71-9320

**ENERGYSOLUTIONS**
**Spent Fuel Division**

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March 20, 2007

**Subject:** **Application for MIDUS Transportation Package Approval, Response to Request for Additional Information (TAC No. L24039)**

Reference: Letter from USNRC to Energy*Solutions* SFD, Subject: Request for Additional Information – Model No. MIDUS Package, March 1, 2007.

Dear Sir or Madam:

This letter transmits the response to the Request for Additional Information (RAI) for the MIDUS Transportation Package provided via the reference letter. It also transmits revision 1 of the MIDUS Transportation Package Safety Analysis Report (SAR), which has been revised to respond to the requests made in the RAI. The RAI response, which include a summary of SAR changes, is attached.

Enclosure 1 contain five (5) electronic copies of the non-public version of the revised SAR that contains proprietary information and security-related sensitive information that should be withheld under 10 CFR 2.390. An affidavit containing a full statement of the reasons that the proprietary information should be withheld from the public, pursuant to the requirements of 10 CFR 2.390, is also attached to this letter. Enclosure 2 contains one (1) electronic copy of the public version of the revised SAR in which all proprietary information and security-related sensitive information is redacted.

Should you or your staff have questions, please contact the undersigned at:

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ENERGYSOLUTIONS



Sincerely,

Steven E. Sisley
Licensing/Regulatory Compliance Manager

Attachments:
(1) RAI response
(2) Affidavit pursuant to 10 CFR 2.390

Enclosures:
(1) CD-ROM, labeled "MIDUS Transportation Package Safety Analysis Report, Revision 1, March 20, 2007, Non-Public Version, Withhold under 10 CFR 2.390," containing file: *001_MIDUS_SAR_r1_non-public.pdf*, 14.7 MB (5 copies)

(2) CD-ROM, labeled "MIDUS Transportation Package Safety Analysis Report, Revision 1, March 20, 2007, Public Version," containing file: *001_MIDUS_SAR_r1_public.pdf*, 12.5 MB (1 copy)

cc) Ms. N. Osgood, Division of Spent Fuel Storage and Transportation w/ Attachments and Enclosures

## 1.0 General Information

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|---|---|
| 1-1 | Depict the location of the containment boundary on drawing TYC01-1604.<br><br>Section 1.2.1.3 of the application states that the drawing TYC01-1604 shows the location of the containment boundary. However, the boundary is not explicitly depicted on this drawing.<br><br>This information is necessary to satisfy the requirements of 10 CFR 71.33. |

**Response to 1-1:**

Comment incorporated.

*Summary of SAR Changes:*

- Drawing TYC01-1604, Revision 0: Revised to include a graphical detail showing the containment boundary.

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|---|---|
| 1-2 | Clarify the dimensions of the cask body bottom shield.<br><br>Drawing TYC01-1602, sheet 2 of 4 indicates that the bottom diameter of the cask body bottom shield is 145.0 mm, and the widest diameter of the cask body bottom shield is 217.0 mm. However, drawing TYC01-1606, sheet 2 of 3 states that these same dimensions are 144.3 mm and 216.3 mm. It appears that this difference may be due to the presence of air gaps that are not depicted.<br><br>This information is necessary to satisfy the requirements of 10 CFR 71.7. |

**Response to 1-2:**

The ø145.0 mm and ø217.0 mm dimensions shown in Section C-C on Sheet 2 of Drawing No. TYC01-1602 apply to the cask outer bottom and outer shell, respectively. The dimensions of the cask body DU shield components are provided on Drawing No. TYC01-1606, as noted in the callouts for the cask body DU shield components on Drawing No. TYC01-1602. A parenthetical note stating "(OUTER BOTTOM)" has been added under the ø145.0 mm dimension shown in Section C-C on Sheet 2 of Drawing No. TYC01-1602 to clarify that this dimensions applies to the cask outer bottom. Note that other changes to TYC01-1602 as discussed in the last section of this response document.

*Summary of SAR Changes:*

- Section 1.3.2, Drawing No. TYC01-1602, Revision 0, Sheet 2, Section C-C: Added note to ø145.0 mm dimension.

## 2.0 Structural

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| 2-1 | Clarify whether there are any welds in the cask containment boundary.<br><br>Page 2-3 of the application states "There are no welds in the cask containment system since the cask containment shell is machined from a single, solid piece of steel." However, p. 2-5 states "The cask containment components consist of the cask containment shell, closure lid, closure bolts, and the circumferential weld between the cask outer shell and cask containment shell…" These two statements provide conflicting information regarding whether there are any welds in the cask containment boundary.<br><br>This information is necessary to satisfy the requirements of 10 CFR 71.7. |

**Response to 2-1:**

The discussion on p. 2-5 has been revised for clarity.

*Summary of SAR Changes:*

- Section 2.1.2.2, pg. 2-5, 1st paragraph: Revised for clarity.

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| 2-2 | Revise Drawing TYC01-1604, sheet 2 of 3, Detail B, to show the "3:1 taper transition" to be consistent with the Section 2.1.1.1, Cask Assembly, description.<br><br>The application states that the taper transition is included between the containment shell wall that surrounds the shield plug cavity and the top flange to minimize stress concentration at the structural discontinuity. This design feature appears to be safety related and should be included in the design drawing.<br><br>Complete and accurate information should be provided in accordance with 10 CFR 71.7(a). |

**Response to 2-2:**

Comment incorporated.

*Summary of SAR Changes:*

- Section 1.3.2, Drawing No. TYC01-1604, Revision 0, Sheet 2, Detail B: Added taper transition dimensions.

