May 23, 2005

Mr. Anthony L. Patko, Director
Licensing
NAC International, Inc.
3930 East Jones Bridge Road
Norcross, GA 30092

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR THE REVIEW OF THE NAC-MAGNASTOR SYSTEM APPLICATION (TAC NO. L23764)

Dear Mr. Patko:

By letter dated August 31, 2004, NAC International (NAC) submitted an approval request to the U. S. Nuclear Regulatory Commission (NRC) for the MAGNASTOR System. This application proposes a new cask design consisting of a welded stainless steel transportable storage canister (TSC), a transfer cask, and a concrete cask. The system is designed to store up to 37 pressurized water reactor (PWR) or 87 boiling water reactor (BWR) spent fuel assemblies. On November 1, 2004, you were notified that the NRC staff had completed its acknowledgment review of your application and that your application contained sufficient information for the staff to begin its detailed technical review. We also provided a proposed schedule for completing the technical review of your application.

In connection with the staff's technical review, we need the information identified in the enclosure to this letter. We request that you provide the information by August 23, 2005. Please inform us in writing at your earliest convenience, but no later than August 9, 2005, if you are not able to provide the information by the requested date. You should also include a new proposed submittal date and the reasons for the delay to assist us in re-scheduling your review.

A meeting has been scheduled for Wednesday, June 8, 2005, to discuss your proposed responses to our requests for additional information. Please reference Docket No. 72-1031 and TAC No. L23764 in future correspondence related to this licensing action. If you have any questions, please contact me at (301) 415-8500.

Sincerely,

/RA/

L. Raynard Wharton, Project Manager
Licensing Section
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Docket No. 72-1031

Enclosure: Request for Additional Information

May 23, 2005

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NAC International, Inc.
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NAC INTERNATIONAL

DOCKET NO. 72-1031

REQUEST FOR ADDITIONAL INFORMATION

RELATED TO THE MAGNASTOR SYSTEM

By submittal dated August 31, 2004, NAC International (NAC) requested approval of the application for the MAGNASTOR system spent fuel storage cask design. The application proposed the NAC MAGNASTOR Safety Analysis Report (SAR), technical specifications (TS), and Certificate of Compliance (CoC).

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

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

Chapter 1.0 General Description

The following information is needed to determine compliance with 10 CFR 72.2(a)(1), 72.11, and 72.236(a), unless otherwise stated. It should be noted that other regulatory requirements may be applicable.

Section 1.3 General Description of MAGNASTOR

1-1 Clarify the inconsistency in the SAR listing for the fuel basket assembly diameter of 69.8 inches in Table 1.3.1 and 70.76 inches in Table 1.3.2.

Section 1.8 License Drawings

1-2 Revise Drawings 71160-551 and 71160-591 for the PWR and BWR fuel tubes, respectively, by adding the following:

a. tube corner pin-to-socket connection details for both the pin and the socket sides, including dimensions, edge finishing, and tolerance, as appropriate, which are needed to secure the load paths for all loading conditions analyzed.

b. boss/bolt assembly details, including bolt torque, bolt thread, and boss-to-tube welds, to ensure proper development of the load paths assumed for all loading condition analyzed.

1-3 On Drawing 71160-561, specify the size of the S-beams.

1-4 On Drawing 71160-561, add the eye diameter and location for the concrete cask lift lug and lift anchor.

1-5 On Drawings 71160-574 and 71160-598, specify the hole diameter to ensure that the basket support weldments and fuel tubes can engage properly at the bosses welded to the fuel tubes.

1-6 On Drawing 71160-590, add design details for the alternative segmented concrete cask as stated in Note 2, "...concrete cask, may be constructed in segments using an upper section that can be removed to meet site specific requirements."

1-7 Delete references to MAGNASTOR transportation cask because it has not been submitted or approved.

For example Page 1.1 states "MAGNASTOR transport cask will be licenced," Page 1.3-1 states "The loaded TSC may be placed into the MAGNASTOR transport cask for offsite transport" and further claims "The TSC is designed for transport per 10 CFR 71." These claims should be removed because they are premature and unverified.

This information is needed to determine compliance with 10 CFR 72.230(b).

Chapter 2.0 Principal Design Criteria

Section 2.1 MAGNASTOR System Design Criteria

2-1 Add NUREG-0612 to SAR Table 2.1-1 as transfer cask design criteria.

Fuel loading with the transfer cask in the reactor or fuel building is also subject to the guidance provided in NUREG-0612, "Control of Heavy Loads at Nuclear Power Plants."

This information is needed to determine compliance with 10 CFR 72.2(a)(1), 72.11, and 72.236.

Section 2.2 Spent Fuel to Be Stored

2-2 Identify the design basis fuel for both PWR and BWR fuel by manufacturer and array size.

This section has a generic list of fuel types, but does not identify the manufacturer nor the design basis fuel for shielding or criticality assessments.

This information is needed to determine compliance with 10 CFR 72.104, 72.106, 72.122, and 72.126.

2-3 Revise the entire application where burnup is indicated, including technical specifications to indicate peak average burnup. This should be limited to no more than 62.5 GWd/MTU. Further, throughout the application where burnup is referenced, specify whether it is the peak rod burnup, average rod burnup, peak assembly burnup etc. (Note: peak average rod burnup is determined by averaging the burnup in any rod over the length of the rod, then using the highest burnup calculated as the peak average for the assembly.)
As stated in Interim Staff Guidance (ISG-11), Revision 3, "Cladding Considerations for the Transportation and Storage of Spent Fuels," approval for storage and transport will be granted only for burnups up to that approved by the Office of Nuclear Reactor

Regulation (NRR) for reactor operation. For example, the value is currently 62.5 GWd/MTU peak average for PWR fuel.

