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April 23, 2008

Mr. Randy Hall, Project Manager
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, MD 20852-2738

Subject: Minutes of the April 17, 2008 UMS® High Burnup Draft Criticality RAI Teleconference
Docket No. 72-1015 (TAC No. L24032)

Dear Mr. Hall:

NAC International (NAC) hereby submits the subject minutes documenting the discussions and clarifications for each Draft Criticality RAI provided to NAC via e-mail and discussed with the NRC staff on April 17, 2008. As discussed during the teleconference, clarification beyond the actual discussion during the teleconference and proposed edits to FSAR text are included in the attached document, as appropriate, with each respective Draft RAI.

This submittal includes eight copies of this transmittal letter and eight copies of Attachment 1 – UMS® High Burnup Draft Criticality RAI, NRC/NAC Teleconference, April 17, 2008. Upon NRC review and approval, the proposed FSAR and Technical Specification changes will be incorporated into a formal supplement to the NAC-UMS® FSAR and Technical Specification currently under review.

If you have any questions regarding this submittal, please contact me at 678-328-1274.

Sincerely,

Anthony L. Patko
Director, Licensing
Engineering

Attachment 1 – UMS® High Burnup Draft Criticality RAI, NRC/NAC Teleconference, April 17, 2008

ED20080050

NMSS01

UMS® High Burnup Draft Criticality RAI
NAC - Response Comments
Teleconference April 17, 2008
Docket No. 72-1015 (TAC No. L24032)

Participants

NRC: Randy Hall, Mike Call

NAC: Tom Danner, Holger Pfeifer

General Discussion:

Randy Hall initiated the conference call to review the Draft RAI questions prepared by the NRC technical staff for the UMS® High Burnup amendment. The format of the interface and proposed resolution path would be similar to the format adopted for the MAGNASTOR application currently in a Draft RAI applicant interface. The guidance being implemented is to have "the licensee include the questions from the teleconference and email or fax in their docketed response" to the teleconference discussion. It is the intent of the call to review each question and determine if it can be closed with teleconference discussion, editorial/or clarification revision to SAR text, or if additional material is required to be addressed. Following this brief introduction, each draft RAI provided by email was discussed. It was noted by Mr. Hall that the three Draft RAI questions provided by email on April 16, and the subject of this call, were the only open issues remaining to be addressed on the UMS® High Burnup amendment request, and that with timely resolution of these RAI questions, the NRC project manager would issue the draft CoC and proceed to rulemaking.

The following material addresses each Draft RAI, summarizes teleconference discussions, and includes the documentation that is intended to close each issue. FSAR and Technical Specification proposed changes are noted in bold italic.

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TS-1 Verify the descriptions of the proposed system contents in Appendix B to the Certificate of Compliance (CoC).

Staff notes that the definitions of damaged, undamaged, and intact fuel were modified in response to the previous RAI questions. The proposed contents in Appendix B to the CoC, with the exception of Table B2-1, paragraphs I.H and I continue to describe the allowable contents as intact BWR and PWR fuel only. Paragraphs I.H and I of Table B2-1 refer to undamaged PWR fuel; however, I.A of that table allows for only Intact PWR fuel contents. The change in the definition of intact fuel impacts the contents that may be stored in the cask system. Staff notes that several pages of the SAR were updated to address undamaged fuel. Also, the definition of Maine Yankee Fuel Can (Appendix A to the CoC) does not address undamaged fuel contents. The proposed system contents should be supported by, or bounded by, the SAR evaluations.

This information is needed to confirm compliance with 10 CFR 72.236(a).

Summary of Technical Discussion

NAC agreed with the NRC review staff comment that "intact" fuel was incorrectly retained in a number of locations while updating the FSAR to include "undamaged" fuel as the primary payload definition (with "intact" fuel being a subset of "undamaged" fuel). NAC further agreed that retaining the "intact" statements within the CoC appendix would limit the payload allowed in the system significantly. As no reduction in allowable content was intended as part of this application, NAC will modify the appendices to the CoC to refer to "undamaged" fuel where applicable.

Proposed Resolution

NAC will revise Chapter 1 and Appendices A and B of the proposed CoC (Technical Specifications) to refer consistently to undamaged fuel as the allowed payload.

Draft FSAR/CoC Text Changes

The proposed nine revised pages for Appendices A and B of the Technical Specifications (pages A1-5, B2-2, B2-6, B2-7, B2-8, B2-15, B2-16, B2-17 and B3-1) and the three proposed modified FSAR pages (pages 1.5-2, 1.5-5 and 1.5-48) are attached to this response document.

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TS-2. Provide the following modifications to the definitions in Appendix A to the CoC:

a. Item 2 of Damaged Fuel. Modify the note to read: Maine Yankee fuel assemblies with missing rods, not replaced by solid filler rods, are an exception based upon the criticality analysis done for these assemblies. However, these Maine Yankee assemblies must be preferentially loaded per Tables B2-6 and B2-7.

b. Item 2 of Damaged Fuel. The language in both the item and the attached note should state that the filler/dummy rods are solid filler/dummy rods.

c. Consolidated Fuel. The individual rods referenced in the definition should be described as undamaged. Note that the definition in the SAR has this wording.

