April 28, 2008

James M. Shuler
Manager, Packaging Certification Program
Safety Management and Operations
Office of Environmental Management
Department of Energy
Washington, DC 20585

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR REVIEW OF THE CERTIFICATE OF COMPLIANCE NO. 9315, REVISION 8, FOR THE MODEL NO. ES-3100 PACKAGE

Dear Dr. Shuler:

By letter dated October 11, 2007, as supplemented March 11 and 25, 2008, the U.S. Department of Energy (DOE) submitted an application in accordance with 10 CFR Part 71 for an amendment to Certificate of Compliance (CoC) No. 9315 for the Model No. ES-3100 package. Various changes were requested.

In connection with our review, we need the information identified in the enclosure to this letter. Additional information requested by this letter should be submitted in the form of revised Safety Analysis Report pages. To assist us in scheduling staff review of your response, we request that you provide this information by May 23, 2008. If you are unable to provide a response by that date, our review may be delayed.

Please reference Docket No. 71-9315 and TAC No. L24141 in future correspondence related to this request. The staff is available to meet to discuss your proposed responses. If you have any questions regarding this matter, I may be contacted at (301) 492-3339.

Sincerely,

/RA/
Kimberly J. Hardin, Senior Project Manager
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9315
TAC No. L24141

Enclosure: Request for Additional Information

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Enclosure: Request for Additional Information
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NAME	KHardin		MDeBose		MPanicker		RParkhill		ABarto		MRahimi	
DATE	4/23/2008		4/25/2008		4/23/2008		4/23/2008		4/24/2008		4/28/2008	

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Request for Additional Information
U.S. Department of Energy (DOE)
Docket No. 71-9315
Certificate of Compliance No. 9315
Model No. ES-3100 Package

By application dated October 11, 2007, as supplemented March 11 and 25, 2008, the U.S. Department of Energy (DOE or the applicant) requested an amendment to Certificate of Compliance (CoC) No. 9315 for the Model No. ES-3100 package. The applicant requested various revisions to the CoC. This request for additional information (RAI) identifies information needed by the U.S. Nuclear Regulatory Commission staff in connection with its review of the application. The requested information is listed by chapter number and title in the applicant's Safety Analysis Report. NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Materials," was used by the staff in its review of the application.

The applicant is proposing changes to the Safety Analysis Report (SAR) and CoC to:

1. Revise criticality safety calculations in the SAR and fissile loadings in the CoC,
2. Revise the Criticality Safety Index (CSI),
3. Revise the quantity of off-gassing material and add a Teflon bottle as a convenience container,
4. Revise the carbon concentration in uranium oxide,
5. Revise the concentration of neptunium-237 in uranium,
6. Add uranium alloyed with aluminum and molybdenum as authorized contents, and
7. Revise the definition of pyrophoric uranium.

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

Chapter 3 Thermal

3-1 Verify that the ambient temperature, referred to in Step 1, of Section 3.1.4.2 "Maximum Hypothetical Accident Conditions (HAC) Pressures" is 38C (100F) and modify the SAR to state that value.

10 CFR 71.73 requires that the ambient air temperature before and after the fire remain constant at a value between -29C and 38C, depending upon which temperature is most unfavorable for the feature under consideration. For maximum HAC pressure, the higher temperature is the most unfavorable.

3-2 Define the subscripts used for lb-moles in Tables 3.10 and 3.11 and add this information to the SAR.

10 CFR 71.33 requires that an application "must include …..sufficient detail to identify the package accurately and provide sufficient basis for evaluation of the package."

3-3 Describe in detail the methodology used to determine the total containment vessel pressure shown in Tables 3.10 and 3.11 for the various containment vessel arrangements (CVAs),

including void volumes and determination of molar amounts. Include the basis for determining the amount of off-gas generated for each CVA, as well as an analysis supporting the amount of off-gas generated. Include this information in the SAR.

10 CFR 71.33 requires that an application "must include …..sufficient detail to identify the package accurately and provide sufficient basis for evaluation of the package."

3-4 As part of the off-gassing evaluation, justify that the flammable gas concentration is less than 5% by volume for the various contents of CVAs. Include consideration of radiolysis on the water vapor and other hydrogen composition materials contained within the CVA. Also, justify the limit of 1500g of off-gassing material per CVA. Include this information in the SAR.

10 CFR Part 71.43(d) requires that a package "must be made of materials …. that assure that there will be no significant chemical, galvanic, or other reaction….. Account must be taken of the behavior of materials under irradiation."

