72-1015

NAC INTERNATIONAL

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April 27, 2001

U.S. Nuclear Regulatory Commission
11555 Rockville Pike
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Attn: Document Control Desk

Subject: Submittal of the NAC Responses to the U.S. NRC Request for Additional Information for the UMS® Universal Storage System Amendment #2 for Maine Yankee Atomic Power Company Site Specific Spent Fuel (TAC No. L23217)

Docket No. 72-1015

References:

1. Request for Amendment of the Certificate of Compliance for the NAC-UMS® Universal Storage System to Incorporate Nonfuel Components and Uncanistered Damaged Fuel Rods as Approved Contents, Revision UMSS-00L, NAC International, October 17, 2000
2. Submittal of Supplemental Information to the Request for Amendment of the Certificate of Compliance for the NAC-UMS® Universal Storage System to Incorporate Nonfuel Components and Uncanistered Damaged Fuel Rods as Approved Contents, Revision UMSS-00M, NAC International, December 7, 2000
3. Request for Additional Information (RAI) for the UMS® Universal Storage System Amendment #2, U.S. NRC, January 22, 2001
4. Notification of the Date for Submittal of the Responses to the UMS-MY Amendment 2 RAI, NAC International, March 20, 2001

In accordance with Reference 4, NAC International (NAC) herewith submits ten copies of the responses to Reference 3, U.S. NRC Request for Additional Information for the UMS® Universal Storage System Amendment #2.

This submittal includes the RAI comments and NAC's responses presented in the standard NAC RAI response format, followed by the associated SAR changed pages, which are designated as Revision UMSS-01A of the UMS Safety Analysis Report (SAR), Revision 5 (UMS FSAR, Amendment 1).

The changed pages have been prepared in accordance with the following conventions:

- Revision indicators (revision bars) are used to highlight changes. Revision bars are not used to indicate text flow, but the revised "text flow" pages are provided for completeness.
- The changed pages for this submittal are designated as Revision UMSS-01A to provide a unique identification of the pages and changes.
- All of the pages in the List of Effective Pages are designated Revision UMSS-01A and no revision bars are used on those pages.

1/2

Rec'd from NMSS on 05/10/01

ED20010617

NMSS01 Public

Please note that after extensive review and consideration of the RAI comments on the proposed storage of uncanned damaged fuel, NAC has elected to withdraw the part of the requested amendment related to uncanned damaged fuel.

As previously discussed, implementation of the NAC-UMS® Universal Storage System is a critical path item for successful completion of the decommissioning of the Maine Yankee site, including the storage of control element assemblies and fuel-related non-fuel items. Therefore, NAC requests that the NRC complete the regulatory approval of this amendment as soon as possible, to support Maine Yankee's decommissioning schedule.

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

Sincerely,

T C Thompson

Thomas C. Thompson
Director, Licensing
Engineering & Design Services

Enclosure

cc: T. Williamson (MY)
P. Plante (MY)

EA790-SAR-002

DOCKET NO. 72-1015

UMS®

UNIVERSAL MPC SYSTEM®

SAFETY ANALYSIS REPORT

for the

UMS® Universal Storage System

APRIL 2001 REVISION UMSS-01A

NAC INTERNATIONAL

NAC-UMS
Docket # 72-1015
TAC # L23217

NAC INTERNATIONAL

RESPONSE TO THE

UNITED STATES
NUCLEAR REGULATORY COMMISSION

REQUEST FOR ADDITIONAL INFORMATION

(RAI-1, AMENDMENT 2; JANUARY 22, 2001)

NAC-UMS® UNIVERSAL STORAGE SYSTEM

(TAC NO. L23217, DOCKET NO. 72-1015)

APRIL 2001

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

TABLE OF CONTENTS FOR NAC-UMSS RAI-1, AMENDMENT 2 RESPONSES

NAC INTERNATIONAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 1: GENERAL DESCRIPTION

Terminology

1-1 Clarify the description of Uncanned Damaged Fuel on page 1-5 to state that only Maine Yankee fuel, as described in the proposed definition, is allowed.

The analyses provided in the SAR are only for Maine Yankee 14x14 fuel assemblies with up to 24 damaged rods per canister. While it may be inferred from the current definition that this is only Maine Yankee fuel, it is not specifically stated. This is required to ensure compliance with 10 CFR 72.236.

NAC Response

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel. Consequently, the subject description is deleted.

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CHAPTER 3: STRUCTURAL EVALUATION

Section 3.4.1.1 Component Operating Environment

3-1 Demonstrate that the control elements, non-fuel items, including startup sources, instruments or thimble plugs to be inserted into the fuel assembly are non-reactive with the fuel and internal fuel components when exposed to the various environments of a spent fuel cask. The evaluation should be comprehensive and specifically consider the effects of oxides on the fuel, elevated temperatures, and high radiation (including neutrons).

In accordance with 10 CFR 72.122(h)(1), which is applicable to an applicant for a general or site-specific license, the spent fuel cladding must be protected from degradation that leads to gross ruptures. The concern is whether any degradation of control elements, non-fuel items, including startup sources, or instruments or plug thimbles could affect the integrity of the cladding.

<u>NAC Response</u>

Refer to RAI Response 5-1 for descriptions of the non-fuel and neutron source materials.

The non-fuel components, including the boronometer source, are non-reactive with the fuel assembly or among themselves. By design, the non-fuel components, other than the boronometer source, are inserted in the guide tubes of a fuel assembly. During reactor operation, the non-fuel components are immersed in acidic water having a high flow rate and are exposed to significantly higher neutron flux, radiation and pressure than will exist in dry storage. The boronometer was housed in a vessel external to the reactor vessel. Reactor coolant (acidic water) was let down from the reactor coolant system, cooled and depressurized prior to being passed through the boronometer vessel. There are no adverse reactions, such as gas generation, galvanic or chemical reactions, or corrosion, that occur in water since, by design, these components are either within or adjacent to the

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NAC Response to RAI 3-1 (Continued)

fuel assemblies during use and in long-term wet (pool) storage. By design the components are non-reactive with the Zircaloy guide tubes and fuel rods. There are no aluminum or carbon steel parts, and no gas generation or corrosion occurs during prolonged water immersion (20 – 40 years).

The following table lists the non-fuel components and their material makeup.

Component	**Material**
Control Element Assembly (CEA)	
Spider Assembly	Type 304 stainless steel
Full Length Rods (Fingers)	Inconel 625
Part Length Rods (Fingers)	Inconel 625
In-Core Instrument (ICI) Thimble	Type 304 stainless steel and Zircaloy
Start-up Source	Encapsulated in Type 304 stainless steel
Boronometer Source	Encapsulated in Type 304 stainless steel
Instrument String Segment	Sheathed in Inconel 600
Rod Tips (Fingertips)	Inconel 625

Since the component materials are those that are typically used in the fabrication of fuel assemblies, no adverse reactions occur in the inert atmosphere that exists in storage. As shown below, the components are physically placed in dry storage in the same configuration as they are when used in the reactor, with the exception of the boronometer source. However, the boronometer source is the same material as the start-up source. Consequently, storage of the boronometer in the guide tube is acceptable.

