Editoral Modifications to the Safety Analysis Report, for the RT-100, Rev 2

Section	SAR REV1	SAR REV2	Explanation
1.2.1.3	"the bottom flange"	"the bottom forging"	No impact on safety. The containment boundary did not change. This is only a clarification of the description in the SAR.
1.2.1.4	In regards to gamma shielding, the RT-100 cask walls provide a shield thickness of 90 mm of lead and 65 mm of stainless steel.	In regards to gamma shielding, the RT-100 cask walls provide a shield thickness of 90 mm of lead and 70 mm of stainless steel including the thermal shield plate of 5 mm thickness (65 mm used for HAC analysis).	No impact on safety or calculations. This is only a clarification of the actual size of the cask compared to the value used for the HAC analysis.
1.2.1.12	"carbon fiber thermal shield"	"ceramic fiber thermal shield"	No impact on safety. The fabrication material did not change. This is only a correction of the description in the SAR.
Table 2.1.3-1	"Weight (kg)"	"Nominal Weight [kg]"	No impact on safety or calculations. This is only a clarification of the weights shown in the table.
2.6.1.1	"the structural evaluations involving internal pressure use a maximum normal operating condition pressure of 241 kPa (35 psig)"	"the structural evaluations involving internal pressure use a maximum normal operating condition pressure of 342.7 kPa (49.7 psia or 35 psig)"	No impact on safety or calculations. Previously only the gauge pressure was listed. In order to maintain consistency, the absolute pressure is now listed, with a conversion to gauge pressure.
Table 3.1.4-1	"Normal Conditions of Transport"	"Normal Conditions of Transport (MNOP)"	No impact on safety or calculations. Clarification of the value described in the table.
3.3.2.5	The design basis maximum normal operating pressure value is conservatively set at 342.7 kPa (49.7 psia or 30 psig) for use in the cask structural analyses for NCT.	The design basis maximum normal operating pressure (MNOP) value is conservatively set at 342.7 kPa (49.7 psia or 35 psig) for use in the cask structural analyses for NCT.	No impact on safety or calculations. The conversion value to psig was incorrect in the original version of the SAR.
4.1	This description includes the containment vessel, welds, seals, lids, cover plates, valves, and other closure devices relevant to the containment boundary of the cask.	This description includes the containment vessel, welds, seals, lids, cover plates, and other closure devices relevant to the containment boundary of the cask.	No impact on safety or calculations. The quick-disconnect valve is not considered part of the containment boundary. The SAR was updated to correctly describe the containment boundary.
4.1.2	There are three penetrations of the containment vessel. These penetrations form the containment boundary and include the following locations: o Primary lid inner O-ring o Secondary lid inner O-ring o Cask vent port cover plate inner O-ring	There are three locations where the containment vessel may be penetrated. For each location, an inner O-ring seals the containment boundary. o Primary lid o Secondary lid o Cask vent port cover plate	No impact on safety or calculations. The original text of the SAR was cumbersome. The text was revised to clarify that the three lids are the locations of the containment boundary penetration.
4.1.2	The vent penetration contains a quick disconnect valve disconnect style connector and is sealed with the vent port cover plate.	The vent penetration contains a quick disconnect valve and is sealed with the vent port cover plate.	Removal of the term "disconnect style connector" to allow for better flow of the text.

Editoral Modifications to the Safety Analysis Report, for the RT-100, Rev 2

Section	SAR REV1	SAR REV2	Explanation
4.1.4	The primary lid closure consists of a partially recessed, 211 mm-thick stainless steel plate.	The primary lid closure consists of a partially recessed, 210 mm-thick stainless steel plate.	No impact on safety or calculations. The dimension was corrected in the SAR revision.
4.1.4	The secondary lid is also sealed with two (2) EPDM O-rings in machined grooves.	Two (2) EPDM O-rings are retained in machined grooves at the lid perimeter.	No impact on safety or calculations. The original text of the SAR implied that two O-rings seal the containment boundary. This was revised to clarify the lid description.
4.1.4		added the following paragraph: The quick-disconnect valve is housed under a 10mm thick stainless steel cover plate. The Quick-Disconnect Valve Cover Plate is attached to the primary lid with six (6) equally spaced M10 hex head bolts. Two (2) EPDM O-rings are retained in machined grooves at the lid perimeter.	Addition of material describing the quick-disconnect valve cover plate.
Table 4.1.4-1		added Quick-Disconnect Valve Cover Plate information	Addition of material describing the quick-disconnect valve cover plate.
8.1.2	Containment boundary welds identified on the drawing RT100 PRS 1011 in Appendix 1.5 are required to be inspected and furthermore, required to meet the acceptance requirements of ASME Code, Section III, Division I, Subsection ND, Article ND-5000 [Ref. 9].	Containment boundary welds are identified in drawing RT100 PRS 1011, Rev. E in Chapter 1, Appendix 1.4. The following welds on this drawing are classified as containment boundary welds: S.1011.01, S.1011.02, and S.1011.03. These welds are required to be inspected and meet the acceptance requirements of ASME Code, Section III, Division I, Subsection ND, Article ND-5000 [Ref. 5].	Addition of material describing the containment boundary welds.
8.1.3	As described in Section 3.3.2, maximum normal operating pressure for the cask cavity is 182.71 kPa; for conservatism, the minimum test pressure is 1.5 x 200 = 300 kPa.	As described in Chapter 3, Section 3.3.2.5, Maximum Normal Operating Pressure for the RT-100 cavity is 182.71 kPa. Per 10 CFR 71.85(b) [Ref. 2], the containment system shall be tested at an internal pressure at least 50% higher than the actual maximum normal operating pressure, or 274 kPa. However, for conservatism, the minimum test pressure is set to 300 kPa.	No impact on safety or calculations. Clarification of the derivation of the value used in the test.

September 18, 2013

AFFIDAVIT OF ROBATEL TECHNOLOGIES, LLC
CONCERNING CONFIDENTIAL INFORMATION AND TRADE SECRETS

Commonwealth of Virginia
County of Roanoke

I, Teofil Grochowski Jr., depose and say that I am duly authorized to make this affidavit and have reviewed or caused to have reviewed the information which is identified below as proprietary, confidential and/or trade secret. The documents listed in this Affidavit and corresponding data files are included as part of our response to NRC "Application for Certificate of Compliance NO. 9365 for the Model No. RT-100 Package – Request for Additional Information", dated March 28, 2013 (reference DOC NO. 71-9365, TAC NO. L24686, Safety Analysis Report for the RT-100 Cask Package) and contain proprietary company information that should be withheld from public disclosure.

Enclosure 1: SAR, Revision 2, dated: September 18, 2013. Content as identified.

1. **Drawings:**

   a) RT100 NM 1000 Rev. E – Bill of Material
   b) RT100 PE 1001-1 Rev. G – Robatel Transport Package RT-100 General Assembly Sheet 1/2
   c) RT100 PE 1001-2 Rev. G – Robatel Transport Package RT-100 General Assembly Sheet 2/2
   d) RT100 PRS 1011 Rev. E – Robatel Transport Package RT-100 Cask Sub Assembly Weld Map Cask Body
   e) RT100 PRS 1013 Rev. C – Robatel Transport Package RT-100 Cask Sub Assembly Weld Map Secondary Lid
   f) RT100 PRS 1031 Rev. D – Robatel Transport Package RT-100 Cask Sub Assembly Weld Map Lower Impact Limiter
   g) RT100 PRS 1032 Rev. D – Robatel Transport Package RT-100 Cask Sub Assembly Weld Map Upper Impact Limiter
   h) 102885 MD 1031-06 Rev. D – Robatel Transport Package RT-100 Sub Assembly Fabrication Drawing Impact Limiter Foam
   i) 102885 PE 2001 Rev. C – RT 100 Scale Model General Assembly Drawing
   j) 102885 NM 2000 Rev. B – Scale Model Bill of Material
   k) 102885 MD 2021-06 Rev. E – Scale Model Foam Drawing

2. **Calculation Packages** (Incorporate into SAR Revision 2 by reference)

   a) RTL-001-CALC-CN-0101 Rev. 5- Containment Evaluation for the RT-100
   b) RTL-001-CALC-SH-0101 Rev. 1 - Source Term Characterization for the RT-100
   c) RTL-001-CALC-SH-0201 Rev. 4 - Shielding Evaluation for the RT-100 Transport Cask

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d) RTL-001-CALC-SH-0301 Rev. 3- Application of RT-100 Loading Table in Shielding Evaluations
e) RTL-001-CALC-SH-0401 Rev. 1 - Validation of MCNP5 Version 1.40 for Shielding Evaluations of the RT-100 Cask
f) RTL-001-CALC-ST-0101 Rev. 0 - RT-100 Weight and Center of Gravity Calculation (verifies drawings only)
g) RTL-001-CALC-ST-0201 Rev. 4 - Lifting Structural Evaluation
h) RTL-001-CALC-ST-0202 Rev. 3 - Tie-Down Evaluation
i) RTL-001-CALC-ST-0203 Rev. 5- RT-100 Cask Bolting Calculation
j) RTL-001-CALC-ST-0401 Rev. 5 - RT-100 Cask Impact Limiter Drop Evaluation
k) RTL-001-CALC-ST-0402 Rev. 3 - Cask Body Structural Evaluation
l) RTL-001-CALC-ST-0403 Rev. 3- Pin Puncture Evaluation
m) RTL-001-CALC-TH-0102 Rev. 5 - RT-100 Cask Maximum Normal Operating Pressure Calculation
n) RTL-001-CALC-TH-0201 Rev. 5 - RT-100 Cask Thermal Evaluation
o) RTL-001-CALC-TH-0202 Rev. 5 - RT-100 Cask Hypothetical Accident Condition Maximum Pressure Calculation

