From:	Garcia Santos, Norma
To:	"Thompson, Chad E"
Subject:	COPY--380-B RAIs
Date:	Friday, March 17, 2017 2:40:37 PM
Attachments:	380-B-RAIs_Ltr_COPY.pdf

Good afternoon Chad,

Attached is a courtesy copy of the RAIs for the Model No. 380-B that you should be receiving in the next week or so. (The letter is currently in processing.) As noted in the letter, the staff is available to meet and discuss the RAIs. Please let me know if you want to discuss the RAIs or not with the staff. (Depending in the level of detail during the discussion, there may be a need for a public meeting, but I need to verify.)

Feel free to contact me is you have questions.

Have a nice weekend,

Norma Garcia Santos
Project Manager
Division of Spent Fuel Management
Office of Nuclear Materials Safety
and Safeguards
Phone No.: (301) 415-6999
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

Mr. Ahmad M. Al-Daouk, Director
Office of Packaging and Transportation
U.S. Department of Energy
National Nuclear Security Administration
P.O. Box 5400
Albuquerque, NM 87185

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR REVIEW OF THE CERTIFICATE OF COMPLIANCE NO. 9370, FOR THE MODEL NO. 380-B PACKAGING (CAC NO. L25109)

Dear Mr. Al-Daouk:

By application dated April 6, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16102A136), and as supplemented on October 13 (ADAMS Accession No. ML16294A260) and October 20, 2016 (ADAMS Accession No. ML16301A022), the U.S. Department of Energy, National Nuclear Security Administration (NNSA or the applicant), requested a Certificate of Compliance (CoC) for the Model No. 380-B packaging. The application proposes authorization of the 380-B packaging as a Type B(U)-96 shipping container to transport non-fissile radioactive sealed sources contained in shielded devices and\or shielded source containers as part of NNSA's Offsite Source Recovery Project mission.

In connection with our review, we need the information identified in the enclosure to this letter. To assist us in scheduling staff review of your response, we request that you provide this information by May 17, 2017. Inform us at your earliest convenience, but no later than April 7, 2017, if you are not able to provide the information by that date. If you are unable to provide a response by, our review may be delayed.

Please reference Docket No. 71-9370 and CAC No. L25109 in future correspondence related to this request. The staff is available to meet to discuss your proposed responses. If you have any questions regarding this matter, I may be contacted at (301) 415-6999.

Sincerely,

Norma García Santos, Project Manager
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9370
CAC No. L25109

Enclosure:
Request for Additional Information

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR REVIEW OF THE CERTIFICATE OF COMPLIANCE NO. 9370, FOR THE MODEL NO. 380-B PACKAGING (CAC NO. L25109)

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ADAMS Accession Number: ML

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DATE	3/3/17	3/7/17	3/3/17	3/7/17
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DATE	3/3/17	3/7/17	3/9/17	

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Request for Additional Information
U.S. Department of Energy
National Nuclear Security Administration
Docket No. 71-9370
Certificate of Compliance No. 9370
Model No. 380-B

By application dated April 6, 2016, and as supplemented on October 13 and October 20, 2016, the National Nuclear Security Administration (NNSA or the applicant), requested a certificate of compliance (CoC) for the Model No. 380-B packaging. The application proposes authorization of the 380-B packaging as a Type B(U)-96 shipping container to ship non-fissile radioactive sealed sources contained in shielded devices and\or shielded source containers as part of NNSA's Offsite Source Recovery Project mission.

This request for additional information (RAI) identifies information needed by the U.S. Nuclear Regulatory Commission (NRC) staff (the staff) in connection with its review of the application. The staff used NUREG-1609, "Standard Review Plan for Transportation Packages for Radioactive Material," in its review of the application.

Each individual RAI describes information needed by the staff to complete its review of the application and to determine whether the applicant has demonstrated compliance with the regulatory requirements of 10 CFR Part 71.

Containment Evaluation

RAI-Co-1 Provide the following information related to gas generation due to radiolysis as described in items (a), (b), and (c) below.

a. explain how the energy depositions of 98.456, 346.826, and 745.697 megaelectron volts per gram per second (MeV/g per s), as shown in Table 5-6 of Section 5.5.4, "Gas Generation due to Radiolysis," of the application, for small, medium, and large devices, respectively, within the Model No. 380-B, are determined using the MCNP model.

b. derived the gas volume per average gas temperature, at room temperature, for the Model No. 380-B.

