From: Saverot, Pierre
Sent: Tuesday, December 15, 2009 12:46 PM
To: Troy Hedger; Raul Pomares; Schrag, Michael R. (GE Infra, Energy); Turner, David W. (GE Infra, Energy)
Subject: AOS Package Application Thermal RAIs

Dear Mr. Hedger,

As a follow-up to our October 28, 2009 teleconference call on a staggered Request for Additional Information (RAI) process during the review of this application, and to the Materials, Shielding, and Structural RAIs sent to you on November 2, November 6, and December 10, 2009, respectively, you will find below our RAIs related to Thermal issues for the AOS-025, AOS-50 and AOS-100 packaging systems.

Sincerely,

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Request for Additional Information
for the
Model Nos AOS-025, AOS-050, and AOS-100 Packages
Docket No. 71-9316

By letter dated September 14, 2009, Alpha-Omega Services, Inc, (AOS) submitted an application for approval of the Model Nos. AOS-025, AOS-050, and AOS-100 packages.

This Request for Additional Information (RAI) identifies information needed by the U.S. Nuclear Regulatory Commission (NRC) staff in connection with its review of the "AOS Radioactive Material Transport Packaging System Safety Analysis Report," Revision No. C, dated September 2009. This RAI is exclusively related to thermal issues at this time and will be followed by containment RAIs.

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

Licensing Drawings as well as Tables 1-5, 2-10, and 3-1

1-1 Clarify the following information from Table 1-5, Table 3-1 and the licensing drawings of the application.

a. Clarify the difference between the packaging weight values for the AOS-50A in Table 1-5 and Table 2-10 or Table 3-1 of the application.

b. Clarify how the packaging weight shown in Table 3-1 of the application is calculated. The staff notes that the definition of packaging in 10 CFR 71.4, "… consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, and devices for cooling or absorbing mechanical shocks." The definition of package includes the packaging together with its contents. Ensure the column label in Table 3-1 of the application is appropriate for the weight calculation that was performed.

c. Clarify if the weight of the impact limiters shown in Table 3-1 of the application is for each impact limiter or the total for both impact limiters.

d. Assuming the applicant calculated the packaging weight by including the cask, limiters (assuming that is the total for both impact limiters), and content, the staff calculated a packaging weight of 3,322 kg for the AOS-100B. This value is greater than the value the applicant provided (3,232 kg) in Table 3-1 of the application. Clarify the inconsistency.

e. Move "Weight" values from Table 3-1 to a more appropriate section of the application (i.e. Chapter 1 or Chapter 2).

f. Clarify the inconsistency between the weight values on drawing number 105E9711 sheet 1 and sheet 2. Note 4 on sheet 1 states that the maximum package weight is 3677 kg +/- 10%, yet the AOS 100A/A-S nameplates on sheet 2 list the gross weights as 4109 kg which is inconsistent with sheet 1 as well as exceeds the maximum tolerance provided on sheet 1.

g. Clarify the inconsistency between drawing number 105E9713 sheet 1 and Table 3-1 of the application. Note 6 on drawing number 105E9713 sheet 1 lists the impact limiter weight as 215 kg while Table 3-1 lists the weight as 272 kg.

h. Clarify the inconsistency in gross weight values on the nameplates in licensing drawings 166D8142 sheet 2 of 2, and 166D8143 sheet 2 of 2, There also appear to be similar inconsistencies in the AOS-50 and AOS-100 packages. The maximum weight of the package should include the packaging and its contents.

i. Remove the weight tolerances from the licensing drawings. Licensing drawings indicate that the maximum package weight tolerance for each package is +/- 10%. The large package weight tolerance does not appear to be physically possible if the dimensional tolerances on the licensing drawings are appropriately constrained.

This information is necessary to determine compliance with 10 CFR 71.33(a)(2).

Bill of Materials / Parts List for all AOS models

1-2 Categorize all model components according to NUREG/CR-6407.

