November 17, 2009

Mr. Mark Whittaker
Energy*Solutions*
140 Stoneridge Drive
Columbia, SC 29210

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR THE REVIEW OF THE MODEL NO. 3-60B PACKAGE

Dear Mr. Whittaker:

By letter dated June 30, 2009, Energy*Solutions* submitted an application for approval of the Model No. 3-60B package as a Type B(U) package. By letter dated July 16, 2009, the NRC staff acknowledged receipt of the application which appeared to contain the necessary information to begin our technical review.

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 January 5, 2010. If you are unable to meet this deadline, you must notify us in writing no later than December 15, 2009, of your submittal date and the reasons for the delay. The staff will then assess the impact of the new submittal date and notify you of a revised schedule.

Please reference Docket No. 71-9321 and TAC No. L24354 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) 492-3408.

Sincerely,

/RA/

Pierre Saverot, Project Manager
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9321
TAC No. L24354

Enclosure: Request For Additional Information

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Distribution:
via email: Daniel Forsyth, Haile Lindsay, Jimmy Chang, David Tarantino, Ata Istar, Neil Day

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DATE:	11/12/09		11/16/09		11/17/09							

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Request for Additional Information
for the
Model No. 3-60B Package
Docket No. 71-9321

By application dated June 30, 2009, Energy*Solutions* submitted an application for approval of the Model No. 3-60B package.

This Request for Additional Information (RAI) identifies information needed by the staff in connection with its review of the "Safety Analysis Report for the Model No. 3-60B Type B Shipping Cask," Revision No. 0, dated June 2009. The requested information is listed by chapter number and title in the applicant's Safety Analysis Report. The staff reviewed the application using the guidance in NUREG 1609, "Standard Review Plan for Transportation Packages for Radioactive Material."

Each individual RAI section 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.

Chapter 1 – General Information

1.1 Clarify the statement that the free water may not exceed 1% by volume of the secondary container under package loading.

Section 1.2.2 of the application states, as one of the Model No. 3-60B package loading restrictions, that the free water may not exceed 1% by volume of the secondary container. Example 2 of Attachment 7.1 states that the swarf, contained in a sealed steel liner, is dewatered to 1% of the waste volume.

The application needs to clarify, or confirm, if the statement "the free water should not exceed 1% by volume of the secondary container under package loading" is applicable to either dewatered swarf, or powdered solids, or irradiated hardware, or to all the contents of the Model No. 3-60B package.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.87.

1.2 Explain why the radiolysis of water is the only primary gas generation mechanism analyzed in the Model No. 3-60B package.

The applicant performs hydrogen generation calculations with the radiolysis of water as the primary mechanism for gas generation, and neglects other mechanisms such as chemical or thermal activity.

The application needs to:

(i) Refer to Table 3.1 of NUREG/CR-6673 "Hydrogen Generation in TRU Waste Transportation Packages" for bounding G values of the package contents which contribute to hydrogen generation, and

(ii) Document why gas generation from other mechanisms, such as chemical or thermal, is expected to be insignificant for the Model No. 3-60B package.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.43(d).

1.3 Provide a detailed description of the characteristics of the contents and of their corresponding radioactive constituents which contribute to hydrogen generation due to radiolysis.

The application does not include a detailed description of the characteristics of the contents (as currently listed in Section 1.2.2 of the application) and of their corresponding radioactive constituents (e.g., radiation types) which are considered to contribute to radiolytic hydrogen generation.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.43(d).

1.4 Justify if the contents consisting of solidified material and resin are considered either as a type of irradiated hardware or as a powdered solid for the evaluation of hydrogen generation.

Section 1.2.2 of the application identifies component segments (irradiated hardware), inorganic solids (powdered solids), inorganic solidified material, and inorganic resins as contents of the Model No. 3-60 B package. The application provides examples for characterizing hydrogen generation only for powered solids and irradiated hardware contents, but not for the other types of contents.

The application needs to clarify how the corresponding approach for the evaluation of hydrogen generation is applicable to resins and solidified material.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.43(d).

1.5 Justify why the dewatered swarf may be considered as a type of powdered solids for the determination of hydrogen generation.

The package contents are categorized into irradiated hardware and powdered solids for the hydrogen generation analysis. Irradiated hardware and dewatered swarf (a type of powdered solids) are used as examples for the evaluation of hydrogen generation.

The application should provide a detailed description of the dewatered swarf, including photos or pictures, to help confirm that dewatered swarf is a type of powdered solids suitable for the evaluation of hydrogen generation.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.43(d).

1.6 Clarify the existence of an NRC-approved Quality Assurance Program.

Section 1.1 of the application states that the application is in accordance with Regulatory Guide No. 7.9; however, the application does not specifically refer to an NRC-approved Quality Assurance Program.

This information is required by the staff to determine compliance with 10 CFR 71.101.

Licensing Drawings

1.7 Explain the welding symbol as shown on Item No. 13, “Inner Cask Shell,” sheets No. 2 of 5 (section view) and No. 3 of 5 (containment boundary) of the 3-60B Cask General Arrangement and Details Drawing C-002-165024-001, Rev. No. 0.