The applicant derived the gas volume by multiplying moles of gas byd 22.4 liters/mole (L/mol). The gas volume of 22.4 L/mol is based on standard atmospheric conditions (1 atm and a room temperature of 25^{o}C). The multiplication of gas mole and 22.4 L/mol may be not accurate under a higher gas temperature (> 25^{o}C) within the Model No. 380-B cavity.

c. explain how the total void volume of the Model No. 380-B corresponding to0.057 L, 0.20 L, 0.4 L, and 4.6 L are derived/calculated in order to ensure that these parameters will remain below 5% (per volume) of flammable gas, as specified in Section 3.5.4.2, "Maximum Normal Operating Pressure," of NUREG 1609, "Standard Review Plan for Transportation Packages for Radioactive Material."

The applicant mentioned in Section 5.5.4, “Gas Generation due to Radiolysis,” of the application that the total void volume of the Model No. 380-B will typically be much larger than 4.6 L and that the minimum required void volumes (to remain below 5% (per volume) of flammable gas) are 0.057 L, 0.20 L and 0.4 L for small, medium and large devices, respectively, in one year.

The applicant used a G value of 4.5 (flammable gas in wood) and the following formula depicted in Section 5.5.4 of the application (page 5.5.4-2) to calculate total amount of gas generated due to radiolysis:

$$\text{Moles of Gas} = G / 100 \times (E \times 10^6) \times T \times M / A$$

In Table 5-6 of the application, the applicant presented the calculated gas moles and volumes of small, medium, and large devices within the Model No. 380-B.

This information is required to determine compliance with 10 CFR 71.35(a) and 71.43(d).

RAI-Co-2 Describe how the personel performing leak testing will be qualified per the recommended practices in accordance with the American Society of Non-Destructive Testing and the ANSI.

The applicant mentions a general description of the leak tests per ANSI N14.5, “American National Standard for Radioactive Materials – Leakage Tests on Packages for Shipment,” (1997) that it would be performing for the Model No. 380-B in the following sections of the application:

1. Section 7.4, “Preshipment Leakage Rate Test,”
2. Section 8.1.4, “Fabrication Leakage Rate Tests,” and
3. Section 8.2.2, “Maintenance/Periodic Leakage Rate Tests.”

The description provided in the sections of the application mentioned above do not clearly state that the leakage test procedures will be approved by qualified personnel in accordance with the American Society of Non-Destructive Testing Recommended Practice No. SNT-TC-1A.

ANSI N14.5, “American National Standard for Radioactive Materials – Leakage Tests on Packages for Shipment,” (2014), Appendix A, notes the following:

1. “The application of leak testing technology expertise early in the design process is required……This Standard assumes the application of the leak testing technology expertise of a Leak Testing Engineer — Practitioner or Leak Testing Level III specialist during the design process,” and

2. “A leak testing NDT Level III specialist can be of great value in the design of a high reliability, economical leak testing program, selection of methods, equipment, and generation of procedures. Early involvement of a leak testing engineer in the design of the package for leak testing can be very useful in producing designs that are suited to economical, reliable leak testing ”

The staff issued this recommendation (regarding the use of ANSI N14.5 (2014)) in March 2016 in NRC's Information Notice (IN)-16-04, "ANSI N14.5-2014 Revision and Leakage Rate Testing Considerations."

This information is required to determine compliance with 10 CFR 71.37(b).

RAI-Co-3 Explain in detail why the maintenance/periodic leakage rate tests may be performed as an option to the pre-shipment leakage rate test for 380-B package.

The applicant noted Section 4.4.3, "Preshipment Leakage Rate Tests," and Step #22b of Section 7.1.2, "Loading of Contents," that the maintenance/periodic leakage rate tests, described in Section 8.2.2, "Maintenance/Periodic Leakage Rate Tests," of the application may be performed as an option, in lieu of the pre-shipment leakage rate tests.

ANSI N14.5 (2014) indicates the pre-shipment leakage rate testing as follows:

> "Pre-shipment leakage rate testing shall be performed before each shipment, after the contents are loaded, and the containment system is assembled."

The maintenance/periodic leakage rate tests are performed with a (1) leakage rate criteria of 10^{-7} reference-cubic centimeters per second (ref-cm^3/s), (2) no contents loaded in the package, and (3) a 12-month period or after maintenance, repair, or replacement. The preshipment leakage rate test is performed with (1) a leakage rate criteria of 10^{-3} ref-cm^3/sec, (2) contents loaded, and (3) before shipment. Given these discrepencies, the applicant should explain or describe the conditions in detail why the maintenance/periodic leakage rate tests may be performed as an option, in lieu of the pre-shipment leakage rate tests.

This information is required to determine compliance with 10 CFR 71.43(f) and 71.51(a)(1).

Materials Evaluation

RAI-M-1 Provide the tolerances for the package dimensions. Also, as part of your response:

a. explain how dimensional tolerances are considered in the structural and thermal evaluations, and
b. revise the drawings with tolerances related to the package dimensions and incorporate these changes into the application.