All model components should have on the Bill of Materials the component safety category according to NUREG/CR-6407 (i.e. Category A, B, or C for components important to safety; or not important to safety).

This information is necessary to determine compliance with 10 CFR 71.107(a).

Licensing Drawings

1-3 Clarify the inconsistencies in licensing drawing number 105E9722, 166D8138, and 105E9713 between the drawings' sheet 1 and 2, specifically the item numbering inconsistencies between sheet 1 and sheet 2 for each drawing.

For example (but not limited to) licensing drawing number 105E9722 sheet 1 of 2 lists item number 13 as polyurethane foam, but licensing drawing number 105E9722 sheet 2 of 2 lists polyurethane foam as item number 11.

This information is necessary to determine compliance with 10 CFR 71.31.

1-4 Provide a parts list for licensing drawing number 105E9712 on sheet 1.

This information is necessary to determine compliance with 10 CFR 71.31.

Table 3-1

1-5 Justify the reason for inconsistent radioisotope activity values in the application. Ensure when values appear in multiple tables throughout the application that the values are consistent and have been appropriately applied in the NCT and HAC assessments.

Radioisotope activity values in Table 3-1 of the application are not consistent and one is less conservative compared to values in Table 1-6 of the application. Based on the inconsistent values presented, the application should be revised to list each table, used by multiple disciplines, once in the application (i.e. in Chapter 1 or Chapters 7 or 8) and then reference the table number in other locations.

This information is necessary to determine compliance with 10 CFR 71.31

1-6 Clarify if there will be fissile contents in any of the AOS packages under review.

Licensing drawing 105E9711 sheet 2 of 2 lists the package type as “B(U)F” on the nameplate. The staff is under the impression that the AOS packages under review will not be licensed for fissile contents.

This information is necessary to determine compliance with 10 CFR 71.33(b)

General

3-0 Specify the reason for inconsistent values and parameters that appear through out the application in multiple design areas. Justify that the AOS quality assurance program satisfies the requirements of 10 CFR 71.107 for control of the thermal and containment design of the package.

The requirements in 10 CFR 71.107(b) state that the applicant for a CoC shall establish measures for the identification and control of design interfaces and for coordination among participating design organizations. These measures must include the establishment of written procedures, among participating design organizations, for the review, approval, release, distribution, and revision of documents involving design interfaces. The requirements in 10 CFR 71.107(b) further state that for the verifying or checking process, the licensee shall designate individuals or groups other than those who were responsible for the original design, but who may be from the same organization. The applicant for a CoC shall apply design control measures for the following: criticality physics, radiation shielding, stress, thermal, hydraulic, and accident analyses.

As indicated by an audit review, several inconsistencies listed in RAI 1-1 appear to indicate that the application does not establish a clear understanding of the fundamental weight of each AOS package. As indicated in RAI 1-5, it appears that the application does not establish a clear understanding of the isotopic contents of each AOS package. As indicated in RAI M15 in ML093060216, it appears that the application does not establish a clear understanding of the seals used in each AOS package. As indicated in RAI 3-22, the application does not ensure consistency between boundary conditions provided in the application and used in the thermal models. As indicated in RAI 8-2, it appears that the application does not establish a clear understanding of the leak testing pressure. The staff also notes that application quality problems of a similar nature were previously identified in many of these same technical areas (by letter dated June 13, 2008) after the withdrawal of original AOS application and in our request for supplemental information (by letter dated July 31, 2009) after the application was resubmitted. The applicant should demonstrate that appropriate design control measures have been established and that all values and associated analyses with the thermal and containment design (not limited to these RAIs) are accurate and reliable.

This information is needed to demonstrate compliance with 10 CFR 71.51 and 71.107.