3-5 Explain why the total containment pressure in Table 3.10 for CVA contents #1 through #6 are identical (i.e. 17.786 psia). Since the void volume for each CVA content should be different and the total moles of gas appear to be different, then the pressures should be different.

10 CFR Part 71.33 requires that an application "must include …..sufficient detail to identify the package accurately and provide sufficient basis for evaluation of the package."

Chapter 4 Containment

4-1 Please clarify and explain explicitly in detail how the licensee complies with 10 CFR 71.43(e) in retaining any leakage of radioactive contents of ES-3100 packaging.

10 CFR 71.43(e) requires that "*A package valve or other device, the failure of which would allow radioactive contents to escape, must be protected against unauthorized operation and, except for a pressure relief device, must be provided with an enclosure to retain any leakage."* The SAR does not contain the assurance that the canister must be protected against unauthorized operation which may allow radioactive contents to escape.

This information is required to determine compliance with 10 CFR 71.43(e).

Chapter 6 Criticality

6-1 Revise Tables 6.1b through 6.1e of the SAR to clarify the ^{235}U amounts given in the column headings. Additionally, revise Table 6.1c to clarify why the amount given for enrichment ≤ 60% is expressed in terms of grams Uranium instead of grams ^{235}U.

It is not clear in the referenced tables that the ^{235}U amounts given in the column headings are intended to be limits, given that some of the analyses described in the tables consider different amounts of fissile material. Also, it is not clear in Table 6.1c why the fissile material amounts for all enrichment levels are not expressed in consistent terms. These tables, and associated text in the criticality analysis, should be revised to clarify these issues.

This information is required in order to demonstrate that the Model No. ES-3100 package meets the criticality safety requirements of 10 CFR Part 71.

6-2 Revise Section 6.2.1 of the SAR to clarify what is meant by "tapped" material with respect to skull oxides.

The fourth paragraph of Section 6.2.1 refers to a skull oxide density of "2.78 g/cm^3 for tapped material." It is not clear what the term "tapped" means.

This information is required to ensure that the package and its contents are adequately described per the requirements of §71.33.

6-3 Revise the criticality analysis to consider aluminum and molybdenum alloys for all HEU metal contents.

Paragraph 3 of Section 6.4 of the SAR (page 6-65) states that: "Where scattering media (aluminum or molybdenum) is treated as multiplying media (^{235}U), the alloy is conservatively assessed." However, the limits on fissile material in the certificate of compliance are expressed in terms of HEU mass, with no limit on alloying material. It is not clear that assuming the alloys are pure HEU is the most reactive case for a given amount of fissile material. The addition of low absorption cross-section material, such as aluminum, to the fissile material could have a significant moderating effect, and it needs to be demonstrated in the SAR that the assumptions on metal composition used in the analysis are conservative.

This information is required in order to demonstrate that the Model No. ES-3100 package meets the criticality safety requirements for single packages in §71.55, and for package arrays in §71.59.

6-4 Revise the criticality analysis to clarify the following statement from Section 6.6.4 regarding hypothetical accident conditions modeling of uranyl nitrate contents:

> "…For the HAC package calculation models with of [sic] UNH crystal content, the 277-4 canned spacers are not actually modeled. Instead, the amount of solution content distributed over the entire containment vessel is reduced proportionally by the free volume of the containment vessel not occupied by canned spacers."

Table 6.2a of the SAR does not include a fissile material limit for uranyl nitrate shipment with can spacers, and the criticality models for uranyl nitrate referenced in the SAR should not include any representation of the spacers. Uranyl nitrate solution in the flooded containment vessel, for all single package and array models, should be allowed to fill the entire vessel. The analysis should also be revised to consider partial flooding of the containment vessel in various orientations to determine the most reactive condition.

This information is required in order to demonstrate that the Model No. ES-3100 package meets the criticality safety requirements for single packages in §71.55, and for package arrays in §71.59.

6-5 Revise the criticality analysis to clarify how the limits on the amount of hydrogenous packing material allowed in the package were determined.

