AOS TRANSPORT PACKAGING SYSTEM,
Docket No. 71-9316,
Meeting with the NRC Staff,
April 29, 2009.

AGENDA

- 1. Introduction
- 2. Major Technical Issues
- a. Materials
- b. Thermal
- c. Criticality
- 3. Chapter 1 General Information
- 4. Chapter 2 Structural
- 5. Chapter 3 Thermal
- 6. Break
- 7. Chapter 4 Containment
- 8. Chapter 5 Shielding
- 9. Chapter 6 Criticality
- 10. Chapter 7 Package Operations
- 11. Chapter 8 Acceptance Test and Maintenance Program
- 12. Schedule for Submittal /Conclusion

Introduction

- Objective:

  To present AOS responses to the Staff's comments issued in a NRC letter from Mr. Eric J. Benes, April 2008.

- Attendees:
  - Troy Hedger, AOS
  - Raúl Pomares, AOS
  - Andrew Langston, GEH

Major Technical Issues

- **Materials**
  1. The chemical composition and physical form of the contents are not specified in sufficient detail to determine if interactions with other materials will occur. The chemical form of the liquid contents dictates which interactions will take place. If there is polymer material surrounding the contents, such as metallographic mounts, gases could be generated. If the contents include bare metal, the size, shape, and chemical form dictates if pyrophoric or other reactions can occur.

To expedite the Staff review, AOS eliminated the request to ship contents in liquid form from the submittal and the special form encapsulation materials (Stainless Steel) will be clearly stated.

Major Technical Issues

- **Materials (cont.)**
  2. The location and properties of the neutron shielding "Boronated WEP/Polyethylene" have not been specified. No methodology has been provided to qualify: (a) the uniformity of the material; (b) the durability of the material for the environmental conditions of service; and (c) its absorption coefficient. Without this information, the staff is unable to assess the expected behavior and interactions of this absorber material.

     AOS has eliminated the request to ship fuel materials in this submittal.

Major Technical Issues

- **Materials (cont.)**

  3. The safety analysis report (SAR) states that the cask is modeled to include a "fuel rod basket," and uses the densities and material properties presented in Table 5-26, along with the standard cask assembly. This is the only instance where "fuel rod basket" is described as an integral structural component within the cask. It is not clear to the staff, which among the seven different models contains this fuel rod basket. Details of the structure of the fuel rod basket have not been provided and an explanation of how the fuel rod basket, if used, was modeled, and also how its independence and structural integrity within the cavity was maintained. Additionally, there was insufficient evaluation of the interaction effects during the required drop scenarios for both normal condition of transportation and hypothetical accident condition.

     AOS has eliminated the request to ship fuel materials in this submittal.

Major Technical Issues

- **<u>Thermal</u>**

  1. The maximum decay heat values used for the thermal analysis were not consistent with the decay heat values provided in other sections of the SAR. A potential unit conversion error with respect to the decay heat values could lead to non-conservative thermal results.

     AOS has reviewed the application and indicated the maximum decay heat values of the content for each of the Model of the AOS Transport Packaging System.

Major Technical Issues

- **Thermal (cont.)**

  2. Temperature limits for the cask cavity and seals were exceeded. Seal temperature limits do not agree with the maximum service temperature reported by the seal manufacturer.

  AOS has changed the material type of the elastomeric seal from EPDM to SILICON material. Manufacture´s data sheets have being incorporated to the application as Appendixes in the applicable Chapters.

Major Technical Issues

- Thermal (cont.)
  3. LIBRA input and output files, as well as a comprehensive discussion of analysis models, were not provided per Interim Staff Guidance 21, “Use of Computational Modeling Software.” Additional models, including those with liners, were not analyzed. The internal fuel rod basket was not modeled in the LIBRA analysis; therefore the model does not thermally represent the designed packages.

AOS has tried to follow the guidelines of Interim Staff Guidance 21 to the extend possible. However, there are limitation because the proprietary nature of the LIBRA program. AOS has negotiated to Structure Mechanics Analysis, developer of the LIBRA program, to provide the NRC staff with a copy of an executable file with Pre’ and Post processors and all input and output. Files. AOS needs to discuss the transfer of this information with the Staff.

Major Technical Issues

- **<u>Thermal (cont.)</u>**
  4. Because of the magnitude of these issues and others, the staff cannot comprehensively apply NUREG-1609, "Standard Review Plan for Transportation Packages of Radioactive Materials," in all thermal review areas until they are resolved. The staff identified many technical discrepancies between information presented in various sections in the SAR, and significant thermal and containment design issues that question the fundamental performance of the proposed packages.

AOS application follows the format given in Regulatory Guide 7.9, December 2003 edition. However, the current application contains a map indicating the location of the information per NUREG-1609 format.

Major Technical Issues

- **Criticality**
  1. AOS did not specify the S (alpha, beta) data for the water. Without the S (alpha, beta) specification, the criticality code (MCNP) used by the applicant will treat a mixture of hydrogen and oxygen as a mixture of free gas rather than a water molecule. Neutrons will interact differently with the gas phases of hydrogen and oxygen than with a water molecule. Preliminary staff calculations show that this will cause the k-effective (k_{eff}) of the uranium-235 cases to increase. In some cases, this value exceeds the k_{eff} limit of 0.95. The applicant will have to repeat all of the criticality calculations with this specification. In many cases the k_{eff} value will increase slightly or not at all and there will be little impact. In some cases, the k_{eff} may not increase above the limit, but the behavior when applied to the sensitivity studies may be different enough to cause different limiting conditions. In other cases, this change may cause k_{eff} to increase above the limit and the applicant may have to make design changes by decreasing the allowed amount of fissile material, or taking credit for geometry aspects, presence of neutron poisons, burn-up, etc.

AOS has eliminated the request to ship fuel materials in this submittal.

Chapter 1 General Information

1. Make the following editorial revisions:

a) Clarify the location of the shielding material in Figure 1.1. It appears that the shielding "tag" is in the wrong place and the arrow is not pointing to the shielding material.

b) Clarify the values in Table 1-6 by adding a space or two between the numerical value for activity limit and the superscript numeral for the footnote to assure activity limit values are clearly presented and distinct from the footnote.

c) Clarify that "Nuslet Number" should be "Nusselt Number." This is located throughout the SAR.

For consistency and clarity the corrections should be made to the application.

This information is needed to determine compliance with 10 CFR 71.7(a).

AOS has corrected all of the above items in the current application.

Chapter 1 General Information

2. Revise the application to clearly state when the personnel barrier is to be used during shipment of the AOS package. Additionally, revise the application to include a general arrangement drawing showing the design of the personnel barrier, and to include a description of the personnel barrier design in the shielding evaluation (see 3-12).

Section 1.2.1.1, page 1-7, of the SAR states: "To meet temperature and dose rate regulation requirements, a Personnel Barrier structure can be added to the package assembly for certain types of shipments." However, a drawing and description of the personnel barrier are not included in the SAR. Additionally, i t is not clear which types of shipments require the use of the personnel barrier.

This information is needed to determine compliance with 10 CFR 71.33.

AOS has replace some of the Figures with new ones showing the Personnel Barrier . In addition, a description of them has been added to Chapters 1 and 5.