1.7.1 Explain if this symbol is a single V groove weld or a seam weld. Describe the intended purpose of this weld symbol including the orientation as welded on Item No. 13.

1.7.2 Explain why the weld symbol, used on sheet No. 2 of 5, depicts a weld “all around” symbol, but is excluded on the weld symbol, sheet No. 3 of 5, for the same weld.

The weld symbol depicts a single V groove joint design; however, the tail of the weld symbol states “typical seam weld.”

This information is required by the staff to determine compliance with 10 CFR 71.33(a)(5)(iii) and 71.39.

1.8 Explain the single V groove joint as shown joining Item No. 16 (Plate, 1-inch) to Item No. 6 (Bolt Ring), sheet No. 3 of 5 (containment boundary) of the 3-60B Cask General Arrangement and Details Drawing C-002-165024-001, Rev. No. 0.

Describe the intended purpose of this weld joint and/or add a complete weld symbol including non-destructive examination (NDE) required to the drawing.

This single V groove joint is only identified or shown as a “V groove” on the drawing containment boundary view without a stated weld symbol, NDE requirements or any other American Welding Society standard description.

This information is required by the staff to determine compliance with 10 CFR 71.33(a)(5)(iii) and 71.39.

1.9 Explain how Item No. 53 (Plate 6 1/2-inch thick by 37-inch diameter) is attached to Item No. 32 (Plate 4-inch thick by 48 3/4-inch diameter), sheet No. 4 of 5 (Section H-H) of the 3-60B Cask General Arrangement and Details Drawing C-002-165024-001, Rev. No. 0.

1.9.1 Provide a full description of the intended method to attach these items for the fabrication of the cask lid.

1.9.2 Provide a description of the intended fabrication methods of Item No. 53 if the fabrication facility chooses a direction in accordance with the General Note No. 16 of the drawing.

Items Nos. 32 and 53 are shown to make-up or fabricate the bolted cask lid. However, no method of how to join these two items is shown and/or described either in the drawing or in the application. Also, whether or not the lid can be manufactured as one piece is not specified. Further, no method for fabricating Item No. 53 is shown and/or described in the drawing or in the application as General Note No. 16 states, “Item No. 53 may be made from multiple pieces.”

This information is required by the staff to determine compliance with 10 CFR 71.33(a)(5)(iii) and 71.39.

1.10 Delete or update the material designation “S/STL” (i.e., stainless steel) for Item No. 36 (Socket Head Cap Screw (SHCS), 1/2-13 UNC Thread, 1 1/2-inch long, S/STL) description on the Model No. 3-60B Cask General Arrangement and Details Drawing C-002-165024-001, Rev. No. 0, sheet No. 1 of 5, Bill of Materials.

Item No. 36 SHCS is fabricated to American Society for Testing & Materials (ASTM) A 193, Grade B7 specifications, and is a Chromium-Molybdenum (Cr-Mo) ferritic alloy steel i.e., not a stainless steel.

This information is required by the staff to determine compliance with 10 CFR 71.33(a)(5)(iii).

1.11 Change the material designation “Grade DB” for Item No. 33 (Seal Ring, 1/2-inch thick) description to reflect the correct Grade of material required for the Model 3-60B Cask General Arrangement and Details Drawing C-002-165024-001, Rev. No. 0, sheet No. 1 of 5, Bill of Materials.

Change or provide the location (i.e., specification) of material designation “Grade B21, Class 1” for the same Item No. 33 described above.

Item No. 33, is fabricated to specification ASTM A 354, Grade DB or A 450, Grade B21, Class 1, as shown on the drawing Bill of Materials description; however, Grade DB and Grade B21, Class 1 do not exist as an option within their respective specifications. For ASTM A 354 a “Grade BD” is offered as an option, not “Grade DB;” therefore, this may be a typographical error made to Item No. 33 drawing description. In addition, for ASTM A 450, no material grade designation “Grade B21, Class 1” can be found within this specification.

This information is required by the staff to determine compliance with 10 CFR 71.33(a)(5)(iii).

1.12 Provide the specification GSA document AA-595588, elastomer, referenced in Note No. 13, General Notes, to be used for Items Nos. 24, 30, 31, 38, and 39 on the Model No. 3-60B Cask General Arrangement and Details Drawing C-002-165024-001, Rev. No. 0, sheet No. 1 of 5.

Provide the specification and/or classification for Item No. 25 (elastomer, used with SHCS, drain port assembly), Bill of Materials, same drawing location as stated above.

No specification and/or classification is provided for material identification of the elastomer, Items Nos. 24, 25, 30, 31, 38, and 39. Specification ASTM D 2000, “Standard Classification System for Rubber Products,” provides a method for specifying rubber materials by the use of a simple “line call-out” designation. Suffix letters are defined and utilized as part of the line call-out.

This information is required by the staff to determine compliance with 10 CFR 71.33(a)(5)(iii).