3. Safety Analysis Report Sections:

a) Table of Content, List of Figures: 2.12.4-1 through 2.12.4-30
b) Figure 2.5.1-1: RT-100 Lifting Pocket Dimensions
c) Appendix 2.12: Impact Limiter Analysis
d) Appendix 2.13: Closure Bolt Evaluation
e) Appendix 2.14: Fabrication Stress Evaluation
f) Appendix 2.15: Seal Region Stress Evaluation
g) Figure 3.3.1-1: RT-100 ANSYS Finite Element Model Volumes
h) Figure 3.3.1-2: RT-100 ANSYS Normal Condition Finite Element Mesh
i) Section 3.3.1.2: Analytical Model
j) Section 3.3.1.3: Analysis Results
k) Section 3.4.1.3: HAC Fire Analysis
l) Section 3.4.2.3: HAC Fire and Cool-down Analysis
m) Figure 4.1.2-1: Illustration of Containment Boundary
n) Section 5.3: Shielding Model
o) Section 5.3.1: Configuration of Source and Shielding
    - Figure 5.3.1-1: NCT Model 1
    - Figure 5.3.1-2: NCT Model 2, 10% Compaction
    - Figure 5.3.1-3: NCT Model Tally Surfaces for Dose Rate Response Estimation
p) Table 5.3.2-1: RT-100 Material Composition Summary
q) Table 5.5.1-1: List of Gamma Nuclides with Greater Than 1 Day Half Life
r) Section 5.5.2: Gamma Nuclide Responses to include the following Tables
    - Table 5.5.2-1 – NCT Dose Rate Responses (mrem/hr/Ci)
    - Table 5.5.2-2 – HAC Gamma Dose Rate Responses (mrem/hr/Ci)
    - Table 5.5.2-3 – NCT Nuclide Neutron Dose Rate Responses (mrem/hr/Ci)
    - Table 5.5.2-4 – HAC Nuclide Neutron Dose Rate Responses (mrem/hr/Ci)
s) Section 5.5.3: Nuclide Maximum Ci/g Loading Limits to include the following Tables
    - Table 5.5.3-1 – Nuclide Maximum Ci/g Loading Limits based on Gamma Response
    - Table 5.5.3-2 – Nuclide Maximum Ci/g Loading Limits based on Neutron Response

t) Section 5.5.4.3: RT-100 Co-60 Gamma Scans
u) Section 5.5.4.4: Comparison of Calculated to Measured Experiment Results for the Co-60 Gamma Scans
v) Section 8.1.5: Component and Material Tests
w) Appendix 8.3, Section 8.3.2: Minimum Lead Thickness and Gap Determination
x) MCNP5 Inputs and Process

Enclosure 2: Drop Test Report in its entirety and supporting documentation as identified.

1. Drop Test Information: Supplied in Supplemental Data Package

a) 102885 RES 001 RT-100 Drop Test Report, Rev. E
b) 102885 NTE 001 Rev. B Note Describing the RT-100 Drop Test Scale Model
c) 102885 PPE 001 Rev. B RT-100 Drop Test Program
d) RT100 Scale Model Impact Limiters Foam CoC and Inspection Reports, General Plastic Reports

Enclosure 3: Select questions and responses as identified below and contained in Robatel Technologies, LLC letter response dated September 18, 2013 to US NRC Letter Request for Additional Information: communication dated March 28, 2013.

1) Both NRC question and Robatel response as identified. The language of the question is such that a technically astute individual could easily discern the novelty of the Robatel impact limiter design, lead pouring process and Bill of Material details.

   a) RAI and answer: 2-2
   b) RAI and answer: 2-15
   c) RAI and answer: 5-3
   d) RAI and answer: 8-1

Enclosure 4: Full size engineered drawings as identified below:

1. Drawings

a) RT100 PE 1001-1 Rev. G – Robatel Transport Package RT-100 General Assembly Sheet 1/2
b) RT100 PE 1001-2 Rev. G – Robatel Transport Package RT-100 General Assembly Sheet 2/2
c) RT100 PRS 1011 Rev. E – Robatel Transport Package RT-100 Cask Sub Assembly Weld Map Cask Body
d) RT100 PRS 1013 Rev. C – Robatel Transport Package RT-100 Cask Sub Assembly Weld Map Secondary Lid
e) RT100 PRS 1031 Rev. D – Robatel Transport Package RT-100 Cask Sub Assembly Weld Map Lower Impact Limiter
f) RT100 PRS 1032 Rev. D – Robatel Transport Package RT-100 Cask Sub Assembly Weld Map Upper Impact Limiter
g) 102885 MD 1031-06 Rev. D – Robatel Transport Package RT-100 Sub Assembly Fabrication Drawing Impact Limiter Foam
h) 102885 PE 2001 Rev. C – RT 100 Scale Model General Assembly Drawing
i) 102885 MD 2021-06 Rev. E – Scale Model Foam Drawing

Enclosure 5: Calculation Packages

1. **Calculation Packages**

   a) RTL-001-CALC-CN-0101 Rev. 5- Containment Evaluation for the RT-100
   b) RTL-001-CALC-SH-0101 Rev. 1 - Source Term Characterization for the RT-100
   c) RTL-001-CALC-SH-0201 Rev. 4 - Shielding Evaluation for the RT-100 Transport Cask
   d) RTL-001-CALC-SH-0301 Rev. 3- Application of RT-100 Loading Table in Shielding Evaluations
   e) RTL-001-CALC-SH-0401 Rev. 1 - Validation of MCNP5 Version 1.40 for Shielding Evaluations of the RT-100 Cask
   f) RTL-001-CALC-ST-0101 Rev. 0 - RT-100 Weight and Center of Gravity Calculation (verifies drawings only)
   g) RTL-001-CALC-ST-0201 Rev. 4 - Lifting Structural Evaluation
   h) RTL-001-CALC-ST-0202 Rev. 3 - Tie-Down Evaluation
   i) RTL-001-CALC-ST-0203 Rev. 5- RT-100 Cask Bolting Calculation
   j) RTL-001-CALC-ST-0401 Rev. 5 - RT-100 Cask Impact Limiter Drop Evaluation
   k) RTL-001-CALC-ST-0402 Rev. 3 - Cask Body Structural Evaluation
   l) RTL-001-CALC-ST-0403 Rev. 3- Pin Puncture Evaluation
   m) RTL-001-CALC-TH-0102 Rev. 5 - RT-100 Cask Maximum Normal Operating Pressure Calculation
   n) RTL-001-CALC-TH-0201 Rev. 5 - RT-100 Cask Thermal Evaluation
   o) RTL-001-CALC-TH-0202 Rev. 5 - RT-100 Cask Hypothetical Accident Condition Maximum Pressure Calculation

I have personal knowledge of the criteria and procedures utilized by Robatel Technologies in designating information as a trade secret or as confidential information of a commercial or financial nature. These calculations contain unique information and methods that have been developed by Robatel Technologies, LLC for the design and engineering evaluation of transportation packages. These methods are considered confidential information that includes company trade secrets incorporated into such evaluation processes. The proprietary information submitted to the NRC contains the type of information Robatel Technologies regards as protected and of the type not to be disclosed to unauthorized persons.

The information designated here as proprietary is not available from public sources. Public disclosure of this information would cause substantial harm to the competitive position of Robatel Technologies, LLC. The company has made substantial resource and monetary investments to the development of the RT-100 Type B radioactive waste transport package. Competitors of Robatel Technologies, LLC would have great difficulty in duplicating the methods developed by Robatel Technologies, LLC, due not only to the financial investment of Robatel Technologies, but also to the unique skills, talents and expertise of Robatel Technologies, LLC employees it's trusted engineering resources who have developed these concepts and mathematical models. Disclosure of this information would cause Robatel Technologies, LLC irreparable financial harm and loss of business associated with this and other projects similar in nature.

Respectfully,

Teofil (Teo) Grochowski Jr., CEO
Robatel Technologies, LLC

Commonwealth of Virginia

County of Roanoke

On this 17th day of September 2013, be me, a Notary Public in and for the Commonwealth of Virginia, duly commissioned and sworn, personally appeared Teofil Grochowski Jr., CEO, Robatel Technologies, LLC and on oath stated that he was authorized to make this affidavit on behalf of the corporation.

IN WITNESS WHEREOF, I have set my hand and affixed my official seal the day and year first above written

Notary Public, Commonwealth of Virginia

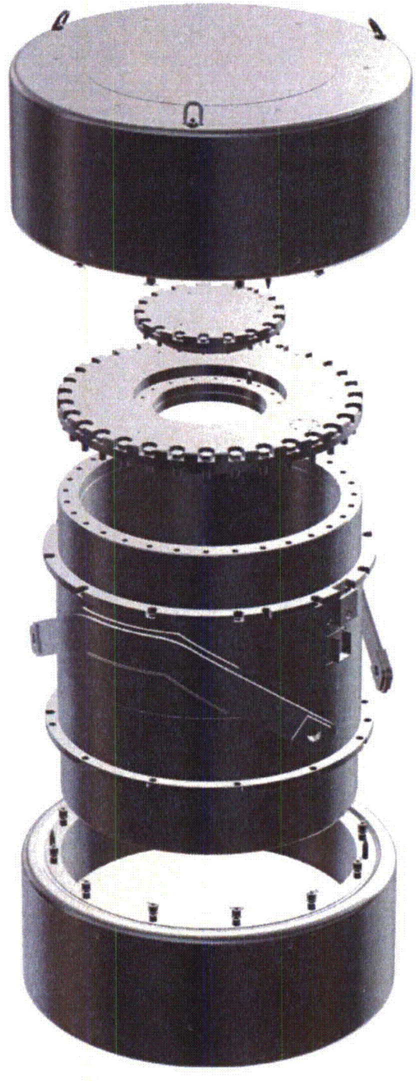
RT-100 Type B Cask

RAI Responses

Docket Number 71-9365

TAC Number L24686

September 18, 2013



This Part 71 Application for Approval of RT-100 Type B Cask Package for Radioactive Material represents Robatel Technologies, LLC approach to its business as applied to the specifications of this submittal. This Application requests that the Nuclear Regulatory Commission respects the proprietary information and withholds it from public disclosure subject to the provisions of 10 CFR 2.390. All detailed drawings are considered proprietary information.

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

The NRC Request for Additional Information (RAI) identifies information needed by the staff in connection with its review of the Robatel Safety Analysis Report, Revision No. 1, dated November 30, 2012. The RAI comments are grouped by chapter number and title from the Safety Analysis Report, along with the Robatel response. The response addresses the comment and where applicable, references the locations in the SAR and/or supporting documents where revised information can be located.

Chapter 1 – General Information

NRC RAI Comment 1-1:

Provide clarification on the authorized contents described in Section 1.2.2 of the application. Regarding the chemical and physical form, indicate whether the contents are limited to solids and whether powdered or dispersible solids will also be present.

The physical and chemical forms of the contents are described in Section 1.2.2. However, based on the information provided, it is unclear whether the contents will include dispersible solids.

This information is required by the staff to determine compliance with 10 CFR 71.33(b)(3).