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| 2-3 | On p. 2-3, Section 2.1.1.3, Overpack Assembly, clarify the statement, "The base of the overpack also includes four integral lugs that may be used for additional tie-down attachment."<br><br>The statement is unclear whether the four base lugs alone can be an option for package tie-down during transport.<br><br>The structural capability of the lugs has not been evaluated in the application under 10 CFR 71.45 (b)(2), which states, "Any other structural part of the package that could be used to tie down the package must be capable of being rendered inoperable...or must be designed with strength equivalent to that required for tie-down devices." |

**Response to 2-3:**

Section 2.1.1.3 has been revised to clarify that the four lugs on the overpack base unit may be used to tie-down the package, but only in combination with the four lugs on the overpack lid.

*Summary of SAR Changes:*

- Section 2.1.1.3, pg. 2-3, 1st paragraph, last sentence: Revised for clarity.

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| 2-4 | In Tables 2-3 and 2-4, on pp. 2-16 and 2-17, change the word "or" to "and" for the stress limit criteria for the hypothetical accident conditions.<br><br>The stress limit criteria such as those called as "Lesser of $2.4S_m$ or $0.7S_u$" should be called as "Lesser of $2.4S_m$ and $0.7S_u$" to be consistent with the ASME Code usage.<br><br>Complete and accurate information should be provided in accordance with 10 CFR 71.7(a). |

**Response to 2-4:**

Comment incorporated.

*Summary of SAR Changes:*

- Tables 2-3, pg. 2-16, and 2-4, pg. 2-17: Revised as suggested.

2-5 Correct the underscored typographical or editorial errors in the following statements:

Page 2-4. "The overpack base and lid both have 6 mm thick outer shells and 2.5 mm thick inner shells." Drawing TYC01-1603, sheet 2 of 3, indicates a 3 mm-thick inner shell.

Page 2-8. In Item 4, "Thus, condition (2) of WB-3221.9(d) is met." Condition (4) should apply.

Page 2-94. "The minimum design margin for primary stress intensities ($P_m$ and $P_m + P_b$) due to NCT free drop loading is +0.08 for primary membrane plus..." Table 2-34 lists the minimum design margin of +0.06.

Page 2-122. "The peak transverse rigid-body acceleration due to the HAC code side drop varies from 793 g at the top end of the shield lid to 292 g at the bottom end of the cask." Table 2-43 lists the top end acceleration of 739 g.

**Response to 2-5:**

The SAR has been revised to correct the identified errors.

*Summary of SAR Changes:*

- Section 2.1.1.3, pg. 2-4, 2nd paragraph, 1st sentence: Changed "2.5 mm" to "3.0 mm".
- Section 2.1.2.4.1, pg. 2-8, Item 4, last sentence: Changed "Condition (2)" to "Condition (4)".
- Section 2.6.7.2, pg. 2-94, 1st paragraph, 4th sentence: Changed "is +0.08 for primary membrane plus bending ($P_m$+$P_b$) stress intensity due to the NCT side drop" to "is +0.06 for primary membrane plus bending ($P_m$+$P_b$) stress intensity due to the NCT bottom end drop".
- Section 2.7.1.2.2, pg. 2-122, 1st paragraph, 4th sentence: Changed "793*g*" to "739*g*".

## 3.0 Thermal

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| 3-1 | Provide information to justify that the physical/chemical property of the payload liquid is such that upon freezing, the Mo-99 precipitates won't form from the solution.<br><br>In order not to enhance the specific activity, the radioactive Mo-99 should not precipitate from the payload solution when the temperature is cooled down to below the freezing point. Information or data are needed to confirm this behavior.<br><br>This information is needed to confirm that the package meets the package requirements of 10 CFR 71.31 and 71.47. |

**Response to 3-1:**

The molybdenum is in the chemical form of $Na_2MoO_4$ at the time of shipment. The amount of $Na_2MoO_4$ corresponding to 4,400 Ci is about 20 milligram. For the maximum specified specific activity of 60 Ci/ml, the concentration of $Na_2MoO_4$ is (0.020 g / 4400 Ci) * (60 Ci / ml) = 2.7E-04 g/ml.

The Handbook of Chemistry[1] gives the solubility of $Na_2MoO_4$ in cold water as 44 gram per 100 ml (page B-131), or 4.4E-01 g/ml. The actual payload solution is natrium molybdate (NaNO3 1M / NaOH 0.2M), which for our purpose has the same characteristics as water.

So, the payload solution will have a very large factor against precipitation equal to 4.4E-01 / 2.7E-04 g/ml = 1600; and thus the solution would freeze before precipitation could occur.

*Summary of SAR Changes:*

- Section 5.3.2: 2nd paragraph revised to indicate the factor against precipitation.

[1] *Handbook of Chemistry and Physics*, 67th Edition, CRC Press, Cleveland, Ohio, 1987.

## 5.0 Shielding

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| 5-1 | Revise the shielding parameters in Tables 5-1 and 5-2 to state the nominal material thicknesses and densities, and their associated tolerances. Additionally, clarify which dimensions are given for each parameter.<br><br>No upper bound is given for any of the parameters in Tables 5-1 and 5-2. Additionally, it is unclear which dimensions are given for the radial shield and bottom shield, which are not symmetrically shaped.<br><br>This information is necessary to satisfy the requirements of 10 CFR 71.7. |

**Response to 5-1:**

The purpose of Tables 5-1 and 5-2 was only to give the overall depleted uranium shielding thickness in radial and axial directions, along with the associated uranium density. The lower-bound thickness and density values that were modeled in shielding analyses are shown. Table 5-6 gives more detailed dimensions for the shielding components, including the nominal dimensions, the dimensions modeled in the shielding analyses, and the basis for setting the modeled dimensions. All of the shielding components are described in detail in the drawings in Section 1.3.2 of the SAR, which give a nominal value and a tolerance for each dimension. For the DU shielding components, the dimensions are given in drawing TYC01-1606. For the steel cask system components, which have a much smaller impact on shielding, the nominal dimensions are modeled in the shielding analyses. The density and composition of each shielding material modeled in the shielding evaluation is given in Table 5-9 of the SAR. The minimum DU density (specified in Drawing TYC01-1606) is shown, along with the nominal densities for steel. For foam, a lower-bound of 12 $lb/ft^3$ is modeled, based on the density range of 12.3 to 14.9 $lb/ft^3$ given in Drawing TYC01-1608.