1.13 Evaluate the continued need and provide a copy of Reference 2.3, ASTM F-501-93, “Aerospace Materials Response to Flame, With Vertical Test Specimen (For Aerospace Vehicles Standard Conditions)” of the application, Section No. 8, Appendix 8.3.1, “Polyurethane Foam Specification ES-M-172, CHEM-NUCLEAR SYSTEMS Specification for Rigid Polyurethane Foam for Impact Limiters.”

Reference 2.3 described above has been discontinued without replacement.

This information is required by the staff to determine compliance with 10 CFR 71.113.

1.14 Provide reasonable assurance that any lubricant procured will not be detrimental to the fit, function, or operation of the Model No. 3-60B lid bolts (Item No. 3, Hex HD. Bolt 1 1/2-6 UNC Thread, 5-inches long), vent cap screws (Item No. 36, SHCS, 1/2-13 thread, 1 1/2-inches long), drain line plug (Item No. 27, SHCS, 1-8 UNC thread, 8-inches long) and impact limiter bolts (Item No. 5, Hex Head Bolt, 7/8-9 UNC thread, 3-inches long) without specifying minimum requirements (e.g., nuclear grade) and/or a lubricant specification.

1.14.1 Change “Item No. 50” referred to in General Note No. 5 on the Model No. 3-60B Cask General Arrangement and Details Drawing C-002-165024-001, Rev. No. 0, sheet No. 1 of 5 to read “Item No. 5.”

General Note No. 5 of the Model No. 3-60B Cask General Arrangement and Details Drawing states to torque (lubricated) the lid bolts, vent cap screws, drain line plug and impact limiter bolts, but provides no minimum requirements or specification. In addition, General Note No. 5, last sentence, states to “torque Item No. 50 impact limiter bolts.” However, “Item No. 50” is the flat washer used with “Item No. 5” the hex head bolt. This should read, “torque Item No. 5 impact limiter bolts.”

Proper lubricants should meet several essential needs for threaded connections (i) to control friction for obtaining true torque values (Correct lubrication and tightening of critical connections ensures proper assembly seating), (ii) to protect against corrosion by opposing oxidation and many chemicals (lubricants should reduce the destructive contact between dissimilar metals and withstand greater temperature stresses), and (iii) to allow for non-destructive disassembly.

This information is required by the staff to determine compliance with 10 CFR 71.39 and 71.43(d).

1.15 Explain the decision not to offer, as a minimum option, a vacuum grease to be used with the elastomer seals, Items Nos 24, 25, 30, 31, 38, and 39 of the Model No. 3-60B Cask General Arrangement and Details Drawing C-002-165024-001, Rev. No. 0, sheet No. 1 of 5, Bill of Materials.

Vacuum grease, a lubricant with low volatility, is designed for sealing and lubricating vacuum and pressure vessel systems may be used in addition to and act as an environmental barrier for elastomer seals. System compatibility and possible detrimental effects must be considered such as viscosity, which may be the most important factor in providing lubricant effectiveness.

Various other factors to consider are additive type, thickener type, consistency, base chemistry, service temperature, specific gravity, melting point, vapor pressure, relative density, resistance to radiation, lubricity, out-gassing, coefficient of expansion, and thermal conductivity.

A shortened lubricant lifecycle may be an outcome of overlooking one or more of these properties.

This information is required by the staff to determine compliance with 10 CFR 71.39 and 71.43(d).

1.16 Change NDE requirements and acceptance criteria referenced in General Note No. 1 of the Model No. 3-60B Cask General Arrangement and Details Drawing C-002-165024-001, Rev. No. 0, sheet No. 1 of 5 to read "Subsection NB-5000," in lieu of Subsection ND-5000.

General Note No. 1 states that NDE of containment welds shall meet the requirements and acceptance criteria of ASME Code, Section III, Division 1, Subsection ND-5000. "ND" refers to class 3 components; however, the staff suggests using "NB," which refers to class 1 components.

This information is required by the staff to determine compliance with 10 CFR 71.119

1.17 Provide an expanded discussion of methods and allowances which are acceptable when evaluating a fabricator's decision to accept the option offered in General Note No. 10 of the Model No. 3-60B Cask General Arrangement and Details Drawing C-002-165024-001, Rev. No. 0, sheet No. 1 of 5. General Note No. 10 states that any welds made to the cask body or lid following the lead pour may use a backing ring at the fabricator's option, a configuration approval required by the applicant.

Staff's concerns include the following: (i) How much lead is required to be removed in the way of the backing ring? (ii) What effect will the removal of lead shielding in the way of the backing ring have on external radiation dose? (iii) Why allow the option whether to use the backing ring (i.e., reasonable assurance of weld integrity on a complete penetration joint welded from one side that no capillary attraction of lead contaminates the weld or without back-gouge sound metal is achieved)? and (iv) What type of material may be used as a backing ring?

Measures should be utilized to keep doses received by workers and members of the public from exposures to sources of radiation as low as is reasonably achievable. It is insufficient to simply respect the appropriate dose limits and every reasonable effort should be made to maintain exposures to ionizing radiation as far below the dose limits as practical. In addition, the use of a backing ring would eliminate potential lead contamination, oxidation, and provide radiation shielding within the region of lead removal.