Robatel Response – RAI Comment 1-1:

Chapter 1, Section 1.2.2.3 of the SAR is revised to clarify that the contents of the package consist of resins and filters in the form of dispersible solids. There are no contents in powdered form.

SAR Impacts

- Section 1.2.2.3

Calculation Impacts

- None

NRC RAI Comment 1-2:

Clarify items listed in the NUREG classification table in Chapter 1.

a) Explain the different ASME subsection choice for the Helicoil M48 x 2D (listed as ITS, category A per ASME III Subsection NF) and O-ring (listed as ITS, category A per ASME III Subsection ND).

b) Typically the NUREG classification table is listed in the licensing drawings to form part of the licensing basis.

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

Robatel Response – RAI Comment 1-2:

a) The references to ASME Subsection ND and NF have been removed from the RT100 NM 1000, Rev. E - Bill of Material (Chapter 1, Appendix 1.4, Attachment 1.4-1). Helicoils, O-rings, bolts and other ITS components, when not procured in accordance with ASME requirements, are procured in accordance with commercial grade dedication plans that are based on ASTM or ISO standards. The revised bill of material includes the quality category of each item in accordance with NUREG/CR-6407.

b) The RT100 NM 1000, Rev. E, Bill of Material (Chapter 1, Appendix 1.4, Attachment 1.4-1) is the formal listing of materials of construction of the cask. This document is part of the licensing drawings.

SAR Impacts

- Revision of RT100 NM 1000 Bill of Material located in Chapter 1, Appendix 1.4, Attachment 1.4-1 of the SAR.
- Chapter 8, Section 8.1.5 "Component and Material Tests" has been revised to specify critical material characteristics and clarify qualification process of non-ASME components.

Calculation Impacts

- None

NRC RAI Comment 1-3:

Provide the scale model test procedure, drawings and reports for the as-built and tested Model No. RT-100 packaging components. Describe and justify the deviations between the scale model and the proposed design.

Provide References 3 *(RT-100 Drop Test Program)*, 4 *(102885 PE 2001 Revision B, RT-100 scale model general assembly drawing)*, 5 *(102885 NM 2001 Revision B, RT-100 scale model bill of material)*, 6 *(102885 MD 2021-06 Revision D, RT-100 scale model Foam drawing)*, 7 *(RT100 scale model Impact limiters foam CoC and inspection reports, General Plastics report)*, and 8 *(102882 DFR 001 Revision A, RT100 scale model fabrication document package)* of the Robatel Model RT-100 Drop test report, Project number 102885, RES 001, Revision C.

These documents are necessary to ensure that the as-built and tested (3/10) scale RT-100 is representative of a full scale Model No. RT-100 package. If there are deviations between the scale model and the proposed design, describe and justify the deviations.

The 3/10th scale model test article and test procedure is described in the Robatel Package Model RT-100 Drop Test Report by reference to the (i) RT-100 Drop Test Program, (ii) RT-100 Scale Model General Assembly Drawing, (iii) RT-100 Scale Model Bill of Material, and (iv) the RT-100 Scale Model Foam Drawing. These references are required in order to confirm the correlation between the scale model and the proposed design.

Staff also notes that RSI 2.2e response states that the assembly drawings for the scale model were provided, whereas staff believes they were not.

Staff also notes that page 2-161 of the application mentions that the dimensions and weight of the 3/10 scale model cask were obtained from 3/10 scale cask drawings and test report.

This information is required by the staff to determine compliance with 10 CFR 71.41(a), 71.51(a), and 71.73.

Robatel Response – RAI Comment 1-3:

ROBATEL provides the following references with the SAR as a supplementary data package due to their proprietary nature:

- Reference 3 - 102885 PPE 001 Revision B, *RT-100 Drop Test Program*
- Reference 4 - 102885 PE 2001 Revision C, *RT-100 Scale Model General Assembly Drawing*
- Reference 5 - 102885 NM 2000 Revision B, *RT-100 Scale Model Bill of Material*
- Reference 6 - 102885 MD 2021-06 Revision E, *RT-100 Scale Model Foam Drawing*
- Reference 7 - RT100 scale model Impact limiters foam CoC and inspection reports, General Plastics report

Reference 8 cited below is a collection QA documents and reports that do not provide any further technical information. After consultation with NRC staff, it was determined that this document need not be provided, but is available on request.

- Reference 8 - 102885 DFR 001 Revision A, RT100 scale model fabrication document package.

102885 RES 001 Rev. E – Safety Analysis Robatel Package Model RT-100 Drop Test Report, is included in the supplementary data package. This document was updated in response to RAI 2-17.

The document addressing the deviations of the 3/10th scale model against the actual RT-100 model is 102885 NTE 001 Rev. B, *Note describing the RT-100 drop test scale model*.
The scale model assembly drawing 102885 PE 2001 Rev. C is provided.

SAR Impacts

The following references are submitted with the SAR as a supplementary data package due to their proprietary nature:
102885 PPE 001 Revision B, *RT-100 Drop Test Program*
102885 PE 2001 Revision C, *RT-100 Scale Model General Assembly Drawing*
102885 NM 2001 Revision B, *RT-100 Scale Model Bill of Material*
102885 MD 2021-06 Revision E, *RT-100 Scale Model Foam Drawing*
RT100 scale model Impact limiters foam CoC and inspection reports, General Plastics report
102885 NTE 001 Revision B, *Note Describing the RT-100 Drop Test Scale Model*

Calculation Impacts

- None

NRC RAI Comment 1-4:

Provide the RT-100 impact limiter drawings illustrating the foam assembly and fabrication details.

Drawings RT100 PRS 1031 and RT100 PRS 1032 include section cuts (A-A) to show several foam components. Also, page 8-2 of the application states that the Model No. RT-100 package is fabricated in accordance with drawings listed in the Certificate of Compliance. Therefore, the drawing(s) related to the impact limiter foam pieces should be provided as part of the design.

Staff requires additional drawing(s) and descriptions that clearly illustrate and describe all the impact limiter pieces and orientation of foam for fabrication.

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

Robatel Response – RAI Comment 1-4:

102885 MD 1031-06, Revision D, RT-100 Impact Limiter foam has been added to the SAR and can be found in Chapter 1, Appendix 1.4, Attachment 1.4-8. It is also included as part of the supplementary data package.

The RT-100 Impact Limiters are comprised of layered foam blocks, with multiple blocks per layer, in an overlapping pattern.

The orientation and number of foam blocks in shown in section A-A of drawing 102885 MD 1031-06, Rev D (Chapter 1, Appendix 1.4, Attachment 1.4-8).

SAR Impacts

- Drawing 102885 MD 1031-06, Rev. D is added to Chapter 1, Appendix 1.4, Attachment 1.4-8 of the SAR.
- Chapter 1, Section 1.2.1.8 Structural Features-Impact Limiters; additional description is provided.

Calculation Impacts

- None

NRC RAI Comment 1-5:

Provide the basis for the O-ring compression and O-ring groove dimensions in the licensing drawings. Provide corresponding manufacturer data sheets.

a) As stated on page 8-2 of the application, there are two seals associated with each of the primary lid, secondary lid, and quick-disconnect valve cover plate. Although some details of the groove dimensions and compression were provided on page 2-230, the basis for the O-ring compression and O-ring groove dimensions, such as from manufacturer data sheets, should be provided for the six seals.

b) Provide the manufacturer and part number of the six O-rings on the licensing drawings.

c) The drawings should indicate both the dimensions and tolerances of the groove dimensions and the O-rings to ensure compression of the O-rings.

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

Robatel Response – RAI Comment 1-5:

O-ring compression and O-ring groove dimensions are based on a combination of the Parker data sheet (in Chapter 2, Section 2.13, Figure 2-13) and Robatel Industries' satisfactory performance of this groove design in other casks.

a) Geometry details of the seal grooves are displayed on the drawings RT100 PE 1001-1, Rev. G (Chapter 1, Appendix 1.4, Attachment 1.4-2) and RT100 PE 1001-2, Rev. G (Chapter 1, Appendix 1.4, Attachment 1.4-3). The dovetail O-ring groove design is similar to those used in the Robatel Industries Models R72, R73, R74, R75, R76, R775 and RTG 32S cask designs. These cask designs certified to IAEA standards have been used over 10 years to ship a variety of radioactive materials including metallic waste, cemented waste, contaminated control rod guide tubes and transuranic waste. All of the casks designs using the O-ring groove configuration has been tested and verified to be able to obtain the leak rate specified in their design approvals. This verification included fabrication maintenance and pre-shipment leak testing. The drawings have been revised to include a maximum surface roughness of Ra 1.6 for the machined grooves and upper flange O-ring mating surface. The value chosen for surface roughness is based on Robatel's experience in designing and certifying numerous cask designs with dovetail O-ring design.

Based on Robatel's experience with fabricating Type B Casks, the O-ring compression requirements should be:

- Over 5% to ensure sufficient compression and contact area (O-ring to upper flange)
- Less than 30% to prevent damage to the O-ring

The RT-100 has been designed to achieve a nominal compression of approximately 20% for both O-ring cross sectional diameters of 5.33 and 12 mm. The minimum and maximum percent compression is calculated based on geometric tolerances. These values are shown in the table below.

O-Ring	Percentage compression		
	Min	Mean	Max
Lid O-Ring	15.96%	20.46%	25.65%
Vent Port Coverplate O-Ring	15.36%	19.99%	25.3%

b) While the O-ring cross sectional diameter standard tolerance is considered in the groove calculation, the O-ring lengths are nonstandard. Lengths are based on the actual cask lids and cover plate dimensions. The O-rings do not have a designated manufacture part number because they are custom fit components.

The O-rings are procured in accordance with a commercial dedication plan (Critical characteristics of non ASME standard materials, including O-rings, have been added in Chapter 8, Section 8.1.5.2). The dimensions are described in RT100 NM 1000 Rev. E – Bill of Material (Chapter 1, Appendix 1.4 Attachment 1.4-1).

c) The licensing drawings RT100 PE 1001-1, Rev G (Chapter 1, Appendix 1.4, Attachment 1.4-2 and RT100 PE 1001-2, Rev G (Chapter 1, Appendix 1.4, Attachment 1.4-3) are revised to include the dimensions and tolerances of the O-rings.

NOTE: Prior to first use, all the containment O-rings are tested to verify that the leakage rate meets the leaktight criteria per ANSI N14.5-1997.