With regard to item a., it is not clear from the currently proposed note text that Maine Yankee fuel assemblies missing fuel rods are not considered damaged fuel. Yet, paragraph I.I of Table B2-1 in Appendix B of the CoC indicates these assemblies are undamaged fuel; thus, the classification of these assemblies is unclear from the currently proposed text.

This information is needed to confirm compliance with 10 CFR 72.236(a).

Summary of Technical Discussion

For modifications "a." and "b.", NAC agreed that inclusion of the term "solid" represents a consistent definition through NAC applications and is consistent with NRC guidance. The wording requested in item "a." will be adopted verbatim (note additional text will be added to clarify that Maine Yankee missing rod assemblies are defined as "undamaged"). As recognized by the NRC review staff, consolidated fuel rods should be labeled as undamaged, and NAC agrees to change the definition accordingly.

To clarify the definition of Maine Yankee assemblies with damaged rods, the note to item 2 in the CoC Appendix A definition is modified to state that Maine Yankee missing rod assemblies are undamaged.

Proposed Resolution

NAC will revise the text in Appendix A to the CoC with the requested wording.

Draft FSAR/CoC Text Change

The proposed revised page A1-2 for Appendix A of the Technical Specifications is attached to this text response.

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TS-3. Demonstrate that the proposed minimum flux trap (structural disk web) thickness dimensions in the Technical Specifications (TS) are consistent with the design tolerances of the PWR and BWR baskets (structural disks) and are supported by the criticality analysis, modifying those dimensions that do not meet these conditions.

The applicant proposed minimum flux trap dimensions in the TS (Appendix B to the CoC, Section B 3.2.1.e). However, these proposed dimensions do not appear to be consistent with the design tolerances described in the technical drawings; the tolerances in the drawings indicate that the flux trap dimensions may be smaller than the proposed TS dimensions. Additionally, it is unclear that the criticality analysis supports the proposed TS dimensions. For example, the sample inputs provided in the analysis (both the MONK and CSAS inputs) use larger dimensions that also are not consistent between sample input files. Further, it is not clear that the application of the tolerances described in SAR Sections 6.4.1.3.1 and 6.4.1.3.2 to the disk opening dimensions in the technical drawings (both for opening size and position) results in the TS values for disk web thickness. The minimum flux trap dimensions in the TS should be consistent with, or bound, the minimum dimensions possible based upon the design tolerances, and the criticality analysis should demonstrate subcriticality for loaded casks with baskets having these minimum flux trap dimensions. These dimensions are important since the basket geometry is a primary means of controlling system reactivity for a spent fuel storage cask in all phases of operation.

This information is needed to confirm compliance with 10 CFR 72.124(b) and 72.236(c).

Summary of Technical Discussion

FSAR criticality evaluations of the UMS® system are based on design drawing dimensions and tolerances. The design drawings provide the technical basis for the fabrication of the system. As recognized by the NRC review staff, applying the tolerances from the licensing drawing would not result in the proposed minimum flux trap dimensions. This issue was recognized during previous licensing efforts on the system. To provide sufficient information for criticality review and independent NRC calculations, the tolerances obtained from the design drawings are specified in Chapter 6 of the FSAR, in particular Section 6.4.1.3.1, Page 6.4-6 (PWR) and Section 6.4.1.3.2, Page 6.4-8 (BWR). The relevant text follows.

From page 6.4-6 of the UMS® FSAR:

"...Variation in basket disk opening is modeled by adding or subtracting a tolerance of ± 0.015 in. (0.038 cm) to the nominal dimension of the opening. The tolerance on the opening size modifies the web thickness but does not impact tube positioning.

"Variation in basket disk opening position is limited by the positional tolerance, within the diameter, of 0.015 in. (0.038 cm). As with the fuel assembly and tube movements, the reactivity effect of the opening position is maximized by shifting the opening to the upper right hand corner by 0.0053 in. $(0.0075^2/2)^{1/2}$ in both +x and +y directions. This minimizes the webbing and corresponding flux trap gap effectiveness."

For reviewer information, and to demonstrate consistency of the analysis input with the proposed specification, a PWR structural disk sketch (Figure TS-3.1) is included in this response. The sketch contains the as-evaluated configuration (dimensions and tolerances) of the PWR disk. A BWR disk sketch is not included, as nominal dimensions are included in existing FSAR figures (e.g., Figure 6.3-5) and tolerances are identical for PWR and BWR structural disks.

The center location and width for each of the basket openings are defined by the design drawing. The toleranced web thickness, i.e., flux trap width, is based on the tolerances on the opening width and opening location. The disk opening may increase by 0.015 inch, resulting in a 0.0075-inch reduction from each of two adjacent openings, for a 0.015-inch web reduction. The opening center location may vary based on a 0.015-inch diameter circle from its nominal location. For a lateral shift (along a coordinate axis), this also would result in a 0.015-inch reduction in web thickness. For the center PWR flux trap, for example, application of the tolerances results in a 1.47-inch minimum web thickness (1.50-inch nominal minus 2 × 0.015 inch). A dimension of 1.47 inches is specified in the proposed technical specification for this web. All proposed specifications are similarly related to the design drawing nominal dimensions and tolerances.

