Chapter 3 – Thermal Evaluation

NRC RAI Comment 3-1:

Explain why a constant solar insolation is not used in NCT and HAC analyses.

The applicant described the solar insolation modeling in Section 6.5 of Calc. No. RTL-001-CALC-TH-0201, converted insolation from 400 and 800 g-cal/cm^2 to 388 and 776 W/m^2, respectively, per a 12-hour time period for both curved and horizontal flat surfaces, and then simulated insolation with the periodic sin(t x π/12) function. However, the insolation with the periodic function sin(t x π/12) should be modified.

Instead of simulating the solar insolation as a periodic heat flux, the applicant should directly apply the constant insolation of 388 W/m^2 for the curved surface and 776 W/m^2 for the flat surface in the model (without the sin(t x π/12) function). Application of a constant insolation is a regulatory requirement.

This information is required by the staff to determine compliance with 10 CFR 71.35, 71.71 and 71.73.

Robatel Response – RAI Comment 3-1:

The NCT and HAC calculations are revised to apply the solar insolation as constant values of 388 W/m^2 for the curved surfaces and 776 W/m^2 for the flat surfaces. Chapter 3, Section 3.3.1.1, 3.4.1.1 and 3.4.2.1 and Section 6.5 of Calculation Package RTL-001-CALC-TH-0201, Rev. 5 have been revised to apply the 10 CFR 71.71 solar insolation values as constants rather than using the sine function. Additionally, during the post-fire cool-down transient, solar insolation is applied as a constant.

SAR Impacts

- Chapter 3 of the SAR is revised throughout to update the analyses with steady state solar insolation boundary conditions for NCT and the initial conditions for the HAC fire accident analysis.

Calculation Impacts

- Calculation Package RTL-001-CALC-TH-0201, Rev. 5 is revised to present the results of the updated analyses that are summarized in the SAR.

NRC RAI Comment 3-2:

Correct the radiation emissivity of the stainless steel used in the post-fire cooldown and re-analyze the HAC fire accident.

Table 3.2-1 "Temperature-Independent Material Properties" shows that a radiation emissivity of 0.9 for the stainless steel 304 is used for both the fire transient and the post-fire cooldown. To evaluate the heat flux under the HAC fire, the applicant should use an emissivity of 0.9 or greater for a 30-minute fire transient and an emissivity of 0.8 or less for the post-fire cooldown (see March 6, 2012, Meeting Summary, included in Appendix 6 of the application, ADAMS Accession No.: ML12075A026).

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.73.

Robatel Response – RAI Comment 3-2:

The emissivity of the outer surface of the cask has been updated to utilize a value of 0.8 for the post-fire cooldown condition.

Table 3.2.1-1, located in SAR Chapter 3, Section 3.2.1, has been revised to utilize a value of 0.8 for the post fire cooldown condition. The temperature results from the cooldown transient are reflected in updated figures and tables in Chapter 3 of the SAR and in Calculation Package RTL-001-CALC-TH-0201, Rev. 5.

SAR Impacts

- Table 3.2.1-1, located in Chapter 3, Section 3.2.1 of the SAR is revised to specify an emissivity value for the outer surface of the cask as 0.8 for the post-fire cooldown transient. The results of the post-fire cooldown transient are also updated as described in response to RAIs 3-5, 3-6 and 3-7.

Calculation Impacts

- Calculation Package RTL-001-CALC-TH-0201, Rev. 5 is revised to utilize the 0.8 value cask surface emissivity value for the post-fire cooldown.

NRC RAI Comment 3-3:

Demonstrate that there is no phase change, melting, or auto-ignition of the contents under NCT and HAC.

The applicant predicted a maximum temperature of 265°C (or 509°F) for the inner shell of the package under HAC. The staff reviewed the model description and identified that the maximum inner shell temperature of 265°C (or 509°F) is used to represent the maximum "local" gas/content temperature. Therefore, the applicant needs to provide the melting points and the auto-ignition temperatures of the allowed contents to assure that the contents (e.g., resin, filter), allowed in the Model No. RT-100 package, will not autoignite, melt, or change phase at a temperature below 265°C (or 509°F) under NCT and HAC.

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

Robatel Response – RAI Comment 3-3:

Calculation Package RTL-001-CALC-TH-0201, Rev. 5 (Thermal Analysis) has been revised to reflect steady-state solar insolation of the packages; it indicates that the maximum average inner shell temperature is 137°C (297°F). Since the inside surface is assumed to be perfectly insulated and no credit is taken for the ability of the contents to absorb heat during the fire transient, the average inner shell temperature provides a reasonable prediction of the contents temperature during the HAC fire event. Additionally, review of the thermal analysis results shows that the maximum inner shell temperature occurs at a localized region of the inner shell and lasts for approximately 10 minutes.

The cask contents include secondary containers, shoring, resins and filters. Secondary containers are constructed of either coated (such as paint) carbon steel or stainless steel, or a thermoplastic such as polyethylene or polypropylene. Resins are made of thermoplastics such as polystyrene, or material such as inorganic carbon or zeolite. Filters may be constructed from thermoplastics such as nylon, polyester, or polypropylene, or paper. The filter media may be held within a stainless steel cartridge. Shoring can be made of wood or one or several of the materials composing the secondary containers.

The acceptable temperatures of the carbon and stainless steel material are approximately 800°C which is significantly above the temperatures experienced by the contents during the fire accident. The melting temperatures of thermoplastics range from 100°C up to 250°C [Ref. 1: below]. These thermoplastics typically soften at these temperatures and do not result in volatiles that will react with any of the contents (based on the maximum average inner shell temperature of 137°C (279°F)). The auto-ignition temperature of thermoplastics is above 300°C (572°F) [Ref. 1: below].

Auto-ignition of the thermoplastics would not occur. The safety analyses of the RT-100 do not assume the presence of secondary containers and the radioactive contents are assumed to be completely filling the cask cavity, therefore, melting of the secondary containers or resins is not a concern. The auto-ignition temperatures of paper and wood vary widely and are a function of their specific composition and moisture content. A commonly accepted value for the auto-ignition point for paper is 232°C (450°F) [Ref. 2: below]. The auto-ignition point for wood has been shown to be at least 300°C (572°F) [Ref. 3: below].

The auto ignition of all contents is below the maximum temperature. Chapter 3, Section 3.2.3 of the SAR is added to provide additional information regarding the thermal specifications of these materials.

SAR Impacts

- Section 3.2 of the SAR has been revised.

Calculation Impacts

- None

References

1. Chapter 3, 3.6 References: #21 SFPE Handbook of Fire Protection Engineering, "Thermal Decomposition of Polymers," C.L. Hirschler, M. Marvelo, Chapter 7 of 3rd Edition, NFPA, 1 Batterymarch Park, Quincy, MA, 2001, www.nfpa.org.

2. Chapter 3, 3.6 References: #22 "Fundamentals of Combustion Processes," A. McAllister, J. Chen, A. Fernandez-Pello, Springer, 2011.

3. Chapter 3, 3.6 References: #23 An Experimental Study of Autoignition of Wood, T. Poespowati, World Academy of Science, Engineering and Technology, Vol. 23, 2008., Retrieved on August 28, 2013, Retrieved from http://www.waset.org/journals/waset/v23/v23-13.pdf.

NRC RAI Comment 3-4:

Explain why the HAC fire analysis does not start with the results from the NCT steady-state analysis.

The applicant used the same approach and models from NCT to evaluate HAC, and identified a time within the total run period of the NCT normal hot case, at which the inner shell temperature reaches its maximum, to serve as the starting time for the HAC fire analysis.

The staff does not find this approach to be conservative. The time at which the inner shell temperature reaches its maximum may not be the instant that other important-to-safety components, e.g., lead shielding and O-ring seal, reach their maximums. Instead of identifying a time to start HAC analysis, the applicant should perform the steady state analysis of NCT and start the HAC fire analysis with the applicable steady-state results.

This steady state analysis of NCT provides the most conservative evaluation for all components in the package.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.73.

Robatel Response – RAI Comment 3-4:

The fire accident analysis has been revised to utilize a steady state pre-fire analysis for the NCT hot case 1 with an ambient temperature of 38°C and insolation as described in Chapter 3, Sections 3.4.1.1 and 3.4.2.1 of the SAR. As a result, the temperatures of all cask components at the start of the fire are taken from the same starting point.

SAR Impacts

- Chapter 3 (sections 3.4.1.1 and 3.4.2.1) of the SAR are revised to reflect the use of the NCT analysis that serves as the initial conditions for the fire accident analysis.

Calculation Impacts

- Calculation Package RTL-001-CALC-TH-0201, Rev. 5 is revised to present the results of the updated analyses that are summarized in the SAR.

<u>NRC RAI Comment 3-5:</u>

Explain the temperature fluctuations of the components, shown in Figures 3.3.1.3-1, 3.4.2.2-3 and 3.4.2.2-6 of the application as well as in Figures 9, 29, 30, 32, 34, 44, 45, 47, 48, and 50 of the report RTL-001-CALC-TH-0201, under NCT and HAC.

The applicant analyzed the NCT and HAC thermal performance of the Model No. RT-100 package and predicted the components' temperatures which fluctuate with time under NCT and HAC. To clarify the uncertainties in the thermal model, and evaluate the thermal performance of the package, explain the phenomena which cause the temperature fluctuations for both NCT and HAC analyses.

This information is required by the staff to determine compliance with 10 CFR 71.35, 71.71 and 71.73.

Robatel Response – RAI Comment 3-5:

The temperature fluctuations of the components were a result of using a sine function to model solar insolation. As described in the response to RAI 3-1, the analytical method has been revised to apply the average of 12-hour solar insolation values as a constant for the NCT steady-state analysis and for the HAC post-fire cool-down transient. Figures 3.3.1.3-1 has been deleted. Figure 3.4.2.2-3 (replaced with 3.4.1-8 and 3.4.1-9) and 3.4.2.2-6 (replaced with 3.4.2-9 and 3.4.2-10) of the SAR are updated to reflect the revised analysis.

SAR Impacts

- Figure 3.3.1.3-1 has been deleted
- Figures 3.4.1-8 and 3.4.1-9 (which replace Figure 3.4.2.2-3) and Figures 3.4.2-9 and 3.4.2-10 (which replace Figure 3.4.2.2-6) were added to present the updated thermal analysis results.

Calculation Impacts

- Figures 9, 29, 30, 32, 34, 44, 45, 47, 48, and 50 of Calculation Package RTL-001-CALC-TH-0201, Rev. 5 are revised to present the updated thermal analysis results.

NRC RAI Comment 3-6:

Provide the maximum component temperatures in Table 3.1.3-2 of the application, separately, for the top lid impact fire accident and the sidewall impact fire accident.

The applicant listed the maximum temperatures of the outer shell, inner shell, inner shell average, lids, base plate, lead, and seals, in Table 3.1.3-2 (page 3-6 of the application) without identifying or categorizing the results from the top lid impact fire accident or the sidewall impact fire accident. The applicant is required to separately list the component temperatures in Table 3.1.3-2 for the top lid impact fire accident and the sidewall impact fire accident.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.73.

Robatel Response – RAI Comment 3-6:

Table 3.1.3-2 of the SAR has been expanded to indicate which accident condition scenario is represented. A second table has been added so that there is one summary table for each of the top lid impact (Table 3.1.3-2) and side impact (Table 3.1.3-3) fire accident events.

SAR Impacts

- Table 3.1.3-2 of the SAR is revised to split the temperature results into two different tables; Tables 3.1.3-2 (RT-100 Maximum Calculated Temperature of Cask under HAC with Pin Puncture Damage on Top Impact Limiter) and 3.1.3-3 (RT-100 Maximum Calculated Temperature of Cask under HAC with Pin Puncture Damage at the side of the Cask Body.

Calculation Impacts

- Calculation Package RTL-001-CALC-TH-0201, Rev. 5 is revised to provide the impact result detail for these two fire accident cases as well.

NRC RAI Comment 3-7:

Explain the inconsistency in the times to reach the maximum lead temperature for the side impact fire accident in Figure 3.4.2.2-3, and the maximum O-ring seal temperature for the top impact fire accident in Figure 3.4.2.2-6.

a. The applicant showed a time of 2077 seconds, which projects to ≈1830 seconds in the X Coordinate of Figure 3.4.2.2-3 (Close-up View), to reach the maximum lead temperature under the side impact fire accident.
b. The applicant also showed a time of 1957 seconds, which projects to ≈2160 seconds in the X Coordinate of Figure 3.4.2.2-6 (Close-up View), to reach the maximum O-ring seal temperature under the top impact fire accident.

The applicant should clarify this inconsistency, as mentioned in a. and b).above. The applicant should plot the temperature history starting from 0 minute (into the fire) to 300 minutes in the close-up views of Figures 3.4.2.2-3 and 3.4.2.2-6.

This information is required by the staff to determine compliance with 10 CFR 71.35 and 71.73.

Robatel Response – RAI Comment 3-7:

Figures 3.4.1-8 and 3.4.1-9 (which replace Figure 3.4.2.2-3) and Figures 3.4.2-9 and 3.4.2-10(which replace Figure 3.4.2.2-6) of the SAR are added to present the results of the updated thermal analysis with additional clarity provided for the time axis along the bottom of each figure.

SAR Impacts

- Figures 3.4.1-8, 3.4.1-9, 3.4.2-9 and 3.4.2-10 were added
- Figures 3.4.2.2-3 and 3.4.2.2.-6 have been removed

Calculation Impacts

- Calculation Package RTL-001-CALC-TH-0201, Rev. 5 is revised to present the results of the updated thermal analysis with additional clarity provided for the time axis along the bottom of each figure.