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NAC Response to RAI 3-1 (Continued)

Component	**In-Core Placement**	**In-Storage Placement**
Control Element Assembly (CEA)	Inserted in Fuel Assembly	Inserted in Fuel Assembly
In-Core Instrument Thimble	Inserted in Fuel Assembly	Inserted in Fuel Assembly
Start-up Source (Sb-Be/Pu-Be)	Inserted in Fuel Assembly Guide Tube	Inserted in Fuel Assembly Guide Tube
CEA Tips	Inserted in Fuel Assembly Guide Tube	Inserted in Fuel Assembly Guide Tube
Instrument String Segment	Inserted in Fuel Assembly Guide Tube	Inserted in Fuel Assembly Guide Tube
Boronometer Source (Pu-Be)	Vessel External to the Reactor Vessel	Inserted in Fuel Assembly Guide Tube

Since all of the components are stored in the guide tubes of a fuel assembly, they are isolated from the oxide layer that may exist on the surface of the fuel tubes.

Because of the materials of construction of the components, the isolation of the components in the guide tubes, the material compatibility with the Zircaloy guide tube material and the dry inert atmosphere during storage, no adverse reactions occur with these components over prolonged periods at least equivalent to wet storage.

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CHAPTER 4: THERMAL EVALUATION

Section 4.5.1.1.12 Fuel Debris from the Failure of 24 Fuel Rods not in a Maine Yankee Fuel Can

4-1 Indicate the heat load used in the Maximum Temperature analysis. Page 4.5-10 references an assembly heat load used in the analysis of 0.113 kW, versus the previous heat load of 0.131 kW. If the heat load used was 0.113 kW, justify the reduction in the assumed heat load per assembly.

In accordance with 10 CFR 72.236(a) and (f), specifications must be provided for the spent fuel to be stored in the spent fuel storage cask, including minimum acceptable cooling time of the spent fuel prior to storage in the spent fuel storage cask, and maximum heat that is designed to be dissipated. In addition, the spent fuel storage cask must be designed to provide adequate heat removal capacity without active cooling systems. The concern is whether the correct values were used in the analysis that demonstrates that the design temperatures of the cask are not exceeded.

<u>NAC Response</u>

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel (failure of 24 fuel rods not in a Maine Yankee Fuel Can). Consequently, the previously submitted Section 4.5.1.1.12, which contained the subject heat load, is deleted.

For the purpose of clarification, the heat load used in the maximum temperature analysis is 0.131 kW per assembly.

NAC INTERNATIONAL RESPONSE
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CHAPTER 4: THERMAL EVALUATION

Section 4.5.1.1.12 Fuel Debris from the Failure of 24 Fuel Rods not in a Maine Yankee Fuel Can

4-2 Demonstrate that an applicant for a general or site-specific license will be able to meet the requirements of 10 CFR 72.122(h)(1) and 10 CFR 72.122(l).

The regulations require that the fuel assemblies be retrievable. Justification must be provided to ensure that the uncanned damaged fuel remains structurally intact, is not grossly ruptured under normal and off-normal conditions, and therefore remains retrievable on an assembly basis.

NAC Response

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel (failure of 24 fuel rods not in a Maine Yankee Fuel Can). Consequently, the previously submitted Section 4.5.1.1.12 is deleted.

For the purpose of clarification, as shown in Section 4.5.1.1.8, fuel assemblies with damaged rods are loaded in the Maine Yankee Fuel Can, which assures retrievability.

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CHAPTER 4: THERMAL EVALUATION

Section 4.5.1.1.13 Standard Fuel Assemblies with Inserted Startup Sources and Other Non-Fuel Items

4-3 Indicate the heat load and thermal properties for each of the non-fuel items. Describe how the heat load will be calculated for assemblies containing non-fuel items, and how this heat load is accounted for when determining maximum assembly loading and maximum vacuum-drying time.

In accordance with 10 CFR 72.236(a) and (f), specifications must be provided for the spent fuel to be stored in the spent fuel storage cask, including minimum acceptable cooling time of the spent fuel prior to storage in the spent fuel storage cask, and maximum heat that is designed to be dissipated. In addition, the spent fuel storage cask must be designed to provide adequate heat removal capacity without active cooling systems. The concern is that sufficient information is provided to demonstrate that the design temperatures of the cask are not exceeded.

NAC Response

As a result of SAR revision, this section has been renumbered as Section 4.5.1.1.12. Refer to RAI Response 5-1 for descriptions of the non-fuel and neutron source materials.

The decay heats for the non-fuel items are:

Source	Decay Heat (Watt)
CEA Tips	0.4
ICI Segment	1.4
Boronometer	10.7
Sb-Be Source	5.8
Pu-Be Unirradiated Source	0.0
Pu-Be Irradiated Source	9.6

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NAC Response to RAI 4-3 (Continued)

The decay heat of the Sb-Be source is from alpha decay of the Be. For the remaining non-fuel items, the decay heat source is gamma decay of activated stainless steel. The decay heat calculation conservatively assumes that the activated stainless steel is 100% cobalt.

As shown in Section 4.5.1.1.12 (was 4.5.1.1.13), the total heat load of the fuel assembly, including the small amount of extra heat generated by these non-fuel items, remains below the design basis heat load.

A description of the non-fuel items is provided in the response to RAI 5-1. The material composition of the CEA tips is solid inconel-625. The major composite elemental composition of inconel-625 is chromium (21.5%), nickel (58.0%) molybdenum (10.0%) and iron (5%). The in-core instrument (ICI) segment is part of the in-core instrumentation used in the reactor. The boronometer Pu-Be neutron source contains 19 grams of special nuclear material consisting of 323 curies of ^{238}Pu and 1.18 curies of ^{239}Pu. The Sb-Be neutron source consists of Type 304 stainless steel (90.9%), Sb-Be (6.8%) and inconel-750 (2.3%). The major material composition of the Pu-Be sources is chromium (17%), iron (64%) and nickel (11%). With these non-fuel items inserted into the guide tubes of the fuel assemblies, the effective conductivity in the axial direction of the fuel assembly is increased because solid material replaces helium in the guide tubes. The change in the effective conductivity in the transverse direction of the fuel assembly is negligible, since the non-fuel items are inside of the guide tubes. Furthermore, the fuel assemblies that contain these non-fuel items are restricted to the basket corner locations, which have an insignificant effect on the maximum basket and fuel temperatures at the center of the basket.

Therefore, the thermal performance of the fuel assemblies with inserted non-fuel items is bounded by that of the standard fuel assemblies.

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CHAPTER 4: THERMAL EVALUATION

Section 4.5.1.1.13 Standard Fuel Assemblies with Inserted Startup Sources and Other Non-Fuel Items

4-4 Provide supporting information regarding the request to include "a 24-inch segment of an in-core instrumentation (ICI) thimble" within a standard assembly. The application cover letter mentions this item, but there is no thermal analysis of the change.

In accordance with 10 CFR 72.236(a) and (f), specifications must be provided for the spent fuel to be stored in the spent fuel storage cask, including minimum acceptable cooling time of the spent fuel prior to storage in the spent fuel storage cask, and maximum heat designed to be dissipated. In addition, the spent fuel storage cask must be designed to provide adequate heat removal capacity without active cooling systems. The concern is that sufficient information is provided to demonstrate that the design temperatures of the cask are not exceeded.