Note that criticality evaluations are based on maximum reactivity configurations and do not necessarily correspond to the minimum web thickness configuration. BWR evaluations demonstrate that there is no effect on system reactivity due to the specified tolerances on disk opening size and location. A 0.65-inch (nominal) web thickness is, therefore, included in the sample input files. PWR inputs were initially based on a maximum reactivity radial shift in a disk opening location (CSAS models). A radial shift toward the basket center disk opening location corresponds to a 0.0053-inch x–coordinate and y–coordinate change (shift along the 45-degree axis of the 0.015-inch diameter tolerance circle). The shift in configuration represents a minor increase in reactivity (0.0015 Δk in FSAR Table 6.4-5) for the infinite fuel height KENO-Va model (FSAR Figure 6.8-1). The MONK finite height cask models were not sensitive to basket opening locations (see FSAR Table 6.4-27 with a $\Delta k < 0.001$) and resulted in a maximum reactivity configuration containing maximum disk opening size and nominal disk opening location (see FSAR Figure 6.8-9 for sample input file). Criticality evaluations of the system do not show a sensitivity to disk opening location due to the small dimensional shift allowed in the maximum reactivity direction (0.0053 inch for a shift in configuration) and the shift only impacting the center flux trap in the shifted configuration (an identical shift in all tubes would retain the remaining flux trap dimensions at their original values).

Proposed Resolution

The previous technical discussion clarifies the origin and justification for the proposed Appendix B of the CoC. As Chapter 6 contains this information, no further information is considered necessary.

Draft FSAR/CoC Text Change

No FSAR/CoC text changes are required for this issue.

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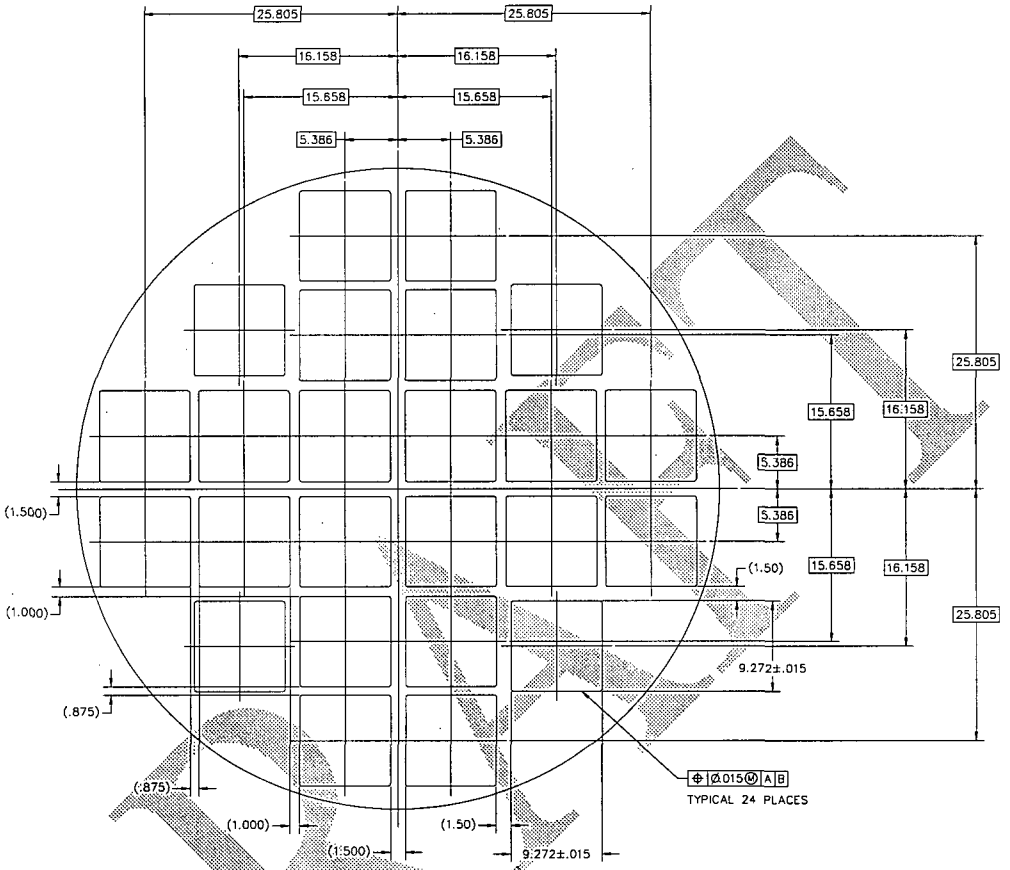
Figure TS-3.1 Criticality Evaluation Basis - Structural Disk Sketch