Chapter 4 – Containment Evaluation

NRC RAI Comment 4-1:

Demonstrate that the release calculations are bounding:

a) The containment analysis focused on the activity associated with the resin as a powder, and its corresponding airborne release and respirable fractions. However, there is no discussion of the activity associated with the gases and volatiles of the void, or "head space," within the package. The effect of the content isotopes' volatiles and gases, including their quantities, activities, and higher release fractions compared to the solid content, should be detailed and included in the NCT and HAC containment discussion.

b) The calculations in Sections 4.2.2 and 4.3 of the application should be expanded to show all of the potential sources of releasable activity, such as the gases/volatiles (from isotopes and their daughter products) and those leached out (from moisture content) and evolved at NCT and HAC temperatures, in addition to the sources associated with the solid resins and filters.

c) Sections 4.2.2 and 4.3 should provide an additional explanation to justify the appropriateness of the airborne release and respirable fraction calculation methodology and how the resin and filter contents are bounded by it. The density of powder aerosol from NUREG/CR-6487 already takes into account the material suspended in air; thus, including the airborne release fraction (ARF) counts twice the aerosol-effect.

This information is required by the staff to determine compliance with 10 CFR 71.43(f), and 71.51.

Robatel Response – RAI Comment 4-1:

The containment criterion for the RT-100 cask has been changed to leaktight. Leak rate testing procedures for the RT-100 cask are revised in Chapter 8 of the SAR to be in accordance with the leaktight criteria of ANSI N14.5-1997. Chapters 4 and 8 of the SAR are revised to reflect this change.

SAR Impacts

- Chapter 4 and 8 of the SAR are revised throughout to address the change to leaktight criteria for the cask.

Calculation Impacts

- Calculation Package RTL-001-CALC-CN-0101, Rev. 5 is revised to implement the ANSI N14.5-1997 criteria for leaktight testing requirements.

NRC RAI Comment 4-2:

Discuss the form of the resin bead and filter contents.

The analysis in Section 4.2.2 assumes a powder content form ("density of powder aerosol", etc.) but does not provide details of the resin bead and filter, such as the range of bead diameter, the powder size classification, etc.

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

Robatel Response – RAI Comment 4-2:

As described in response to RAI 4-1, the containment analysis has been revised in accordance with ANSI N14.5-1997 to be leaktight. Because the cask design is leaktight, the powder size and resin bead diameters are no longer needed to calculate a package leak rate. A general description of the contents of the resin beads and filters are provided in SAR Chapter 1, Section 1.2.2.3. Chapter 4, Section 4 and 4.3.1 of the SAR have been revised to address the leaktight criteria.

SAR Impacts

- Chapters 1 and 4 of the SAR have been revised.

Calculation Impacts

- Calculation Package RTL-001-CALC-CN-0101, Rev. 5 has been revised to implement the ANSI N14.5-1997 leaktight criteria.

NRC RAI Comment 4-3:

Provide a clearer picture and description of the containment boundary; the image and red line in Figures 4.1.2-1 and 4.1.2-2 on page 4-3 of the application do not clearly show the extent of the containment boundary in the upper right hand side figure.

The resolution of the line and image in Figures 4.1.2-1 and 4.1.2-2 is insufficient to clearly understand the containment boundary. A clearer image and description of the containment boundary should be provided.

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

Robatel Response – RAI Comment 4-3:

The SAR Figures 4.1.2-1 and 4.1.2-2 have been replaced by a single figure (Figure 4.1.2-1) that is larger and of a higher resolution.

SAR Impacts

- Figures 4.1.2-1 and 4.1.2-2 have been replaced by a single figure, Figure 4.1.2-1.

Calculation Impacts

- None

NRC RAI Comment 4-4:

Clarify that the caps associated with the primary lid, secondary lid, and vent port cover plate are listed on the Bill of Materials.

It is unclear from the application's Bill of Materials whether the caps associated with the primary lid, secondary lid, and vent port cover plate are listed on the Bill of Materials in the drawings or not; this should be clarified.

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

Robatel Response – RAI Comment 4-4:

The terms "cap" and "plug" have been used interchangeably in the drawings (Chapter 1, Appendix 1.4, Attachments 1.4-2 through 1.4-8) and throughout the text. RT100 NM 1000 Rev. E – Bill of Material (Chapter 1, Appendix 1.4, Attachment 1.4-1) has been revised to reflect that "cap" and "plug" are used to describe the same component.

The caps associated with the primary lid and the secondary lid are on the licensing drawing RT100 PE 1001-2, Rev G (Chapter 1, Appendix 1.4, Attachment 1.4-3) and in RT100 NM 1000, Rev. E – Bill of Material, Item Number 1016, (Chapter 1, Appendix 1.4, Attachment 1.4-1).

The vent port cover plate leak test port cap is displayed on Section G-G of Drawing RT100 PE 1001-2, Rev. G (Chapter 1, Appendix 1.4, Attachment 1.4-3), and in RT100 NM 1000, Rev. E –

Bill of Material, Item Number 1017-05 "Cover Plate Leaktest Port Plug Cylindrical Leak Test Plug Size: M10x1 (Viton seal included)".

The Bill of Material is revised to modify the quality category of the leak test port plugs (caps) from Category C to Category B.

SAR Impacts

- RT100 NM 1000 Rev. E - The Bill of Material (Chapter 1, Appendix 1.4, Attachment 1.4-1) is revised.

Calculation Impacts

- None

NRC RAI Comment 4-5:

Confirm the extent of the containment boundary for the fabrication helium leakage test.

Section 4.4 references ANSI N14.5 when discussing the fabrication, maintenance, periodic and pre-shipment leak test. ANSI N14.5 indicates that the entire containment boundary, which includes welds, joints, base material, valves, etc., is part of the fabrication helium leakage test. The extent of the containment boundary that is helium leak tested should be stated in Section 8.1.4 of the application.

This information is required by the staff to determine compliance with 10 CFR 71.43, 71.51 and 71.85.

Robatel Response – RAI Comment 4-5:

The containment boundary that will be helium leak tested is composed of the following components that are listed below as they appear in RT100 NM 1000, Rev. E – Bill of Materials (Chapter 1, Appendix 1.4, Attachment 1.4-1)

For the Cask Body, Item 1011:

- Upper Flange, Item Number 1011-01
- Inner Shell, Item Number 1011-02
- Inner Bottom, Item Number 1011-03

For the Primary Lid, Item 1012:

- Inner O-ring ∅12 Length 5414mm (∅1723.3 mm), Item Number 1012-02

For the Secondary Lid, Item 1013:

- Inner O-ring ∅12 Length Dev. 2410 EPDM 80SH, Item Number 1013-05

For the Quick Disconnect Valve Cover, Item 1017:

- Inner Seal O-ring R50 EPDM 80SH. ∅INT.107.32 – TORE ∅5.33, Item Number 1017-03

Welds that are part of the containment boundary that will be leak tested are shown in RT100 PRS1011 Rev. E – Robatel Transport Package RT-100 Cask Sub Assembly Weld Map Secondary Lid (Chapter 1, Appendix 1.4, Attachment 1.4-4).

- Associated welds S.1011.01, S.1011.02 and S.1011.03

Prior to lead pouring, the fabrication verification helium leak test is performed for the cask body (inner shell). The acceptance criteria for this test will be no leakage in the cask body welds (i.e., leaktight). Testing is performed for the lids and O-rings after completion of fabrication. Chapter 8 of the SAR is revised to clarify the containment boundary extents and the leak test procedure

Chapter 8, Section 8.1.4 has been revised to clarify the description of the leak testing of the containment boundaries. Chapter 4, Section 4.1 and its subsections clarify the extent of the containment boundary.

SAR Impacts

- Chapter 8 of the SAR is revised to show a more detailed description of the testing procedures.

Calculation Impacts

- None

<u>NRC RAI Comment 4-6:</u>

Confirm that the vent port cover plate's bolts are at the appropriate torque to maintain proper compression of the vent port cover plate's O-rings.

Section 2.14 provides the closure bolt evaluation for the primary and secondary lid. Similar calculations should be provided for the vent port cover plate's bolts.

This information is required by the staff to determine compliance with 10 CFR 71.43(f), and 71.51.

Robatel Response – RAI Comment 4-6:

Chapter 2, Section 2.13.5 has been added to the SAR to provide an analysis (Calculation Package RTL-001-CALC-ST-0203, Rev. 5) which confirms that the vent port cover plate bolts are at the appropriate torque to maintain proper compression of the vent port cover plate O-rings.

In addition, the procedures for torqueing bolts in Chapter 7, Section 7.4.5.1 have been revised to reflect the torque values in Tables 7.4.5-1 and 7.4.5-2.

The vent port cover plate is 200 mm diameter and is recessed in the primary lid by 1 mm. The cover plate serves to cover a 100 mm opening in the cask body for the vent port quick disconnect fitting. Because this opening is smaller than the pin diameter, no prying forces can be generated on the port cover plate bolts. The only stresses on the bolts are those required to compress the O-ring.

SAR Impacts

- Chapter 2, Section 2.13.5 has been added to address the required bolt torques.
- Chapter 7, Section 7.4.5.1 has been revised to reflect the torque values.

Calculation Impacts

- Section 7.3 of Calculation Package RTL-001-CALC-ST-0203, Rev. 5 was added to address the required torque for the port cover plate.

NRC RAI Comment 4-7:

Justify that combustible gases generated in the package during the shipping period do not exceed 5%, by volume, of the free gas volume.

Section 1.2.2.6 states that the shipper must ensure that the hydrogen concentration within the container will be below 5%, by volume. In addition, page 1-8 states that the moisture content is limited to no more than 1% free water by volume. A bounding calculation of combustible gases that could form, based on the approved contents with their respective alphas, betas, etc., should be provided. This information is required by the staff to determine compliance with 10 CFR 71.43(d).

Robatel Response – RAI Comment 4-7:

The restrictions on moisture and free water contained in the package contents have been clarified to reflect the assumptions used in the Calculation Package RTL-001-CALC-SH-0301, Rev. 3 for the determination of hydrogen generation. This calculation verifies that the cask will have less than 5% hydrogen by volume during shipment, for resins.

Hydrogen generation calculations are sensitive to the G values of the materials shipped in the cask and the free gas volume. The hydrogen gas generation G values of water and resin are illustrated in Table 4.4-1 as 0.45 molecules/100 eV and 1.7 molecules/100 eV, respectively. The ionic resin beads are assumed to be uniform spheres. The packing fraction for uniform spheres is 0.64 based on the reference in the SAR, "Particle-size distribution and packing fraction of geometric random packings". Therefore, the volume occupied by resin is 64% resin beads and 36% empty space.

Resin beads shipped in the RT-100 could potentially have a maximum moisture content of up to 55% by weight according to NUREG/CR-4062, Extended Storage of Low-Level Waste: Potential Problem Areas. The hydrogen generation calculations presented in Calculation Package RTL-001-CALC-SH-0301, Rev. 3, and in Chapter 4, Sections 4.4 and 4.4.1 and Chapter 7, Section 7.5 of the SAR provide calculations for determining maximum allowable decay heat as a function of the volume occupied by the resin for a 10 day shipping period. The results of these calculations bound resin with this maximum moisture content.

Within the hydrogen generation calculations of Section 4.4, the ionic resin G value of 1.7 molecules/100 eV is used for the resin contribution to the hydrogen generation rate in the cask. This assumption considers that all of the volume inside the bead is comprised of resin, in actuality the internal volume could be up to 55% water by weight as described above. If the amount of water contained in the resin were to be considered in the calculation, the lower G value for water would reduce the hydrogen generation rate within the resin bead volume. The hydrogen generation calculations performed in the SAR require the user to input the volume occupied by the ionic resin beads (referred to as the volume occupied by the waste material, Vwaste, in the calculations). The hydrogen generation calculations utilize the higher G value of resin for the entire matrix of the material (both ionic resin and water volume in the beads).

If the water were to seep out of the resin beads over time, the volume of free gas within the waste material volume would not change. The volume occupied by the hydrogenous material that makes up the ionic resin bead lattice would still be 0.64 volume fraction of the total occupied waste

volume. Resin beads that are initially swollen due to water absorption occupy greater cask volume, but do not alter the volume fraction of the ionic resin beads in the lattice (0.64).
The hydrogen generation calculations, assumes 1% of the waste volume is free water and 99% of the waste volume is the ionic resin bead lattice. Of the remaining 0.36 volume fraction (1-0.64) of the volume occupied by the ionic resin bead lattice, 0.25 volume fraction of water is assumed to exist within the resin bead lattice (in other words, the resin is treated as a slush in the hydrogen generation calculations even though it is grossly dewatered). These assumptions are entered into the hydrogen generation calculations in order to decrease the amount of initial free gas volume in the cask, which increases the rate at which the hydrogen gas volume fraction rises in the cask and subsequently limits the amount of decay heat allowed in the cask.

Since RTL-001-CALC-0301 Rev. 3 and Chapter 4, Sections 4.4 and 4.4.1 and Chapter 7, Section 7.5 of the SAR, consider free water inventories that are much greater than 1% by volume and the maximum moisture content found in dewatered resins, Chapter 1, Section 1.2.2.3 of the SAR has been revised to remove the restriction on moisture content.

Chapter 4, Sections 4.4, 4.4.1 and Chapter 7, Section 7.5 were added to the SAR to provide guidance to cask users regarding how to calculate the gas generation rate for their contents. The sections provide complete instructions regarding the gas generation factors for the contents, including any water in the container. These sections provide the hydrogen gas generation rate parameters from NUREG/CR-6673 for the materials comprising the resin and filter contents and thermoplastic secondary containers. The cask user can then calculate the maximum allowable shipping time for their contents, ensuring that hydrogen generation would not result in a concentration in the free gas volume in excess of 5% by volume.

Bounding calculations are presented in the revised SAR for a set of basic assumptions:

- Shipping time of 10 days (20 days used for hydrogen generation)
- Loading curve establishes the allowable decay heat as a function of the waste volume in the cavity

The key parameters in the calculation of hydrogen gas generation include:

- Mass of hydrogen generating materials (thermoplastic secondary containers, resins, filters, etc)
- Mass of water in the cavity
- Moisture content of contents
- Free volume in the cask cavity
- Decay heat load

The revised SAR also provides detailed information to be utilized by cask users to perform the hydrogen gas generation calculations that will be required for contents that exceed any of the parameters used in the loading curve.