This information is needed to determine compliance with 10 CFR 72.122(h)(1).

Chapter 3.0 Structural Evaluation

The following information is needed to determine compliance with 10 CFR 72.2(a)(1), 72.11, and 72.236(a), unless otherwise stated. It should be noted that other regulatory requirements may be applicable.

Section 3.5.1 TSC Evaluation for Normal Operating Conditions

3-1 SAR Tables 3.5-1, -2, -3, and -4 Revise stress summary tables to include stresses, as a minimum, at section cut locations 2, 3, 8, and 9 on the TSC shell body and location 1 at the closure-to-shell weld joint. (Note: This request also applies to stress summary tables for all other TSC loading conditions.)

The stress values and margins, reported mostly for locations in the closure and the bottom plates, are not sufficiently indicative of the TSC structural performance under various loading conditions. Stresses at other critical shell body locations and at the closure weld should also be listed for a comprehensive TSC evaluation.

Section 3.5.2 Fuel Basket Evaluation for Normal Operating Conditions

3-2 On SAR Pages 3.5-6 and 3.5-16, describe how the bearing areas of 0.21 in^2 and 0.34 in^2 at the fuel tube and connector pin interfaces are established for the PWR and BWR baskets, respectively.

The SAR sketches lack sufficient details for staff review. Also, it's unclear why the bearing area considered for the PWR basket tube, with a 5/16-inch thick wall, is smaller than that for the BWR basket tube with a relatively thinner wall thickness of 1/4 inch.

3-3 Thermal Stress Evaluations For the axial fuel power distribution of SAR Figures 4.4-4 and 4.4-5 for the PWR and BWR fuel assemblies, respectively, evaluate temperature effects on fuel basket deformations and thermal stresses resulting from the tube end constraints accorded by the connector/drive pin assemblies between fuel tubes.

For the design basis axial power distributions, the connector/drive pin assemblies at the basket top and bottom ends tend to restrain radial thermal growth of the basket, thereby resulting potentially in large thermal stresses in the fuel tubes. This information is needed for a comprehensive evaluation of the thermal performance of the baskets.

Section 3.7.1 TSC Evaluations for Storage Accident Conditions

3-4 With respect to SAR Tables 3.7.1 and 3.7.2 and Figure 3.C-2, discuss why section cut location 1, in lieu of location 2, was determined to be the most critical for reporting membrane and membrane-plus-bending stresses during the tip-over accident.

Figure 3.C-2 shows that location one cuts right into the 2¾-inches thick TSC bottom plate while location two establishes the interface between the 1/2-inch thick shell body with the bottom plate. By inspection, internal forces developed at section cuts one and two should essentially be in equilibrium. Contrary to those reported in the tables, it appears that the TSC shell is much thinner than the bottom plate, stresses at cut location two should be much more critical than those at location one.

Section 3.7.2 Fuel Baskets Evaluation for Storage Accident Events

3-5 PWR Fuel Tube Evaluation With respect to SAR Figures 3.7-2 and 3.A-8, explain the apparent discrepancy in element discretization scheme for the two-dimensional plane strain plastic finite element model for the basket fuel tube. (Note: This request also applies to the BWR fuel tube evaluation.)

3-6 PWR Fuel Tube Evaluation Revise SAR Figures 3.7-2 and 3.7-4 to provide sufficient description of finite element modeling details for the pin-to-socket connection by also recognizing, as appropriate, physical attributes of the pin and socket recess for force distribution consideration at the connection interface. (Note: This request also applies to the BWR fuel tube evaluation.)

3-7 PWR Fuel Tube Evaluation On SAR Page 3.7-9, (1) clarify the statement, "The 45E basket orientation does not produce shear loads in the pins, the load between adjacent fuel tubes is reacting out directly in bearing in the corner flats;...," and (2) discuss how the bounding maximum shear load of 10,000 lbs. is established for the pins.

SAR Figure 3.7-4 appears to suggest that, for the 45E basket orientation, the pin at section cut location four is subject to shear, in lieu of bearing force, during a cask tip-over accident.

3-8 On the basis of the quasi-static analysis of the fuel baskets subject to a side-drop loading of 40 g, provide sketches, as appropriate, to depict the deformed basket configurations resulting from potential plastic deformations of the basket components. (Note: This request also applies to the BWR fuel tube evaluation)

Information on permanent basket tube deformations due to material yielding, if any, is needed for criticality control evaluation of the stored fuel subject to the cask tip-over accident.

3-9 PWR Corner Support Weldment Evaluation For the stress evaluation on SAR Page 3.7-15, provide a free-body diagram to illustrate the forces and section cuts for which the weld stress is evaluated. (Note: This request also applies to the BWR support weldment evaluation)

3-10 PWR Side Support Weldment Evaluation On SAR Page 3.7-15, clarify the statement, “The minimum factors of safety for the corner support weldment mounting plates are 3.42 for membrane stresses and 1.43 for membrane plus bending stresses.”

It is not clear why the stress results calculated for side support weldment is reported for the corner support weldment.

3-11 PWR Fuel Basket Buckling Evaluation Considering the unique features of the pin-to-socket connections between fuel tubes, perform time-history impact and rebound response sensitivity analysis, including the most adverse combination of fabrication tolerances, to demonstrate that the load path assumptions are conservative for the quasi-static evaluation of fuel basket buckling strengths. In performing impact response analyses for different azimuthal orientations (0E, 20E, 45E, etc.) about the cask axis, compute also time-history responses of the interface by recognizing potential relative motion between the pin and socket surfaces to demonstrate that pins and sockets will not become disengaged during the cask tip-over accident. The analysis should include drop orientations in addition to 0E and 45E. (Note: This request also applies to the BWR fuel basket evaluation.)