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APPENDIX 1

The following proposed revised pages are contained in Appendix 1:

Technical Specifications – Appendix A

A1-2
A1-5

Technical Specifications – Appendix B

B2-2
B2-6
B2-7
B2-8
B2-15
B2-16
B2-17
B3-1

NAC-UMS® FSAR

1.5-2
1.5-5
1.5-48

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CANISTER HANDLING FACILITY	The CANISTER HANDLING FACILITY includes the following components and equipment: (1) a canister transfer station that allows the staging of the TRANSFER CASK with the CONCRETE CASK or transport cask to facilitate CANISTER lifts involving spent fuel handling not covered by 10 CFR 50; and (2) either a stationary lift device or mobile lifting device used to lift the TRANSFER CASK and CANISTER.
CONCRETE CASK	See VERTICAL CONCRETE CASK
CONSOLIDATED FUEL	A nonstandard fuel configuration in which the ***undamaged*** individual fuel rods from one or more fuel assemblies are placed in a single container or a lattice structure that is similar to a fuel assembly. CONSOLIDATED FUEL is stored in a MAINE YANKEE FUEL CAN.
DAMAGED FUEL	Spent nuclear fuel (SNF) that cannot fulfill its fuel-specific or system-related function. DAMAGED FUEL must be placed in a MAINE YANKEE FUEL CAN unless otherwise noted. Spent fuel is classified as damaged under the following conditions. 1. There is visible deformation of the rods in the SNF assembly. Note: This is not referring to the uniform bowing that occurs in the reactor; this refers to bowing that significantly opens up the lattice spacing. 2. Individual fuel rods are missing from the assembly and the missing rods are not replaced by ***solid*** dummy/***filler*** rods that displace a volume equal to, or greater than, the original fuel rods. Note: Maine Yankee fuel assemblies with ***missing rods,*** not replaced by ***solid dummy/***filler rods, ***are an exception based upon the criticality analysis done for these assemblies. They are, therefore, considered to be undamaged. However, these Maine Yankee assemblies must be preferentially loaded per Tables B2-6 and B2-7.***

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MAINE YANKEE FUEL CAN	A specially designed stainless steel screened can sized to hold ***UNDAMAGED*** FUEL, CONSOLIDATED FUEL, DAMAGED FUEL or FUEL DEBRIS. The screens preclude the release of gross particulate from the can into the canister cavity. The MAINE YANKEE FUEL CAN may only be loaded in a Class 1 canister.
NAC-UMS® SYSTEM	NAC-UMS® SYSTEM includes the components approved for loading and storage of spent fuel assemblies at the ISFSI. The NAC-UMS® SYSTEM consists of a CONCRETE CASK, a TRANSFER CASK, and a CANISTER.
OPERABLE	The CONCRETE CASK heat removal system is OPERABLE if: 1. System validation is performed by taking temperature measurements on a one time per canister basis, between 5 and 30 days following placement of the CONCRETE CASK on the ISFSI pad. The difference between the ISFSI ambient temperature and the average outlet air temperature shall be ≤102°F for the PWR CANISTER, or ≤92°F for the BWR CANISTER, for each canister loaded. 2. Once validated using temperature difference measurements, system surveillance monitoring may be performed by temperature measurements or visual inspection of inlet and outlet screens to verify that they are not obstructed.

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B 2.1.1 Fuel to be Stored in the NAC-UMS® SYSTEM

UNDAMAGED FUEL ASSEMBLIES meeting the limits specified in Tables B2-1 through B2-5 may be stored in the NAC-UMS® SYSTEM.

B 2.1.2 Maine Yankee SITE SPECIFIC FUEL Preferential Loading

The estimated Maine Yankee SITE SPECIFIC FUEL inventory is shown in Table B2-6. As shown in this table, certain of the Maine Yankee fuel configurations must be preferentially loaded in specific basket fuel tube positions.

Corner positions are used for CONSOLIDATED FUEL, certain HIGH BURNUP FUEL and DAMAGED FUEL or FUEL DEBRIS loaded in a MAINE YANKEE FUEL CAN, for fuel assemblies with missing fuel rods, burnable poison rods or fuel assemblies with fuel rods that have been replaced by hollow zirconium alloy rods. Designation for placement in corner positions results primarily from shielding or criticality evaluations of these fuel configurations. CONSOLIDATED FUEL is conservatively designated for a corner position, even though analysis shows that these lattices could be loaded in any basket position. Corner positions are positions 3, 6, 19, and 22 in Figure B2-1.

Preferential loading is also used for HIGH BURNUP fuel not loaded in the MAINE YANKEE FUEL CAN. This fuel is assigned to peripheral locations, positions 1, 2, 3, 6, 7, 12, 13, 18, 19, 22, 23, and 24 in Figure B2-1. The interior locations, positions 4, 5, 8, 9, 10, 11, 14, 15, 16, 17, 20, and 21, must be loaded with fuel that has lower burnup and/or longer cool times to maintain the design basis heat load (23 kW per canister).