<u>NAC Response</u>

As a result of SAR revision, this section has been renumbered as Section 4.5.1.1.12. Section 4.5.1.1.12 is revised to include the in-core instrumentation (ICI) segment. As shown in the response to RAI 4-3, the 24-inch length of the ICI segment has a decay heat of 1.4 watts. The decay heat results from the gamma decay of activated stainless steel. The decay heat is conservatively calculated, assuming that the activated stainless steel is 100% cobalt. The 24-inch length of instrument string is a part of the ICI segment component described in Section 4.5.1.1.5.

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CHAPTER 5: SHIELDING EVALUATION

Section 5.6.1.4.6 Additional Non-Fuel and Neutron Source Material

5-1 a. Provide an evaluation as to how the additional neutron source material, In-Core Instrumentation (ICI) thimble segment and Control Element Assembly (CEA) fingertips identified in SAR Section 5.6.1.4.6 meets the definition of "Spent Nuclear Fuel" given in 10 CFR 72.3.

b. Provide a description of the following components, include source strengths and a description of its use as a component at a reactor operating facility:

1. Boronometer
2. ICI string segment
3. Sb-Be sources
4. Pu-Be sources

Components which might be stored with the spent fuel must be described to allow staff to evaluate the impact to the dose rates in accordance with 10 CFR 72.236(d). Additionally, the components to be placed in a cask with spent fuel must meet the definition of "Spent Nuclear Fuel" specified in 10 CFR 72.3.

<u>NAC Response</u>

Spent Nuclear Fuel is defined in 10 CFR 72.3 as follows:

> "*Spent Nuclear Fuel* or *Spent Fuel* means fuel that has been withdrawn from a nuclear reactor following irradiation, has undergone at least one year's decay since being used as a source of energy in a power reactor, and has not been chemically separated into its constituent elements by reprocessing. Spent fuel includes the special nuclear material, byproduct material, source material, and other radioactive materials associated with fuel assemblies."

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NAC Response to RAI 5-1 (Continued)

The additional non-fuel and neutron source materials to be stored at Maine Yankee in the UMS® Storage System fall under the definition of "special nuclear material, byproduct material, source material, and other radioactive materials associated with fuel assemblies."

The Sb-Be and Pu-Be start-up neutron sources are used at the start-up of each refueling in a PWR reactor to provide neutrons for the chain reaction. The boron level in the reactor is reduced and/or control rods are withdrawn until the reaction is self-sustaining, at which time the start-up sources remain in residence in their host assemblies throughout the cycle. The Sb-Be and Pu-Be start-up sources fall under the "source material" envelope of the 10 CFR 72.3 definition. Source strengths for these items are given in Table 5.6.1-21, which is based on the waste characterization and the irradiated hardware spectrum shown in Tables 5.6.1-18 and 5.6.1-19, respectively.

Control Element Assembly (CEA) fingertips are that part of the CEAs typically left inserted in the top few inches of the active fuel of the reactor, positioned there to facilitate insertion in the event of control rod insertion or a reactor trip. CEAs are typically positioned symmetrically in the core, grouped in various banks of rods, and are inserted into the fuel assemblies themselves. Thus, they fall under the envelope of "other radioactive materials associated with fuel assemblies." The gamma spectrum of the CEA fingertips is shown in Table 5.6.1-20, which is based on the waste characterization shown in Table 5.6.1-17.

The ICI segment is part of the in-core instrumentation used in the reactor and is typically used to monitor reactor parameters, such as hot channel factors, enthalpy factors, power peaking and core axial offsets. ICIs are inserted into the instrument tubes of fuel assemblies and, therefore, are enveloped by the definition of "other radioactive materials associated with fuel assemblies." The gamma spectrum of the ICI segment is

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NAC Response to RAI 5-1 (Continued)

shown in Table 5.6.1-20, which is based on the waste characterization shown in Table 5.6.1-17.

The boronometer Pu-Be source is also part of the core monitoring routine. The source rate of the boronometer is used to calculate the concentration of boric acid in the reactor core. An accurate measurement of the boron level is needed because this is the primary means of reactivity control during normal full-power operations. Because the boronometer is a neutron source, it falls under the "source material" envelope of 10 CFR 72.3. The gamma and neutron spectra of the boronometer are given in Table 5.6.1-20, which is also based on the waste characterization in Table 5.6.1-18.

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CHAPTER 6: CRITICALITY EVALUATION

Section 6.5.2 SCALE 4.4 Validation in Accordance with NUREG/CR-6361

6-1 Provide a justification for including additional benchmarks in the validation for SCALE 4.4 which were not used in the validation for SCALE 4.3.

The proposed SAR change states that additional "benchmarks with zircaloy clad fuel are also considered" without any further justification. Any new, additional benchmarks to be used in the validation for SCALE 4.4 must have a valid justification for their inclusion. The only difference between this amendment and the previous version of the SAR is allowing damaged fuel to be uncanned. It appears that if any new benchmarks are required for this amendment that they would deal only with the additional fuel configurations and fuel-water mixtures considered in the flux traps. To correctly establish the bias and uncertainty, benchmarks are to be characteristic of the package design. Not all benchmarks with zircaloy clad fuel are necessarily applicable to the specific package in question. Also, note that it appears that some of the new experiments are not zircaloy clad – experiments 69 and 70, Table 6.5.2-1 are listed as stainless steel clad. This is required to ensure compliance with 10 CFR 72.236(c).

NAC Response

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel (failure of 24 fuel rods not in a Maine Yankee Fuel Can). Consequently, SCALE 4.4 Validation information (SAR Section 6.5.2) is deleted.

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TO
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CHAPTER 6: CRITICALITY EVALUATION

Section 6.5.2 SCALE 4.4 Validation in Accordance with NUREG/CR-6361

6-2 Describe in greater detail how the Upper Subcritical Limit (USL) was determined for the Pressurized Water Reactor (PWR) fuel. Also, describe the relevance of a new USL for Boiling Water Reactor (BWR) fuel since this amendment is only for 14x14 PWR fuel.

The validation does not list the bias and uncertainty associated with the USL determination, nor does it appear to include any uncertainty due to modeling approximations. Note that only biases that increase keff should be applied. This is required to ensure compliance with 10 CFR 72.236(c).

NAC Response

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel (failure of 24 fuel rods not in a Maine Yankee Fuel Can). Consequently, SCALE 4.4 Validation information (SAR Section 6.5.2) is deleted.

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CHAPTER 6: CRITICALITY EVALUATION

Section 6.5.2 **SCALE 4.4 Validation in Accordance with NUREG/CR-6361**

6-3 Update Table 6.5.2-1 to include the titles of the critical experiments as was done in Table 6.5.1-1.

This is needed to identify the critical experiments so that their applicability to the amendment can be determined (specifically fuel-water mixtures in the flux traps) and to ensure compliance with 10 CFR 72.124.

NAC Response

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel (failure of 24 fuel rods not in a Maine Yankee Fuel Can). Consequently, SCALE 4.4 Validation information (SAR Section 6.5.2) is deleted.

NAC INTERNATIONAL RESPONSE
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CHAPTER 6: CRITICALITY EVALUATION

Section 6.5.2 **SCALE 4.4 Validation in Accordance with NUREG/CR-6361**

6-4 Provide a table of correlation coefficients in Section 6.5 for the SCALE 4.4 Validation, similar to Table 6.5.1-2 for the SCALE 4.3 validation.