From the discussion starting in Section 6.2.3 “Packing Materials” (page 6-31) the applicant seems to indicate that the flooded condition of the package bounds any of the hydrogenous packing materials that would be used in the package. The applicant states (page 6-32) “the 7.1 – 10.1 kg quantities of evaluation water required in both the NCT and HAC criticality calculations bound reasonable amounts of hydrogenous material and inherent moisture of fissile material (primarily HEU oxides) present inside the containment vessel. Thus, an administrative criticality control is not needed to restrict either the amount of hydrogenous material normally present inside the containment vessel or other sources of moisture present in the fissile content.” Provide additional information justifying that the flooded condition is more conservative than modeling the actual hydrogenous material contents (such as polyethylene).

This information is needed to satisfy the requirements of 10 CFR 71.33 which states that “the application must include a description of the proposed package” … “and provide a sufficient basis for evaluation of the package.” 10 CFR 71.33(b)(4) states that the description must include the “extent of reflection, the amount and identity of nonfissile materials used as neutron absorbers or moderators, and the atomic ratio of moderator to fissile constituents.”

6-6 Revise the criticality section to correct a discrepancy between the fissile materials limits in Table 6.2a for HEU metal slugs and the fissile material amounts assumed in the analysis.

Table 6.1b (page 6-11) says that for slugs of enrichment less than or equal to 100% that the package is load limited to 18,287g ^{235}U for CSI=0 and no can spacers are required (this is nearly the same as the licensee stated in the draft CoC). Table 6.2a does not list a value for these same conditions.

This information is needed to satisfy the requirements of 10 CFR 71.7(a) which states that the information provided by the applicant shall be complete and accurate in all material respects.

6-7 Revise Section 6.1.1 of the SAR to clarify the properties of Teflon or polyethylene bottles that will be used as convenience containers in the package.

In the SAR Section 6.1.1, “Design Features,” it is stated that “configurations with three Teflon or three polyethylene bottles, ~5.0in. in diameter, the 277-4 canned spacers are not used.” It is not clear if there other sizes of Teflon or polyethylene bottles that will be used. Additionally, it is not clear if it can be concluded that metal convenience cans will be used for all content configurations in which canned spacers are used, and therefore the amount of hydrogenous packing material for any configurations with spacers is limited to 500g.

This information is needed to satisfy the requirements of 10 CFR 71.33 which states that “the application must include a description of the proposed package” … “and provide a sufficient basis for evaluation of the package.” 10 CFR 71.33(b)(4) states that the

description must include the "extent of reflection, the amount and identity of nonfissile materials used as neutron absorbers or moderators, and the atomic ratio of moderator to fissile constituents."

6-8 Revise the discrepancy between the analyzed slug mass and dimensions and the slug mass and dimensions requested in the proposed certificate of compliance.

For the slug configurations, the input decks referenced for the 18.286 kg and 25.601 kg cases give a slug size of 1.983875 cm radius and 5.23875 cm height, and with 5 slugs per can this gives a total package mass of 18.277 kg (^{235}U density at 18.81109 g/cc – also from the SCALE input deck). This is lower than the value requested in the CoC for 100% enriched ^{235}U with no spacers (18.286 kg) and in SAR Table 6.2.a. The application should be revised to address this discrepancy and to verify that the mass of ^{235}U used in the analyses for the other slug cases (80% and 95% enriched, with and without spacers) are within the limits of the proposed CoC.

This information is needed to satisfy the requirements of 10 CFR 71.33. This regulation requires that the description of the contents identify maximum quantities of fissile constituents (10 CFR 71.33(b)(2)). In addition this information is needed to demonstrate that the applicant has determined the maximum reactivity of the system per the requirements of 10 CFR 71.55(b).

6-9 Revise the criticality analysis to clarify the arrangement of HEU metal slugs used in the calculations for 95% enriched ^{235}U.

For the slug calculations using 95% enriched ^{235}U with a CSI of 0.4, the arrangement of slugs used to perform this analysis is not clear. Justify that it is the most conservative arrangement of slugs.

This information is needed to demonstrate that the applicant has determined the maximum reactivity of the system per the requirements of 10 CFR 71.55(b).

6-10 Provide the conditions used in the analyses for all of the limiting calculations used to establish limits in Table 6.2.a and the CoC.

Specifically the staff would like a table with the following information for each calculation:

a. Exact dimensions of fissile material used in the analyses
b. Mass of the fissile material used in the analyses
c. Enrichment
d. Density of the fissile material
e. Moderator properties including contents (water, polyethylene, etc.), density, H/Fissile ratios, etc.
f. Arrangement of the fissile material including amount of spacing (if any) between fissile material and/or spacers. The staff is especially interested in the arrangement of the slugs.