Staff's guidance in NUREG-5502, "Engineering Drawings for 10 CFR Part 71 Package Approvals," Section 3.2, "General Arrangement of Packaging and Contents," mentions that all dimensions indicated on drawings should include tolerances that are consistent with the package evaluation. Based on the information reviewed by the staff, it is not clear how the applicant considered the dimensional tolerances in the package evaluation and how the tolerances used in the evaluation were incorporated into the drawings.

The applicant did not include tolerances for some of the package components depicted in the drawings submitted in the application. The applicant included tolerances for the seal grooves in Detail M of drawing No. 1916-02-02-SAR, "LANS 380-B Package Assembly SAR Drawing," Sheet 6 of 6. Nevertheless, the applicant did not include tolerances for the following components:

1. the Lid Assembly (drawing No. 1916-02-02-SAR, Sheet 6 of 6),
2. the Inner Cover Assembly (drawing No. 1916-02-02-SAR, Sheet 5 of 6), or
3. the Cask Body Assembly (drawing No. 1916-02-02-SAR, Sheet 4 of 6).

Also, the applicant notes in Section 2.3.1, "Fabrication," of the application that the containment shell fabrication complies with the tolerances of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code (ASME B&PV Code or ASME Code), Section NE, Article NE-4220. It is not clear if the allowable tolerances in ASME B&PV Code, Section NE, Article NE-4220, are sufficient to avoid inadequate clearances between the inner cover and the cask body, and the lid assembly and the cask body. In addition, the requirements in ASME B&PV Code, Section NE, Article NE-4220, do not address design requirements for shielding. The applicant should revise the application to ensure that the applicable standards are used for the design of the Model No. 380-B.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

RAI-M-2 Provide the following information for items 19 and 20 in drawing No. 1916-02-02-SAR, "LANS 380-B Package Assembly SAR Drawing":

a. the revised drawing with welding symbols indicating the type of weld joint (e.g., square, V, bevel, U, etc.), and
b. the nondestructive examination methods used for the welds related this drawing, with the corresponding justification for using such methods.

Incorporate the revised drawings and the discussion related to item b. of this question in the application.

The bill of materials in drawing No. 1916-02-02-SAR, Sheet 1 of 6, indicates that the inner and outer shell are manufactured from ASTM A240, Type 304, plate material. This material would need to be formed into a cylinder and include at least one axial weld. Nevertheless, drawing No. 1916-02-02-SAR did not show or describe the welds that will be used when fabricating the Model No. 380-B inner and outer shells.

The design, fabrication aspects, and examination of the welds are important for the structural performance of the packaging. In terms of nondestructive examination, the applicant notes in Section 2.3.1 of the application that all containment boundary welds are full penetration joints and that would apply to the inner shell plate welds (item 19 in drawing No. 1916-02-02-SAR), but it is unclear if the same would apply to the outer shell weld (item 20 in drawing 1916-02-02-SAR). For both of these shells, there is no statement in Section 2.3.2, "Examination," of the application that identifies the type of nondestructive examination that that the applicant would require on these welds to ensure compliance with the applicable regulatory requirements.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

RAI-M-3 Provide a revised drawing No. 1916-02-02-SAR with the welding symbols indicating the type of weld joint (e.g., square, V, bevel, U, etc.) for welds joining of items 17 to 19, 17 to 20, 18 to 19, and 18 to 20 in drawing No. 1916-02-02-SAR. Incorporate this change into the application.

In drawing No. 1916-02-02-SAR, Sheet 4 of 6, the applicant identifies items 17 to 19 and 20 and items 18 to 19 and 20 as complete joint penetration welds that are welded all around and examined using ultrasonic testing (UT) and penetrant testing (PT). However, the information in these items is not consistent with the applicable industry code and standard American Welding Society (AWS) 2.4, "Standard Symbols for Welding, Brazing, and Nondestructive Examination." Moreover, Note 1 on Sheet 1 of drawing No. 1916-02-02-SAR specifies that the weld joint information should be consistent with AWS 2.4.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

RAI-M-4 Provide the dimensions (including schematics), composition of materials of construction, and moisture content of the proposed contents (i.e., sources and source containers) and dunnage. As part of your response,

a. demonstrate how the Model No. 380-B package would maintain:
   i. positive clearances between the inner cavity and the lodgment, both axially and radially, under normal conditions of transport (NCT) and hypothetical accident conditions (HAC), and
   ii. an allowable maximum normal operating pressure (considering dunnage as well as proposed contents)
b. explain how the chemical form and moisture content of the blockage and dunnage material were used to determine the maximum pressures in the package during NCT and HAC.