The correlation coefficients are not given for the SCALE 4.4 validation. This is required to ensure compliance with 10 CFR 72.124.

NAC Response

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel (failure of 24 fuel rods not in a Maine Yankee Fuel Can). Consequently, SCALE 4.4 Validation information (SAR Section 6.5.2) is deleted.

NAC INTERNATIONAL RESPONSE
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CHAPTER 6: CRITICALITY EVALUATION

Section 6.5.2 **SCALE 4.4 Validation in Accordance with NUREG/CR-6361**

6-5 Change B-10 loading in Table 6.5.2-2 from 0.25 to 0.025 for the UMS design basis fuel.

The correct value is 0.025 g/cm^2.

NAC Response

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel (failure of 24 fuel rods not in a Maine Yankee Fuel Can). Consequently, SCALE 4.4 Validation information (SAR Section 6.5.2) is deleted.

NAC INTERNATIONAL RESPONSE
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CHAPTER 6: CRITICALITY EVALUATION

Section 6.6.1.3.3 Fuel Debris from 24 Fuel Rods not in Maine Yankee Fuel Cans

6-6 Justify not considering dispersal of damaged fuel, either as a fuel-water mixture or as loose fuel pellets, in the active fuel region of the fuel basket in Section 6.6.1.3.3.

The calculational models are not adequately justified as being the most bounding scenario for uncanned damage fuel. Since the fuel is not contained in a can which confines it to a specific basket cell, the fuel could be located anywhere in the canister. Also, note that individual fuel pellets dispersed throughout the canister or broken rods located beside other rods may be more reactive than what has been considered in the amendment. This is required to ensure compliance with 10 CFR 72.236(c).

NAC Response

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel (failure of 24 fuel rods not in a Maine Yankee Fuel Can). Consequently, Section 6.6.1.3.3 is deleted.

For the purpose of clarification, as described in Section 6.6.1.3, fuel assemblies with damaged rods are loaded in the Maine Yankee Fuel Can. As stated in Section 6.6.1.3.2, the maximum k_s of the canister is less than 0.95, including associated uncertainty and bias, in this configuration.

NAC INTERNATIONAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 6: CRITICALITY EVALUATION

Section 6.6.1.3.3 Fuel Debris from 24 Fuel Rods not in Maine Yankee Fuel Cans

6-7 Justify the use of a 20%-80% fuel-water mixture versus some other value.

The use of this value is not justified as bounding the most reactive possible scenario. This is required to ensure compliance with 10 CFR 72.236(c).

NAC Response

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel (failure of 24 fuel rods not in a Maine Yankee Fuel Can). Consequently, Section 6.6.1.3.3 is deleted.

For the purpose of clarification, as described in Section 6.6.1.3, fuel assemblies with damaged rods are loaded in the Maine Yankee Fuel Can. As shown in Section 6.6.1.3.1, varying the volume fraction of fuel versus water mixture from 0 to 100 for fuel in the Maine Yankee Damaged Fuel Can results in a maximum k_s less than 0.95, including associated uncertainty and bias.

NAC INTERNATIONAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 6: CRITICALITY EVALUATION

Section 6.6.1.3.3 Fuel Debris from 24 Fuel Rods not in Maine Yankee Fuel Cans

6-8 Provide KENO input files for the most limiting dispersed pellet case and also the dispersed homogeneous mixture of fuel and moderator case discussed.

The input files were not provided. This is required to ensure compliance with 10 CFR 72.236(c).

NAC Response

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel (failure of 24 fuel rods not in a Maine Yankee Fuel Can). Consequently, Section 6.6.1.3.3 is deleted and the requested KENO input files are not used.

NAC INTERNATIONAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 6: CRITICALITY EVALUATION

Section 6.6.1.3.3 Fuel Debris from 24 Fuel Rods not in Maine Yankee Fuel Cans

6-9 Describe how the calculations in Section 6.6.1.3.3 were performed, and any associated uncertainties, for the cases where fuel is homogeneously mixed with the moderator and where fuel pellets are dispersed in various areas of the canister.

While different fuel elements can be modeled in the same cask by using Dancoff correction factors, SCALE (i.e., NITAWL) does not correctly handle a "double heterogeneity" scenario with fuel in different configurations (intact in the fuel rod and fuel dispersed in the water in the same model). This is required to ensure compliance with 10 CFR 72.236(c).

NAC Response

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel (failure of 24 fuel rods not in a Maine Yankee Fuel Can). Consequently, Section 6.6.1.3.3 is deleted.

For the purpose of clarification, as described in Section 6.6.1.3, fuel assemblies with damaged rods are loaded in the Maine Yankee Fuel Can. The SCALE analysis provided in Section 6.6.1.3.1 is acceptable for the configurations analyzed in Section 6.6.1.

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CHAPTER 6: CRITICALITY EVALUATION

Section 6.6.1.3.3 Fuel Debris from 24 Fuel Rods not in Maine Yankee Fuel Cans

6-10 Provide color figures of the following calculational models that clearly identify the different model regions and the location of the view. Also provide axial (side) views where appropriate;

a). with pellets in flux traps, guide tubes, and hardware zones (figures 6.6.1-4 through 6.6.1-8) and

b). dispersed fuel (figures 6.6.1-9 through 6.6.1-13).

The figures provided are difficult to assess, do not identify the different material regions and locations within the basket, and do not include dimensions. This is required to ensure compliance with 10 CFR 72.236(c).

<u>NAC Response</u>

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel (failure of 24 fuel rods not in a Maine Yankee Fuel Can). Consequently, Section 6.6.1.3.3 is deleted and the requested calculational models are not used. Previously submitted Figures 6.6.1-3 through 6.6.1-13 are deleted.

NAC INTERNATIONAL RESPONSE
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CHAPTER 11: ACCIDENT ANALYSIS

Section 11.2.15.1.5 Buckling Evaluation for Maine Yankee High Burnup Fuel Rods

11-1 Verify the lowest axial vibration frequency of 218.9 Hz and the corresponding dynamic load factor (DLF) of 0.244 for the high burnup fuel rod.

The reported axial vibration frequency and DLF appear to be associated with those calculated previously for the fuel rod with a nominal outer diameter of 0.440 inches. In the revised calculation, at a reduced clad outer diameter of 0.434 inches, the SAR reports a modified lowest lateral vibration frequency of 25.9 Hz, which is different from the 26.3 Hz based on the nominal clad outer diameter of 0.440 inches. Therefore, the calculated axial vibration frequency and DLF are also expected to be different from those reported values. This information is needed to assure compliance with 10 CFR 72.236(m).

NAC Response

The analysis establishing the lowest axial vibration frequency and the corresponding dynamic load factor (DLF) has been reviewed to confirm the vibration frequency and DLF. The review identified minor numerical differences that increased the lowest axial vibration frequency to 219.0 from 218.9 and changed the corresponding DLF to 0.240 ($\beta = 8.44$) from 0.244.

Section 11.2.15.1.5 is revised to incorporate these values. The changes in lowest axial vibration frequency and corresponding DLF are not significant with respect to the results of the analysis.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 11: ACCIDENT ANALYSIS

Section 11.2.15.1.6 Buckling Evaluation for High Burnup Fuel with Mechanical Damage

11-2 Considering appropriate cross sectional properties of the high burnup fuel rod, revise the fuel rod structural performance evaluation.