This information is needed to satisfy 10 CFR 71.7(a) which requires that the information provided by the applicant be complete and accurate in all material respects. This Information is also needed to demonstrate that the applicant has determined the maximum reactivity of the system per the requirements of 10 CFR 71.55(b).

6-11 Revise the criticality analysis to clarify the assumptions used in the HEU broken metal criticality analysis.

The assumptions and inputs to the criticality analysis for HEU broken metal are unclear. The application should be revised to provide the H/X ratio for each of the HEU broken metal criticality calculations, as well as an explanation at how these ratios were determined, and the justification that they are conservative. Additionally, the application should explain how the size of the cubes in the discrete array model ("sqa") affected the H/X ratio choice for the licensing calculations.

This information is needed to demonstrate that the applicant has determined the maximum reactivity of the system per the requirements of 10 CFR 71.55(b).

6-12 Revise the criticality analysis to provide clarifying information (in addition to that provided in Section 6.9.3.1, starting on page 6-116, and that in Table 6.1.d) explaining the assumptions used in the modeling of the HEU product oxide and the HEU skull oxide.

Specifically, the application should describe the geometry of the mixture. Table 6.1.d states that "the oxide fills the containment vessel to a height determined by the oxide mass." Explain how this height is determined. Additionally, describe how the homogenization was performed, give the H/X ratio used in the analysis, and describe how the analyses differ for each of the oxides (UO_2, UO_3, U_3O_8, etc.).

This information is needed to demonstrate that the applicant has determined the maximum reactivity of the system per the requirements of 10 CFR 71.55(b).

6-13 In Appendix 6.9.6, clarify the difference between input decks for "content in CV calculation model" and "content in packaging calculation models."

This information is needed to satisfy 10 CFR 71.7(a) which requires that the information provided by the applicant be complete and accurate in all material respects.

6-14 Revise the criticality section of the SAR to define the term "N" in the column heading for "slugs enr. ≤ 'N'%" in Table 6.2a.

It is not clear what this column is intended to mean given the column heading.

This information is needed to satisfy 10 CFR 71.7(a) which requires that the information provided by the applicant be complete and accurate in all material respects.

6-15 Revise the application to clarify the difference in the criticality models between "flooded containment" versus "flooded package."

The SAR states on page 6-66: "…calculation results for the flooded containment rather than a flooded package are reported in Tables 6.1a-6.1e for 10 CFR 71.55(b) and are taken into consideration in the determination of HEU fissile mass loading limits." Provide additional information describing the difference in the models for the "flooded containment" versus "flooded package." It is unclear which HEU fissile mass loading limits were determined in each model.

This information is needed to satisfy 10 CFR 71.7(a) which requires that the information provided by the applicant be complete and accurate in all material respects.

6-16 Revise the criticality analysis to justify the spacing assumptions used to model the fissile material within the Model No. ES-3100 containment vessel.

Based on the various content models described in the SAR, it is not clear that the most reactive positioning of fissile material has been used to determine the maximum k_{eff}. For instance, Figure 6.1 of the SAR shows the arrangement of HEU metal cylinders inside the ES-3100 containment vessel. No credit is taken for the spacing provided by the convenience cans, and the cylinders are modeled stacked directly on top of the 277-4 can spacers. However, the applicant did not demonstrate that this is the most reactive condition. If the convenience cans are not credited for configuration control, then the possibility exists for the fissile material to be spaced farther apart, which could isolate the material from the internal neutron absorber and make it less effective for criticality control. The applicant should demonstrate, for all contents to be shipped in the package, that the most reactive credible configuration has been identified.

This information is required in order to demonstrate that the Model No. ES-3100 package meets the criticality safety requirements for single packages in §71.55, and for package arrays in §71.59.

6-17 Revise the application to provide documents Y/DD-896/R1 and Y/DD-972/R1 as appendices to the criticality analysis.

This information is referenced in the benchmarking analysis in Section 6.8 of the SAR but is not provided. The applicant should provide this information as the staff is not familiar with these documents and they are not readily available.

This information is needed to satisfy 10 CFR 71.7(a) which requires that the information provided by the applicant be complete and accurate in all material respects.

6-18 Revise the criticality analysis to justify the internal moderation assumptions for all of the allowed contents. Justify that the most reactive configuration has been found.

This information is needed to demonstrate that the applicant has determined the maximum reactivity of the system per the requirements of 10 CFR 71.55(b).