December 31,2002

Mr. Thomas C. Thompson
Licensing Manager
NAC International, Inc.
655 Engineering Drive
Norcross, GA 30092

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION ON NAC-UMS AMENDMENT APPLICATION

Dear Mr. Thompson:

By application dated January 25, 2002, NAC International (NAC) requested approval of an amendment, under the provisions of 10 CFR Part 72, Subpart K, to the proposed Certificate of Compliance (CoC) for the NAC-UMS dry spent fuel storage system. Enclosed is the staff's request for additional information (RAI) for the continued review of the amendment request.

Your application was based on Amendment 2 of the NAC-UMS Final Safety Analysis Report. We request that you submit revised application pages to address the individual RAI items, if appropriate, rather than simply providing a response. This will enable us to more effectively review the responses for incorporation into the application.

Your complete and timely response to the enclosed RAI is necessary for the staff to complete its review. Please provide your responses to the RAI within 60 days. If we receive your responses within 60 days and have no further questions, we expect to complete our review and forward the proposed CoC for rulemaking by June 6, 2003, as indicated in my letter to you on August 1, 2002. If you are unable to provide a response within 60 days, please notify us in writing prior to that date and provide the reason for the delay. We will notify you of any review schedule changes resulting from the delayed RAI responses.

If you have any comments or questions concerning this request, you may contact me at 301-415-8561. Please refer to Docket No. 72-1015 and TAC No. L23409 in future correspondence related to this request.

Sincerely,

/RA/
Stephen C. O'Connor, Sr. Project Manager
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Docket No.: 72-1015

Enclosure:
Request for Additional Information

December 31, 2002

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NAC International, Inc.
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DATE	12/18/02		12/18/02		12/19/02		12/31/02	

* - see previous concurrence

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REQUEST FOR ADDITIONAL INFORMATION

NAC-UMS AMENDMENT APPLICATION
DOCKET NO. 72-1015
TAC NO. L23409

This document, titled Request for Additional Information (RAI), contains a compilation of additional information requirements identified by the U.S. Nuclear Regulatory Commission (NRC) staff, during its review of NAC International's (NAC's) revised application for approval of an amendment to the proposed Certificate of Compliance (CoC) for the NAC-UMS dry spent fuel storage system under 10 CFR Part 72. The staff's questions are based on the NAC-UMS application dated January 25, 2002, and Amendment 2 of the NAC-UMS Final Safety Analysis Report. The sections in this RAI follows the same format as NAC's application.

Each individual RAI describes information required by the staff to complete its review of the application to determine whether NAC has demonstrated compliance with the regulatory requirements. The following RAIs are needed for the staff to ensure compliance with 10 CFR 72.236. The responses to these RAIs should be incorporated into the Safety Analysis Report (SAR) amendment application as appropriate.

CHAPTER 1 - GENERAL DESCRIPTION

1.1 Revise the definition of high burnup fuel in Table 1-1 to conform to NRC Interim Staff Guidance No. 11 (ISG-11), "Cladding Considerations for the Storage and the Transportation of Spent Fuel," Revision 2. The ISG may be obtained electronically on NRC's website at http://www.nrc.gov/reading-rm/doc-collections/isg/spent-fuel.html.

The definition presented in the application does not reflect NRC's position on the storage of high burnup fuel.

1.2 In Section 1.1.2.1, clarify how the Metamic in the Advanced PWR Fuel Basket remains in its designed configuration if a fuel element jams on loading or unloading.

This information is needed to assure that the neutron absorber remains in its designed configuration to provide criticality control.

1.3 In Section 1.2.1.4, clarify whether burnable poison and thimble plug inserts are permitted in the 100-ton transfer cask.

Section 1.2.1.4 states, "Fuel assemblies, which include non-fuel source terms, such as burnable poison or thimble plug inserts, are not allowed within this (100-ton) transfer cask." Yet Section 5.1.3.3 discusses the increased dose rates on the exterior of the 100-ton transfer cask due to the presence of burnable poison and thimble plug inserts. The application is not consistent in describing the expected contents.

1.4 Describe the precautions that are in place to ensure that the neutron shield cavity is filled when needed. In addition, Revise Chapter 8 as appropriate.

Since the 100-ton transfer cask uses water as a neutron shield, more information is necessary for staff to evaluate if the design is adequate to protect workers from unnecessary radiation exposure.

1.5 Revise Section 1.3 to describe the fuel loading patterns of the Advanced NAC-UMS design.

The SAR should consistently describe the expected contents.

1.6 Revise Section 1.3.1 to identify the maximum initial enrichment for both the NAC-UMS Standard and Advanced designs.

Section 1.3.1 states that the maximum initial enrichment for the spent PWR fuel is 5.0 wt% ^{235}U. However, the Technical Specifications for the Standard NAC-UMS design limit the maximum initial enrichment to 4.2 wt% ^{235}U. The SAR should consistently describe the expected contents.

1.7 In Drawings 792-591, 592, 593, 594, 595, 600, 602, 603 and 604, specify tolerances, as appropriate, for the parts to be consistent with the tolerance stack-ups considered in the analysis described in Section 11.2.12.6 for the advanced canister and basket.

The structural integrity of the fuel basket depends on the ability of the tabs to stay inside the slots during all operational and accident conditions. Tolerances for reference dimensions must be controlled in the design drawings for various parts of the basket components.

CHAPTER 2 - PRINCIPAL DESIGN CRITERIA

2.1 In Section 2.1 and Appendix 12B, revise application to state that burnable poison and thimble plug inserts are permitted for storage in the NAC-UMS-Advanced design. These sections of the application do not mention the storage of burnable poison and thimble plug inserts in the Advanced NAC-UMS design and should accurately describe the expected contents.