The calculation of flexural rigidity, El, was based on the nominal clad outer diameter of 0.440 inches. A reduced clad thickness should be considered for fuel rod stress evaluation for the side drop loading condition. This information is needed to assure compliance with 10 CFR 72.236(m).

NAC Response

Section 11.2.15.1.6 is revised to correct the fuel clad outer diameter used to calculate the flexural rigidity, EI. The correct outer diameter value is 0.434 in., which reduces the value of EI to 21,048 lb-in^2.

NAC INTERNATIONAL RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

CHAPTER 12: OPERATING CONTROLS AND LIMITS

Appendix 12A **Technical Specifications for the NAC-UMS System**

Section 12A 1.1 **Definitions**

12-1 Describe in detail the methods used for Maine Yankee uncanned damaged fuel to determine the number of failed fuel pins in each assembly, and justify how those methods adequately ensure that the number of failed fuel pins for that assembly is properly determined. Additionally, provide appropriate controls, such as the controls described in 12A 5.6, "Verification of Oxide Layer Thickness on High Burnup Fuel," to ensure that those methods will be used to determine the number of pins that are damaged for all damaged assemblies to be stored uncanned.

With canned damaged fuel, 100% of the rods are assumed to be damaged, thus many different methods (reactor records, sipping, visual, etc.) may be used to determine if one or more pins in an assembly are damaged. In that case, the number of pins that are actually damaged in the assembly is not critical to the safety analysis. ISG-1 describes the minimum acceptable methods for demonstration of fuel condition. This guidance was developed under the assumption that damaged fuel would be canned. However, under this proposed amendment, the maximum number of pins that could be damaged in an assembly (and therefore the canister) must be known. The structural, thermal and criticality analyses all assume a maximum of 24 uncanned damaged pins are loaded into a canister. For this amendment, the determination of the fuel condition must be on a pin basis, and not an assembly basis, as assumed in ISG-1. The applicant must demonstrate that the methods for determining the number of pins that are damaged are reliable and provide reasonable assurance that the maximum number of uncanned damaged pins per canister bounded by analysis is not exceeded. Additionally, no controls have been presented to ensure that specific method(s) will be used to determine the number of damaged fuel pins. Similar controls do exist for the verification of oxide layer thickness (Section 12A 5.6). This information is needed to ensure compliance with 10 CFR 72.236.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 12-1

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel. Consequently, the subject definition is deleted.

Chapter 12 is revised throughout, including Sections A 1.1, B 2.1.3, Table 12B2-6 and Table 12B2-7, to show that fuel classified as damaged is loaded in the Maine Yankee Fuel Can.

NAC INTERNATIONAL RESPONSE
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CHAPTER 12: OPERATING CONTROLS AND LIMITS

Appendix 12A **Technical Specifications for the NAC-UMS System**

Section 12A 3.1.6 **Concrete Cask Heat Removal System**

12-2 Explain how deletion of Required Action B.2.2 maintains adequate assurance that corrective action can be taken to restore cooling to the canister upon failure of the heat removal system, including a description of the actions that would be taken, or justify why events which could exceed the time allotted to clear the vents are not credible.

The Federal Register Notice (65 FR 62581), published on October 19, 2000, for the addition of NAC-UMS to the list of approved spent fuel storage casks included a response to comment H-3, which stated the NRC's judgement was that the use of the transfer cask to provide a means of cooling should remain an option. This information is needed to ensure compliance with 10 CFR 72.236(a).

NAC Response

The concrete cask employs a passive, chimney effect heat removal system. The system has no moving parts, and the air passageway is formed by substantial steel structures. As shown in the analysis, there are no design basis normal, off-normal or accident events that obstruct or close the passageway. Access to the passageway, once the shield and concrete cask lids are installed, is through air inlet and outlet openings. As shown in Drawing 790-562, the inlet and outlet ports are closed by screens, which have a small mesh size (less than 0.25 inches square). These screens on each air inlet and outlet effectively preclude the introduction of foreign material into the passageway. Because the air inlets and outlets are protected, blockage of the heat removal system during the period of storage is considered unlikely.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 12-2 (Continued)

It is considered possible, but highly unlikely, that a burrowing or nesting animal or bird could penetrate the screen and enter either an air inlet or outlet. Blockage of an outlet is expected to be detected, since this results in an increase in outlet air temperature. Because of the high temperature of the air and surrounding outlet steel and concrete, no animal or bird is expected to remain in the outlet. Entry of an animal into an air inlet may not be initially indicated from temperature readings and may rely on a periodic safety/security inspection for discovery. The reason is that, as shown in the analysis of the one-half inlets blocked case (Section 11.1.2), there is no immediate and large difference in air outlet temperature readings. This is because the system is designed with offset inlets and outlets, which force a division of cooling air. Based on the analysis of Section 11.1.2, a significant blockage must occur before the air outlet temperature rises significantly enough to indicate a blockage. Finally, the ISFSI site is an open area protected by a security fence. This fence is expected to preclude the casual entry of animals. Since there is no natural cover provided by trees or shrubs, animals are unlikely to remain in the ISFSI site, even if they gain entry.

Catastrophic events (such as a deep, fast-flowing flood, strong earthquake, or landslide) that could overwhelm the loaded concrete cask are considered in the site and UMS® System design basis, but these events are not expected to occur. As required by Administrative Control A.5.4, actions must be taken to clear any obstruction of the air inlets or outlets following an off-normal, accident or natural phenomena event, including lesser magnitude floods and earthquakes.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

NAC Response to RAI 12-2 (Continued)

Given the assumption that one or more inlets are blocked by an animal or wind-borne debris, less time would be required to remove the debris or animal than would be required to place the transfer cask in operation. During Storage Operations (the applicability of this LCO), retrieval of a transfer cask, a crane and the required ancillary equipment and services (yoke, transfer adapter plate, hose and piping) may not be readily accomplished. Further, it is expected that in the case of a catastrophic event not envisioned in the design basis (landslide, deep flood or severe earthquake), use of the transfer cask may not be immediately feasible due to issues such as accessibility to a crane, unevenness of the ground or ground stability.

Nevertheless, NAC concurs with the NRC comment that use of the transfer cask should remain an option for providing cooling to the canister. This provision remains an option, as long as Transfer Operations are in progress and the resources necessary to implement the Forced Air Cooling option are available. This option can be exercised in accordance with LCO 3.1.7, which provides for the removal of the canister from the concrete cask based on a determination that removal of the canister from the concrete cask is the only reasonable remedial action option.

Based on the consideration of factors specified in the design basis (barriers to intrusion into the air passageway and the absence of components, parts or debris that could physically block the heat removal system), no failure of this system is reasonably expected to occur.

NAC believes that the deletion of Required Action B.2.2 is appropriate, as there are no identified mechanisms by which the heat removal system fails and that, as shown in the analysis, heat removal from the canister is best achieved when the canister is in the concrete cask. The opportunity to implement supplemental cooling is provided for in LCO 3.1.7, if it is determined that the canister must be removed from the concrete cask.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

DUAL-PURPOSE CANISTER

During the course of its review, the staff identified issues that, while not directly relevant to storage, may be applicable to the intended transportation of the stored contents. These issues are not required to be addressed to obtain a 10 CFR Part 72 Certificate of Compliance.