Chapter 1 General Information

3. Provide support for the upper useable temperature limit of 450°F for the elastomer seal.

   Figure 1-2 indicates that the elastomer is EPDM compound. The staff's specification on this material (Specifications Seals Co.) is an upper usable temperature of 300°F.

   This information is needed to determine compliance with 10 CFR 71.51(a)(1) and (2), and 71.73(c)(4).

AOS has changed the material type of the elastomeric seal from EPDM to SILICON material. Manufacture´s data sheets have being incorporated to the application as Appendixes in the applicable Chapters.

Chapter 1 General Information

4. Revise Table 1-5 of the SAR to include a fissile material decay heat limit for the AOS-100A package.

   The "Content" row of this table indicates that this package is designed to transport fissile material, but no decay heat limit is provided for fissile material in this package.

   This information is needed to determine compliance with 10 CFR 71.33.

   AOS has eliminated the request to ship fuel materials in this submittal.

Chapter 1 General Information

5. Either justify or provide an analysis as to why the chosen representative model size is conservative.

   There are seven models as presented in Table 1-1, “AOS Transport Packaging System Summary.” The application should include seven sets of each NCT and HAC analysis, yet only four were provided - one for each model size. In Table 1-5, “AOS Transport Packaging System Analyses Summary (continued),” on page 1-19, the thermal analysis was not performed for models AOS-100B, AOS-100A-S, and AOS-165B. There are at least three more models that have not been classified that should be analyzed (i.e., the AOS-025A, AOS-100A, and AOS-165B) which may or may not require a liner to convey certain quantities of radioactive material as stated on page 1-7 in the third paragraph.

   This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

   AOS has performed Structural and Thermal analyses of all the Models with the exception of the Model AOS-100A-S as this Model is similar to the AOS -100A Model. These analyses are included in the corresponding Chapters.

Chapter 1 General Information

6. With regards to Table 1-6:

   a) Specify if plutonium is included under the category fissile isotope in, “Activity Limits.”

   b) Define “U-235 mass equivalent,” referenced in footnote 5.

   c) Explain what is meant by “Unbounded” and “No Analysis” in the activity limits for various contents.

   Section 1.3.2 of the application states that “[t]he criticality evaluation demonstrated that the Model AOS-100A and Model AOS-165A transport packages can transport up to 350 g and 300 g of 100% enriched Pu in solid form, without employing shielding liners or criticality control devices.” Table 1-6 does not list plutonium on the isotope list. It is also unclear what is meant by the terms “U-235 mass equivalent” and “Unbound” or “No Analysis” in reference to the activity limits for various package types and radionuclide contents.

   This information is needed to determine compliance with 10 CFR 71.33.

   AOS has eliminated the request to ship fuel materials in this submittal. Further more a new Activity Table has been included.

Chapter 1 General Information

7. Clarify the discrepancy between Table 1-7, which currently lists AOS-165B as "N/A" regarding a liner and the 3rd paragraph on page 1-7, which states in part that, "[…] the Model AOS-025A, AOS-100A, and AOS-165B transport packages, require the use of a liner to convey certain quantities of radioactive materials."

   The application should clearly state when liners are or are not used.

   This information is needed to determine compliance with 10 CFR 71.35.

   AOS has correct the 3rd paragraph on page 1-7. Also the Activity Table identify which of the isotope requires additional shielding.

Chapter 1 General Information

8. Specify the compression required on the port and lid sealing O-rings on details K and H of Drawing No. 105E9712, Revision No. 2, sheet 1 of 2.

The drawing does not explicitly state what the compression requirement is on the port and lid sealing O-rings.

This information is needed to determine compliance with 10 CFR 71.73.

AOS has added to the Certification Drawings the torque requirement for the components mentioned above.

Chapter 1 General Information

9. Discuss the specifications of the foam used in the impact limiter, including its density, on Drawing Nos. 105E9713, Revision No. 2; 166D8138, Revision 1; and 105E9722, Revision 1.

The drawings mentioned above specify a FR-3212 foam; no such foam was identified by the staff in the General Plastics Catalogue. This does not correspond with the information presented in the application, which claims the foam is the General Plastics Last-a-Foams FR-3700 series.

This information is needed to determine compliance with 10 CFR 71.73.

AOS corrected the foam type to be FR-3712.

Chapter 1 General Information

10. Specify which type of polyurethane foam is used in the impact limiter for the AOS-165.

Drawing No. 1059709, Revision 4, identifies polyurethane foam for the impact limiter but does not specify the type of foam used. The only information presented in the drawing regarding this foam mentions the latest GE specification 2249420 for installation.

This information is needed to determine compliance with 10 CFR 71.43(d) and (f).

AOS has updated all foam call-out on each of the Model drawings and throughout the Application texts.

Chapter 2 Structural

1. Revaluate stress load combinations in Section 2.1.2 to assure they are being evaluated according to the design criteria in Section 2.1.2.

   The design criteria for NCT includes $P_m + P_b + Q < 3.0\ S_m$, yet in Tables 2-152, 2-217, and 2-280 this is presented as the stress combination for hypothetical accident conditions of transport.

   This information is needed to determine compliance with 10 CFR 71.35.

   All structural analyses have been re-done, as well as the load combinations. Table 2-152 represents HAC of the package dropping onto a rod at -40 degree.; Table 2-217 represents the HAC of increase external pressure to 2MPa.; and Table 2-280 if for HAC , 30 ft drop on the head on orientation.

Chapter 2 Structural

2. With regards to Table 2-3, "Design Criteria," consider the following revisions:

   (a) Clarify the meaning of the "stress section" column with the values as shown in the table.

   (b) Clarify the temperature values in the table. The columns are not correct as labeled. (i.e., 427°C = 800°F and 85°C = 185°F).

   (c) Clarify the meaning of footnotes 1 and 2, as shown in the table.

   The table should be revised for clarity and consistency.

   This information is needed to determine compliance with 10 CFR 71.35.

   Table 2-3 has been corrected to clarify the information presented.

Chapter 2 Structural

3. With regards to Table 2-3, "Design Criteria," consider the following revisions:

(a) Clarify the meaning of the "stress section" column with the values as shown in the table.

(b) Clarify the temperature values in the table. The columns are not correct as labeled. (i.e., 427°C = 800°F and 85°C = 185°F).

(c) Clarify the meaning of footnotes 1 and 2, as shown in the table.

The table should be revised for clarity and consistency.

This information is needed to determine compliance with 10 CFR 71.35.

Table 2-3 has been corrected to clarify the information presented.

Chapter 2 Structural

4. Provide evidence of AOS' experience showing that interactions between the designated payloads and similar casks do not occur.

Section 2.2.2 of the application states in part that, "AOS' experience in operating other transport packages with similar arrangements indicate that neither chemical, galvanic, nor other reactions between the cask cavity surface and radioactive material containers, nor between these containers and their solid contents, occur." A major part of AOS' justification that no chemical, galvanic, or other interactions occur is their experience base with similar systems. To be valid the staff must be able to evaluate the same data and come to similar conclusions.

This information is needed to determine compliance with 10 CFR 71.39.

The statement has been expanded to incorporated the fact that "AOS has been performing shipments of special forma radioactive material for more since 1974 in the AOS 5979 Type B package. "

Chapter 2 Structural

5. State the radiation dose rate at the location of the polymer seal.

Section 2.2.3 of the application states that there is no effect of radiation on the closure and port polymer seals. The staff needs the expected dose rates at the seal position to independently determine if the seals will degrade and/or emit gases.

