TRANSNUCLEAR INC.

DOCKET NO. 72-1030

REQUEST FOR ADDITIONAL INFORMATION

RELATED TO AMENDMENT 1 TO THE

NUHOMS® HD SYSTEM

By application dated November 1, 2007, Transnuclear Inc. (TN) requested approval of an amendment to Certificate of Compliance (CoC) No. 1030. This amendment has two main purposes:

- allow additional fuel assembly types as authorized contents, and
- allow additional control components as authorized contents.

This request for additional information (RAI) identifies additional information needed by the U.S. Nuclear Regulatory Commission (NRC) staff in connection with its review of the amendment. The requested information is listed by chapter number and title in the applicant's safety analysis report. NUREG -1536, "Standard Review Plan for Dry Cask Storage Systems," was used by the staff in its review of the amendment application.

Each individual RAI section describes information needed by the staff to complete its review of the application and the Safety Analysis Report (SAR) and to determine whether the applicant has demonstrated compliance with the regulatory requirements.

CHAPTER 1 - GENERAL INFORMATION

1.1 **(Technical Specifications (TS))** Expand and clarify the definition of damaged and intact fuel assemblies. Include separate definitions for intact and damaged fuel rods in the proposed TS.

The definitions for intact and damaged fuel assemblies provided in the SAR appear to be for intact and damaged fuel rods, not fuel assemblies. Interim Staff Guidance Document 1 (ISG-1), Rev. 2, "Classifying the Condition of Spent Nuclear Fuel for Interim Storage and Transportation Based on Function" provides guidance on acceptable definitions. In the provided definitions, list specific defects which would still permit an assembly to be classified as undamaged, and justify accordingly.

The current definitions are not sufficiently precise to categorize the large number of defects which may be observed in a fuel assembly. It is unclear how a fuel assembly with a missing grid spacer, for example, would be categorized under the current definition.

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

1.2 **(Technical Specifications)** Clarify which portions of the SAR are incorporated by reference in the proposed TS.

It is unclear if certain portions of the SAR are intended to be incorporated by reference in the TS. For example, the footer, "NUHOMS® HD System Technical Specifications," denotes pages in the introduction to the SAR which are incorporated into the TS. The opening page of Section 12 appears to indicate the Operating Controls and Limits are intended to be part of the TS, but the "Technical Specifications" footer does not appear on any pages in Section 12.

This information is needed to assure compliance with 10 CFR 72.44(c).

1.3 **(SAR Sections 1.2.3, 2.1, etc.)** Describe the difference between "fuel types" as specified in the original FSAR, and "fuel classes" as specified in Amendment 1. Explain the reason for the change, and the basis for inclusion.

The original approved FSAR specified the 32PTH Dry Shielded Canister (DSC) contents as "up to 32 intact PWR Westinghouse 15x15... *fuel assemblies*" (emphasis added). The application for Amendment 1 specifies the DSC contents as "up to 32 intact PWR Westinghouse 15x15... *class* fuel assemblies"(emphasis added). This appears to be a more inclusive category, and any additional fuel (including future changes or improvements to existing designs) that could be included under fuel classes should be described and fully qualified. Rather than selecting the potential worst-case fuel design, the design-basis limits used to determine whether fuel can be loaded in the future should be based on the current worst case fuel design.

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

1.4 **(Technical Specifications and SAR Sections 1.2.3, 2.1.1, 5.2, etc.)** Include the definition of reconstituted fuel in the TS, Section 1.1. In addition, specify the cooling time requirements as stated in Section 5.2 of the SAR and in the Table 2 of the TS.

The definition for reconstituted fuel is not included in the TS, and is necessary to characterize what may be included in a reconstituted fuel assembly. In addition, the cooling time requirements described in Section 5.2 of the SAR should be included in the TS, if they are necessary to assure acceptable performance.

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

1.5 **(SAR Section 1.2.3, Table 2-1, etc.)** Describe how WEV 17x17 assemblies, WEO 17x17 assemblies, and ANP Advanced MK BW 17x17 fuel assemblies fit into the fuel assembly *classes* that the 32 PTH DSC is designed to store, or explain why they are no longer included as acceptable contents.