DP4.1 Demonstrate that the uncanned damaged fuel maintains its configuration for all design basis events including accidents or, thermally analyze the reconfigured uncanned damaged fuel for its impact on seal temperature and intact cladding temperature considering normal and accident conditions, including relocation of the fuel to the center of the cask or to a position near the seals.

This information is required to assure compliance with 10 CFR 71.33(a)(5)(v) and (7) and 71.35(a). Sections 71.33(a)(5)(v) and 71.33(a)(7) require that the application provide information regarding the structural and mechanical means for the transfer and dissipation of heat and the maximum amount of decay heat. Section 71.35(a) requires demonstration that the package satisfies the standards specified in 10 CFR Part 71, Subparts E and F. The concern is that the rubblized fuel may result in temperatures exceeding design limits, when the cask is placed on its side for shipment.

NAC Response

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel. Consequently, the subject loading configuration is deleted.

Chapter 12 is revised throughout, including Sections A 1.1, B 2.1.3, Table 12B2-6 and Table 12B2-7, to show that fuel classified as damaged is loaded in the Maine Yankee Fuel Can. This loading condition ensures that relocation of fuel debris within the canister is substantially precluded.

NAC INTERNATIONAL RESPONSE
TO
REQUEST FOR ADDITIONAL INFORMATION

DUAL-PURPOSE CANISTER

DP6.1 Justify not considering dispersal of damaged fuel, either as a fuel-water mixture or as loose fuel pellets, in the active fuel region of the fuel basket during transportation.

The calculational models are not adequately justified as being the most bounding scenario for uncanned damaged fuel. Since the fuel is not contained in a can which confines it to a specific basket cell, the fuel could be located anywhere in the canister. Also, note that individual fuel pellets dispersed throughout the canister or broken rods located beside other rods may be more reactive than what has been considered in the amendment. This is required to ensure compliance with 10 CFR 71.55.

NAC Response

See the NAC Response to RAI 6-6.

NAC has elected to withdraw that part of the amendment request related to uncanned damaged fuel (failure of 24 fuel rods not in a Maine Yankee Fuel Can). Consequently, Section 6.6.1.3.3, the subject loading configuration, is deleted.

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Table 1-1 Terminology (Continued)

Maine Yankee Fuel Can	A specially designed stainless steel screened can sized to hold an intact fuel assembly, consolidated fuel, or damaged fuel. The can screens permit draining and drying, while precluding the release of gross particulates into the canister cavity. The Maine Yankee Fuel Can may only be loaded in a Class 1 Canister.
Transportable Storage Canister (Canister)	The stainless steel cylindrical shell, bottom end plate, shield lid, and structural lid that contain the fuel basket structure and the contents.
Shield Lid	A thick stainless steel disk that is located directly above the fuel basket. The shield lid comprises the first part of a double-welded closure system for the Transportable Storage Canister. The shield lid provides a containment/confinement boundary for storage and shielding for the contents.
- **Drain Port**	A penetration located in the shield lid to permit draining of the canister cavity.
- **Vent Port**	A penetration located in the shield lid to aid in draining and in vacuum drying and backfilling the canister with helium.
- **Port Cover**	The stainless steel covers that close the vent and drain ports, and that are welded in place following draining, drying, and backfilling operations.
- **Quick Disconnect**	The valved nipple used in the vent and drain ports to facilitate operations.

Table 1-1 Terminology (Continued)

Structural Lid	A thick stainless steel disk that is positioned on top of the shield lid and welded to the canister. The structural lid is the second part of a double-welded closure system for the Transportable Storage Canister. The structural lid provides a confinement boundary for storage, shielding for the contents, and canister lifting/handling capability.
Fuel Basket (Basket)	The structure located within the Transportable Storage Canister that provides structural support, criticality control, and primary heat transfer paths for the fuel assemblies.
- **Support Disk**	The primary lateral load-bearing component of the fuel basket. The PWR support disk is a circular stainless steel plate with 24 square holes machined in a symmetrical pattern. The BWR support disk is a circular carbon steel plate with 56 square holes machined in a symmetrical pattern. Each square hole is a location for a fuel tube.
- **Heat Transfer Disk**	A circular aluminum plate with 24 (PWR basket) or 56 (BWR basket) square holes machined in a symmetrical pattern. The heat transfer disk enhances heat transfer in the fuel basket.
- **Fuel Tube**	A stainless steel tube having a square cross-section with enclosed BORAL neutron poison material on its exterior surfaces. One fuel tube is inserted through each square hole in the support disks and heat transfer disks. Fuel assemblies are loaded into the fuel tube.
- **Tie Rod**	A stainless steel rod used to align, retain, and support the support disks and the heat transfer disks in the fuel basket structure. The tie rods extend from the top weldment to the bottom weldment.
- **Spacer**	Installed on the tie rod between the support disks (BWR only) or between the support disks and top and bottom weldments (BWR and PWR) to properly position the disks and provide axial support for the support disks.

1.3.2.1 Maine Yankee Site Specific Spent Fuel

The configurations of Maine Yankee site specific fuel assemblies that have been evaluated and found to be acceptable contents are:

- Fuel assemblies with up to 176 fuel rods removed from the assembly lattice.
- Fuel assemblies with fuel rods replaced with stainless steel rods, solid Zircaloy rods or fuel rods enriched to 1.95 wt %.
- Fuel assemblies with burnable poison rods replaced with hollow Zircaloy tubes.
- Fuel assemblies that are variably enriched with a maximum fuel rod enrichment of 4.21 wt % ^{235}U and that also have a maximum planar average enrichment of 3.99 wt % ^{235}U.
- Fuel assemblies with variable enrichment and/or annular axial blankets.
- Fuel assemblies with a control element assembly inserted.
- Fuel assemblies with an instrument thimble inserted in the center guide tube.
- Fuel assemblies with up to two fuel rods inserted in any or all of the guide tubes.
- Fuel assemblies with inserted non-fuel components, including startup sources.
- Consolidated fuel.
- Fuel assemblies having up to 100% of the rods damaged in each assembly.
- Fuel assemblies having a burnup of greater than 45,000 MWD/MTU but less than 50,000 MWD/MTU.

These site specific fuel configurations are evaluated against the limits established for the UMS® Storage System based on the design basis fuel. The site specific fuel is either shown to be bounded by the evaluation of the design basis fuel or is separately evaluated to establish limits which are maintained by preferential loading administrative controls. Where applicable to specific configurations, the preferential loading controls are described in Section 2.1.3.1.1. The preferential loading controls take advantage of design features of the UMS® Storage System to allow the loading of fuel configurations that may have higher burnup or additional hardware or fuel source material that is not specifically considered in the design basis fuel evaluation.

The Transportable Storage Canister loading procedures will indicate that the loading of a fuel configuration with removed fuel or poison rods, damaged or consolidated fuel in a Maine Yankee fuel can, or fuel with burnup greater than 45,000, but less than 50,000, MWD/MTU is administratively controlled in accordance with Section 2.1.3.1 and Table 2.1.3.1-1. As shown in the table, only one consolidated fuel lattice is loaded in any single canister. Preferential loading positions in the canister basket are shown in Figure 2.1.3.1-1.

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2.1.3 Site Specific Spent Fuel

The UMS® Storage System design basis PWR fuel assemblies are described in Section 2.1.1. Four different assembly arrays: 14 x 14, 15 x 15, 16 x 16 and 17 x 17, produced by several different fuel vendors, were evaluated in the determination of the PWR design basis fuel.

