ENERGY*SOLUTIONS*

April 4, 2014
ES/NRC 14-007
Docket No. 71-9321

ATTN: Document Control Desk
Director, Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: **Response to Request for Supplemental Information – Application for Amendment 1 of Certificate of Compliance for the Model No. 3-60B Package (TAC No. L24883)**

References:
1. Letter from S. Sisley (Energy*Solutions*) to U.S. Nuclear Regulatory Commission, "Amendment Request for Certificate of Compliance No. 9321 for the Model 3-60B Type B Shipping Cask," ES/NRC 14-003, January 30, 2014, ADAMS Accession Number ML14034A135.

2. Letter from C. Allen (NRC) to S. Sisley (Energy*Solutions*), "Application for Certificate of Compliance for the Model No. 3-60B Package – Supplemental Information Requested," March 21, 2014, ADAMS Accession Number ML14083A045.

By letter dated January 30, 2014 (Reference 1), Energy*Solutions* (ES) submitted an application to amend the Certificate of Compliance (CoC) for the Model No. 3-60B Type B Shipping Cask. By letter dated March 21, 2014 (Reference 2), NRC staff requested that ES provide supplemental information needed for NRC staff to continue their review of the application. The Request for Supplemental Information (RSI) also included observations.

ES hereby provides the information requested by NRC in the Reference 2 letter, as described in Enclosure 1, Responses to Request for Supplemental Information. Enclosure 1 also includes responses to the observations included in the Reference 2 letter. As discussed in Enclosure 1, the Safety Analysis Report (SAR) for the Model 3-60B Type B Shipping Cask has been revised in response to the Reference 2 letter. A detailed summary of SAR changes is included in Attachment 1 of this letter. Enclosure 2 contains one (1) paper copy of the non-public version of the revised 3-60B Safety Analysis Report (SAR), which contains security-related sensitive information that should be withheld under 10 CFR 2.390. Enclosure 3 contains one (1) paper copy of the public version of the revised 3-60B SAR.

Should you or any member of your staff have questions, please contact the undersigned at (408) 558-3509.

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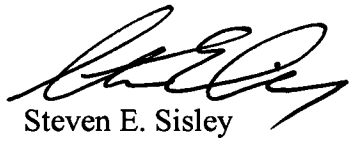
Sincerely,



Steven E. Sisley
Cask Licensing Manager
Energy*Solutions*

Attachment:
1) Summary of Changes, 3-60B SAR, Revision 5 (2 pages)

Enclosures:
1) Responses to Request for Supplemental Information (7 pages),
2) Safety Analysis Report for Model 3-60B Type B Shipping Cask, Revision 5, April 2014, Non-Public Version (1 paper copy), **(Security-Related Information – Withhold Under 10 CFR 2.390)**,
3) Safety Analysis Report for Model 3-60B Type B Shipping Cask, Revision 5, April 2014, Public Version (1 paper copy),

cc w/ enclosure
Chris Allen, U.S. NRC, NMSS, SFST
Dan Shrum, Energy*Solutions*

The following is a summary of the changes incorporated in the Safety Analysis Report for Model 3-60B Type B Shipping Cask, Revision 5.

Summary of Changes, 3-60B Safety Analysis Report, Revision 5

Section	Page(s)	Change	Purpose
1.3	1-9	Change revision number of general arrangement drawing.	General arrangement drawing revised in response to RSI.
1.3	---	Add flagnote 35 and QL column to Sheet 1 of Dwg. No. C-002-156024-001, Rev. 2.	Revised in response to Observation #1 of the "Structural & Materials" section of the RSI.
1.3	---	Revise the short term service temperature requirement in flagnote 13, 3rd bullet, on Sheet 1 of Dwg. No. C-002-156024-001, Rev. 2.	Revised in response to Observation #1 of the "Thermal" section of the RSI.
1.3	---	Revise Item 4 leader location on Detail R on Sheet 8 of Dwg. No. C-002-156024-001, Rev. 2.	Editorial correction. Item 4 leader location was incorrect on Revision 1 of drawing.
2.2.1	2-5	Increase the required short-term temperature limit of the seal material from ≥350°F from to ≥400°F.	Revised in response to Observation #1 of the "Thermal" section of the RSI.
3.2.2	3-2	Increase the required short-term temperature limit of the seal material from ≥350°F from to ≥400°F.	Revised in response to Observation #1 of the "Thermal" section of the RSI.
3.5.1	3-12	Revised document revision number in Reference [3-8].	Editorial correction. Document was revised in response to the NRC RAI prior to issuance of the initial CoC, but the SAR reference was not revised at that time.
Table 3-1	3-19	Add note (3) to clarify that the location of the reported seal temperature and that it is bounding for all other containment seals.	Revised in response to Observation #1 of the "Thermal" section of the RSI.