Table 2-1 of the original FSAR includes WEV 17x17 assemblies and WEO 17x17 assemblies. These assemblies were described in Section 1.2.3 of the original SAR, as included in the Westinghouse 17x17 type fuel assemblies. In addition, the original FSAR includes ANP Advanced MK BW 17x17 fuel assemblies. However, the SAR for Amendment 1 does not specifically include any of these, and they have been removed from the Fuel Qualification Tables.

This information is necessary to determine compliance with 10 CFR 72.236(a).

CHAPTER 2 – PRINCIPAL DESIGN CRITERIA

2.1 **(Technical Specifications)** Include clarifying statements in the proposed TS to specify that during loading, drying, or unloading operations the provisions of ISG-22, "Potential Rod Splitting Due to Exposure to an Oxidizing Atmosphere During Short-Term Cask Loading Operations In LWR or Other Uranium Oxide Based Fuel" will be satisfied, or provide justification and associated technical bases for any proposed alternative.

Amendment 1 to the NUHOMS HD Safety Analysis Report appears to indicate that with the exception of 0.25 volume percent of oxidizing gas in the cask during drying (Section B 12.3.1.1, page B12-10), the fuel assemblies will be maintained in an inert environment during loading, drying, and unloading. The staff requests assurance that the fuel assemblies will have limited (or no) exposure to an oxidizing environment during the loading, drying, or unloading operations.

This information is needed to determine compliance with 10 CFR 72.166.

2.2 **(Technical Specifications)** Incorporate by reference wording from Section 2.1.1 of the Safety Analysis Report into the proposed TS such that:

a) The maximum fuel cladding temperature limit of 400°C (752°F) is set for normal conditions of storage and all short term operations from the spent fuel pool to the Independent Spent Fuel Storage Installation (ISFSI) pad including vacuum drying and helium backfilling of the NUHOMS®-32PTH DSC per the guidance delineated in ISG-11, Rev. 3, "Cladding Considerations for the Transportation and Storage of Spent Fuel."

b) The change in fuel cladding temperature is restricted to less than 65°C (117°F) and is limited to less than 10 cycles during DSC drying, backfilling and transfer operations, per the guidance delineated in ISG- 11, Rev. 3.

c) The maximum fuel cladding temperature limit is set to 570°C (1058°F) for accidents or off normal thermal transients, per the guidance delineated in ISG-11, Rev. 3.

The temperature limits defined in ISG-11, Rev. 3, have been established by the staff to ensure the integrity of the fuel cladding.

This information is needed to assure compliance with 10 CFR 72.166.

2.3 **(SAR, Chapter 2, Tables 2-1, 2-3, etc.)**

a) Clarify the composition of both the cladding and internal components of the non-fuel hardware that is being proposed as an addition to the contents of the package.

b) Additionally, provide data or discussion to show that no adverse chemical, galvanic, or other reactions between or among the hardware, or canister internals, or with water during loading, drying, unloading, or storage.

This information is needed to determine compliance with 10 CFR 72.120(3)(d).

2.4 **(SAR, Section 2.1.1, Table 2-1. TS p. 2-1, etc.)** Clarify if the dimensions of the stainless steel or zirconium "dummy rods" placed in reconstituted assemblies are identical to the dimensions of the spent fuel rods, or provide the dimensions of the dummy rods for analysis, if different.

If the dimensions of the "dummy rods" do not match those of the spent fuel rods, the free volume within the cask will be different, which may influence the criticality analysis.

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

2.5 **(Technical Specifications)** Provide justification for the increase in maximum assembly weight in the amended TS.

TS 2.1 lists maximum assembly plus control component (CC) weight as 1585 lbs. The maximum assembly weight of the design basis WE 17x17 is shown as 1575 lbs in Table 2-1 of the FSAR. What is the reason for this change?

This information is necessary to verify compliance with 10 CFR 72.236(a).