This information is required by the staff to determine compliance with 10 CFR 71.39 and 71.47(a).

1.18 Explain the counterfeit/fraud inspection process for independent sampling and testing of cask materials used for components important to safety.

The NRC issued Generic Letter 89-02, "Actions to Improve the Detection of Counterfeit and Fraudulently Marketed Products," March 21, 1989, and Information Notice No. 89-70, "Possible Indications of Misrepresented Vendor Products," dated October 11, 1989, intended for all holders of operating licenses or construction permits for nuclear power reactors to alert for possible indications of misrepresented vendor products and to provide information related to detection of such products.

It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems.

The above NRC issued documents are publicly available through the NRC web site and are examples of the on-going NRC concerns in detecting counterfeit and fraud associated with all areas of commercial nuclear power generation.

This information is required by the staff to determine compliance with 10 CFR 71.31(c), 71.39, and 71.115(a)(b)(c).

Chapter 2 – Structural Evaluation

2.1 Justify the applicability of the boundary conditions used in the quasi-static analyses in ANSYS.

Subsection titled "Boundary Conditions," of Section No. 6.0 of ST-504, Revision No. 1, states, "The rigid body motion is prevented in the model by restraining it at the locations where such restrains have insignificant effect on the overall behavior of the model." Provide additional information related to the applied boundary conditions that present "insignificant effects" on the overall behavior for all ANSYS analyses. As stated above, the staff was unable to make a determination on the applicability of the boundary conditions from the reviewed ANSYS models.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73.

2.2 Justify not including the end drop case in the benchmark evaluation.

In ST-551, Rev. No. 2, "Validation of the LS-DYNA Drop Analyses Results with the Test Data," benchmarking does not provide any analysis or explanation for not including an end drop case. Therefore, concluding on a conservative/realistic solution is not possible.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73.

2.3 Provide additional discussions of the shallow angle drop case.

Section 7.1.4 of ST-504, Rev. No. 1, includes the following statement and how it relates to the effects of the shallow angle drop case: "The results of the shallow angle drop analyses show that the tail-end impact is more severe than the nose-end impact for the 3-60B cask. This result is consistent with the conclusion of Reference No. 11, which shows that for a slender cask with length-to-radius of gyration ratio larger than 2, the tail-end impact is more severe than the nose-end impact. For both shallow angle orientations (slapdown-1 and slapdown-2), and for cold and hot environmental conditions, the tail-end impact reactions are larger than nose-end impact limiter reactions (see Figure Nos. 86, 91, 96, and 101 of Reference No. 4)."

The shallow angle analysis is unclear based on (i) the referenced Sandia National Laboratories (SNL) Report No. SAND88-0616UC-71 (Reference No. 11, ST-504, Rev. No. 1) and (ii) the lack of a length-to-radius of gyration ratio (aspect ratio) determination.

The ANSYS analysis for the side drop conditions were amplified by using the ratio of impact limiter reaction forces for the side and shallow angle drop cases from LS-DYNA to verify the shallow angle drop scenario. Variations in the coefficient of friction (See RAI No. 2.6), and also on the aspect ratio of transportation packages are interrelated as reported in the SNL Report No. SAND90-2187, printed June 1991, "An Analysis of Parameters Affecting Slapdown of Transportation Packages."

Justify how the side drop case can be used to conservatively bound the shallow angle drop case.

This information is required by the staff to determine compliance with 10 CFR 71.73.

2.4 Demonstrate that the orientation of the foam's properties is realistic and conservative for each drop test case.

Justify the use of uni-directional rather than orthogonal properties of the foam for each drop case.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73.

2.5 Justify the properties of the impact limiter foam material.

Using the General Plastics publication, titled "Design Guide for Use of LAST-A-FOAM FR-3700 for Crash and Fire Protection of Radioactive Material Shipping Containers, iss005," staff was unable to replicate the applicant's tabulated data in Table No. 1 of ST-557, Rev. No.1.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73.

2.6 Justify that the friction coefficient values used in the drop analyses are realistic and conservative.

The static and dynamic coefficients of friction are assumed to be 0.3 for all the contact surfaces for "Drop Analyses of the 3-60B Cask Package using LS-DYNA Program" (Section No. 5 of ST-557, Rev. No. 1) and "Validation of the LS-DYNA Drop Analyses Results with the Test Data" (Section No. 5 of ST-551, Rev. No. 2).

Please refer to SNL Report No. SAND90-2187, "An Analysis of Parameters Affecting Slapdown of Transportation Packages," and provide a justification for using 0.3 for all contact and friction values.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73.

2.7 Justify the material stress intensity allowable limits for the "Peak Stress" criterion.

The material allowable stresses are listed in Table No. 2-2 and explained in Table No. 2-3 of the application. The "Peak Stress" criterion for the normal conditions of transport (NCT) and the hypothetical accident conditions (HAC) are described as a combination of the primary membrane, primary bending, secondary membrane plus bending, and secondary peak.