2.2 In Table 2-1, revise the local/surface concrete temperature criterion of $\leq 300^{o}F$ for the normal condition.

For normal conditions, Section A.4.1 of Reference 4, ACI 349-95, allows increased temperatures for local areas not to exceed $200^{o}F$.

2.3 Explain why the maximum weight of 120,010 lbs as listed in Table 2-1 is different from that of 121,500 lbs shown in Table 1.2-7 for the Standard/Advanced Transfer Cask

The SAR must provide consistent information throughout.

2.4 In Section 2.1, identify the bounding lattice designs (among all the possible 14x14, 15x15, 16x16, and 17x17 PWR arrays) used to derive Tables 2.1.1.2-3 and 2.1.1.2-4. Provide input files (for each of the fuel designs: 14x14, 15x15, 16x16, and 17x17) that allowed the determination of the minimum cooling years for spent fuel with 55 GWd/MTU burnup, initial enrichment 3.3 wt% ^{235}U and a decay heat less than 700 watts.

The staff evaluations are not agreeing with the values provided in the application.

2.5 Revise Section 2.1.1 to describe and/or reference the information for design basis thermal and radiological source terms for burnable poison and thimble plug inserts. In addition, address how the decay heat from burnable poison inserts was taken into account when deriving Tables 2.1.1.2-3 and 2.1.1.2-4. Identify if any other source of decay heat (e.g., thimble plug inserts) may also be stored with the spent fuel and, therefore, contribute to the heat source.

The SAR should consistently describe the expected contents. Burnable poison and thimble plug inserts typically contribute to the heat load within the canister. The application does not describe the thermal contribution of these fuel components and the staff evaluations are not agreeing with the values provided in the SAR Tables.

2.6 Revise Tables 2.1.1.2-2, 2.1.1.2-3, and 2.1.1.2-4 to indicate minimum initial enrichments of $4.9 \leq E < 5.0$ wt% ^{235}U.

The analyses presented in the application only address spent PWR fuel with initial enrichments up to 5.0 wt% ^{235}U. Tables 2.1.1.2-2, 2.1.1.2-3, and 2.1.1.2-4 must be consistent with the SAR analyses. The SAR should consistently describe the expected contents.

2.7 In Section 2.2.6, justify the use of 76°F ambient air temperature for the base case when some regions of North America have monthly averages that are far higher. Consider revising Chapter 12 (Section B 3.4) in the SAR so that this limitation in the design is clearly specified.

For example, in the Phoenix area, the National Weather Service (www.phx.noaa.gov/climate/summaries/phoenix.html) indicates a maximum average temperature of 106°F and a minimum average temperature of 80°F for the month of July over a period of 52 years. The ambient temperatures at the Palo Verde site should be similar to those values. The time response of a dry storage cask should be on the order of one to two weeks; therefore, annual averages may not be appropriate when defining the air temperature for the base-case condition.

CHAPTER 3 - STRUCTURAL EVALUATION

3.1 For the canister hoist rings analysis in Section 3.4.3.5, justify the assumption of equal-load distribution for the four-legged-sling lifting configuration.

The four-leg-sling configuration, by definition, is statically indeterminate. As such, minor length difference in individual slings would tend to result in an uneven load distribution in individual slings and hoist rings to invalidate the SAR results.

3.2 In Section 3.4.3.6.1, provide a discussion on how the total weight of approximately 217,300 lbs was determined for the heaviest loaded transfer cask (Advanced Class 3 PWR).

It is unclear as to how weight value was determined when the maximum canister weight of 103,000 lbs, shown in Drawing 790-560 for the heaviest loaded cask, was used in the structural analysis of the 121,500 lb transfer cask (103,000 + 121,500 = 224,500 lbs).

3.3 For the finite element model in Figure 3.4.4.3-2, provide a diagram showing how and where the canister is supported by the hoist rings for the dead load analysis. Revise the canister finite element analysis, if any new hoist ring configuration other than the reported four-legged-sling lifting configuration is considered.

Figure 3.4.4.3-2 does not contain the loading boundary condition. As noted in RAI 3-1 above, the proposed four-legged-sling lifting configuration is statically indeterminate in that the canister weight cannot be assumed to be equally distributed through the hoist rings.

3.4 For the finite element models in Figures 3.4.4.3-5 and -6 of the basket and bottom weldment, respectively, provide sufficient annotations at representative locations to illustrate the modeling approaches for: (1) gap elements to simulate contact between adjacent basket components, (2) contact between the basket outer shell and the canister shell, and (3) nodal coupling between tabs and slots.

Sufficient details must be presented in the figures to accommodate staff review of the modeling approaches.

3.5 In Section 3.4.4.3.9, clarify the SAR statement, "[t]he size of the gaps in the model is determined using nominal dimensions of the contacting components," and discuss why the modeling approach is sufficient for calculating the stress and deformation performance of the basket assembly, including neutron absorber plates.

The effects of tolerance stack-ups on the basket performance should be considered in determining the tab/slot engagement status. For the neutron absorber plates, which serve no structural function but could potentially fit tightly between the basket plates, the application should address their structural performance resulting from the deformations or displacements of the supporting basket plates.

3.6 Revise the sketch in Figure 3.4.4.3-7 to provide sufficient details of model attributes, including finite element scheme, element types and temperature boundary conditions for the thermal stress analysis.

The figure does not provide sufficient details to support the SAR description of the thermal stress analysis model.

3.7 In Section 3.4.4.3.9, provide a summary of differential thermal growths at key tab/slot connections and describe how these differential thermal growths are considered in determining the basket tab/slot gap status during the cask tip-over event, as evaluated in Section 12.2.12.6.