2.6 **(Technical Specifications)** Is the increase in maximum MTU/assembly taken into account in determining the bounding source-term analyses for all assembly classes? If not, explain how this is conservative or inconsequential, or provide alternate specifications in the Fuel Qualification Table (FQT).

Revised Table 2 lists maximum MTU/Assembly for every fuel class as 0.476 MTU. In the original FSAR, the WE 15x15 and CE 14x14 are listed as 0.467 MTU/assembly, and 0.385 MTU/assembly, respectively. It is not clear if an analysis was performed for any fuel classes other than the design-basis assembly at the maximum uranium loading. Explain how the design-basis assembly at maximum uranium loading analysis bounds the fuel classes, or provide further analysis.

This information is necessary to verify compliance with 10 CFR 72.104.

2.7 **(SAR Table 2.1)** Explain how the increased maximum weight to 1,585 lbs per fuel assembly is considered in evaluating structural adequacy of the system components, including the fuel basket, under the design basis transfer cask side-and corner-drop handling accidents.

The maximum assembly plus CC weight of 1,585 lbs, as listed in the reformatted and expanded Table 2-1, is higher than the previously approved weights ranging from 1,450 to 1,575 lbs.

This information is necessary to determine compliance with 10 CFR 72.236(a).

2.8 **(SAR Section 2.1.1)** Specify in the SAR that utilities which choose to load fuel with burnups greater than 45 GWD/MTU may be unable to transport those fuel assemblies at a later time.

Section 2.1.1 of the Safety Analysis Report states the maximum assembly burnup is 60 GWD/MTU. Currently, fuel assemblies with burnups above 45 GWD/MTU may be licensed for storage under 10 CFR Part 72, but may not be transported under 10 CFR Part 71. Utilities which chose to load fuel with burnups above 45 GWD/MTU do so at their own risk, as these utilities may not be able to transport these fuel assemblies at a later time.

This information is necessary to assure compliance with 10 CFR 72.236(a).

CHAPTER 3 - STRUCTURAL EVALUATION

3.1 **(SAR Section 3.5.3.2)** Technical Specification 5.3.2 (Cask Drop), states in the Background, "…the potential exists to drop the cask 15 inches or more." Revise the SAR by performing an evaluation of structural integrity of the fuel cladding associated with corner- or end-dropping, as appropriate, a loaded 32PTH DSC within the OS187 transfer cask (TC) en route from the fuel handling building to the ISFSI.

NUREG-1536, page 3-6, in the section on "Structural Design Criteria and Design Features," specifies that "the [cask] design must ensure that the spent fuel will not experience accelerations that would damage its structural integrity or jeopardize its subcritical condition or retrievability." Section 3.5.3.2 of the (original) SAR states that the structural integrity of the fuel cladding due to the end drop loading condition will be evaluated by the user under the 10 CFR 50 site license. Recognizing that fuel clad ductility capability may be limited for the high burnup fuel certified for the NUHOMS HD system, the staff notes that, for a 10 CFR 72 general license, the structural integrity of fuel clad must be evaluated for the cask drop conditions described in the Technical Specifications for administrative lifting controls.

This information is necessary to assure compliance with 10 CFR 72.122(b).

3.2 **(SAR Appendix 3.9.10)** With respect to the mode shape displayed in Figure 3.9.10-18 of the original SAR, for the dominant axial vibration frequency of 141.07 hz, post-process the corner drop results by considering only the lid center for nodal averaging acceleration responses to ensure that a bounding forcing function input is used for the fuel clad evaluation as described in Question 3.1 above.

SAR Pages 3-9.10-11 through -13 describe post-processing of the LS-DYNA results, which suggest that the Figure 3.9.10-22 time-history response was a nodal average over the entire transfer cask lid. The staff notes that, per the Figure 3.9.10-18 mode shape, the vibratory component of the cask lid axial response may contribute significantly to the fuel clad impact response. As such, the nodal averaging associated with the entire lid or for the nodes in the immediate vicinity of the point of impact at the corner of the cask may be inadequate, and it should only be performed for the lid center with the highest modal coefficients to capture the maximum fuel clad response.