However, stress concentrations and fatigue conditions are not applicable to NCT and HAC. Therefore, the only allowable limits of stress intensities that should be considered are the combinations of primary membrane, primary bending, and thermal expansion.

The table of allowable stresses in Calculation Package ST-504, Section No. 5.0, illustrates the applicant's use of the "Peak Stress" criterion. For NCT, allowable stresses are listed for membrane, membrane plus bending and peak. Note No. 3 of the table states that the limit on peak stress is $3S_m$. ASME Section III, Division 3, WB-3200, Figure WB-3221-1, clearly shows that $3S_m$ is the limit for primary plus secondary stress, not peak stress. Peak stress is the increment of stress added to primary or secondary stress by a stress concentration or notch. The allowable peak stress is the alternating stress intensity obtained from a fatigue curve. Calculation ST-504 evaluates the cask under drop conditions, not fatigue. The use of peak stress would only be applicable if the applicant were performing a fatigue evaluation of vibrations normally incident to transport as required in 10 CFR 71.71(c)(5).

The applicant performed a linear elastic analysis to evaluate the containment boundary under drop impact conditions. At structural discontinuities, stresses are linearized and compared to secondary stress allowables. Peak stresses are never included.

The same situation occurs for HAC when the applicant defines a peak stress based on a fatigue allowable and proceeds to use it as an allowable stress in a drop impact evaluation. A cask drop has less than one stress cycle and does not involve fatigue.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73.

2.8 Provide a methodology for determining and identifying the worst stress intensity levels that need to be addressed for all drop cases:

The staff noted inconsistencies in identifying the worst case stress intensity levels. The location of maximum stress intensity must be determined for all drop cases. For example, the calculated stress intensity of approximately 29,000 psi was identified in Figure No. 33 of ST-504, Rev. No. 1, as the maximum value on the inner cask shell (Item No. 13). This stress occurred at a distance greater than the shell thickness above the shell to flange intersection. However, the maximum stress is expected to occur at the shell to flange intersection and is expected to be much greater than 29,000 psi.

The staff believes that the maximum stress did not occur at the intersection because of the applicant's method of applying nodal-stress-averaging. To properly utilize nodal-stress-averaging at this location, the shell must be isolated from the flange prior to employing nodal-stress-averaging to avoid nodal results from highly stressed elements to be averaged at the same node with lower stress element results, and thereby eliminating the true maximum stress.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73.

2.9 Provide an element mesh convergence study for the inner shell at the intersection with the flange to demonstrate that a single element through the thickness of the shell provides accurate results.

It has been the experience of the staff that a single SOLID185 element through the thickness of a shell in a region of high moment gradient may not produce sufficiently accurate results. As an alternative to performing the convergence study on the actual cask model, the staff will accept a simple mesh convergence study of a cylindrical shell fixed at its base or attached to a thick circular plate subjected to internal pressure loading. The aspect ratio of the elements should not be any greater than that of the element at the shell to flange intersection in current model.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73.

2.10 Provide an analysis in Calculation ST-504 that considers a realistic load-path from the impact limiter through the bolt-ring-lip and into the hex-head-bolts in order to maximize the shear stresses in the bolts.

Structural Analyses of the package under drop conditions (Figure No. 19, ST-504, Rev. No. 1) – calculated the stress intensity levels at the bolt-ring-lip (Item No. 6, C-002-165024-001, Rev. No. 0) reaching approximately 2.8 times the yield-strength of the bolt-ring-lip material. Due to the fact that the lip was not allowed to deform plastically, it does not appear that the impact limiter resultant loads were transferred appropriately from the bolt-ring-lip through the cask-lid-assembly (item No. 2, C-002-165024-001, Rev. No. 0) onto the hex-head-bolt(s) (item No. 5, C-002-165024-001, Rev. No. 0).

Furthermore, results from this evaluation should be incorporated into the hex-head-bolt evaluations in Section No. 2.7.1.9 of the application.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73.

2.11 Justify the methodology used to satisfy the lifting and tie down criteria.

2.11.1 ST-503, Rev. No. 0, “3-60B Cask Trunnion Analyses under Various Load Conditions,” lifting/handling analyses do not include a dynamic load factor for load cases 1 and 2. Section No. 7.2 of ANSI Standard No. 14.6, “Radioactive Materials – Special Lifting Devices for Shipping Containers Weighing 10000 Pounds (4500 kg) or More,” requires a dynamic load factor for the design of critical load lifting.

Provide an analysis using an appropriate dynamic load factor and justify the value used.

This information is required by the staff to determine compliance with 10 CFR 71.45(a).

2.11.2 10 CFR 71.45(b)(1) requires that a static force, acting at the center of gravity of the package, with components of 2g vertical, 10g in direction of travel, and 5g transverse be analyzed. ST-503, Rev. No. 0 applies these loads as three separate conditions and the combination due to these three forces was not considered as required.

Provide an analysis for the combined system of forces such that maximum reactions at each support are achieved.