The information is needed to evaluate the validity of the initial condition assumptions related to the tab/slot status evaluation.

3.8 In Section 3.4.4.3.10, justify the use of the at-temperature (400^{o} F) yield strength of 14.0 ksi as the acceptance criterion for the cooling shunt functionality analysis.

The pre-loaded aluminum cooling shunt could be subject to the time-dependent relaxation or creep material behavior. This tends to cause the cooling shunt to lose its preload or functionality for storage operation. Sufficient test data or references on material performance should be provided to demonstrate that appropriate acceptance criteria were considered in the analysis.

3-9 In Section 3.4.4, provide a description of the structural components of the 100-ton transfer cask that are needed during the up-ending and down-ending operations. Also, provide an analysis of those components to demonstrate their structural capabilities for horizontal handling of the transfer cask, including the up-ending and down-ending operations.

Section 1.2.1.4 states that the loaded 100-ton transfer cask may be moved in a horizontal orientation using a wheeled cradle. However, Drawing 790-566 provides no design information on how transfer cask components can be used to facilitate the up-ending and down-ending operations associated with the horizontal handling of the transfer cask.

CHAPTER 4 - THERMAL EVALUATION

4.1 In Section 4.4.1.2, correct the list of thermal models listed in the beginning of the section. The first item should read: “Two-Dimensional Air Flow and Concrete Cask Model.” The seventh item is missing and should read: “Two-Dimensional Fuel Basket Cooling Insert Model.”

4.2 In Section 4.4.1.2.7, revise the second paragraph so that the cooling insert model is referenced rather than the neutron absorber plate model.

4.3 In Section 4.1.2, provide the maximum allowable temperatures and the safe operating ranges for both Boral and Metamic, including appropriate references.

Criticality as well as structural performance are dependent on this information.

4.4 In Section 4.1.2, revise the temperature limits to conform to ISG-11, “Cladding Considerations for the Storage and the Transportation of Spent Fuel,” Revision 2.

The application does not reflect NRC’s position on the storage of high burnup fuel.

4.5 In Section 4.4.1.2.1, justify the insolation values proposed for the Advanced-model vertical concrete cask configuration. Identify exactly where the solar loads are applied in the corresponding ANSYS model.

The application proposes smaller insolation values for the Advanced design (120 W/m^2 on the side surface of the concrete, 240 W/m^2 on the top surface of the concrete, and 320 W/m^2 on the top surface of the cask lid) than for the Standard design (192 W/m^2 on the side surface of the concrete, 387 W/m^2 on the top surface of the concrete).

4.6 In Section 4.4.3.2, justify the use of a new forced air flow modeling approach for cooling the Advanced transfer cask (page 4.4.3-19) when compared to methodology proposed for the Standard transfer cask (Section 4.4.1.1.7) .

Since the Advanced canister is essentially identical to the Standard canister (except for the increased bottom plate thickness) and the Advanced transfer cask is also identical to the Standard transfer cask (except for the trunnion design), it would be expected that the same methodology would apply.

4.7 In Section 4.4.3.2, justify use of the short-term fuel loading temperatures of 777°F (during the vacuum drying phase) and 837°F (during the helium phase) to demonstrate that hydride reorientation does not occur in the cladding during fuel loading operations or modify the fuel loading procedures such that the short-term cladding temperatures do not exceed the 400°C (752°F) limit as specified in ISG-11, Revision 2.

Alternatively, for fuel with burnup less than 45 GWD/MTU, demonstrate that the best estimate hoop stress experienced by the fuel cladding during the transfer process (vacuum and helium phases) does not exceed 90 MPa for the fuel that is being loaded into the casks at the maximum temperature calculated in the SAR (i.e., 837°F). If the hoop stress exceeds 90 MPa at 837°F, then the loading procedure must be modified such that the new maximum calculated temperature of the cladding that corresponds to 90 MPa is not exceeded. For example, if the calculated best estimate hoop stress is equal to 90 MPa at 800°F, then 800°F becomes the maximum allowable temperature for loading operations. The reduced load cases must be addressed as well.

In accordance with 10 CFR 72.122(h)(1), spent fuel cladding must be protected from degradation that leads to gross ruptures or the fuel must otherwise be confined so that degradation of the cladding will not impose operational safety problems. Further, 10 CFR 72.122(l) requires that the storage system must be designed to allow ready retrieval of the spent fuel from the storage system for further processing or disposal.

4.8 In Section 4.4.3.2, discuss how the uncertainties associated with the heat source, component geometries, material properties, numerical methods, and correlations are accounted for in the proposed thermal modeling methodology.

According to Table 4.4.3.2-1, the normal storage maximum fuel cladding and basket plate temperatures (707°F and 693°F, respectively) are close to their allowable limits (734°F and 700°F, respectively). These values assume an ambient air temperature of 76°F. Uncertainties in the calculation as well as exposure to a hotter environment could likely reduce the small existing thermal margin.

4.9 Explain the discrepancy between Figure 4.4.3.2-5 and the Section 4.4.3.2 description of the transfer condition times for the advanced configuration design: 17 hours for the drain operation, 44 hours for the vacuum and drying operation, and 30 hours for the helium condition (which include the helium backfill process and the period of time until the canister is placed into the vertical concrete cask for storage).

The time duration of events shown in Figure 4.4.3.2-5 do not agree with what is described in Section 4.4.3.2 and yet the time limits from the figure are used in the Chapter 12 Technical Specifications.

4.10 Justify the procedure of determining time limits for vacuum and drying operations (after either in-pool or forced-air cooling has been required) by interpolation of the vacuum curve for normal transfer conditions. Address both base and reduced load cases. For example, provide a more detailed explanation of how Table 4.4.3.2-3 was established.