SAR Impacts

- Updated Drawings are provided in Chapter 1, Appendix 1.4:
  - RT100 PE 1001-1, Rev. G – Robatel Transport Package RT-100 General Assembly Sheet 1/2 (Attachment 1.4-2)
  - RT100 PE 1001-2, Rev. G – Robatel Transport Package RT-100 General Assembly Sheet 2/2 (Attachment 1.4-3)
- Chapter 8, Section 8.1.5.2 has been added to the SAR

Calculation Impacts

- None

Chapter 2 – Structural Evaluation

NRC RAI Comment 2-1:

Clarify which materials are acceptable for use as (i) secondary containers, (ii) metal housings, and (iii) for shoring. Alternatively, indicate the critical characteristics of these materials, e.g., melting or sublimation temperature, radiation resistance, nobility, etc., necessary to ensure that no inadvertent chemical reactions will occur. Justify the loading restriction that indicates that materials that change phase at temperatures less than 177°F, not including water, are not included in the contents. Update Section 2.2.2 of the application to assess these allowable materials for chemical, galvanic, or other reactions. This RAI is, in part, a follow-up to RSI 1.1.

A requirement for the use of secondary containers is stated in the application, but acceptable materials to be used for this purpose are not adequately described. It is important to clarify which materials are acceptable for this purpose to ensure that unacceptable chemical reactions do not ensue. The materials must be described with enough detail to make this determination and cannot rely solely on the shipper's judgment. There is a loading condition that states that materials that change phase at temperatures less than 177°F are not included in the contents; however, this temperature does not appear to correspond to the maximum temperatures stated in Chapter 3 of the application.

This information is required by the staff to determine compliance with 10 CFR 71.33(b)(3) and 71.43(d).

Robatel Response – RAI Comment 2-1:

Secondary containers may be constructed of carbon steel or stainless steel, or a thermoplastic such as polyethylene or polypropylene. Secondary containers may be positioned or braced within the cavity using shoring. Shoring may be constructed of carbon steel or stainless steel, wood, or a thermoplastic material or any combination thereof.

Thermoplastics can have a phase change below 140°C (282°F). These phase changes would not result in any chemical or galvanic reactions. Pressure calculations that include off gassing due to the potential melting of these secondary containers are evaluated in Chapter 3, Section 3.3.2. The stresses that result from maximum HAC pressures are evaluated in Chapter 2, Section 2.7.4.

Finally, the stresses due to the phase change do not have a significant impact on the overall stresses, because they have a margin of safety +6.4.

Filter housing would be made from stainless steel or a thermoplastic such as polyethylene or polypropylene.

The temperature of 140°C (282°F) is greater than the highest average inner shell temperature that the cask experiences during accident conditions. As described further in response to RAI 3-3, the temperatures of contents will be lower than 137°C (279°F) due to the thermal gradient across the cask body during the fire transient and the thermal modeling considering the fact that no credit is taken for heat migrating into the contents from the inner shell in the thermal modeling.

Chapter 1, Sections 1.2.2.3 and 1.2.2.9 and Chapter 2, Sections 2.2.2.1.9 and 2.2.2.1.10 of the SAR have been revised to include additional information regarding the materials of construction of the secondary containers, contents and shoring. Additionally, the sections address the potential for chemical, galvanic and other potential reactions.

SAR Impacts

- Chapter 1, Section 1.2.2.3
- Chapter 1, Section 1.2.2.9
- Chapter 2, Section 2.2.2.1.9
- Chapter 2, Section 2.2.2.1.10

Calculation Impacts

- None

NRC RAI Comment 2-2:

Provide further justification that explains how and why the foam crush strength data, in the "densification region" for strains beyond 60%, is used. This is a follow-up to RSI 2.2. Explain how lock-up is considered and evaluated in the analysis.

In response to RSI 2.2, the applicant indicated that the extrapolated values used are considered to be conservative and yielded a conservative deceleration value when compared to the drop test results. In addition to this justification, also provide an explanation of why a deviation from the manufacturer's recommended properties is required and appropriate. This deviation may be important in the analytical effort that considers variations in the package design that were not present in the scale model drop test.

This information is needed by the staff to determine compliance with 10 CFR 71.51(a)(2) and 71.73

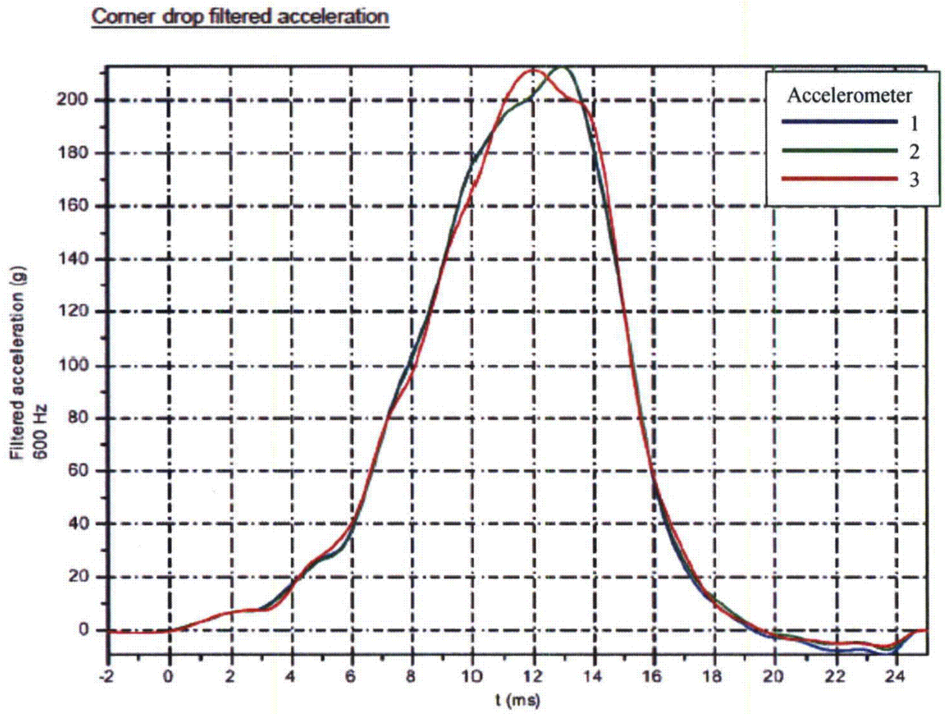
Robatel Response – RAI Comment 2-2:

The analytical approach used extrapolation values past 60% strain in the foam. The accelerations and crush was bench marked with actual scale model drop testing. The calculation results always bound the drop test results. There is no lock up even above 60% compression of the foam.

The foam densities are held to a tighter tolerance than the manufacturer's recommended values to allow the size of the impact limiter to be optimized given the oversize dimensional restrictions and the size of the cask body. The deviation from the manufacturer's recommended properties is appropriate due to the fact that the foam is poured under controlled conditions rather than injected as is typically performed for impact limiters. The supplier was consulted and is in agreement with these tolerances. The supplier is required to provide density testing results confirming that the material is within the acceptable tolerance range.

The analytical technique has been validated against the RT-100 drop test results in Chapter 2, Section 2.12.4.3 (previously 2.14.4.4) of the SAR. In this section, the actual test conditions are reported, listing the temperatures of the foam and the actual densities of the foam material, as delivered. The material properties for these combinations of temperature and density are computed and utilized for the analytical evaluation of accelerations and crush depths. In all cases, the analytical technique is shown to over-predict the maximum accelerations and the crush depths when compared to the actual scale model drop test results.

In considering the high strain rate behavior of the foam, the performance of the impact limiter design is verified by the successful performance of the impact limiters during the scale model drop test program. The results of the drop test program, has been validated by the analytical model comparison described above, demonstrate that the impact limiters perform their intended function, which is to remain attached to the cask body while limiting accelerations to below the design basis values and ensuring the crush depth is maintained below the maximum acceptable value for each drop orientation. The acceptable crush depths are defined as those values that will ensure that the cask body does not impact the ground. For the corner drop, while the central portion of the foam along the line from point of initial impact to the corner of the cask body will exhibit high strain rates, the foam away from this central "axis" will incur lower strain rates. Indeed, with each increment in crush depth, new foam material is brought into contact with the ground and begins to crush a new ring of material beginning with lower strain rate. The net result is that while some portions of the foam may experience high strain rates, much of the energy of the impact is absorbed by foam with strain rates below 60%. The figure below is taken from the scale model drop test report (102885 RES 001 Rev. E – Safety Analysis Robatel Package Model RT-100 Drop Test Report) for the corner drop. The two curves represent each accelerometer, and their results agree. The figure indicates that no lockup occured during the drop, as there is no spike in the acceleration data.



SAR Impacts

Chapter 2, Section 2.12.2.2.1 of the SAR has been revised to provide additional details regarding the procurement process for the impact limiter foam.

Calculation Impacts

- None

NRC RAI Comment 2-3:

Clarify or correct Table 2.2.1-1 of the application, "Cask Temperature-Dependent Material Properties" to address the following items:

a. Clarify the column labeled "Membrane Allowable (S_m)." It appears that the values listed in this column are from ASME B&PV Code, Section II, Part D, Subpart 1, Table 2A, Table 5A, and Table 3, for UNS No. S30403, UNS No. S31803, and ASTM A354 Grade

BD, respectively. Table 2A provides design stress intensity values, S_m; Table 5A provides Maximum Allowable Stress Values, S_m; and Table 3 provides Maximum Allowable Stress Values, S.

b. Justify the use of values from ASME B&PV Code, Section II, Part D, Subpart 1, Table 3 for ASTM A-354 Grade BD. Table 3 provides Section III, Classes 2 and 3; Section VIII, Divisions 1 and 2; and Section XII maximum allowable stress values, S, for Bolting Materials. The design stress intensity value, S_m, is required to support the analysis effort.
c. Justify the use of values from ASME B&PV Code, Section II, Part D, Subpart 1, Table 5A for ASTM A-240 (UNS No. S31803). Table 5A provides Section VIII, Division 2 Maximum Allowable Stress Values, S_m. The design stress intensity value, S_m, is required to support the analysis effort.
d. Correct the Young's Modulus values listed for ASTM A-240 (UNS No. S31803). The values listed appear to be from ASME B&PV Code, Section II, Part D, Subpart 1, Table TM-1 for Material Group G. However, UNS No. S31803 is classified under Material Group H.
e. Clarify the source and units of the coefficient of thermal expansion values for UNS No. S30403, UNS No. S31803, and ASTM A354 Grade BD.

