ROBATEL technologies

30 November 2012

Mr. Pierre Saverot
Project Manager
Licensing Branch
US Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Response to RSI dated 15 November 2012

Reference: 1) Docket No. 71-9365, TAC No. L24686
2) USNRC Request for Supplemental Information, dated 15 November 2012
3) Revision 0 - Safety Analysis Report for the RT-100 Package, dated 09 October 2012

Dear Mr. Saverot:

Please find attached Robatel Technologies, LLC response to USNRC Request for Supplementary Information (RSI) letter dated 15 November 2012 regarding our license application for the RT-100 Package as a Type B(U)-96 Package.

On review, we have determined that elements of questions raised in the RSI letter as well as our reply to those questions disclose Robatel proprietary and trade secret information. We are requesting this information be withheld from public disclosure. Exact detail and reference is made in the attached affidavit related to this and other corresponding submittals.

Please do not hesitate to contact me directly at tgrochowski@robateltech.com or by phone if you have any questions to our reply or items for clarification. Thank you for your attention to our submittal.

Cordially,

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Robatel Technologies Responses to the
NRC Request for Supplemental Information and Observations
for the
Model No. RT-100 Package
Docket No. 71-9365

This Request for Supplemental Information (RSI) identifies information needed by the staff in connection with its acceptance review of the Robatel Safety Analysis Report, Revision No. 0, dated October 9, 2012. The requested information is listed by chapter number and title in the applicant's Safety Analysis Report.

Chapter 1 – General Information

1.1 *Describe the types of metals housing the content's media, and the potential reactions of the metal(s) with both the contents and water.*
The applicant noted in Section 1.2.2.3 of the application that contents may also include metal(s) housing the media. The applicant should describe the types of metals and their potential reactions with contents and water.
This information is required by the staff to determine compliance with the requirements of 10 CFR 71.33(a)(5)(v) and 71.33(b)(3).

Robatel Response – Comment 1.1:
The secondary containers are either polyethylene or metal liners used to package resins or filters generated by nuclear power plants. There is a long history of the transportation of these resins and filters using typical polyethylene and metal liners in metal casks by the nuclear power industry and other low-level waste generators. The stainless steel used in the fabrication of the RT-100 inner cavity does not interact with the polyethylene or metal liners typically used in the nuclear industry for the shipment of resins and filters.
Filters packaged in the secondary liner can have metal housings. The metal housings for the filters are designed to be utilized in an operating nuclear power plant's primary water chemistry and thus, are most likely to be stainless steel or other similar non-corrosive or reactive metal. They are designed to provide for the filtration of radioactive materials from the water, and thus are acceptable for use in a radiation environment. These filter housings do not interact with the secondary container and therefore, do not interact with the RT-100 metal cavity.

1.2 *Clarify the maximum allowable shipping time for the package.*
The applicant explained in Section 1.2.2.6 that "the shipper will ensure that the total amount of hydrogen gas……and during twice the expected shipping time will be limited to a molar quantity that would be no more than 5% by volume of the secondary container void at STP conditions." The applicant should clarify the maximum allowable shipping time, i.e., number of days, within which transportation will be completed and for which the amount of hydrogen generation will be evaluated.
This information is required by the staff to determine compliance with the requirements of 10 CFR 71.43(d).

Robatel Response – Comment 1.2:
As indicated in Section 1.2.2.6, it is the shipper's responsibility to ensure that any hydrogen generation in the cavity will be below 5% by volume, which represents the lower flammability limit for hydrogen. The maximum allowable shipping time is not restricted for any other reason. This approach is equivalent to that utilized in several other NRC-approved transport cask Safety Analysis Reports.

Licensing Drawings and Bill of Materials

1.3 *Provide legible versions of the Bill of Materials and Licensing drawings in Appendix 1 of the application.*

The Bill of Materials and licensing drawings are critical elements of an application that describes the package's design. The detailed drawings that were provided were not clearly legible. A detailed review cannot be completed without legible licensing drawings.

This information is required by the staff to determine compliance with the requirements of 10 CFR 71.31(a).

Robatel Response – Comment 1.3:
The Bill of Materials & drawings are updated to provide improved legibility.

Chapter 2 – Structural Evaluation

2.1 *Clearly indicate which material properties were used for the impact limiter analysis in Section 2.13 of the application. Tabulate the static and/or dynamic stress-strain curves, as applicable, that were used to analyze the impact limiters. Identify the level of variability that is considered in the analysis and justify any deviations from the manufacturer's recommendations of ±15% for densities greater than 8 pcf and ±20% for densities less than or equal to 8 pcf. Justify the use of temperature-independent thermal conductivity values for the polyurethane foams: FR-3705, FR-3720, and FR-3740, as indicated in Table 3.2-1 of the application.*

The package evaluation is largely dependent on the material properties used as inputs to the analytical models. However, the properties used for the impact limiter foam were either not clearly identified nor justified in some cases.