Note that the heat-up process (heating from within) is not the same as the forced cool-down process (cooling from the surface); therefore, the time-evolution curves should not be the same, which would indicate the proposed interpolation is an approximation. Address the degree of uncertainty obtained with the proposed methodology.

4.11 Provide input files (electronic format) as well as other supporting files (electronic format) for the following ANSYS models: three-dimensional Advanced canister model, three-dimensional Advanced transfer cask and canister model.

This information is needed for staff to perform independent verification of the results in the application.

4.12 In Section 4.4.5, provide detailed calculations supporting the determination of the maximum internal pressure (26.6 psig) for the Advanced canister under normal conditions of storage.

This information is needed for staff to perform independent verification of the results in the application.

CHAPTER 5 - SHIELDING EVALUATION

5.1 In Section 5.1, revise the application to discuss the actual dose rate differences between the Standard and Advanced transfer cask designs.

The term “insignificant” is not quantifiable.

5.2 In Section 5.1.2, explain the reduced dose rates around the Advanced Vertical Concrete Cask and the Advanced Transfer Cask. Explain and justify any differences between the shielding models which result in lower dose rates around the Advanced NAC-UMS design.

The cool-time and burnup combinations of the spent PWR fuel, and the burnable poison and thimble plug inserts in the Advanced configuration result in a significantly higher source term than that of the Standard configuration. Yet, there is no significant change in the radial shielding between the Standard and Advanced designs. It would be expected for the dose rates to increase around the NAC-UMS Advanced design rather than decrease. The text of Section 5.1.3.1 does not provide sufficient justification.

5.3 Clarify the design basis fuel that was used to generate the dose rates reported in Tables 5.1-3 and 5.1-4.

Section 5.1.3 does not state the parameters of the design basis fuel that resulted in the dose rates reported in Tables 5.1-3 and 5.1-4.

5.4 Revise Tables 5.1-3 and 5.1-5 regarding the maximum dose rates around the Advanced design (both the Vertical Concrete Cask and Transfer Cask) to include the storage of the burnable poison and thimble plug inserts.

The maximum dose rates provided in these tables should be consistent with the expected contents.

5.5 In Section 5.1.3.1, provide a summary of the accident dose rates for the NAC-UMS Advanced configuration when burnable poison and thimble plug inserts are present.

The maximum dose rates provided in the discussion should be consistent with the expected contents.

5.6 In Section 5.2, justify using SCALE4.3 to evaluate the source term. Explain why the cross section library used to evaluate the source term was appropriate and that the changes between SCALE4.3 and SCALE4.4a will not affect the radiological (both gamma and neutron) and thermal source terms. If the changes are found to affect the radiological and thermal source terms, revise all affected sections of the SAR as appropriate.

The revisions of SCALE4.3 to SCALE4.4a included updating of cross-section libraries based on experimental isotopic validations. This is necessary to ensure that the bounding source term has been adequately evaluated.

5.7 In Section 5.2, justify using SAS2H code for evaluating fuel burnups up to 55 GWd/MTU. Provide justification that the bounding radiological (both gamma and neutron) and thermal source terms have not been underestimated due to this code limitation. If the source terms are found to be underestimated, revise the affected sections of the SAR as appropriate.

Section 5.2 states that the isotopic comparisons with the results of the SAS2H code have been validated for burnups up to 47 GWd/MTU. The applicability of using this code for burnups beyond 47 GWd/MTU has not been discussed in the SAR. This is necessary to ensure that the bounding source term has been adequately evaluated.

5.8 Justify using 0.8 g/kg for the cobalt impurities in both inconel and steel in the source term analyses for the Advanced NAC-UMS design. Alternatively, revise the Chapter 12 Technical Specifications to include a requirement that all fuel is certified prior to storage to a cobalt impurity level below 800 ppm in all stainless and inconel components. Revise all affected sections of the SAR as appropriate.

The SAR does not provide sufficient information to determine that an 0.8 g/kg cobalt impurity level for the non-fuel hardware is appropriate for a general license application. Staff reviewed EPRI TR-10429, referenced in Chapter 5 of the application, and found that the 800 ppm maximum for stainless steel and the 1000 ppm maximum for inconel is not based on published data but rather on a private communication between Transnuclear and Westinghouse in June 1984. Staff also reviewed the information for the Maine Yankee fuel and found it to be of limited value, since this information is from a single utility regarding a single site specific fuel type. The information provided in Chapter 5 does not demonstrate that 800 ppm maximum cobalt impurity for both inconel and stainless components of spent fuel is a fair representation of all 14x14, 15x15, 16x16, and 17x17 fuel arrays.

In addition, PNL-6906-Volume 1, “Spent fuel Assembly Hardware, Characterization and 10 CFR 61 Classification for Waste Disposal, Volume 1, Activation Measurements and Comparisons with Calculations for Spent fuel Assembly Hardware,” (A. Luksic, June 1989), provides test data regarding cobalt concentrations in stainless steel and inconel components for Westinghouse and CE fuel assemblies. This report publishes cobalt impurity values which are nearly twice the 800 ppm value described in the application.

5.9 In Section 5.2.4.1, revise the application to include the design basis bounding source spectra for each of the three-zone loading limits of 700 Watts/assembly, 1000 Watts/assembly and 1100 Watts/assembly. In addition, provide bounding gamma source spectra for the active fuel, fuel hardware region, and burnable poison and thimble plug inserts.

This is necessary for the staff to ensure that the bounding source term has been adequately evaluated.