SAR Impacts

- Chapter 1, Section 1.2.2.3 has been revised to remove the restriction on moisture content.
- Chapter 4, Sections 4.4, 4.4.1 and Chapter 7, Section 7.5 were added to the SAR to provide procedures for calculating the gas generation rate of the contents.

Calculation Impacts

- Calculation Package RTL-001-CALC-SH-0301, Rev. 3 is added to support the evaluation of hydrogen generation in the contents, in enhanced detail.

NRC RAI Comment 4-8:

Clarify where the information related to the EPDM O-rings is discussed.

Page 4-3 states that the EPDM O-rings are addressed in Section 0. This appears to be in error; please provide the appropriate section.

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

Robatel Response – RAI Comment 4-8:

Chapter 4, Section 4.1.3 of the SAR is revised to remove the reference to Section 0. The revised wording is:

> "O-rings may-be supplied by manufacturers such as those in Parker O-Ring Handbook ORD 5700 [Ref. 10] and Trelleborg Sealing Solutions O-Ring and Backup Rings Catalog, August 2011 [Ref. 11]."

SAR Impacts

- Chapter 4, Section 4.1.3 of the SAR has been revised to correct the typographical error.

Calculation Impacts

- None

NRC RAI Comment 4-9:

Clarify the calculation used to determine the leakage rate of helium in Calc No. RTL-001-CN-CALC-0101 and provide further explanation for applying Section 4.4.1 calculations, Figure 4.4.1-1, and Figure 4.4.1-2.

a) It appears from the Calc No. RTL-001-CN-CALC-0101 calculation sheet that a "Dmax" is calculated for helium at NCT and HAC conditions. Per ANSI N14.5, however, the determination of leakage rates other than actual conditions is based on using the diameter calculated at the actual condition (e.g., air at NCT or HAC) as an input to the leakage rate calculation. The reasoning for the calculation presented in "Calc No. RTL-001-CN-CALC-0101" should be clarified.

b) Further explanation of Section 4.4.1 calculations and when/how Figures 4.4.1-1 and 4.4.1-2 would be used in practice should be provided.

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

Robatel Response – RAI Comment 4-9:

The containment evaluation has been revised to address the change to ANSI N14.5-1997 leaktight criteria. In the revised evaluation, the properties of air are used in the standard condition calculations (presented in Chapter 4, Section 4.3.1 of the SAR for normal conditions) to determine the leak hole diameter $D_{max,}$ which is used to calculate the test leakage rate. This is confirmed in Section 7.2 of Calculation Package RTL-001-CALC-CN-0101, Rev. 5.

Chapter 4, Section 4.3.1 of the SAR presents the conversion of the air standard allowable leakage rate to a test leak rate using helium gas for the new leaktight criteria. Figure 4.3.1-1 provides the allowable leak rate for a mixture of air/helium as a function of temperature for a cask evacuated to pressures ranging from 0.0 to 0.75 atm and then backfilled with helium to a pressure of 1.0 atm. Chapter 4, Figure 4.3.1-2 and Table 4.3.1-2 are the actual allowable helium leakage rates as a function of temperature for various partial helium pressures.

Chapter 4, Figure 4.3.1-2 is to be used to determine the allowable leak rate L_{He} for the maintenance, fabrication, and periodic leak tests of the RT-100 based on partial pressure of helium and ambient temperatures used in the test. If the measured leakage rate is below the value shown in Figure 4.3.1-2 then the leaktight criteria has been met.

SAR Impacts

- Chapter 4, Section 4.3.1 has been revised to address the change to leaktight criteria for containment as defined in ANSI N14.5-1997, the leak rate of helium/air mixtures are correlated to a leak rate of 1.0E-7 ref. cm^3/sec of air at standard conditions.

Calculation Impacts

- Calculation Package RTL-001-CALC-CN-0101 Rev. 5 is revised to calculate the leak hole diameter based on air standard conditions at a leak rate of 1.0E-7 ref. cm^3/sec. Helium leakage rates at various helium partial pressures and ambient temperatures, using the derived hole diameter, presented in the calculation.

Chapter 5 – Shielding Evaluation

NRC RAI Comment 5-1:

Clarify if the secondary container is required to support a safety function and, if required, provide both the drawings and the detailed operating procedures for the secondary container and its shoring device. Clarify also the term "standard devices."

Page 1-8 of the application states: "All contents will be packaged in a secondary container (liner)." Section 7.1.2.1 of Chapter 7 of the application requires the use the secondary liner and a shoring device. In addition, the operating procedures instruct the user of the package to use a "process liner as necessary and cap the liner using standard devices." However, the licensing drawings do not include the design of the secondary container and there appears to be conflicting information through different sections of the application.

It is not clear whether a secondary container, together with its shoring device, is required or not in all cases. Further, it is not clear what the term "standard devices" means in the context of this item. If the secondary container/liner is required, the applicant needs to provide licensing drawings for the secondary container/liner and its shoring devices, and also clarify the use of the secondary container/liner along with a specific description of the "standard devices."

This information is required by the staff to determine compliance with 10 CFR 71.47, 71.51, and 71.89.

Robatel Response – RAI Comment 5-1:

Secondary containers and shoring are not required to support a safety function. They are utilized to facilitate handling of the radioactive material contents. No credit is taken for a secondary container in the shielding analysis.

We have removed the term "standard devices" which was used to refer to the tooling required to install the lid on a secondary container because it plays no role in the safety evaluation.

SAR Impacts

- Chapter 5, Section 5.3.1 has been revised to include a statement that no credit is taken for liners or high integrity containers or shoring of the contents in order to meet the regulatory dose rate limits. Chapters 1, Sections 1.2.2.3, 1.2.2.4 and 1.2.2.7 and Chapter 7, Section 7.1.2.1 have been revised to indicate that use of a secondary container is optional.

Calculation Impacts

- None

NRC RAI Comment 5-2:

Confirm that the packaging is used to ship only wastes with a uniform source distribution and that sources with a "point source" geometry are not authorized as contents at this time. Provide specific operating procedures that can determine and assure the uniform distribution of the source in the contents.

The application indicates that (i) the Model No. RT-100 package is designed for shipping general wastes from reactors, (ii) the radioactive sources are assumed to be uniformly distributed, and (iii) the contents are restricted in terms of Curie/gram concentration to assure homogeneity. For these reasons, the application does not provide any shielding analysis for concentrated sources and indicates that the sources will be defined in terms of Curie per gram of content. However, the application does not include clear guidance and/or operating procedures regarding the appropriate determination of authorized contents.

The applicant needs to both confirm the intended contents and develop loading procedures that can determine the eligibility of the contents based on the source concentration (i.e., Curie/gram or Becquerel/gram). The applicant also needs to develop operating procedures to determine the maximum and minimum allowed density of the contents. With respect to the density limits, an average density obtained by dividing the total weight by the total volume should not be used because this method cannot provide information on the uniformity of the contents and of the source in the package cavity. The same principle applies to the source term distribution in the contents, i.e., the user must be given specific instructions to assure uniform distribution of the source in the contents as well.

This information is required by the staff to determine compliance with 10 CFR 71.47, 71.51, and 71.89.

Robatel Response – RAI Comment 5-2:

The contents of the RT-100 will consist of dewatered resins and filters. The material is not intended to be shipped as a "point source". Waste Generators are required to perform sampling prior to shipment. This sampling verifies the homogeneity of the material. Prior to shipment the waste generators are required to provide the complete waste stream characteristics and characterization in the form of a waste profile. This waste profile ensures that the material is in compliance with the receiving facilities Waste Acceptance Plan and includes any analytical data process knowledge, radiological activities, anticipated dose rates of the material and the chemical/physical make-up of the waste. The maximum isotopic unit activity of any waste samples is used in the Loading Table for the entire contents of a package. This provides reasonable assurance that the RT-100, when loaded, will not have significant variation in the homogeneity of its contents, that could result in a dose rate at the package surface or one meter from the vehicle boundary that exceeds the dose limits in 10 CFR 71.47 b(2). The dose rate measurements required by NRC and DOT before shipment are used to indirectly verify (not to make the primary determination) that there are no significant variations in package contents. Multiple pre-shipment measurements are taken at various points on or from the RT-100 surface to assure that there are no "hot spots" (i.e., significant non-homogeneity in the contents), and that there are no regions on the RT-100 that exceed the dose limits required by NRC in 10 CFR 71.47 b(2) and DOT in 49 CFR 173.441(b). Dose rate and contamination surveys are performed on the RT-100 and vehicle (at the time of receipt) to verify compliance with NRC, DOT and state regulations. The dose rates taken when the waste is received are compared and analyzed against the waste profiles prepared by the shipper (waste generator), to ensure that the waste has been correctly analyzed.

As addressed in the responses to RAI 5-6 and RAI 7-1, Chapter 7, Section 7.6.1 of the SAR has been revised to provide additional examples of how the Loading Table is utilized to demonstrate compliance with the individual nuclide activity density limits specified in Chapter 5, Appendix 5.5, Section 5.5.3. See Calculation Package RTL-001-CALC-SH-0301, Rev. 3

The analysis in Calculation Package RTL-001-CALC-SH-0201, Rev. 4 demonstrates that resin with a density of 0.65 g/cm^3 produces the lowest maximum allowable Ci/g for each radionuclide. Thus, higher and lower density concentrations of resin in the package are bounded by the current evaluations.

SAR Impacts

- Chapter 5, Sections 5.3.1 and Chapter 7, Section 7.6.1 are revised to provide additional information regarding the Loading Table process.

Calculation Impacts

- Calculation Package RTL-001-CALC-SH-0201, Rev. 4
- Calculation Package RTL-001-CALC-SH-0301, Rev. 3 has been developed to provide additional guidance on the Loading Table process.

NRC RAI Comment 5-3:

Explain the basis for assuming the additional 1 mm annular air gap between the lead shield layer and the shells housing the lead layer of the Model No. RT-100 package; justify the adequacy of the subsequent 2.478 cm lead slump assumption; recalculate the lead slump if necessary, and provide an updated loading table for various contents based on the updated lead slump.

The application indicates that lead slump was considered in the HAC shielding analysis. On pages 26-27, the applicant calculated the lead slump for both side and end drop impacts. However, the basis for the air gap formed by the lead slump is unclear. In its response to RSI 5-1, the applicant did not provide any basis for its determination and simply replaced the axial 1.62 mm with a lead slump gap of 2.478 cm in the application. In addition, the applicant characterized the gap as manufacturing tolerance.

It is unclear if the manufacturing tolerances include lead shrinkage. More importantly, it is unclear if the stainless steel shells housing the lead layer have the same tolerances. If so, the space available for lead slump will be much larger when the tolerances move in opposite directions. Further, the staff was unable to find any update to the maximum allowable design basis contents, Table 5.4.4-4, for a package under HAC as a result of this change. The maximum allowable contents in this table are identical to what was presented in Revision 0 of the application.

The staff requests the applicant to provide: (1) a justification for the assumed lead gaps under both NCT and HAC, (2) correct the data if necessary, and (3) recalculate the dose rates for the package under both NCT and HAC.

This information is required by the staff to determine compliance with 10 CFR 71.47 and 71.51.

Robatel Response – RAI Comment 5-3:

Explanation of the gap between lead and the external shell

Prior to lead pouring, the cask body components that form the mold for lead pouring are heated to approximately 350°C (662°F). The components include the inner shell, outer shell, inner bottom plate and upper flange. The thermal expansion for each of these components is calculated using the thermal expansion coefficient for the materials used in the fabrication of the individual component.