Table 3-4

3-1 In Table 3-4 of the application, separate regulatory/component criteria into two columns, one for NCT limits and one for HAC limits. Also in Table 3-4 of the application, separate Case 3 into two columns; one providing maximum temperatures during the fire and one providing maximum temperatures during the post-fire steady-state condition, as well as the time at which these temperatures occur after fire initiation. In addition to the components currently listed in Table 3-4 of the application, add the following components: lid, bottom plate, outer shell, and inner shell. Clarify if the cask cavity temperature is the maximum temperature of the cavity surface of the inner shell or the maximum temperature of both the cavity surface of the inner shell and the cavity surface of the lid plug. Finally, clarify if the shielding temperature is the maximum for all shielding in the package (i.e. the maximum of the radial, lid plug, and end plug shielding).

In order to verify the temperature results, the applicant should provide maximum component temperatures in one table containing NCT, fire, and post-fire maximum temperatures, as well as component temperature limits; or two tables separating NCT maximum temperatures and associated component temperature limits from fire and post-fire maximum temperatures and component temperature limits. Currently the staff has to review and interpret numerous tables located throughout Chapter 3 of the application to determine the maximum component temperature. The current summary of temperatures in Table 3-4 is misleading in that the maximum temperatures appear to be provided in the table. The application should also report temperatures for the lid, bottom plate, outer shell, and inner shell because they are structural components. The cask cavity temperature should be the maximum of both the cavity surface of the inner shell and the cavity surface of the lid plug. The shielding temperature should be the maximum temperature for all shielding in the package.

This information is necessary to determine compliance with 10 CFR 71.51

3-2 Justify the lid seal temperature limit of 572°F.

In the licensing drawings 166D8143 and 166D8137 for the AOS-25A and AOS-50A respectively, the lid seal free height is 0.11 inch. Using the information provided in Section 3.5.7, "Lid seal" the maximum temperature of a Helicoflex spring energized seal with a silver jacket and a cross-section of 0.098 inch is 536°F. The next cross-section dimension is 0.118 inch which is greater than the lid seal free height in the licensing drawings.

This information is necessary to determine compliance with 10 CFR 71.73

Section 3.2.2 and Licensing Drawings

3-3 Clarify if the elastomeric silicone based seal is Parker compound S1224-70 and not 51224-70. Provide the minimum temperature limit for the elastomeric seal. In addition, provide a component technical specification for the metallic lid seal (also see RAI M15 from ML093060216).

The metallic lid seal will be designed by the manufacturer based on the flange design, if this has been performed, complete information on the metallic lid seal including the manufacturer, part number, materials of construction, and minimum and maximum temperature limits should be provided in the technical specifications. If this seal design has not been performed, metallic lid seal information that includes the materials of construction, and minimum and maximum temperature limits is necessary in the technical specification to preclude an amendment to the certificate.

This information is necessary to determine compliance with 10 CFR 71.51.

Section 3.3.1

3-4 Clarify if the shielding is modeled with four-node quadrilateral conduction elements. Also explain in more detail how convective elements are being used to model the decay heat as well as solar insolation.

In the first paragraph of Section 3.3.1, state if the shielding has been modeled with four-node quadrilateral conduction elements. A more detailed explanation is necessary to understand how the decay heat and solar insolation were modeled using convection elements.

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

Figure 3-4

3-5 In Figure 3-4 of the application clearly label the six air gaps given in the numbered list on page 3-22 of the application by providing the air gap numbers on the figure. Ensure this figure is consistent with Figure 3-2 in the contact resistance appendix as well as Figure 3-2 in the air appendix of the application, as well as the description in Section 3.3.1 of the application. Verify the final figure is consistent with the thermal models and report results.

The application needs to clearly and consistently present how the package was thermally modeled. This includes the air gaps that are represented in the model. Figures 3-4 of the application and Figure 3-2 of the contact resistance and air appendix of the application appear to inconsistently show where the air gaps are located.

This information is necessary to determine compliance with 10 CFR 71.33 and 71.51.