SAR Figures 3.7-23 and -24 indicate large, sharp impact response peaks and reversals. Because the pin-to-socket connections are not positively joined together, there exists a possibility for the out-of-phase motion among the fuel tubes to cause pins to jump out of corresponding sockets. This may result in disengagement of a pin from its notch recess during the cask tip-over accident. This type of basket instability has not been addressed in the SAR.

3-12 Fuel Rods Demonstrate that fuel rods with high burnup properties will maintain cladding integrity during drop impacts. Section 3.8 does not address high burnup fuel cladding integrity under drop impact conditions.

Appendix 3.A PWR Fuel Basket Finite Element Models

3-13 Related to the load path description on SAR Page 3.A-1, justify that friction can be relied upon for transmitting forces between tube corners (consider tube alignment details and dimension tolerances). Also, identify the element model capable of simulating friction force magnitude and direction at tube corners. (This request also applies to the BWR fuel basket of Appendix 3.B.)

The staff notes that, for the 0° basket drop orientation, development of tube corner friction will depend on the curvature of the tube flats and the friction realized between two convex surfaces is inherently unstable. For the 45E basket orientation, there exists generally no normal force between tube corners to call into action friction forces. Therefore, the pin-to-socket connections appear to be the only credible load paths for the cask tip-over accident. The bearing reaction across tube flats, F_B, per Figure 3.A-3, should not be counted on for load paths development. (This request also applies to the BWR fuel basket of Appendix 3.B.)

3-14 Provide relevant sketches to depict implementation of the BEAM4 element for the weld between the fuel tube and the pin, as described on SAR Page 3.A-2. (This request also applies to the BWR fuel basket of Appendix 3.B)

Appendix 3.B BWR Fuel Basket Finite Element Models

3-15 For the middle fuel tube shown in SAR Figure 3.B-4, discuss how its rigid body rotation about the Z-axis can be averted during the cask tip-over accident over the full range of impact and rebound.

Figure 3.B-4 shows that only two out of four corners of the subject tube are constrained from diametrical displacement, which is statically unstable in the X-Y plane. Clarify the design provisions that are accorded to this inherently unstable tube array configuration to alleviate potential fuel basket collapse during the cask tip-over accident.

3-16 Demonstrate that all quasi-static and time history impact analysis have been performed for the highest g loading that is expected to occur for either storage or transportation accidents.

SAR Page 1-1 states that, "The TSC is designed and fabricated to meet the requirements for storage in the concrete cask, for transport in the transport cask, and be compatible with the U. S. Department of Energy planning for permanent disposal in a Mined Geological Disposal System." As such the TSC, fuel basket, and fuel assemblies will be subjected to both storage and transportation accident events. Therefore, these components must be designed to resist the highest g loads that occur in either storage or transportation.

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

Chapter 4. 0 Thermal Evaluation

The following information is needed to determine compliance with 10 CFR 72.236(f).

4-1 Justify the assumption of applying the same porous media flow resistance parameters for the radial and axial components of the flow.

These parameters were calculated for the cross-sectional view of the storage cell (direction of flow) and should not be applied to the radial direction. Because the bounding walls of the basket storage cells do not allow transverse flow, one acceptable approach to represent the flow resistance in the radial direction (which is basically infinite) could be to use values that are at least two orders of magnitude larger than the calculated parameters of the main direction of flow.

4-2 Justify why an emissivity value was specified for the bounding walls of the porous media in the FLUENT model of the storage cask.

Emissivity of the basket walls enclosing the porous media regions of the FLUENT 2-D model should be equal to zero or a very small value. Radiation heat transfer is used to calculate the effective thermal conductivity of the basket in the ANSYS models. Therefore, the radiation heat transfer through the porous media regions should be removed from the FLUENT model because it is already taken into consideration in the ANSYS model.

4-3 Provide a thermal calculation package of the BWR fuel configurations similar to the calculation package of the PWR fuel configurations provided in the SAR.

The staff needs to review the calculation package to ensure that it is acceptable.

4-4 Provide the flow resistance calculation for PWR and BWR fuel assembly configurations.

One possible approach to determine the porous media flow resistance parameters would be to perform a computational fluid dynamics (CFD) analysis for each type of fuel assembly for the expected operating conditions (pressure and average gas temperature) when it is inside the dry storage cask.

4-5 Justify the assumed turbulent flow conditions for the air annular gap of the storage cask.

The staff believes that in order to justify the assumption of conditions of fully developed turbulent flow in the air annular gap, it would be necessary to validate the assumption by comparing it with experimental data obtained from a geometry that closely resembles the system geometry. Also, the applicable turbulent flow option (k-epsilon, k-omega, etc.) should be fully justified. The staff's analysis of the VSC-17 Ventilated Concrete Cask has indicated that the use of FLUENT's k-omega turbulent flow model (which includes transitional flow) may produce the best fit to experimental data.

NOTE: Additional information prepared by the staff on the use of FLUENT and other CFD codes can be found in the letter to Holtec International dated March 23, 2005, (Agencywide Documents Access and Management System (ADAMS) Accession Number ML050830056).

4-6 Justify the use of a continuous annulus cooling system so allowable maximum temperatures are not exceeded during transfer operations.

This may not meet the 10 CFR Part 72 regulations for heat removal. An exemption and additional specific technical specifications may be required for this cooling system.