$$D_m(T_2) = Dm(T_1)\cdot\left[1 + \lambda\cdot(T_2 - T_1)\right]$$

$$e(T_2) = e(T_1)\cdot\left[1 + \lambda\cdot(T_2 - T_1)\right]$$

$$H(T_2) = H(T_1)\cdot\left[1 + \lambda\cdot(T_2 - T_1)\right]$$

$Dm(T_2), Dm(T_1), e(T_1), e(T_2), H(T_1), H(T_2)$

Are the mean diameters, thicknesses and lengths at the temperature T_2, T_1

λ Is the stainless steel linear thermal expansion coefficient

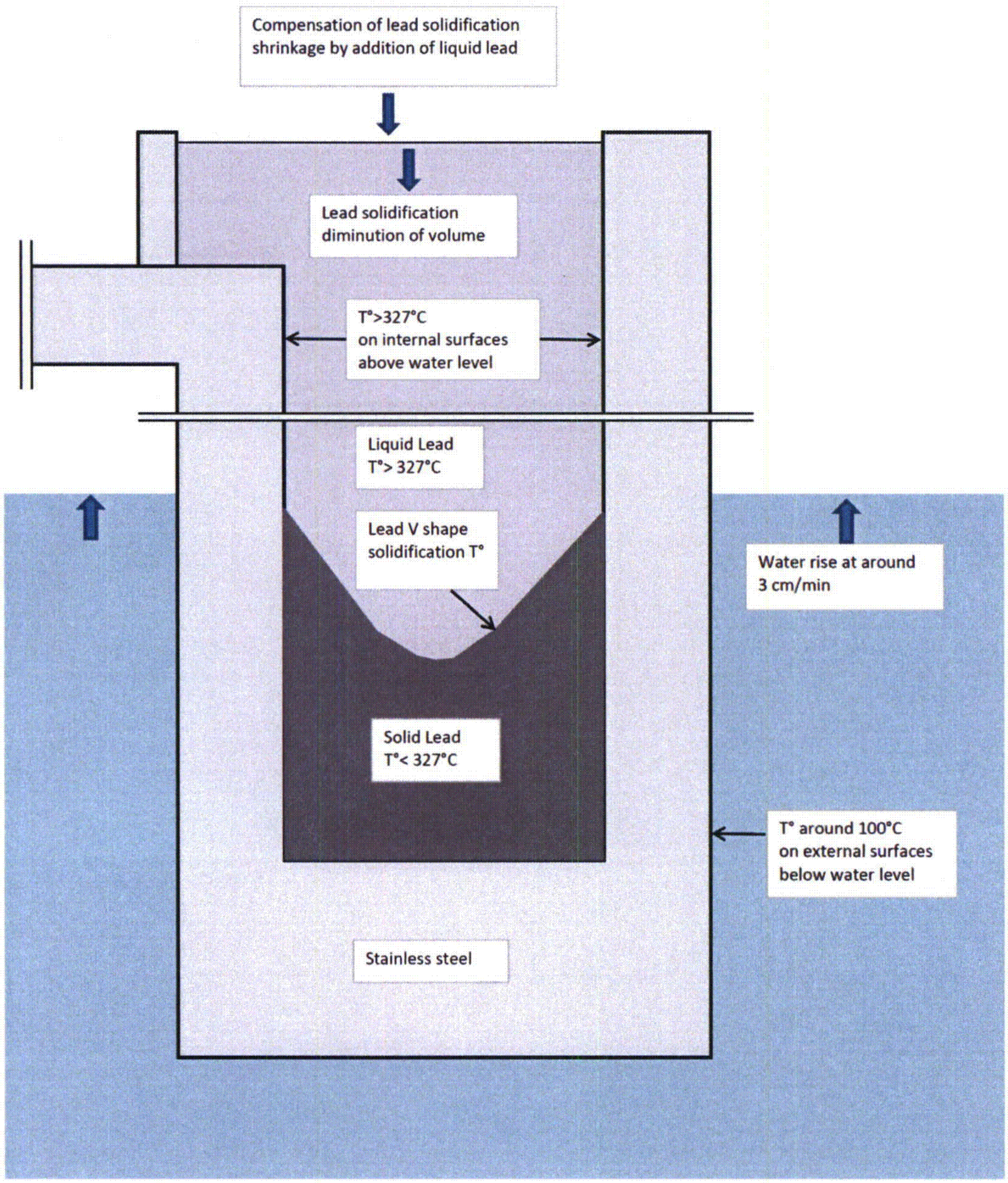
Liquid lead is poured in the gap between the two (2) pre-heated shells. At this stage, the lead fills the cavity completely (within the specified geometry tolerances). The manufacturing tolerances ensure that the gap between the inner shell and the outer shell is 90 +5/-4 mm.

Chapter 8, Section 8.1.6 of SAR, Rev. 2 has been revised to state that gap is measured to be at least 86 mm prior to lead pouring operations. Therefore, the thickness of liquid lead is at least 86 mm and there is no gap between the liquid lead and the shells.

After filling the entire annulus between inner shell and outer shell with liquid lead, the lead solidification is controlled by carrying out a progressive water rise on both the external surface of the outer shell and the internal surface of the inner shell. This process ensures that the lead solidifies beginning at the bottom of the lead column. Solidification occurs when the temperature of the shells cools to 327°C (621°F). Lead solidifies initially at the upper flange (bottom for lead pour) then progressing upward along the inner and outer shells. Liquid lead forms a 'V' shape in the vertical section of the lead column in the area of solidification.

The lead shrinkage during solidification due to the difference of densities of liquid and solid lead at 327°C (621°F) does not result in the creation of a gap between the shells and the lead because the gap formed by solidification is immediately compensated by the liquid lead from inside of the 'V' (see sketch 1 below). Therefore, the effect of lead solidification is the lowering of the liquid lead level. This is compensated by addition of liquid lead throughout the solidification process.

sketch 1:



As the lead continues to cool below the solidification temperatures, a gap between the outer shell and the lead is created. This results from the fact that the thermal expansion coefficient of lead is higher than for stainless steel. During the cooling process, the inner and outer shells shrink according to the stainless steel expansion coefficient. The lead shrinkage, which has a greater thermal expansion coefficient than the stainless steel, cannot be calculated the same way. The lead cannot shrink freely on its inner annular surface because the inner shell (having far higher yield and tensile strength) precludes this. As a result the inner annular surface of the lead presses against the inner shell and consequently the lead shrinkage is constrained by the inner shell. It is assumed that all this missing lead shrinkage is transferred to the lead thickness only. A lead section perpendicular to the cask vertical axis shrinks following the formula:

$$S(T2) = (1 + \lambda)^2 \cdot S(T1) \cdot (T_2 - T_1)$$

The internal lead diameter being the outer diameter of the internal shell.

$S(T2), S(T1)$ are the lead section areas at the temperatures T_2, T_1

$(1 + \lambda)^2$ is the surface thermal expansion coefficient of lead.

When solidification occurs from bottom to top, the height shrinkage is compensated by addition of liquid lead on the top surface. So, vertical shrinkage is not taken in account in the gap estimation. The annular gap is created because of thermal expansion differences between lead and stainless steel as previously described.

In the calculation, the lead linear thermal expansion coefficient found in the literature is 28.9E-6 mm/mm/°C. The linear thermal expansion coefficient of stainless steel is 16E-6 mm/mm/°C which is less than what was found in the literature (average between 0° and 300°C (572°F) is around 16.33E-6 mm/mm/°C according to Figure 2.7.1.0 in DOT/FAA/AR-MMPDS-01 – Metallic Materials Properties Development and Standardization (MMPDS) January 2003, (see below).

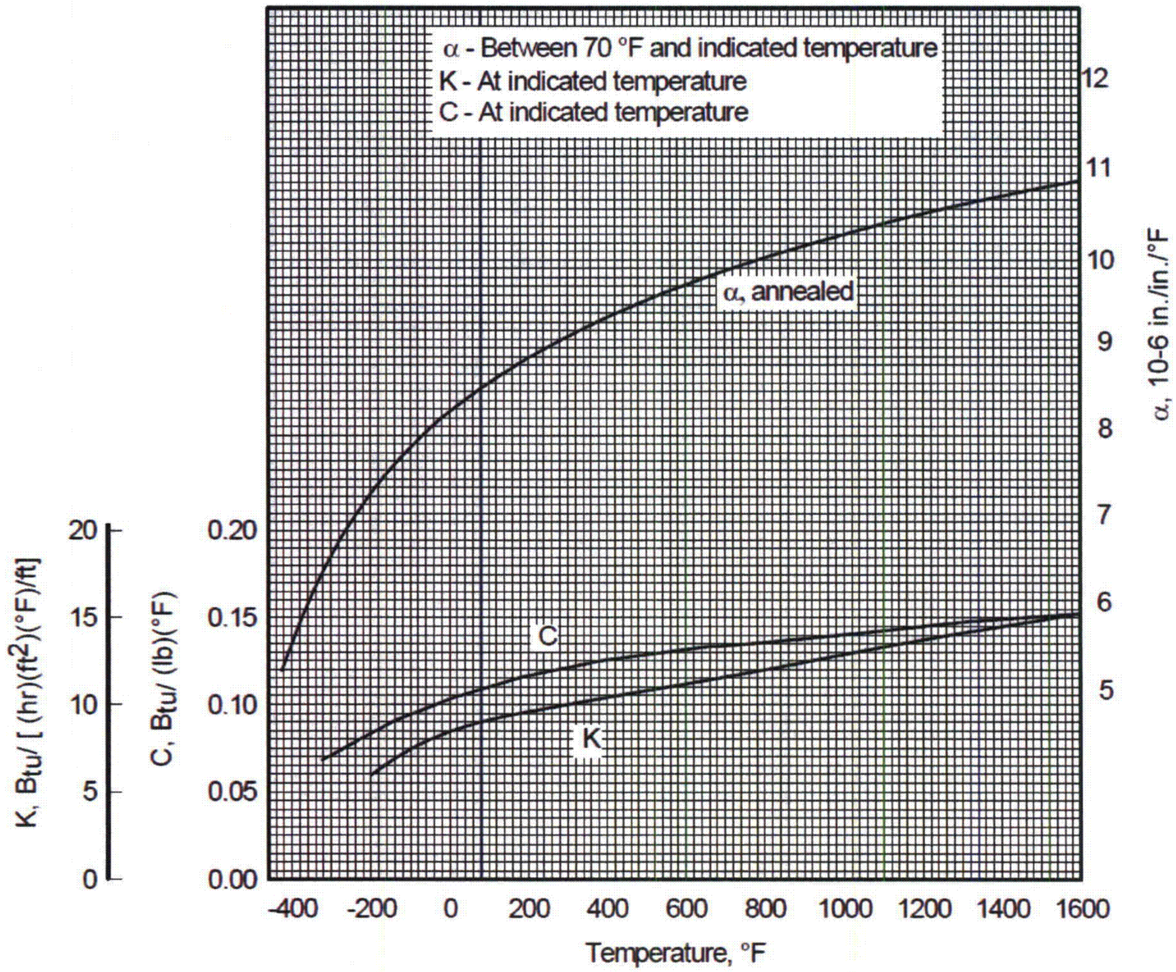


Figure 2.7.1.0. Effect of temperature on the physical properties of AISI 301 stainless steel.

Data

$\lambda_{lead} := 28.9 \cdot 10^{-6} \cdot mm \cdot mm^{-1} \cdot K^{-1}$	linear expansion coefficient of lead
$\lambda_{steel} := 16 \cdot 10^{-6} \cdot mm \cdot mm^{-1} \cdot K^{-1}$	linear expansion coefficient of stainless steel
$\theta_0 := 20°C$	reference temperature
$Dm0_i := \frac{1790 + 1730}{2} mm$	mean diameter of inner shell at θ_0
$Dm0_o := \frac{2040 + 1970}{2} mm$	mean diameter of outer shell at θ_0
$t0_i := 30mm$	thickness of inner shell at θ_0
$t0_o := 35mm$	thickness of outer shell at θ_0
$\theta_s := 327°C$	lead melting point

Diameter and thickness of shells at temperature

$Dm_i(\theta) := Dm0_i \cdot \left[1 + \lambda_{steel} \cdot (\theta - \theta_0)\right]$ $\qquad Dm_i(\theta_s) = 1.769 \times 10^3 mm$

$Dm_o(\theta) := Dm0_o \cdot \left[1 + \lambda_{steel} \cdot (\theta - \theta_0)\right]$ $\qquad Dm_o(\theta_s) = 2.015 \times 10^3 mm$

$t_i(\theta) := t0_i \cdot \left[1 + \lambda_{steel} \cdot (\theta - \theta_0)\right]$ $\qquad t_i(\theta_s) = 30.147mm$

$t_o(\theta) := t0_o \cdot \left[1 + \lambda_{steel} \cdot (\theta - \theta_0)\right]$ $\qquad t_o(\theta_s) = 35.172mm$

Outer diameter of inner shell and inner diameter of outer shell

$D_i(\theta) := Dm_i(\theta) + t_i(\theta)$ $\qquad D_i(\theta_s) = 1.799 \times 10^3 mm$

$D_o(\theta) := Dm_o(\theta) - t_o(\theta)$ $\qquad D_o(\theta_s) = 1.98 \times 10^3 mm$

Section of liquid lead at lead solidification temperature θ_s

$$S_{lead.liq}(\theta_s) := \pi \frac{D_o(\theta_s)^2 - D_i(\theta_s)^2}{4} \qquad S_{lead.liq}(\theta_s) = 0.537m^2$$

Section of solid lead at reference temperature θ_0

$$S_{lead}(\theta) := S_{lead.liq}(\theta_s) \cdot \left[1 + \lambda_{lead} \cdot (\theta - \theta_s)\right]^2 \qquad S_{lead}(\theta_0) = 0.527m^2$$

Inner and outer diameter of solid lead at reference temperature

$D_{lead.i}(\theta) := D_i(\theta)$ $\qquad D_{lead.i}(\theta_0) = 1.79 \times 10^3 mm$

$$D_{lead.o}(\theta) := \left(\frac{4}{\pi} S_{lead}(\theta) + D_{lead.i}(\theta)^2\right)^{\frac{1}{2}} \qquad D_{lead.o}(\theta_0) = 1.969 \times 10^3 mm$$

Gap between lead and outer shell

$$j(\theta) := \frac{D_o(\theta) - D_{lead.o}(\theta)}{2} \qquad j(\theta_0) = 0.687mm$$

Conclusion:

Drawing RT100 PE 1001-1 Rev. G (Chapter 1, Appendix 1.4, Attachment 1.4-2) and drawing RT100 PE 1001-2 Rev. G (Chapter 1, Appendix 1.4, Attachment 1.4-3) are revised to clarify that the gap between the inner and outer shells prior to lead pouring is 90 +5 / -4 mm. This dimension is measured during the fabrication process to ensure that the minimum lead thickness of 85 mm will be maintained including the subsequent lead shrinkage during cooling, given that the thickness prior to lead pour is ensured to be at least 86 mm.

The calculation above shows a final calculated gap between the outer shell and the lead of 0.687 mm, the gap is assumed to be 1 mm for the shielding simplified lead slump calculation. This calculation considers the unlikely event that the lead completely slumps to fill the 1 mm annular gap between the lead and the outer shell. This creates a ring shaped void above the lead in the top of the cask with a height of 24.78 mm.

The shielding analyses (Calculation Packages RTL-001-CALC-SH-0201 Rev. 4, RTL-001-CALC-SH-0301 Rev. 3, and RTL-001-CALC-SH-0401 Rev. 1) have been performed assuming a minimum lead thickness at all locations, and the accident condition model of the cask for lead slump assumes a gap of 24.78 mm at the top of the lead column in the cask body. The actual lead slump that occurs (Chapter 2, Section 2.7.1.1.2 of the SAR) is 1.62 mm.

SAR Impacts

- Chapter 5, Section 5.3.1 has been cross referenced to Appendix 8.3, Section 8.3.2
- Chapter 8, Appendix 8.3, Section 8.3.2 has been added to describe the lead pouring process.
- Drawing RT100 PE 1001-1, Rev. G (Chapter 1, Appendix 1.4, Attachment 1.4-2) revised.
- Drawing RT100 PE 1001-2, Rev. G (Chapter 1, Appendix 1.4, Attachment 1.4-3) revised.