5.10 In Table 5.2-25, provide further explanation for Note 1.

Table 5.2-25, Note 1, states that “[i]ncreased hardware mass in the 14x14 and 15x15 assemblies is due to steel guide/instrument tubes in reference models.” Explain what this notation means and why it applies to the 14x14 and 15x15 reference assemblies and not to the 16x16 and 17x17 reference assemblies.

5.11 Revise the application to include the calculation, algorithm, or a detailed description of the computer code used to rebin from the SAS2H standard neutron and gamma energy grouping to the MCBEND 28 neutron and 22 gamma standard group structures.

This is necessary for the staff to ensure that the bounding source term has been adequately incorporated into the shielding evaluation.

5.12 Revise the application to include the SCALE4.3 computer input file for the design basis gamma (including active fuel, each hardware region, and burnable poison and thimble plug inserts) and neutron source term calculation for the 700W, 1000W and 1100W design basis fuels.

This is necessary for the staff to ensure that the bounding source term has been adequately evaluated.

5.13 Clarify the axial source profile used in the MCBEND shielding evaluation. Revise the text of Chapter 5 as appropriate.

The text of Section 5.2 implies that the MCBEND shielding evaluation includes axial source profiles; however, it is not clear about the axial source profile applied to the MCBEND model. This is necessary for the staff to ensure that the bounding source term has been adequately incorporated into the shielding evaluation.

5.14 In Table 5.3-6, identify what portions of the fuel assembly are being described by the terms “Inside Tubes” and “Interstitial.”

5.15 Revise Tables 5.3-7 and 5.3-9 to include material densities in g/cc as well as in atom/b-cm.

5.16 In Section 5.3, justify modeling the top fitting hardware region as stainless steel.

The top fitting hardware contains a considerable amount of inconel. Combining inconel and stainless steel in this region would result in less self-shielding.

5.17 In Section 5.3, justify neglecting the inconel in the grid spacers from the shielding evaluation.

5.18 Revise the application to include detailed radial and axial sketches, including all dimensions, of the shielding model for normal and accident conditions. In addition, Revise Figures 5.3-7, 5.3-9, and 5.3-11 to include the dose receptor locations.

The application does not provide sufficient detail to determine if the NAC-UMS Advanced as shown in the drawings provided in Chapter 1 have been appropriately represented in the shielding model. For example, Figure 5.3-7 needs additional detail regarding: the diameter of the base plates, the air inlet and outlets (several plate thicknesses are missing), the pedestal stand height, the diameter of the lid plate, the height of the baffle plates at the air outlet, and the thickness and diameter of the NS-4-FR. Neither Figures 5.3-8 nor 5.3-10 provide sufficient detail of the radial and axial models of the fuel basket. In addition, the sketches do not identify the location of the fuel assembly within the basket.

5.19 Clarify how the shielding model considered the preferential loading pattern within the cask.

Section 5.3 does not discuss how the preferential loading pattern was evaluated in the shielding evaluation.

5.20 Provide sample input files of MCBEND 3-d shielding model.

The input files should be appropriate for the staff to verify the design basis bounding neutron doses, gamma doses from the active fuel, capture gamma doses and gamma doses from the activated hardware. The staff cannot determine if the NAC-UMS Advanced design has been appropriately represented in the shielding models.

5.21 In Section 5.4.2, provide a “step by step” description of the 3-dimensional dose response function method.

The description of the 3-dimensional dose response function method in Section 5.4.2 is too general and does not permit independent verification of the analysis.

5.22 Revise Chapter 5 to include all sets of dose response functions, both radial and axial, that were developed for each source region (fuel gamma, fuel neutron, fuel capture gamma, lower end fitting, upper plenum, upper end fitting, and burnable poison and thimble plug inserts) for each configuration of the loaded Advanced Vertical Concrete Cask.

This is necessary for the staff to verify the Advanced Vertical Concrete Cask loading tables presented in Tables 5.4.2-7, 5.4.2-8, 5.4.2-9, 5.4.2-14, and 5.4.2-15.

5.23 Explain how the preferential loading pattern affects the dose response function method.

Section 5.4 does not discuss how the preferential loading pattern was considered in the dose response function method. This is necessary for staff to verify the adequacy of the shielding evaluation.

5.24 Revise the application to include the calculation or a detailed description of the computer code used to convert ANSI N6.1.1-1977 flux-to-dose conversion factors into MCBEND energy groups.

This is necessary for the staff to ensure that the flux-to-dose conversion factors have been adequately incorporated into the shielding model.

5.25 In Section 5.4.2, include a thimble plug insert loading table similar to those provided for the fuel assemblies and burnable poison inserts. The table should show limiting assembly source terms for each of the 15 case combinations. In addition, revise this section to include the dose rate limit at the air outlet for the thimble plug inserts similar to the value provided for burnable poison inserts.

5.26 On page 5.4.2-6, in the section title “Thimble Plug Loading Tables,” clarify the reference to burnable absorbers.

5.27 In Section 5.3.1, provide a dose rate evaluation of the Advanced design with NS-3. Provide the elemental composition of NS-3 and the density of each element.

The application does not provide a dose rate evaluation for the Advanced design with NS-3 nor the composition of NS-3.

CHAPTER 6 - CRITICALITY EVALUATION

6.1 In Section 6.1.1, revise the first paragraph to provide additional information to explain why the differences in cask bodies (i.e., thicker bottom plate, baffle changes, and inserts into the canister to cask gap) do not significantly impact system reactivities.

This information is necessary to ensure that the modeled cases adequately bound all potential reactivity effects.