Notes have been added to Tables 5-1 and 5-2, which refer the reader to Table 5-6 and the Section 1.3.2 drawings for a detailed description of all shielding components. The notes also refer the reader to Table 5-9 for a description of the shielding component materials. The Table 5-1 notes state that the listed DU density is the lower-bound value specified in Drawing TYC01-1606. Notes are also added to Table 5-9, which clarify that the presented density for steel is a nominal value, whereas the listed DU and foam densities are lower-bound values. The note also gives the nominal DU density of 18.9 $g/cm^3$. Finally, Section 5.3.2 was revised to clarify that the nominal density is modeled for steel components, whereas minimum thicknesses and density are modeled for the DU shield components.

*Summary of SAR Changes:*

- Tables 5-1, 5-2, and 5-9: Added notes for clarification.
- Section 5.3.2: Added clarifying text to 1st paragraph.

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| 5-2 | State the assumptions alluded to on p. 5-9 of Section 5.3.1.1 of the application.<br><br>The application states that the inverted cases depicted in Figure 5-6 represent different assumptions about the fluid displacement by the snap ring assembly. State what those assumptions are, and how they impact the source location.<br><br>This information is necessary to verify compliance with 10 CFR 71.47. |

**Response to 5-2:**

Some fraction of the upper part of the cask cavity will be filled by the snap ring of the product bottle illustrated in Figure 1-1. The design payload internals are subject to minor changes as required by the medical isotope supplier (within the limitations of Section 1.2.2.2). Since the amount of space displaced may vary, this variation must be accounted for in the shielding analysis. Therefore, two extreme cases were analyzed.

One case (shown on the left in Figure 5-6) assumes that the snap ring completely fills the upper cavity section, preventing any source fluid from entering the region in the event of an inverted cask. (Note that the shielding analysis conservatively neglects the shielding effects of the snap ring steel.) The second case (shown on the right in Figure 5-6) assumes a negligible snap ring steel volume, and models the upper cavity section as being completely filled with source fluid (while maintaining the total fluid volume of 75 ml). Figure 5-6 shows the location of the source fluid for these two cases. In the case where the snap ring steel is neglected, some of the source fluid moves into the upper section of the cask cavity, closer to the top end of the cask, but the amount of fluid in the upper corner of the main cask cavity, near the streaming path between the shield plug and the cask flange, is reduced.

The Section 5.3.1.1 has been revised to clarify the purpose of the two analyses illustrated in Figure 5-6, and the source configurations analyzed in those two cases.

*Summary of SAR Changes:*

- Section 5.3.1.1: Added more detailed descriptions of modeling assumptions.

5-3 Justify why it is conservative to model the extra fluid volume in the main payload activity, rather than to account for source fluid in the threaded hole in the shield plug.

Section 5.3.1.1 (p. 5-10) of the application states: "Scoping runs show that the source fluid in the threaded hole is very well shielded by the shield plug DU, so it is conservative to model the extra fluid volume in the main payload cavity." Justify why it is conservative to discount the source fluid that may be in the threaded hole.

This information is necessary to verify compliance with 10 CFR 71.47.

**Response to 5-3:**

An additional shielding analysis has been performed to evaluate the impact of having source fluid, as opposed to steel, in the lower threaded hole in the shield plug. The modeled configuration, for this additional evaluation, is similar to that shown on the right in Figure 5-6, except that a small cylinder of steel is removed from the lower pintle socket and replaced with source fluid. An equivalent volume of source fluid (0.6 ml) is removed from the main cask cavity, by raising the bottom edge of the source fluid very slightly. The NCT gamma dose rates, on the top surface of the package and one meter above the top surface of the package, are presented in the table below for the two configurations illustrated in Figure 5-6 and for the third analyzed configuration discussed above. Dose rates are presented for the cask centerline, and for the outer edge of the defined regulatory surfaces, where the peak dose rate occurs.

| Location | Peak Dose Rate (mrem/hr) | | |
|---|---|---|---|
| | Main Cask Cavity Only | Main & Upper Cask Cavity | Entire Cavity (w/ threaded hole) |
| Package Top Surface - Center | 1.113 | 0.750 | 0.784 |
| Package Top Surface – Edge (peak) | 3.437 | 2.551 | 2.519 |
| One Meter Top Surface - Center | 0.174 | 0.105 | 0.102 |
| One Meter Top Surface – Edge (peak) | 0.196 | 0.147 | 0.148 |

There are no changes to the worst case dose rates reported in the SAR. The results show that the cask top end dose rates produced by placing source fluid in the threaded hole are bounded by those produced by at least one of the two analyzed fluid configurations shown in Figure 5-6. For all dose rates except the package surface centerline dose rate, both of the Figure 5-6 configurations bound the case where source fluid is present in the threaded hole. Furthermore, the peak cask top end dose rates presented in Table 5-3 are higher than those shown in the above table for any of the three analyzed cases. This is

because a source configuration other than the three evaluated above (specifically, the top sphere source case) yielded the maximum cask top end dose rates, as discussed in the Section 5.4.4.1.4. Therefore, the additional shielding evaluation discussed above confirms that allowing source fluid to fill the threaded hole in the top shield plug will not result in cask top end dose rates higher than the bounding values presented in the SAR.

Section 5.3.1.1 has been revised. It now refers to three analyzed cases, including the additional case described above (where source fluid is placed within the threaded hole in the bottom of the shield lid), in addition to the two cases illustrated in Figure 5-6. As discussed elsewhere in the SAR, the case which yields the highest peak dose rate, for any given regulatory dose surface, is used as the basis of the dose rate results presented in Section 5.4, and in Table 5-4.