Calculation Impacts

- None

NRC RAI Comment 5-4:

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

From Figure 5.3.1-4 of the application, it seems that a material density of 1.13 g/cm^3 was used in the model for the package under HAC. However, it is unclear that the assumed material density is conservative for shielding calculations. Page 5-17 of the application states: "This density is based on the random packing fraction (~0.65) for polystyrene spheres (beads) which has a theoretical density of ~ 1 g/cm^3. Under HAC, the material is conservatively assumed to compress to half its volume and double the source density. Thus under HAC, the contents maximum density increases to 1.13 g/cm^3 due to compression from the drop." From these statements, it appears that 1.13 g/cm^3 was used for conservatism in dose rate calculations. However, this assumption may not be valid and conservative for shielding analysis. First of all, this density exceeds the theoretical density of the polystyrene resin which is the main authorized content. Second, shielding analysis models typically use material densities that are lower than the actual densities. Arbitrary increase in material density will increase the attenuation of the particles traversing the media; hence compaction of the media may underestimate the dose rate outside the package. Although the source was condensed accordingly in the model for a package under HAC, the evaluated configuration may not be the bounding. The applicant needs to examine this approach, demonstrate that the assumed configuration is bounding in terms of dose rates, and recalculate the dose rates for the package.

This information is required by the staff to determine compliance with 10 CFR 71.47 and 71.51.

Robatel Response – RAI Comment 5-4:

The determination of the acceptable maximum Ci/g for the HAC has been recomputed (Calculation Package RTL-001-CALC-SH-0201, Rev. 4) as a function of material density up to the 1 g/cm^3 theoretical density for polystyrene resin.

The typical response behavior as a function of resin density for Co-60 is as shown in the following table.

Resin Density	**1 meter Dose Rate Response**
g/cm^3	mrem/hr/Ci
0.65	0.179
0.75	0.183
0.85	0.186
1.00	0.187
1.13	0.186

As shown in the table, the trade-off between resin self-shielding and the increase in source density is essentially constant. Chapter 5, Section 5.3.2 of the SAR is revised to clarify that the dose rate responses are evaluated for resin densities of up to 1.0 g/cm^3.

The dose rates are essentially the same for density of 1.0 g/cm^3 and the density of 1.13 g/cm^3, however, the package dose rates have been re-calculated for HAC using a maximum density of 1.0 g/cm^3.

SAR Impacts

- Chapter 5, Section 5.3.2 is revised to clarify the range of densities evaluated for resin.

Calculation Impacts

- Sections 7.2 and 7.7.4 of Calculation Package RTL-001-CALC-SH-0201, Rev. 4, have been revised to evaluate the maximum Ci/g as a function of material density up to the 1 g/cm^3 theoretical density for polystyrene resin.

NRC RAI Comment 5-5:

Clarify if the package is transported with an enclosure or a personnel barrier. If neither of these devices are used, provide a justification for using the dose rate at 3219.2 mm from the cask centerline of the package for demonstration of compliance with 10 CFR 71.51(a)(1).

Page 5-3 of the application states: "During normal conditions of transport, shielding evaluations assume that the RT-100 is transported on a truck trailer that is 2438.4 mm and 12801.6 mm long with the cask tied downed in the center. Thus, the 2 meter radial surface is 3219.2 mm from the cask centerline and the distance to the cab, taking into account the trailer hookup and the distance to back of cab, is 8915.4 mm from the cask centerline." Page 1-4 of the application states: "The RT-100 does not require the use of personnel barriers to meet 10 CFR 71 dose rate limits." As shown on licensing drawing RT100 PE 1001-1, it appears that the diameter of the package body is 2060 mm. If there is no personnel barrier and the package is not transported in an enclosure, the requirements of 10 CFR 71.47(b)(1) apply. The dose rate at 2 meters from the package surface should be 2060/2 + 2000 = 3030 mm rather than 3219.2 mm from the centerline of the package. The applicant needs to clarify this design feature and provide updated shielding calculations and results if the package is not transported in an enclosure or with a personnel barrier.

This information is required by the staff to determine compliance with 10 CFR 71.47 and 71.51.

Robatel Response – RAI Comment 5-5:

It is intended that the package be in compliance with 10 CFR 71.47(b)(2). Table 5.1.2-1 of the SAR has been revised to provide a reference 10 CFR 71.47(b)(2) rather than 71.47(a).

Figure 5.4.4-1 (reproduced below) has been added to the Chapter 5, Section 5.4.4 to provide additional clarity on where the doses for exclusive use shipment are taken

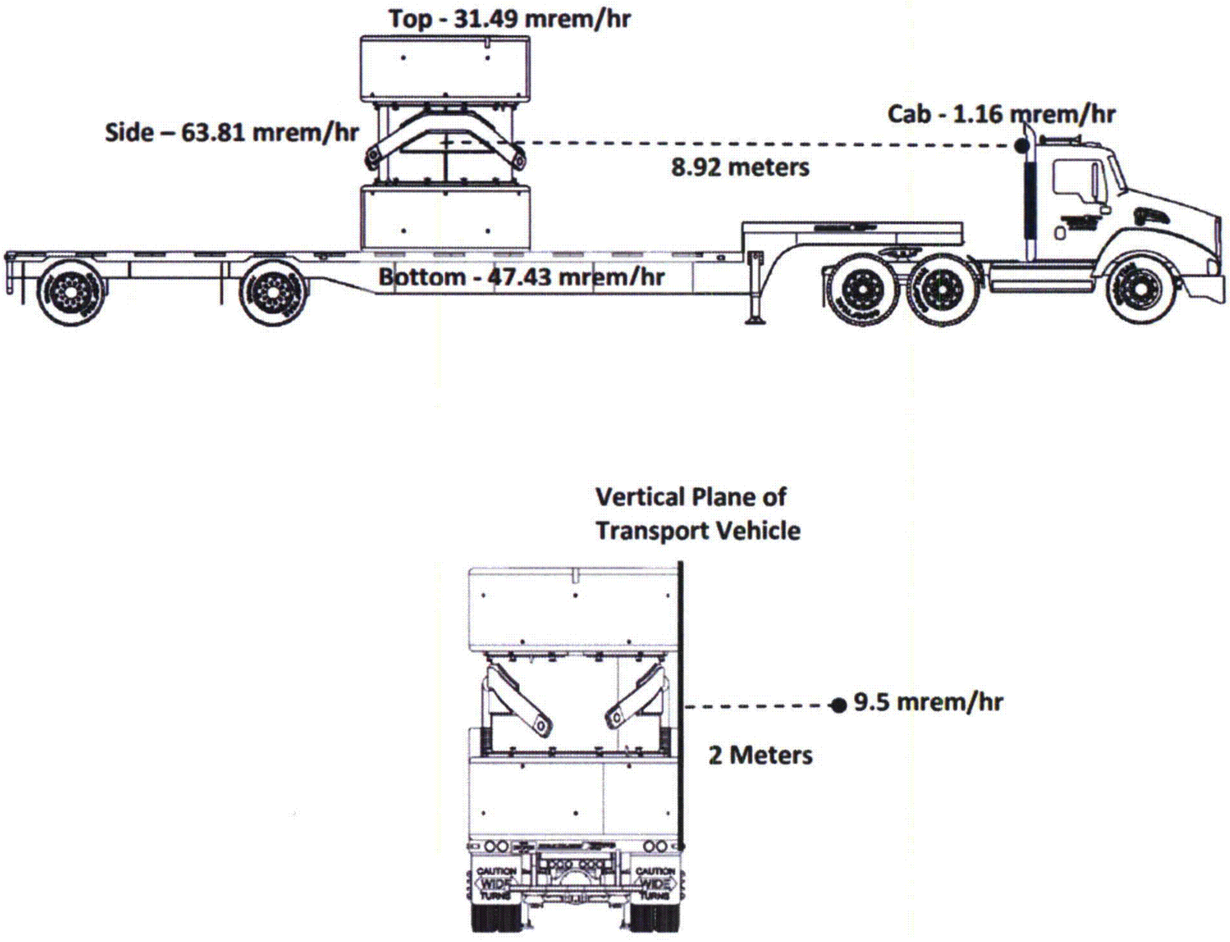


Figure 5.4.4-1 NCT Dose Rates for the Maximum CO-60 Loading of 741.4 Ci

SAR Impacts

- Table 5.1.2-1 of the SAR has been revised to clarify that compliance is in accordance with 10 CFR 71.47(b)(2).

Calculation Impacts

- None

NRC RAI Comment 5-6:

Demonstrate that the approach used to calculate the maximum allowable content is accurate and reliable for all actual contents.

Table 7.8.1-1 lists maximum allowable contents for each potential isotope in a typical resin waste composition. The application states that this approach is an inverse calculation approach and that the method attempts to determine the maximum allowable quantity for each isotope of interest for the given regulatory dose rate limits. Since a pure nuclide was used in each calculation, it is unclear if the results are applicable to a content that is a mixture of multiple nuclides. The applicant needs demonstrate that this approach is accurate and reliable for determining the maximum allowable content with consideration of the differences between the materials used in the model and the actual contents.

This information is required by the staff to determine compliance with 10 CFR 71.47 and 71.51.

Robatel Response – RAI Comment 5-6:

The approach used to calculate the maximum allowable contents has been developed to ensure accuracy and reliability. This approach is intended to assure that the maximum activity of each radionuclide includes sufficient margin to ensure that the maximum dose rates of a loaded RT-100 cask will comply with regulatory dose rate limits. The following points highlight the methodology used to ensure reliability and accuracy of the results:

- The shielding model is constructed using the minimum shielding material thicknesses, and assumes that the maximum activity concentration of a specific radionuclide completely fills the cask cavity with no credit given for attenuation provided by secondary containers.

- The use of MCNP is validated using benchmark data from several sources. This validation demonstrates that the dose rates calculated by MCNP are accurate, and conservative as compared to the reported benchmark results.

- The method utilized to determine the dose responses for a specific radionuclide uses responses from specific energy lines to interpolate for the response at each of the energy lines for the specific radionuclide. This method also carries forward the "fsd" uncertainty value resulting from the MCNP computations, combining them statistically so that the final calculated response for the specific radionuclide includes the combined fsd value for all energies given off by the radionuclide. The MCNP calculations are converged to the extent that the Monte Carlo uncertainty for every isotope, as developed from the fsd values, is no more than 5%.

- The final dose rate responses for a specific radionuclide is computed by considering the nominal dose rate responses and adding two times the computed standard deviation value to ensure that the reported values represent the maximum possible dose rate to a confidence level of more than 95%. Therefore, only 2.5% of all possible variations in the calculated values could exceed the value reported.

- Finally, an administrative margin of 5% is applied to each regulatory dose rate limit (i.e, the 2 meter NCT dose rate limit applied in the method is 9.5 mrem/hr rather than 10 mrem/hr).

The loading table discussion presented in Chapter 7, Section 7.6.1 of SAR, Rev 2 has been revised to include a methodology for calculating the maximum quantity allowed when shipping a mixture of multiple nuclides. In order to ensure that the contents do not produce external dose rates that exceed regulatory limits, users are required to input into the loading table (loading table located in SAR, Rev 2, Chapter 7, Table 7.6.1-1) the maximum curie concentration (Ci/gram) of each radionuclide present in their waste streams. In the event that a shipment contains a mixture of multiple nuclides, the maximum curie concentration from all streams must be assumed. As shown in Chapter 7, Section 7.6.1 of SAR, Rev 2, the loading table utilizes a sum of fractions approach to ensure that the dose contributions from each radionuclide when summed together will not exceed the regulatory limits.

Chapter 5, Section 5.4.1 of SAR, Rev 2 describes how the sources are modeled in the cask for the shielding evaluation (Calculation Package RTL-001-CACL-SH-0201, Rev. 4). The models assume that the waste fills the cavity at a given curie concentration. Regardless of the volume of material present, the analysis assumes that the entire cavity is filled with radioactive material at the maximum curie density. This is also described in Chapter 5, Section 5.3.1 of the SAR. The shielding models consider a range of content materials and densities. The values selected for analysis are bounding in terms of producing the lowest acceptable curie densities. The previous analysis utilized an approach that modeled the RT-100 cask response to gamma energy groups in two ranges. Due to relatively large uncertainties in the lower energy groups, the analysis has been revised to utilize a three range approach as described in Chapter 5, Section 5.4.2 of the SAR.

Chapter 5, Section 5.4.4 of the SAR summarizes the results of the shielding analysis for NCT and HAC and provides an example of how the dose rate responses determined in the shielding evaluation are utilized to calculate the external dose rates produced for a given radionuclide and activity density in the contents.

In order to ensure that the analysis methods utilized in the RT-100 shielding evaluation are appropriate, a validation of MCNP5 is provided in Chapter 5, Appendix 5.5, Section 5.5.4 of the SAR. This section presents the results of calculations performed in comparison to an available neutron dose rate benchmark and to gamma dose rate benchmarks produced in association with the fabrication of the first RT-100 unit. These benchmark calculations demonstrate that MCNP5 produces results that are accurate as compared to measured dose rates, and typically produce values that are slightly higher than the measured values.

The SAR, Rev 2 presents a complete approach that can be utilized by end users to ensure that the contents to be loaded in the RT-100 will meet regulatory requirements. The analytical approach is shown to produce dose rates that exceed measured values. The acceptance criteria for the loading table requires users to assume bounding curie concentration values for their contents, and a 5% administrative margin is also applied to ensure that actual dose rates will be lower than the regulatory limits. In addition, the methodology includes a two-sigma Monte Carlo uncertainty and worst case tolerances in the model.

In addition, during the review of the shielding analysis it was found that the bottom outer plate thickness dimension (33 mm) was incorrect in the shielding calculation model. The shielding model was corrected in the revised calculation package RTL-001-CALC-SH-0201, Rev. 4 to match the correct dimension of 30 mm provided in the drawing RT100 PE 1001-1, Rev. G (Chapter 1, Appendix 1.4, Attachment 1.4-2).