This information is needed to determine compliance with 10 CFR 71.43(d) and (f).

The radiation dose rate at the seal has been estimated and included in the write up.

Chapter 2 Structural

6. Provide the source of data used to determine the stress strain relationship for the impact limiter foam shown in Table 2-58 of the application. Also provide a data source for Poisson's ratio.

   The staff could not find the requested data in Table 2-58 in the supplier's data sheets for the indicated foam material.

   This information is needed to determine compliance with 10 CFR 71.73

   The manufacturing material property data sheet are included in Appendix 2.x.x.

Chapter 2 Structural

7. Clarify the discrepancy in Table 2-63 between the title “Maximum Cavity Pressure Due to Fire Conditions” and footnote 1, “Temperature listed is the maximum value obtained throughout Normal condition of transport events.”

For consistency and clarity the corrections should be made to the application.

This information is needed to determine compliance with 10 CFR 71.7.

Table 2-63 has been corrected to clarify the information presented.

Chapter 2 Structural

8. Provide summary tables (similar to Tables 2-151, 2-152, 2-216, 2-217, 2-279, and 2-280) reporting the minimum margin of safety related to stress combinations for normal conditions of transport (NCT) and hypothetical accident conditions (HAC) for the AOS-100.

The application should clearly provide and summarize minimum margin of safety for all analysis.

This information is needed to determine compliance with 10 CFR 71.35.

All Load Combination Tables include a column where the Margin of Safety

Chapter 2 Structural

9. Re-evaluate all load combinations to ensure Regulatory Guide 7.8 is being properly applied to determine the load combinations.

For example, to create the hot environment load combination for NCT, from the applicant's load cases, the staff should see a combination that includes load cases 102, 201, and 211. The staff does not specifically see that load combination in Tables 2-151, 2-216, or 2-279.

This information is needed to determine compliance with 10 CFR 71.33(b)(3) and 71.43(d).

All structural analyses have been re-done, as well as the load combinations.

Chapter 2 Structural

10. With regards to the neutron shielding/absorber material for the Model No. AOS Transportation Packages:

a) Specify the location and properties of the neutron shielding "Boronated WEP/Polyethylene."

b) Provide the dimensions and the tolerances of construction and the structural components that maintain the position of the absorber material within the package.

c) Describe the methodology to qualify the uniformity and durability of the absorber material for the environmental conditions of service. Also describe the methodology for measuring the material's absorption coefficient.

d) Provide data sheets on the absorber material.

Without additional information the staff is unable to assess the expected behavior and interactions of this absorber material.

This information is needed to determine compliance with 10 CFR 71.47.

AOS has eliminated the request to ship fuel materials in this submittal. Therefore, the neutron shielding is not longer part of this application.

Chapter 2 Structural

11. Describe the material and form of the container that will hold the various contents within the cask cavity. The extent of interaction of the contents can not be assessed without knowing the container material.

This information is needed to determine compliance with 10 CFR 71.33(b)(3) and 71.43(d).

The analytical approach taken , applied decay heat at the cask cavity walls, analyzed the shielding characteristic using a point source located at the cask cavity walls, and including the weight of any cavity device to hold the content during transportation. Therefore such device(s) do not performs or enhance any safety function and is considered shoring considered a shoring device.

Chapter 3 Thermal

1. Verify that "cask component" should be "impact limiter" in Section 3.1.

The first paragraph, fourth sentence, in Section 3.1 reads, "[t]he cask component consists of a thin-walled cylindrical shell, with a flat disk at one end and a dish head at the other end." For consistency and clarity the corrections should be made to the application.

This information is needed to determine compliance with 10 CFR 71.7.

Section 3.1 has been corrected and expanded to also describe the AOS-025 Impact limiter.

Chapter 3 Thermal

2. Review all unit conversions in the entire application and associated analysis files and correct and report any discrepancies found.

   In Table 3-1, "AOS Transport Packaging System Summary," the unit conversion from Watts to BTU/hr is incorrect. The staff would recommend placing the "Watts" label over the Watts column for easier understanding.

   This information is needed to determine compliance with 10 CFR 71.33(b)(7).

Table 3-1 has been changed to present only the decay heat in "watts" units. The conversion unit used before came from ASTM E 380-76, where watts is equal to Btu/h divided by 2.90711E-01.

Chapter 3 Thermal

3. Clarify the discrepancy in decay heat values taking note of the following:

   a) The decay heat values in BTU/hr in Table 1-5, "AOS Transport Packaging System Analyses Summary," do not match the values in Table 3-1, "AOS Transport Packaging System Summary."

   b) The decay heat value for the AOS-050A in Table 3-1, "AOS Transport Packaging System Summary," (100 Watts) does not match the decay heat value for the AOS-050A in Table 1-5, "AOS Transport Packaging System Analyses Summary" (200 Watts).

   The application needs to use the maximum decay heat in the thermal analyses.

   This information is needed to determine compliance with 10 CFR 71.33(b)(7).

Tables 1-5 and 3-1 have been changed to provide the correct decay heat values for each on the AOS Model packaging. Also, the decay heat is presented only in "watts" units

Chapter 3 Thermal

4. Verify that the values in Table 3-3 are for the AOS-025A, AOS-050A, AOS-100A, and AOS-165A, as opposed to the models currently listed in the table.

The application needs to clearly state which models are associated with which thermal results.

This information is needed to determine compliance with 10 CFR 71.35.

All information have been reviewed and corrected as needed.

Chapter 3 Thermal

5. Clarify the discrepancy between the following decay heat values:

a) Table 3-4, “Transport Package Temperature Summary (Continued),” on page 3-6, footnote 3, “Maximum Decay Heat of 2.5 kW.”

b) Table 3-1, “AOS Transport Packaging System Summary,” for the AOS-165 which is 1,500 Watts.

c) Table 1-5, “AOS Transport Packaging System Analyses Summary,” for the AOS-165 which is 1.2 kW.

d) Section 5.2.1.3.2, the decay heat, 1,200 g source = 1,051 Watts.

The staff needs to be assured the maximum decay heat is being used in the analysis.

This information is needed to determine compliance with 10 CFR 71.33(b)(7).

The information in these Tables have been revised and corrected as needed.

Chapter 3 Thermal

6. Provide references for the seal temperature limits stated in Table 3-4, "Transport Package Temperature Summary." If references are not available (due to the references being a proprietary test report or other non-public document) provide a copy of the reference cited.

The staff must have reasonable assurance that the thermal limits provided for seal performance are based on sufficient testing and data. The limits listed in Table 3-4 are not referenced. Table 3-4 indicates, for example, that the limit for the metallic helicoflex seals used in the AOS-165 with a 7 kW heat load is 800°F. This does not agree with the maximum service temperatures reported by the seal manufacturer.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

A new Figure, Figure 1-10, has been added. This Figure has been provided by the seal manufacture and it shows a service temperature of 842 oF for the metal seal and 450 oF for the elastomeric one. Also, a page from the manufacture catalog and Parker Technical Data Sheet for the Silicone S1224-70 have been added as Appendix to Chapters 3 and 4.

