February 26, 2010

Dr. Robert A. Vaughan
Managing Director
Croft Associates Limited
Building 4F, Culham Science Centre
Culham, Abingdon
Oxfordshire, OX14 3BD, United Kingdom

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR REVIEW OF THE MODEL NO. 3979A PACKAGE

Dear Dr. Vaughan:

By application dated July 30, 2009, as supplemented October 15, 2009, Croft Associates Limited requested that the Nuclear Regulatory Commission approve the Model No. 3979A package as a Type B(U) package for the transport of radioisotopes and radiochemicals used in a wide range of therapeutic and diagnostic applications and research.

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 April 2, 2010. Inform us at your earliest convenience if you are unable to provide a response by that date.

Please reference Docket No. 71-9337 and TAC No. L24361 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, please contact me at (301) 492-3292.

Sincerely,

/RA/

Michele M. Sampson, Sr. Project Manager
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-9337
TAC No. L24361

Enclosure: Request for Additional Information

cc w/encl: E. Redmond, NEI

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Request for Additional Information
Croft Associates Limited
Docket No. 71-9337
Model No. 3979A

By application dated July 30, 2009, as supplemented on October 15, 2009, Croft Associates Limited requested approval of the Model No. 3979A as a Type B(U) transportation package. This request identifies additional information needed by the Nuclear Regulatory Commission staff in connection with its review of the application. The requested information is listed by chapter number and title in NUREG-1609, “Standard Review Plan for Transportation Packages for Radioactive Material," which was used by the staff in its review of the application. This request describes information needed by the staff for it to complete its review of the application and to determine whether the applicant has demonstrated compliance with regulatory requirements.

1.0 GENERAL INFORMATION

1.1 Drawings

1.1-1 Revise the drawings to clarify which division of Section VIII of the American Society of Mechanical Engineers (ASME) Code is specified on the licensing drawings.

There are multiple divisions of Section VIII of the ASME Code. A specific division should be identified on the drawings. Information provided on the drawings should be consistent with the code requirements called out in the remainder of the application.

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

1.1-2 Revise drawings OC-6042, IC-6045 and IC-6046 to correct the reference for the acceptance criteria for visual and dye penetrant testing of welds.

Section V of the ASME Code specifies the procedures, but not the acceptance criterion for non-destructive examination of welds. It should be noted that Section VIII, Division I, of the ASME Code does not contain acceptance criterion for visual examination.

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

1.1-3 Specify minimum and maximum diameters for the stainless steel shell on drawing 0C-6042. This request for additional information is in reference to note 3 on drawing 0C-6042.

Dimensional limits for the SafeKeg diameter should be stated on the licensing drawings.

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

1.1-4 Clarify if the American Iron and Steel Institute (AISI) Type 304 top and bottom square rims (Item #1 on the Bill of Materials, drawing 0C-6042) are safety related.

Items which are safety related should have an industry standard associated with their procurement. The AISI designation specifies the composition of the metal, but no minimum mechanical properties, or other requirements regarding the quality of the material.

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

1.1-5 Correct or justify the minimum annealing temperature of the containment vessel outer wall.

ASTM A511/A511M – 08, "Standard Specification for Seamless Stainless Steel Mechanical Tubing" states, "Unless otherwise specified, all austenitic tubes shall be furnished in the annealed condition. The anneal shall consist of heating the material to a minimum temperature of 1900°F [1040°C] and quenching…" The minimum annealing temperature of the containment vessel outer wall on drawing 0C-6042, note 2b is 1010°C.

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

1.1-6 Clarify the material of construction for the outer wall of the containment vessel.

Section 2.2.1.1 of the application states that the outer wall of the containment vessel can be made of 304L or 316L stainless steel. There is no mention of 316L stainless steel on the licensing drawings. Only packages fabricated in accordance with the license drawings, which will be referenced in the Certificate of Compliance, are authorized for transport.

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

1.1-7 Clarify the thickness of the "2 Stock" stainless steel used to construct the shell of the package on drawing 0C-6042.

Drawing 0C-6042 lists the thickness of the steel shell as "2 Stock." The staff is more familiar with the gauge terminology and presumes that that "2 Stock" is equivalent to 2 mm, or approximately 14 gauge steel, but requests clarification regarding this nomenclature.

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

1.1-8 Revise the application to specify the compound and manufacturer of the ethylene propylene seals. Alternatively, provide a list of quantifiable critical characteristics for the seal material, and an example of a seal material meeting these characteristics.

The ASTM standards listed by the application describing the seal material do not specify the material in sufficient detail; neither does a reference to the seals being made of ethylene propylene. The staff notes that the maximum use temperature is significantly different between Parker Compound E0740-75 and E0515-80, yet both are classified as "ethylene propylene" by Parker.