Summary of Changes, 3-60B Safety Analysis Report, Revision 5

Section	Page(s)	Change	Purpose
Table 3-2	3-19	Revise the maximum calculated temperature value for the seal to include the peak temperature of the drain port plug seal. Add note (1) to discuss the reported seal temperatures.	Revised in response to Observation #1 of the "Thermal" section of the RSI.
4.1	4-3	Revise to increase the maximum short-term temperature limit from ≥350°F to ≥400°F.	Revised in response to Observation #1 of the "Thermal" section of the RSI.
8.1.5	8-2	Revised first sentence to correct reference to the Quality Assurance Program.	Revised in response to Observation #2 of the "Structural & Materials" section of the RSI.

Enclosure 1

Responses to Request for Supplemental Information

(7 pages)

The responses to the NRC Request for Supplemental Information (RSI) and Observations associated with the Energy*Solutions* (ES) request to amend the Certificate of Compliance (CoC) for the Model No. 3-60B Type B Shipping Cask are provided below. The NRC RSI and Observation questions, which are shown in *italics*, are followed by the ES response and a summary of the resulting changes to the 3-60B Safety Analysis Report (SAR).

Thermal

1. *Provide further justification that the previous application's thermal analyses bound the proposed changes in the current application, or provide the following documentation that supports the Chapter 3 thermal analyses:*

   a) *ANSYS input and output files (.db, text readable files, etc.)*
   b) *Energy Solutions Document No. TH-022, Rev. 1 (steady-state NCT thermal analyses of 3-60B cask)*
   c) *Energy Solutions Document No. TH-023, Rev. 3 (HAC thermal analyses of 3-60B cask)*

   The above files and documents would provide model details and help staff to perform a thermal review if the previous amendment's thermal analyses do not bound the proposed changes.

   This information is needed to determine compliance with 10 CFR 71.33.

   Response:

   NRC staff has already reviewed the information that is being requested and determined that it is acceptable. As stated in Section 3.5 of the NRC's Safety Evaluation Report (SER) for Revision 0 of Certificate of Compliance No. 9321 for the Model No. 3-60B Package, "*The staff has reviewed the package description, model evaluation, the material properties, and component specifications used in the thermal evaluation and has reasonable assurance that the information provides sufficient basis for evaluation of the package against the thermal requirements of 10 CFR Part 71.*" Section 3.5 of the SER also states that "*The staff has reviewed the methods used in the thermal evaluation and has run the applicant's ANSYS files to verify the results given in the application.*" and that "*The application of the analysis methods, presented in the application, to this package design has been found to be adequate.*". As discussed in Section 3.3 and detailed in the response below, the proposed cask design changes do not significantly affect the thermal response of the package and the results of the existing thermal analysis are bounding for both cask Configurations A and B. Therefore, no further review of the requested documents and ANSYS computer run files should be required.