6.2 In Section 6.1.2, explain whether an Advanced canister will fit into a Standard Vertical Concrete Cask.

The modeled cases assume an Advanced canister in an Advanced Vertical Concrete Cask. This information is necessary to ensure that the modeled cases adequately bound all potential configurations.

6.3 In Section 6.2.2, justify how the assumptions of maximum and minimum relevant fuel assembly characteristics tolerances were determined (reference Table 6.2.2-3).

This information is necessary to ensure that the modeled cases adequately bound all potential fuel assembly tolerances. No indication was provided as to how these bounding tolerances were selected.

6.4 In Section 6.5.2, provide the USLSTATS generated for k_{eff} versus soluble boron concentration in the moderator.

This information is necessary to ensure that the USL (Upper Safety Limit) used in the evaluation is appropriate for all fuel configurations.

6.5 In Section 6.5.2, justify the applicability of the USLSTATS methodology to determine the USL.

This information is necessary to ensure that the USL used in the evaluation is appropriate for all fuel configurations. Due to the lack of data points for certain experimental parameters, most notably boron concentration, ^{10}B plate loading, and mean neutron-energy-causing fission, the data may not indicate a normal distribution over the entire area of applicability. Since normality of data distribution is one of the conditions with this USLSTATS approach is based, additional justification is necessary.

6.6 In Section 6.5.2, provide additional justification for using soluble boron at levels greater than that supported by the benchmark maximum.

This information is necessary to ensure that the benchmarks adequately bound all modeled parameters. As indicated in Table 6.5.2-1 and in Figure 6.5.2-9, the JEF 2.2-based point energy neutron libraries stop well short of the NAC assumed ^{10}B concentration of 2300 ppm. This concentration appears to be well outside the area of applicability of the data. Since any errors in the boron cross-sectional data set in the JEF library would be compounded by extrapolation of the data, additional justification is necessary to conclude that these elevated concentrations are indeed bounded by the experimental data.

6.7 In Section 6.5.2, provide additional justification for using the JEF 2.2-based point energy neutron libraries for enrichments greater than 4.75 wt% ^{235}U.

This information is necessary to ensure that the benchmarks adequately bound all modeled parameters up to and including 5.0 wt% ^{235}U. As indicated by Figure 6.5.2-1 and Table 6.5.2-3, there is only one experimental data point above this enrichment level (reference case 27.01 at 7.0 wt% ^{235}U). In addition, this one case is a cylindrical configuration, clad in stainless steel, and does not incorporate any boron into the experiment, which would appear to make it a poor match for benchmarking the proposed Advanced fuel configurations.

6.8 In Section 6.5.2, provide additional justification for using the JEF 2.2-based point energy neutron libraries for the Mean Neutron Log (E) Causing Fission.

This information is necessary to ensure that the benchmarks adequately bound all modeled parameters. As stated on page 6.5.2-2, credit is given for the trend line plotting the mean energy increases contributing to the applicability of the USL. However, only two data points are provided for the far range of the neutron energies (reference cases 50.06 and 50.07 in Table 6.5.2-3 and illustrated in Figure 6.5.2-5). Since the analysis relies on this figure to demonstrate USL applicability, additional justification is needed.

CHAPTER 8 - OPERATING PROCEDURES

8.1 In Section 8.3, provide the bases for the proposed reflood rate, fluid temperature and pressure monitoring during the canister refill and fuel cooldown operations.

In the case where the canister must be brought back to the spent pool and unloaded, operational limits (quench fluid flow rate, for example) must be justified in order to guarantee the integrity of the fuel, the canister, and the operation itself.

CHAPTER 9 - ACCEPTANCE CRITERIA AND MAINTENANCE PROGRAM

9.1 In Section 9.1.6, provide a separate description of the qualification and acceptance testing planned for the Metamic neutron absorber material. Justify the qualification and acceptance tests proposed for 90% credit for boron content.

The discussion provided in 9.1.6 mixes the qualification and acceptance testing being proposed for both Boral and Metamic. It is not clear what additional testing is being proposed to support 90% credit for boron content of the Metamic material. The staff notes that in past license applications, acceptance testing for 90% credit has included neutron transmission tests. See ISG-15 for a discussion on acceptance criteria for neutron absorbing materials.

CHAPTER 10 - RADIATION PROTECTION

10.1 In Section 10.2.1.1, revise the table to provide design basis surface dose rates consistent with Table 2-1 and Chapter 12 Technical Specifications for the Standard NAC-UMS configuration.

Table 2-1 and the Technical Specifications have increased the design basis for the Standard configuration. The SAR should consistently describe the design basis dose rates.

10.2 Justify the occupational exposures for the 100-ton transfer cask.

Based on the shielding evaluation in Chapter 5, it appears that the occupational exposures are underestimated. This information is necessary to determine if the occupational dose evaluation is adequate.

10.3 Revise the occupational exposures from the NAC-UMS Advanced design to include the additional occupational exposure due to the presence of burnable poison and thimble plug inserts.

Address the incremental dose increase due to the burnable poison and thimble plug inserts as it applies to occupational doses. Chapter 10 should describe the bounding occupational doses from the NAC-UMS Advanced design.

10.4 Clarify whether the off-site doses from the NAC-UMS Standard Configuration have been re-evaluated following the increase in design basis surface dose. If not, revise the analysis of Chapter 10 accordingly.

The off-site dose evaluation should consider the design-basis surface dose rate in its evaluation. In both Chapter 2 and Chapter 12, the design basis surface dose rate has been increased for the NAC-UMS design. Therefore, the off-site dose evaluation for the standard configuration should reflect this increase. This is necessary to demonstrate the design's ability to comply with the requirements of 10 CFR 72.104.