This information is necessary to assure compliance with 10 CFR 72.122(b).

CHAPTER 4 – THERMAL EVALUATION

4.1 **(SAR Section 4.8.2)** Provide a justification for use of the UO_2 material properties in Section 4.8.2 of the SAR. Update any analyses that rely on these values if any changes in the UO_2 material properties are warranted

The values provided for UO_2 material properties in Section 4.8.2 are from a dated source and are for unirradiated UO_2. Recent data has indicated that there may be potential changes in the characteristics and properties of irradiated UO_2 that could affect heat transfer in the fuel. This could potentially have an impact on the effective thermal conductivity for the spent fuel assemblies.

References:
"Thermal conductivities of irradiated UO_2 and $(U,Gd)O_2$," K. Minato et al. Journal of Nuclear Materials 300 (2002) 57–64.

"Effect of burn-up on the thermal conductivity of uranium dioxide up to 100.000 MWdt," C. Ronchi et al. Journal of Nuclear Materials 327 (2004) 58-76.

This information is needed to satisfy the provisions of 10 CFR 72.24(c)(3) and 10 CFR 72.236(f).

4.2 **(SAR Chapter 4)** Provide the thermal analysis models (input and output files) for the NUHOMS HD system that were revised for Amendment 1.

The staff needs to review this information as part of its review to make a reasonable assurance safety finding for the amendment application.

This information is needed to satisfy the provisions of 10 CFR 72.24(d) and 10 CFR 72.236(f).

4.3 **(SAR Chapter 4)** Review the RAIs provided as part of the Standardized NUHOMS (CoC 1004) Amendment 10 (Accession numbers ML072410348 and ML081150596) and Amendment 11 (ML072980876) reviews that also apply to the NUHOMS HD design, and provide responses specific to the NUHOMS-HD Amendment 1 (CoC 1030), as appropriate.

Given the similarities between the Standardized NUHOMS and NUHOMS HD designs, changes made to the analyses or operating procedures of the Standardized NUHOMS designs, due to responses to previously issued RAIs, could potentially impact the NUHOMS HD design. The staff needs reasonable assurance that issues addressed for the Standardized NUHOMS design are reviewed and applied to the NUHOMS HD design, as appropriate.

This information is needed to satisfy the provisions of 10 CFR 72.24(d) and 10 CFR 72.236(f).

4.4 **(SAR, Section 4.2)** Provide thermal conductivity data for aluminum clad metal matrix composites (MMCs) both parallel to, and perpendicular to the plate surface. Describe how any anisotropic thermal conductivity of aluminum clad MMCs is considered in the thermal analysis of the package.

The thermal analysis of the package assumes that Boral® has anisotropic thermal properties (Section 4.2, subsection 9 of the Safety Analysis Report), but does not take into account that aluminum clad MMCs may also have anisotropic thermal properties.

This information is required for compliance with 10 CFR 72.124(b), 10 CFR 72.236(c), and 10 CFR 72.236(f).

CHAPTER 5 – SHIELDING EVALUATION

5.1 (**SAR Section 5.1)** Show that the source-term for fuel assemblies with less than 1.5 wt% U-235 is bounded by the design-basis assembly.

The third paragraph on page 5-2 of the SAR states that "fuel assemblies with enrichment between 0.2 wt % U-235 and 1.5 wt % U-235 are qualified by limiting their burnup … (ensuring) that the shielding analysis is also bounding for these fuel assemblies." Furthermore, the discussion at the top of page 5-4 of the SAR describes burnup limits to maintain gamma and neutron source terms within the limiting assembly design. No reference or analysis is provided as a basis for this assumption.

Present a source-term comparison of the design-basis assembly and the low-enriched fuel assembly in question at the burnup indicated. A complete description of the analysis will include, with justification, assumed bounding dimensions, burnup, power history, cross section libraries used, code versions, and material information.