   The proposed changes to the 3-60B cask design do not require revision of the 3-60B cask thermal evaluation because the existing thermal evaluation is bounding for the proposed cask design changes. The existing finite element model used for the thermal evaluation of the 3-60B cask is based on cask "Configuration A," whereas "Configuration B" includes the

proposed cask design changes that differ from, but are bounded by, the existing finite element model. As discussed in Section 1.2 and shown in the general arrangement drawing included in Section 1.3 of the SAR, Configurations A and B are identical in most respects. The only significant differences between Configurations A and B that require consideration in the thermal evaluation are as follows:

- Bottom Corner Detail: As shown in Details –B– and –B2– on Sheet 4 of the general arrangement drawing, cask Configuration B eliminates the cask bottom cover forging (Item 10) that is included in cask Configuration A between the outer shell (Item 7) to the bottom plate (Item 11). Instead, the outer shell and bottom plate are extended to the corner and connected directly to one another by a full-penetration groove weld in cask in Configuration B. Since the thermal properties of the outer shell and bottom plate are the same as those of the bottom cover forging and there are no other differences in the cask bottom corner geometry, the existing thermal model is concluded to be applicable to, and representative of, both cask Configurations A and B.

- Cask Lid Assembly - Seal Ring Design: The cask lid assembly designs for Configurations A and B (Items A5 and A6, respectively) are shown on Sheets 5 and 6 of the general arrangement drawing. As discussed in Section 1.2.1, the Configuration A and B lid assembly designs differ primarily in the seal features. Configuration A, upon which the thermal model is based, includes a separate seal ring with two O-ring grooves that is welded to the inner surface of the lid outer plate, whereas in Configuration B the seal ring is integral to the lid outer plate and has three O-ring grooves. O-ring grooves are not explicitly modeled in the 3-60B cask thermal analysis since they have no significant affect on its thermal response. The thermal evaluation models the separate seal ring design of cask Configuration A, conservatively assuming full thermal connectivity (i.e., no thermal contact resistance) across the interface between the seal plate and lid outer plate. This is conservative and bounding for Configuration A, particularly for the HAC thermal test, since it allows maximum heat transfer to the seal region during the 30-minute HAC fire and results in a bounding peak temperature for the O-ring seal. For Configuration B, this represents the actual thermal response and is directly applicable.

- Vent Port Plug Assembly – Seal Ring Design: The vent port plug assembly designs for Configurations A and B (Items A7 and A8, respectively) are shown on Sheet 7 of the general arrangement drawing. The primary difference between the two vent port plug assembly designs is the seal ring. Similar to the cask lid assemblies discussed above, the Configuration A vent port plug assembly includes a separate seal ring (Item 42) that is welded to the vent port cover plate (Item 35), whereas Configuration B has a seal ring that is integral with its vent port cover plate. The two configurations also differ in the geometry of the vent plug bar (Item 40) and its connection to the vent port cover plate (Item 35), although these differences are minor and do not have any measurable effect on the cask temperatures. The vent port plug assembly is not explicitly modeled for the thermal evaluation because it is relatively small and has little influence on the overall thermal response of the cask. The peak temperatures in

the proximity of the vent port plug assembly for NCT and HAC are bounded by the peak temperatures occurring elsewhere in the cask. Thus, it is not necessary to include a detailed representation of the vent port plug assembly in the thermal model.

Because the existing thermal evaluation of the 3-60B cask is bounding and directly applicable to the cask amendment request, it is not necessary to provide copies of the requested documents and ANSYS files that were previously provided to and reviewed by NRC staff for the initial issue of the CoC.

Summary of SAR changes:

- None.

2. *Provide allowable temperatures, and their references, for seals and impact limiter foam.*

   In order to perform a thermal review, the allowable temperature of the impact limiter foam should be provided so that it can be compared with calculated values. Likewise, references that list the allowable temperatures of the foam and the various seal materials should be provided for verification.

   This information is needed to determine compliance with 10 CFR 71.33.

   Response:

   The allowable temperatures for the elastomeric material used for the containment O-rings are provided in Section 3.2.2. The O-ring material compound must have a normal service temperature range (i.e., long-term continuous temperatures for NCT and HAC, exclusive of the HAC thermal test) from -40°F to 250°F and be capable of withstanding a maximum short-term (i.e., 1-hour excursion) temperature for the HAC thermal test (fire) of 350°F. As discussed in Section 8.1.5.2, the elastomeric compounds used for the containment O-rings will be qualified based on a range of tests, including temperature-pressure testing using the methods described in ASTM E1069-85 at a long- and short-term temperatures of 250°F and 350°F, respectively. Per Figure 2-3 of the Parker O-Ring Handbook,[1] several elastomeric compounds, including ethylene-propylene-diene-rubber (EPDM) and silicone rubber (VMQ), have long- and short-term temperature ranges that satisfy these criteria. As discussed below in the response to Observation 1 for Thermal, the SAR has been revised to increase the minimum required short-term temperature of the elastomeric compound used for the cask containment seals to 400°F.

