ENERGYSOLUTIONS

18 June 2010
E&L-070-10

Mr. Pierre Saverot
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Response to Request for Additional Information and Revised Application for Energy*Solutions* 3-60B,Docket No. 71-9321 and TAC NO. L24354

Dear Mr. Saverot:

Enclosed for your review and approval please find Energy*Solutions'* revised Safety Analysis Report (SAR) for the 3-60B Package. The application has been revised as required by the response to the Request for Additional Information dated April 27, 2010. Energy*Solutions* hereby requests issue of a Certificate of Compliance (CoC) for this new cask design.

There are six parts to this submittal:

1. Revised SAR; 6 CDs each with the complete SAR for staff review, one CD for NRC Document Control without the SAR drawing, which is to be withheld from public disclosure as security-related sensitive information per 10 CFR 2.390.
2. Proprietary references to the SAR, which support the demonstrations of compliance in the SAR; one CD with the documents and one CD with the associated data (two copies of each for staff review)
3. Non-proprietary references, which support the demonstrations of compliance in the SAR; one CD with the documents and one CD with the associated data (two copies of each for staff review)
4. A proprietary information affidavit for the proprietary references and data; included on the SAR CD
5. A response to each of the issues raised in your April 27, 2010 letter; included on the SAR CD

The documents are provided as PDF files along with the associated data files on the electronic media as noted above. Please discard the set of electronic media submitted earlier to you with Energy*Solutions* letter No. E&L-066-10, dated June 4, 2010.

In addition to the response to the RAI, the revised data supplied with this letter incorporates the following.

- The verbal and e-mail comments made by the staff on Chapters 4 and 8 in addition to correcting some formatting and editorial errors in Chapter 4. The changes are marked in revised Chapters 4 & 8 with revision bars on the right margin.
- An error in the data input of Energy*Solutions* document ST-551 Revision 2 was discovered. This error has been corrected in Revision 3 of ST-551.
- The revision number of ST-551 in the references of Chapter 2 of the SAR and Energy*Solutions* documents ST-557, ST-596 and ST-618 has been updated.

Should you or members of your staff have questions about the responses, please contact Mark Whittaker at (803) 758-1898.

Sincerely,

Mirza I. Baig
Technical Services Manager – Engineering & Licensing

Chapter 2 – Structural Evaluation

2.1 Provide a detailed justification for the use of static properties of the foam material in the following reports: (1) ST-551, Rev. 2; the validation of the ANSYS/LS-DYNA analysis technique using the prototype tests data from Sandia and BAM. (2) ST-557, Rev. 1; drop analyses of the package for Normal Conditions of Transport (NCT) and Hypothetical Accident Conditions (HAC).

The General Plastics "LAST-A-FOAM© FR-3700" foam material is referenced to be used for this application and is stated to meet the regulatory requirements of drop conditions. The crush strength of the "LAST-A-FOAM© FR-3700" material, like any other material, is sensitive to strain rate.

The dynamic adjustments based on the significant testing program at strain rates in the range of 30 sec^{-1} and 100 sec^{-1} was determined by General Plastics. However, the stiffer dynamic crush strength properties, suggested by the General Plastics design guide publication for radioactive material shipping container, were not used in the analyses. If the suggested dynamic properties were to be used in the finite element analyses, the structural members of the Model No. 3-60B package would be subjected to higher resultant impact forces, and consequently to higher stress intensity levels.

Note also that the Safety Analysis Report (SAR) must be revised to reflect the applicant's position on this matter.

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

RESPONSE

A new document package ST-618 has been added to the reference which provides a discourse on the foam properties used in the EnergySolutions developed modeling techniques for the drop analyses using LS-DYNA software package. This document provides a detailed discussion on the use of standard ASTM D-1621 testing data versus the dynamic data provided by General Plastics. ST-557 has been revised to include the reference to ST-618.

2.2 Provide minimum and maximum (variability) foam material properties based on the density that will be used in the fabrication of the Model No. 3-60B package.

The foam properties in the principal directions are expected to be varying as some percentage of the median value. Therefore, the applicant needs to ensure that, through the selected foam properties, the worst resultant forces could be transferred under NCT and HAC.

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

RESPONSE

A new document package ST-618 has been added to the reference which addresses the tolerance on the foam properties allowed by the procurement specification and its effect

on the computed quantities by the finite element program. ST-557 has been revised to include the reference to ST-618.

2.3 Correct the lid bolt shear stress calculations in ST-609, Rev. 0.

The tensile-area of 1.41 in^2 for the cross section of 1-1/2 inch lid-bolt was considered for the shear stress calculations. However, the root-area of 1.29 in^2 for the cross section of lid bolt needs to be used to determine the shear stress levels.

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

RESPONSE

The calculations in ST-609 have been revised to use the "conservative" root area for the shear stress calculations.

2.4 Provide a justification for not considering all the surface forces (FX, FY, FZ) at the skirt tip in ST-609, Rev. 0.

The staff believes that the resultant force from all combined surface forces (FX, FY, FZ) at the skirt tip needs to be considered for the skirt-lid interaction under HAC.