This information is necessary to verify compliance with 10 CFR 72.104.

5.2 **(SAR Section 5.2)** Provide detailed information on the SAS2H analysis of assemblies with an average enrichment below 1.5 wt%.

The Fuel QualificationTable appears to apply to all classes of fuel assemblies. The depleted uranium assembly (0.2 wt% U-235) was intended for a specific fuel design burned approximately to 5,000 MWd/MTU, yet the allowable burnup has been greatly extended to 20,000 MWd/MTU. Using the methods explicitly described in the amendment and the sample input deck in the original SAR, staff confirmatory analysis of such an assembly cooled for the minimum five year period allowed by the FQT did not support the applicant's statement at the top of page 5-4 of the SAR, that a 0.2 wt% enriched assembly at 20 GWd/MTU and cooled for the minimum five years would be bounded by the design-basis assembly. Further, information methods and assumptions are not included in the amendment and the FQT limits are potentially non-conservative.

An analysis at the boundary of enrichment categories is necessary to demonstrate that the allowable enrichment and burnup levels, when permitted to all fuel classes, are still bounded by the design basis assembly as stated in the application.

This information is necessary to verify compliance with 10 CFR 72.126.

5.3 (**SAR Section 5.2)** Justify the enrichment chosen for the bounding design-basis assembly.

The source term analysis on page 5-3 is based on a design bounding assembly determination by initial heavy metal alone. In the example given, an initial enrichment of 4 wt% U-235 is not conservative according to NUREG-1536, "Standard Review Plan for Dry Cask Storage," which states: "the shielding source term … should be based on the lowest enrichment (for a given burnup)." With the changes to the FQT to more generalized bounding parameters, it is appropriate for all analyses in the application to follow the same thought. Since the cask contents are no longer restricted, specific designs with set heavy metal content and enrichment that can be analyzed, bounding conditions need to be taken into account at all steps of the source-term analysis. For this specific assembly class and enrichment, the design basis analysis should utilize 2.5 wt% U-235. Include such an analysis for each enrichment group in the FQT, or limit the burnup below the initial enrichment analyzed.

This information is necessary to verify compliance with 10 CFR 72.126.

5.4 **(SAR Section 5-3 and Table 2-1)** Show that MK BW 17x17 is still bounding with the new limits allowed in the FQT.

The reason given for using the MK BW 17x17 as the design basis assembly was the higher heavy metal content. Given that all assemblies have the same maximum heavy metal limit, justify the continued use of the MK BW 17x17 as a design basis assembly.

This information is necessary to verify compliance with 10 CFR 72.126.

5.5 **(SAR Section 5.2)** Show that the enrichments used for the Thimble Rod Assemblies (TPAs) and the Burnable Poison Rod Assemblies (BPRAs) source term analyses are conservative.

The TPA and BPRA source term analyses are conducted with different initial enrichments of the fuel source term. Describe the basis for the different initial enrichments. Justify the choice of 3.5 wt% U-235 as the bounding calculation for these control components.

This information is necessary to verify compliance with 10 CFR 72.126.

5.6 **(Editorial - SAR Page 5-4)** This discussion on reconstituted fuel assemblies could be More clearly articulated. Please rewrite to clarify the cooling requirements.

The third paragraph on page 5-4 of the SAR, states: "There is no limit on the number of rods that are reconstituted with unirradiated stainless steel or Zircalloy or low enriched UO2." Does this mean that both Zircalloy and low-enriched UO2 may be irradiated or is the adjective 'unirradiated' intended to apply to all materials in that list? Please rewrite to clarify.

The same paragraph also states "that for cooling times less than 10 years, 1 year of cooling time is added." This could be interpreted as permitting an assembly to be treated as if it were cooled an additional year in the pool. The discussion is revisited in the fifth paragraph with improved clarity. Please rewrite the third paragraph on page 5-4 of the SAR to clarify. One possibility would be to move the discussion in the fifth paragraph to the third paragraph.

5.7 **(Editorial)** The discussion on possible streaming paths could be more clearly articulated.