4-7 Provide thermal analyses for off-normal and accident conditions for transfer operations with continuous annulus cooling, limiting conditions for operation, and design features.

Design features of the annulus cooling may need to be included in the technical specifications. It may also be necessary to include a requirement in the CoC for first time use of the cooling system. The SAR should include a description of the cooling system and the acceptance criteria for the first time use of the system.

Chapter 5.0 Shielding Evaluation

The following information is needed to determine compliance with 10 CFR 72.104, 72.106, 72.122, and 72.126.

5-1 Provide a diagram of the concrete cask that includes dimensions and materials. This diagram should also include dimensions of the inlets and outlets.

Detailed drawings are provided of the canister, fuel baskets and transfer cask. No drawings could be found in the SAR that clearly identify the dimensions and locations of the inlets and outlets of the concrete canister. Drawings with dimensions of the inlets and outlets are needed to perform confirmatory calculations.

5-2 Identify the PWR and BWR fuel used to determine the dose rates reported in Section 5.1 and Table 5.1-1 of the SAR.

This section and table list dose rates for the transfer cask and concrete cask, but does not specify the design basis fuel or if the dose rates are for PWR or BWR fuel.

5-3 Explain why the dose effect from the cask top for the design basis accident is enveloped by the concrete cask side dose.

In Table 5.1-2, a summary of the concrete cask maximum dose rates is given. For the cask top for the design basis accident, there is a footnote that indicates that the dose effect is enveloped by the concrete cask side dose, but there is no supporting evaluation provided in the SAR.

5-4 Provide information on the verification and validation of the NAC-CASC code. Also, provide information on how the code was modified.

Section 5.1.3 indicates that the NAC-CASC is a modified version of SKYSHINE-III, but no information is provided as to how the code was modified, by whom, or the process used to validate the code after modification.

5-5 Provide additional information on how the source term for the PWR and BWR fuel with high burnup was determined.

The SAR indicated that the SAS2h module of SCALE4.4 was used to develop source terms for a range of average burnups and initial enrichments. However, as noted in NUREG-1536, many libraries used in the codes are not appropriate for burnups greater than 33,000 MWd/MTU.

5-6 Explain why the MCBEND neutron spectrum was used or revise the SAR to indicate the MCNP neutron spectrum.

SAR Section 5.2.2 indicates that the neutron energy spectrum was rebinned into the MCBEND default neutron structure. However, the SAR also indicates that the MCNP code was used to determine doses, not the MCBEND code.

5-7 Provide information on the SKYSHINE component of annual doses for a single filled cask and for a 2x10 cask array, for both PWR and BWR fuel. Include the assumptions used to calculate the SKYSHINE component.

SAR Section 5.6.4, NAC-CASC Dose Evaluation, indicates that detailed PWR and BWR evaluations are presented in the calculation appendices. However, Section 5.C.5 of the Chapter 5 Appendices only contains a summary of the doses, not a description of how the doses were determined.

5-8 In Figure 5.6-8, Site Boundary Dose Rates vs. Distance, include that this is for PWR fuel, the burnup, initial enrichment, and cooling time for the fuel.

Figure 5.6-8 does not indicate the parameters of the fuel used to develop the figure or whether it was design basis fuel.

Chapter 6.0 Criticality Evaluation

The following information is needed to determine compliance with 10 CFR 72.124.

6-1 Provide the method for calculating the isotopic content in the full density water with boron concentration of 2500 ppm that is given in Table 6.3-1.

These isotopic number densities do not appear to be consistent with the values used in the criticality analysis as indicated in the input file in Figure 6.A-3.

6-2 Clarify the term “interface width” as used in Section 6.4.3.1 and elsewhere in the SAR.

This term is not commonly used, but appears to be applied to a specific aspect of the basket design.

6-3 Describe the controls used to prevent misloading of BWR fuel assemblies into the five cell locations which may not contain fuel assemblies in the 82-BWR maximum capacity configuration.
The analysis shows that fuel assemblies are not allowed in five of the center basket cell positions when the initial peak planar-average enrichment in the BWR fuel assemblies exceeds the specified value for that fuel assembly type. The operating procedures should include appropriate steps to ensure that effective controls are implemented and that a confirmatory check is made before the cask lid is put into place. Distinguishing features should be discussed and employed which would make it easy to visually determine that fuel assemblies have not been inserted into the designated non-fuel locations.

6-4 Show that the neutron absorber sheets continue to cover the active fuel region of the fuel assemblies during off-normal and accident conditions.

Consider the maximum possible axial shifting of the absorber sheets and the fuel assemblies in opposite directions such that the active fuel may project past the ends of the absorber plates during off-normal and accident conditions. Revise the criticality safety analysis as necessary to show that criticality safety is maintained. This type of shifting could affect the safety of any unloading operations. The neutron absorber sheets have oblong slots that allow some axial movement and the sheets are different lengths in the PWR and BWR baskets. The response should consider all fuel types to be loaded into the PWR and BWR basket configurations.

It should be kept in mind that the hypothetical accident conditions (HAC) for transport may be more challenging to the design than the storage conditions, particularly, the potential for axial shifting may be greater. Thus, if there is a desire to gain approval to transport the canisters without repackaging, any necessary measures such as inserts needed to assure continued positioning of the fuel assemblies during the HAC should be incorporated into the current design and implemented before loading begins.

6-5 Justify or delete the statement that removal of some absorber sheets on the basket periphery does not impact system reactivity.

This statement appears in Sections 6.A and 6.D, "The analyzed basket configuration includes absorber sheets on all four sides of the fuel tubes and no analysis has been provided to justify the removal of some of the sheets." The optional notes on Drawing No. 575, sheet 3, and Drawing No. 599, sheet 3, should be removed unless they are appropriately justified.