This information is required by the staff to determine compliance with 10 CFR 71.45(b).

2.12 Correct the information regarding the Energy*Solutions* Quality Assurance Program.

Section No. 2.3 of the application states the following: "Energy*Solutions* will apply its USNRC approved 10 CFR 71 Appendix B Quality Assurance Program, which implements a graded approach to quality based on a component's or material's importance to safety…." Please note that there is no 10 CFR Part 71 Appendix B QA program.

This information is required by the staff to determine compliance with 10 CFR Part 71 Subpart H.

Chapter 3 – Thermal Evaluation

3.1 Correct the mass fraction of water in the calculations of hydrogen generation for both irradiated hardware and dewatered swarf.

The applicant calculates the mass fraction of water F_w by excluding the water mass from the total mass in the cask, but includes the water volume in the calculation of void volume for both irradiated hardware and dewatered swarf in Attachment 3B of the application. The applicant is required to correct the equation for the mass fraction of water from $F_w = M_w / (M_L + M_H)$ to $F_w = M_w / (M_L + M_H + M_w)$, to make both the mass fraction calculation and the void volume calculation consistent.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.43(d).

3.2 Provide the basis for the determination that 2 gallons of water remaining in the cask cavity, after the cask is drained, is a conservative assumption for the evaluation of hydrogen generation.

The applicant assumes that the grooves in the cask cavity base and the drain port have a combined volume of less than 0.02 gallons after the package is drained. The applicant estimates a volume of 2 gallons if any additional water remains on the base to a depth of 0.5 inch, and then uses a total of 4-gallon water for the determination of hydrogen generation in the package containing irradiated hardware waste form.

The applicant is required to (i) validate the assumption that there are 2 gallons of water remaining in the cask cavity for hydrogen generation after the package is drained, and (ii) demonstrate that such assumption is conservative for the analysis (see also RAI No. 7.1).

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.43(d).

3.3 Correct the maximum normal operating pressure (MNOP) for a hot-day case with the ambient temperature of 100ºF.

The applicant used a cavity gas temperature of 225ºF in the calculation of the MNOP for a hot-day case with the ambient temperature 100°F, which is inconsistent with the maximum cavity temperature of 227.3°F listed in Table 3-3 of the application. The applicant is required to correct the MNOP with the exact cavity gas temperature from Table 3-3 for a hot-day case.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.71.

3.4 Explain why the fire shield temperature (1331ºF), as reported in Table No. 3-1 and illustrated in Figure No. 3-8 of the calculation package TH-023, is significantly less than the ambient air temperature (1475ºF) during the fire transient for 30 minutes for HAC thermal analysis of the Model No. 3-60B package.

During the HAC fire test for the Model No. 3-60B package, staff found out that the fire shield temperature was reported as 1331ºF when the ambient temperature the package is exposed to is 1475°F. Figure No. 3-8 of the calculation package TH-023 indicates that the fire shield and inner shell temperature rises to 1331ºF, while the outer shell temperature rises to 353.3°F, a difference of almost 1000ºF. The NCT model results seem to indicate that there is little to no temperature gradient across the fire shield, outer shell and inner shell of the package, which would not be anticipated for this type of design. A detailed explanation on why the temperature is significantly below the fire temperature of 1475ºF should be provided.

This information is required by the staff to determine compliance with 10 CFR 71.71 and 71.73.

3.5 Provide clarification for the maximum allowable temperature of the seals listed in Table Nos. 3-1 and 3-2 of the application.

Section 3.2.2 of the application states that the seals are specified to be elastomer, 50 – 70 Durameter, temperature range of -40°F to 350°F. Table No. 3-1, “Summary of Maximum NCT Temperatures” and Table No. 3-2, “Summary of Maximum HAC Temperatures,” list the maximum allowable temperature of the seals as 450°F, which is higher than the maximum specified in Section 3.2.2.

The applicant should clarify this discrepancy and specify a reference for the seal’s maximum temperature.

This information is required by the staff to determine compliance with 10 CFR 71.43, 71.71, and 71.73.

3.6 Clarify how the impact limiters affect the flow of heat into the package in the HAC model.

Section 5.0 of the calculation package No. TH-022 states that (i) the impact limiters are not modeled, (ii) the impact limiters support plates are modeled, and (iii) the outer surfaces of the impact limiter plates are not covered by foam but are considered to be totally insulated.

It is not clear how the heat migrates into the package through the impact limiter plates during the HAC fire.

This information is required by the staff to determine compliance with 10 CFR 71.73.

3.7 Provide an analysis of the HAC fire with a radiation emissivity of 0.9 and an ambient temperature of 1475°F.

In the Calculation Package TH-023, the applicant assumes the emissivities of the fire shield and the environment to be 0.8 and 0.9 respectively, and derives an overall emissivity of 0.7347 by equation for radiation heat transfer between the fire shield and the environment.

As required in 10 CFR 71.73, a flame emissivity of at least 0.9 must be 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.