Section 1.2.2 of the application mentions that the details of the device designs may not be known and that blocking/dunnage materials are metallic structures, polyurethane foam, or wood. Section 3.1.4, "Summary Tables of Maximum Pressures," and Table 3.1-2, "Summary of Maximum Pressures," of the application describe the maximum pressure rise that would occur assuming a fill gas at one atmosphere of pressure and an initial temperature of 70°F. In this analysis, the applicant did not consider moisture content of the materials inside the package. At elevated temperatures, moisture could be released and vaporized resulting in a potential increase of internal pressure. Regulatory Guide (RG) 7.9, "Standard Format and content of Part 71 Applications for Approval of Packages for Radioactive Material," includes the following information related to the package internal pressure:

For NCT, Section 3.3.2, "Maximum Normal Operating Pressure," mentions that the calculation of pressures should consider possible sources of gasses including water vapor from the contents.

For HAC, Section 3.4.3, "Maximum Temperatures and Pressures," mentions that the evaluation of the maximum pressure in the package should be based on the maximum normal operating pressure, and should consider fire-induced increases in package temperatures, thermal combustion or decomposition processes, fuel rod failure, phase changes, etc. …

This information is needed to determine compliance with 10 CFR 71.33(a)(5) and (b)(3).

RAI-M-5 Provide the following information related to drawing No. 1916-02-02-SAR, "LANS 380-B Cask assembly SAR Drawing":

a. material properties for ASTM A351, Grade CF8A, cast stainless steel identified in the "bill of materials" in items 14 (Lid Forging), 17 (Forging, Cask Upper), and 18 (Forging, Cask Bottom).
b. reference(s) used as the basis of response in item a. above.
c. revised drawing No. 1916-02-02-SAR with the correct material descriptions (forging, plate, etc.) of the components of the cask assembly.

For example, the following is information extracted from the "bill of materials" of drawing No. 1916-02-02-SAR, "LANS 380-B Cask assembly SAR Drawing":

ITEM NO.	**BRIEF DESCRIPTION**		**SPECIFICATION**
14	lid	Forging	ASTM A351, Grade CF8A,…or ASTM A240…
17	cask upper	Forging	
18	cask bottom	Forging	

The staff notes the following:

1. ***ASTM A351, Grade CF8A***, is a Type 304 stainless steel cast material and should not be described as a forged material. The applicant does not provide mechanical properties for this material in the application. ASME B&PV Code, Section II, Part D, includes the following information:
   i. ASTM A351, Grade CF8A, has a maximum allowable temperature of 700ºF.
   ii. Other stainless steels such as A240 and A182 have an 800ºF maximum temperature.

   The applicant treats A351 as if it has the same allowable temperature as A240 or A182, which is not correct.

2. ***ASTM A240*** plate is wrought material and should not be described as a forged material. The mechanical properties of A240 were provided in Table 2.2-1, "Mechanical Properties of Wrought Type 304 Stainless Steel," of the application.

3. ***Drawing No. 1916-02-02-SAR*** refers to components as “forgings” even though these components can be made from a cast or wrought (i.e., rolled plate) materials. The applicant should consider the differences in mechanical properties, allowable temperatures, and inspection methods of the materials.

Note that this question includes examples and the applicant should review and revise its drawings to ensure accuracy in the description of the materials used in the design of the Model No. 380-B.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

RAI-M-6 Provide a reference for the mechanical properties of ASTM A276, Type 304 stainless steel.

Table 2.2-1, “Mechanical Properties of Wrought Type 304 Stainless Steel,” of the application lists the material specification ASTM A276. For ASTM A276, Type 304, the applicant referenced the following sections of the ASME B&PV Code:

1. Section II, “Materials,” Part D, “Properties,” Tables 2A,
2. Section III, Division 1, Class 1, and
3. Section III, Division 3, Classes TC and SC, “Design Stress Intensity Values Sm for Ferrous Materials,” Table U, “Tensile Strength Values Su for Ferrous and Nonferrous Materials,” and Table Y-1, “Yield Strength Values Sy for Ferrous and Nonferrous Materials.”

The applicant did not provide an equivalent material specification for ASTM A276, Type 304 stainless steel because the referenced ASME B&PV Code, Section II, Part D, Tables do not include material properties for ASME SA-276, Type 304 stainless steel.

This information is needed to determine compliance with 10 CFR 71.31(c) and 71.33(a)(5).

RAI-M-7 Revise Tables 2.2-1, “Mechanical Properties of Wrought Type 304 Stainless Steel,” and 2.2-2, “Mechanical Properties of Forged Type 304 Stainless Steel,” to use consistent terminology for “Design Stress Intensity” (Sm) as referenced in ASME B&PV Code, Section II, Part D, Table 2A, and not “Allowable Strength.”