This information is required by the staff to determine compliance with the requirements of 10 CFR 71.35(a).

Robatel Response – Comment 2.1:
The foam material properties utilized in the analysis considered a density range of ±10% as specified in Section 2.13.2.2.1. These tolerance ranges are imposed as a requirement during foam procurement in accordance with the procurement specification PAP-008. The SAR is revised to include this specification as a reference in Chapter 2.

The thermal conductivity of polyurethane foam is provided only as a single value at ambient temperature. Because of the highly insulating nature of the foam material, it was determined that the use of this value is acceptable. As shown in the temperature results in Chapter 3, the foam provide essentially no heat transfer across the impact limiters. As a result, much of the foam mass remains at ambient temperatures throughout the normal and hypothetical accident loading conditions. The SAR is revised to provide this additional clarification in Chapter 3.

2.2 *Revise, as appropriate, Attachment 2.13-B, Volume II, "Verification of Selected Crush Strength Strain Equation Form," by clarifying the following:*

a. *Justify the use of foam crush strength data in the "densification region," particularly for strains beyond 60%. Explain how lock-up is considered and evaluated in the analysis.*

Earlier versions of the General Plastics LAST-A-FOAM FR-3700 for Crash and Fire Protection of Nuclear Material Shipping Containers (NRC ADAMS ML050410066) indicate that the polyurethane foams begin to lock up and shouldn't be pushed beyond strains of 60%. Use of foam property data in the densification region may have a significant effect on calculated deceleration values.

Robatel Response – Comment 2.2a:
The foam material properties at higher strain rates are evaluated using conservative extrapolations as described further in response to comment "b" below. These extrapolations are shown to be conservative via comparison to the scale model drop test results.

The extrapolation method utilized for the curves was carefully selected to ensure conservatism in the results. This was confirmed by comparison to the 125B drop test results, and later to the RT-100 scale model results.

The SAR is revised to provide additional clarification regarding the process of evaluating potentially high strains in the foam, and comparison to the actual drop test results.

b. *With respect to the BAM results presented in the 2012 paper by Eva M. Kasparek, et al., (Reference 1), explain whether the* ***true*** *(boldface added) stress-logarithmic strain relations are used for arriving at Equation 2 of Page 2-64, Volume II, for extrapolating the General Plastics foam testing data for foam strains greater than 70%.*

The stress-strain plots of the BAM paper appear to be associated with true strains. However, it is unclear, from Figures 1 and 2 of Attachment 2.13-B, Volume II of the application, whether Equations 1 and 2 are formulated with true strains. If, indeed, true strains were considered in Equations 1 and 2 for comparing the BAM test results with the equation-extrapolated stress-strain curves, also explain how true strains were used in the numerical integration solution, in Section 2.13.3.1, for calculating dissipated energy, deceleration, velocity, and crush depth of the RT-100 package impact limiter.

Robatel Response – Comment 2.2b:
The BAM results (Ref. 1) are indeed true stress-logarithmic strain while the crush strength data supplied by the foam manufacturer is provided in terms of engineering stress and engineering strain. The SAR is revised to remove references to the BAM paper while retaining the extrapolation methodology. The revised SAR demonstrates that the calculated impact limiter results are conservative when compared to the 125B drop tests and the scale model RT-100 drop test results. This confirms that the extrapolations of foam behavior obtained with equations 1 and 2 provide conservative predictions of cask decelerations and crush depths.

c. *Provide an appropriate reference for Table 2.13.4.1-1, "Crush Strength for Cask 125B – Excerpt from Reference 37."*

Section 2.12 "References" of the application, cites, as Reference 37, the 2012 BAM paper by Eva M. Kasparek, et al. However, in a cursory staff review of Sandia National Laboratory (SNL) Report, SAND85-2129/UC-71, as cited in Section 2.14.4.1, "Verification with Published Data," Volume II of the application, the staff could not find the tabulated crush strength curves as presented in Table 2.13.4.1-1 for the NuPac 125B ¼-scale cask drop tests.

Robatel Response – Comment 2.2c:
This reference should be to the following paper:

"Benchmarking of LS-DYNA for Use with Impact Limiters," J. C. Nichols, et al, WM'01 Conference, February 2001.