*Summary of SAR Changes:*

- Section 5.3.1.1: Revised to include new case. No changes to previous conclusions.

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| 5-4 | Discuss the assumptions made in the HAC shielding models compared to the final structural evaluation results from Section 2.7 of the application.<br><br>Table 5-8 shows deviations between the deformations assumed for the shielding model and the deformations estimated in the structural evaluation. Section 5.3.1.2 does not address the underlying assumptions pertaining to these deviations. It is unclear what part(s) of the package deformed. Additionally, it is not clear how the HAC shielding model dimensions differed from those assumed for the NCT shielding models.<br><br>This information is necessary to verify compliance with 10 CFR 71.51. |

**Response to 5-4:**

The only significant geometry change, or deformation, to the package configuration that occurs from the HAC sequence is that the side, top or bottom foam layers are crushed, in the event of a cask side, top end or bottom end drop, respectively. This results in a reduction in thickness of the affected foam layer. Another result is that the inner cask body moves (within the overpack) towards the overpack side, top or bottom outer surface, as a result of the side, top end, or bottom end drop, respectively. Thus, on the affected side, the foam thickness is reduced, and the inner cask (and source zone) is closer to the overpack surface, as well as the regulatory dose plane one meter above that surface. There are no significant alterations or deformations in the inner cask or the overpack outer shell thickness that occur as a result of HAC. The reduction in foam thickness, on the affected side of the system, is the only significant change between the HAC and NCT geometric configurations. This results in a reduction in distance between the gamma source region and the 1-meter regulatory dose plane.

The HAC shielding models conservatively address the potential effects of the HAC fire on the foam by reducing the foam density to zero. Given that the thicknesses and densities of the steel and DU shielding components are unaffected by HAC, the only other HAC effect (or change) that needs to be addressed in the model is the reduction in distance between the gamma source region and the regulatory dose surface that occurs as a result of foam crush. The reduced-distance effect can be accurately modeled by moving the 1-meter dose tally surfaces inwards, closer to the gamma source zone, in lieu of rigorously modeling changes in the cask system geometric configuration. Thus, moving the 1-meter dose rate tally surfaces inward, by the foam crush depths listed in Table 5-8, is the only difference between the NCT and HAC shielding models.

The foam crush depths listed in the middle column of Table 5-8, which are modeled in the HAC shielding analyses, were estimated based on preliminary structural analysis results. The final structural analysis results are shown in the right column of Table 5-8. For the cask side and bottom end, the foam crush depths modeled in the HAC shielding analyses are greater than those determined in the final structural evaluation. Modeling larger crush depths is conservative, as it results in a lower distance between the source zone and the dose rate tally surface. For the cask top end, the crush depth assumed in the shielding analyses is 2 mm less than that determined by the final structural evaluation. However, reducing the distance between the gamma source zone and the cask top 1-meter tally surface by 2 mm will not have a significant effect on dose rate, given that the reduction in distance is less than 0.2%. Given the fact that there is a significant margin, versus the regulatory limit, for the cask top end HAC dose rate, the assumed cask top end foam crush depth of 5.4 cm is adequate.

Section 5.3.1.2 has been revised to clarify the differences between the analyzed HAC and NCT shielding configurations, and the bases for the modeled changes. The basis for the foam crush depths assumed in the shielding analyses (and listed in Table 5-8) is also clarified. Finally, the title of Table 5-8 is changed (to "HAC foam thickness reductions") and table notes are added to clarify the meaning of the presented values, and to refer the reader to the Section 5.3.1.2 discussion.

<u>Summary of SAR Changes:</u>

- Section 5.3.1.2: Revised and supplemented for clarity.
- Table 5-8: Title changed for clarity.
- Table 5-8: Notes added for clarity.

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| 5-5 | State whether the hypothetical accident condition shielding models assume that the foam is present.<br><br>Section 5.3.1.2 of the application addresses the condition of the package following the drop accidents, but does not address the condition of the package after the fire. Section 3.5.4 of the application indicates that the foam will char, and predicts a recession depth of 6 cm (2.4 inches). It is unclear whether this was accounted for in the HAC shielding models.<br><br>This information is necessary to verify compliance with 10 CFR 71.51. |

**Response to 5-5:**

The HAC shielding models assumed that the foam was present.

The thermal predictions did predict charring, which would result in some weight loss in the foam in the form of volatiles. The shielding analysis neglected this because it was expected that the amount of weight loss would be negligible, especially when compared to the conservatisms in modeling the annular HAC source term region.

For conservatism, the HAC model has been re-run with the foam completely removed, and the SAR has been updated to include the higher results. Removing 100% of the foam from the model resulted in the peak HAC dose rate rising from 813 mrem/hr to 906 mrem/hr. This approach is very conservative, since the thermal analysis predicts only partial charring.

For clarity, Figures 5-15, 5-16, and 5-17 have been combined into one consolidated figure (refer to related response to question 5-8).

*Summary of SAR Changes:*

- Section 5.3.1.2: Revised 1st paragraph to describe HAC foam assumption.
- Sections 5.4.4.2.1 – 5.4.4.2.4: Revised for new HAC model results.
- Old figure numbers 5-15, 5-16, and 5-17 combined into one consolidated figure (new numbering 5-17) for clarity, and revised with new 1-meter HAC data.

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| 5-6 | Specify whether Figures 5-2 through 5-8 represent normal conditions of transport or hypothetical accident conditions.<br><br>This information is necessary to verify compliance with 10 CFR 71.47 and 71.51. |

**Response to 5-6:**

The gap configurations described in Tables 5-3 through 5-5 apply to all shielding models, NCT and HAC. The models depicted in Table 5-2 and in Tables 5-6 through 5-8 are NCT models. As discussed in Sections 5.4.4.2.1 through 5.4.4.2.3, all the HAC analyses include the dose rate of a centered sphere of source inside the cask cavity. It should be noted, however, that the cask configuration modeled in the HAC analyses are identical to the NCT cask configuration, the only difference being the location of the external dose tally planes.