SAR Impacts

- Chapter 5, Sections 5.3.1, 5.4.1, 5.4.2 and 5.4.4 have been revised to provide greater clarity in the method and approach.
- Chapter 5, Appendix 5.5, Section 5.5.4 of the SAR is added to present the validation of MCNP5 for use in performing the RT-100 shielding evaluation.
- Chapter 5, Tables 5.1.2-1, 5.1.2-2, 5.4.4-1 and 5.4.4-2, and Figures 5.3.1-1 and 5.3.1-2
- Chapter 7, Section 7.6.1 is also revised to provide additional examples of the loading table process and to include a loading table (Table 7.6.1-1)

Calculation Impacts

- Calculation Package RTL-001-CALC-SH-201, Rev. 4 has been revised to update the analyses for the three energy range approach and to provide enhanced descriptions of the assumptions utilized in the shielding evaluation.
- Calculation Package RTL-001-CALC-SH-0401, Rev 1 has been added to document the validation of MCNP5.

NRC RAI Comment 5-7:

Explain why only the Bremsstrahlung gamma flux at 2 mm from the inner surface, rather than in the entire range of the inner steel shell, was computed and used in the subsequent shielding analysis, and recalculate the contribution of Bremsstrahlung gamma to the total dose rates, if necessary.

The applicant used an indirect method to compute the dose rate contributed by the Bremsstrahlung reactions that occur while high energy beta particles traverse heavy metals such as lead and steel. However, it is unclear why only the Bremsstrahlung gamma flux at 2 mm was computed and used in the subsequent shielding analysis rather than all the gamma particles produced in the entire range of the inner steel shell.

This information is required by the staff to determine compliance with 10 CFR 71.47 and 71.51.

Robatel Response – RAI Comment 5-7:

The initial approach presented in the SAR for Bremsstrahlung gamma production has been revised to include the Bremsstrahlung gamma produced throughout the cask rather those produced in the first 2mm thickness of the inner shell. The initial approach in Section 7.7.7 of Calculation Package RTL-001-CALC-SH-0201, Rev. 1, is as follows:

> In order to model this, the Bremsstrahlung photon spectra produced in the first 2 mm of the inner steel shell was computed using an MCNP tally, assuming all the source is in direct contact with the wall. A predominance of the electrons emitted by the source are absorbed within the first 2 mm of high-Z materials such as stainless steel. The resulting Bremsstrahlung photon spectra was then folded into the energy dependent photon responses generated for gamma emission in order used to reasonably assess the dose rate due to Bremsstrahlung. Dose rate responses were very low (< 2×10^{-6} mrem/hr/Ci) and basically negligible for resin/filter contents.

The revised approach is provided in Section 7.7.7 of Calculation Package RTL-001-CALC-SH-0201, Rev. 4. The approach utilizes two source configurations:

- Uniform source in resin (polystyrene and zeolite)
- Uniform source in void, i.e. direct impact on the interior shell yielding highest response

The MCNP transport is executed in mode e p (electron-photon) using a coupled e p weight window variance reduction. The most energetic Beta nuclides evaluated are:

- Y-90 $E_{max} = 2.281$ MeV
- Sb-124 $E_{max} = 2.302$ MeV
- Cs-137 $E_{max} = 1.175$ MeV
- La-140 $E_{max} = 2.165$ MeV
- Ce-144 $E_{max} = 2.996$ MeV

The beta energy spectra is taken from ICRU Report 56, Appendix D. The revised analysis calculates the integrated production of Bremsstrahlung gammas throughout the model rather than just those produced in the first 2-mm thickness of the inner shell as performed in the initial analysis.

The results for normal conditions are presented in the following table:

Nuclide	Response at 2 Meters(mrem/hr/Ci)
Y-90	6.60E-07
SB-124	1.59E-07
CS-137	1.45E-11
LA-140	3.88E-08
CE-144	1.95E-06
CE-144-void	3.64E-05
CE-144-Zeolite	3.12E-06

The void case represents the source in direct contact with the inner shell, while the Zeolite resin contains aluminum, silicon and calcium which tend to produce more energetic gammas. For comparison, the Co-60 response at 2 meters is 1.28E-02 mrem/hr/Ci.

Based on these results, the beta emitters would produce a maximum dose rate of 0.05 mrem/hr for a maximum isotopic quantity of 3000 A_2. The limiting case is shown to be CE-144 in Zeolite. The CE-144 A_2 value is 5.4 Ci. Therefore, the maximum quantity of CE-144 is 16,200 Ci. The A_2 limit imposed for the RT-100 precludes the shipment of enough Curies of the Beta/Bremsstrahlung emitting isotopes to produce a significant contribution to the total dose rate limit at two meters. Therefore, the bremsstrahlung gamma response functions are omitted from the Loading Tables provided in Chapter 7 Appendix 7.6 of the SAR.

SAR Impacts

- Chapter 5, Sections 5.2.1 and 5.4.4 have been revised to clarify the approach to assess Bremsstrahlung.

Calculation Impacts

- Section 7.7.7 of Calculation Package RTL-001-CALC-SH-0201, Rev. 4.

<u>NRC RAI Comment 5-8:</u>

Provide justification for including the S(α, β) reaction for the up-scattering treatment of thermal neutrons in the neutron shielding analysis.

The applicant applied the S(α, β) reaction modification to the material cards in its MCNP shielding models. However, it is unclear why such a modification is necessary for the shielding analyses. The applicant needs to provide discussions on the meaning of the S(α, β) reaction modification and why it is necessary to include this treatment in neutron shielding analyses.

This information is required by the staff to determine compliance with 10 CFR 71.47 and 71.51.

Robatel Response – RAI Comment 5-8:

The S(α, β) reaction was used for thermal neutron scattering to increase the accuracy for up and down energy scattering at thermal energies. Section 7.7.8 of Calculation Package RTL-001-CALC-SH-0201, Rev. 4, addresses the impact of S(α, β) treatment on the RT-100 shielding evaluations. The conclusions are that the maximum Ci/g limits for the neutron emitting actinides with and without S(α,β) treatment are within ± 1% of each other.

SAR Impacts

- Chapter 5, Section 5.3.2 has been revised to clearly state that the $S(\alpha, \beta)$ treatment is applied.

Calculation Impacts

- None

Chapter 6 – Criticality Evaluation

None

Chapter 7 – Package Operations

NRC RAI Comment 7-1:

Provide operating procedures and/or instructions for the user to calculate the maximum allowable contents for a mixture of some of the isotopes listed in Appendix 5 of the application.

The applicant provides a list of Gamma Nuclides with Greater than 1 Day Half Life, a list of Gamma Dose Rate Response (NCT) (5.6.2-1), a list of Gamma Dose Rate Response (HAC) (Table 5.6.2-2), and a list of Nuclide Maximum Ci/g Loading Limits (Table 5.6.3-1) in Appendix 5 of the application. However, the applicant did not provide any instructions regarding the use of this data to determine the maximum allowable quantity of contents that are typically mixtures of some of the nuclides. The applicant needs to develop operating procedures and/or instructions for the users to determine the maximum allowable quantity if the contents are mixtures of some of the nuclides. This information is required by the staff to determine compliance with 10 CFR 71.87.

Robatel Response – RAI Comment 7-1:

Chapter 7 has been revised to include Appendix 7.6 with the following sections:

- 7.6.1 RT-100 Loading Table Discussion
- 7.6.1.1 RT-100 Loading Table Procedure
- 7.6.1.2 Turkey Point Source Term Example Evaluation
- 7.6.1.3 St. Lucie Loading Table
- 7.6.1.4 Additional Examples

These sections describe the RT-100 Loading Table and the procedure to be followed to ensure the contents are within regulatory limits. These sections also provide additional instruction in response to RAI 5-6. Chapter 7, Appendix 7.6, Section 7.6.1 provides a procedure to instruct the user in completing the Loading Table. The loading table is the primary tool used to ensure that the contents comply with the loading restrictions for the cask.

SAR Impacts

- Chapter 7 has been revised to include Appendix 7.6 to give direction on loading the RT-100

Calculation Impacts

- Calculation Package RTL-001-CALC-SH-0301, Rev. 3 is created to document the loading table process in enhanced detail.

NRC RAI Comment 7-2:

Clarify or modify the removal and replacement procedures for the impact limiters.

Following the procedures in sections 7.1.1.2 ("Lower Impact Limiter Removal") and 7.1.1.3 ("Upper Impact Limiter Removal") of the application, as sequentially written, it is unclear whether the impact limiters can be removed in this order. If the lower impact limiter can be removed prior to the upper impact limiter, indicate how the package will be lifted.

Section 7.1.1.1 "Package Removal from Trailer," directs to section 7.4 of the application. Staff notes that the first bullet on page 7-16 of the application states, "With or without the lower impact limiter attached, lift the RT-100 cask from the transport trailer (Figure 7.4-4)." Staff also notes that there is no reference to a specific set of procedures pertaining to the removal of the lower impact limiter in section 7.4 of the application.

This information is required by the staff to determine compliance with 10 CFR 71.87 and 71.111.

Robatel Response – RAI Comment 7-2:

Chapter 7, Section 7.4 of the SAR has been revised to clarify the removal and replacement procedure for the lower impact limiter. The upper impact limiter must be removed prior to removing the package from the trailer or removing the lower impact limiter.

Chapter 7, Section 7.1.1, Figure 7.1.1-1 (Preparation for Loading Process Flowchart), Section 7.1.2, Figure 7.1.2-1 (Loading of the RT-100 Process Flowchart) and Section 7.1.3, Figure 7.1.3-1 (Preparation for Transport Process Flowchart) are now included to illustrate the general sequence for cask operations, including removal and replacement procedures for the impact limiters.

SAR Impacts

- Chapter 7, Section 7.1.1 and its subsections are revised and reordered to clarify the loading sequence operations
- Chapter 7, Section 7.1.2 and its subsections are revised and reordered to clarify the loading the RT-100 sequence operations.
- Chapter 7, Section 7.1.3 and its subsections are revised and reordered to clarify the transport preparation process.

Calculation Impacts

- None

<u>NRC RAI Comment 7-3:</u>

Confirm the appropriateness of leakage test procedures and leakage test personnel qualifications.

The leak testing discussion in Chapters 7 and 8 lacks details, as evidenced further in subsequent RAI comments. Confirm that appropriate leak test procedures (i.e., detailed procedures are found in lower tier documents, etc.) and test personnel qualifications (i.e., ASNT certified) are established, per quality assurance requirements.

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

Robatel Response – RAI Comment 7-3:

Chapter 8, Sections 8.1.4 and 8.2.2 of the SAR have been revised to provide additional detail on leak test procedures and test personnel qualifications. All leak testing procedures are now located in Chapter 8 of the SAR.

Note: Leak Testing Procedures described in Chapter 8, Sections 8.1.4 and 8.2.2 must be approved by ASNT NDT or COFREND Level III certified personnel. Test personnel shall be ASNT or COFREND certified.

SAR Impacts

- o Chapter 7, Section 7.6 "Containment Seals Leakage Testing" of the SAR Revision 1 was deleted. References to this section are revised to direct the reader to the appropriate test specified in Section 8.2.2.
- o Chapter 8 was restructured.
- o Chapter 8, Section 8.1.4 Leakage Tests (Acceptance Testing following fabrication) is revised to describe the following activities:
  - Leakage Testing Procedures
  - Leakage Testing Acceptance Criteria and its basis, test sensitivity, and action if criteria not met
- o Chapter 8, Section 8.2.2 Leakage Tests (Pre-Shipment Testing, Periodic Testing, and Maintenance Testing) is revised to describe the following activities:
  - Leakage Testing Procedure

- Leakage Testing Frequency
- Leakage Testing Acceptance Criteria and its basis, test sensitivity, and action if criteria not met
- Test Personnel Qualifications

Calculation Impacts

- None

NRC RAI Comment 7-4:

Clarify the appropriate periodic and maintenance leakage tests discussed in Chapter 7.

a) Sections 7.1.1.4, 7.1.1.5, 7.1.1.6, 7.1.2.2, 7.1.2.3, and 7.1.2.4 of the application appear to refer to the ANSI N14.5-1997 periodic and maintenance leakage tests of the seals and containment. If so, these tests should be explicitly stated so that the appropriate components, acceptance criteria and sensitivity criteria are known to the test personnel.

b) These periodic and maintenance tests refer to a pressure rise leakage test found in Section 7.6 of the application. According to ANSI N14.5, the pressure rise test sensitivity is between 1E-1 to 1E-5 ref-cm^3/sec, which is not sufficient to meet the 3.077E-6 ref-cm^2/sec sensitivity described on page 4-11 of the application. An appropriate leakage test procedure is required for the periodic and maintenance leakage tests.

This information is required by the staff to determine compliance with 10 CFR 71.43(f), and 71.51.

Robatel Response – RAI Comment 7-4:

The following changes have been made to the SAR:

a) All leak testing procedures are now located in Chapter 8 of the SAR.

b) The acceptance and sensitivity criteria for leak tests performed on components of the containment boundary are given in Chapter 8, Section 8.2.2 "Leakage Tests".

c) The Containment requirement for the RT-100 has been revised to be leak-tight, in accordance with ANSI N14.5-1997. The periodic and maintenance leakage test have been modified to require a sensitivity of 5E-8 ref-cm^3/sec.

SAR Impact

- o As described in the response to RAI 7-2, Chapter 7 of the SAR is reordered to clarify the loading sequence of the RT-100.
- o The following sections include instructions to inspect the seal for signs of deterioration, and replace if necessary. If the seal is replaced a maintenance leak test is required. The reader is referred to Section 8.2.2.1.
  - 7.1.1.3 Removal of Quick-Disconnect Valve Cover Plate
  - 7.1.1.4 Removal of the Primary Lid
  - 7.1.1.5 Removal of the Secondary Lid
- o The following sections include instructions to conduct a pre-shipment leak test. The reader is referred to Section 8.2.2.2.
  - 7.1.2.2 Primary Lid Replacement
  - 7.1.2.3 Secondary Lid Replacement
  - 7.1.2.4 Quick-Disconnect Valve Cover Plate Replacement
- o Section 8.2.2.1 is revised to reference the reader to applicable subsections of Section 8.1.4. (These periodic and maintenance leak tests are identical to those performed on the RT-100 prior to its initial use.)
- o Section 8.2.2.2 is revised to define the procedure, criteria, and sensitivity requirements for a pre-shipment leak test. This section explicitly states the use of ANSI N14.5 requirements.
- o Section 7.6 "Containment Seals Leakage Testing" of the SAR Revision 1 is deleted; this material is covered in Chapter 8.