Table 2.2.1-1 of the application includes material property data that is used in the Model No. RT-100 package structural analysis. It is important that the data used in the structural analysis and the allowable values that are compared against to determine margins are consistent with the licensing strategy proposed in the application. The package is being fabricated per Section III, Division 1, Subsection ND – Class 3 Components, and analyzed per Section III, Division 1, Subsection NB – Class 1 Components. As such, the design stress intensity values are needed to support the analysis effort.

In some cases, materials that appear in the Subsection ND material property tables do not appear in the Subsection NB materials property tables in the ASME B&PV Code. In this case, the applicant can propose and justify the design stress intensity values that will be used in the analysis, or choose materials that are consistent with Subsections ND and NB.

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

Robatel Response – RAI Comment 2-3:

2-3(a-c) Chapter 2, Table 2.2.1-1 is revised to include the S_m value for ASME SA-240 UNS No. S31803 and ASME SA-354 Grade BD using the guidance presented in

ASME 2007 Section II-D, Table 2-100 (c), where the stress intensity is defined as the lesser of $2/3S_y$ and $1/3S_u$.

2-3(d) For UNS No. S31803, the Young's Modulus has been revised using the values presented in ASME 2007 Section II-D, Table TM-1, Group H.

2-3(e) Thermal expansion values for the ferrous materials presented in Table 2.2.1-1 are taken from ASME Section II-D, Table TE-1. Table 2.2.1-1 is revised to correct the thermal expansion values for ASME SA-354 Grade BD.

To simplify the stress reporting process, calculated stresses are compared to the allowable stress defined by Regulatory Guide 7.6. Stress intensity properties not found in the standard tables are derived using the guidance in ASME Section II-D "Mandatory Appendix 2 Basis for Establishing Design Stress Intensity Values for Tables 2A, 2B, and 4, and Allowable Stress Values for Table 3". From Table 2-100(c), the stress intensity is defined as the lesser of $2S_y/3$ and $S_u/3$.

SAR Impacts

Table 2.2.1-1 of the SAR is revised.

Calculation Impacts

- None

NRC RAI Comment 2-4:

Identify the source of the density values provided in Table 2.2.1-2, "Cask Temperature-Independent Material Properties." Clarify whether an alternative to the values provided in the ASME B&PV Code is being proposed, and justify the alternative, as applicable. The density values provided in Table 2.2.1-2 appear to be inconsistent with the values provided in ASME B&PV Code, Section II, Part D, Subpart 1, Table PRD.

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

Robatel Response – RAI Comment 2-4:

All the Structural and Thermal Calculations were revised to reflect the use of the metric version of the ASME code. The differences to the results are small and are documented in the revised calculations presented in chapter 2 & 3 of the SAR. They are as listed below:

- Calculation Package RTL-001-CALC-ST-0201 Rev. 4
- Calculation Package RTL-001-CALC-ST-0202 Rev. 3
- Calculation Package RTL-001-CALC-ST-0203 Rev. 5
- Calculation Package RTL-001-CALC-ST-0401 Rev. 5
- Calculation Package RTL-001-CALC-ST-0402 Rev. 3
- Calculation Package RTL-001-CALC-ST-0403 Rev. 3
- Calculation Package RTL-001-CALC-TH-0102 Rev. 5
- Calculation Package RTL-001-CALC-TH-0201 Rev. 5
- Calculation Package RTL-001-CALC-TH-0202 Rev. 5

With the exception of the ASTM Specification for B29 Lead, the density values presented in Chapter 2, Table 2.2.1-2 were derived from ASME 2007 Section II-D (Customary/English) edition, Table TCD. Using the equation:

$$TD = \frac{TC}{density\ x\ specific\ heat}$$

where TC is the thermal conductivity and TD is the thermal diffusivity, the density may be calculated.

The difference between the values presented in the SAR and ASME 2010 Section II-D (Metric) is the result of rounding during the conversion of the English units to the equivalent Metric units. However, the variations are small and do not affect the results of the thermal analyses.

The difference between the English and Metric editions is shown in the following table, by converting from English to Metric units. Values for lead are taken from the ASTM BLG Specification for chemical lead.

Material	**Density (lb/in^3) (ASME 2007 Section II-D Customary)**	**Density (kg/m^3) (converted from Customary Units)**	**Density (kg/m^3) (ASME 2010 Section II-D Metric)**
ASME SA240 Type 304/304L Stainless Steel	0.290	8027	8030
ASME SA240 UNS No. S31803 Stainless Steel	0.290	8027	8030
ASME SA354 Gr. BD High Strength Steel	0.280	7750	7750

Chapter 2, Table 2.2.1-2 of the SAR has been revised with the Metric edition of ASME Section II-D, Materials, 2010:

Table 2.2.1-2 Cask Temperature-Independent Material Properties

Material	Density (kg/m^3)	Poisson's Ratio
ASME SA-240 Type 304/304L (Dual Certified)	8030	0.31
ASME SA-240 UNS No. S31803	8030	0.31
ASME SA-354 Grade BD (Bolting material)	7750	0.30
ASTM B29 Lead	11300	0.40

SAR Impact

- Chapter 2, Table 2.2.1-2 has been revised

Calculation Impacts

- None

NRC RAI Comment 2-5:

Justify the susceptibility of the package external surface to chloride-containing salt, as noted in Section 2.2.2.1.1 of the application.

The application notes that the external surfaces of the package may be susceptible to degradation due to chloride-containing salts. In addition to the pitting phenomenon indicated in the application, these surfaces could also be susceptible to stress corrosion cracking. These surfaces may also be susceptible when dry salts are deposited on the surface (in addition to salt spray). The maximum transportation period and routine and/or periodic maintenance should clearly address this degradation mechanism.

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

Robatel Response – RAI Comment 2-5:

Chapter 2, Section 2.2.2.1.1 misstated the fact that the external surface was susceptible to degradation due to chloride-containing salts.

The external surfaces of the RT-100 cask and its impact limiters are made of stainless steel, and chemically passivated after fabrication for recovery of corrosion protection characteristics (after machining, welding and grinding operations whichever is the last operation in the fabrication process). Thus, corrosion due to chloride containing salt would be extremely unlikely. In addition, any corrosion on the cask body will be detected during the visual inspection required in the maintenance procedures found in Chapter 8, Section 8.2.3 of the SAR.

SAR Impacts

- Chapter 2, Section 2.2.2.1.1 is revised to clarify that the external surface of the cask is not susceptible to degradation.

Calculation Impacts

- None

NRC RAI Comment 2-6:

Clarify whether the impact limiter shell will be welded after the polyurethane foam blocks are in place. Assess any potential reactions that may occur as a result of this process, as applicable.

Chemical, galvanic, and other reactions of the cellular polyurethane foam are noted in Section 2.2.2.1.5 of the application. It is noted in this section that the foam is cured prior to installation and, therefore, no potential reactions associated with the foam exist. However, if the impact limiter shell is welded after the foam blocks are placed within the impact limiter, the temperature of the foam may be such that chemical reactions, including outgassing, may occur. Potential reactions that may occur during the fabrication process should be assessed.

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

Robatel Response – RAI Comment 2-6:

The welds of the impact limiters that are made after the polyurethane foam blocks are in place are:

- For the lower impact limiter: S.1031.21 (closure weld) displayed on weld map drawing RT100 PRS 1031 Rev. D – Robatel Transport Package RT-100 Cask Sub Assembly Weld Map Lower Impact Limiter (Chapter 1, Appendix 1.4, Attachment 1.4-6)

- For the upper impact limiter: S.1032-21 (closure weld) and S.1032.43 through 45 (Impact limiter lifting blocks welds) displayed on weld map drawing RT100 PRS 1032 Rev. D – Robatel Transport Package RT-100 Sub Assembly Weld Map Upper Impact Limiter (Chapter 1, Appendix 1.4, Attachment 1.4-7).

The closure welds are full penetration butt welds with a backing strip (Detail 6, Scale 1:1, Ref 13 RT100 PRS 1032 Rev. D - Robatel Transport Package RT-100 Sub Assembly Weld Map Upper Impact Limiter (Chapter 1, Appendix 1.4, Attachment 1.4-7). The foam in this area is not in contact with the backing strip. Furthermore, rock wool (Detail 6, Scale 1:1 Ref 14 RT100 PRS 1032 Rev. D - Robatel Transport Package RT-100 Sub Assembly Weld Map Upper Impact Limiter (Chapter 1, Appendix 1.4, Attachment 1.4-7) is inserted between the foam and the backing strip as a measure to insulate the foam from the welding heat. These measures prevent out-gassing due to the welding operation. The same weld configuration applies to the lower impact limiter closure weld.

The upper impact limiter lifting block welds are 2.5mm throat Y groove type weld. These welds are not in contact with the foam during the welding operation and heat tape is placed on the foam blocks behind the lifting blocks to protect them from excessive heat, preventing any out-gassing.

Additional information has been added to Chapter 2, Section 2.2.2.1.5 of the SAR.

SAR Impacts

- Chapter 2, Section 2.2.2.1.5 has been updated to reflect this information.

Calculation Impacts

- None

NRC RAI Comment 2-7:

Justify the use of non-ASME B&PV Code properties in Table 3.2-2, including the properties incorporated in the analysis at temperatures greater than 750°C.

ASME B&PV Code, Section II, Part D, Tables PRD and TCD contain density, thermal conductivity and thermal diffusivity values. For materials that are fabricated to the ASME B&PV Code, it is expected that the material properties will be in accordance with the code values. However, it appears that the values used in the thermal analysis came from another source. The ASME B&PV code only lists thermal conductivity and specific heat data up to 750°C.

Robatel Response – RAI Comment 2-7:

The physical properties used in the RT-100 analyses were taken from the 2007 edition of ASME Section II-D, which does not include Table PRD. However, the thermal conductivity and derived specific heat values are taken from Table TCD of the 2007 edition of ASME Section II-D Customary (English) edition. The difference between the values presented in the SAR and ASME Section II-D (Metric) is the result of round-off during the conversion of the English units to the equivalent Metric units. However, the variations are small and do not affect the results of the thermal analyses. For clarification, Table 3.2.1-2 is revised to include the properties from the 2007 edition of ASME Section II-D (Metric) and values above 750°C are not specified. The values for Specific Heat are derived from the following equation:

TABLE TCD (CONT'D)

GENERAL NOTES:

(a) TC is the thermal conductivity, W/(m·°C), and TD is the thermal diffusivity, m^2/sec:

$$TD = \frac{TC\ [W/(m\cdot{}^\circ C)]}{\text{density}\ (kg/m^3) \times \text{specific heat}\ [J/(kg\cdot{}^\circ C)]}$$

where,

Density = 8030 kg/m^3. [Table 2.2.1-2, as explained in RAI 2-4.]