The design basis BWR fuel assemblies are described in Section 2.1.2. Three different arrays: 7 x 7, 8 x 8 and 9 x 9, produced by several different fuel vendors were evaluated in the determination of the UMS® BWR design basis fuel.

This section describes site specific spent fuel, i.e., fuel assemblies that are configured differently or that have different fuel parameters, such as enrichment or burnup, than the design basis fuel assemblies. The site specific fuel configurations result from conditions that occurred during reactor operations, participation in research and development programs, testing programs intended to improve reactor operations or from the insertion of control components or other items within the fuel assembly.

A summary description of the site specific spent fuels is presented in Section 1.3.2. The site specific spent fuel configurations are either shown to be bounded by the design basis fuel analysis or are separately evaluated. Unless specifically excepted, site specific spent fuel must also meet the conditions specified for the design basis fuel presented in Section 1.3.1.

2.1.3.1 Maine Yankee Site Specific Spent Fuel

The Maine Yankee site specific spent fuel assemblies are categorized as intact (undamaged) or damaged as defined in Table 1-1. Generally, damaged fuel and certain undamaged fuel configurations are placed in a Maine Yankee fuel can for storage in the Transportable Storage Canister; however, under certain conditions, fuel classified as damaged may be loaded as intact fuel (Section 2.1.3.1.7).

The configurations of Maine Yankee site specific spent fuel that have been evaluated and found to be acceptable contents are summarized in Section 1.3.2.1, and include those standard fuel assembly configurations, which were modified by the installation or removal of fuel or non fuel-bearing components.

The three principal types of these modifications are:

- The removal of fuel rods without replacement.
- The replacement of removed fuel rods or burnable poison rods with rods of another material, such as stainless steel, or with fuel rods of a different enrichment.
- The insertion of control elements, non-fuel items including startup sources, or instrument or plug segments, in guide tube positions.

Site specific spent fuel also includes fuel assemblies that are uniquely designed to support reactor physics. These fuel assemblies include those that are variably enriched or that are variably enriched with annular axial blankets. Generally, these fuel assemblies (described in Sections 6.6.1.2.2 and 6.6.1.2.3) are bounded by the evaluation of the design basis fuel.

As described in Section 2.1.3.1.6, certain of the site specific spent fuel configurations, including damaged and consolidated fuel loaded in Maine Yankee fuel cans, must be preferentially loaded in corner positions of the fuel basket. In addition, certain of the site specific fuel has experienced burnup that exceeds the 45,000 MWD/MTU design basis burnup. The thermal evaluation of these fuel assemblies is presented in Section 4.5.1. The results of that evaluation show that a fuel assembly with a burnup between 45,000 and 50,000 MWD/MTU must be preferentially loaded in peripheral fuel positions in the basket.

2.1.3.1.1 Damaged Fuel Lattices

There are two lattices for damaged fuel rods in the current Maine Yankee fuel inventory, designated CF1 and CA3, that are loaded in Maine Yankee fuel cans. CF1 is a lattice having roughly the same dimensions as a standard fuel assembly. It is a 9 x 9 array of tubes, some of which contain damaged fuel rods. CA3 is a previously used fuel assembly lattice that has had all of the rods removed, and into which, damaged fuel rods have been inserted. The CF1 and CA3 lattices are placed in a Maine Yankee fuel can for storage. No credit is taken for the lattice structures in the criticality, structural, or thermal analysis.

2.1.3.1.2 Maine Yankee Consolidated Fuel

The Maine Yankee fuel inventory includes two consolidated fuel lattices, which house intact fuel rods taken from three fuel assemblies. Each lattice is a 17x17 array formed using stainless steel grids and top and bottom stainless steel end fittings. Four solid stainless steel connector rods connect the end fittings. The top end fitting is designed so that the lattice can be handled by the standard fuel assembly lifting fixture (grapple). These lattices were not used in the reactor and the stainless steel hardware is not activated.

One of these lattices contains 283 fuel rods and 2 rod position vacancies. The other contains 172 fuel rods, with the 76 stainless steel dummy rods in the outer periphery of the lattice.

The consolidated fuel is placed in a Maine Yankee fuel can for storage. No credit is taken for the lattice structures in the criticality, structural, or thermal analysis.

2.1.3.1.3 Maine Yankee Spent Fuel with Inserted Integral Hardware or Non-Fuel Items

Certain Maine Yankee fuel assemblies have either a Control Element Assembly or an Instrument Segment inserted in the fuel assembly. These components add to the gamma radiation source term of the standard fuel assembly.

A Maine Yankee Control Element Assembly (CEA) consists of five control rods mounted on a Type 304 stainless steel spider assembly. The five control rods are inserted in the fuel assembly guide tubes when the CEA is inserted in the fuel assembly. When fully inserted, the control element spider rests on the fuel assembly upper end fitting. The rods are fabricated from Inconel 625 or stainless steel and encapsulate B_4C as the primary neutron poison material. Fuel assemblies with a control element installed must be loaded into a Class 2 canister because of the additional height that the control element spider adds to the fuel assembly overall length.

Some standard fuel assemblies have an in-core instrument (ICI) thimble inserted in the center guide tube of the fuel assembly. The detector material and lead wire have been removed from the ICI assembly. The thimble top end and tube are primarily Zircaloy. When installed, the instrument thimble does not add to the overall fuel assembly length. Consequently, fuel assemblies with ICI thimbles are loaded in the Class 1 canister.

The non-fuel inventory includes an ICI instrument segment approximately 24 inches long. This segment is loaded in the corner guide tube position of an intact fuel assembly. The fuel assembly with the ICI segment installed must have a CEA flow plug installed to close the top of the corner guide tube, capturing the segment between the CEA flow plug and the bottom end plate of the fuel assembly. The ICI segment may be installed in a fuel assembly that also holds CEA finger tips in other corner guide tube positions. Because of the CEA fuel plug, the fuel assembly must be installed in a Class 2 canister.

The non-fuel inventory also includes five startup sources and one boronometer source. One of the start-up sources is unirradiated.

The boronometer source contains 16 grams of plutonium and 8 grams of beryllium that are double encapsulated within a Type 304 stainless steel sealed tube. The tube is approximately 3.5 inches in length and 0.5 inches in diameter. The boronometer source is loaded in the corner guide tube position of an intact fuel assembly. This fuel assembly must also have a CEA flow plug installed to close the top of the corner guide tube, capturing the boronometer source between the CEA flow plug and the bottom end plate of the fuel assembly. The boronometer source may not be installed in a fuel assembly that also holds a start-up source, but may be installed in a fuel assembly that also holds the CEA finger tips and/or ICI segment.

The start-up sources include three Pu-Be sources and two Sb-Be sources that are installed in the center guide tubes of fuel assemblies that subsequently must be loaded in one of the four corner fuel positions of the basket. Each source is designed to fit in the center guide tube of an assembly, and only one startup source may be loaded in any fuel assembly. All five of these startup sources contain Sb-Be pellets, which are 50% Be by volume. One of the three Pu-Be sources is unirradiated and evaluation of this source is based on a "fresh" source material assumption.