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

RESPONSE

The calculations in ST-609 have been revised to conservatively use the SRSS value of the combined forces instead of the only the bearing force.

2.5 Provide a justification for the assumption that two lid bolts near the 6 o'clock location could equally carry the entire impact force, as stated in ST-609, Rev. 0, for both the side and corner drop cases.

The staff believes that the maximum resultant force may be carried by two lid bolts, but may not be equally carried by two lid bolts under HAC cases. Based on the local deformation of the skirt, for both the side and corner drop cases, the applicant should determine the worst resultant force, and recalculate the shear stress on a lid bolt.

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

RESPONSE

ST-609 has been revised to distribute the reaction force in a non-uniform fashion. The distribution assumed results in 80% of the load being reacted by one bolt alone.

2.6 Provide weld qualification calculations for "trunnion (item 18)" to "trunnion back-up plate (item 19)," and "trunnion back-up plate (item 19)" to the "outer cask shell (item 7)" for the load conditions covered in ST-503, Rev. 1.

The cross sectional properties of the welds appear to be smaller than the cross sectional properties of the structural members at weld joints, and the allowable stress intensity limit of the welds is lower than the allowable stress intensity of the materials; thus, the weld qualification calculations must be provided to justify the structural integrity of the containment boundary under the loading conditions addressed in 10 CFR Part 71.45.

Item numbers listed above were taken from the "Bill of Materials" list in Drawing No. C-002-165024-001, Rev. 0, "3-60B Cask General Arrangement and Details."

This information is required by the staff to determine compliance with 10 CFR Part 71.45.

RESPONSE

ST-503 has been revised to clearly indicate that the finite element models explicitly represent the welds. Therefore, the weld stresses are bounded by the maximum stress in the finite element model. The AWS welding process ensures that the weld materials have higher strength than the base metal. Therefore, the weld materials are also qualified, if the base metals meet the corresponding allowable values.

Chapter 3 – Thermal Evaluation

3.1. Revise the calculations for the maximum pressure within the 3-60B containment vessel under NCT.

The maximum pressure within the 3-60B containment vessel under NCT is attributed to the radiolytic gas generation, the thermal expansion of initial gases, and the pressure of the water vapor within the package. Therefore, the applicant should calculate a maximum NCT pressure attributed to these three sources, i.e., the pressure induced by the radiolysis and the subsequent thermal expansion, the pressure increase from the initial gas/air due to thermal expansion, and the pressure due to the water vapor.

The application should include the equations, the related parameters and values, and the calculations, including the pressure due to the water vapor.

This information is required by the staff to determine compliance with 10 CFR 71.35, 71.43(d), and 71.71.

RESPONSE

Section 3.3.2 has been revised to show the pressure contribution from radiolytic gas generation, the thermal expansion of initial gases, and the pressure of the water vapor within the package, including the equations and related parameters.

3.2. Provide the allowable temperature limits, the melting points, and the ignition temperatures of the package contents under NCT and HAC.

The applicant modeled the package contents with air and displayed the calculated temperatures of the package cavity and the waste container (waste contents) in Table No. 3-3 of the application, without providing the maximum allowable temperature limits of

the package contents under NCT and HAC. The applicant should:

(1) Explain or verify that, instead of modeling the package contents in the cavity, as specified in Section No. 1.2.2 of the package application, the simulation of the air in the cavity is the bounding case for the thermal analyses, and

(2) Provide the melting points, the auto-ignition temperatures, and the allowable temperature limits of the package contents under NCT and HAC. The applicant should ensure that the package contents will not be melted or ignited under NCT and HAC.

This information is required by the staff to determine compliance with 10 CFR 71.35, 71.43(d), 71.71, and 71.73

RESPONSE

1) Section 1.2.2 of the SAR states that, the contents of the cask shall be packaged in secondary containers. For the thermal analysis, the waste content is considered to be concentrated in the wall of the liner. As detailed in Section 5.4.2 of TH-022, Rev.2, the size of the liner has been conservatively assumed to be much smaller than the actual liner. This assumption not only concentrates the heat load in a smaller volume than the actual heat load but also increases the cavity air thickness around the liner thereby increasing the thermal insulation around the waste. The entire heat load of 500W is concentrated in the wall of this liner not the air of the cavity. This simulation results in a conservative representation of the waste content temperature under both NCT and HAC loadings.

2) Inorganic solid contents are stable inorganic compounds such as oxides, nitrates, sulfates, or chlorides. Solidified materials are radioactive liquids solidified with cement. Inorganic resins are mineral compounds with ion-exchange properties, such as zeolites. Reactor or accelerator components are metal, usually stainless steel. None of these materials have melting points or auto-ignition temperatures less than the maximum contents temperature of 294°F. To ensure no inappropriate contents are loaded in the cask the following prohibition will be added to the contents description: Materials that may auto-ignite or change phase (i.e., change from solid to liquid or gas) at temperatures less than 300°F, not including water, shall not be included in the contents. In addition, as required by 10 CFR 71.43 (d), the contents shall not include any materials that may cause any significant chemical, galvanic, or other reaction.