One of the two loading patterns (Standard or Preferential) shown in Table B2-8 must be used to load each canister. For the Standard loading pattern, the heat load of each fuel assembly is limited to 0.958 kW. For the Preferential loading pattern, the heat load of the fuel assemblies at the basket periphery locations is limited to 1.05 kW, and the heat load of the fuel assemblies at the basket interior locations is limited to 0.867 kW. Once selected, all of the spent fuel in that canister must be loaded in accordance with that pattern. Within a pattern, mixing of enrichment and cool time is allowed, but no mixing of loading patterns is permitted. Choosing a Preferential pattern restricts the interior fuel to the cool times shown in the Preferential (I) column, and the peripheral fuel to the cool times shown in the Preferential (P) column.

(continued)

Table B2-1
Fuel Assembly Limits

I. NAC-UMS® CANISTER: PWR FUEL

A. Allowable Contents

1. Uranium oxide PWR ***UNDAMAGED*** FUEL ASSEMBLIES listed in Table B2-2 and meeting the following specifications:

a. Cladding Type:	Zirconium alloy with thickness as specified in Table B2-2 for the applicable fuel assembly class.
b. Enrichment, Post-irradiation Cooling Time and Average Burnup Per Assembly:	Maximum enrichment limits are shown in Table B2-2. For variable enrichment fuel assemblies, maximum enrichments represent peak rod enrichments. Combined minimum enrichment, maximum burnup and minimum cool time limits are shown in Table B2-4.
c. Assembly Average Burnup:	Value calculated by averaging the burnup over the entire fuel region (UO_2) of an individual fuel assembly. The maximum assembly average burnup is 60,000 MWd/MTU.
d. Peak Average Rod Burnup:	Value calculated by averaging the burnup in a rod over the length of the rod, then using the highest burnup calculated for any rod as the peak average rod burnup. The maximum peak average rod burnup is 62,500 MWd/MTU.
e. Decay Heat Per Assembly:	≤ 958.3 watts [+†]
f. Nominal Fresh Fuel Assembly Length (in.):	≤ 178.3
g. Nominal Fresh Fuel Assembly Width (in.):	≤ 8.54
h. Fuel Assembly Weight (lbs.):	≤ 1,602 [‡]

[+†] Decay heat may be higher for site-specific configurations. A site-specific maximum decay heat of 1.05 kW is specified in Section B 2.1.2.

[‡] Includes the weight of nonfuel-bearing components.

B. Quantity per CANISTER: Up to 24 PWR ***UNDAMAGED*** FUEL ASSEMBLIES.

C. PWR ***UNDAMAGED*** FUEL ASSEMBLIES may contain a flow mixer (thimble plug), an in-core instrument thimble, a burnable poison rod insert (Class 1 and Class 2 contents) consistent with Table B2-2, or solid stainless steel rods (inserted in the guide tubes).

D. PWR ***UNDAMAGED*** FUEL ASSEMBLIES shall not contain a control element assembly, except as permitted for SITE-SPECIFIC FUEL.

E. Stainless steel spacers may be used in CANISTERS to axially position PWR ***UNDAMAGED*** FUEL ASSEMBLIES that are shorter than the available cavity length to facilitate handling.

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Table B2-1
Fuel Assembly Limits (continued)

F. Unenriched fuel assemblies are not authorized for loading.

G. The minimum length of the PWR ***UNDAMAGED*** FUEL ASSEMBLY internal structure and bottom end fitting and/or spacers shall ensure that the minimum distance to the fuel region from the base of the CANISTER is 3.2 inches.

H. PWR UNDAMAGED FUEL ASSEMBLIES with one or more grid spacers missing or damaged such that the unsupported length of the fuel rods does not exceed 60 inches. End fitting damage including damaged or missing hold-down springs is allowed, as long as the assembly can be handled safely by normal means.

I. PWR UNDAMAGED FUEL ASSEMBLIES not containing the nominal number of fuel rods specified in Table B2-2 must contain solid filler rods that displace a volume equal to, or greater than, that of the fuel rod that the filler rod replaces. SITE-SPECIFIC FUEL may contain missing fuel rods or hollow rods without replacement by solid filler rods provided the loading restrictions listed in Table B2-7 are met.

II. NAC-UMS® CANISTER: BWR FUEL

A. Allowable Contents

1. Uranium oxide BWR ***UNDAMAGED*** FUEL ASSEMBLIES listed in Table B2-3 and meeting the following specifications:

a. Cladding Type:	Zirconium alloy with thickness as specified in Table B2-3 for the applicable fuel assembly class.
b. Enrichment:	Maximum INITIAL PEAK PLANAR-AVERAGE ENRICHMENTS are shown in Table B2-3. Combined minimum enrichment, maximum burnup and minimum cool time limits are shown in Table B2-5.
c. Decay Heat per Assembly:	≤ 410.7 watts
d. Post-irradiation Cooling Time and Average Burnup Per Assembly:	As specified in Table B2-5 and for the applicable fuel assembly class.
e. Nominal Fresh Fuel Design Assembly Length (in.):	≤ 176.1
f. Nominal Fresh Fuel Design Assembly Width (in.):	≤ 5.51
g. Fuel Assembly Weight (lbs):	≤ 702, including channels

