June 30, 2005

Dr. James M. Shuler
Office of Licensing
U.S. Department of Energy
EM-24/CLV-1081
1000 Independence Avenue, S.W.
Washington, DC 20585-2040

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR MODEL NO. ES-3100 PACKAGE

Dear Dr. Shuler:

By letter dated February 28, 2005, as supplemented on April 27 and May 26, 2005, the Department of Energy submitted an application to the U.S. Nuclear Regulatory Commission for approval of a new transport package for high enriched uranium, Model No. ES-3100.

In connection with the staff's review, we need the information identified in the enclosure to this letter. We request that you provide this information by August 30, 2005. Inform us at your earliest convenience, but no later than August 16, 2005, if you are not able to provide the information by that date. To assist us in re-scheduling your review, you should include a new proposed submittal date and the reasons for the delay.

Please reference Docket No. 71-9315 and TAC No. L23818 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) 415-8500.

Sincerely,

/RA/

Shawn Williams, Project Engineer
Licensing Section
Spent Fuel Project Office
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9315
TAC No. L23818

Enclosure: Request for Additional Information
Dr. James M. Shuler

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Request for Additional Information
Department of Energy
Docket No. 71-9315
Model No. ES-3100

By letter dated February 28, 2005, as supplemented on April 27 and May 26, 2005, the Department of Energy submitted a Safety Analysis Report to the U.S. Nuclear Regulatory Commission (NRC) for approval of a new transport package, Model No. ES-3100. This request for additional information (RAI) identifies information needed by the NRC 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 Material,” was used by the staff in its review of the application.

Each individual 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 the regulatory requirements.

1.0 General Information

RAIs 1-1 and 1-2 are requested to determine compliance with 10 CFR 71.7.

1-1 The text on page 1-4 states, “By certifying that the drums used in production meet the same specifications as those in the compliance tests specified in 10 CFR 71.” Provide justification that this statement is valid given that the production drums are by default not built to the same specifications as the drums tested for compliance due to the change in the neutron absorber.

1-2 Assess the statement on page 1-145, Appendix 1.4.6, “this package is classified in Table 2.2 of NUREG-1609 as a Category II package.”

There is no Table 2.2 in NUREG-1609, as referenced.

2.0 Structural

RAIs 2-1 through 2-6 are requested to determine compliance with 10 CFR 71.7.

2-1 Provide consistent wording when using confinement and containment. Be consistent in wording when conveying the same conclusion in different sections. Revise as appropriate.

Statements on pages 2-57, 2-59, and 2-61 read “…thus, confinement of the containment vessel and contents was maintained.” Confinement is not defined in Part 71 Regulations. Statements in other sections attempting to convey the same conclusion is different, for example on page 2-63, the statement reads “…thus, the position of the thermal barrier and neutron poison was maintained.”

2-2 Provide the correct range in the last sentence on page 2-131, “The range is zero to *5,175* psi and the alternating stress is half of the range or *5,147* psi / 2 = 2,574 psi.”

The range is either 5,175 psi or 5,147 psi.

2-3 Use the same hardening exponent label throughout the application and correct its definition.

The strain hardening equation on page 2-181 labels the hardening exponent with the letter “m.” The power law equations on pages 2-181, 2-183, and 2-185 labels the hardening exponent as epsilon (ε). Also, the hardening exponent is incorrectly defined as the “hardening coefficient.”

2-4 Figure 2.3.5.1 (page 2-186), Table 2.3.5.1.1 (page 2-187), Table 2.3.5.2.1 (page 2-188), and Table 2.3.5.3.1 (page 2-190) reference uniaxial strain. To be consistent with the test report, the text should reflect that constrained Kaolite material data is the same for uniaxial and volumetric strain.

2-5 The text on page 2-189, second to last line reads “a density of 27 lb/ft^3 is used as in the low density run.” This sentence should read “a density of 27 lb/ft^3 is used as in the low stiffness run.”

2-6 Justify the circumstances that exempt the weld studs from having a Certified Material Test Report on file as noted on page 1-69.

2-7 Provide an explanation as to which of the statements below is correct and revise as necessary.

The text on page 1-5 states that “No tie-down devices are integral to the package, nor can any features be used for these purposes.” Page 2-2 states, “This [welded angle ring] was incorporated in the ES-3100 package for use during transport to facilitate tie-down as a single unit in the Safe-Secure Trailer/Safeguards Transporter (SST/SGT)…”

This information is required to determine compliance with 10 CFR 71.7 and 10 CFR 71.45.

2-8 Provide information regarding the tie down arrangement for the package(s) and include any stress calculations that demonstrate the package can withstand any tie down forces that may act on a structural component integral to the package.

No explicit information is given for the tie-down arrangement.

This information is required to determine compliance with 10 CFR 71.7 and 10 CFR 71.45.

2-9 Demonstrate that the TID lugs cannot be used for a tie-down location that is integral to the package.

This information is required to determine compliance with 10 CFR 71.7 and 10 CFR 71.45.

RAIs 2-10 through 2-19 are requested to determine compliance with 10 CFR 71.7, 10 CFR 71.71, and 10 CFR 71.73.

2-10 Provide relevant details regarding what cases and under what circumstances the modeling techniques utilized are valid.

In three locations in the SAR, the use of the language “has been historically used” (pages 2-173, 2-186), and “has historically shown” (page 2-183), is insufficient to make a determination of fact regarding the adopted FEA modeling approaches.

2-11 Justify the use of LS-DYNA material *MAT_SOIL_FOAM for modeling the Borobond and Cat 277-4 material (HABC).