   The maximum allowable temperature for the polyurethane foam (LAST-A-FOAM FR-3700) used in the impact limiters for continuous service is 250°F.[2] The temperatures in the impact

[1] Parker Hannifin Corporation, 5700 Handbook, Parker O-Ring Handbook, 2001 Edition.

[2] General Plastics Manufacturing Company, LAST-A-FOAM User Guide, Tooling and Molds, Rev. 10.10.13, www.generalplastics.com.

limiter foam are not calculated in the thermal analysis due to the conservative modeling approach used. For the NCT thermal evaluation, the impact limiter foam is not explicitly modeled; instead adiabatic boundary conditions are modeled on the outside surfaces (i.e., foam side) of the impact limiter inner casing plates, conservatively assuming the foam to be a perfect insulator. This approach results in conservatively high temperatures on the ends of the cask. The results of the NCT thermal evaluation show that the maximum temperatures at the ends of the cask are less than 180°F, which is lower than the maximum allowable foam temperature of 250°F. Furthermore, if the impact limiter foam is treated in a more realistic manner in the thermal evaluation, the maximum temperature at the inside of the impact limiter foam will be much lower than 180°F and the bulk average temperature of the foam will be only slightly higher than the ambient air temperature of 100°F for NCT hot conditions.

For the HAC thermal evaluation, the impact limiter foam is not explicitly modeled and it is assumed not to provide any insulation from the effects of the fire, even though the structural evaluation concludes that the impact limiters will remain intact and attached to the cask following the HAC free drop and puncture drop tests. Therefore, no temperatures are calculated and no temperature limits are provided for the impact limiter foam for the HAC thermal test.

Summary of SAR changes:

- None.

Observations

Thermal

1. *Clarify whether the maximum temperature of the seals during NCT and HAC include all of the seals, such as lid, drain, etc.*

   Table 3-1 and Table 3-2 provide a maximum seal temperature during NCT and HAC, respectively, but there is no indication that this represents the maximum value of all the seals used in the package.

   This information is needed to determine compliance with 10 CFR 71.33.

   Response:

   The maximum seal temperatures reported in Tables 3-1 and 3-2 for NCT and HAC, respectively, occur at the location of the cask lid assembly containment O-ring. The other containment O-ring seals on the cask include the vent port plug assembly inner O-ring (Item 39 on Configurations A and B) and the test port plug fastener seal (Item 57 on Configuration B), which are all embedded in the lid outer plate and located near the plate perimeter (as shown in the cut-away side views on Sheet 2 of the general arrangement drawing), and the drain port plug fastener seal (Item 24 on Configurations A and B), which is

located in the bottom corner region of the cask body assembly (as shown in the section views on Sheet 4 of the general arrangement drawings).

For NCT, as shown in Figures 3-4 through 3-7, the temperatures in the regions of these other containment O-rings are approximately the same or lower than the temperature at the location of the cask lid assembly containment O-ring. Therefore, the maximum temperature of 249°F, as reported in Table 3-1, is a bounding NCT temperature for all of the cask containment O-rings.

For the HAC thermal test condition, the peak temperature of the drain, vent port, and test port containment seals may exceed the maximum temperature of 288°F reported for the cask lid assembly containment O-ring for the HAC thermal test in Table 3-2. Based upon the temperature time-history and temperature contour plots shown in Figures 3-11 and 3-12, respectively, the highest seal temperature is expected to occur in the drain port plug containment O-ring located near the bottom corner of the cask body. As shown in Figure 3-12, the temperature in the bottom corner region of the cask body near the drain port plug seal, which is slightly higher than the temperature at the center of the cask bottom outer plate, reaches a peak temperature of approximately 350°F. Therefore, minimum required short-term temperature of the elastomeric compound used for the cask containment seals has been increased from 350°F to 400°F to provide additional design margin. Furthermore, as discussed in the response to RSI-2 above, the elastomeric compound used for the cask containment seals will be qualified based on testing using the methods described in ASTM E1069-85 for the minimum required short-term temperature of 400°F.