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Table B2-1
Fuel Assembly Limits (continued)

B. Quantity per CANISTER: Up to 56 BWR ***UNDAMAGED*** FUEL ASSEMBLIES
C. BWR ***UNDAMAGED*** FUEL ASSEMBLIES can be unchanneled or channeled with zirconium alloy channels.
D. BWR ***UNDAMAGED*** FUEL ASSEMBLIES with stainless steel channels shall not be loaded.
E. Stainless steel fuel spacers may be used in CANISTERS to axially position BWR ***UNDAMAGED*** FUEL ASSEMBLIES that are shorter than the available cavity length to facilitate handling.
F. Unenriched fuel assemblies are not authorized for loading.
G. The minimum length of the BWR ***UNDAMAGED*** FUEL ASSEMBLY internal structure and bottom end fitting and/or spacers shall ensure that the minimum distance to the fuel region from the base of the CANISTER is 6.2 inches.
H. BWR ***UNDAMAGED*** FUEL ASSEMBLIES not containing the nominal number of fuel rods specified in Table B2-3 must contain solid filler rods that displace a volume equal to, or greater than, that of the fuel rod that the filler rod replaces.

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Table B2-7 Maine Yankee Site Specific Fuel Limits

A. Allowable Contents
   1. Combustion Engineering 14 × 14 PWR ***UNDAMAGED*** FUEL ASSEMBLIES meeting the specifications presented in Tables B2-1, B2-2 and B2-4.
   2. PWR ***UNDAMAGED*** FUEL ASSEMBLIES may contain inserted Control Element Assemblies (CEA), In-Core Instrument (ICI) Thimbles or Flow Mixers. CEAs or Flow Mixers may not be inserted in damaged fuel assemblies, consolidated fuel assemblies or assemblies with irradiated stainless steel replacement rods. Fuel assemblies with a CEA or Flow Mixer inserted must be loaded in a Class 2 CANISTER and cannot be loaded in a Class 1 CANISTER. Fuel assemblies without an inserted CEA or CEA Plug, including those with inserted ICI Thimbles, must be loaded in a Class 1 CANISTER.
   3. PWR ***UNDAMAGED*** FUEL ASSEMBLIES with fuel rods replaced with stainless steel or zirconium alloy rods or with uranium oxide rods nominally enriched up to 1.95 wt %.
   4. PWR ***UNDAMAGED*** FUEL ASSEMBLIES with fuel rods having variable enrichments with a maximum fuel rod enrichment up to 4.21 wt % ^{235}U and that also have a maximum planar average enrichment up to 3.99 wt % ^{235}U.
   5. PWR ***UNDAMAGED*** FUEL ASSEMBLIES with annular axial end blankets. The axial end blanket enrichment may be up to 2.6 wt % ^{235}U.
   6. PWR ***UNDAMAGED*** FUEL ASSEMBLIES with solid filler rods or burnable poison rods occupying up to 16 of 176 fuel rod positions.
   7. PWR ***UNDAMAGED*** FUEL ASSEMBLIES with one or more grid spacers missing or damaged such that the unsupported length of the fuel rods does not exceed 60 inches or with end fitting damage, including damaged or missing hold-down springs, as long as the assembly can be handled safely by normal means.

B. Allowable Contents requiring preferential loading based on shielding, criticality or thermal constraints. The preferential loading requirement for these fuel configurations is as described in Table B2-6.
   1. PWR ***UNDAMAGED*** FUEL ASSEMBLIES with up to 176 fuel rods missing from the fuel assembly lattice.
   2. PWR ***UNDAMAGED*** FUEL ASSEMBLIES with a burnup between 45,000 and 50,000 MWd/MTU that must be loaded in accordance with Tables B2-6 and B2-8.
   3. PWR ***UNDAMAGED*** FUEL ASSEMBLIES with a burnable poison rod replaced by a hollow zirconium alloy rod.

Table B2-7 Maine Yankee Site Specific Fuel Limits (continued)

4. ***UNDAMAGED*** FUEL ASSEMBLIES with a start-up source in a center guide tube. The assembly must be loaded in a basket corner position and must be loaded in a Class 1 CANISTER. Only one (1) start-up source may be loaded in any fuel assembly or any CANISTER.
5. PWR ***UNDAMAGED*** FUEL ASSEMBLIES with CEA ends (finger tips) and/or ICI segment inserted in corner guide tube positions. The assembly must also have a CEA plug installed. The assembly must be loaded in a basket corner position and must be loaded in a Class 2 CANISTER.
6. ***UNDAMAGED*** FUEL ASSEMBLIES may be loaded in a MAINE YANKEE FUEL CAN.
7. FUEL enclosed in a MAINE YANKEE FUEL CAN. The MAINE YANKEE FUEL CAN can only be loaded in a Class 1 CANISTER. The contents that must be loaded in the MAINE YANKEE FUEL CAN are:

   a) PWR fuel assemblies with up to two ***UNDAMAGED*** or DAMAGED FUEL rods inserted in each fuel assembly guide tube or with up to two burnable poison rods inserted in each guide tube. The rods inserted in the guide tubes cannot be from a different fuel assembly. The maximum number of rods in the fuel assembly (fuel rods plus inserted rods, including burnable poison rods) is 176.