Calculation Impacts

- None

NRC RAI Comment 7-5:

Clarify whether the leakage test described in Section 7.1.3 of the application represents the ANSI N14.5 pre-shipment leakage test.

Section 7.1.3 "Preparation for Transport" lists tasks to be performed "… prior to final assembly of the RT-100." One listed task is leak rate testing. It should be clarified whether this leak rate testing refers to the ANSI N14.5 pre-shipment test, which occurs after the contents are loaded and the package is closed. The corresponding acceptance leakage rate and sensitivity criteria should also be provided.

This information is required by the staff to determine compliance with 10 CFR 71.43(f), and 71.51.

Robatel Response – RAI Comment 7-5:

The pre-shipment leak test required before shipment of each loaded RT-100 is described in Chapter 8, Section 8.2.2.2. The frequency, sensitivity, leak rate and ANSI N14.5-1997 provision governing the pre-shipment leak test are given in Chapter 8, Appendix 8.3, Table 8.3-1.

SAR Impacts

- Chapter 7, Sections 7.1.2.2, 7.1.2.3, and 7.1.2.4 of the SAR note pre-shipment leak testing of the primary lid, secondary lid and vent port cover plate O-ring seals. These sections reference Section 8.2.2.2 for the specific ANSI N14.5-1997 leak testing requirements.

- Chapter 7, Section 7.1.3 of the SAR has been revised to remove the reference to leak testing.

Calculation Impacts

- None

NRC RAI Comment 7-6:

Clarify the use of fabrication, maintenance, periodic, and pre-shipment tests in Chapters 7 and 8.

a) Section 4.4 of the application references ANSI N14.5 when discussing the fabrication, maintenance, periodic, and Pre-Shipment tests. However, for completeness and as an aid to the test personnel, it also should be stated in Chapters 7 and 8 that "the fabrication, maintenance, periodic, and Pre-Shipment tests are performed in accordance with ANSI N14.5."

b) The appropriate leakage rate test and sensitivity criteria should be listed in Chapters 7 and 8 for the fabrication, maintenance, periodic, and pre-shipment leakage tests.

This information is required by the staff to determine compliance with 10 CFR 71.43(f), and 71.51.

Robatel Response – RAI Comment 7-6:

a) Chapter 8, Section 8.1.4 and Section 8.2.2 are revised to state that all fabrication, maintenance, periodic and pre-shipment leak tests are performed in accordance with ANSI N14.5-1997. The operating procedures in Chapter 7, Sections 7.1.2.2, 7.1.2.3 and 7.1.2.4 regarding lid replacement have been revised to reference Table 8.2.2.2.

b) The frequency, sensitivity and leak rates are given in Table 8.3-1 "RT-100 Leakage Test Types".

SAR Impact

Section 7.6 "Containment Seals Leakage Testing" of the SAR Revision 1 has been deleted. Leak testing requirements for the cask are provided in Chapter 8, Sections 8.1.4 and 8.2.2.

Chapter 8, Sections 8.1.4 and 8.2.2 are revised to specify the fabrication, maintenance, periodic, and pre-shipment leakage testing per ANSI N14.5-1997, including:

- o Leakage Test acceptance criteria and its basis
- o Leakage Test sensitivity
- o Action to be taken if criteria not met

Chapter 8, Appendix 8.3, Table 8.3-1 has been created to communicate the leak test requirements established in Chapter 4, Sections 4.2 and 4.3.

Calculation Impacts

- None

NRC RAI Comment 7-7:

Confirm the appropriate use of the pressure rise leakage test.

a) Section 7.6 states that a pressure rise leakage test is performed on the containment seals for the primary lid, secondary lid, and quick-disconnect valve cover plate. Although the procedure applies to the primary lid, secondary lid, and quick-disconnect valve cover plate, the initial listed task is for the vacuum pump to be positioned on the primary lid leak test port. The drawings indicate that the primary, secondary, and quick-disconnect valve cover plate leak test ports are independent. Would not the vacuum pump be positioned on the appropriate port that is to be tested, i.e., primary, secondary, or quick-disconnect valve cover plate?

b) The fourth step of the procedure indicates that the vacuum pump should be isolated. It is recognized that a running vacuum pump can pull vacuum across "closed" valves. The procedure should also provide guidance to physically disconnect the pump from the arrangement and/or turn the pump off.

c) Explicit instruction should be provided as it relates to the pressure rise leakage test. Therefore, the following statement should be removed: "Another type of leakage rate testing is acceptable if it complies with the RT-100 design, and ensures every leakage testing requirement is met."

This information is required by the staff to determine compliance with 10 CFR 71.43(f), 71.51, 71.85 and 71.87.

Robatel Response – RAI Comment 7-7:

Chapter 7 and 8 of the SAR have been revised to incorporate the changes requested in the RAI regarding the pressure rise leak test. The revisions are listed below:

Section 7.6 of the SAR, Rev 1 is deleted, with references to Section 7.6 replaced by Chapter 8, Sections 8.2.2.1 "Periodic and Maintenance Leak Test" and 8.2.2.2 "Pre-Shipment Leak Test" as appropriate.

Chapter 8, Section 8.2.2.2 has been revised to clarify that the pressure rise test will be performed by attaching the vacuum pump to the appropriate test port of the primary lid, secondary lid, or vent port cover plate, as directed by the procedures in Chapter 7, Sections 7.1.2.2, 7.1.2.3, and 7.1.2.4.

Chapter 8, Section 8.2.2.2 has also been revised to state that once the vacuum pump is isolated, it is physically disconnected and/or turned off.

Chapter 8, Section 8.2.2.2 is revised to delete references to using an equivalent leakage testing procedure.

SAR Impacts

- Revision of Sections: 8.2.2 and its subsections (8.2.2.1, 8.2.2.2)
- Deletion of Section: 7.6

Calculation Impacts

- None

NRC RAI Comment 7-8:

Discuss the need to prevent contamination during unloading.

a) The potential for release of radioactive gases, volatiles, etc., as well as combustible gases, from the package during unloading (such as a quick-disconnect valve failure, etc.) of contents should be discussed, especially in Sections 7.2.1 and 7.2.2.

b) If available, provide "field data" that shows the activity from the void/headspace from a package with the proposed contents.

This information is required by the staff to determine compliance with 10 CFR 71.43(d), (f), and 71.51.

Robatel Response – RAI Comment 7-8:

Chapter 7, Section 7.2 of SAR has been revised to include additional guidance to users regarding potential contamination release:

- Section 7.2.1 Step 1 instructs the user to follow the requirements of 10 CFR 20.1906.
- Section 7.2.1 Step 2 requires the user to review and follow any special instructions provided by the licensee, as specified in 10 CFR 71.89.
- Section 7.2.2 Step 2, instructing the user to open the quick-disconnect valve cover plate, includes a note:

  "Caution: In the event of failure of the quick disconnect valve, radioactive material may be released when opening the vent port cover plate. Use caution to consider potential release of material consistent with the form of the cask contents."

While there is always the potential for the release of contamination, 10 CFR Part 20 (or equivalent provisions adopted by an NRC Agreement States) requires Licensed Facilities to have Radiological Safety Programs in place in order to prevent, detect, mitigate and report any release of radioactive material. To date Robatel is not aware of any significant release of contamination that has been reported with these types of shipments.

SAR Impacts

- Section 7.2

Calculation Impacts

- None

NRC RAI Comment 7-9:

Provide instructions in Chapter 7 that indicate contents are limited such that the concentration of combustible gases must be below 5%, by volume, at the end of the shipping period.

Chapter 7 should provide instructions to indicate that contents are limited such that the concentration of combustible gases must be below 5%, by volume, at the end of the shipping period. In addition, the shipping period should be explicitly stated.

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

Robatel Response – RAI Comment 7-9:

Chapter 7, Sections 7.5 "Hydrogen Buildup in the RT-100 Transport Cask" and Appendix 7.6, Table 7.6.1-1 "RT-100 Loading Table Illustration" are added to the SAR to provide guidance to cask users regarding how to calculate the gas generation rate for their contents. Additional details regarding these calculations are provided in response to RAI 4-7.

The revised SAR section in Chapter 7 provides complete instructions regarding the gas generation factors for the contents. The maximum combustible gas generation within the cask is required to be limited to less than 5% volume for a period of time that is twice the expected shipping time after closure of the cask.

SAR Impacts

- Chapter 7, Sections 7.5 and Appendix 7.6, Table 7.6.1-1 "RT-100 Loading Table Illustration" are added to provide procedures for calculating the gas generation rate of the contents.

Calculation Impacts

- Calculation Package RTL-001-CALC-SH-0301, Rev. 3 is created to document the loading table process in enhanced detail.

Chapter 8 – Acceptance Tests and Maintenance Program

NRC RAI Comment 8-1:

Clearly indicate the dimensions, materials used, design criteria, fabrication criteria, and acceptance tests required for all important to safety, non-standard materials and components. This is a follow-up to RSI 8.1.

The Bill of Materials indicates that several important to safety components are "commercial," or described based on a manufacturer description. Some of these components, such as O-Rings, are not detailed in the drawings. In order to adequately describe the proposed design, provide either the detailed drawing showing dimensions or the materials of construction of the component, or include a specific reference to the desired part. If a reference is provided, enough detail is needed to understand the design details of the specific component.

Further, an understanding of the data that is used to develop material properties, design allowable, and acceptance tests for these components is needed. Section 8.1.5 discusses the Commercial Grade Dedication (CGD) Plan that will be prepared to ensure that the material meets all specifications critical to safety. However, a description of those tests that are required to ensure the safety of the packaging is needed in Chapter 8 of the application. This can be accomplished by detailing the tests in Chapter 8. For example, for the impact limiter foam, a test matrix of the formulation, batch and pour tests required to ensure that the desired material properties are achieved could be provided. Acceptance tests may also be proposed for the seals and the carbon fiber thermal shield. Alternatively, if this information is already contained in another document, such as a CGD Plan, that document can be referenced and provided as an appendix to Chapter 8.

This information is required by the staff to determine compliance with 10 CFR 71.31(c), 71.33(a)(5), 71.71, 71.73, and 71.85.

Robatel Response – RAI Comment 8-1:

RT100 NM 1000, Rev. E - Bill of Materials (Chapter 1, Appendix 1.4, Attachment 1.4-1) and supporting text in the SAR have been revised to provide the safety classification and clarify the material properties for all non-standard components classified as important to safety. The following table identifies where information can be found for the non-standard components.

Non-Standard Component Important to Safety	Material	Class-ification	Dimension, Material (Drawings and/or Text)	Design Criteria (Drawings and/or Text)	Fabrication Criteria (Drawings and/or Text)	Acceptance Tests (Drawings and/or Text)
Lower Impact Limiter Foam	Foam	A	RT100 NM 1000 Rev. E, ID No. 1031-06, and Attachment 2.12-1	Attachment 2.12-1	Section 8.1.5.1	Attachment 2.12-1
Upper Impact Limiter Foam	Foam	A	RT100 NM 1000 Rev. E, ID No. 1032-06, and Attachment 2.12-1	Attachment 2.12-1	Section 8.1.5.1	Attachment 2.12-1
Primary Lid Containment O-ring (Inner O-ring)	EPDM	A	RT100 NM 1000 Rev. E, ID No. 1012-02, and Section 8.1.5.2	Table 8.1.5-1	Table 8.1.5-2	Table 8.1.5-3
Primary Lid Control O-ring (Outer O-ring)	EPDM	C	RT100 NM 1000 Rev. E, ID No. 1012-03, and Section 8.1.5.2	Table 8.1.5-1	Table 8.1.5-2	Table 8.1.5-3
Secondary Lid Containment O-ring (Inner O-ring)	EPDM	A	RT100 NM 1000 Rev. E, ID No. 1013-05, and Section 8.1.5.2	Table 8.1.5-1	Table 8.1.5-2	Table 8.1.5-3
Secondary Lid Control O-ring (Outer O-ring)	EPDM	C	RT100 NM 1000 Rev. E, ID No. 1013-06, and Section 8.1.5.2	Table 8.1.5-1	Table 8.1.5-2	Table 8.1.5-3
Quick Disconnect Valve Cover Plate Inner O-ring	EPDM	A	RT100 NM 1000 Rev. E, ID No. 1017-03, and Section 8.1.5.2	Table 8.1.5-1	Table 8.1.5-2	Table 8.1.5-3
Quick Disconnect Valve Cover Plate Outer O-ring	EPDM	C	RT100 NM 1000 Rev. E, ID No. 1017-02, and Section 8.1.5.2	Table 8.1.5-1	Table 8.1.5-2	Table 8.1.5-3
Leak Test Port Plug Seal	EPDM	B	RT100 NM 1000 Rev. E, ID No. 1016, and Section 8.1.5.2	Table 8.1.5-1	Table 8.1.5-2	Table 8.1.5-3
Ceramic Paper	Ceramic Paper	A	RT100 NM 1000 Rev. E, ID No. 1011-20, and Section 8.1.5.3	Table 8.1.5-4	Table 8.1.5-4	Table 8.1.5-4