Chapter 3 Thermal

7. Describe the effects of exceeding the seal temperature limit for the AOS-165 package with the 2.5 kW decay heat load, as indicated in Table 3-4, "Transport Package Temperature Summary," page 3-6, for the "Cask Seal Area."

Exceeding temperature limits of seals may lead to seal failure. Performance of the package seals must be demonstrated for the duration of package transportation.

This information is needed to determine compliance with 10 CFR 71.73.

The current application clearly shows the resulting temperatures have not violated any of the thermal limits imposed on the design. These limits are supported by manufactures' technical data. Which are enclosed in the application.

Chapter 3 Thermal

8. Describe the effects of exceeding the cask cavity limit for the AOS-165 package with the 7 kW decay heat load, as indicated in Table 3-4, “Transport Package Temperature Summary,” for the “Cask Cavity.”

Exceeding the temperature limit of the cavity may lead to cask failure or material damage. Performance of the package must be demonstrated for the duration of package transportation.

This information is needed to determine compliance with 10 CFR 71.73.

The current application clearly shows the resulting temperatures have not violated any of the thermal limits imposed on the design. These limits are supported by manufactures’ technical data. Which are enclosed in the application.

Chapter 3 Thermal

9. Describe the effects of exceeding the cask test port temperature limit for the AOS-165 package with the 2.5 kW decay heat load, as indicated in Table 3-4, "Transport Package Temperature Summary," for the "Cask Test Port."

Exceeding temperature limits of the cask test port may lead to failure.

This information is needed to determine compliance with 10 CFR 71.73.

The test port is not part of the containment boundary, it does not penetrate the cask cavity. The port lead to the region between the seal to test the adequacy of the first seal boundary. Its failure will has not consequence to the integrity of the cask.

Chapter 3 Thermal

10. Clarify that the units in Table 3-6 for Specific Heat, which are "KT/(kg-°C)," should be "KJ/(kg-°C)." For consistency and clarity the corrections should be made to the application.

    This information is needed to determine compliance with 10 CFR 71.7.

    Table 3-6 has been corrected, the correct unit for Specific Heat is given.

Chapter 3 Thermal

11. Provide temperature values for all components that affect structural integrity, containment, shielding, and criticality for both NCT and HAC.

The application needs to clearly state all component temperatures that affect structural integrity, containment, shielding, and criticality for both NCT and HAC.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

These temperature values are given for all Models, except the ASO-100A-S, which is bounded by AOS-100A. Refer to Tables 3-19 thru 3-24 for NCT and 3-27 thru 3-32 for HAC for Model 100A and Appendixes 3.5.1 and 3.52 for the others Models.. Also , In addition, at the end of each Table the maximum temperature with in a

Chapter 3 Thermal

12. Provide a clear description of which packages and under which conditions personnel barriers are required for shipment. Clearly describe which shipments will be made as "exclusive use" and which will not. Additionally, for exclusive use shipments demonstrate that the surface of the personnel barrier remains below 185°F for NCT. Similarly, for non-exclusive use shipments demonstrate that the accessible package surfaces or personnel barrier surfaces remain below 122°F (see 1-2).

This information is needed to determine compliance with 10 CFR 71.43(g).

The personnel barrier is considered to be the closest accessible surface of the package for the normal condition of transport. It is modeled as air for conservatism in our MCNP models. In the shielding analysis, this means that the dose limit of 200 mrem/hr is applicable at the distance corresponding to the personnel barrier's location both axially and radial.

The personnel barrier is not considered for hypothetical accident conditions. For this case the surface of the cask represent the outer surface of the package.

Chapter 3 Thermal

13. Either reference or provide Table 2-63, “Maximum Cavity Pressure Due to Fire Conditions, in Section 3 of the application.

This information is needed to determine compliance with 10 CFR 71.35.

The “Maximum Cavity Pressure Due to Fire Conditions” information is also presented in Chapter 3.

Chapter 3 Thermal

14. Incorporate pressure values in Table 4-6, “Model AOS-100 and AOS-165 Transport Package Fission Gas Inventory and Resulting Pressure,” into
    Chapter 3.

This information is needed to determine compliance with 10 CFR 71.35.

The information is added to Chapter 3.

Chapter 3 Thermal

15. Provide further description as to how pressure values were calculated in Table 3-3, “Transport Package Pressure,” as well as a sample calculation.

It is not clear from the information presented in the SAR how the pressure values were calculated for NCT.

This information is needed to determine compliance with 10 CFR 71.71.

Sample calculation is included in Chapter 4 and referenced in Chapter 3.

Chapter 3 Thermal

16. Provide references for all material properties and equations used in the analysis. For example, references are not given for the following (this is not a comprehensive list):

a) Section 3.2.1.1, Table 3-5 “Tungsten Thermophysical Properties”

b) Section 3.2.1.2, Table 3-6 “Stainless Steel (SS304) Thermophysical Properties”

c) Section 3.2.1.3, Table 3-7 “Air Thermophysical Properties”

d) Section 3.2.1.4, Table 3-8 “Last-A-Foam Thermophysical Properties”

e) Section 3.2.1.4, Table 3-9 “Transport Package Foam Density”

f) Section 3.3.1, page 3-12, third paragraph, packed stainless steel wool thermal properties (or the assumption that they are 10% of SS304)

g) Section 3.3.1.3, Table 3-13 “Polynomial Coefficients Used in Equivalent Convective Property of Ambient Temperature and External Surface”

The applicant should reference all material properties used in the application.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

Appendix 3.5.4, “Material Property Reference,” is added to include this information.

Chapter 3 Thermal

17. Confirm that the minimum allowable service temperature of all components is less than or equal to -40 C (-40 F) as referenced in Section 3.2 of the application.

The application needs to allow for verification that all components are able to withstand -40 C (-40 F).

This information is needed to determine compliance with 10 CFR 71.35.

Material Properties are given for a range of temperature including cryogenic conditions. Also, components temperature of major components are also given.

Chapter 3 Thermal

18. Confirm that all equations provided for material properties produce results in the provided tables. Provide units of temperature if temperature is an input value in a given equation.

The staff tried to reproduce the Prandtl Number for air from Table 3-7, "Air Thermophysical Properties," using the given equation and with all possible units of input for temperature without success.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

A Note have been added to the Prandtl Number equation to indicated that the Temperature unit is degree F.

Chapter 3 Thermal

19. With regards to the information provided in Table 3-8:

a) Explain why Last-A-Foam thermophysical properties are given for FR-3706, FR-3712, and FR-3718.

b) Provide the reference used to determine the conductivity values for FR-3710 and FR-3720.

It is not clear to the staff why thermophysical properties were provided for FR-3706, FR-3712, and FR-3718 when they were not used in the models mentioned in the application. Additionally, the conductivity values for FR-3710 and FR-3720 do not agree with the values provided in the "Design Guide for Last-A-Foam FR-3700 for Crash & Fire Protection of Radioactive Material Shipping Containers."

This information is needed to determine compliance with 10 CFR 71.71 and 71.73

Table 3-8 has been revised to list only those foam type used on the in the AOS Transport Packaging. Appendix 3.5.4 now contains foam material properties reference.

Chapter 3 Thermal

20. Re-evaluate the tungsten material properties in Table 3-5 (i.e., density, specific heat, conductivity). The values given in Table 3-5 do not match values found in MATPRO NUREG/CR-6150 Volume 4, Revision 2.