Table 3.2.1-2 Temperature-Dependent Material Properties—Stainless Steel 304

Temperature (°C)	Specific Heat (J/kg-K)	Thermal Conductivity (W/m-K)
20	472.6	14.8
50	483.6	15.3
75	493.1	15.8
100	499.4	16.2
125	506.7	16.6
150	511.4	17.0
175	520.1	17.5
200	525.7	17.9
225	530.0	18.3
250	532.5	18.6
275	536.5	19.0
300	541.7	19.4
325	545.5	19.8
350	547.7	20.1
375	551.4	20.5
400	552.3	20.8
425	557.0	21.2
450	557.8	21.5
475	562.3	21.9
500	563.1	22.2
525	566.3	22.6
550	568.1	22.9
575	571.2	23.3
600	572.9	23.6
625	575.9	24.0
650	577.5	24.3
675	580.4	24.7
700	581.9	25.0
725	585.8	25.4
750	587.2	25.7

SAR Impacts

- Chapter 3, Table 3.2.1-2 of the SAR has been revised.

Calculation Impacts

- None

NRC RAI Comment 2-8:

Justify the discrepancy between the Design and Fabrication Codes for the package containment system.

Sections 2.1.2 and 2.1.4 of the application identify the RT-100 containment system codes of construction. ASME Section III, Division 1, Subsection NB was used for design and ASME Section III, Division 1, Subsection ND was used for the fabrication of the containment system. Per NCA-2120 and NCA-2133 (applicable to Section II, Divisions 1 and 2) of the ASME Code, all activities (i.e. Design, Fabrication, Acceptance Testing, etc.) should follow the same subsection of code according to the class of code (per NCA-2131). Therefore, as it has been done for the Model No. RT-100 package containment system, it may not be appropriate to jump from different subsections of the code.

Staff also noted that both Section 2.6.7.1 of the application (and Section 6 of Calculation Package ST-0402) state that the Model No. RT-100 package is designed in accordance with ASME, Section III, Subsection ND, which is different from the statement in Section 2.1.2 of the application.

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

Robatel Response – RAI Comment 2-8:

To simplify the design analysis acceptance criteria for the RT-100, the SAR has been revised to reference Regulatory Guide 7.6 "Design Criteria for the Structural Analysis of Shipping Cask Containment Vessels". Regulatory Guide 7.6 defines the acceptance criteria for Levels A and D without referencing specific sections of ASME Section III. The combined stresses calculated based on Regulatory Guide 7.6 are then compared to the appropriate allowable stress value derived from the Stress Intensity values appropriate to ASME, Section III, Subsection ND. Chapter 2, Sections 2.1.2 and 2.6.7.1 have been revised to present the revised acceptance criteria.

SAR Impacts

Chapter 2, Sections 2.1.2 and 2.6.7.1 of the SAR have been revised.

Calculation Impacts

- None

NRC RAI Comment 2-9:

Provide/justify that the containment boundary final geometrical configuration (using a validated model) from the post normal conditions of transport (NCT) free drop and hypothetical accident conditions (HAC) tests correspond to the containment analysis assumptions.

Per RSI 4.2 response, there will be "minor" inelastic deformation on the inner shell (containment boundary).

Section 2.5.7 of NUREG-1609 states that "inelastic deformation is generally unacceptable for the containment evaluation." Also, Section 4.5.3.2 of NUREG-1609 states that the containment boundary, seal region, and closure bolts should not undergo any inelastic deformation.

RSI 4.2 response and Appendix 2.14 of the application discuss analysis of the closure bolts but do not provide complete insight regarding containment integrity (must remain elastic or the final geometry must correlate to the N14.5 containment analysis).

Staff notes the following statements in RSI 4.2 response: "While some localized areas of the inner shell have minor inelastic deformation, the stresses do not exceed the ultimate strength of the material. Therefore, the ability of the inner shell to maintain positive containment is not compromised." Staff does not agree with this approach, unless the final geometrical configuration is less severe than the assumptions included in the containment analysis.
This information is required by the staff to determine compliance with 10 CFR 71.51.

Robatel Response – RAI Comment 2-9:

The RT-100 containment boundary, seal region, and closure bolts do not undergo inelastic deformation. All reported stresses for the containment boundary are below the ASME allowables. The section stresses in the inner shell, as shown in Chapter 2, Tables 2.7.1.-2 and 2.7.1.-3 of the SAR, do not exceed S_y for the material. Additionally, calculations based on NUREG/CR-6007 show that the closure bolts maintain a tight seal during NCT and HAC.

According to Chapter 2, Section 2.5.1.2 of NUREG-1609, the design criteria for the containment system of Type B Packages can be found in NRC Regulatory Guide 7.6. Position 6 of Regulatory Guide 7.6 addresses accident conditions, and indicates that the acceptance criteria for the containment boundary stress intensity is $< 3.6\ S_m$ and $< S_u$. Since S_m is equal to $2S_y/3$, $3.6\ S_m$ would be greater than S_y and thus inelastic deformation would be acceptable as long as the ultimate strength of the material is not exceeded.

Under load, the O-ring grooves in the primary and secondary lids can cause a stress riser at the radius where the groove transitions from horizontal to vertical. For this evaluation, the load is in the form of a bending moment. For the primary and secondary lids, the stress concentration factors for these groove radii are 2.6 and 2.2, respectively.

For the lid gasket grooves, the linearized stress is calculated for each peak stress location and multiplied by the stress concentration factor. The following table provides a summary of the resulting factored stress values.

Accident Condition	Yield Strength at Max NCT Seal Temp (MPa)	Stress Concentration	Linearized Stress in Primary Lid Primary Seal (MPa)	Maximum Stress (MPa)	FS	Stress Concentration	Linearized Stress in Secondary Lid Primary Seal (MPa)	Maximum Stress (MPa)	FS
Side Drop	184.2	2.6	15.0	38.9	4.7	2.2	66.1	145.3	1.3
End Drop	184.2	2.6	45.1	115.9	1.6	2.2	47.7	102.6	1.8
Puncture	184.2	2.6	59.1	153.6	1.2	2.2	71.8	158.0	1.2

As the table shows the minimum factor of safety is 1.2. The RT-100 stress analysis is in compliance with Regulatory Guide 7.6, Section B and NUREG-1609, Section 4.5.3.2.

Chapter 2, Appendix 2.15, Section 2.15.2 of the SAR has been added to present the result of the detailed groove stress calculation.

SAR Impacts

- Chapter 2, Appendix 2.15, Section 2.15.2 of the SAR has been added to present the result of the detailed groove stress calculation.

Calculation Impacts

- Calculation Package RTL-001-CALC-ST-0402, Rev. 3 "Cask Body Structural Evaluation".

NRC RAI Comment 2-10:

Justify the lack of torque specifications for the impact limiter attachment bolts.

Per drawing RT100 PE 1001-1, there is no torque specification for the impact limiter attachment bolts. The lack of a defined specification will affect the packages tamper indication features and the package's response during NCT and HAC tests.

This information is required by the staff to determine compliance with 10 CFR 71.31, 71.43, 71.71, and 71.73.

Robatel Response – RAI Comment 2-10:

The impact limiters are held in place by a system comprised of studs, nuts and cotter pins. The cotter pins are used to lock the nuts in place and prevent the nuts from disengaging during NCT and HAC conditions. (Reference Drawing RT100 PE 1001-2 Rev. G: Section B-B, Chapter 1, Appendix 1.4, Attachment 1.4-3). The nuts are hand torqued. The cotter pins are adequate to keep the nuts in place during NCT and HAC because neither tension nor shear is applied to the cotter pin.

Drawing RT100 PE 1001-2 (Chapter 1, Appendix 1.4, Attachment 1.4-3) and Chapter 2, Section 2.4.2 has been revised to require that the tamper indicating device will be attached to the aligning pin, which is an integral part of the impact limiter.

SAR Impacts

- RT100 PE 1001-1 and RT100 PE 1001-2 revised to G (Chapter 1, Appendix 1.4, Attachments 1.4-2 and 1.4-3).
- Chapter 2, Section 2.4.2 has been revised.

Calculation Impacts

- None

NRC RAI Comment 2-11:

Justify the discrepancy between the drop test cover page and the drop test report.

The signed cover page (signed by Teofil Grochowski Jr. and dated 30 November 2012), states that, "This report provides 1/3 scale model drop test methodology…" and was done under contract "in accordance with criteria of Robatel Technologies, LLC Part 71 Quality Assurance (QA) Program Approval No. 0952, Rev. 0.

However, Section 3.3 of Project number 102885, RES 001, Rev. C, states that, "the upper and lower impact limiter designs are representative of the RT-100 package at a 3/10th scale." There appears to be a discrepancy between this statement and the cover page of the report done in accordance with the Robatel Technologies Part 71 QA program.

This information is required by the staff to determine compliance with 10 CFR 71.39.

Robatel Response – RAI Comment 2-11:

The transmittal letter was incorrect in describing the drop scale model as "1/3rd" scale. Section 3.3 of Project number 102885, Res 001, Rev C is correct in describing the drop test as a "3/10th" scale model.
102885 RES 001 Rev. E – Safety Analysis Robatel Package Model RT-100 Drop Test Report has been revised to Rev. E.

SAR Impacts

- No impact on SAR Sections. Impacts only the Drop Test Cover Letter.

Calculation Impacts

- None

NRC RAI Comment 2-12:

Clarify the containment system hydrostatic pressure testing.

Describe how the acceptance criteria (leakage per ND-6224) is verified for the containment boundary (drawing PE 1001-1 1011 components 1011-01, 1011-02, and 1011-03, etc.) in a steel, lead, steel body construction.

Also, clarify that the "during hold time" primary lid and secondary lid closure leakage examination is done in addition to the hydrostatic (with 10 minute hold time) pressure test.

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

Robatel Response – RAI Comment 2-12:

The hydrostatic pressure test is conducted at the end of fabrication to verify the performance of the entire cask.