6-6 Provide a justification for not including specifications for the fuel pellet outer diameter, fuel rod pitch, and clad thickness in the TS.

The applicant has concluded that the fuel assemblies are under-moderated. Thus, there is a sensitivity to the moderator-to-fuel ratio in the fuel rod lattice. The analyses performed to create Tables 6.B-3 and 6.E-3 modeled the pellet-to-clad gap as dry. This assumption reduced the sensitivity to pellet outer diameter, fuel rod pitch, and clad thickness and also led to a decision to put only an upper limit on the pellet diameter. Data showing the sensitivity to variations of the these three fuel parameters needs to be developed for the case where the pellet-to-clad gap is flooded with unborated water (gap flooding is most likely to result from conditions near the end of the irradiation cycle when the boron concentration is approaching zero). For some of the key fuel parameters such as pellet diameter, it may be necessary to establish a maximum and minimum limit.

The data reported in NUREG/CR-6716 show that sensitivity to these three parameters can be significant for some fuel types. The degree of sensitivity can depend on the specific basket design and conditions, and needs to be assessed on a case-by-case basis.

When a cask design is intended to be a dual purpose design, it should be kept in mind that the degree of sensitivity in the PWR basket may decrease as the boron concentration in the moderator increases. Thus, parameters which may be of low significance under the analysis for storage operations may be important when a canister is evaluated for transport. Care should be taken to assure that fuel assemblies are not loaded under parameter limits that may be acceptable for storage but are not able to meet the parameter limits necessary to qualify for transport.

a. Provide the upper subcritical limits (USL) that apply to the sensitivity study results.

   Tables 6.B-3 and 6.E-3 do not give the USL values. The margin in k_{eff} with respect to the USL as well as the range of parameter variation considered are important factors when assessing the significance of the parameter sensitivity. Consider using the range of values given in Tables 6.2-1 and 6.2-2 when specifying the three fuel parameters discussed above.

b. Add fuel assembly type BW15H3 to the sensitivity analysis.

   The BW15H3 fuel type appears to be the most reactive case of the BW15 class.

6-7 Include a specification for guide tube thickness in Tables 6.4-1 and 6.4-2 and a maximum limit on the assembly channel thickness of 120 mils in Table 6.4-2.

The presence of guide tubes has been included in the criticality analysis. As recommended in NUREG/CR-6716, it may be appropriate to eliminate guide tube thickness from the fuel parameter specification when these tubes are not included in the analysis. Alternatively, Section 6.B of the SAR states that the absence of guide tubes may increase reactivity significantly. This last statement implies that a minimum thickness is necessary in the guide tubes. A channel thickness of 120 mils maximized k_{eff} and forms an upper limit.

6-8 Clarify whether the pellet-to-clad gap in the analysis used to generate the curves in Figure 6.C-1 was modeled as dry, wet with borated water, or wet with fresh water.

The data presented in Table 6.B-1 suggest that some of the assembly types have reached a condition of being over-moderated with high boron concentrations in full density water. The condition assumed in the gap could influence the results plotted in the Figure 6.C-1.

6-9 Clarify the configuration conditions assumed for the Normal case in the summary tables on pages 6.C-3 and 6.F-3.

It is not clear what modeling assumptions were changed for the Accident/Off-Normal case versus the Normal case in the two tables.

6-10 State whether the boron areal density in the neutron absorber sheets was held constant (i.e., atom number density was changed as the sheet thickness was varied) for the analysis reported in Tables 6.C-2 and 6.C-3.

Proper interpretation of the results of the parameter variation depends on how the variation was carried out.

6-11 Provide the number of fuel assemblies assumed in the basket to produce the results shown in Table 6.E-1.

Some values exceed the applicable USL.

6-12 Provide a description and the results for the analysis that show that partial length rods are acceptable in the fuel assembly types as designated in Table 6.F-5.

In the description specify the number and location of partial length fuel rods that are to be allowed in the designated fuel assemblies.

6-13 In the BWR basket analysis, provide a table with the k_{eff} and USL values such as presented in Tables 6.C-4 and 6.C-5.

Table 6.F-5 does not provide sufficient information to compare the results of the criticality analysis with its applicable limits.

6-14 Describe and justify any differences in the modeling approaches and code options that exist between the benchmark and design computations.

Section 6.G states that, where available, MCNP models were extracted from the references when performing the analysis to determine the appropriate USL. It is preferable that benchmark calculations are modeled and run by the analyst making the design calculations to provide as much commonality as possible. At a minimum, the modeling approaches and code options should be the same as those used for the design calculations. Any differences between the two calculations need to be identified and evaluated to show that the final value of the USL is appropriate.

6-15 In the second sentence in Section 6.C.2, correct the word “coater.”

There appears to be a typographical error in this sentence.

6-16 Provide an analysis similar to that in Figure 6.F-1 for the case when only 82 BWR assemblies are allowed in the basket.

This analysis is needed to assure that the optimum moderation in the canister interior continues to be full density water.

6-17 Include BWR assembly type B9 76A in Tables 6.F-2, 6.F-3, and 6.F-4.

This fuel assembly type appears to be most limiting.

6-18 Correct the dimensions in Tables 6.1-2, 6.4-2 and 6.F-5.

The columns are incorrectly labeled. Verify that all values are the same as used in the applicant’s analysis.

Chapter 7.0 Confinement Evaluation

7-1 Delete reference to ‘calculations’ provided in Chapter 4 and substitute ‘explanation’ or ‘information’, or provide the specific reference and the calculations.