Tables 2.2-1 and 2.2-2 of the application describe “Sm” as “Allowable Strength.” The ASME B&PV Code, Section II, Part D, Table 2A, describes “Sm” as “Design Stress Intensity.” Therefore, the applicant needs to revise the application to use the correct terminology.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

RAI-M-8 Justify the maximum temperatures for the ASTM A564, Grade 630, Condition H1100, Impact Limiter Attachment Bolts, provided in Table 3.1-1, “Maximum NCT and HAC Temperatures,” Table 3.3-1, “NCT Temperatures for 380-B Package with Open Dunnage Support,” and Section 3.2.3, “Component Specifications,” of the application.

In Tables 3.1-1 and 3.3-1 and Section 3.2.3 of the application, the applicant indicates that the allowable temperature for ASTM A564, Grade 630, Condition H1100, bolts is 800°F. Section 3.2.3 of the application indicates that Type 630 stainless steels have an allowable temperature of 800°F per the ASME BP&V Code, Section III, "Rules for Construction of Nuclear Facility Components," Division 1, Subsection NB, Class 1 Components. The allowable temperature per ASME B&PV Code, Section II, Part D, is 650°F. Therefore, the temperatures listed in Tables 3.1-1 and 3.3-1 and Section 3.2.3 of the application exceed the maximum allowable temperature of 650°F listed in ASME BP&V Code, Section II, "Materials," Part D, "Properties," Table 4; Section III, Classes 1, TC, and SC; and Section VIII, Division 2, "Design Stress Intensity Values Sm For Bolting Materials."

This information is needed to determine compliance with 10 CFR 71.33(a)(5) and 71.51(a)(2).

RAI-M-9 Justify design stress intensity values (Sm) values for SA-564, Grade 630, Condition H1100, bolts, in Table 2.2-3, "Mechanical Properties of ASTM A564, Grade 630, Condition H 1100, Stainless Steel," of the application. Provide applicable references as part of the response.

The applicant should use the values listed in ASME BP&V Code, Section II, Part D, Table 4, which are specific to SA-564, Grade 630, Condition H1100, instead of using generic guidance such as NUREG/CR-6007. The Sm values listed in Table 2.2-3 of the application are based on generic guidance of NUREG/CR-6007, "Stress Analysis of Closure Bolts for Shipping Casks," that is 2/3 of the yield strength (2/3 Sy). ASME BP&V Code, Section II, Part D, Table 4; Section III, Classes 1, TC, and SC; and Section VIII, Division 2, "Design Stress Intensity Values Sm For Bolting Materials," include specific values applicable to SA-564, Grade 630, Condition H1100, bolts for use in Class 1 systems. The values provided in the application exceed the Sm values listed in ASME B&PV Code, Section II, Part D, Table 4. Values of Sm in ASME BP&V Code, Section II, Part D, Table 4, are approximately ½ of the values based on generic guidance in NUREG/CR-6007 (2/3 Sy). Note that for bolts in Class 1 systems, ASME B&PV Code, Section III, "Rules for Construction of Nuclear Facility Components," Division 1, Subsection NB, "Class 1 Components," NB-3232.1, the maximum value of service stress, averaged across the bolt cross section and neglecting stress concentrations, shall not exceed two times the stress values of Section II, Part D, Subpart 1, Table 4.

This information is needed to determine compliance with 10 CFR 71.31(c) and 71.33(a)(5).

RAI-M-10 Provide and identify the allowable grades of ASTM B29 lead used for the shielding material of the Model No. 380-B.

Section 1.2.1.1, "Cask Assembly," of the application states the following:

> "All lead shielding is made from ASTM B29 lead or optionally, from lead per Federal Specification QQ-L-171E, Grade A or C."

There are four grades of lead included in ASTM B29-14. The applicant should provide a complete specification for the materials used in the design of the Model No. 380-B.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

RAI-M-11 Provide the material properties for ASTM B16, C3600, Temper H02 Brass, and applicable references as part of the response. Also, as part of the response, include at least the following material properties:

a. yield strength,
b. ultimate strength,
c. design stress intensity,
d. elastic modulus, and
e. thermal expansion coefficients.

Regulatory Guide (RG) 7.9, Section 4.3, "Containment under Hypothetical Accident Conditions," notes that under HAC the structural performance of the containment system should be addressed, including seals, closure bolts, and penetrations, as well as leakage testing of the containment system. Section 4.1.1, "Containment Boundary," of the application indicates that the brass vent port plug is part of the containment boundary. The applicant provided Table 2.2-5, "Mechanical Properties of Brass Material," but did not provide material properties of brass as a function of temperature such as in Table 2.2-2, "Mechanical Properties of Forged Type 304 Stainless Steel."