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

1.1-9 Remove the term "or equivalent" from Item #14, the keg closure nut, listed in the Bill of Materials on drawing 0C-6042.

The keg closure nuts are related to safety, and specific industrial codes should specify the characteristics of the nut material.

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

1.2 Contents

1.2-1 Revise the application to limit the chemical form for solid materials to ensure the material remains in solid form during normal conditions of transport (NCT) or hypothetical accident conditions (HAC).

The solid contents, as specified in Tables 1-3-1 through 1-3-3, include a variety of radionuclides with chemical form as element or compound. Staff notes that cesium is one of the radionuclides. If shipped as a pure metal, the temperature inside the package could cause the cesium to change state, from solid to liquid. A change of state of the package contents during transport could lead to an unanalyzed condition. The application must include limitations to ensure materials do not change state during transit, or include analysis of the materials as liquid, solid, and/or gas as appropriate.

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

1.2-2 Provide a description of the chemical form for the liquid matrix for contents described in Tables 1-3-4 and 1-3-5. Clarify the presence or absence of other hazardous materials in the contents.

For liquid contents, the current description prohibits hydrochloric acid, but does not describe the solutions which may be included in the contents.

This information is required to determine compliance with 10 CFR 71.31(a) and 71.33(b).

1.2-3 Revise the contents to include only liquids which have been analyzed and shown to not result in a maximum normal operating pressure greater than 700 kPa, and to not generate combustible gases in the package during a period of one year exceeding 5%, by volume, of the free gas volume in any confined region of the package.

The application does not provide an analysis for each of the liquid contents documenting that all possible combinations of radionuclide, solution, and container used to hold the solution result in a pressure less than 700 kPa, and a hydrogen concentration not exceeding 5% in the containment vessel. Factors to be considered should include radiation induced hydrolysis of water, degradation of the polymer (if the container is polymeric), and evaporation of the solution from decay heat over a one-year period. If a bounding analysis is provided, the bounding conditions must be clearly identified and should be included as limits for the package operations.

If the maximum normal operating pressure is shown to exceed 700 kPa, the package cannot receive unilateral approval, and could only be authorized as Type B(M).

This information is needed to determine compliance with 10 CFR 71.43(d).

1.2-4 Revise the application to demonstrate that the O-ring material and stainless steel containment vessel will not undergo a significant chemical, galvanic, or other reaction with liquid contents during transport.

The application does not contain sufficient information about the chemical form of the liquid contents to assess the potential for degradation of the containment vessel and O-ring. The application should include an analysis of all possible combinations of salts and radionuclides, at the maximum temperature observed during HAC.

The type of information that should be considered in the analysis includes: adequacy of the proposed O-ring material to contain aqueous nitrates; the potential for acidic fluorine solutions to degrade the stainless steel containment vessel near the O-ring.

This information is needed to determine compliance with 10 CFR 71.43(d).

1.2-5 Provide information regarding the potential for gas contents, as specified in Table 1-3-6, to be pressurized, and confirm that the pressure has been appropriately addressed in the NCT and HAC analyses.

The application does not specify the maximum amount of internal pressure, and the volume of the container holding gaseous contents. The application must describe the maximum pressure and demonstrate that breach of the container holding the gaseous contents will not result in a pressure that is higher than the maximum acceptable limits for the interior of the containment vessel under HAC.

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

2.0 STRUCTURAL

2-1 Specify the containers used to hold liquids in the containment vessel on the licensing drawings or in Chapter 2 of the application, and justify that these containers will not breach or degrade during NCT.

The applicant cannot take credit for containers that are not specified in the application. The containers must be specified or else they cannot be considered to hold liquid in the containment vessel under NCT, as stated in Section 2.2.2 of the application.

The response should take the combined action of radiation induced hydrolysis of water, and radiation and heat degradation of polymeric materials (if the containers are polymeric), as well as increased pressure within the container caused by the aforementioned processes over a one-year period into consideration.

The applicant is cautioned that most fluoropolymers are sensitive to radiation damage, and that the decay heat from radionuclides can significantly soften many polymers.

This information is needed to determine compliance with 10 CFR 71.43(d).

2-2 Revise the licensing drawings to categorize all welded joints that are in the package per the ASME code.

The categories established by the ASME code are for use in specifying special requirements regarding joint type and degree of examination for certain weld joints.

Categorize all welded joints that are in the package per the requirements of Section III, Division I, Subsection NB-3350 of the ASME Code, or Part UW-3 of Section VIII, Division I of the ASME Code, as applicable.

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

2-3 Revise the application to clarify the ASME Code of construction used to design, fabricate, and examine the package.