The cask cavity is filled with water up to a certain level. Lids are then installed and pressure in the cask is controlled and monitored through the vent port. The acceptance criterion is: "No water leakage". After draining, drying of the cask and lids, the cask is reassembled and the fabrication verification leakage test is performed to demonstrate that the cask meets the containment fabrication leak rate criteria of 2×10^{-7} cm^3/s helium.

Chapter 8, Section 8.1.3 is revised to state "The hydrostatic test pressure is held for a minimum of 10 minutes. Afterward, the primary lid and secondary lid closures are examined for leakage."

SAR Impacts

- SAR Section 8.1.3 has been revised.

Calculation Impacts

- None

NRC RAI Comment 2-13:

Provide validation of the finite element analysis used for the NCT and HAC test analyses.

Staff noted that the application, dated November 30, 2012, was revised to address RSI 2.5. However, there were no changes to the technical reports referenced ST-402 and ST-403, dated October 7, 2012.

Section 2.6.7.2.1 of the application was revised to address the below issues queried in RSI 2.5: "Of particular interest, but not limited to, the reviewer is interested in the applicant's selection of elements and the meshing scheme. Sensitivity analyses should be incorporated in the element selection/meshing methodology. Also, the applicant needs to benchmark the "ability of the code" and their "use of the code" against a physical drop or other established test. Note that these studies may be applicable to some drop/load cases, and not to others, e.g., side drop vs. lid down end drop."

The applicant needs to provide a report to (i) resolve the issues that were discussed in RSI 2.5 and (ii) justify the information provided in section 2.6.7.2.1 of the revised application. For example, the applicant explains that "the cask outer shell was meshed using the sweep method and the element size was varied until there was a sufficient number of elements across the shell thickness. The element ratio was reviewed to ensure adequate results;" however, the applicant does not explain the acceptance criterion for element selection/mesh refinement, which is independent for each finite element model/part and specific element selection, in a sensitivity study.

Each model and test scenario result needs to be compared to a physical representation (which may be simplified with assumptions and justification) to validate the results. The report should include this information.

Staff recommends, where possible, validation and comparison using the 3/10th scale drop test results to the cask body finite element results.

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

Robatel Response – RAI Comment 2-13:

Appendix 4 was added to Calculation Package RTL-001-CALC-ST-0402, Rev. 3 to document the verification of the finite element model and the predictive classic calculation. This appendix compares the pressure stresses in the RT-100 using classic methods to pressure stresses calculated using the ANSYS finite element code to assure that the ANSYS code provides reasonable results.

The pressure stresses are determined using classical pressure vessel closed form solutions provided in Timoshenko's "Theory of Plates and Shell's and Young's "Roark's Formulas for Stress and Strain". These classic solutions are compared to ANSYS finite element results that include both models meshed at a high density (6 elements through wall) and lower density (3 elements through wall). To provide a better comparison between the classic solution and ANSYS results, the pressure boundary of the full finite element model is selected to focus on the inner shell and the transition regions where maximum pressure stresses occur. In this way the model is simplified to the basic geometric components of flat plates and cylinders that comprise all basic cask geometries. Once the mesh was optimized for the inner shell, the same method and mesh density was applied to the outer shell and other cask structural components.

SAR Impacts

- None

Calculation Impacts

- Calculation Package RTL-001-CALC-ST-0402, Rev. 3, "Cask Body Structural Evaluation", Appendix 4 was added to document the verification of the finite element model and the predictive classic calculation.

NRC RAI Comment 2-14:

Justify and modify the assembled package lifting analysis. The detailed assembled package lifting analysis is provided in Section 7.7 of report RTL-001-CALC-ST-0201 and Section 2.5.1.3.1 of the application. As required by 10 CFR 71.45(a), any lifting attachment must be designed with a minimum safety factor of three against yielding, when used to lift the package in the intended manner.

Per ASME Section III, Division 1, Subsection NF-3323.2, the allowable (corresponding to yield for pure shear) for pure shear stress is $0.6S_m$. When considering this value, the new "yielding" or allowable is less than the S_y/f_{sy} value used.

Section 7.2 of ANSI standard 14.6 (ST-0201 reference 3.12), "Radioactive Materials –Special Lifting Devices for Shipping Containers Weighing 10000 Pounds (4500 kg) or More," requires a dynamic load factor for the design of critical load lifting. Therefore, the applicant shall provide an analysis using an appropriate dynamic load factor and justify the value used.

It also appears that the analysis is not the same between the calculation package referenced ST-0201 and the application. For example the lifting pocket tear out stress safety margin is calculated to be 4.9 in the application, but only 1.27 in ST-0201. Also, the lifting pocket bearing stress is calculated in the application (safety margin of 1.73), but not in ST-0201.

Ensure consistency between all technical reports, e.g., ST-0201 and the application.

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

Robatel Response – RAI Comment 2-14:

The safety criteria used in the lifting analysis is a factor of three against yielding in accordance with 10 CFR 71.45(a). The analyses presented in the Chapter 2, Section 2.5.1 of the SAR and developed in Calculation Package RTL-001-CALC-ST-0201, Rev. 4 are prepared using $S_y/3$ as the limit. Chapter 2, sub-sections of 2.5.1 of the SAR are revised to show that the lifting system has a minimum safety factor of 3 when compared to the yield strength of the material. Shear stresses in the base metal and weld material are addressed as specified in Blodgett's "Design of Welded Structures" and "Roark's Formulas for Stress and Strain." The Analysis is also revised to show positive safety margins in accordance with ASME Section III, Subsection NF, Article 3223.2. In all cases the shear stresses are evaluated using a 0.6 reduction in the stress allowable.

The analysis presented in the SAR and supporting calculation is revised to utilize a Dynamic Load Factor of 1.35. Because a U.S. standard for dynamic lifting load factors could not be located, this value is obtained from the German Safety Standard KTA 3905. This standard typically specifies the use of a "live" or dynamic load factor of 1.35 in the calculation of lifting stresses. A review of other applications shows that values of 1.15 to 1.3 have been used. The use of 1.35 is believed to be acceptable.

The calculation document was found to have some inconsistencies when compared to the SAR, Rev 1. Both SAR, Rev 1 and the Calculation Package RTL-001-CALC-ST-0201, Rev. 1 were revised to address these inconsistencies, and to add the use of the dynamic load factor (this necessitated minor design changes: the size of the weld connecting the lifting block to the cask body was increased from 10mm to 15mm, the lock pin has been moved to be placed under the lifting block and the lifting eye height have been increased to keep high safety margins in the lifting fixture. The revised calculations ensure that the minimum safety margins required by 10 CFR 71.45(a) are met for all RT-100 cask lifting equipment.

SAR Impacts

- Chapter 2, sub-sections of 2.5.1 of the SAR have been revised to update the lifting analysis to include the use of a dynamic load factor of 1.35, to correct minor typographical errors and to incorporate a design change to the lifting block to cask body weld.

Calculation Impacts

- Calculation Package RTL-001-CALC-ST-0201, Rev. 4 is being submitted to update the lifting analysis to include the use of a dynamic load factor of 1.35, to correct minor typographical errors and to incorporate a design change to the lifting block to cask body weld.

NRC RAI Comment 2-15:

Justify the 9m HAC corner drop test case being bound by the 9m end and side drop cases.

The applicant claims, in Section 2.7.1.3, that the 9m end and side drop HAC tests bound the 9m corner drop test. Appendix 2.13.3.4.1 of the application develops the impact limiter time history response for the 9m HAC corner drop case, and the impact limiter methodology was verified in Section 2.13.4.1 against a scaled NUPAC-125B package (Single Foam - Series FR3700 with a density of 12 pcf). However, the construction of the Model No. RT-100 package impact limiter design is fundamentally different from the NUPAC-125B design.

Per Table 2.13.4.2.1.3-2, the calculated crush depth is 534mm whereas the maximum crush depth is 544mm, which gives only a 10 mm margin. Also, Appendix F of the RT-100 3/10 scale drop test report, referenced 102885 RES 001, does not provide a final impact limiter crush depth for the corner drop. See also RAI 2-17.

This information is required by the staff to determine compliance with 10 CFR 71.41, and 71.73.

Robatel Response – RAI Comment 2-15:

The analysis of impact limiters previously found in Chapter 2, Appendix 2.13 of SAR Rev 1 is now found in Chapter 2, Appendix 2.12 of the SAR.

Chapter 2, Section 2.7.1.3 of the SAR has been added to provide the stress analysis of the HAC Corner Drop. The evaluation shows that the minimum margin of safety is +1.0.

Chapter 2, Appendix 2.13, Section 2.13.4.1 of the SAR that compares the analytical method to the scaled NUPAC-125B has been removed from the SAR. This section has been revised to include only the comparison to the $3/10^{th}$ scale testing of the RT-100 cask.

The analytical method used to analyze the RT-100 cask design determined the maximum decelerations and crush depths as presented in Chapter 2, Appendix, 2.12, Section 2.12.3 of the SAR. The decelerations predicted by the analytical method are:

- Side = 226 g
- End = 123 g
- Corner= 116 g
    - X axis = 71.4 g
    - Y axis = 91.4 g

As the results above demonstrate, the predicted accelerations show that the corner drop component accelerations are significantly less than the side and end drop results. This is best explained by the geometry of the impact limiter during the corner drop where the peak acceleration is controlled by the initial projected area of the cask body. Unlike the end drop where the projected area on impact is equivalent to the diameter of the cask, the corner drop crush area progressively increases as the impact limiter crushes. This results in a near perfect bell shaped acceleration time-history curve as shown in Figure 2-15.1 (shown below), which shows the data from two accelerometers attached to the 3/10th scale model corner drop. Figure 2-15.1 (shown below) also shows that the impact limiter has sufficient capacity. If the impact limiter design did not have sufficient capacity there would be a spike near the end of the impact indicating that the impact limiter bottomed out causing a spike in the date near the end of the impact. However, in the case of the RT-100, the impact limiter has sufficient capacity.