10.5 Revise the application to clearly describe the direct and skyshine offsite dose evaluation for the NAC-UMS Advanced design. In particular, address the following:

a. Clarify whether the offsite doses are based on the surface dose limits identified in the Chapter 12 Technical Specifications. Section 10.3.2.2 states that the offsite doses are based on 14x14 fuel with an initial enrichment of 3.5 wt% ^{235}U, 60 GWd/MTU and cooling time of 9 years. The SAR must demonstrate that this initial enrichment, cooling time, and burnup combination results in the surface dose limits identified in both Chapter 2 and Chapter 12. If not, revise the analysis accordingly.

b. Describe the development of the angular emission shapes.

c. Describe how the preferential loading pattern was considered in the analysis.

d. Provide sample SKYSHINE-III and MCBEND input files, as appropriate.

This information is necessary to determine if the offsite dose evaluation is adequate and to demonstrate the design's ability to comply with the requirements of 10 CFR 72.104.

CHAPTER 11 - ACCIDENT ANALYSES

11.1 Address the consequences of a fire during a 100-ton transfer cask operation.

Since the Advanced 100-ton transfer cask can be moved out of the spent fuel pool building, the fire scenario must be considered.

11.2 In Section 11.1.2.3, justify the use of a two-dimensional model for simulating the half-blocked inlet vents scenario. Address the effects upon the resulting temperatures had a fully three-dimensional approach been used.

In the Advanced NAC-UMS design, the presence of T-shaped channel weldments challenges the use of an axisymmetric model, since the channels do not allow a radial redistribution of the cooling air once inside the annular duct.

11.3 For the finite element model of the fuel basket in Figure 11.1.3-2, provide annotations at representative locations to illustrate modeling the approaches for: (1) gap elements to simulate contact between adjacent basket components, (2) contact between the basket outer shell and the canister shell, and (3) nodal coupling between tabs and slots.

Sufficient details must be presented in the figures to accommodate staff review of the modeling approaches.

11.4 In Section 11.1.5, include the calculation that demonstrates residual contamination of approximately 1.57×10^5 dpm/100 cm^2 (beta-gamma) and 5.24×10^2 dpm/100 cm^2 (alpha) results in a dose rate of 0.1 mrem at a distance of 100 meters.

Chapter 12 Technical Specifications raise the permissible residual contamination to 10,000 dpm/100 cm^2 (Beta-gamma) and 100 dpm/100 cm^2 (alpha).

11.5 In Section 11.2.1, clarify the statement, "[a] total of 19 angular locations for each axial location," for which the sectional stresses are reported.

The referenced Figure 3.4.4.3-4 shows 25 angular locations at 7.5^o apart.

11.6 For Table 11.2.1-9, describe how the canister pressure of 153.9 psi and corresponding bending stresses were determined for the load case of accident pressure-plus-normal handing.

The SAR text does not provide sufficient information for staff review.

11.7 In Section 11.2.1.3.2, provide detailed calculations supporting the determination of the maximum internal pressure (124.9 psig) for the Advanced canister under 100% fuel failure.

This information is needed for staff to perform independent verification of the results in the application.

11.8 In Section 11.2.1.3.2, provide the internal pressure design limit value for the Advanced canister.

The staff needs to verify the design margin resulting from the pressurization calculations.

11.9 In Section 11.2.6.3.2, clarify why the cool down phase is only continued for an additional 17.5 minutes, during the fire event simulation, to evaluate the maximum canister shell temperature.

In Section 11.2.6.3.1, for the Standard configuration, the maximum canister shell temperature is reached in 10.7 hours. There does not appear to be enough difference in the two canister configurations to account for the difference in the heat-up time.

11.10 In Section 11.2.8, revise the seismic stability analysis to include two additional cases. In particular, 0.30 g horizontal and 0.20 g vertical, as listed in Chapter 12, Section B 3.4, “Site Specific Parameters and Analyses,” for the Standard and Advanced Vertical Concrete Cask configurations.

11.11 In Section 11.2.12.5, explain how the T-shaped channel weldments on the steel liner of the Advanced Vertical Concrete Cask were considered in the cask tip-over analysis.

On the basis of the analysis methodology for the Standard Vertical Concrete Cask, the SAR should discuss how the mass and stiffness of the added structural entities, the T-shaped weldments, were considered in the tip-over analysis for the Advanced Vertical Concrete Cask.

11.12 On Page 11.2.12-81, clarify the statement, “[n]odal coupled degrees of freedom are used to represent the various basket plate joints,” by providing sketches depicting element connectivity, initial gap size, contact stiffness, and nodal coupling equation, as appropriate, for all representative types of basket joints of the finite element analysis model.

Finite element joint modeling details are needed to accommodate staff review of the modeling approaches for determining gap opening status.

11.13 On Page 11.2.12-84, clarify the statement, “[t]he stress evaluation for the support disk is performed according to....”

The Advanced fuel basket consists of a series of interlocking plates and does not have support disks.

11.14 On Page 11.2.12-85, clarify the statement, “[t]he tabs are 0.05 inches shorter than the nominal thickness of...an additional 0.05 inches for each tab is subtracted to account for manufacturing tolerances,” by discussing how tolerance stack-ups and differential thermal growths are considered in determining the initial gap status at various basket tab/slot joints.

The effects of tolerance stack-ups and differential thermal growths on the basket performance must be considered in determining the engagement status of the tabs and corresponding slots.

11.15 On Page 11.2.12-86, remove reference to the “30 ft. side-drop.”

The Advanced basket has not been evaluated for a 30 ft. side-drop.

11.16 On Page 11.2.12-87, in the section titled “Advanced PWR Basket METAMIC Plate Analysis,” describe and justify the force and displacement design bases and corresponding stress/deformation acceptance criteria for analyzing the neutron absorber sheet and its tab/slot connections to the supporting basket plates.