The Sandia report does not include material property information for the foam, so it was obtained from this paper. The SAR is revised to provide the proper reference.

d. *Provide a summary, in the application, of the foam crush strains, including locations where they developed in the impact limiter, corresponding to the maximum decelerations reported in Table 2.13.4.1-3, "Maximum Decelerations Summary," to facilitate staff's review of the impact limiter performance.*

The calculated maximum decelerations can be very much dependent on the foam crush strain beyond 60%. The peak strains reached at key impact limiter locations are, therefore, needed to help assess the impact limiter performance during a 30-ft free-drop accident.

Robatel Response – Comment 2.2d:
The SAR is revised to provide a table of maximum strains. While some drop orientations are calculated to exhibit high strains, in some cases above 70%, the decelerations calculated are shown to conservatively bound the drop test results.

e. *Provide the General Plastics/Robatel benchmarking drop testing report for the FR 3700 series foam used in the impact limiters.*

Staff notes that the impact limiter is constructed of multiple foam components. Each component has a different geometric configuration and density. Provide the report, with a schematic of an impact limiter assembly) that documents the impact limiter response in a physical drop test. Include test article fabrication information that links the test article to the proposed design.

The information cited in Items a through e above is needed by the staff to determine compliance with the requirements of 10 CFR 71.73(c)(1).

Robatel Response – Comment 2.2e:
The scale model drop test report is provided, along with the assembly drawings for the scale model. These documents illustrate how the foam block construction utilized in the scale model matches that of the full-sized cask.

2.3 *Justify that the numerical integration can terminate before reaching "apparent" peak decelerations for the deceleration vs. time plot displayed on Page 2-29 and 2-30, Volume II. In addition, discuss the differences between the NuPac Cask 125B and the RT-100 impact limiter designs that may influence the correlation between the analytical results and the package behavior, considering differences in foam formulation, inclusion of more than one foam formulation, and complexity of the geometry, at a minimum.*

The calculation is incomplete to demonstrate verification or benchmarking of the Enercon impact limiter analysis methodology. The calculated deceleration time histories do not appear to have reached plateaus, which indicate that higher calculated decelerations could result. The calculated deceleration is not conservative in all cases for the NuPac Cask 125B case and it is not clear that trending that is observed would translate to the Model No. RT-100 package design.

The information is needed by the staff to determine compliance with the requirements of 10 CFR 71.73(c)(1).

Robatel Response – Comment 2.3:
The decelerations vs. time plots in the SAR terminate at the point where the velocity of the cask is calculated to be zero. Once the body is at rest, there is no additional acceleration on the cask, and it can be assumed that the forces from deceleration drop to zero. The 125B test data is utilized to demonstrate that the numerical integration approach utilized to evaluate impact limiter performance can conservatively predict the decelerations resulting from the drop tests. This benchmarking is independent of any specific similarities between the 125B and RT-100 designs. The technique is further benchmarked against the RT-100 scale model drop test results that are provided with this response.

The SAR is revised to add these clarifications to the text.

2.4 *Provide a summary description of the rigid body decelerations under a 30-ft free drop hypothetical accident condition in "Section 2.7.1 Free Drop," Volume I of the application, to demonstrate that consistent loading conditions are considered for structural integrity analysis of the packaging components.*

*Page 2-69, Volume I of the application states, "The inertia loads imposed upon the cask by the impact limiter...being acted upon by a design deceleration value of **60 g** (boldface added) for the 30-ft end-drop case." It is unclear why the design deceleration is far less than all of the values reported in Table 2-13.4.2.1.1-1, "Maximum Decelerations Summary for 9.0 m End-Drop Case." Please, note that this request applies to all other drop orientations.*

The information is needed by the staff to determine compliance with the requirements of 10 CFR 71.73(c)(1).

Robatel Response –Comment 2.4:
The SAR is revised to add a summary table of decelerations considered as design basis for the cask body evaluations to Section 2.7.1.

The 60g deceleration value listed on Page 2-69 is a typographical error and is corrected.

2.5 *Provide a report consistent with ISG-21 to ensure that computational modeling for finite element analysis is properly and sufficiently done.*

Staff noted that reports ST-402 and ST-403 document normal conditions and hypothetical accident condition tests. However, the reports do not adequately address the criteria listed in ISG-21 "Use of Computational Modeling Software".

Of particular interest, but not limited to, staff is interested in the applicant's selection of elements and the meshing scheme. Sensitivity analyses should also be incorporated in the element selection/meshing methodology. Also, the applicant needs to benchmark the "ability of the code" and their "use of the code" against a physical drop or other established test. Note that these studies may be applicable to some drop/load cases, and not others (e.g., side drop vs. lid down end drop).