   b) A DAMAGED FUEL ASSEMBLY with up to 100% of the fuel rods classified as damaged and/or damaged or missing assembly hardware components. A DAMAGED FUEL ASSEMBLY cannot have an inserted CEA or other nonfuel component.

   c) Individual ***UNDAMAGED*** or DAMAGED FUEL rods in a rod type structure, which may be a guide tube, to maintain configuration control.

   d) FUEL DEBRIS consisting of fuel rods with exposed fuel pellets or individual intact or partial fuel pellets not contained in fuel rods.

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Table B2-7 Maine Yankee Site Specific Fuel Limits (continued)

e) CONSOLIDATED FUEL lattice structure with a 17 × 17 array formed by grids and top and bottom end fittings connected by four solid stainless steel rods. Maximum contents are 289 fuel rods having a total lattice weight ≤ 2,100 pounds. A CONSOLIDATED FUEL lattice cannot have an inserted CEA or other nonfuel component. Only one CONSOLIDATED FUEL lattice may be stored in any CANISTER.

f) An ***UNDAMAGED*** FUEL ASSEMBLY.

C. Unenriched fuel assemblies are not authorized for loading.

D. A canister preferentially loaded in accordance with Table B2-8 may only contain fuel assemblies selected from the same loading pattern.

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B 3.0 DESIGN FEATURES

B 3.1 Site

B 3.1.1 Site Location

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

B 3.2 Design Features Important for Criticality Control

B 3.2.1 ***CANISTER***

a) Minimum ^{10}B loading in the neutron absorbers:
   1. PWR – 0.025g/cm^2
   2. BWR – 0.011g/cm^2

b) Minimum length of ***UNDAMAGED*** 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. PWR – 3.2 inches
   2. BWR – 6.2 inches

c) Soluble boron concentration in the PWR fuel pool and CANISTER water:
   1. Fuel meeting the enrichment limits in Table B2–2 without boron - 0 ppm.
   2. Fuel meeting the enrichment limits in Table B2–2 with boron ≥ 1000 ppm.

d) Minimum water temperature for PWR fuel to ensure boron is soluble:
   1. Temperature should be 5 - 10°F higher than the minimum needed to ensure solubility.

e) Minimum flux trap (structural disk web) thickness:
   PWR (flux trap locations per Figure B2-1)
   Location "A" – 1.47 inches
   Location "B" – 0.97 inch
   Location "C" – 0.845 inch
   Location "D" – 1.47 inches
   BWR (flux trap locations per Figure B2-2)
   Location "A" – 0.62 inch
   Location "B" – 0.47 inch

(continued)

Table 1.5-1 NUREG-1536 Compliance Matrix

Chapter 1 – General Description			
Area	**Requirement**	**Acceptance Criteria**	**Description of Compliance**
1. General Description and Operational Features	The application must present a general description and discussion of the DCSS, with special attention to design and operating characteristics, unusual or novel design features, and principal safety considerations. [10 CFR Part 72.24(b)]	The applicant should provide a broad overview and a general, non-proprietary description (including illustrations) of the DCSS, clearly identifying the functions of all components and providing a list of those components classified by the applicant as being "important to safety."	A general description of the system is provided in Section 1.2. Safety classifications are provided in Table 2.3-1.
2. Drawings	Structures, systems, and components (SSCs) important to safety must be described in sufficient detail to enable reviewers to evaluate their effectiveness. [10 CFR Part 72.24(c)(3)]	The applicant should provide non-proprietary drawings of the storage system, of sufficient detail, that an interested party can ascertain its major design features and general operations.	Drawings of the system are provided in Section 1.8.
3. DCSS Contents	The applicant must provide specifications for the contents expected to be stored in the DCSS (normally spent fuel). These specifications may include, but not be limited to, type of spent fuel (i.e., boiling-water reactor (BWR), pressurized-water reactor (PWR), or both), maximum allowable enrichment of the fuel before any irradiation, burnup (i.e., megawatt-days/metric ton Uranium), minimum acceptable cooling time of the spent fuel before storage in the DCSS (aged at least 1 year), maximum heat designed to be dissipated, maximum spent fuel loading limit, condition of the spent fuel (i.e., ***undamaged or damaged*** assembly or consolidated fuel rods), weight and nature of non-spent fuel contents, and inert atmosphere requirements. [10 CFR Part 72.2(a)(1) and 10 CFR Part 72.236(a)]	The applicant should characterize the fuel and other radioactive wastes expected to be stored in the DCSS. If the potential exists that the DCSS will be used to store degraded fuel, the SAR should include a discussion of how the sub-criticality and retrievability requirements will be maintained.	A description of the contents to be stored is presented in Section 2.1, and Tables 2.1.1-1 and 2.1.2-1.