This information is needed to determine compliance with 10 CFR 71.35.

The tungsten material properties given in the application were verified with the tungsten supplier, They concurred that the properties given are correct for the tungsten alloy used on the AOS packaging. According with them, the properties values given in MATPRO NUREG/CR-6150 Volume 4, Revision 2. are for pure tungsten, rather than for tungsten alloy. A letter form the manufacture is included in Appendix 3.5.4.

Chapter 3 Thermal

21. Provide the absorptivity for SS304 during NCT in Section 3.2.1.2 (i.e., the outer surface absorbing insolation).

The application should contain the thermal absorptivity values for all outer surfaces.

This information is needed to determine compliance with 10 CFR 71.71.

Table 3-14 (Normal conditions of transport) and Table 3-15 (Fire condition) define the polynomial coefficients used in the equivalent convective property (conversion and radiation) of each ambient temperature and external surface (total external surface divider in 11 logical regions), for each AOS Transport Packaging System model

Chapter 3 Thermal

22. Rewrite the following statement in Section 3.2.2, "[o]ther package materials used are stainless steel and tungsten. The melting points of these materials are 1,430 C (2,606 F) and 3,370 C (6,098 F), respectively. All temperatures resulting from Normal and Accident thermal conditions fall within these temperatures."

This statement could be interpreted to mean that melting points are acceptable temperature limits for NCT when they are not acceptable limits.

This information is needed to determine compliance with 10 CFR 71.71.

Statement has been re-written to read: " … All temperatures resulting from Normal and Accident thermal conditions are well below these temperature limits, therefore melting of these metals will not occur."

Chapter 3 Thermal

23. With regards to Section 3.3.1, “Analytical Model:”

a) Provide a comprehensive discussion of the development of analysis models for the NCT and HAC analyses of the package in Section 3.3.1. Include descriptions of the analysis methodology and development of analysis inputs. In addition, analysis input and output files should be provided, with sufficient description of the content of these files.

(b) Provide documentation that describes the validation or benchmarking of the LIBRA code for thermal analysis of radioactive material packages.

Guidance on what information should be provided is available in Interim Staff Guidance (ISG) 21, “Use of Computational Modeling Software,” (ADAMS Accession # ML061080669).

This information is needed to determine compliance with 10 CFR 71.35.

Section 3.3.1, “Analytical Model” has been expended to include addition details. Figure 3-2 is added and together with Figure 3-2, former 3-2, enhance the understanding of the model techniques.

Chapter 3 Thermal

24. Provide a copy of the reference [3.10], *Heat Transfer Data Book*, in Section 3.5, cited for the value of a thermal contact resistance (0.03 hr-in^2 F/BTU). Alternatively, a portion of this reference including a relevant discussion of the source of the contact resistance value may be submitted.

The staff requires a clear explanation and discussion of values used for contact resistances in the analyses models of the package.

This information is needed to determine compliance with 10 CFR 71.35.

Applicable pages from such reference source have been added to Appendix 3.5.4.

Chapter 3 Thermal

25. Provide descriptions, including drawings, of the internal basket assemblies used in the various designs in Section 3.3.1. Describe how the payload will thermally interact with the internal surfaces of the inner canister.

    The assumption that the heat on internal surfaces is evenly distributed may not be conservative. The temperature distribution within the inner cavity will be dependent on the arrangement of the contents. While the overall decay heat generated may be represented, the distribution of this heat load is not captured by applying it uniformly on the inner surface of the canister. The staff requires reasonable assurance that the decay heat generated by the contents is appropriately modeled in relation to the interior of the package.

This information is needed to determine compliance with 10 CFR 71.33(a)(5)(v).

All liners used in the operation of the AOS Transport Packaging System have been included in Chapter 1, Appendix 1.4.1. They are not included the other Chapters because they do not affect the analytical approach taken, other than in their weights, whish they are part of the weight of the content. The thermal approach is to applied the maximum decay heat to the cavity wall and for Chapter 5, the analysis is based on point source located at the cavity surfaces also.

Chapter 3 Thermal

26. Provide a direct comparison of the thermal test results and the NCT analysis models. Highlight any differences between the results of the experiments and the analyses and provide explanations of any differences between the two. Describe how the experiments provide a validation of the analysis models developed.

The staff recommends that all methods used for analysis of a package design be validated with experimental data. A comparison of the thermal test conducted and the analyses results would provide reasonable assurance that the analyses methods employed in the application are sound.

This information is needed to determine compliance with 10 CFR 71.35.

The purpose of the thermal test is to validate the analytical model, therefore is a validation against experimental data produced by an independent third party.

Chapter 3 Thermal

27. Provide a reference for:

    a) oxidized SS304, emissivity = 0.52, mentioned in Section 3.3.1.2, on page 3-18, and,

    b) the emissivity value of 0.20 stated for the cask's outer surface in Section 3.3.1.3, page 3-21.

    The applicant should reference all materials properties used in the SAR.

    This information is needed to determine compliance with 10 CFR 71.35.

    Reference for these values has been added to Chapter 3.

Chapter 3 Thermal

28. Clarify why each of the surfaces listed in Table 3-12, "Cask Assembly External Surface Orientation and Size," have length and width dimensions that are equal.

The staff would like clarification regarding the length and width dimensions listed in Table 3-12 to ensure that the proper dimensions are being used to calculate the cask assembly external surface size.

This information is needed to determine compliance with 10 CFR 71.35.

Tables 3-12 and 3-13 have the width and length dimension of each surface, for NCT and HAC (based on deformed geometry).

Chapter 3 Thermal

29. Clarify the statement in Section 3.3.1.3.4, "[i]n the evaluation, the values averaged over a 12-hour period in a steady-state solution."

Based on the above statement, it is not clear to the staff how the solar heat load is applied.

This information is needed to determine compliance with 10 CFR 71.71(c)(1).

The statement has been changed to read: "In the evaluation, the solar load is applied for a 12 hours period using a steady-state analytical solution."

Chapter 3 Thermal

30. Reevaluate the maximum temperatures provided in Section 3.3.4 for NCT, page 3-25, and HAC, page 3-46. This applies to all AOS models.

It appears that samples of nodes were chosen from the analysis and then the temperature of those nodes was monitored to provide maximum temperatures. The staff has not been assured that maximum temperatures have been provided for package components based upon the entire set of nodes.

This information is needed to determine compliance with 10 CFR 71.35.

All thermal conditions have been re-analyzed.

Chapter 3 Thermal

32. Provide the heat transfer coefficient used for the convective heat input to the package for the HAC analysis.

In Section 3.4, page 3-43, the convective heat input to the package for the HAC condition is described as "based on still ambient air" when the fire environment is actually characterized as turbulent with hot gasses driven by the combustion process. A convective coefficient for HAC analyses should take the presence of combustion-driven gas flow into account.

This information is needed to determine compliance with 10 CFR 71.73(c)(4).

The statement is corrected. A value in the range of 5 to 10 m/s is applied.

Chapter 3 Thermal

33. Provide either a summary, table, or a graph of the maximum component temperature performance against the time at which they occur after the fire in Section 3.4.

The application should provide a summary of the maximum component temperature performance against time performance of all the packages analyzed in Section 3. If a graph is provided, the figures should contain a meaningful legend that lists the components of interest for the package design.