ISG-21 is a comprehensive review protocol that provides a complete discussion on modeling techniques and practices, discussion of computer model development, computer model validation, justification of bounding conditions/scenarios, description of boundary conditions and assumptions, documentation of material properties, description of model assembly, discussion and justification of selected loads and time steps, and sensitivity studies. In order for the applicant to use computational modeling software for finite element analysis, a report that addresses all of these issues is deemed to be necessary.

This information is needed by the staff to determine compliance with the requirements of 10 CFR 71.31(a)(2), 71.31(b), and 71.35(a).

Robatel Response – Comment 2.5:
The SAR and calculation document are revised to provide additional discussion of the studies performed during model development to ensure that a properly converging model of the cask body was constructed. This discussion is provided in Section 2.6.7.2.1 and addresses the selection of elements and development of the mesh size to ensure proper convergence. Additionally, results of the finite element calculations were confirmed by simple hand calculations of values such as the hoop stress in the inner shell to ensure that the results were valid.

The analysts also relied upon their experience in performing 10 CFR 71 analyses on other NRC-approved cask designs as a guide to developing valid models.

Observations

2.1 *Revise descriptions of the package containment boundary acceptance criteria, including those of Section 2.1.2.1, "Cask Body Criteria," and Section 2.1.4, "Identification of Codes and Standards for Package Design," to ensure consistent alignment of stress acceptance criteria defined in the codes and those implemented in the application. Also, revise, as appropriate, page 2-11, Items 3 and 5 descriptions on using the ASME, Section III, Division 3, WB-3200 criteria for evaluating the package containment boundary shell.*

Section 2.1.2.1 states, "The criteria for the cask shells and lids are developed per Regulatory Guide (R.G.) 7.6." In addition to noting R.G. 7.6 as the codes and standards used for the package, Section 2.1.4 also cites NUREG/CR-3854 for the package containment system design per the ASME Code, Section III, Subsection ND. As noted below, citation of multiple codes/standards is confusing in that it mandates use of different types of reported stress for acceptance criteria consideration.

a. *The R.G. 7.6 design-by-analysis stress evaluation is based on ASME Code, Section III, Subsection NB, for Class 1 nuclear containment vessel, which considers stress intensity limits acceptance criteria. R.G. 7.6 does not allow Subsection ND design stress evaluation, which is based on allowable stress limits associated with maximum normal stresses instead for the Class 3 nuclear containment vessels.*
b. *R.G. 7.6 Positions 4 and 7, as cited above for Items 3 and 5 of Page 2-11, Volume II, are not explicitly related to the Division 3, Subsection WB-3200 provisions. They should not be used as guidance for the RT-100 containment evaluation without proper justification for code use exceptions.*
c. *NUREG/CR-3854 accepts ASME Code, Section III, Subsection ND stress acceptance criteria for Category II shipping package, which applies to the Model No. RT-100 package. However, as described in pages 2-5 and 2-6, if the containment shell stress evaluation is performed with R.G. 7.6 consistent, Subsection NB criteria, it should properly be presented throughout the application, including those described in Sections 2.1.2 and 2.1.4 of the application.*

This information cited in Items a through c above is required by the staff to determine compliance with the requirements of 10 CFR 71.31(c).

Robatel Response – Observation 2.1:
The SAR is revised to clarify the design criteria utilized for the RT-100 cask.

The descriptions provided in these sections contained some inconsistencies which are corrected. The reference to ASME, Section III, Division 3, WB-3200 is unnecessary and is removed.

R.G. 7.6 is used for establishing the acceptance criteria for evaluating the RT-100 cask for NCT and HAC conditions. R.G. 7.6 recommends ASME B&PV Code, Section III, Division I, Subsection NB (Class 1), Service Level A and D criteria for NCT and HAC evaluations of Type B casks used to transport irradiated fuel assemblies, which would be a Category I container as described in NUREG/CR-3854. This is conservative for the RT-100 cask whose contents are much less radioactive, making it a Category II container per the NUREG.

NUREG/CR-3854 is intended for evaluation of fabrication stresses. This document allows the use of Subsection ND criteria (containment boundary) and NF criteria (cask features not related to containment) for a Category II container.

Sections 2.1.2 and 2.1.4 of the SAR are revised to clarify that RG 7.6 is used to establish the stress acceptance criteria for design of the RT-100, and NUREG/CR-3854 is used to establish the fabrication requirements.