The captions for Figures 5-3 through 5-5 have been revised to state that the apply for both NCT and HAC conditions. The captions for Figures 5-6 through 5-8 have been revised to add the term "NCT", to indicate that they show NCT analysis models. The Figure 5-2 caption already stated that it was an NCT model.

*Summary of SAR Changes:*

- Figures 5-3 through 5-8: Caption text revised for clarity.

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| 5-7 | Clarify which package orientation is associated with each of Figures 5-9 through 5-17.<br><br>Specify the geometry (i.e., as depicted in Figures 5-2, 5-6, 5-7, and 5-8) was assumed for each of the dose rate profiles in Figures 5-9 through 5-17. This information is necessary to verify that the most limiting orientation was considered in the shielding analysis.<br><br>This information is necessary to verify compliance with 10 CFR 71.47 and 71.51. |

**Response to 5-7:**

Sections 5.4.4.1.1 through 5.4.4.1.6 have been revised so that the specific source configuration case that is the basis of the presented dose rate profile is specified, along with the figure where that source configuration case is illustrated.

With respect to the HAC analysis dose rate profiles shown in Figures 5-15 through 5-17, Sections 5.4.4.2.1 through 5.4.4.2.3 already state that the dose rate contributions from the source fluid that remains in the cask cavity is calculated based on a spherical source that is axially centered within the cask cavity (similar to the lower and upper sphere configurations shown in Figure 5-8, but at an intermediate axial location). As shown in (new) Figure 5-17, the cask cavity payload source does not significantly contribute to HAC dose rates. Virtually all of the dose rate comes from the "annulus", "disk", "thimble" and "O-ring" source regions, whose locations are described in Section 5.3.1.2, and whose source fluid volumes are listed in Table 5-7.

*Summary of SAR Changes:*

- Sections 5.4.4.1.1 through 5.4.4.1.6: Revised for clarity.

5-8 Specify, for Figures 5-9, 5-12, and 5-17, the maximum dose rate observed, and at what distance from the package it occurs. Revise Sections 5.4.4.1.4 and 5.4.4.2.3 to address the increasing dose versus distance trend.

Figures 5-9, 5-12, and 5-17 each show a trend of dose increasing with distance from the package. Section 5.4.4.1.1 indicates that the dose rates shown in Figure 5-9 eventually drop off in the radial direction, but does not state what the maximum dose rate is, or at what distance the dose rate eventually begins to drop off. Revise Sections 5.4.4.1.1, 5.4.4.1.4, and 5.4.4.2.3 along with Figures 5-9, 5-12, and 5-17, if appropriate, to explain why the dose increasing with distance trends are observed. To demonstrate the integrity of the shielding model, state and/or show the maximum dose rate, along with its location relative to the package, and demonstrate that an appropriate trend of dose decreasing with distance eventually occurs.

This information is necessary to verify compliance with 10 CFR 71.47 and 71.51.

**Response to 5-8:**

Figures 5-9, 5-12, and 5-17 correctly show the dose rate profiles on the surfaces of interest. The trends in dose rate are accurate and reasonable, considering the geometry of the package shields and the different source location assumptions necessary to bound all possible package orientations. But because the results for individual sides of the package were presented separately, and due to the differing scales of the plots, it was not readily apparent how the different plots mesh with one another. As a result, it was more difficult to determine that the computer models are properly functioning.

A summary discussion has been added to Section 5.4.4.1 to give a better overview of the results. Figures 5-9 and 5-13 have been added to summarize the results. These figures "unfold" the three sides into a single plot. When viewed together, and at the same scale, the overall results more directly demonstrate compliance with 10 CFR 71.47 and 71.51.

The six NCT figures (new numbering 5-10, 5-11, 5-12, 5-14, 5-15, and 5-16) have been left unchanged because (particularly in the case of 5-14 and 5-15) they show important details about the dose rate profiles with respect to packaging features.

The three 1-meter HAC figures (old numbering 5-15, 5-16, and 5-17) have been combined into a consolidated Figure 5-17. Note that the data in the HAC figure has changed as discussed in response 5-5.

*Summary of SAR Changes:*

- Section 5.4.4.1: Added summary text.
- Added figures 5-9 and 5-13 for clarity.
- Three 1-meter HAC figures (old numbering 5-15, 5-16, and 5-17) combined into one consolidated figure (new numbering 5-17 for clarity).
- Sections 5.4.4.2 through 5.4.4.2.4 revised to refer to the one consolidated figure.

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| 5-9 | Revise Figures 5-15 through 5-17 to show the location of the dose rate estimations relative to the package.<br><br>The horizontal axis of Figures 5-15 through 5-17 is labeled "interval" on all three figures. This label provides no information regarding the location of the dose rates relative to the package. Revise each figure to clearly indicate the dose point locations relative to the package surface.<br><br>This information is necessary to verify compliance with 10 CFR 71.51. |

**Response to 5-9:**

Comment incorporated. Note that these three figures have been combined into a single figure for clarity (refer to response 5-8).

*Summary of SAR Changes:*

- Three 1-meter HAC figures (old numbering 5-15, 5-16, and 5-17) were combined into one consolidated figure (new numbering 5-17) for clarity. This new figure has an abscissa scale.