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

RAI-M-12 Describe the proposed process for ultrasonic testing (UT) including equipment description and procedures that demonstrate UT is sufficient to identify and size welding defects in:

a. the welds between the Plate, Inner Shell (item 19 in drawing 1916-02-02 SAR), and the Forging Cask Upper (item 17), and Forging, Cask Bottom (item no. 18), and
b. the welds between the Plate, Outer Shell (item 20), and the Forging, Cask Upper (item 17), and Forging, Cask Bottom (item 18), for the case where items 17 and 18 are manufactured from ASTM A 351, Grade CF8A, cast austenitic stainless steel.

As part of your response, demonstrate that the UT examination of the welds is sufficient to detect weld defects that may affect the structural performance of the package.

Section 2.3.2, "Examination," of the application mentioned that UT would be used to examine the welds mentioned in items a. and b. of this question. Ultrasonic examination (UT) of welds in cast austenitic stainless steels is known to be difficult owing to the microstructure of these materials which often contain a wide range of grain sizes that scatter ultrasonic waves. Generally, UT is not the preferred volumetric nondestructive examination method for cast austenitic stainless steels. Weld defects near the fusion line of the cast components could be difficult to detect using UT.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

RAI-M-13 Provide the following information for the ASTM A564, Grade 630, stainless steel closure lid bolts:

a. an analysis consistent with the information summarized in Table 3.1-1, “Maximum NCT and HAC Temperatures,” under NCT and HAC,
b. the maximum temperatures along with allowable temperatures for NCT, and
c. temperature margins (Table 3.4-1, “Peak HAC Temperatures for 380-B Package,” and Section 3.4.3,“ Maximum Temperatures and Pressure”) under HAC for the ASTM A564, Grade 630, Condition H1100, stainless steel closure lid bolts.

Also, provide a demonstration that the package would remain leaktight at the maximum NCT and HAC temperatures in Table 3.1-1.

Table 3.1-1 of the application depicts a maximum temperature of 649°F for the closure lid (Type 304 stainless steel) under HAC (see also RAI-8 and RAI-9). The upper temperature for Type 630 stainless steel in ASME Code, Section II, Part D (Tables 1A, 2A, 3, and 4), is of 650°F. Since that the closure lid bolts are part of the containment boundary, the applicant needs to provide an analysis to demonstrate the package would remain leaktight under NCT and HAC.

This information is needed to determine compliance with 10 CFR 71.33(a)(5) and 71.51(a)(2).

RAI-M-14 Provide the following information for the “Forging Cask Upper” (item 17), “Forging Cask Bottom” (item 18), and “Lid Forging” (item 14) as depicted in drawing No. 1916-02-02-SAR:

a. an analysis consistent with the information summarized in Table 3.1-1, and
b. temperature margins (Table 3.4-1, “Peak HAC Temperatures for 380-B Package,” and Section 3.4.3, “Maximum Temperatures and Pressure”) under HAC, when these components are manufactured from ASTM A351, Grade CF8A.

Table 3.1-1 of the application includes temperatures of the closure lid, bottom forging, and top forging, under NCT and HAC conditions. The allowable temperature for these components under normal and accident conditions is listed as 800°F. The allowable temperature of 800°F is correct, if these components are manufactured from wrought (ASTM A240) or forged (ASTM A182) Type 304 stainless steel. However, if these components are constructed from ASTM A351, Grade CF8A, stainless steel as shown in the “bill of materials” in drawing No. 1916-02-02-SAR, Sheet 1 of 6, “LANS 380-B Cask Assembly SAR Drawing,” the allowable temperature is 700°F per ASME BP&V Code, Section II, Part D, Table 2A.

This information is needed to determine compliance with 10 CFR 71.33(a)(5).

RAI-M-15 Provide the applicable ASTM standard or other industry standard used for estimating the compressive stress of the polyurethane. If the testing and analysis is not based on a referenced standard, justify the testing and analysis methods.

Section 8.1.5.1.2.3.2, “Compressive Stress,” of the application mentions testing of the foam in an “Universal Testing Machine.” Regulatory Guide (RG) 7.9, Section 2.2.1, “Material Properties and Specifications,” mentions that properties where material properties are determined by testing, this section (“Compressive Stress”) should describe the test procedures, conditions, and measurements in sufficient detail to enable the staff to evaluate the validity of the results. The staff notes that ASTM D1621, “Standard Test Method for Compressive Properties of Rigid Cellular Plastics,” has previously been used to describe the testing of polyurethane foam on impact limiters.

This information is needed to determine compliance with 10 CFR 71.31(c).

RAI-M-16 Explain the methodology to determine the presence of voids greater than 5% of the nominal lead thickness using dose rate measurements using a cobalt-60 source. As part of your response, indicate the expected variation in dose rate based on the allowable dimensional tolerances of the packaging materials.

Section 8.1.6.1, “Poured Lead Shielding,” of the application mentions that poured lead shielding integrity shall be confirmed by using gamma scanning. The test is considered acceptable if it is determined that no voids exist that exceed 5% of the nominal lead thickness. The bases for a 5% of the nominal lead thickness should be consistent with the dimensional tolerances for the thickness of the lead material used for the shield.