2.2 *Revise Section 2.7.1 of the application to clarify the 9-m free-drop HAC package rigid body decelerations considered for stress evaluation of the package containment boundary components for individual drop orientations. The applicable rigid body decelerations and bases for their determination should clearly be presented in Section 2.7, which addresses the free-drop HAC.*

The second sentence, third paragraph, Page 2-69, Volume II of the application states, "[T]he inertia loads imposed upon the cask…by a design value of 60 g for the 30-ft end-drop case." Although, as noted in the last sentence of the preceding paragraph, "…the discussions in the following sections refer to Section ***2.6.7*** *(boldface added)…" the inertia load accelerations called out in Section 2.6.7 are 44 g and 52 g for the end and side drop conditions, respectively, are different from the 60 g cited in Section 2.7.1. This observation is also applicable to Sections 2.7.1.2, "Side Drop," and 2.7.1.3, "Oblique Drop," for which no deceleration g-loads are presented.*

This information is required by the staff to determine compliance with the requirement of 10 CFR 71.73(c)(1).

Robatel Response – Observation 2.2:
As indicated in response to Comment 2.4 above, the SAR is revised to provide a summary table of design basis decelerations considered for the cask body analyses.

The SAR is revised to correct the typographical errors.

2.3 *Editorial and Typographical Errors – Staff noted that the application contains numerous typographical errors along with incorrect references, e.g., page 2-6, 2-11, 2-22, 2-86, etc. Please perform an holistic review of the application to ensure its readiness for staff's detailed technical review.*

Also, regarding the impact limiter analysis, revise the application to ensure proper representation of the safety analyses performed for the impact limiter, including:

- *a. Insert section, "2.13.2 Methodology," to Page 2-7, Volume II.*
- *b. Realign "2.13.3.4 Side-Drop Case" to follow "Section 2.14.4.3 Pin Puncture," as appropriate, on Page 1-3, Volume II.*
- *c. Relocate "2.13.3.3 Crush Force," in Page 2.14, Volume II, to follow completion of the Section 2.13.3.2 crush strength presentation, as appropriate.*
- *d. Correct the underlined typo, "Section X.2.3," on Pages 2-18 and 2-21, Volume II.*
- *e. Correct the underlined typo, "Figure 2.13.4.1-4...(Side-Drop Case)".*
- *f. Correct the underlined typo, "Figure 2.13.4.1-5...(Corner-Drop Case)".*
- *g. Add caption to the plot on Page 2-30, Volume II.*
- *h. Correct the underlined typo, "Table 2.13.4.2.1.1-2 Maximum Decelerations ..."*

This information cited in Items a through h above is required by the staff to determine compliance with the requirement of 10 CFR 71.1(b) and 71.31(a)(1).

Robatel Response – Observation 2.3:
The SAR is revised to correct the typographical errors.

Chapter 3 – Thermal Evaluation

3.1 *Clarify the maximum average temperatures of the gas in the package cavity under NCT and HAC.*

Staff noted that the maximum average temperatures of the gas in the package cavity were not listed in Tables 3.1.3-1 and 3.1.3-2 of the application for NCT and HAC, respectively.

This information is required by the staff to determine compliance with the requirements of 10 CFR 71.33(a)(5)(v), 71.71 and 71.73.

Robatel Response – Comment 3.1:
The SAR is updated to clarify the assumption of an average cavity gas temperature of 80°C for normal conditions and 150°C for accident conditions, based on the inner shell temperature.

3.2 *Provide detailed information of the seal (EPDM) used in the package.*

Besides providing the melting temperature (150°C) of the EPDM seal, the applicant should also provide information regarding the resistance of the EPDM seal to very low temperature (-40°C), permeation of helium, damage by radiation, and change in hardness.

This information is required by the staff to determine compliance with the requirements of 10 CFR 71.33.

Robatel Response – Comment 3.2:
The SAR is revised to provide additional details regarding the EPDM o-rings in Chapter 3. It should be noted that 150°C is not the melting temperature, but rather the maximum long term operating temperature.

3.3 *Provide the derivation of the uniform heat flux of 13.04 W/m^2.*

The applicant simulated the internal heat load of 200 watts as a uniform heat flux of 13.04 W/m^2 in the thermal model but did not explain how the heat flux of 13.04 W/m^2 is derived. Such derivation should be described in the application.

This information is required by the staff to determine compliance with the requirements of 10 CFR 71.35.

Robatel Response – Comment 3.3:
The SAR is revised to provide additional details regarding the derivation of the heat flux of the decay heat of the contents utilized in the thermal evaluation.

3.4 *Provide calculations of the pressure, due to water vapor, in the package.*

The applicant assumed a condensing surface temperature at 80°C, and stated that the water pressure at 80°C is 6.87 psia without showing any calculation. The applicant should provide calculations or attach pertinent references to show how the water pressure of 6.87 psia is derived in Section 3.3.2.3 of the application.