Section 3.3.1.2

3-6 Provide sensitivity studies on enclosed air space gap sizes and contact resistance values used in the thermal models.

It appears the same gap size values and contact resistance values were used in the NCT, fire, and post-fire cooldown models. Using the same value for all three cases does not produce maximum temperatures. Enlarging gaps during the NCT and post-fire cooldown and reducing the gap sizes during the fire would produce maximum component temperatures. Increasing contact resistance during the NCT and post-fire cooldown and reducing the contact resistance during the fire would also produce maximum component temperatures. A sensitivity study should show the effects of changing the gap sizes and contact resistance values on maximum component temperatures. Based on the sensitivity studies, show that the values currently used in the thermal models are appropriate to produce maximum component temperatures or modify and rerun the models to produce maximum component temperatures.

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

3-7 Justify the assumption that $\varepsilon_1 = \varepsilon_2 = 0.52$ for all air gaps.

Air gaps listed in numbered list on page 3-22 of the application are not all stainless steel to stainless steel as is assumed in the radiation calculation on page 3-28 and discussed on page 3-29 of the application. Justify the conservatism of this assumption during NCT and HAC.

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

3-8 Justify taking credit for each air gap in the thermal models since many gaps are within the tolerances provided on the licensing drawings.

Many air gap dimensions in Table 3-12 of the application are within the dimensional tolerances presented on the licensing drawings. If justification cannot be given, the gaps should be removed and the thermal models rerun to provide updated maximum temperatures.

Tolerances on the engineering drawings to the 2nd decimal are 0.01 inches. Many air gaps are less than this tolerance. Therefore the use of the gaps in the thermal models needs to be justified and if they cannot be justified by possibly adjusting the tolerance if physically possible, they need to be removed and the thermal models rerun without the gaps.

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

3-9 Justify the following assumptions presented in Section 3.3.1.2 of the application.

a. The application states, "Table 3-11 lists air gaps 1, 2, 3, 5, and 6 with a temperature of 300 K (26.85°C, 80.33°F) and a delta T = 5.6°C (42.08°F)." Show how these chosen temperatures provide bounding values for all conditions (NCT and HAC) of the models. Also, a delta T = 5.6°C is not equivalent to a delta T = 42.08 °F, clarify the correct value.

b. Table 3-11 of the application shows values for the AOS-165, it would be more appropriate to use bounding values for the models AOS-25, AOS-50, or AOS-100, packages that have been accepted for review.

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

3-10 Provide the assumptions used to reduce the effective conductivity equations in Table 3-12 of the application to a function of one temperature. Justify the conservatism of this assumption during NCT and HAC. Also show an example how you arrived at these equations.

In Table 3-12 of the application, the effective conductivity equations are a function of one temperature when it was previously stated in the application that the effective conductivity is a function of radiative heat transfer across the air gaps which is a function of both temperatures on either side of the air gap. The applicant has not justified the use of the equations in Table 3-12 of the application for both NCT and HAC conditions.

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

3-11 Justify the Grashof Number lower bound values in Section 3.3.1.2 of the application.

Some Grashof Number lower bound values in Section 3.3.1.2 of the application are different from the cited reference.

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

Section 3.3.1.3

3-12 Provide justification and a reference for the statement that a horizontal curved surface can be assumed to be flat if the length is relatively short compared to the radius.

The staff notes that Section 3.3.1.3.3 is for convection from a horizontal cylinder which is in disagreement with the statement above from Section 3.3.1.3. Clarify if that sentence in Section 3.3.1.3 of the application is referring to the AOS-25 and AOS-50 that are oriented vertically, the vertical curved surfaces can be assumed to be flat and vertical.

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

Section 3.3.1.3 and Tables 3-13 and 3-14

3-13 Explain how the length and the width values in Table 3-13 of the application relate to the licensing drawings and how the length and width values in Tables 3-14 of the application relate to the licensing drawings and results of the drop tests. Also, remove surface convection on some package surfaces during normal conditions of transport based on the licensing drawings.