The last paragraph on Page 7.1.1 makes reference to calculations provided in Chapter 4 for determining the molar amount of helium in the canister. However, no such calculations are readily apparent in Chapter 4.

This information is needed to determine compliance with 10 CFR 72.146(b).

7-2 Provide the specific calculations in the SAR for determining the TSC design pressure including the justification of the helium bulk average temperature associated with the final helium fill.

During an initial fill, the lower the bulk average temperature of helium, the more moles of helium are added. As a result, the canister pressure increases once it reaches thermal equilibrium. For example, if a helium bulk average temperature for the initial fill is assumed to be 245EF, the maximum normal canister pressure appears to be 130 psig (20 psig above the current design pressure) coinciding with a maximum helium equilibrium temperature of 467EF.

This information is needed to determine compliance with 10 CFR 72.122(h).

7-3 Provide redundant sealing of the confinement boundary as required by 10 CFR 72.236(e).

ISG-4, “Cask Closure Weld Inspections,” describes the weld examination method acceptable for the closure weld and provides relief from a hydrostatic pressure test providing the weld’s margin of safety $1.5 was demonstrated by analysis against design pressure. This is relief from preforming a hydrostatic pressure test that demonstrates the structural integrity of the weld’s design and fabrication.

ISG-18, “The Design/Qualification of Final Closure Welds on Austenitic Stainless Steel Canisters as Confinement Boundary for Spent Fuel Storage and Containment Boundary for Spent Fuel Transportation” provides relief from performing a leakage test for austenitic stainless steels that are very ductile and don’t lend themselves to crack propagation providing the final closure welds are executed in accordance with ISG-15, “Materials Evaluation.”

In the 10 CFR Part 72 Statements of Consideration (SOC) for the TN-24 and VSC-24, dated April 30, 1993, it was recognized that volumetric examination as required by the ASME Code was not implemented because an additional margin of safety was provided by (1) a double weld, (2) weld joint has been analyzed for all load conditions, (3) pressure inside the canister is approximately one atmosphere resulting in low stress intensities, and (4) weld integrity is ensured by Code examination using liquid penetrate and a NRC required leak test. The aforementioned margin of safety has been further reduced in the MAGNASTOR application by pressurizing the canisters, not performing the hydrostatic pressure test, deletion of leak test, and the applicant’s proposed single sealing of the MAGNASTOR canister.

Other factors influencing the double sealing requirement include the realization that the closure weld is performed in the field under conditions that could be an impedance to quality workmanship, examination and inspection. As a result, the requirement for double seal of the containment boundary is necessary.

Chapter 8.0 Materials Evaluation

8-1 Clarify the definition of intact fuel in Chapter 1 and 13 and define damage fuel. Additionally, define cladding defects and quantify the size.

The definition of intact fuel on page 13A-1 uses the phrase "no fuel rod cladding defects." The rest of the definition implies that cladding defects do not refer to cladding breaches. The response to this question should also be included in the “Cladding Integrity” section of Chapter 8 and in the TS. It should be noted that the applicant’s definition of damaged fuel can be broader than that specified in ISG-1, Revision 1, “Damaged Fuel.” As a minimum, the definition should include items 1 through 3 from the ISG definition.

This information is needed to determine compliance with 10 CFR 72.122(h)(1).

8-2 Revise Chapter 2 to define the term “Retrievability” and Chapter 8 to include a brief discussion that addresses retrievability of spent fuel from the MAGNASTOR using normal means of handling.

The spent fuel cladding must be protected during storage against degradation that leads to gross rupture of the fuel and must be otherwise confined such that degradation of the fuel during storage will not pose operational problems with respect to its removal from storage.

This information is needed to determine compliance with 10 CFR 72.122(h)(1), 72.122(l), and 72.236(m).

8-3 Provide a reflood analysis to show that the cladding will not be damaged and result in breaches and fracture. The analysis should support statements in Section 1.3 .1.4, "alternatively the loaded TSC may be returned to the spent fuel pool for in-pool cooling" and in Section 8.11, where it is indicated that in the unlikely event that the TSC must be reopened that it will be filled with water.

ISG-15, Section X.5.4.3, Cask Reflooding discusses the technical basis for preforming a reflood analysis.

This information is needed to determine compliance with 10 CFR 72.122(l).

8-4 Specify what effects of the zirconium channel are evaluated (e.g., thermal, structural, shape effects, etc). Additionally, provide the supporting evaluation.
On page 1.2.1, the SAR states: "effects of the zirconium channel are evaluated."

This information is needed to determine compliance with 10 CFR 72.122(h)(1).

8-5 Provide a copy of the document(s) used to obtain the fuel and cladding parameters in Tables 5.A-1, 5.A-4, 6.1-1, 6.1-2, 6.2-1, 6.2-2, 6.4-1, 6.4-2. Additionally, provide a diagram for the BWR 10 x 10 configuration, in Table 5.2-2, showing any sub-arrays, partial rods, extra grid spacers, etc.

The staff is unable to verify the fuel and cladding parameters in the tables for the varying structural configurations of the designs.

This information is needed to determine compliance with 10 CFR 72.122(h)(1).

8-6 In Table 8.3-26, indicate if emissivity is for oxidized cladding, crudded cladding, or bright cladding. If the emissivity is for bright cladding, provide emissivity values for oxidized cladding.

Radiant heat transfer will depend on the emissivity of the surface of the cladding.

This information is needed to determine compliance with 10 CFR 72.11.