The **sixth paragraph on page 5-2** states: "Locations where streaming could occur are discussed in Chapter 10." The staff could find no specific mention of streaming paths in Chapter 10 of the FSAR. Compliance with Regulatory Position 2b of Regulatory Guide 8.8 is stated in Chapter 10 as simply: "Regulatory Position 2b on radiation shielding is met by the heavy shielding of the NUHOMS System which minimizes personnel exposures." The presence of heavy shielding alone does not necessarily preclude streaming paths through joints, vents, gaps, etc. There is a later discussion on locations of the maximum dose rates, which sufficiently addresses the issue; however it is not immediately obvious to look there. It is recommended that this level of detail be provided on page 5-2 from Chapter 10 of the SAR.

5.8 **(Editorial)** Since this amendment is specifically intended to add the CE 16x16 fuel, it should be included in the discussion in a manner consistent with other authorized cask contents.

Revise **final paragraph on page 5-3** to include the 16x16 fuel in bounding assembly comparison.

Material information on the CE 16x16 class, similar to that found in Tables 5-7 through 5-9 would be very useful for the confirmatory analysis.

CHAPTER 6 – CRITICALITY EVALUATION

There are no RAIs for Chapter 6 updates.

CHAPTER 7 – CONFINEMENT EVALUATION

There were no Chapter 7 updates for Amendment 1.

CHAPTER 8 – OPERATING PROCEDURES

8.1 **(Technical Specifications)** Incorporate wording, by reference, from Section 8.1.1.3 of the SAR into the proposed TS such that:

a) Hydrogen gas monitoring or mitigation measures will be conducted when performing any lid welding or cutting operations.

b) All welding operations will be stopped and the DSC cavity will be purged with helium if the hydrogen concentration exceeds 2.4%.

Hydrogen gas may be evolved during wet loading (or unloading) operations and must be monitored or controlled to preclude the possibility of creating a flammable mixture inside the canister during welding or cutting operations.

This information is required for compliance with 10 CFR 72.166.

CHAPTER 9 – MATERIALS EVALUATION (ACCEPTANCE TESTS AND MAINTENANCE PROGRAM)

9.1 **(Technical Specifications)** Incorporate Sections 9.5.3.2, 9.5.3.4, 9.5.3.6, 9.5.3.7, 9.5.4.1, and 9.5.4.2 of the SAR into the proposed Technical Specifications by reference. Assuming that clarifications (see RAI 9.3) are made, Section 9.5.3.3 should also be incorporated in the proposed TS by reference.

The acceptance testing of all neutron poisons used in a spent fuel canister is important to the safety of the NUHOMS HD package and should not be amendable under 10 CFR Part 72.48 without approval by NRC staff.

This information is required for compliance with 10 CFR Part 72.44(c)(4) and 10 CFR 72.236(b).

9.2 **(SAR Section 9.5.3.4)** Delete the statement in Section 9.5.3.4(a) that scanning electron microscopy (SEM) may be used as an alternative method to evaluate the ductility of MMCs.

Due to the heterogeneous nature of MMCs, microscopic strain observed using SEM may not be used to reliably estimate macroscopic ductility. As such, room temperature tensile tests measuring the elongation to failure of the MMCs (both clad and unclad), as stated in Section 9.5.3.4(a), should be conducted.

The Staff considers qualitative acceptance tests, such as visual inspection by SEM or American Society for Testing and Materials (ASTM) E290, in general, not acceptable for verifying the mechanical properties of neutron absorbing materials.

This information is required for compliance with 10 CFR 72.124(b) and 10 CFR 72.236(c).

9.3 (SAR Section 9.5.3.3, and Technical Specifications) Clarify in Section 9.5.3.3 (and incorporate into the Technical Specifications by reference) the conditions which necessitate that neutron absorbing plate materials will undergo corrosion and thermal damage testing if there has been a key process change, as defined in Section 9.5.4.3.

a) It is unclear if corrosion testing is required for the neutron absorbing plate material if the neutron absorbing material used is an alloy other than 1100 aluminum.

b) If the neutron absorbing plate material consists only of boron carbide and 1100 aluminum, clarify if an increase of porosity will require qualifying corrosion and thermal damage tests. If applicable, justify why an increase of porosity for a boron carbide and 1100 aluminum-based neutron absorber would not require qualification testing.