It is not clear how the length and width values in Tables 3-13 and 3-14 of the application compare to the dimensional values in the licensing drawings or the results of the drop test. Ensure all values used in calculations compare to the licensing drawings or hypothetical accident conditions damages as appropriate. The staff does not feel it is appropriate to model convection during normal conditions of transport on certain surfaces of the package based the inclusion of a pallet on the licensing drawings (i.e. including, but not limited to the AOS-025A surfaces 1, 2, and 3).

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

Section 3.3.1.3.1

3-14 Define the Rayleigh number and its component variables.

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

Section 3.3.1.3.2

3-15 Support the Rayleigh Number limits in Section 3.3.1.3.2 of the application.

The Rayleigh Number limits in Section 3.3.1.3.2 of the application are different from the staff's reference; Incropera, Frank P., David P. DeWitt, Fundamentals of Heat and Mass Transfer, Wiley, John & Sons, Incorporated, 4th Ed., 1996.

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

Section 3.3.1.3.5

3-16 Modify the gray body shape factor in Section 3.3.1.3.5 to be 0.8 rather than 0.7347.

In the fire thermal model, the gray body shape factor should be the absorptivity = 0.8 based on 10 CFR 71.73. 10 CFR 71.73 requires a flame emissivity of at least 0.9 provided in the test when the specimen is fully engulfed in the fire, and a package surface absorptivity of at least 0.8 used in the calculation when the package is fully exposed to the fire. All surface convection equations in the fire models should be modified to include this new gray body shape factor of 0.8 rather than 0.7347.

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

Section 3.4

3-17 Replace LAST-A-FOAM materials properties with air during the post-fire cooldown if the melting point has been exceeded. Rerun post-fire cool down thermal models to provide maximum component temperatures.

It appears from the application that the LAST-A-FOAM reaches 1471°F during the fire while the glass transition temperature from the General Plastics LAST-A-FOAM appendix is 279°F.

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

3-18 Include a table in the SAR showing the modified foam properties for all models due to the damage during the drop tests.

The applicant states in Section 3.4 that the foam properties have been modified due to the reduced volume from damage during the drop, but has not provided the modified LAST-A-FOAM materials properties in the application.

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

3-19 For each model (AOS-25, AOS-50, and AOS-100) describe HAC drop effects and any dimensional modifications made to each thermal model. Describe any damage due to the crush test for the AOS-25 and AOS-50 and any dimensional modifications made to each thermal model. Provide figures for each model with dimensions clearly showing the damage due to drop tests and crush tests.

It is not clear how the dimensions provided in Section 3.4 of the application have been translated from the Impact (Free-Drop) Test Report in Section 8.3.2 and the Dimensional Inspection Report in Section 8.3.3 of the application. The staff needs to have a clear understanding as to how each model was modified due to drop or crush damage.

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

3-20 Justify linearly scaling the drop effects for each thermal model considering the impact limiter foam density is different for each model.

Section 3.4 of the application states that, "... the reduced impact limiter effects are linearly scaled by their cask size." The staff notes that the impact limiter foam density is different for each model.

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

Section 3.4.3

3-21 Include a table showing maximum cask cavity pressure due to hypothetical accident conditions for all models in Section 3.1 of the application. Also reference this table in Section 3.4.3 of the application.

The table showing maximum cask cavity pressure due to hypothetical accident conditions currently appears in Chapter 2 of the application, but would be more appropriate in Section 3.1 of the application. Currently Table 3.3, "Maximum Cask Cavity Pressure Due to Normal Conditions of Transport - All Models" is referenced in Section 3.4.3 of the application.

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

3-22 Modify Table 3-4 of the application to include maximum component temperatures as stated in Section 3.4.3 of the application (See RAI 3-1).