This information is required by the staff to determine compliance with the requirements of 10 CFR 71.35.

Robatel Response – Comment 3.4:
The SAR is revised to provide details of how the vapor pressure component of the total cavity pressure is determined.

3.5 *Explain or demonstrate how the quantity of hydrogen is limited to less than 5% by volume in the Model No. RT-100 package.*

The applicant assumed the quantity of hydrogen is limited to less than 5% by volume and then calculated the pressure due to gas generation. Before using a 5% limit for gas generation in calculations, the applicant should explain how the hydrogen generated in the package will be limited to less than 5% by volume.

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

Robatel Response – Comment 3.5:
As specified in Section 1.2.2.6 the shipper is required to ensure that the inventory of hydrogen gas generated is less than 5% by volume for previous storage and a shipment time that is twice the expected shipping time.

This evaluation is to be performed using the methods of NUREG/CR-6673. This approach is similar to that specified in other NRC-approved transport cask Safety Analysis Reports.

Chapter 3 of the SAR references Section 1.2 for details regarding the 5% hydrogen limit.

3.6 *Improve the legends and add the temperature unit in the figures of the application and Report RTL-001-CALC-TH-0201.*

The applicant should revise the legends and add the temperature unit (°C or °F) in Figure Nos. 3.3.1.3-1, 3.4.2.2-3, and 3.4.2.2-6 of the application as well as Figure Nos. 9, 29, 30, 32, 34, 44, 45, 47, 48, and 50 of Report RTL-001-CALC-TH-0201 to clarify the temperature curves in which the components are represented. For example, instead of using the name (e.g., 43-TDpocketT-01) defined in the computer model, the applicant should revise the name to the real name of each component described in the application.

This information is required by the staff to determine compliance with the requirements of 10 CFR 71.35 and 71.95.

Robatel Response – Comment 3.6:
The SAR and calculation are updated to add the requested information to the figures.

3.7 *Revise the time frame in the x coordinate and round the numbers to the 0 decimal place for Figures displayed in the application and Report RTL-001-CALC-TH-0201.*
For the HAC fire analysis, the applicant should re-plot the temperature history with the time frame (x coordinate) starting from 0 second of the 30-minute fire period and covering the entire period of 30-minute fire and the subsequent post-fire cooldown. The applicant should begin the x coordinate with 0 second, instead of 899.79 seconds or 8997.9 seconds, in Figure Nos. 3.4.2.2-3 and 3.4.2.2-6 of the SAR and Figure Nos. 29, 30, 32, 34, 44, 45, 47, 48, and 50 of Report RTL-001-CALC-TH-0201.
It is also suggested to round the time values in x coordinate to the 0 decimal place.
This information is required by the staff to determine compliance with the requirements of 10 CFR 71.95.

Robatel Response – Comment 3.7:
The SAR and calculation are updated to add the requested information to the figures.

Chapter 4 – Containment Evaluation

4.1 *Confirm the basis for the O-ring selection and groove dimensions.*

The basis of the O-ring selection and groove dimensions should be clarified. For example, provide the vendor's datasheet if the specifications are based on an O-ring supplier's technical handbook.

This information is required by the staff to determine compliance with the requirements of 10 CFR 71.51.

Robatel Response – Comment 4.1:
The SAR is revised to include additional information regarding the O-ring and grove dimensions.

Section 2.14.4 of the SAR describes the design of the groove and O-ring compression demonstrating that the seal maintains positive compression through normal and accident conditions. The temperature results presented in Chapter demonstrate that the temperatures of the O-rings are maintained within the allowable operating temperature ranges for EPDM material. Section 4.1.3 of the SAR presents information regarding the gas permeability and radiation resistance of the EPDM material.

4.2 *Correlate the containment leakage rates, in Section 4 of the application, with the associated post NCT and HAC (total sequence) containment boundary closure seal system configuration.*

Satisfying the ASME ND stress allowables does not demonstrate regulatory compliance with 10 CFR 71.51. Provide a detailed analysis that concludes that there will be no inelastic deformation, in reference to NUREG-1609 Section 2.5.7, for the package containment boundary closure and seal system, or that the deformation correlates to a release less than the regulatory limits (using ANSI N14.5).

This information is required by the staff to demonstrate compliance with the requirements of 10 CFR 71.51.

Robatel Response – Comment 4.2:
The SAR is revised to include additional summary information regarding the cask performance under normal and hypothetical accident conditions.