Non-Standard Component Important to Safety	Material	Class-ification	Dimension, Material (Drawings and/or Text)	Design Criteria (Drawings and/or Text)	Fabrication Criteria (Drawings and/or Text)	Acceptance Tests (Drawings and/or Text)
Fusible Plugs	Poly-ethylene	C	RT100 NM 1000 Rev. E, ID No. 1031-15, 1032-17, and Section 8.1.5.4	Section 8.1.5.4	Section 8.1.5.4	Section 8.1.5.4
Primary and Secondary Lids Bolts and Washers	Carbon Steel and Alloy Steel	A	RT100 NM 1000 Rev. E, ID No. 1012-04, 1012-05, 1013-07, 1013-08, and Section 8.1.5.5	Table 8.1.5-5	Table 8.1.5-6	Table 8.1.5-7
Leak Test Port Plugs	Stainless Steel	B	RT100 NM 1000 Rev. E, ID No. 1016, and Section 8.1.5.6	Table 8.1.5-8	Table 8.1.5-9	Table 8.1.5-10
Quick Disconnect Valve Cover Plate Leak Test Port Plug	Stainless Steel (Viton seal included)	B	RT100 NM 1000 Rev. E, ID No. 1017-05, and Section 8.1.5.6	Table 8.1.5-8	Table 8.1.5-9	Table 8.1.5-10
Quick Disconnect Valve Cover Bolts	Stainless Steel	A	RT100 NM 1000 Rev. E, ID No. 1017-04, and Section 8.1.5.6	Table 8.1.5-8	Table 8.1.5-9	Table 8.1.5-10
Thread Pin and Nut	Stainless Steel	B	RT100 NM 1000 Rev. E, ID No. 1033-01, 1033-02, and Section 8.1.5.6	Table 8.1.5-8	Table 8.1.5-9	Table 8.1.5-10
Threaded Inserts	Stainless Steel	A	RT100 NM 1000 Rev. E, ID No. 1011-27, and Section 8.1.5.7	Section 8.1.5.7	Table 8.1.5-13	Table 8.1.5-14
Quick Disconnect Valve	Stainless Steel / EPDM	A	RT100 NM 1000 Rev. E, ID No. 1012-07, 1012-08, Section 8.1.5.8	Section 8.1.5.8	Section 8.1.5.8	Section 8.1.5.8

Chapter 8, Section 8.1.5 of the SAR has been revised to provide additional details regarding CGD plan requirements:

- Critical characteristics for each material are identified
- Specification for test requirements for each material

RT100 NM 1000, Rev. E - Bill of Materials (Chapter 1, Appendix 1.4, Attachment 1.4-1) has been revised to reference the standard components' data sheets.

SAR Impacts

- Chapter 8, Section 8.1.5 has been revised to include the critical characteristics of non ASME standard material (i.e. O-ring, Thermal shield ceramic paper, foam).
- RT100 NM 1000, Rev. E – Bill of Material (Chapter 1, Appendix 1.4, Attachment 1.4-1) is revised to clarify material.

Calculation Impacts

- None

NRC RAI Comment 8-2:

Clarify which components will be inspected during normal use and periodic maintenance. Clearly indicate the differences between the maintenance during normal use and the periodic maintenance every 12 months, as defined in Section 8.2.1 and 8.2.2 of the application, respectively.

A clear understanding of the maintenance approach is needed to verify that the packaging will continue to perform adequately during its licensed period. Based on the description provided, it is unclear whether, for example, the lid and lid seals are inspected each time the Model No. RT-100 package goes through a cycle of loading and unloading.

This information is required by the staff to determine compliance with 10 CFR 71.31.

Robatel Response – RAI Comment 8-2:

Chapter 8, Section 8.2 of the SAR has been revised to include Section 8.2.3, "Component and Material Tests", including:

- 8.2.3.1 Routine Component Inspection – Provides a detailed description of the inspections performed during each cycle of loading and unloading.
- 8.2.3.2 Annual Component Inspection – Provides a detailed description of the inspections, tests, and maintenance performed every 12 months of cask service.

The following table provides a description of the components to be inspected, the frequency, and the type of inspection to take place.

Component to be Inspected	Frequency	Test Type	Test Description	SAR Section
Fasteners	Routine	Visual	Inspect, clean, lubricate, replace if necessary.	8.2.3.1
Subcomponents	Routine	Visual	Inspect the condition of the primary lid, secondary lid, quick disconnect valve cover plate, upper impact limiter, and lower impact limiter.	
Welds	Routine	Visual	Inspect the condition of the cask attachment ring welds and cask lifting pocket welds.	
O-rings	Routine	Visual	Inspect and replace if necessary. If replaced, a leak test is required.	
Labels	Routine	Visual	Inspect and repair if necessary.	
Exterior Cask Surfaces	Annual	Visual	Inspect the impact limiters, cask body, impact limiter fusible plugs, and cask markings.	8.2.3.2
Welds	Annual	Visual	Inspect the visible exterior surface welds and interior cavity welds for defects.	
O-Rings	Annual	Leak Test	New inner and outer containment boundary O-rings are installed and tested.	

SAR Impacts

- Chapter 8, Section 8.2.3.1 Routine Component Inspection – Provides a detailed description of the inspections performed during each cycle of loading and unloading.
- Chapter 8, 8.2.3.2 Annual Component Inspection – Provides a detailed description of the inspections, tests, and maintenance performed every 12 months of cask service.
- Chapter 8 has been revised to reflect the component test frequency in the following tables, Appendix 8.3, Table 8.3-1 "RT-100 Leakage Test Types" and Table 8.3-2 "Allowable Helium Leakage Rates.

Calculation Impacts

- None

<u>NRC RAI Comment 8-3:</u>

Specify the details of an appropriate fabrication, periodic and maintenance leak test that meets the acceptable leakage criteria.

a) Sections 8.1.4 and 8.2.3.1 provide information on a leakage test. It appears that the leakage test method relies on sniffer or spray methods, which are qualitative techniques. These methods are not appropriate for leak-testing the entire containment boundary (welds, base material, seals, etc.) for a fabrication leak test or for the periodic and maintenance leak tests which must meet a quantifiable, allowable leak rate, as specified in Table 4.4-1 of the application. An appropriate leak test method should be specified.

b) Sections 8.1.4 and 8.2.3.1 state: "… or in accordance with other approved procedures using different leak detector gases." Explicit instruction should be provided as it relates to a leakage test. In addition, the different gases and resulting leak rate criteria should be specified.

c) Section 8.2.3 states: "The leakage rate testing is performed in accordance with Chapter 4 requirements." This sentence should be clarified with further discussion and details.

This information is required by the staff to determine compliance with 10 CFR 71.33, 71.43(f), 71.51, and 71.85.

Robatel Response – RAI Comment 8-3:

The following table describes the frequency, acceptance criteria, leak test method and procedures, by reference to appropriate sections of the SAR:

Component	Leak Test Type	Fabrication	Periodic	Maintenance
Cask Body (performed during fabrication)	Helium, Leak Tight, ANSI N14.5, 1997	Prior to first shipment Section 8.1.4.1	NA	NA
Primary Lid inner O-ring	Helium, Leak Tight, ANSI N14.5, 1997	Prior to first shipment Section 8.1.4.2	Annually Section 8.1.4.2	As needed Section 8.1.4.2
Secondary Lid inner O-ring	Helium, Leak Tight, ANSI N14.5,1997	Prior to first shipment Section 8.1.4.2	Annually Section 8.1.4.2	As needed Section 8.1.4.2
Quick Disconnect Valve Cover Plate inner O-ring	Helium, Leak Tight, ANSI N14.5,1997	Prior to first shipment Section 8.1.4.3	Annually Section 8.1.4.3	As needed Section 8.1.4.3

Fabrication and maintenance leak tests are performed using a helium leak test capable of meeting a 1×10^{-7} ref.cm^3/sec leak rate. Pre-shipment leak tests are performed using a method capable of meeting the leakage rate criteria of 1×10^{-3} ref.cm^3/sec.

The phrase "or in accordance with other approved procedures using different leak detector gases" has been deleted from the SAR.

SAR Impacts

Chapter 8, Sections 8.1.4 and 8.2.2 are revised to define each Leakage Test in accordance with ANSI N14.5-1997 requirements, including:

- Frequency
- Components to be tested
- Testing procedure
- Acceptance criteria
- Actions to be taken if the test fails

SAR Sections 8.1.4 and 8.2.2 are revised to include:

- Instructions to clearly indicate the leakage test method, the gas used and its dedicated acceptance leak rate criteria
- The fabrication, periodic and maintenance leakage tests are performed using a helium leakage test to demonstrate compliance with the leak-tight criteria of 1×10^{-7} ref·cm^3/sec for an upstream pressure of 1 atm and a downstream pressure of 0.01 atm or less, in accordance with ANSI N14.5-1997
- The pre-shipment leakage tests are performed using an air pressure rise test demonstrating no leakage at a sensitivity of 1×10^{-3} ref·cm^3/sec or better, in accordance with ANSI N14.5-1997

Calculation Impacts

- None

NRC RAI Comment 8-4:

Clarify the parts to be leak tested before each loading.

The General Notes included in page 8-2 of the application state the following: "... This test is conducted when the cask is breached at either the primary lid, secondary lid or quick-disconnect valve cover. A leak test on these parts is not necessary if the secondary lid or quick-disconnect valve cover have not been opened." These sentences imply that a leak test of the primary lid, that has been opened, is not necessary if the secondary lid or quick-disconnect valve cover have not been opened. The intent of these sentences is unclear to staff and they should be re-written.

This information is required by the staff to determine compliance with 10 CFR 71.43(f), and 71.51.

Robatel Response – RAI Comment 8-4:

The statement referenced above has been removed from the SAR.

The general note was replaced with a note stating that a pre-shipment leak test is performed on the primary lid, secondary lid, or vent port cover plate inner O-ring as appropriate after the contents have been loaded, per ANSI N14.5-1997, as mentioned in Chapter 4, Table 4.3-1.

SAR Impacts

- SAR Chapter 7, Sections 7.1.2.2, 7.1.2.3, and 7.1.2.4 have been revised to state the requirements for performing a pre-shipment leak test on a loaded cask in accordance with Section 8.2.2.2, for the primary lid, secondary lid, and vent port cover plate, respectively.
- Revision of Chapter 8, Section 8.1 (General Notes)

Calculation Impacts

- None

<u>NRC RAI Comment 8-5:</u>

Clarify that the pre-shipment leak test will be performed after loading of contents.

The General Notes included in page 8-2 of the application state that a leak test is performed before each loading. Page 8-9 states that a pre-shipment leakage test is required before each shipment of Type B material quantities. In order to prevent confusion between the tests described on pages 8-2 and 8-9, it should also be stated that the pre-shipment test is performed after the contents have been loaded, per ANSI N14.5, and as mentioned in Table 4.4-1.

This information is required by the staff to determine compliance with 10 CFR 71.43(f), and 71.51.

Robatel Response – RAI Comment 8-5:

The following changes are made in the revised SAR:

Chapter 8, Sections 8.1 and 8.2.2.2 have been revised to clarify that the pre-shipment leak test is performed on a loaded package.

SAR Impacts

- Revision of Chapter 8, Section 8.1 "General Notes"
- Chapter 8, Section 8.2.2 Leakage Tests
- Chapter 7, Section 7.1.2 Loading of the RT-100 and its subsections

Calculation Impacts

- None

NRC RAI Comment 8-6:

Provide additional details in Section 8.1.4.2 Leakage Test Procedure.

Additional details associated with the fabrication leakage test should be included in the procedure in order to provide appropriate guidance to the person performing the test. Some issues to address include the following:

a) The leakage test procedure stated that a substitute-sealed plate may be used if the cask lid(s) are unavailable. There is no mention of when the actual cask lid(s) [primary, secondary, quick disconnect cover plate] would be tested and how the leakage rates would be accounted for in the total package leakage rate.

b) The need to leak test the entire containment boundary must be explicitly stated so that the leak rate can be compared correctly to the acceptable leakage rate criteria.

c) The origin and intent of the "sealed metal cavity filler canister" was not adequately discussed. Further information on this canister should be provided in the section.

This information is required by the staff to determine compliance with 10 CFR 71.33, 71.43(f), and 71.51.

Robatel Response – RAI Comment 8-6:

Section 8.1.4 of the SAR has been revised and provides detailed guidance for performance of the fabrication leak test and describes the leakage rate for each component of the containment boundary:

- Testing of the entire containment boundary is performed in two parts.
- Leakage testing of the inner shell portion of the containment boundary is performed prior to lead pouring to enable the welds of the inner shell, bottom forging and upper forging to be inspected. This test is performed only once during fabrication.
- Leakage testing of the final fabricated cask is performed to test the O-ring seals in the primary lid, secondary lid, and vent port cover plate portions of the containment boundary.
- The acceptance criterion for the cask body containment boundary is leaktight, in accordance with ANSI N14.5-1997.

The cask body containment boundary leak test procedure has been revised and no longer utilizes the "sealed metal cavity filler canister".

SAR Impacts

- Revision of Chapter 8, Section 8.1.4

Calculation Impacts

- None

<u>NRC RAI Comment 8-7:</u>

Clarify the seal replacement period discussed on pages 8-7 and 8-8 of the application.

a) Section 8.2.1 indicates that records should "... ensure that seals are within the 24 month replacement period." The replacement period should reflect the 12-month period described on page 8-8.

b) Provide the basis for the 50 cycle seal limited period stated on page 8-8.

This information is required by the staff to determine compliance with 10 CFR 71.43(f), and 71.51.

Robatel Response – RAI Comment 8-7:

Chapter 8 of the SAR has been revised as described below:

a) Chapter 8, Section 8.2.3.2 of the SAR is revised to specify the periodic replacement interval for the O-rings is every 12 months in accordance with the recommendation of NUREG-1609.

b) The 50-cycle seal limit was based on the maximum number of shipments that could be made in a year and is essentially equivalent to the requirement for the annual O-ring test. Because it is redundant, it has been deleted.

O-rings will be replaced or reseated in any instance where pre-shipment leak tests cannot be met (Chapter 8, Section 8.2.2.2).

SAR Impacts

- Chapter 8 Section 8.2.3.2

Calculation Impacts

- None