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|---|---|
| 5-10 | Revise Section 5.3.1.2 of the application to explain the role of the cleanliness seal during HAC.<br><br>Section 4.1 of the application states: "The cleanliness O-ring performs a housekeeping function, and it indirectly provides a post-accident shielding function as discussed in Sections 5.1.1.1 and 5.3.1.2." Section 5.1.1.1 states that the presence of the cleanliness seal minimizes the potential volume for flooding under HAC, but does not quantify this volume. Section 5.3.1.2 does not address the role of the cleanliness O-ring under HAC. Revise Section 5.3.1.2 of the application to explain the role of the cleanliness seal during HAC. Specify the additional source volumes, along with their locations (i.e., annulus, disk, thimble, ring) that would be expected if the cleanliness seal did not function properly during HAC. Provide justification that the cleanliness seal will perform as expected; i.e., justify the source region volumes listed in Table 5-7 on p. 5-13 of the application will not be exceeded as a result of a hypothetical accident.<br><br>This information is necessary to verify compliance with 10 CFR 71.51. |

**Response to 5-10:**

Section 5.3.1.2 has been expanded to describe the function of the cleanliness O-ring. It now provides justification that the cleanliness O-ring will perform as expected, and it discusses the manufacturing, maintenance, and operational steps which are taken to ensure the presence and proper operation of the cleanliness O-ring.

No additional volumes are specified because the cleanliness O-ring is not credited as a seal, but only as a compliant "spring." It merely needs to be present to perform it's HAC function. This design approach was chosen instead of specifying precision axial tolerances on the shield plug and it's mating seat. This way, there is no chance that a "tall" shield plug will interfere with the bolted containment closure, or a "short" one would result in a gap between the shield plug and closure lid.

*Summary of SAR Changes:*

- Added discussion of the cleanliness seal to Section 5.3.1.2.

5-11 Revise the application to include an assessment of the shielding effectiveness under hypothetical accident conditions, considering the possible brittle fracture of the depleted uranium shielding.

Based on the information on the mechanical properties of the depleted uranium (Table 2-19 of the application), the presence of an undetected flaw greater than 2.5 mm (see, e.g., SAND80-1836) may result in a brittle failure of the shield under drop test conditions at temperatures lower than 70°F. The dose rates from the package could increase due to the resulting crack in the shield material. The application should be revised to include an assessment of the effects of potential brittle failure of the DU. The assessment may consider either providing assurance that there would be no brittle failure under free drop conditions or showing that any brittle failure would not result in a dose rate increase greater than the regulatory limit of 1 rem/hr at a distance of 1 meter from the package surface. To show that there would be no brittle failure, including at cold conditions, supplemental information would be needed, for example regarding temperature dependent materials properties (Table 2-19 of the application), demonstrating absence of flaws greater than 2.5 mm, based on material specification, nondestructive examination, or other test or determination, etc.

This information is needed to show the package meets the dose rate requirements of 10 CFR 71.51 (a)(2).

**Response to 5-11:**

The application has been revised to provide additional assurance that the DU shield will not experience brittle fracture failure under any NCT or HAC free drop condition. A discussion of the tests and inspections performed on the DU shielding components to detect flaws that could result in brittle fracture has been added to Section 2.1.2.5. A calculation of the critical flaw size corresponding to the maximum stress level in the DU shield for any NCT or HAC free drop condition has been added to Section 2.1.2.5. Furthermore, Table 2-19 has been revised to include temperature-dependant yield and ultimate strength values for DU over the temperature range of interest.

*Summary of SAR Changes:*

- Section 2.1.2.5, pg. 2-11 and 2-12: Revised discussion of DU fracture toughness.
- Table 2-19, pg. 2-43: Revised to include temperature-dependant yield strength and ultimate strength values for DU.
- Section 2.7.1.1.2, pg. 2-115: Revised yield strength of DU.
- Section 2.7.1.4.2, pg. 2-133: Revised yield strength of DU.

## 7.0 Package Operations

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|---|---|
| 7-1 | Revise Section 7.1.1, step 16, and Section 7.1.2, step 10, to clarify that any containment system replacement O-rings are tested to demonstrate that they are leak tight.<br><br>Steps 10 and 16 specify that any damaged O-rings are replaced. However, it is not clear that the containment system O-ring seal must be leak tested to demonstrate it is leak tight after replacement. Revise steps 10 and 16 to indicate that any containment system O-ring seal must have been leak tested to leak tight within the 12 month period prior to shipment, as described in Section 8.2 of the application. Note that this does not relieve the need to perform a pre-shipment leakage test of the assembled package prior to shipment, after the contents are loaded.<br><br>This information is needed to confirm that the package meets the containment requirements of 10 CFR 71.51. |

**Response to 7-1:**

Steps 16 and 10 have been revised to clearly state that (1) whenever the containment O-ring seal must be replaced, it must also be leak tested, and (2) the containment O-ring seal must have been leak tested with the 12 month period prior to shipment.

*Summary of SAR Changes:*

- Section 7.1.1 step 16 and Section 7.1.2, step 10: Revised to incorporate comments.

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|---|---|
| 7-2 | Revise Section 7.1.2 to clarify that the contents are authorized in the Certificate of Compliance.<br><br>Step 1 instructs the shipper to confirm that the payload meets the contents specification in Section 1.2.2. Revise step 1 to clarify that the contents must be authorized for transport by the Certificate of Compliance.<br><br>The requirements of 10 CFR 71.87 state that the shipment must be made in conformance with the license, which invokes the terms and conditions of the Certificate of Compliance. |

**Response to 7-2:**

Comment incorporated.

*Summary of SAR Changes:*

- Section 7.1.2, Step 1: Revised to clarify that the contents are authorized in the Certificate of Compliance.