The analyses of the inner shell of the cask are presented in Sections 2.6.7 for NCT and 2.7 for HAC. While some localized areas of the inner shell have minor inelastic deformation, the stresses do not exceed the ultimate strength of the material. Therefore, the ability of the inner shell to maintain positive containment is not compromised.

The analyses of the lid closure system are evaluated in Section 2.14 for NCT and HAC. This evaluation is performed in accordance with NUREG/CR-6007. Section 6.3 of the NUREG specifies basis for stress limits established for the bolts, and indicates that the intent of the stress limits are to "preserve the overall elastic behavior of the closure bolt so that the bolt preload and the leak-proof seal of the bolted closure can be maintained." Further, Section 6.3 of the NUREG indicates that a small amount of plastic deformation is permitted due to the use of the material yield strength as an acceptance criterion.

Section 2.14.4 of SAR evaluates the impact of the 0.02% plastic deformation on the ability of the closure lids to maintain positive seal compression. The seals are shown to maintain adequate compression in accordance with manufacturer requirements to maintain positive closure throughout NCT and HAC events.

Sections 4.1.1 and 4.1.4 summarize the performance of the containment vessel and closure system under NCT and HAC.

Observations

4.1 *There appears to be missing text on page 4-6 and 4-7. For example, staff could not find Equation 4.1.*

Robatel Response – Observation 4.1:
The SAR is revised to correct this typographical error. Equation 4.1 refers to the first equation in Section 4.2.1, and the SAR has been noted as such.

4.2 *Page 4-8 states a standard leakage rate of 5.952E-6 cm3/sec whereas Table 4.3-1, the second to last sentence on page 4-10, and the second to last sentence on page 4-11 lists 6.154E-6 cm3/sec.*

Robatel Response – Observation 4.2:
The SAR is revised to correct this typographical error. The correct value is 6.154E-6 cm3/sec

4.3 *Section 7.1.2.2 states that seal leakage rate tests of primary seals should follow Section 7.8. However, Section 7.8 is not relevant to a seal leakage rate test.*

Robatel Response – Observation 4.3:
The SAR is revised to correct this typographical error. The correct reference is Section 7.6

Chapter 5 – Shielding Evaluation

5.1 *Demonstrate that there is only about a 1.62 mm lead slump in the lead shield layer of the Model No. RT-100 package.*

Section 5.3.1 of the SAR indicates that lead slump was considered in the HAC shielding analysis. On page 2-70, the application states that the total displacement of the lead is 1.62 mm. It was not clear how this number was determined and how it was used in the shielding analysis. Given the fact that lead will shrink during the solidification process, there may be some gaps along both the axial and radial directions in the lead layer, even without a drop impact.

The staff requests the applicant to provide justification for the assumed lead gaps under both NCT and HAC. A demonstration by testing is preferred, but not required, to provide a full and complete justification of the data. Correct the data if necessary, and recalculate the dose rates for the package under both NCT and HAC.

This information is necessary for the staff to determine if the package meets the regulatory requirements of 10 CFR 71.47 and 71.51.

Robatel Response – Comment 5.1:
Details of the conservative gap calculations are provided in the Reference 7 calculation. The SAR is revised to explicitly include these details in Section 5.3.1 and to reference the evaluation in Chapter 2 to establish the conservatism present in the approach.

5.2 *Provide justification for the use of a material density of 0.65 g/cm^3 in the free gas model used for carbon and hydrogen mixture for all contents and redo the shielding analyses, if necessary.*

The applicant provided, in Tables 5.6.2-1 and 5.6.2-2 (Tables 5.7.2-1 and 5.7.2-2 in the proprietary part) of the application, the gamma dose rate equivalent factors for each isotope in the package under NCT and HAC, respectively. The applicant provided, in Tables 5.6.3-1 and 5.6.3-2 of the application, the neutron dose rate equivalent factors for each isotope in the package under NCT and HAC, respectively. However, it was not clear what material density assumptions were used in those calculations. If the same material property was used in determining these data, as stated on page 5-8 of the application, i.e., a density of 0.65 g/cm^3 in the free gas model for carbon and hydrogen mixture, the results may be unreliable and, consequently, the final shielding analyses may also be not accurate.

Although acceptable for gamma emitter contents, this assumption may be incorrect for neutron dose rate calculations with heavy isotope contents because the free gas model of carbon and hydrogen mixture will provide significantly larger neutron slow-down capability and, hence, the calculations will give a lower neutron dose rate. The staff requests the applicant to examine the appropriateness of this approach for all intended contents, and recalculate the dose rates for the package if necessary, particularly for the packages with neutron emitter contents.

This information is necessary for the staff to determine if the package meets the regulatory requirements of 10 CFR 71.47 and 71.51.