To ensure package safety and compliance with 10 CFR 71.73, the model should implement the following requirements:

a) A package surface absorptivity of 0.8 or greater and an ambient temperature of 1475°F should be used in a 30 minute HAC fire calculation,

b) A uniform internal heat loading should be used for the temperature of the waste component.

c) The rest of the package calculation setups should remain the same as those in TH-023 for a 30-minute fire and its cool down (post-fire) phase.

An update of the calculation package TH-023 with new data, tables, and plots of HAC fire, including maximum material/component temperatures, maximum temperature difference through-wall results, nodal temperature distributions, and temperature transients of fire shield, O-ring, lead gamma shield, cavity bulk air, and inner and outer steel shells should be provided in responding to this RAI.

This information is required by the staff to determine compliance show compliance with 10 CFR 71.33 and 71.73.

Chapter 4 – Containment Evaluation

4.1 Determine how the containment seal will be characterized as an equivalent to the Parker Lock-O-Seal critical characteristics.

Section 4.1.1 of the application states that a socket head cylindrical rod is threaded into the exterior opening to shut the drain port during transport. The cylindrical rod is torqued shut and sealed tight with a Parker Lock-O-Seal (or its equivalents).

The evaluation of an equivalent seal to the Parker Lock-O-Seal should be based on the critical characteristics of a seal in (i) low temperature performance, (ii) high temperature performance under NCT, (iii) high temperature performance under HAC, (iv) dimensional tolerance, (v) hardness, (vi) permeability, (vii) radiation resistance, and (viii) environmental (corrosion) resistance.

This information is required by the staff to determine compliance with 10 CFR 71.33 and 71.51.

4.2 Clarify the pre-shipment leak test statement provided for LSA contents or for fissile contents which are exempted from classification as fissile material.

The applicant describes the package contents in Section No. 1.2.2 of the application and specifies in Section No. 4.5 that “the pre-shipment leak test is not required for contents that meet the definition of low specific activity material or surface contaminated objects in 10 CFR 71.4 and also meet the exemption standard for low specific activity material and surface contaminated objects in 10 CFR 71.14(b)(3)(i).”

The applicant is required to clarify if LSA, SCO, or exempt materials are requested as authorized contents and if other leak testing procedures should apply.

This information is required by the staff to determine compliance with 10 CFR 71.4, 71.14(b)(3)(i), 71.15, and 71.51.

4.3 Provide a description of the materials characteristics of R-134a halogen gas to prove its suitability as a tracer gas for leak testing.

The applicant states in Section No. 4.5 and Table No. 4.2 of the application that the fabrication, maintenance, and periodic leakage tests may be performed using helium, R-12 halogen, and R-134a halogen, as tracer gases, and that the corresponding acceptance criteria are adjusted for the individual properties of each tracer gas.

The staff needs more detailed information on the characteristics of the R-134a halogen gas to document its suitability as test gas for leak testing.

This information is required by the staff to determine compliance with 10 CFR 71.33 and 71.51.

4.4 Provide descriptions of (i) the characteristics of the cavity filler material, (ii) the corresponding installation procedures, and (iii) the materials suitable as filler materials in the leak test.

The applicant states in Section No. 4.5 of the application that some of the volume of the cavity may be temporarily filled with cavity filler material in the periodic leak tests for the closure lid and vent port to reduce the volume of tracer test gas required to conduct the tests.

The application shall include (i) the characteristics of this cavity filler material, (ii) the related installation procedures, and (iii) the list of the filler materials to ensure that the filler material will not interact with or be penetrated by the test gases (helium, R-12, and R-134a) and will not thermally expand to cover the drain opening during the leak tests.

This information is required by the staff to determine compliance with 10 CFR 71.33, 71.35, and 71.43(d).

4.5 Explain (a) the difference between the backfill pressures of helium and R-12/R-134a of the leak test, and (b) if the pressurization to 1 psig for helium in the leak test is sensitive enough for leak test.

The applicant describes test procedures, in Section No. 4.5 of the application, for the maximum allowable leak rates. The package void is first evacuated to 20” Hg vacuum for each tracer gas, and then pressurized to 25 psig for both R-12 and R-134a, or 1 psig for helium.

The demonstration that the backfill pressure of 1 psig is sensitive enough for the helium test gas in the leak test should be included in the application.

This information is required by the staff to determine compliance with ANSI N14.5 and 10 CFR 71.51.

4.6 Provide a derivation for the equations relative to the allowable test leakage and allowable test leakage sensitivity as a function of temperature for the tracer gases used in the leak test.

The applicant is required to provide the derivations of allowable test leakage rate and allowable test leakage sensitivity for the tracer gases of helium, R-12, R-134a, helium/air mixture, R-12/air mixture, and R-134a/air mixture, to their final forms as a function of the temperature only, in Section Nos. 4.5.1, 4.5.2, and 4.5.3 of the application. Such derivations are needed for the staff to confirm the validity of Figure Nos. 4.4 through 4.14 of the application.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.51.

