9.26.

The maximum primary membrane plus bending stress calculated in the canister is 15.18 ksi. The allowable primary membrane plus bending stress for accident conditions is 60.12 ksi. The margin of safety for primary membrane plus bending stress is +2.96.

Consequently, there is no adverse consequence to the canister as a result of the 22 psig external pressure. This pressure conservatively bounds an explosion event.

11.2.3.3 Radiological Consequences

There are no radiological consequences for this accident.

11.2.3.4 NAC-MPC Performance

This analysis shows that the NAC-MPC system performance is not affected by explosion over pressure.

11.2.3.5 Recovery and/or Corrective Actions

Response Surveillance of the storage casks at the ISFSI in accordance with Section A 5.3 of the Technical Specifications is required following an explosion event to verify the heat removal systems of the casks are operable.

11.2.6.5 Recovery and/or Corrective Actions

Response Surveillance of the NAC-MPC systems at the ISFSI shall be performed following the flood accident in accordance with Section A 5.3 of the Technical Specifications to verify the heat removal systems of the casks are operable. Corrective actions will be taken, as required, to clear blockage of the inlet and outlet screens of each concrete cask.

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11.2.10 Maximum Anticipated Heat Load (125°F Ambient Temperature)

This analysis evaluates the NAC-MPC response to storage operation with an ambient temperature of 125°F. The NAC-MPC is evaluated at steady state conditions.

11.2.10.1 Cause of Accident

The cause of this condition is a weather event that causes the NAC-MPC to be subject to a 125°F ambient temperature with full solar insolance.

The condition is analyzed in accordance with the requirements of ANSI/ANS 57.9 to evaluate a credible worse case thermal loading. This condition is considered in the load combinations described in Chapter 2.

Detection of the ambient high temperature condition would occur during measurement of site ambient temperatures.

11.2.10.2 Analysis of the 125°F Ambient Temperature Event

11.2.10.2.1 Analysis of the 125°F Ambient Temperature Event for the Yankee-MPC

The severe high temperature condition is evaluated using the thermal models described in Section 4.4.1. A contents heat load of 12.5 kW is assumed. The principal component temperatures for this ambient condition are:

Component	125°F Ambient Max Temp. (°F)	Allowable Max Temp. (°F)
Fuel Cladding	607	806
Support Disks	575	800
Heat Transfer Disks	574	700
Canister Shell	372	800
Concrete	228	350

This evaluation shows that the component temperatures are within the allowable temperature for the severe high ambient temperature conditions.

This event is considered an "accident condition" for the purpose of this evaluation. Consequently, the thermal stress (secondary) occurring in the canister due to this thermal loading is not evaluated.

However, the thermal stresses for the concrete cask are calculated using the same methodology as shown in Section 3.4.4.2 for the stress calculation for normal conditions of storage. The same finite element model is used with the boundary temperatures based on concrete cask thermal analysis results (Section 4.4.4.1). The maximum vertical and circumferential (compressive) stresses at the concrete inside surface are calculated to be 660.1 psi and 127.5 psi, respectively. These stresses are included in the load combination (No. 4) as presented in Table 3.4.4.2-1. The maximum tensile forces in the vertical and hoop reinforcing bars are 19,380 lbs. and 23,196 lbs., respectively. Comparison of these forces and the allowable forces is shown in Table 3.4.4.2-2. As shown in Tables 3.4.4.2-1 and 3.4.4.2-2, the maximum combined concrete stress and reinforcing bar force for the load combination of dead (D), live (L) and accident temperature (T_a) are below the allowable stress and force, respectively.

11.2.10.2.2 Analysis of the 125°F Ambient Temperature Event for the CY-MPC

The severe high temperature condition is evaluated using the thermal models described in Section 4.5.1. The principal component temperatures for this ambient condition are:

Component	125°F Ambient Max Temp. (°F)	Allowable Max Temp. (°F)
Fuel Cladding	670	806
Support Disks	583	800
Heat Transfer Disks	579	700
Canister Shell	363	800
Concrete	235	350

This evaluation shows that the component temperatures are within the allowable temperature for the severe high ambient temperature conditions.

Chapter 12

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 that states for this LCO, separate Condition entry is allowed for each CONCRETE CASK. This is acceptable since the Required Actions for each Condition provide appropriate compensatory measures for each CONCRETE CASK not meeting the LCO. Subsequent CONCRETE CASKs that do not meet the LCO are governed by subsequent Condition entry and application of associated Required Actions. <u>A.1</u> If the CONCRETE CASK heat removal system has been determined to be not OPERABLE, it must be restored to OPERABLE status within 8 hours. Eight hours is reasonable based on the accident analysis that shows that the limiting CONCRETE CASK component temperatures will not reach their temperature limits for 24 hours after a complete blockage of all inlets and outlets. 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 Technical Specifications, plus 8 hours (typically, one operating shift) to take action to remove the obstructions in the air flow path. <u>B.1</u> Until the completion of Required Action A.1, performance of SR 3.1.6.1 shall be performed on an increased Completion Time Frequency of 6 hours to document the OPERABLE status of the CONCRETE CASK heat removal system. <u>AND</u>

(continued)

ACTIONS (continued)

B.2.1

If Required Action A.1 cannot be met, an engineering evaluation is performed to verify that the CONCRETE CASK heat removal system is OPERABLE. The Completion Time for this Required Action of 12 hours will ensure that the CANISTER remains in a safe, analyzed condition.

OR

B.2.2

Place the affected NAC-MPC SYSTEM in a safe condition. The Completion Time for this Required Action of 12 hours will ensure that the NAC-MPC SYSTEM is maintained in a safe condition.

SURVEILLANCE REQUIREMENTS

SR 3.1.6.1

The long-term integrity of the stored fuel is dependent on the ability of the CONCRETE CASK to reject heat from the CANISTER to the environment. Visual observation that all four air inlet and outlet screens are unobstructed and intact ensures that air flow past the CANISTER is occurring and heat transfer is taking place. Complete blockage of one or more air inlet or outlet screens renders the heat removal system not OPERABLE and this LCO is not met. Partial blockage of one or more air inlet or outlet screens does not result in the heat removal system being not OPERABLE. However, corrective actions should be taken promptly to remove the obstruction and restore full flow through the affected air inlet and outlet screens. Alternatively, based on the thermal analyses, if the air temperature rise is less than the limits stated in the SR, adequate air flow and, therefore, adequate heat transfer is occurring to provide assurance of long-term fuel cladding integrity. The reference ambient temperature used to perform this Surveillance shall be measured at the ISFSI facility.

The Frequency of 24 hours is reasonable based on the time necessary for CONCRETE CASK and CANISTER components to heat up to unacceptable temperatures assuming design basis heat loads, and allowing for corrective actions to take place upon discovery of the blockage of the air inlet and outlet screens.

(continued)

REFERENCES	1.	FSAR Chapter 4 and Chapter 11, Section 11.1.1 and Section 11.2.8.