Section 2.1.4 of CTR 2008/10, Rev. 0, states, “All welds are qualified in accordance with ASME Section VIII and subjected to non destructive visual and liquid penetrant examination in accordance with ASME Section V.”

Section 4.1 of CTR 2008/10, Rev. 0, states, “The containment system is designed, fabricated, examined, tested, and inspected in accordance with ASME B&PV Code Section III, Subsection NB.”

Staff noted that the package is designed and fabricated per the requirements of Subsection NB of ASME Section III, as stated in Section 2.1.4 of CTR 2008/10, Rev. 0.

Based on the inconsistent application of code in the application, the staff was unable to make a safety determination.

Depending on the safety classification for Structures, Systems, and Components (SSCs) and the level of activity of the contents, the applicant should clearly identify the applicable codes for design, fabrication, and examination of each SSC within the assembly. The applicant may use guidelines provided in NUREG/CR-3854, “Fabrication Criteria for Shipping Containers” and NUREG/CR-6407, “Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety,” noting the guidance appropriate to a Category I package.

This information is required to assess compliance with 10 CFR 71.31.

2-4 Revise the application to clarify the maximum normal operating pressure for the package.

The application, in Section 2.2.3, states that the package pressure is < 7 bar (700 kPa) for shipment durations up to 1 year. Section 2.6.1.1 specifies that the upper pressure experienced by the containment vessel is 700 kPa gauge pressure. However, Section 3.3.2 states the maximum normal operating pressure in practice will be less than 200 kPa absolute. The table in Section 3.3.2 lists the normal conditions of transport operating condition as 800 kPa absolute. Packages with maximum normal operating pressure greater than 700 kPa may only be authorized as Type B(M) packages.

The application must provide an analysis to determine the maximum normal operating pressure for both solid and liquid contents. Only contents which can be shown to comply with all regulatory requirements will be authorized for transport. The analysis may be specific to the contents, or bounding. If a bounding analysis is provided, the bounding conditions must be clearly identified and should be included as limits for the package operation.

This information is required to determine compliance with 10 CFR 71.71 and 71.85.

2-5 Provide the evaluation for differential thermal expansion of dissimilar materials or correct the reference to where this information is located in the application.

Section 2.6.1.2 of CTR 2008/10, Rev. 0, states that, "The differential thermal expansion… described in the Vectra Report 925-3272/R1 (Section 1.12.2)."

The staff was not able to identify any discussion related to the effects of differential thermal expansion on dissimilar materials in Vectra Report 925-3272/R1.

This information is required to assess compliance with 10 CFR 71.71 and 73.

2-6 Revise the application to clarify the discrepancy between the puncture and penetration tests.

Section 2.7 of CTR 2008/10, Rev. 0, states, "The HAC tests were performed on the prototype keg after the NCT penetration and drop tests. The HAC tests were carried out sequentially in the order of **penetration** tests, drop tests, additional **penetration** test and thermal test. Therefore the keg was tested for the cumulative effects of both the NCT and HAC tests. The drop and **penetration** tests were carried out …."

Section 2.7.3 of CTR 2008/10, Rev. 0, correctly titles this test as **puncture**.

10 CFR 71.73(c)(3) (HAC) designates the **puncture** test. 10 CFR 71.71(c)(10) designates the **penetration** test.

This information is required to assess compliance with 10 CFR 71.71 and 71.73.

2-7 Provide all ABAQUS files used for the finite element analysis.

a) Provide all ABAQUS ".cae" files as they are required to review the finite element analysis.

b) Staff was unable to access several of the files in Request for Supplemental Information (RSI) response dated October 15, 2009 (ML0929604390):
LS_CV1_NCT1_c.odb
LS_CV1_NCT9_HAC_b.odb
LS_CV1_NCT9_HAC.odb
LS_CV1_NCT9_c.odb
LS_CV1_NCT8_a.odb

Ensure that all the files submitted in the applicant's response to the Request for Supplemental Information are readable, and resubmit all files for review.

This information is required to assess compliance with 10 CFR 71.71 and 71.73.

2-8 Provide an element mesh convergence study for the CV Flange/Cavity Wall (drawing 1C-6046, Issue A., Item #1) to demonstrate that use of four elements through the thickness of the shell provides adequate results.

Section 2.1 of Vectra report 925-3272/R1, Rev. 4, states, "First order brick elements were used throughout the model. In thin sections of the vessel, at least four elements through the thickness were used to capture the stress distribution."

It has been the experience of the staff that an insufficient number of elements through the thickness of a shell in a region of high moment gradient may not produce sufficiently accurate results. As an alternative to performing the convergence study on the actual cask model, the staff will accept a simple mesh convergence study of a cylindrical shell fixed at its base or attached to a thick circular plate subjected to internal pressure loading. The aspect ratio of the elements should not be any greater than that of the elements in current model CV Flange/Cavity Wall thickness.