This information is needed to determine compliance with 10 CFR 71.31(c).

Structural Evaluation

RAI-St-1 Revise the impact limiter assembly drawing No. 1916-02-03-SAR to identify the design details for the ¼-inch thick by 2-inch wide reinforcing ring to alleviate potential shell casing weld failure, which was observed for the certification test unit (CTU) accident sequence of the C.G.-over-corner free drop followed by a puncture drop.

Figure 2.12.3-36, “Impact Limiter Added Reinforcing Ring,” of the application includes details of the reinforcing ring design. Drawing No. 1916-02-03-SAR should reflect the reinforcing ring design details depicted in Figure 2.12.3-36 to ensure control of the shipping packaging design and that such design is not altered.

This information is needed to determine compliance with the requirements in 10 CFR 71.33(a)(5)(iii).

RAI-St-2 Revise the following sections of the application as follows:

a. Section 2.7.8, “Summary of Damage,” of the application to identify the minimum margin of safety applicable to the containment system, which consists primarily of the cask body inner shell, inner bottom plate, and closure lid assembly.

b. Section 2.7.1.3, “Side Drop,” to:

   i. identify the stress linearization section cuts and corresponding margins of safety for the side drop accident if it is judged to be the drop orientation for which the maximum damage is expected of the package containment boundary, and.

   ii. include a summary of stress analysis results for the containment boundary.

Section 2.7.1.3 of the application states the following:

> “[T]he minimum margin of safety…, which corresponds to the side drop impact case, is +0.06.”

Per the applicant this margin of safety is associated with the stress at the bottom outside edge of the outer shell. The staff notes that the outer shell is not part of the containment boundary. A summary of stress analysis results for the containment boundary, which is the most indicative of the package structural capability, should be provided in Section 2.7.1.3 for the package subject to the 30-ft side drop accidents to determine that the minimum safety margins are acceptable.

This information is needed to determine compliance with the requirements in 10 CFR 71.73(c)(1).

RAI-St-3 Explain how the decoupling process may impact the finite element stress analysis of the cask body and closure lid components as mentioned in Section 2.12.4.4, “Load Cases and Allowable Stress,” of the application.

Section 2.12.4.4 of the application, page 2.12.4-4, top paragraph, first sentence, states the following:

> “[F]or most cases, the maximum stress resulting from the model is evaluated by decoupling the primary stress from bending and secondary stress.”

The stress analysis description does not appear to be conducive to a finite element stress analysis approach that are commonly practiced using a superposition principle. Therefore, the applicant should provide a clear description of a finite element analysis approach used for performing containment boundary the stress analysis mentioned in Section 2.12.4.4.

This information is needed to confirm that the stress analysis method, as described, was implemented properly for demonstrating the package structural performance in meeting the requirements of 10 CFR 71.35(a) and 71.41(a).

This information is needed to determine compliance with the requirements in 10 CFR 71.35(a) and 71.41(a).

RAI-St-4 In terms of the structural analysis of the Model No. 380-B, provide the time-history comparison plots for the measured full-scale equivalent rigid body accelerations to corroborate the peak response results in Table 2.12.5-9 with respect to Figures 2.12.5-24 through -26 on the simulated accelerations for the end, C.G.-over-corner, and side drops.

Table 2.12.5-9, "Benchmark Results Comparison," of the application includes a comparison of the measured and simulated peak cask rigid body decelerations and the impact limiter deformations. The staff notes that, in addition to evaluating correlation between the measured and simulated peak accelerations, two other acceleration response attributes, namely, the pulse shape and pulse duration, should also be evaluated. The staff needs this information to verify that the impact limiter finite element analysis model is adequately benchmarked and it can be used in an evaluation by analysis approach to demonstrate that the package meets the structural performance requirements for the free drop test requirements.

This information is needed to determine compliance with the requirements in 10 CFR 71.71(c)(7) and 71.73(c)(1).

Thermal Evaluation

RAI-Th-1 Provide the basis for determining the distribution of the content's decay heat percentage as described in Section 3.1.2, "Content's Deacy Heat" of the application.

The Model No. 380-B is designed for a maximum decay heat of 205 watts. In Section 3.1.2 of the application, the applicant provides the following assumptions related to the thermal analyses:

1. 86% of the content's decay heat deposited on a 10.6-inch height of the inner shell directly opposite of the irradiation device (shield device), and
2. 14.0% of the heat load located on the underside of the inner cover and the upper 16.8 inches of the inner shell on an area basis.

The applicant did not provide justification or basis for these values (86% and 4.0%).

This information is required to determine compliance with 10 CFR 71.35(a) and 71.71(c)(4).