The staff compared Table 3-4 of the application to the numerous maximum component temperature tables located in Sections 3.4.6, 3.4.7, and 3.5.2 of the application and found values exceeded those reported in Table 3-4 of the application. See RAI 3-1 for further clarification on reporting maximum component temperatures.

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

Sections 3.3 and 3.4

3-23 Rerun all thermal models taking into account the information below and provide updated maximum component temperatures (see RAI 3-1) and temperature plots in the application. Provide LIBRA input and output files for all thermal models that have been changed.

a. For the AOS-25 and AOS-50 thermal models include solar insolation on all surfaces according to 10 CFR 71.71(c)(1) during normal conditions of transport and post-fire cooldown. Currently the LIBRA AOS-25 NCT and post-fire cooldown models do not have solar insolation on surfaces 1, 2, and 3 (see Figure 3.5 of the application). Also, the LIBRA AOS-50 NCT and post-fire cooldown models do not have solar insolation on surfaces 1, 2, 3, and 7 (see Figure 3.5 of the application).

b. AOS-25 polynomial coefficients for the 0.0303 inch air gap in the AOS-25 normal conditions of transport model and post-fire cooldown model do not match values in Table 3-12 of the application. Also, the AOS-50 polynomial coefficients for the 0.009 inch air gap in the AOS-50 normal conditions of transport model does not match values in Table 3-12 of the application. Clarify which values are correct. Also consider tolerances in the licensing drawings as related to these gap sizes (see RAI 3-8).

c. AOS-25 and AOS-50 fire model polynomial coefficients for the total surface convection for surfaces 1 and 2 (see Figure 3.5 of the application) appear to be NCT-like rather than fire convection-coefficients shown in equation h_t on page 3-46 of the application. Also in the AOS-25 and AOS-50 fire model, surfaces 1 and 2 (see Figure 3.5 of the application) have a boundary condition of 100°F; the boundary condition should be 1475°F due to the exposure of those surfaces to the fire. The packages should be fully engulfed in the fire.

d. During the post-fire cooldown for all AOS models, the impact limiter foam should be modeled as air because during the fire the impact limiter foam has exceeded its melting temperature. (See RAI 3-17)

e. In the AOS-25 and AOS-50 NCT and post-fire models it appears that convection is considered on surfaces 1, 2, and 3, yet it appears from the licensing drawings 166D8142 and 105E9718 there is a base that the packages rest in and therefore there would not be convection on those surfaces (See RAI 3-13).

f. Provide justification for the total surface convection polynomial coefficients used in the LIBRA post-fire thermal models. In the AOS-25 post-fire model the polynomial coefficients for the total surface convection for surfaces 1, 2, 3, 4, 9, 10, and 11 (see Figure 3.5 of the application) do not appear in the application. In the AOS-50, AOS-100A/A-S, and AOS-100B post-fire models the polynomial coefficients for the total surface convection for surfaces 1 - 11 (see Figure 3.5 of the application) do not appear in the application.

g. Remove Section 3.5.10 from the application and reevaluate the NCT and fire thermal models using LAST-A-FOAM materials properties that appear in the General Plastics LAST-A-FOAM Design Guide. Update Table 3-8 of the application with the properties that appear in the General Plastics LAST-A-FOAM Design Guide. Section 3.5.10 shows that the "New" LAST-A-FOAM properties produce less conservative component temperatures compared to the "Old" LAST-A-FOAM properties used in the thermal model and therefore the thermal models should be reevaluated with the "New" LAST-A-FOAM properties that appear in the General Plastics LAST-A-FOAM Design Guide.

h. In the AOS-100A/A-S and AOS-100B NCT models the polynomial coefficients for the total surface convection for surfaces 1 – 11 (see Figure 3.5 of the application) do not match the values in the application. Clarify which values are correct.

i. The AOS-100A "lc111-t2-update.100" and "lc112-t-update.100" input files are not producing the temperatures that have been provided in the application. For example, Table 3-35 of the application states the node 5001 has the temperature 262.8°F while the "lc111-t2-update.100" input file produces the temperature 235°F for the same node. The output file, "tape6-111t2" also shows that node 5001 has the temperature 235°F. Provide the LIBRA thermal models that produce the temperatures in the application.