If the impact limiter foam were modeled in a more realistic manner (rather than conservatively neglecting it), the peak temperature of all containment O-ring seals will be much lower than predicted in the thermal evaluation due to the insulating effects of the impact limiter foam. When exposed to pool-fire conditions, the polyurethane foam used in the 3-60B impact limiters decomposes into an intumescent char that swells and tends to fill voids or gaps (such as those that may be created by free drop or puncture bar damage). The resulting char layer shields the underlying undamaged foam from further direct exposure to the external high temperatures. Since the decomposition of the foam under elevated temperatures is an endothermic process, the foam is self-extinguishing and will not support a flame once the external temperature is removed. Fire tests conducted on the polyurethane foam used in the impact limiters show that the total recession of the foam due to the HAC fire will be only a few inches at most, leaving the majority of the foam thickness in an undamaged state to insulate the ends of the cask from the direct effects of the fire. While no credit is taken for these insulating effects of the impact limiter foam, these effects provide additional assurance that the peak seal temperatures during the HAC thermal test will remain well below the maximum allowable temperature of 350°F.

Summary of SAR changes:

- Section 1.3, Drawing No. C-002-165024-001, Revision 2: Revise the 3rd bullet in flagnote 13 to increase the maximum short-term (1-hour) temperature limit from ≥350°F to ≥400°F.

- Section 2.2.1, pg. 2-5, 3rd paragraph: Revise the last sentence to increase the maximum short-term (1-hour) temperature limit from ≥350°F to ≥400°F.

- Section 3.2.2, pg. 3-2, 1st bullet: Revise to increase the maximum short-term (1-hour) temperature limit from ≥350°F to ≥400°F.

- Table 3-1, pg. 3-19: Add note (3) to clarify that the location of the reported seal temperature and that it is bounding for all other containment seals.

- Table 3-2, pg. 3-19: Revise the maximum calculated temperature value for the seal to include the peak temperature of the drain port plug seal. Add note (1) to discuss the reported seal temperatures.

- Section 4.1, pg. 4-3, "O-rings": Revise to increase the maximum short-term (1-hour) temperature limit from ≥350°F to ≥400°F.

Structural & Materials

1. *Provide a classification for all structures, systems, and components (SSCs), including welds, according to their importance to safety. Engineering justification should be provided for weld classification based on their role in the package.*

   All SSCs should be identified as either important to safety (ITS) or not important to safety (NITS), either in the SAR or on the licensing drawings. ITS components should be further categorized into one of three classification categories (A, B, or C), based on the component's importance to safety. Further guidance can be found in NUREG/CR-6407: "Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety." Note also that per NUREG-CR-6407: "Welds that join a component (such as a cylinder longitudinal seam weld) are the same classification as the components they are a part of."

   This information is needed to ensure compliance with requirements in 10 CFR 71.101(b) and 71.107(a).

   Response:

   The general arrangement drawing included in Section 1.3 of the SAR has been revised to add the Quality Level of each item.

   Summary of SAR changes:

   - Section 1.3, General Arrangement Drawing: Revised as noted above.

2. *Verify correct referencing to a Quality Assurance Program in Section 8.1.5, "Component and Material Tests."*

The section references a Quality Assurance Program as detailed in Appendix B of 10 CFR Part 71. Appendix B does not exist. The Quality Assurance Program is detailed in Subpart H of 10 CFR Part 71.

This information is needed to ensure compliance with requirements in 10 CFR 71.7(a).

Response:

The reference to the Quality Assurance Program in Section 8.1.5 has been corrected.

Summary of SAR changes:

- Section 8.1.5: Revised first sentence of section to delete reference to "Appendix B" of 10 CFR Part 71, since it is not correct.