This information is needed to determine compliance with 10 CFR 71.73.

Figures 3-65 thru 3-105 are corrected to provide the figure Legend based on a particular component rather than the component number.

Chapter 4 Containment

1. Provide a list of the ASME Boiler and Pressure Vessel Code requirements that are met by the AOS series of packages.

   Section 4.1.1 states, "[…]containment vessel and cask meet the ASME Boiler and Pressure Vessel Code requirements." This statement is vague and more specificity is needed.

   This information is needed to determine compliance with 10 CFR 71.31(b).

   Section 4.1.1 has been expanded to provide additional information of how the ASME Code is used and which Sections of the Code are applicable.

Chapter 4 Containment

2. Clarify Figure 4-2 by providing a clearer representation of what component is being featured in the figure. Placing the detail in the context of location on a representation of a complete package may add additional clarity.

This information is needed to determine compliance with 10 CFR 71.31(b).

Figure has been revised to clarify the two different weld design used in the AOS packaging.

Chapter 4 Containment

3. Provide additional explanation of the placement of the seals using four small screws, as mentioned on page 4-5.

It is unclear from the application whether or not the use of screws to secure the seals is a standard configuration.

This information is needed to determine compliance with 10 CFR 71.31(b).

An sketch has been provided in this section to clarify the seal installation.

Chapter 4 Containment

4. Correct the reference to Table 3-2 in Section 4.3, page 4-8.

Section 4.3 states: "Temperatures at the lid seal and port cover seals are also below the temperature criteria for the applicable seal material listed in Chapter 3, Table 3-2, 'Transport Package Thermal Environment Conditions,' on page 3-3." Table 3-2 does not contain the information stated.

This information is needed to confirm compliance with 10 CFR 71.31(b).

AOS has corrected this information.

Chapter 4 Containment

5. Provide additional details on the leakage rate test described in Section 4.4.

The description of the leakage rate test done on the AOS packages does not provide any specific information or results. A discussion of how the leak test demonstrates that all the different AOS packages will remain leak tight under all loading configurations should be included. If the AOS packages were tested to demonstrate that it is leak tight in accordance to ANSI N14.5, further description of how the package was tested and what the results were are needed.

This information is needed to confirm compliance with 10 CFR 71.31(b).

A more detailed description of the test have been added to the application.

Chapter 4 Containment

6. Provide a description of how the test provided for the seals in Appendix 4.5 demonstrates how the seals installed on the AOS packages allow those packages to meet the ANSI N14.5 leaktight criteria.

It is not clear how the test flange used in the helium leak test is representative of the AOS cask design closure, and if the seals tested are representative of the seals that will be utilized for the AOS packages.

This information is needed to confirm compliance with 10 CFR 71.31(b).

The test described in Appendix 4.5 was performed to demonstrate that the material selected for the seals are capable the meet the ANSI N14.5 leaktight criteria under regulatory conditions of cold, normal, and high temperature conditions. The seal tested has the same material and cross section characteristics than those prescribed for the AOS packaging.

Chapter 4 Containment

7. Justify the validity of the test and new higher seal temperature limits for the Garlock Helicoflex metallic seals in the AOS-165 for the highest 7kW heat load (Section 4.5.1).

The seal temperature limit is specified as 800 F (Tables 2-3 and 3-4 of the application) while the manufacturer limit is 536 F. It appears that the seal was tested in a mock-up configuration at 800 F, and demonstrated a maximum leak rate of 2.2x10^{-7} cc/sec when the acceptance criterion was 2.4x10^{-7} cc/sec. The test duration was stated as three minutes in Table 1 in Section 4.5.1. It is possible that, had the test duration been longer, the seal could have leaked greater than the acceptance criteria. Stating that the seal temperature limit is 800°F, based on the tests conducted, is not correct, and would not be supported by the seal manufacturer.

This information is needed to determine compliance with 10 CFR 71.45(f).

The metal seal selected is rated to 842 oF per Helicoflex catalog. Garlock catalog page have been added to Chapters 3 and 4 as an Appendix.

Chapter 4 Containment

8. Provide a basis for the amount of fission gas available to be released from the spent fuel to the transport cavity as quoted in Table 4-6.

Since neither the amount of spent fuel, nor its characteristics are given, the staff could not verify the values given. This information is needed to determine if the cavity will pressurize.

This information is needed to determine compliance with 10 CFR 71.51(2).

AOS has eliminated the request to ship fuel materials in this submittal.

Chapter 4 Containment

9. Either describe the effects of exceeding the design pressure limit for the AOS-100A-S when transporting spent fuel or state that you will not be using the AOS-100A-S to transport spent fuel.

Table 4-6 states the pressure from fission gas inventory and the resulting pressure for the AOS-100 is 15.37 atm (the staff converted that to 1557 kPa). This value alone, excluding pressure from heated air in the cavity, exceeds the design pressure in Table 2-1, which states that the design pressure limit for the AOS-100A-S is 517 kPa. Additionally, Table 1-6 on page 1-24, states that fissile material will be placed in the AOS-100A.

This information is needed to determine compliance with 10 CFR 71.73.

AOS has eliminated the request to ship fuel materials in this submittal.

Chapter 4 Containment

10. Describe the effects of exceeding the design pressure limit for the AOS-165 when transporting spent fuel.

Table 4-6 states the pressure from fission gas inventory and the resulting pressure for the AOS-165 is 13.57 atm (the staff converted that to 1375 kPa). The pressure from the fission gas inventory along with the pressure from the HAC heated air (Table 2-63: 235 kPa) is 1610 kPa which exceeds the design pressure in Table 2-1, which states that the design pressure limit for the AOS-165 is 1517 kPa. Additionally, Table 1-6 on page 1-24, states that fissile material will be placed in the AOS-165A.

This information is needed to determine compliance with 10 CFR 71.73.

AOS has eliminated the request to ship fuel materials in this submittal.

Chapter 5 Shielding

1. Explain and elaborate the details and structure of the fuel rod basket.

Section 5.2.2.2 of the SAR states, "[t]he cask is modeled to include the fuel rod basket, and uses the densities and material properties presented in Table 5-26, along with the standard cask assembly." This is the only instance where the fuel rod basket is described as an integral structural component within the cask. It is not clear to the staff, which among the seven different models contains this fuel rod basket. Explain how the fuel rod basket, if used, was modeled. Also, explain how its independence and structural integrity was maintained within the cavity. Elaborate on how the interaction effects during the required drop scenarios for both NCT and HAC were evaluated.

This information is needed to determine compliance with 10 CFR 71.33, 71.71, and 71.73.

References to the fuel rod basket have been removed from Chapter 5 of the SAR submittal.

Chapter 5 Shielding

2. Provide references to support the tungsten data in Table 3-5 and the tungsten density in Table 5-3, 5-29.

According to the CRC Handbook, the density of tungsten is 19.13 g/cc not 18.11 g/cc. The specific heat in the table is 20% higher than MATPRO and the conductivity is 60% lower than that in MATPRO at the same temperatures. Correct information is needed as input to the shielding and thermal calculations. The staff could not find values of the diffusivity.

This information is needed to determine compliance with 10 CFR 71.7(a) and 71.47.