In a tightly fitting basket configuration neutron absorber sheets could potentially experience large stresses resulting from deformations or displacements of adjacent supporting basket plates, in addition to inertia force effects.

11.17 On Page 11.2.12-88, at the top of the page, please clarify what is meant by "structural carbon" when referring to the gap elements. Also, in the middle of the page, when referring to the figures depicting section cuts (Figures 11.2.12.6.1-17 and -18), Figure 11.2.12.6.1-18 appears to be a typographical error.

11.18 Address dynamic load factors and corresponding bounding decelerations in the evaluation of the neutron absorber sheets, considering dynamic amplification by the fuel basket plates and neutron absorber sheets.

The SAR must address dynamic amplification by considering all intervening structural components in the load path, which may result in a deceleration higher than 60 g.

11.19 For the tip-over event, revise the SAR to include an evaluation of the tab/slot gap status for the neutron absorber sheets.

11.20 On Page 11.2.12-89, in the section titled "Advanced Basket Tab Analysis," provide sketches and drawing references to illustrate the gaps and tolerances which are considered in the analysis model used to calculate the maximum tab deflection of 0.012 inches.

11.21 On Page 11.2.12-91, in the section titled "Advanced Concrete Cask T-Shaped Channel Weldment Analysis," provide an analysis for the compressive stress in the web of the T-shaped weldment.

The analysis for the web should address failure modes in addition to buckling.

11.22 On Page 11.2.12-92, in the section titled "Advanced PWR Basket Buckling Evaluation," justify the "effective" column length used in calculating the critical buckling load for the center most basket plate, and re-evaluate buckling strength, as appropriate.

The tab/slot pin connections and the "short" basket plates appear to be ineffective in preventing lateral sway of the center most basket plate. Short of ideal boundary conditions, a conservative column effective length or a more rigorous analysis may have to be considered for the buckling evaluation.

11.23 In Section 11.2.16, provide a discussion on the operational controls needed to ensure that the loaded 100-ton transfer cask will not be subject to conditions susceptible to cask end-drop and tip-over accidents.

During the up-ending and down-ending operations, the 100-ton transfer cask may also be susceptible to cask end-drop and tip-over accidents. The SAR should either provide results of analyses to demonstrate that the cask will continue to serve its function after the accident or establish criteria for controlling transfer cask operations to preclude those accident scenarios.

11.24 In Section 11.2.16, reevaluate the side drop of the 100-ton transfer casks for the Standard PWR, Standard BWR, and Advanced PWR configurations by noting that: (1) a much higher filter cutoff frequency than 50 Hz should be considered in calculating applicable cask impact responses for the support disks evaluation, and (2) a sufficient number of locations on the transfer cask should be considered for determining the governing (individual or envelope) impact response spectra for the support disks.

In accordance with the modal properties on SAR page 11.2.16-6, dynamic load factors may markedly be affected by modal frequencies up to about 371 Hz and 211 Hz for the PWR and BWR support disks, respectively. In addition, impact responses at different cask locations are expected to be non-uniform, because of the spatial dependence of mode shape amplitudes.

11.25 With respect to the desired roll-off or attenuation rate of the LS-POST Butterworth filter, revise, as appropriate, the SAR discussion on the criteria for selecting the low-pass cut-off frequency in processing cask impact response data.

The staff notes that the order of the Butterworth filter must be selected for an acceptable attenuation rate by considering frequencies of all dominant modes of vibration of the support disk. For instance, considering the PWR support disk with the highest dominant frequency of 371 Hz, the cut-off frequency for processing the cask impact response may have to be much higher than 371 Hz, depending on filter properties.

11.26 Provide a description of the damage in the outer shell and evaluate its effects on potential loss of liquid neutron shield resulting from the side drop of the 100-ton transfer cask.

The outer shell of the transfer cask is likely to get crushed and result in a loss of the liquid neutron shield.

CHAPTER 12 - OPERATING CONTROLS AND LIMITS

12.1 In Appendix 12B, include reduced heat load preferential loading pattern information (as shown in Table 4.4.3.2-11) in the list of approved contents for the Advanced NAC-UMS System so that appropriate time limits can be clearly specified in the limiting conditions (LCO 3.1.8 & LCO 3.1.9).

Only cases bounded by the ones considered in the SAR calculations can be subjected to a longer time limit during the vacuum drying and helium backfill process. The Technical Specifications should clearly identify the allowable cases.

12.2 In Table 12B2-10, justify the inclusion of the Class 2, 15x15 assembly, with a maximum MTU loading of 0.4954.

This 15x15 assembly is not bounded by the 3-dimensional 15x15 fuel assembly description in Chapter 5.

12.3 For Tables 12B-11, 12B-12, and 12B-13, revise to indicate minimum enrichments of $4.9 \leq E < 5.0$ wt%.

The analyses presented in the SAR only permit spent PWR fuel with initial enrichments up to 5.0 wt% ^{235}U. Tables 12B-11, 12B-12, and 12B-13 must be consistent with the SAR analyses.

12.4 In Section B2.0 of Appendix 12B, "Approved Contents," include references to burnable poison and thimble plug inserts for the NAC-UMS Advanced design.

Provisions for storage of burnable poison and thimble plug inserts that are addressed in the SAR are missing from the Technical Specifications.

12.5 In Section B2.0 of Appendix 12B, "Approved Contents," include a discussion of the 100-ton transfer cask and its permissible contents.

Chapter 2 indicates that burnable poison and thimble plug inserts are not permitted in the 100-ton transfer cask. This should be included in the Technical Specifications.