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

Section 3.5.7 Insolation

3-24 In Section 3.5.7, "Insolation" provide solar insolation values and external surface identification figures used for the AOS-25 and AOS-50 which are both oriented vertically rather than horizontally like the AOS-100 models. Also modify the table heading "horizontal surface" because all surfaces in the figure are not horizontal. Finally, clarify if solar insolation values as reported in the application were applied continuously during NCT and the post-fire.

Although not explicitly labeled, it appears the cask assembly external surface identification and values in Section 3.5.7, "Insolation" are for the AOS-100 models. The applicant should include the solar insolation values and external surface identification figures that were used for the AOS-25 and AOS-50 models. The staff notes that the regulatory values in 10 CFR 71.71(c)(1) for solar insolation are total values for a 12 hour period.

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

Section 3.5.9

3-25 Address the thermal test results in relation to the temperature of the contents, basket, and shielding liners/plates that were not thermally modeled for the benchmark model described in Section 8.1.7 of the application or the AOS-25, AOS-50, AOS-100A/A-S, or AOS-100B thermal models due to the assumption of uniform decay heat.

It appears that the thermal test results in Section 8.1.7 of the application show that thermocouples 1 and 2 inside the cask cavity report significantly higher temperatures than thermocouple 7 on the cask cavity wall and the analytical results predicted cask cavity temperature using the assumption of uniform decay heat (see Figure 8-13 of Section 8.1.7). The applicant needs to address the temperatures of the contents, basket, and shielding liners/plates that have not been modeled due to the assumption of uniform decay heat in Section 3.5.9 of the application.

This information is necessary to determine compliance with 10 CFR 71.71, 71.73.

Chapter 7

7-1 Add procedures for the AOS-100B as appropriate in the operating procedures.

For example, but not limited to "Note: Unless indicated otherwise, all information related to the Model AOS-100A is also applicable to the Model AOS-100A-S." and Figure 7.3.

This information is necessary to determine compliance with 10 CFR 71.87.

Section 7.3.5.5

7-2 Describe the temperature survey to verify that limits specified in 71.43(g) are not exceeded.

According to 10 CFR 71.43(g), "A package must be designed, constructed, and prepared for transport so that in still air at 38°C (100°F) and in the shade, no accessible surface of a package would have a temperature exceeding 50°C (122°F) in a nonexclusive use shipment, or 85°C (185°F) in an exclusive use shipment." A temperature survey to verify these limits have not been exceeded has not been described in the operating procedures.

This information is necessary to determine compliance with 10 CFR 71.43(g) and 71.87(k).

Section 7.3.5.5 or Section 7.3.1

7-3 Describe proper marking and labeling of the package or the visual inspection of proper marking and labeling in the operating procedures.

According to 10 CFR 71.85(c), "The licensee shall conspicuously and durably mark the packaging with its model number, serial number, gross weight, and a package identification number assigned by NRC. Before applying the model number, the licensee shall determine that the packaging has been fabricated in accordance with the design approved by the Commission." The proper marking and labeling or the visual inspection of the proper marking and labeling of the package has not been described in the operating procedures.

This information is necessary to determine compliance with 10 CFR 71.85(c).

Section 7.4.1

7-4 Describe any special actions to be taken if the tamper indicating devices are not intact and verify tampering has not occurred in Section 7.4.1 of the operating procedures.

This information is necessary to determine compliance with 10 CFR 71.87.

Section 7.4.2.2

7-5 Describe removal of tamper indicating device and describe the appropriate method to open the package.

This information is necessary to determine compliance with 10 CFR 71.87.