4.7 Provide the calculations to determine the charge time, H, of the vent port and the drain port in the leak test.

The application should provide the data of dimensions used to calculate the volume of the annulus for the vent port (4.1 cm^3) and the volume of drain port cavity (21.9 cm^3) which help determine that a volume of 31.6 cm^3 used in the Equation B.14 of ANSI N14.5 is more conservative for the determination of the charge time in the leak test.

The application should also provide all parameters used in the calculation to determine the charge time of 12.2 minutes on the vent port and the drain port leak tests.

This information is required by the staff to determine compliance with ANSI N14.5, 10 CFR 71.35, and 71.51.

Chapter 7 – Operating Procedures

7.1 Provide a description of the container dewatering process during wet loading.

The applicant only delineates in Section No. 7.1.2.4.c of the application that one should "leave the cask suspended and allow water to drain from the cavity."

The description of the container dewatering process under wet loading should address details such as vacuum pump operation, valve operation, measurement of cavity pressure, backfilling of helium, and other required operations for the container dewatering process.

This information is required by the staff to determine compliance with 10 CFR 71.85 and 71.87.

7.2 Revise Attachment No. 7.1 to be a stand-alone procedure in Chapter 7.0 "Package Operations," for package users to determine the flammable gas concentration for the authorized contents.

The applicant develops a method for the determination of the hydrogen generation to ensure that the flammable gas concentration does not exceed a limit of 5%, and describes this method in Chapter 3.0 and Attachment No. 7.1 of the application.

The applicant is required to revise Attachment 7.1 as a stand-alone procedure for package users to determine the void fraction (Fv), the mass fraction of water (Fw), and the allowable decay heat load (Q) for the loaded contents.

The procedure should instruct users for categorizing the contents (irradiated hardware, powder solids, etc.), listing all parameters/values used in the calculations and applying the appropriate formulas for determining F_v, F_w and Q, as generally described in Section 3.3.2 and the current examples in Attachment No. 7.1 of the application.

This information is required by the staff to determine compliance with 10 CFR 71.33, 71.35, 71.43(d), and 71.87.

7.3 Clarify how the water content and density of the dewatered swarf are determined for the evaluation of hydrogen generation.

Attachment No. 7.1 of the application mentions that the swarf, contained in a sealed steel liner, is dewatered to 1% of the waste volume and has a density of 4.0 g/cc for the evaluation of hydrogen generation. The applicant is required to clarify how the water content and density of the swarf are determined for the calculations.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.43(d).

7.4 Provide clarification that an empty package would comply with 49 CFR 173.443 and properly describe the package's closure requirements.

Section 7.3 of the SAR lacks a description of the package's closure requirements. In addition, an explanation demonstrating compliance with 49 CFR 173.443 is not provided.

This information is required by the staff to determine compliance with 10 CFR 71.87 and 49 CFR 173.443.

Chapter 8 – Acceptance Tests and Maintenance Program

8.1 Specify the backfill pressures for the tracer gases of helium/air, R-12/air, and R-134a/air mixtures used in the leak test.

The applicant calculates the allowable test leakage rates of the test gases using a test pressure of 20" Hg for helium and helium/air mixture (air, 30.8%), a test pressure of 25.0 psig for R-12, R-134a, R-12/air mixture (air, 12.2%), and R-134a/air mixture (air, 12.2%) in Section No. 4.5 of the application, but only specifies the required backfill pressures of helium, R-12, and R-134a in Section No. 8.1.4 of the application. The applicant is required to document the backfill pressures of the tracer gases of helium/air mixture, R-12/air mixture, and R-134a/air mixture in Leakage Tests of Section No. 8.1.4.

This information is required by the staff to determine compliance with ANSI N14.5 and 10 CFR 71.51.

8.2 Provide a justification for the omission of thermal and maintenance acceptance tests from the Acceptance Tests portion of the application, or revise the application to include a thermal acceptance test.

In Section No. 8.1.7 of the application, the applicant states that no thermal acceptance testing would be performed on the packaging and refers to Chapter 3 of the application. The thermal acceptance test of a package provides an indication of the quality and accuracy of manufacturing and the thermal evaluation of the package. An adequate justification should be provided if no tests are to be performed. 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 by the staff to determine compliance with 10 CFR 71.93(b).

8.3 Revise Section No. 8.2.2.1 of the application as a stand-alone procedure in instructing the user to perform appropriate maintenance and periodic leak tests.

The procedure should combine/arrange the leak test information displayed in Figure Nos. 4.1 through 4.3 (Periodic Leak Tests for Lid, Vent Port, and Drain Port), Figure Nos. 4.7, 4.11, and 4.14 (Allowable Test Leakages), and Table No. 8.1 (Periodic Leak Test of 3-60B) of the application, and then revise Section No. 8.2.2.1 (Periodic Leak Test in Maintenance Program) in a way that specifies the maintenance and periodic leak test steps in a sequential order.

The procedure should also specify the critical criteria of each tracer gas, and ensure that the cask user performs appropriate leak tests in accordance with ANSI N14.5.

This information is required by the staff to determine compliance with 10 CFR 71.85 and 71.87.