Given that compressive strength material properties were obtained using ASTM C109-02 *Standard Test Method for Compressive Strength of Hydraulic Cement Mortars* and that reported material properties are more representative of lightweight concrete rather than soil or foam, it is unclear as to why a concrete material model was not used for the Borobond and Cat 277-4 (HABC).

2-12 Provide an example calculation and source used to derive the pressure vs. volumetric strain relationship from the uniaxial strain information for Cat 277-4 (HABC). Specifically address how the coefficient, mu (μ) was derived, where mu is the ratio of lateral strain to longitudinal strain.

Given that volumetric stress strain data is lacking, a full methodology along with assumptions and sample calculations is necessary for determining if the derivation is appropriate.

2-13 Provide methodology and justification for the extrapolation beyond 0.6 volumetric strain for the Kaolite 1600 material.

It is unclear what procedures were used to extrapolate the stress strain curve for the Kaolite material. Test reports indicate that a sixth order polynomial was used, however, the basis and formulation of this technique was insufficient.

2-14 Justify the lack of pre-torqueing of the stud nuts or the CV nut ring in the finite element analysis.

Bolt /stud preload can have a significant effect on the resistance to shear loading. No explanation is given that takes the interaction of shear and tension into account.

2-15 The SAR states that, “the lower nodes on the studs are allowed to merge with the angle nodes” (page 2-173). Describe what is meant by merge.

There are a variety of ways to construct transitions of this type. It is unclear what has been used.

2-16 Justify the termination of the transition near the midpoint of the diameter of the adjacent washer rather than at the exterior edge of the washer.

Figure 2.1.7 on page 2-173 shows a shell to solid element transition for the drum lid. The load path in this region is from the nut to washer in bearing and from the washer to lid in bearing. Eliminating the bearing surfaces prematurely may have an impact on the stress distribution in this region.

2-17 Justify the use of constrained Kaolite material properties in the analytical models rather than unconstrained Kaolite material properties.

Using constrained Kaolite material testing properties that were obtained to "simulate the deformation mode of accident conditions…" in effect is overestimating the material properties of the Kaolite. Using constrained Kaolite properties, and then constraining it again with the exterior drum in the ES3100 simulation in effect "double counts" the Kaolite contribution to strength.

2-18 Demonstrate that the relative volume at full compaction and the density reported for the low stiffness ($V = 0.10$, $\rho = 27$ lb/ft^3), average stiffness ($V = 0.20$, $\rho = 22.4$ lb/ft^3), and high stiffness ($V = 0.12$, $\rho = 27$ lb/ft^3) are accurate.

The numerical trends for the relative volume at full compaction as well as the density appear to be counterintuitive. The expectation would be that for relative volume at compaction, the average stiffness case would fall between the low stiffness case and the high stiffness case. This is particularly true given that the density of the average stiffness case is lower than both the low and high stiffness case.

2-19 Demonstrate that using engineering stress strain information for 304 stainless steel stud connectors is appropriate for use as input into LS-DYNA numerical models. True stress strain data is presented in the data tables in the SAR but was not used.

LS-DYNA computes true stresses and true strains. The input for material should be true stress / true strain as well. Elongation at failure is not a failure strain but a measure of ductility that can under predict the true failure strain because it is dependent on gauge length. To obtain a true failure strain, one must utilize the reduction of area to calculate the localized strain at the location of necking. Additionally, the use of an engineering stress strain curve severely under predicts the amount of strain energy that can be absorbed by a material. The mixed use of failure strain and ultimate stress is also inappropriate for this analysis. Ultimate stress is generally not considered the point in which the material fails.

3.0 Thermal

3-1 Justify the assertion (on page 3-29 of the application) that “little or no hydrogen gas is generated inside the containment vessel due to thermal- or radiation-induced decomposition of the water vapor (limiting moisture content in oxide: 3 wt %) or polyethylene bagging (limiting plastic content: 500 grams). Provide a detailed and bounding calculation indicating the time evolution of the hydrogen concentration as it approaches a conservative flammable limit (5% volume in air). Address the generation of helium from the radioactive decay (alpha sources) of the contents. Include the effect of these gases upon the maximum operating pressures (normal and accident conditions). Modify the SAR so that a time limit for keeping a sealed and uranium-filled containment vessel is specified.

Radiolytic generation of hydrogen (or other gases), also known as radiolysis, occurs when ionizing radiation interacts with hydrogenous materials. NUREG/CR-6673, "Hydrogen Generation in TRU Waste Transportation Packages," may provide useful information in preparing the evaluation. NUREG-1609 indicates that both helium (from radioactive decay) and hydrogen (from radiolysis) should be considered when estimating the maximum internal pressures (both at normal and accident conditions). A time limit for contents to be held inside the ES-3100 would avoid the use of a transportation package as a storage cask.

10 CFR 71.43(d) states that the behavior of materials under irradiation must be taken into account when assuring that a package design (including packaging and contents) will not result in a significant chemical, galvanic, or other reaction. If left unattended, the hydrogen generated within the Oxide Vessel may reach flammable/explosive levels and/or design pressure limits.

Other Minor Editorial Comments noted:

The text “mode” should be “move” on page 2-107, second to last line.
The text “tansportation” should be “transportation” on page 2-125 and 2-131 (section title).
The text “bare” should be “bear” on page 2-171, last paragraph, first sentence.
The text “plain” should be “plane” on page 2-173, second paragraph, second sentence.
The text “minium” should be “minimum” on page 2-458, third paragraph, fifth line.