The corrosive effects of a spent fuel pool environment and the subsequent drying step may lead to cracking and/or delaminating of the aluminum clad metal matrix composites As such, appropriate qualifying corrosion and thermal damage tests should be required for neutron absorbing materials when there has been a change in the aluminum alloy and/or an increase in porosity.

This information is required for compliance with 10 CFR 72.120(d), 10 CFR 72.124(b) and 10 CFR 72.236(c).

9.4 (SAR Section 9.5.4.3) Specify that for aluminum clad MMCs, significant changes (which should be quantified by the applicant) of the internal core thickness relative to the thickness of the aluminum cladding qualify as a major process change according to Section 9.5.4.3 of the Safety Analysis Report.

The aluminum cladding is expected to be significantly more ductile than the boron carbide reinforced inner core of the aluminum clad MMCs. The relative thickness of the aluminum cladding to the internal core thickness will greatly influence the mechanical properties of the final material.

This information is required for compliance with 10 CFR 72.124(b) and 10 CFR 72.236(c).

9.5 (SAR Sections 9.1.7.3 and 9.5.3.4) Describe how the edges of the neutron poison Plates of aluminum clad neutron absorbers will be adequately sampled for flaws to ensure that edge cracks will be detected.

Cracks may form at the edges of aluminum clad neutron absorbers or on plates with high boron carbide volume fractions (> 40%) during rolling, which may result in localized regions deficient in boron carbide. This is of particular concern in the case of aluminum clad MMCs, where edge cracking may not be detectable by visual inspection.

This information is required for compliance with 10 CFR 72.124(b) and 10 CFR 72.236(c).

9.6 **(SAR Section 9.5.3.1**) Clarify if the 3% maximum permissible porosity for the aluminum clad metal matrix composites (MMCs) pertains to the open, closed, or total porosity of the MMCs. Quantitatively describe the pore size distribution in these MMCs.

The porosity of the MMCs influences the mechanical strength and corrosion resistance of the MMCs. Pores greater than the average boron carbide particle size, or smaller, interconnected pores (even if enclosed), can affect the homogeneity of the boron carbide distribution in the neutron absorbing material. This, in turn, could lead to neutron streaming, and a reduction in the neutron absorbing effectiveness of the MMCs.

This information is required for compliance with 10 CFR 72.124(b) and 10 CFR 72.236(c).

9.7 **(SAR Section 9.5.3.1)** Specify how the aluminum clad neutron absorbers will be visually inspected and the qualifications of the individuals performing the inspection to ensure that the aluminum cladding is intact and that the internal core is not exposed to the spent fuel pool environment.

According to Section 9.5.3.4, "testing or examination for exposed interconnected porosity shall be performed by a means to be approved by the Certificate Holder." The Staff requests that the applicant specify how the aforementioned testing or examinations will be conducted.

This information is required for compliance with 10 CFR 72.124(b) and 10 CFR 72.236(c).

9.8 **(SAR Section 9.5.3.3)** Demonstrate that the aluminum clad metal matrix composites (MMCs) are adequately resistant to the combined affects of corrosion and heating which the MMCs are expected to see during loading and drying of the spent fuel canister.

The aluminum clad metal matrix composites proposed in the amendment are different enough from the unclad material, that qualifying corrosion and thermal damage testing should be considered. The corrosive affects of a spent fuel pool environment in combination with subsequent drying may produce a synergistic effect leading to cracking and/or delaminating of the aluminum clad metal matrix composites.

This information is required for compliance with 10 CFR 72.120(d), 10 CFR 72.124(b) and 10 CFR 72.236(c).