8-7 In Table 8.3-27, indicate the density of the fuel used to measure the conductivity and specific heat. Also, discuss briefly how the density compares to the density of the irradiated fuel. If they are not comparable, provide an estimate for conductivity and specific heat at the actual fuel density. The applicant should note that the conductivity of the fuel will depend on its density.

Staff is unable to verify and evaluate the physical properties of the fuel.

This information is needed to determine compliance with 10 CFR 72.11.

8-8 Revise Chapters 8 and 13 (Technical Specifications) in tabular form, to indicate for each neutron absorber material, the B-10 percent credit, the manufacturer's trade name, the minimum areal density required, actual areal density to be used, and the volume percent of B_4C used in metal matrix composites proposed for use in the MAGNASTOR system. Greater than 75% credit for BORAL is currently under review by the NRC and should not be considered by the applicant in the criticality analysis unless the applicant has the appropriate test data to support a greater credit. Furthermore, neutron attenuation testing should be done for materials taking greater than 75% credit in the criticality analysis. Note that an acceptance criterion for neutron attenuation would need to be presented by the applicant for any absorber in which a greater credit than 75 percent is taken. For tests methods other than neutron attenuation, the applicant should benchmark the results of the proposed acceptance test method against the results of neutron attenuation examination.

This information is needed to determine compliance with 10 CFR 72.11and 72.236 (c).

8-9 Provide a detailed discussion of the sampling plan and acceptance criteria based on statistical analysis that includes how uncertainties are accounted for in the analysis.

BORAL should not be considered at the 90% credit level unless the applicant supported the request with data.

(a) Revise the application to state that neutron transmission testing will be used to verify the B-10 areal density for neutron absorbers at the 90% level. For neutron attenuation measurements, the applicant should specify a test area small enough that variations in neutron absorber content would not be masked by measurements of an average value over a large area. Alternatively, the applicant should demonstrate that chemical analysis is an acceptable alternative for verifying the minimum effective B-10 areal density for absorbers at the 90% level of credit.

(b) Revise Chapter 8 to define the following terms: lot, physical sampling method, and statistical sampling plan. In particular, discuss:

- how lot failure is handled (e.g., a rejection during reduced inspection will require a return to 100% inspection of the lot.)
- the basis for reduced sampling,
- locations of samples removed from the material (e.g., random, on the ends, etc.),
- how the lower tolerance limit of neutron absorber content is determined,
- how the acceptability of the lot is determined,
- the number of production runs or lots to be included in the data set used in the statistical analysis, and
- how an estimation of the variances is done for greater than 75% credit.

Based upon recommendations in the applicable standard review plans, NUREGs -1609, -1617, and -1537, it has been the staff practice to either (a) limit the credit for absorber materials to only 75% of the minimum amount of neutron poison shown to be present, or (b) consider giving credit up to 90% if comprehensive measures are implemented to establish the presence, uniformity, and neutronic effectiveness of an absorber material.

This information is needed to determine compliance with 10 CFR 72.11 and 72.236(c).

8-10 Revise the acceptance testing for the neutron absorbers to explain how an accurate determination of the B-10 areal density will be determined. The applicant should note that neutron attenuation should be done for greater than 75% credit or specify an alternate technique with a technical basis.

Wet chemical analysis of the boron in the absorber requires a knowledge of the fraction of B-10 in the boron in order to determine an accurate areal density. It is unclear how the applicant will determine the B-10 fraction from the information provided in the application.

This information is needed to determine compliance with 10 CFR 72.11and 72.236(c).

8-11 Revise Chapters 8 and 10 to specify that standard industrial techniques for verifying other product acceptance characteristics will be conducted on all absorbers, (i.e., dimensions, including flatness, straightness, etc., chemical analysis, thermal conductivity, tensile properties, and surface quality and finish).

This information is needed to ensure that the acceptance tests done on the finished product are implemented in accordance with a recognized industry code, e.g., ASTM.

This information is needed to determine compliance with 10 CFR 72.11 and 72.236(c).

8-12 Justify the use of the mechanical properties for aluminum 1100 in the derivation of the mechanical properties of the neutron absorbers in Table 8.3-16, Mechanical Properties of Neutron Absorber.

Neutron absorbers proposed for this application could be fabricated from aluminum from the 6000 series. Further, these materials contain boron carbide in the matrix. The mechanical properties of a particular neutron absorber will be dependent on the volume percent of boron carbide in the matrix.

This information is needed to determine compliance with 10 CFR 72.11 and 72.236(c).

8-13 Provide the mechanical properties for SA-182 steel.

The applicant has stated that SA182 stainless steel may be substituted for SA240 Type 304/304L stainless steel provided that the SA182 material yield and ultimate strengths are equal to or greater than those of the SA240 material. However, the SA182 contains more than fifty grades, types, and classes. In some case, depending on the class and grade, the materials may have a lower yield and ultimate than SA 240.

This information is needed to determine compliance with 10 CFR 72.11 and 72.246.

8-14 Specify the weld filler metal(s) for the confinement boundary welds.

As stated in ISG-15, the weld filler metals should be specified by ASME Section II, Part C, and an associated American Welding Society (AWS) classification.

This information is needed to determine compliance with 10 CFR 72.11 and 72.246.

Chapter 9.0 Operating Procedures

9-1 State in Section 9.1.1, Step 57(c) and LCO 3.1.1 that the vacuum pump is not running during the 10 minute period when the pressure in the canister is being observed to be equal to or less than 10 mm Hg.

These sections of the SAR do not explicitly state that the vacuum pump is to be turned off when performing the canister vacuum pressure rise check. A leaking isolation valve could cause the canister vacuum conditions to be inappropriately maintained, resulting in an accurate reading of a pressure rise in the canister.