Section 5.3.2 explicitly states that pure tungsten is used in the models with a density lower than the theoretical density of natural tungsten. This density is a conservative estimate of the tungsten density in the shield.

Chapter 5 Shielding

3. Either revise Section 5.0 to specifically evaluate liquid radioactive contents or revise Table 1-5 to delete reference to liquid contents for the AOS-025A and AOS-050A packages or specifically valuate liquid radioactive contents in the criticality evaluation.

The shielding evaluation in Section 5.0 evaluates the contents either as a point source or as a uniformly distributed source throughout the package cavity. Table 1-5 states that the form of the contents for the AOS-025A and AOS-050A packages may be liquid, in which case the contents could potentially relocate in a region of the package to cause a much higher external dose rate, e.g., the seal region or in a corner where streaming through the axial and radial shields is more likely. The application should be revised to either 1) demonstrate that relocated liquid contents will not result in a dose rate exceeding those specified in 10 CFR 71.47; 2) demonstrate that liquid contents will not relocate such that the source geometry assumed in the calculation is invalid; or 3) remove liquid contents as an allowable form in Table 1-5.

This information is needed to determine compliance with 10 CFR 71.47 and 71.51.

Liquid contents was removed as an allowable form in Table 1-5. No change to Chapter 5 required.

Chapter 5 Shielding

4. Revise Table 5-4 and the associated analysis in Section 5.0 to justify the source geometry used in the external dose rate determination.

It is not clear that the source geometries identified in Table 5-4 for the various analyses are the most limiting for the package. The contents may be able to relocate under NCT and HAC into a position in the package to produce a higher external dose rate than for contents centered within the shielding of the package. The analysis should either demonstrate that relocated contents will not result in an external dose rate higher than those specified in 71.47 and 71.51, or that the various contents to be shipped will not relocate under NCT and HAC.

This information is needed to determine compliance with 10 CFR 71.47 and 71.51.

All isotopes are now modeled as point sources located at the center of the top edge of the cavity for axial cases and at the center of the radial edge of the cavity for the radial cases for both Normal Conditions of Transport [NCT] and Hypothetical Accident Conditions [HAC].

A justification of the utilization of point sources and point detectors is provided in Section 5.2.1.3 and Section 5.3.1.3 respectively. This includes a discussion of the conservatisms associated with the selection of these geometries.

Chapter 5 Shielding

5. Revise the application to clearly state which contents are to be shipped in which package.

Tables 5-4 through 5-9 of the application list the source strength assumed for each of the radiation shielding evaluations performed for the AOS system (the accompanying proposed wording for the CoC, however, only gives a decay heat limit for the contents), which is not a sufficient limit to describe the contents evaluated in the application (if AOS decides to submit proposed wording for the CoC it should include a table, similar to Tables 5-4 through 5-9 of the application, which will appropriately limit the allowable contents of the package).

This information is needed to determine compliance with 10 CFR 71.33.

Final dose limited source strength tables is provided in the proposed CoC.

Chapter 5 Shielding

6. Revise the shielding evaluation in Section 5.0 to discuss the adequacy of the margins on regulatory radiation dose rate limits calculated for each of the contents.

Tables 5-4 through 5-9 of the SAR give calculated external dose rates for each content to be shipped in the AOS system. Some of the dose rates are equal to or very near the allowable external dose rates specified in 71.47, leaving little or no margin for calculation uncertainties. The shielding evaluation should be revised to either show that the margins included in the analysis are appropriate given the level of conservatism in the calculation, or reduce the allowable contents to provide additional margin on the allowable external dose rates.

This information is needed to determine compliance with 10 CFR 71.47 and 71.51.

A 10% margin was added to the radiation dose rate limits to provide additional margin to the dose limits. This is stated in Section 5.4.4.1.

Chapter 5 Shielding

7. Revise the application to include drawings and descriptions of the package cavity shielding inserts to be used for various contents.

Tables 5-4 through 5-9 state that, for certain contents, additional cavity shielding inserts are required to meet external dose rate limits. The application should be revised to include a description of these inserts, including drawings and a clear indication of which contents require the inserts.

This information is needed to determine compliance with 10 CFR 71.33.

Drawings and a description of the cavity shielding inserts are included. The proposed CoC is updated to clearly indicate which contents require shielding inserts.

Chapter 5 Shielding

8. Revise Section 5.0 of the application to clarify the bounding energy spectra used in some parts of the shielding analysis.

Tables 5-4 through 5-9 include comments that for some contents, the gamma energy spectrum for a different content was used in the shielding analysis, because it was determined to be bounding. The shielding evaluation should be revised to include a discussion of how each gamma energy spectrum was determined to be bounding, and how this source term was used to model different contents.

This information is needed to determine compliance with 10 CFR 71.47 and 71.51.

Section 5.4.4.1 updated to include discussion on how gamma energy spectrum was determined to be bounding, and how the limiting source strengths for bounded isotopes were calculated.

Chapter 5 Shielding

9. Revise the shielding evaluation of Section 5.0 to adequately describe the fissile material contents to be transported in the AOS package system.

It is not clear if the 400 g and 1,200 g ^{235}U limits specified in the analysis, in Tables 5-10 and 5-11, respectively, are pre- or post-irradiation. Additionally, it is not clear if the 4% enrichment assumed in the analysis is intended to be a minimum limit for the package. If the package is intended to ship ^{235}U enriched to less than 4%, this material will have to be evaluated in the shielding analysis. Additionally, it is not clear if the package is intended to ship fuel types other than GE14. The application should be revised to either: 1) state that the package is only intended to ship GE14 fuel; 2) show that GE14 fuel bounds the other spent fuel contents to be shipped with respect to shielding; or 3) evaluate all spent fuel contents to be shipped in the package.

This information is needed to determine compliance with 10 CFR 71.33.

References to SNM have been removed from Chapter 5 of the SAR submittal.

Chapter 5 Shielding

10. Revise the application to justify all depletion parameters used to determine the spent fuel composition of the fissile material contents.

Section 5.2.1 state that the composition was determined assuming GE14 fuel at 4% ^{235}U enrichment, irradiated for 3,872 days, but does not discuss the basis for using these parameters. Additionally, the shielding analysis should be revised to justify the specific power assumptions given in Table 5-12.

This information is needed to determine compliance with 10 CFR 71.47 and 71.51.

References to SNM have been removed from Chapter 5 of the SAR submittal.

Chapter 5 Shielding

11. Revise the application to justify the use of the ORIGEN-2 depletion code for determining the contents radiation source terms.

The ORIGEN-2 isotopic depletion code is no longer supported by the code developer and is no longer the industry standard for such calculations. Any use of this code should be thoroughly benchmarked against actual isotopic assay data from spent nuclear fuel.

This information is needed to determine compliance with 10 CFR 71.47 and 71.51.

References to SNM have been removed from Chapter 5 of the SAR submittal.

Chapter 5 Shielding

12. Revise the application to justify the use of the spontaneous fission energy spectrum for ^{244}Cm in the MCNP model, as opposed to the energy spectrum provided by the depletion code.

The application should justify that the energy spectrum used in the external dose calculation is conservative with respect to the external doses calculated.

This information is needed to determine compliance with 10 CFR 71.47 and 71.51.

References to SNM and neutron sources have been removed from Chapter 5 of the SAR submittal.