RAI-Th-2 Justify using the peak inner shell temperature plus 50% as appropriate or conservative in the maximum normal operating pressure (MNOP) calculation.

The applicant stated in Section 3.3.2, "Maximum Normal Operating Pressure," of the application that the MNOP is estimated based on no payload outgassing, but will rise from ideal gas expansion and outgassing from the payload dunnage. To calculate the pressure-rise from the ideal gas expansion, the applicant assumed that the bulk gas temperature is equal to the peak inner shell temperature plus 50%, since the applicant did not explicitly model the payload.

Since that the peak gas temperature can be higher than the peak inner shell temperature, the applicant needs to explain and justify using the peak inner shell temperature plus 50% in the MNOP calculation.

This information is required to determine compliance with 10 CFR 71.33(b)(5) and 71.71(c)(4).

RAI-Th-3 Provide Table 4.2.19 of Reference No. 29 depicted in Section 3.5.1, “References,” of the application to verify the water/moisture saturation pressure. Incorporate Table 4.2.19 of Reference #29 in Section 3.3.2 of the application.

The applicant stated in Section 3.3.2, “Maximum Normal Operating Pressure,” of the application that dunnage fabricated of wood has the potential of contributing to the pressurization of the package cavity due to long-term evaporation of the moisture content in the wood. The applicant evaluated a saturation pressure of 2.6 psi for water/moisture at the peak inner shell temperature (i.e., 136°F) from Table 4.2.19, “Mark's Standard Handbook for Mechanical Engineers,” 10th Edition (Reference #29 listed in Section 3.5.1, “References,” of the application).

This information is required to determine compliance with 10 CFR 71.71(c)(4).

RAI-Th-4 Estimate impact of the loss of polyurethane foam during a HAC fire, including both the 30-minute transient fire and its post-fire cooldown. As part of your response, explain the following:

a. whether a loss of <u>more than</u> 2.7 inches of polyurethane from is needed to reflect the feature in the HAC 30-minute fire, and
b. whether a loss of polyurethane foam can be less conservative in the post-fire cooldown and even in a HAC fire event.
c. how the safety margins for a fire event will be maintained.

As described in Section 3.4.1, “Initial Conditions,” the applicant modeled the HAC fire by assuming a loss of 2.7 inches of polyurethane foam from the impact limiter due to thermal decomposition to enhance heat input into the package during the HAC 30-minute fire. The staff needs to verify how safety margins are maintained.

This information is required to determine compliance with 10 CFR 71.73(c)(4).

RAI-Th-5 Provide the convection heat transfer coefficients used in the model analyses for the HAC 30-minutes transient fire and its post-fire cooldown.

The applicant stated in Section 3.4.2, “Fire Tests Conditions,” of the application that the convection heat transfer coefficients between the package and the ambient air during the HAC 30-minute fire event are derived based on an average gas velocity of 10 meters per second (m/s). Following the 30-minute fire event, the convection heat transfer coefficients are derived based on still air in the post-fire cooldown.

Instead of “based on an average gas velocity of 10 m/sec during the 30-minute fire and based on still air in the post-fire cooldown,” the applicant needs to provide values of the convection heat transfer coefficients (with units) used in the model analyses for the HAC 30-minutes transient fire and its post-fire cooldown.

This information is required to determine compliance with 10 CFR 71.73(c)(4).

RAI-Th-6 Demonstrate the adequacy of the bounding solar absorptivity value described in Section 3.4.2 of the application for the package exterior surfaces during the HAC post-fire cooldown.

The applicant stated in Section 3.4.2 of the application that the ambient condition of 100°F with insolation is assumed following the HAC 30-minute fire event. A solar absorptivity of 0.9 is assumed for the exterior surfaces to account for potential soot accumulation on the package surfaces during the post fire cooldown.

NUREG 1609 recommends the use of a bounding absorptivity of 1.0 for the package exterior surfaces to maximize the solar heat input to the package and use of a solar emissivity of less than 0.8 in order to minimize the decay heat out of the package during the post-fire cooldown.

This information is required to determine compliance with 10 CFR 71.73(c)(4).

RAI-Th-7 Provide and include a description of a temperature survey in Section 7.1.3 of the application to ensure that the limit specified in 10 CFR 71.43(g) (for an exclusive use shipment) is not exceeded.

The applicant stated in Section 7.1.4 of the application that the user needs to verify that the total heat is less than or equal to 205 watts to meet the decay heat limit for the package. Besides the limit of heat load, the applicant needs to provide and include a description of a temperature survey in Section 7.1.3, “Preparation of the Package for Transport,” of the application to verify that the limit of 185°F, specified in 10 CFR 71.43(g) for an exclusive use shipment, is not exceeded.

This information is required to determine compliance with 10 CFR 71.43(g) and 71.87(k).