Section 7.5.1

7-6 After operation 7.5.1.a, verify the package is empty

This information is necessary to determine compliance with 10 CFR 71.87.

Section 7.5.1.c and 7.5.4

7-7 Correct the reference to 71.10(b)(1). Add regulation 49 CFR 173.443 to Section 7.5.4 of the application.

The staff could not find 71.10(b)(1) in 10 CFR Part 71 and would like to have clarified what reference was intended. The applicant has not referenced 49 CFR 173.443 in Section 7.5.4 to ensure external contamination control levels meet the requirements of 49 CFR 173.443.

This information is necessary to determine compliance with 10 CFR 71.87.

Section 7.3.5.1.c

7-8 Correct the reference to 171.87(i).

The staff could not find 171.87(i) and assumes the applicant meant 10 CFR 71.87(i).

This information is necessary to determine compliance with 10 CFR 71.87(i).

Section 8.1.7

8-1 Provide a physical comparison between the analytical model and the package used in the physical test (i.e. materials and gaps).

Section 8.1.7 of the application says that a thermal test was performed to evaluate the thermal analytical model. Yet there was no descriptive comparison between the analytical model and the package used in the physical test.

This information is necessary to determine compliance with 10 CFR 71.33 and 71.51.

Table 3-3, Section 7.3.5.3, Section 8.2.1.1, and Section 8.2.2

8-2 Justify the inconsistency between the maximum normal operating pressure in Table 3-3 and Sections 7.3.5.3, 8.2.1.1 and 8.2.2 of the application. Describe steps in Chapter 8 of the application to monitor the cask internal pressure during leakage testing to ensure the design pressure for the AOS-25 has not been exceeded. Discuss the structural and containment effects over the life of the package and during HAC due to performing leakage testing at a pressure within 1% of the design pressure.

Table 3-3 states that the maximum normal operating pressure for the AOS-25 is 18 psia, while the AOS-50, AOS-100A/A-S, and AOS-100B are 20 psia. Section 7.3.5.3 states that the cask cavity will be pressurized to 15 psia. Section 8.2.1.1 states that as part of the leak test the package is pressurized to 1 atmosphere above the background pressure of the cavity (that is equivalent to 29.4 psia), and Section 8.2.2 states that the cask cavity is pressurized to 15 psig (that is equivalent to 29.7 psia). The application should consistently report the maximum normal operating pressure throughout the application. If the maximum normal operating pressure is close to the design pressure as the case may be for the AOS-25, the applicant needs to describe steps to monitor the cask cavity pressure during leakage rate testing, and discuss the structural and containment effects over the life of the package and during HAC due to performing leakage testing.

This information is necessary to determine compliance with 10 CFR 71.33(b)(5).

8-3 Provide justification for not performing thermal acceptance and/or maintenance tests to verify the heat transfer characteristics and predicted temperature profiles of fabricated AOS-25, AOS-50, AOS-100A, AOS-100A-S, and AOS-100B transportation packages.

In Section 8.1.7 of the application, the applicant should justify not performing thermal acceptance testing on the AOS-25, AOS-50, AOS-100A, AOS-100A-S, and AOS-100B transportation packages. The thermal acceptance test of a package provides an indication of the quality and accuracy of manufacturing and the thermal evaluation of the package. In Section 8.2.5 of the application, the applicant should justify not performing thermal maintenance testing on the AOS-25, AOS-50, AOS-100A, AOS-100A-S, and AOS-100B transportation packages. The thermal maintenance test of a package provides an indication of package aging during the service life of the package. The staff recognizes that the applicant stated the packages are constructed of materials that will not degrade over normal conditions of transport.

An adequate justification should be provided for not performing thermal acceptance and maintenance tests. The justification should consider uncertainties in calculations, fabrication, accuracy, and the influence of gaps in heat transfer performances, thermal margins, and package aging.

This information is required to show compliance with 10 CFR 71.85(a) + 71.85(b

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