The analytical prediction of the deceleration and the maximum crush depths were confirmed by comparison to the 3/10th scale model drop test results. Table 2-15.1 (shown below) provides a comparison of the 3/10th scale drop test results and the analytical method predictions. The data presented in Table 2-15.1 (shown below) is presented in the revised SAR. For this comparison, the analytical predictions for both the static and dynamic foam properties at the drop test temperature are provided. As Table 2-15.1 (shown below) shows, the maximum crush depth for the scale model using the analytical method is 157.1 mm as compared to the drop test result of 140.8 mm. This represents an additional crush capacity of 16.3 mm. Scaling the 3/10-scale model deformation to full-sized would result in a crush depth of 469.3 mm. Comparing the full scale analytical corner drop prediction of 544 mm results in an additional capacity of 74.7 mm. Therefore, the results indicate the analytical prediction over predicts the accelerations and crush when compared to the 3/10th scale test results. Additionally, the test shows that there is sufficient capacity to protect the cask during the corner drop event. Chapter 2, Appendix 2.12, Section 2.12.5 of the SAR is revised to present the comparison of analytical and scale model test results.

To evaluate the stresses generated in the RT-100 cask during the corner drop (38° from vertical), the ANSYS stress results for the side and end drop evaluations are scaled by the ratio of the end and side drop accelerations and the corner drop axial and lateral component accelerations. Once scaled, the resulting axial and lateral component stresses are summed and compared to the allowable stress intensity. Stress results for the 9-meter corner drop combined loading conditions are documented in Table 2-15.2 (shown below). The table documents the primary membrane (P_m), primary membrane plus primary bending (P_m+P_b) stresses in accordance with the criteria presented in Regulatory Guide 7.6.

As shown in Table 2-15.2 (shown below), the margins of safety when compared to the stress intensity for each category are positive. The most critically stressed component in the system is the inner lid. The minimum margin of safety is found to be +1.0 for primary membrane plus bending stress intensity. Chapter 2, Section 2.7.1.3 of the SAR has been revised to include this information.

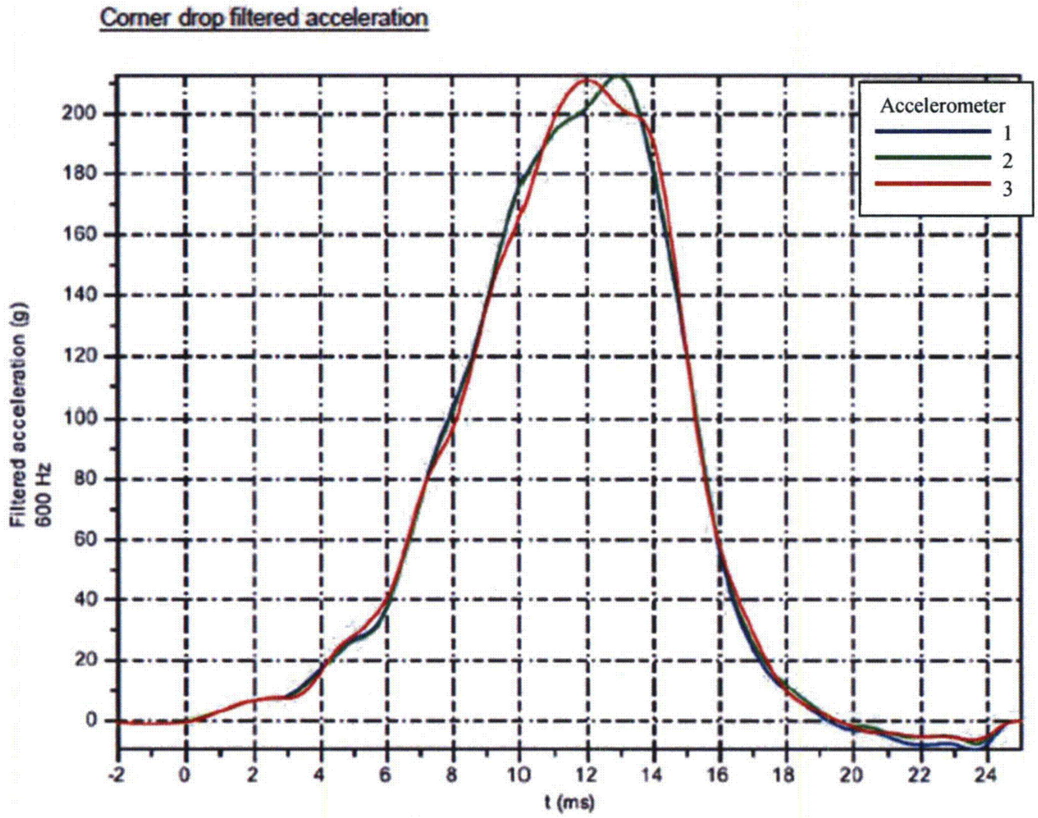


Figure 2-15.1 3/10th Scale Corner Drop Accelerations

Table 2-15.1 Comparison of 3/10th Scale Drop Test Results and Analytical Method

Case	Acceleration (g)			Crush (mm)		
	End	Side	Corner	End	Side	Corner
3/10th Scale Drop Test	270	423	213	39.8	36.5	140.8
Dynamic Foam Properties						
RT-100 Analytical	300	491	290	38.4	35.1	151.5
Difference (%)	11.1	16.1	36.2	-3.5	-3.8	7.6
Static Foam Properties						
RT-100 Analytical	269	480	342	51.3	42	157.1
Difference (%)	-0.4	13.5	60.6	28.9	15.1	11.6

Table 2-15.2 HAC Corner Drop Stress Summary

Stress State	End Drop SINT	Side Drop SINT	Corner SINT	Stress Intensity, S_m (304)	Allowable Stress	Margin of Safety
INNER SHELL	MPa	MPa	MPa	MPa	MPa	
Pm	38.4	159.6	79.0	138	331	3.2
Pm + Pb	64.1	159.7	98.1	138	496	4.1
	38.4	159.6	79.0	138	496	5.3
	19.4	159.6	64.9	138	496	6.7
OUTER SHELL	MPa	MPa	MPa	MPa	MPa	
Pm	32.8	187.1	83.5	138	331	3.0
Pm + Pb	33.5	405.3	153.0	138	496	2.2
	32.8	187.1	83.5	138	496	4.9
	32.0	169.0	77.2	138	496	5.4
FLANGE	MPa	MPa	MPa	MPa	MPa	
Pm	14.3	162.2	61.9	138	331	4.4
Pm + Pb	14.2	161.5	61.6	138	496	7.1
	14.3	162.2	61.9	138	496	7.0
	28.6	162.8	72.7	138	496	5.8
OUTER LID	MPa	MPa	MPa	MPa	MPa	
Pm	40.3	200.5	93.3	138	331	2.5
Pm + Pb	74.8	296.3	149.2	138	496	2.3
	40.3	200.5	93.3	138	496	4.3
	44.4	172.3	87.4	138	496	4.7
INNER LID	MPa	MPa	MPa	MPa	MPa	
Pm	35.9	160.1	77.3	138	331	3.3
Pm + Pb	190.4	350.6	252.3	138	496	1.0
	35.9	160.1	77.3	138	496	5.4
	138.4	66.3	123.8	138	496	3.0

SAR Impacts

- Chapter 2, Section 2.7.1.3 has been revised.

Calculation Impacts

- None

NRC RAI Comment 2-16:

Justify the 9m HAC oblique drop test case being bound by the 9m end and side drop cases.

Section 2.7.1.4 states the following: "Based on the impact limiter analysis provided in Appendix 2.13, the oblique drop configuration is bounded by the end and side drop analyses. Therefore, no further analysis is required." However, Appendix 2.13 of the application does not provide a justification for the bounding of the oblique drop orientation by the 9m end and side drop cases. Staff also notes that there was no physical data comparison for the oblique test orientation in the NUPAC-125B or RT-100 scale tests.

Justify how the statement in section 2.7.1.4 of the application was derived and verified.

This information is required by the staff to determine compliance with 10 CFR 71.41, 71.71, and 71.73.

Robatel Response – RAI Comment 2-16:

The SAR has been revised to present in Chapter 2, Section 2.7.1.4 an evaluation justifying that forces resulting from an oblique-angle drop configuration are bounded by the forces imposed on the cask from the side and end drop configurations.

SAR Impacts

- Section 2.7.1.4 of the SAR has been revised to present an analysis of the oblique drop configuration.

Calculation Impacts

- None

NRC RAI Comment 2-17:

Justify and/or correct the impact limiter test report 102885 RES 001.

Staff is unable to make determinations of the drop test report as it appears that the notation of "n" which refers to the drop test condition is misused with the notation "c" which refers to the impact limiter marking/identification, in the write-up of the test report.

For example, Appendix F.III of the RT-100 scale drop test incorrectly labels n3 drop as corner, where the n3 drop per Section 6.3 is a side drop. It is believed that the F.III reports n2 drop and c3 impact limiter.

Rewrite the test report to ensure that the information is reported consistently and in an understandable and comprehensive manner.

Provide a table of values and write-up of the final crush/deformations and maximum allowable in Section 7 of the 102885 RES 001 report. See also RAI 2-16.

Also, provide a discussion on the foam property scaling and how it may influence the deformation and maximum decelerations.

This information is required by the staff to determine compliance with the requirements of 10 CFR 71.41, 71.71, and 71.73.

Robatel Response – RAI Comment 2-17

102885 RES 001 Rev. E – Safety Analysis Robatel Package Model RT-100 Drop Test Report is revised to correct the misuse of the notation 'n' and 'c'. Clarification is added to describe the content of the appendices.

The table value of the final crush and the max g-load of the impact limiters of the scale model is provided is Section 7 of the drop test report. Maximum allowable crush depths and g-loads are provided in Chapter 2, Appendix 2.12, Section 2.12.4.3 of the SAR.

Discussions of the foam material properties are given in Chapter 2, Appendix 2.12, Section 2.12.2.2 "Foam Material Properties" of the SAR. The foam dynamic crush strength calculation is explained in Chapter 2, Appendix 2.12, Section 2.12.2.2.2 "Crush Strength" of the SAR, based on information from the General Plastics Design Guide for Last-A-Foam FR-3700 (Chapter 2, Appendix 2.12, Attachment 2.12-1).

General Plastics FR-3700 series foam is described as "modestly" sensitive to strain rate. The dynamic impact characteristics of foam are defined for different strains and in a wide strain rate range from 30 sec^{-1} to 100 sec^{-1} with the same formula. Discussion on the foam is provided in the RAI 2-15 response.

SAR Impacts

- 102885 RES 001 Rev. E – Safety Analysis Robatel Package Model RT-100 Drop Test Report.
- Chapter 2, Appendix 2.12, Table 2.12.4-14

Calculation Impacts

- None