Robatel Response – Comment 5.2:
The NCT density of 0.65 g/cm3 is based on the optimum packing fraction for polystyrene beads. Details are provided in Reference 7 of Chapter 5. The SAR is revised to include additional discussion from Reference 7.

Additional neutron transport calculations with the hydrogen scattering kernel for polyethylene in the resin materials have been performed. These calculations indicate that the neutron results are not as sensitive to source density as the gamma cases. The SAR and calculation are revised to include this additional discussion.

5.3 *Provide a justification for the use of a material density of 1.13 g/cm^3 for dose rate calculations for package under HAC and redo the analysis with the correct material density, if necessary.*

From Figure 5.3.1-4 of the application, it seems that a material density of 1.13 g/cm3 was used in the model under HAC. However, it was not clear why such a content material density was used. It is particularly important to note that compaction of media for neutron shielding may significantly underestimate the dose rate outside the package because of the arbitrary increase in material density and, hence, the moderation of the neutrons traversing the media. The staff requests the applicant to examine this approach and recalculate the dose rates for the package, particularly for the packages with neutron emitter contents.

This information is necessary for the staff to determine if the package meets the regulatory requirements of 10 CFR 71.47 and 71.51.

Robatel Response – Comment 5.3:
The HAC density of 1.13 is based on compressing both the material and the source density to produce the most conservative dose rate at the lead slump. Details are provided in Reference 7 of Chapter 5. Discussion will be added to the SAR.

Observation

5.1 *Review and correct, if necessary, the dimensions provided in Table 5.3-1. Perform the shielding analyses with the correct dimensions.*

The application provides, in Table 5.3-1, the dimensions of the package and those that were used in the models. However, the data appear to be incorrect: (i) no unit was given for any of these data, (ii) the data do not appear to be meaningful for any of the commonly used units. For example, the name of the second row of the data table is "lead" and the nominal dimension given for lead is 90. It is not clear whether here 90 means 90 cm or 90 inches. By cross checking with the MCNP input file, it looks like that the dimension unit should be millimeter. The staff requests the applicant to examine the data provided in Table 5.3-1.

This information is necessary for the staff to determine if the package meets the regulatory requirements of 10 CFR 71.47.

Robatel Response – Observation 5.1:
The SAR is revised to provide clarification in Table 5.3-1.

Chapter 8 – Acceptance Tests and Maintenance Program

8.1 *Describe the acceptance tests required for non-standard materials and components.*

Section 8.1.5 discusses component and material tests that are required for those components and materials that meet ASME code specifications. For materials and components that are not fabricated to consensus standards, such as the impact limiter foam, describe the required acceptance tests.

This information is needed by the staff to determine compliance with the requirements of 10 CFR 71.31(c).

Robatel Response – Comment 8.1:
The SAR is revised to provide clarification of this issue.

Materials will be procured in accordance with Robatel's NRC-approved QA program. Materials that are not procured strictly in accordance with standards will utilize Commercial Grade Dedication (CGD) plans which specify the critical characteristics for the material. The plans will also identify all the analysis to be performed by the supplier to ensure that the material meetings the requirements imposed on it by the design and with complete and appropriate documentation.

8.2 *Revise Section 8.1.3 of the application to add the containment boundary structural tests to meet the ASME Code, Subsection NB, Article NB-6000 or ND, Article ND-6000, provisions, which require hydrostatic tests of containment boundary components at not less than 1.25 times the lowest design pressure.*

The hydrostatic tests are done to meet 10 CFR Part 71.31(c) codes/standards compliance requirements for the packaging components and the quality assurance program provisions per NUREG -1609, Sections 8.3.1 and 8.5.1.3, respectively. The application needs to make a case to demonstrate either that the 150% maximum normal operating pressure testing is bounding or to perform the hydrostatic tests, which are based on 125% of the containment boundary design pressure.

This information is required by the staff to determine compliance with the requirement of 10 CFR 71.31(c), 71.37(b).

Robatel Response – Comment 8.2:
As stated in Section 8.1.3, the containment boundary is tested hydrostatically to 150% of 200 kPa, which is taken to bound the maximum normal conditions internal pressure of 182.7 kPa as specified in Section 3.3.2.5. This exceeds the requirement to test to 125% of the lowest design pressure. However, Section 3.3.2.5 of the SAR also provides a "design basis" MNOP of 342.7 kPa. This design basis pressure was established early in the design process as a conservative value to facilitate the structural and thermal analyses of the cask design. So that the fabrication hydrostatic test is not performed at an unreasonably high value, 200 kPa is utilized as the design value rather than 342.7 kPa.