2.1.3.1.4 Maine Yankee Spent Fuel with Unique Design

Certain Maine Yankee fuel assemblies were uniquely designed to accommodate reactor physics. These assemblies incorporate variable radial enrichment and axial blankets.

Two batches of fuel used at Maine Yankee contain variably enriched fuel rods. The maximum fuel rod enrichment of one batch is 4.21 wt % ^{235}U with the variably enriched rods enriched to 3.5 wt % ^{235}U. The maximum planar average enrichment of this batch is 3.99 wt % ^{235}U. For the other batch, the maximum fuel rod enrichment is 4.0 wt % ^{235}U, with the variably enriched rods enriched to 3.4 wt % ^{235}U. The maximum planar average enrichment of this batch is 3.92 wt % ^{235}U.

Fuel assemblies with a startup source in the center guide tube position or the Boronometer source in a corner guide tube position must be loaded in one of the basket corner positions. A fuel assembly may not hold more than one startup source and may not hold both a startup and a Boronometer source.

The loading position of fuel assemblies holding the CEA finger tips and/or the ICI segment in a fuel assembly corner guide tube position is not controlled; however, these fuel assemblies must have a CEA flow plug to ensure these items are captured within the guide tube(s).

2.1.3.1.7 Maine Yankee High Burnup Fuel

There are ninety (90) Maine Yankee fuel assemblies that have achieved a burnup between 45,000 and 50,000 MWD/MTU. As described in Section 2.1.3.1.6, these fuel assemblies are preferentially loaded in peripheral locations in the basket. The high burnup assemblies are similar to the other Maine Yankee fuel planned to be placed in dry storage (i.e., those with burnup less than 45,000 MWD/MTU), but have design differences that support the high burnup objective.

The Combustion Engineering 14 x 14 high burnup fuel assemblies incorporate a lower (fuel rod) internal pressure than the UMS design basis fuel, which results in lower cladding stress throughout their reactor and storage life, and a greater cladding thickness. The greater cladding thickness, together with a larger fuel rod diameter, provide additional margin against regulatory limits. Some of the fuel assemblies have a "low tin" Zircaloy cladding, which results in lower hydrogen pick-up in the cladding and a lower cladding oxide layer thickness.

Publicly available DOE-sponsored research studies on high burnup fuel have measured irradiated Zircaloy material properties. These studies show that even at burnups over 50,000 MWD/MTU, Zircaloy cladding has adequate material strength and ductility to maintain fuel rod integrity throughout all conditions of storage. The technical details of the DOE sponsored research studies include hot cell examination of spent fuel from the Fort Calhoun [22] and Oconee [23] reactors.

The published reports conclude that there is an increase in the yield and ultimate strengths, and a decrease in ductility of the high burnup fuel rod Zircaloy cladding with an oxide layer thickness less than or equal to 80 microns. The Fort Calhoun and Oconee fuel rods examined had maximum burnup up to 55,700 and 54,800 MWD/MTU, respectively. Localized burnup of these fuel rods reached over 60,000 MWD/MTU. The burnups encompass the burnups of the Maine Yankee high burnup fuel. Tables 17, 18 and 19 of the Fort Calhoun report (DOE/ET/34030-11) demonstrate that, at the respective burnups, there is a significant increase in the yield and ultimate strengths of the Zircaloy cladding with a corresponding decrease in the material ductility (plastic strain). This is further confirmed in the Oconee fuel examination report (DOE/ET/34212-50) in Table 20. These studies show that the Zircaloy material property changes occur during the early stages of irradiation and do not change significantly during the higher burnup periods. The Fort Calhoun and Maine Yankee fuels are essentially identical and are fabricated by the same supplier (Combustion Engineering). Therefore, it is concluded that the Maine Yankee high burnup fuel (45,000 < Burnup < 50,000 MWD/MTU) Zircaloy cladding ultimate and yield strengths are greater than those of standard burnup fuel assemblies, while maintaining adequate material ductility to perform its design functions.

The Maine Yankee high burnup fuel assemblies were fabricated according to their respective fuel specifications without any discrepancies or deviations that affected cladding. Review of Plant Operating Data demonstrates that the fuel has not been subjected to any unanalyzed events that could potentially lead to excessive cladding stress.

Review of fuel inspection records and video tapes of the Maine Yankee high burnup fuel assemblies shows that the fuel is essentially identical to fuel that is burned less than 45,000 MWD/MTU, with no evidence of damage or excessive cladding oxidation.

The supporting data and information demonstrates that the physical and mechanical characteristics of the Maine Yankee high burnup fuel assemblies (45,000 < Burnup < 50,000 MWD/MTU) are essentially identical to those of the fuel assemblies with burnup less than 45,000 MWD/MTU.

Figure 2.1.3.1-1 Preferential Loading Diagram for Maine Yankee Site Specific Spent Fuel

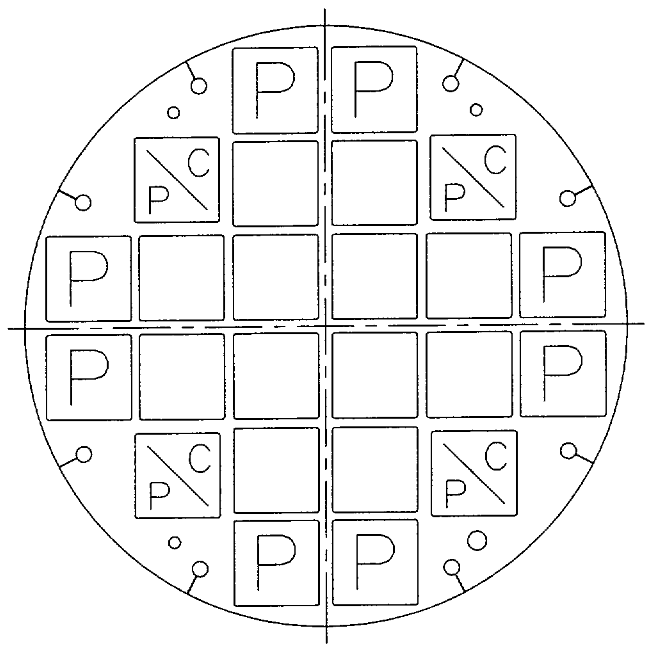

Table 2.1.3.1-1 Maine Yankee Site Specific Fuel Population

Site Specific Spent Fuel Configurations[1]	**Est. Number of Assemblies**[2]
Standard Fuel	1,434
Inserted Control Element Assembly (CEA)	168
Inserted In-Core Instrument (ICI) Thimble	138
Consolidated Fuel	2
Fuel Rod Replaced by Rod Enriched to 1.95 wt %	3
Fuel Rod Replaced by Stainless Steel Rod or Zircaloy Rod	18
Fuel Rods Removed	10
Variable Enrichment	72
Variable Enrichment and Axial Blanket	68
Burnable Poison Rod Replaced by Hollow Zircaloy Rod	80
Damaged Fuel in Maine Yankee Fuel Can	12
Burnup between 45,000 and 50,000 MWD/MTU	90
Maine Yankee Fuel Can	As Required
Inserted Startup Source	4
Inserted Boronometer Source	1
Inserted CEA Fingertips or ICI String Segment	1

1. The loading of the site specific fuel is controlled by the requirement of Section 12B2 of the Technical Specifications presented in Chapter 12.
2. The number of fuel assemblies in some categories may vary depending on future fuel inspections.