9.9 **(SAR Section 9.5.3.4)** Provide statistically significant qualifying data demonstrating that the aluminum clad metal matrix composites meet the minimum mechanical properties specified in Section 9.5.3.4 and the porosity requirements specified in Section 9.5.3.1 (see RAI 9-6).

The aluminum clad metal matrix composites proposed in the amendment are different enough from the unclad material, that qualifying mechanical testing and porosity measurements should be considered.

This information is required for compliance with 10 CFR 72.124(b) and 10 CFR 72.236(c).

9.10 (Technical Specifications) In the Technical Specifications, incorporate by reference controlling documents which link the fabrication details of the neutron absorbing materials outlined in Section 9 of the Safety Analysis Report to the procedures which were used to produce the originally qualified neutron absorbing materials.

The fabrication procedures for the neutron absorbers intended for service in spent nuclear fuel storage casks should be the same (unless otherwise described) as those used to produce the neutron absorbers for qualification testing.

This information is needed to assure compliance with 10 CFR 72.44(c)(4).

9.11 (SAR Section 9.5.3.4) Justify the use of ASTM B311 as a testing method for measuring porosity of aluminum clad MMCs.

ASTM B311 is a test method used for density determination of powder metallurgy materials containing less than two percent porosity, yet the maximum permissible porosity of the aluminum clad MMCs exceeds two percent.

This information is required for compliance with 10 CFR 72.124(b) and 10 CFR 72.236(c).

9.12 (Licensing Drawings) Clarify or remove the term, “or equivalent” from the licensing drawing 10494-72-1 when referring to “SA240, Type 304 Steel.”

Any material equivalent to SA240, Type 304 steel should have identical or superior mechanical properties, and an accompanying level of quality assurance identical or superior to materials meeting ASME Code requirements.

This information is needed to determine compliance with 10 CFR 72.236(b).

9.13 (Licensing Drawings) Detail or remove the reference to the “alternate weld configuration” in Note 4 on licensing drawing 10494-72-5 and the “alternate equivalent weld detail” on Note 1 on licensing drawing 10494-72-17. Alternatively, demonstrate that these welds have no safety significance.

Any alternate welding configuration must be described adequately, such that a structural evaluation of the weld can be conducted.

This information is needed to determine compliance with 10 CFR 72.236(b).

9.14 (Editorial) Edit Section 9.5.3.4(b) of the Safety Analysis Report (SAR) so that the maximum permissible porosity of the aluminum clad metal matrix composites is consistent throughout the SAR.

The applicant should consider amending 9.5.3.4(b) of the SAR so that the porosity (see RAI 9-6) of aluminum clad metal matrix composites may not exceed 3% (rather than 2%) to be consistent with the proposed changes in Amendment 1 to the application.

9.15 **(Editorial)** Clarify the term "full density" as referred to in Section 9.5.3.3 of the SAR.

The applicant may be referring to those MMCs which pass the density acceptance criteria in Section 9.5.3.4(b), but the term "full density" is usually applied to materials which are ≥ 99.9% of theoretical density.

9.16 **(Editorial)** The title of Section 9.5.3.4 should be clarified.

Section 9.5.3.4 does not refer to a qualification test, but rather an acceptance test of samples manufactured during a production run. It is suggested that the applicant rename the title of Section 9.5.3.4 to a title that reflects this more clearly, (e.g., "Required Acceptance Tests and Examinations to Insure Mechanical Properties").

CHAPTER 10 – RADIATION PROTECTION

10.1 **(Editorial)** The first complete bullet point on page 10-6 incorrectly lists the neutron and gamma ray spectra to be shown in "Table 10-."

Include the correct table number on page 10-6.

CHAPTER 11 – ACCIDENT ANALYSIS

There were no Chapter 11 updates for Amendment 1.

CHAPTER 12 – OPERATING CONTROLS AND LIMITS

There are no RAIs for Chapter 12 updates.

CHAPTER 13 – QUALITY ASSURANCE

There were no Chapter 13 updates for Amendment 1.

CHAPTER 14 –DECOMMISSIONING

There were no Chapter 14 updates for Amendment 1.