This information is needed to determine compliance with 10 CFR 72.162.

9-2 Perform a hydrostatic pressure test of the closure weld to 1.25 times the design pressure in accordance with ASME Code requirements, prior to drying operations.

Because the canister is pressurized to over 8 atm with a compressible gas during normal operations, a hydrostatic pressure test will insure weld integrity (both from a design and fabrication perspective) prior to adding the helium. In addition, the only approved spent fuel storage pressurized canister design requires performing a hydrostatic pressure test of the closure weld prior to drying operations. ISG-4, which excludes the hydrostatic pressure test, was written considering canisters containing approximately 1 atm of helium.

This information is needed to determine compliance with 10 CFR 72.122(h).

9-3 Add a step in the loading procedures to verify that the fuel assemblies being loaded meet the specifications, as applicable for the boron concentration and basket configuration of the canister being loaded.

The operating procedures only call for a check of the boron concentration in the pool or cask water prior to loading. A check that the proper fuel assemblies have been selected for loading is also needed.

This information is needed to assure that use of the package will comply with 10 CFR 72.124(a) and 72.150.

Chapter 11.0 Radiation Protection

11-1 Provide the evaluation used to determine the estimated onsite collection dose summarized in Section 11.3 of the SAR.

The doses used to determine the person-rem exposure in Tables 11.3-1, 11.3-2, 11.3-3, and 11.3-4 seem to be much lower than they should be considering the surface dose rates determined in Chapter 5.

This information is needed to determine compliance with 10 CFR 72.104, 72.126, and 10 CFR Part 20.

11-2 Provide the evaluations that demonstrate the exposure to the public.

SAR Section 11.4, Exposures to the Public, indicates that a detailed controlled area boundary is contained in Chapter 5. However, Section 5.1.3 contains only two paragraphs, which briefly summarize the methodology and Section 5.6, which provides a brief summary of results.

This information is needed to determine compliance with 10 CFR 72.106, 72.126, and 10 CFR Part 20.

Chapter 12.0 Accident Analysis

12-1 Provide the evaluation for the radiological impact from a tornado-driven missile.

Section 12.2.11.5 provides only a brief summary of the results, but no supporting evaluation.

This information is needed to determine compliance with 10 CFR 72.106.

12-2 Provide the evaluation for the radiological impact from a cask tip-over on the concrete pad.

Section 12.2.12.6 provides only a brief summary of the results, but no supporting evaluation.

This information is needed to determine compliance with 10 CFR 72.106.

Chapter 13.0 Operating Controls and Limits

13-1 Explain how Table 3.1 is utilized to determine helium backfill pressure if vacuum drying is employed in accordance with Surveillance Requirement (SR) 3.1.1.1.

The subject table identifies the required helium backfill pressure in terms of decay heat load and temperature from the TSC outlet of the pressurized helium drying (PHD) system used per SR 3.1.1.1. No guidance is provided if the alternate means of vacuum drying the canister from SR 3.1.1.1 is utilized.

This information is needed to determine compliance with 10 CFR 72.146.

<u>Section 13 Technical Specifications (Appendix A)</u>

13-2 Revise the definition of INTACT FUEL ASSEMBLY (ROD) to state that any missing fuel rods must be replaced by solid filler rods that displace a volume at least equals to that of the original rod. Also, remove the last sentence of the definition.

The criticality analysis assumes that all fuel rods are present.

This information is needed to determine compliance with 10CFR 72.124(a).

13-3 Revise the frequency for SR 3.2.1.1 to be conducted within 4 hours prior to commencing loading or unloading operations and every 24 hours thereafter.

Recent information indicates that boron dilution events at some reactors may proceed fairly rapidly. Because of the small margin in setting the minimum boron concentrations and the fact that these specifications must be appropriate for all potential users, the surveillance times proposed do not provide an appropriate level of control for a general license certificate. Also, revise the bases accordingly.

This information is needed to assure compliance with 10 CFR 72.124(a).

13-4 Add a specification for the inner cross section dimensions of the fuel tubes to Section 4.1.1.

The parameters most important to safety should be included in the TS.

This information is needed to assure compliance with 10 CFR 72.124(a).

Section 13 Technical Specifications (Appendix B)

13-5 Provide footnotes in Tables 2.3 and 2.10 stating those detailed fuel dimensions by assembly type are specified in the SAR.

A link to the specifications in the SAR is needed to assure that they are followed and not overlooked by the user. The final limits on the fuel parameters should be consolidated into a single reference in part of the SAR like Tables 6.4-1 and 6.4-2.

This information is needed to assure compliance with 10 CFR 72.124(a).

13-6 Revise item I.A.1 in Table 2-1 to read, "Uranium PWR INTACT FUEL ASSEMBLIES listed in Tables 2-2 and 2-3 and meeting the following specifications":

Important specifications are listed in each of the two tables.

This information is needed to assure compliance with 10 CFR 72.124(a).

13-7 Revise item B in Table 2-1 to state that filler rods must displace a volume at least equal to the original rod.

Also, see item 13-2 above.

This information is needed to assure compliance with 10 CFR 72.124(a).

Chapter 15.0 Decommissioning

15-1 Provide a discuss of TSC decontamination efforts for fuel particulate release as a result of an off-normal event.

Section 15.2 states the following: "some effort may be required to remove surface contamination prior to disposal but absolute decontamination of the TSC internals is not necessary." Staff believes that this may be true for CRUD, but not if some fuel particulate is released from the rods during off-normal events (cask tip over).

This information is needed to determine compliance with 10 CFR 72.11.