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|---|---|
| 7-3 | Revise Section 7.4.2 to include additional information regarding the pre-shipment leakage testing of the package:<br><br>(a) Section 7.4.2 should be expanded to provide information about how the minimum test sensitivity is assured. For example, a methodology for determining the minimum test duration and an acceptable pressure change (including instrument sensitivity as indicated in Section 7.4.1) should be provided. Although the application states the method to be used for the leak test (i.e., pressure rise test) there are not sufficient details to assure that the test method will achieve the specified test sensitivity ($1 \times 10^{-3}$ ref/cc-sec).<br><br>(b) Revise the test description to indicate that the test is a go-no-go test, and to clarify that an indication of leakage (at the specified test sensitivity) means that the package may not be shipped. Although the pre-shipment leak test sensitivity need not be greater than $1 \times 10^{-3}$ ref/cc-sec, any leakage greater than $1 \times 10^{-7}$ ref/cm$^3$-sec is not acceptable (consistent with the valuation in Section 4 of the application). |

**Response to 7-3:**

(a) Section 7.4.2 has been expanded to address the comment. The revised SAR presents additional details showing how the test volume is calculated, how the minimum test duration is calculated, and it defines the acceptable pressure change for the test.

(b) Section 7.4.2 now clearly states that packages not meeting the test acceptance criterion may not be shipped, and that the test is a go-no-go test.

*Summary of SAR Changes:*

- Section 7.4.2: Revised to address comments.

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|---|---|
| 7-4 | Revise Section 7.3, step 19, to include appropriate radiation surveys to confirm that the package is empty and meets the radiation limits specified in DOT regulations for empty packagings.<br><br>Step 19 specifies surface contamination measurements, but does not specify radiation measurements.<br><br>See 49 CFR 71.421 (a)(2), as referenced in 49 CFR 71.428, for radiation limits specific to empty packagings. |

**Response to 7-4:**

Section 7.3, step 15 has been added to include the appropriate radiation surveys.

*Summary of SAR Changes:*

- Section 7.3: Revised to add a new step 15. Note that, due to an editorial change, step 19 now reads step 14.

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|---|---|
| 7-5 | The following editorial comments are noted.<br>(a) Review and revise as necessary to ensure that Section 7 uses consistent terms for the package components. For example, Section 7.3, step 1 uses the term "shield plate" where it may be referring to the shield lid.<br>(b) Review and revise as necessary Section 7.2.2, step 8, to clarify what components are surveyed for radiation and contamination. Note that step 3 indicates that the shield lid is not transferred into the hot cell, however, step 7, includes the shield lid. In addition, the section on Special Controls or Precautions specifically refers to step 8. |

**Response to 7-5:**

Editorial comments noted and addressed.

*Summary of SAR Changes:*

- Chapters 2, 5, 7, and 8: Revised the term “shield plate” to “shield lid” for consistency.

- Section 7.2.2, step 8: Added clarification as to which components are surveyed for radiation and contamination.

## 8.0 Acceptance Tests and Maintenance Program

1. Revise Section 8.1.1 to clarify that each packaging must meet the drawings referenced in the certificate of compliance.

   This section references the drawings in Section 1.3.2, however, it should be clarified that, per 10 CFR 71.85 and 71.87, the package must meet the drawings referenced in the Certificate of Compliance.

**Response to 8-1:**

Comment incorporated.

*Summary of SAR Changes:*

- Section 8.1.1: Revised to incorporate comment.

2. Revise Section 8.1.6 to include an appropriate shielding test, or include justification for why a shielding test is not needed.

   The shielding function is one of the primary safety features of the package. It is an established practice that each packaging should be tested prior to first use to demonstrate that the shielding is adequate, and does not contain unacceptable voids or porosity. Note that NUREG/CR-3854, "Fabrication Criteria for Shipping Containers," may contain useful information.

   This information needs to be provided to show that the package design has adequate Shielding to meet the requirements of 10 CFR 71.47.

**Response to 8-2:**

Section 8.1.6 has been revised to summarize what tests are performed on the packaging during fabrication and discuss why an additional test, such as gamma scanning or probing, are not necessary.

*Summary of SAR Changes:*

- Section 8.1.6: Revised for clarity.

3. Revise Section 8.1.7 to include an appropriate thermal test, or provide justification for why such a test is not needed.

   The application states that the thermal test is not applicable. However, the packaging incorporates specific design features (i.e., the thermal spider) to assure adequate heat transfer from the package. A thermal test would demonstrate that the thermal spider functions as designed.

   This information is needed to demonstrate that the package will not exceed the internal temperatures and pressures for which it was analyzed, including the maximum normal operating pressure as defined in 10 CFR 71.4.

**Response to 8-3:**

Section 8.1.7 has been revised to summarize the fabrication tests performed on the packaging's thermal design feature and discuss why additional testing, such as a heater test, is not necessary.

*Summary of SAR Changes:*

- Section 8.1.7: Revised for clarity.

4. Revise Section 8.2.3.4 to address metal removal that reduces the thickness of a containment component.

   The second bullet under Section 8.2.3.4 instructs the Certificate Holder/Designer to evaluate and approve replacement and repair tasks addressing metal removal that reduces the thickness of a structural, shielding, or thermal component below its licensed dimension. This bullet should be revised to also include containment components.

   This revision is necessary to satisfy the requirements of 10 CFR 71.43(f) and 71.51(a)(1).

**Response to 8-4:**

Comment incorporated.

*Summary of SAR Changes:*

- Section 8.2.3.4: Revised second bullet to include containment.

5. Review and revise as necessary Section 8.2.3.4, first bullet, to clarify that packagings that do not meet the drawings referenced in the Certificate of Compliance are not authorized for transport of radioactive material.

   For use under the general license in 10 CFR 71.17, the packagings must be fabricated in accordance with the design approved by the Commission.

**Response to 8-5:**

Comment incorporated.

*Summary of SAR Changes:*

- Section 8.2.3.4: Revised second bullet to incorporate comment.

## Summary of Non-RAI SAR Changes

1. Drawings TYC01-1602, TYC01-1603: Allowed the use of ER308LSi and ER309Si weld wire as noted.

**Reason:**

Fabricator request. The "Si" type material is more available. "Si" weld wire types are equivalent or superior to the ER308L and ER309L types specified in Revision 0.