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

Chapter 2 – Principal Design Criteria			
Area	**Requirement**	**Acceptance Criteria**	**Description of Compliance**
2. Design Bases for Structures, Systems, and Components Important to Safety **a. Spent Fuel Specifications**	The applicant must provide the range of specifications for the spent fuel to be stored in the DCSS. These specifications should include, but are not to be limited to: the type of spent fuel (i.e., boiling-water reactor (BWR), pressurized-water reactor (PWR), or both); content, weight, dimensions and configurations of the fuel; maximum allowable enrichment of the fuel before any irradiation; maximum fuel burnup (i.e., megawatt-days/mtu); minimum acceptable cooling time of the spent fuel before storage in the DCSS (aged at least 1 year); maximum heat load to be dissipated; maximum spent fuel elements to be loaded; spent fuel condition (i.e., ***undamaged or damaged*** assembly or consolidated fuel rods); and any inerting atmosphere requirements. [10 CFR 72.2(a)(1) and 72.236(a)]	Detailed descriptions of each of the items listed below are generally found in specific sections of the SAR; however, a brief description of these areas, including a summary of the analytical techniques used in the design process, should also be captured in Section 2 of the SAR. This description gives reviewers a perspective on how specific DCSS components interact to meet the regulatory requirements of 10 CFR Part 72. This discussion should be non-proprietary since it may be used to familiarize interested persons with the design features and bounding conditions of operation of a given DCSS. The applicant should define the range and types of spent fuel or other radioactive materials that the DCSS is designed to store. In addition, these specifications should include, but are not to be limited to, the type of spent fuel (i.e., boiling-water reactor (BWR), pressurized-water reactor (PWR), or both), weights of the stored materials, dimensions & configurations of the fuel, maximum allowable enrichment of the fuel before any irradiation, burnup (i.e., megawatt-days/mtu), minimum acceptable cooling time of the spent fuel before storage in the DCSS (aged at least 1 year), maximum heat designed to be dissipated, maximum number of spent fuel elements, condition of the spent fuel (i.e., ***undamaged or damaged*** assembly or consolidated fuel rods), inerting atmosphere requirements, and the maximum amount of fuel permitted for storage in the DCSS. For DCSSs that will be used to store radioactive materials other than spent fuel, that is, activated components associated with a spent fuel assembly (e.g., control rods, BWR fuel channels), the applicant should specify the types and amounts of radionuclides, heat generation and the relevant source strengths and radiation energy spectra permitted for storage in the DCSS.	Specifications of the spent fuel contents are provided in Section 2.1. Specific physical parameters of the design basis fuel are listed in Tables 2.1.1-1 and 2.1.2-1.

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

Chapter 12 – Operating Controls and Limits	
Regulatory Requirement	**Description of Compliance**
The applicant must provide specifications for the spent fuel to be stored in the DCSS. At a minimum, these specifications should include, but not be limited to the following details [10 CFR 72.236(a)]: a. type of spent fuel (i.e., BWR, PWR, or both) b. maximum allowable enrichment of the fuel prior to any irradiation c. burn-up (i.e., megawatt-days/MTU) d. minimum acceptable cooling time of the spent fuel prior to storage in the DCSS (minimum 1 year) e. maximum heat that the DCSS system is designed to dissipate f. maximum spent fuel loading limit weights and dimensions g. condition of the spent fuel (i.e., ***undamaged or damaged*** assembly or consolidated fuel rods) h. inerting atmosphere requirements	Specifications for the spent fuel contents are provided in Appendix B, Tables B2-1 through B2-5. As specified in Appendix A, LCO 3.1.3, the canister is backfilled with helium gas to maintain an inert atmosphere for the spent fuel.
The applicant must provide design bases and design criteria for structures, systems, and components (SSCs) important to safety. [10 CFR 72.236(b)]	The design bases and criteria for the system are specified in Section 2.2.
The applicant must design and fabricate the DCSS so that the spent fuel will be maintained in a subcritical condition under credible conditions. [10 CFR 72.236(c)]	As shown in Section 6.4, the spent fuel is maintained in a subcritical configuration under all credible configurations.
The applicant must provide radiation shielding and confinement features that are sufficient to meet the requirements in 10 CFR 72.104 and 72.106 regarding radioactive material in effluents, direct radiation, and area control. [10 CFR 72.236(d) and 10 CFR Part 20] 10 CFR 72.104 Criteria for Radioactive Materials in Effluents and Direct Radiation from an ISFSI or MRS 10 CFR 72.106 Controlled Area of an ISFSI or MRS	The maximum external dose rates for the system are specified in Appendix A, Section A3.2.2. These limits are established to ensure that, for the minimum controlled area boundary distance presented in Section 10.4, the controlled area boundary annual dose will be maintained within allowable limits.

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