Chapter 5 Shielding

13. Provide a list of components in the model, the absence of which provides a more conservative dose estimate.

Page 5-1 of the application states, "the absence of other components in the model provides a more-conservative dose estimate." However, there is no further information about these other components.

This information is needed to determine compliance with 10 CFR 71.33.

A discussion on the components whose absence provides a more conservative dose estimate is provided in Section 5.1.1.1. These include the impact limiters, the personnel barrier, the securing lines, and any internal structures. The content geometries are also modeled as point sources to conservatively ignore self-shielding effects.

Chapter 5 Shielding

14. Clarify the inconsistency of the dimensions for the cavity shown on Table 5-1 and the technical drawing for the models AOS-025, AOS-050, and AOS-165.

On Table 5-1 of the application, the applicant states that the half-height of the cavity for Models AOS-025, AOS-050, and AOS-165 are 2.50 inches (full-height 5.00 inches), 5.00 inches (full-height 10.00 inches), and 16.50 inches (full-height 33.00 inches), respectively. However, Drawing Nos. 166D8143, 105E9718, and 105E9707 show full height measurements for the cavity as follows: 4.65 inches for the AOS-025, 9.92 inches for the AOS-050, and 32.76 inches for the AOS-165.

This information is needed to determine compliance with 10 CFR 71.33.

Final dimensions have been verified against the final drawings and are now consistent.

Chapter 5 Shielding

15. Clarify how a geometrical source with a diameter of 1.1 cm could fit into a tungsten liner with an inner diameter of 0.4 inch (1.01 cm).

Table 5-4 states that for the Model AOS-025, a source of Ir-192 with a cylindrical geometry has 1.1 cm diameter. This source is placed into a tungsten liner. However, Drawing No. 183C8485 shows that the diameter of the tungsten liner is about 0.4 inch (1.01 cm).

This information is needed to determine compliance with 10 CFR 71.33.

All isotopes are modeled as point sources located at the radial center of the top edge of the cavity for axial cases and at the axial center of the radial edge of the cavity for the radial cases for both Normal Conditions of Transport [NCT] and Hypothetical Accident Conditions [HAC]..

Chapter 5 Shielding

16. Clarify how a tungsten liner with a full-height of 4.9 inches could fit into the cavity of the Model AOS-025 with a full-height of 4.65 inches.

Drawing No. 183C8485 shows that the height of the tungsten liner is about 4.9 inches. However, Drawing No. 166D8143 shows that the cavity has a height of 4.65 inches.

This information is needed to determine compliance with 10 CFR 71.33.

Drawings updated. No change to Chapter 5.

Chapter 5 Shielding

17. Revise the application to clarify which flux-to-dose conversion factors were used to obtain the gamma dose. Additionally, provide a table of these factors in the shielding analysis of Section 5.0.

Page 5-43 states that ANSI/ANS 6.1.1 was used for flux-to-dose conversion factors for gammas (Reference 5.6). However, Reference 5.6 on page 5-207 states that the conversion factors are dated 1972. Flux-to-dose conversion factors should be based on ANSI/ANS 6.1.1-1977.

This information is needed to determine compliance with 10 CFR 71.47 and 71.51

Standard used was ANSI/ANS 6.1.1 1977 for the gamma dose conversion factors. This has been updated in Section 5.4.3 and Reference 5.6. A listing of these values is provided in Reference 5.4 Appendix H.

Chapter 5 Shielding

18. Clarify the total of the neutron source presented in Table 5-13 for 64 GWd/MTU burned fuel.

Table 5-13 of the application notes that the total neutron source for 64 GWd/MTU burned fuel is given as 6.16E+08 n/s; however, plotting that number on the graph presented on Figure 5-3 gives a different curve and power trend line equation.

This information is needed to determine compliance with 10 CFR 71.47 and 71.51

References to SNM and neutron sources have been removed from Chapter 5 of the SAR submittal.

Chapter 5 Shielding

19. Provide the MCNP input file and output file for the shielding calculations for the bounding fissile material cases.

This information is needed to determine compliance with 10 CFR 71.47 and 71.51.

References to SNM have been removed from Chapter 5 of the SAR submittal.

Chapter 5 Shielding

20. Revise the application to specify how many pin slots are used for the Model AOS-165.

Page 5-34 states that the inner five (5) pin slots are used for the Model AOS-100 transport package design. However, there is no further information about how many pin slots are used for the Model AOS-165.

This information is needed to determine compliance with 10 CFR 71.47 and 71.51.

Reference to pin slots has been removed from Chapter 5 of the SAR submittal.

Chapter 6 Criticality

NOT APPLICABLE AT THIS TIME, SINCE THIS SUBMITTAL DOES NOT INCLUDE ANY SPENT FUEL. HOWEVER , THE STAFF`s COMMENTS WILL BE ADDRESED WHEN A SUBMITTAL TO INCLUDE SPENT FULE IS MADE.

Chapter 7 Package Operations

1. Provide operating procedures on the loading and unloading of the cask contents.

Operating procedures are necessary to assure the package will be operated in a manner consistent with the staff's evaluation for approval. Include any special steps necessary to ensure safety of the personnel and non-combustibility of the contents.

This information is needed to determine compliance with 10 CFR 71.127.

AOS has revised Chapter 7 to provide additional details.

Chapter 8 Acceptance Tests and Maintenance Program

1. Describe what is meant by “referee testing” for the sensitization test in Table 8-2.
The staff does not have experience with this procedure. Clarify using standard recognized terminology.
This information is needed to determine compliance with 10 CFR 71.7(a).
Describe what is meant by “referee testing” for the sensitization test in Table 8-2.
The staff does not have experience with this procedure. Clarify using standard recognized terminology.

This information is needed to determine compliance with 10 CFR 71.7(a).

The referee test for sensitization is a test used as a second check if the ASTM A262 is borderline or inconclusive. The 5% ditching acceptance criteria is imposed by GE and is tighter than ASTM A262 itself where practice A is used only for screening and practice E for acceptance. GE has an internal specification for performing the electrolytic nitric referee test. Nevertheless, the referee testing was not needed for the AOS-165 prototype material and it may not be for the future fabrication.

Chapter 8 Acceptance Tests and Maintenance Program

2. Indicate how the crush strengths in Table 8.6 were obtained.

   Using data in the General Plastics Manufacturing Co. Design Guide for the use of Last-A-Foam FR-3700, page 11, the staff could not duplicate the stresses stated in Table 8.6.

   This information is needed to determine compliance with 10 CFR 71.35.

   Data was provided by Supplier, and represent "in-situ" condition.

Chapter 8 Acceptance Tests and Maintenance Program

3. Provide additional details on the leakage rate test described in Sections 4.4 and 8.1.4.

Section 4.4 states, “[t]he leakage rate test for Type B package is performed by pressurizing the cavity of the cask to 15 to 17 psia with helium[…]” Section 8.1.4 states, “[t]he assembled cask is leak-tested by pressurizing the cavity to 15 psig with helium.” It is not clear to the staff what pressurization the cavity is subjected to for the helium leak test.

This information is needed to determine compliance with 10 CFR 71.31(b).

AOS has clarified the pressure value required by the test on both Sections of the application. The objective of the test is to determine a leak rate through the seal boundary when there is a 1 atm. pressure differential across it. Therefore,