- TYC01-1602, Revision 0, Sheet 1, Note 5: Added ER308LSi.
- TYC01-1603, Revision 0, Sheet 1, Note 7: Added ER308LSi.
- TYC01-1603, Revision 0, Sheet 1, Note 9: Added ER309Li.

2. Drawings TYC01-1602 and -1603: Moved tolerances between part and assembly levels. Relaxed one tolerance for overpack outer shell cylindricity.

**Reason:**

Fabricator requests. Some tolerances were placed at the wrong level in the manufacturing process (e.g., piece part tolerances called out on features that weren't machined until the assembly level). One tolerance (on the overpack base outer shell) was inappropriate for fabrication. There was no design impact to the tolerance change because none of the changes affect the safety analyses. The specific changes are summarized below.

- TYC01-1602, Revision 0, Sheet 2: Changed (4.0) to 4.0 to better match manufacturing plan. No change to the design.
- TYC01-1602, Revision 0, Sheet 2: Removed ø217.0 dimension and associated GD&T because the outer shell 4.0 mm thickness is no longer a reference dimension (see above). No change to the design.
- TYC01-1603, Revision 0, Sheet 2: Cylindricity 1.0 changed to 2.0 mm to accommodate fabricator's request. 1.0 mm was unnecessarily tight.
- TYC01-1603, Revision 0, Sheet 3: Removed 37.0 dimension and added 18.5 and 55.5 dimensions to reflect that inspections will be off the flange datum. No change to the design.

3. Drawing TYC01-1610 "QA Requirements" was removed. The allowable maintenance and repair activities have been moved to the packaging O&M manual.

**Reason:**

The competent authority's CoCA, not the SAR, specifies QA requirements for cask users.

4. Section 2.3.2, "Functional Tests" subsection: Struck last sentence "Additional functional tests are performed to assure proper fit-up of all interfacing package components".

**Reason:**

Statement was false. There are no additional tests beyond those listed.

5. Section 7.1.3: Corrected step numbering. The list incorrectly began with number 2. No changes were made to the steps or their order.

**Reason:**

Editorial change.

# AFFIDAVIT PURSUANT TO 10 CFR 2.390

State of California )<br>
) SS.<br>
County of Santa Clara )

I, Steven E. Sisley, depose and say as follows:

(1) I am Licensing/Regulatory Compliance Manager of Energy*Solutions* Spent Fuel Division (Energy*Solutions* SFD), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been duly authorized to apply for its withholding.

(2) The information sought to be withheld is contained in the document listed in Table 1. This document has been appropriately designated as proprietary.

**TABLE 1**

| Document No. | Document Title | Rev/Date |
|---|---|---|
| TYC01.1600 | MIDUS Transportation Package Safety Analysis Report | 1 |

(3) I have personal knowledge of the criteria and procedures used by Energy*Solutions* SFD in designating information as trade secret, privileged, or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of 10 CFR 2.390, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure, including the information as designated in paragraph (2) above, should be withheld.

(i) The information sought to be withheld from public disclosure is included in the report documenting information which is owned and has been held in confidence by Energy*Solutions* SFD.

(ii) The information is of a type customarily held in confidence by Energy*Solutions* SFD and not customarily disclosed to the public. Energy*Solutions* SFD has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Energy*Solutions* SFD policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process or component, structure, tool, method, etc., and the prevention of its use by Energy*Solutions* SFD's competitors, without license from Energy*Solutions* SFD, gives Energy*Solutions* SFD a competitive economic advantage.

(b) The information consists of supporting data (including test data) relative to a process or component, structure, tool, method, etc. and gives Energy*Solutions* SFD a competitive economic advantage, e.g., by optimization or improved marketability.

(c) The information, if used by a competitor, would reduce the competitor's expenditure of resources or improve the competitor's advantage in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.

(d) The information reveals cost or price information, production capacities, budget levels, or commercial strategies of Energy*Solutions* SFD, its customers or suppliers.

(e) The information reveals aspects of past, present, or future Energy*Solutions* SFD or customer funded development plans and programs of potential commercial value to Energy*Solutions* SFD.

(f) The information contains patentable ideas, for which patent protection may be desirable.

(g) The information is third-party Proprietary Information.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10 CFR Section 2.390, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked and being transmitted by Energy*Solutions* SFD to the Document Control Desk. The proprietary information has been presented to the Nuclear Regulatory Commission and is being voluntarily provided by Energy*Solutions* SFD.

(vi) Public disclosure of the information is likely to cause substantial harm to the competitive position of Energy*Solutions* SFD because:

(a) Similar products are manufactured and sold by competitors of Energy*Solutions* SFD.

(b) The development of this information by Energy*Solutions* SFD is the result of a significant expenditure of staff effort and a considerable sum of money. To the best of my knowledge and belief, a competitor would have to undergo similar effort and expense in generating equivalent information.

(c) In order to acquire such information, a competitor would also require considerable time and inconvenience.

(d) The information consists of detailed descriptions, properties and test data. The availability of such information to competitors would enable them to modify their product to better compete with Energy*Solutions* SFD, take marketing or other actions to improve their product's position or impair the position of Energy*Solutions* SFD's product, and avoid developing fabrication data in support of their processes, methods, and/or apparatus.

(e) In pricing Energy*Solutions* SFD's products and services, significant research, development, engineering, analytical, licensing, fabrication, quality assurance and other costs must be included. The ability of Energy*Solutions* SFD's competitors to utilize such information without similar expenditure of resources may enable them to sell their product at prices reflecting significantly lower costs.

Further the deponent sayeth not.

I declare under penalty of perjury that the forgoing is true and correct.

Executed on March 20, 2007
Date

Steven E. Sisley
Licensing/Regulatory Compliance Manager
Energy*Solutions* Spent Fuel Division