This information is required to assess compliance with 10 CFR 71.71 and 71.73.

2-9 Provide the methodology for preloading the containment vessel closure screws and for applying these screws as a boundary condition in the finite element models.

Containment vessel closure screws (Item #4 of drawing IC-6044, Issue A) torque to a value of 10 Nm. Section 2.1 of Vectra report 925-3272/R1, Rev. 4, states, "A pre-load of 8.12 kN was applied to the bolts at the start of the analysis prior to any other loads being imposed. This corresponds to an applied torque of 10 Nm as specified on the drawing."

Staff requires the calculation/analysis of converting the torque value (10 Nm) to the preloading value (8.12 kN), and the methodology of applying the preload into the finite element analysis.

Furthermore, prying effects relative to the flexibility of the bolted joint components should be evaluated per NUREG/CR-6007, "Stress Analysis of Closure Bolts for Shipping Casks." This evaluation may impact the calculated bearing and containment vessel closure screw stress intensity levels.

This information is required to assess compliance with 10 CFR 71.71 and 71.73.

2-10 Justify the following applied conditions used in the finite element analysis.

a) Section 2.1 of Vectra report 925-3272/R1, Rev. 4, states, “Bounding values were used for the accelerations applied to the model for the impact cases. A value of 300 g was used for the HAC free drop cases from 9 m and a value of 180 g was used for the NCT free drop cases from 1.2 m.”

b) Section 2.1 of Vectra report 925-3272/R1, Rev. 4, states, “Sliding contact was defined between all the parts with a friction coefficient of 0.1.”

Justify the values used and reference the source of this information.

This information is required to assess compliance with 10 CFR 71.71 and 71.73.

2-11 Clarify the discrepancy of the lowest calculated design margin for the NCT drop.

Section 2.6.7 of CTR 2008/10, Rev. 0, states, “the lowest design margin calculated is 0.45 which is due ….”. Table 2-28 of CTR 2008/10, Rev. 0, illustrates the lowest minimum design margin as 0.25 in the C2-180 stress location. Clarify the location and the lowest minimum design margin and revise the appropriate section of the application.

This information is required to assess compliance with 10 CFR 71.31.

2-12 Justify the methodology for modeling all welds in the finite element analysis.

Examples include:

a) Items #1 and #2 in Detail A of drawing 1C-6046, issue A, illustrates a partial penetration weld joint between the CV Flange/Cavity Wall (Item #1) and the CV Outer Wall (Item #2) junction.

b) Items #2 and #4 in Detail B of drawing 1C-6046 issue A, illustrates a partial penetration weld joint between the CV Outer Wall (Item #2) and the CV Base (Item #4) junction.

c) Items #1 and #2 in Detail B of drawing 1C-6045, issue A, illustrates a partial penetration weld joint between the CV Lid Top (Item #1) and the CV Lid Shielding Casing (Item #2) junction.

However, staff noted that these joint configurations were modeled as full penetration welds in the finite element analysis modeling in Vectra report 925-3272/R1, Rev. 4.

This information is required to assess compliance with 10 CFR 71.71 and 71.73.

2-13 Revise the application to provide a confirmatory calculation for the package density to support the statement that the crush test is not required.

Section 2.7.2 of CTR 2008/10, Rev. 0, states, "The crush test is not required as the package has a density > 1000kg/m^3 based on the external dimensions." A calculation of the density should be included in the application to support this statement.

This information is required by the staff to assess compliance with10 CFR 71.73.

2-14 Revise the application to provide an evaluation of lead-slumping effects on the structural integrity of the containment inner and outer walls and the subsequent effect to the package's shielding capabilities.

Section 5.15 of CTR 2009/21, Issue A, does not discuss lead slumping that may have occurred during the HAC tests. It has been the experience of the staff, that deformation (slumping) may occur in lead components due to the malleable nature of the material and the high impact stresses that are generated during the HAC drop conditions.

This information is required to assess compliance with10 CFR 71.51, 71.64, and 71.73.

2-15 Revise the application to provide an evaluation to show the package meets the required accident conditions for air transport of plutonium or clarify that the package is not designed for transport of plutonium by air.

Table 1-4-7, CTR 2008/10, Rev. 0, and Table 9 of PCS 036, Issue A, state the package will be used for shipment of plutonium. Also, Section 1.1 of CTR 2008/10 Rev. 0, states that the modes of transportation include air. Therefore, the accident conditions for air transport of plutonium must be considered.

This information is required to assess compliance with 10 CFR 71.63 and 71.74.

2-16 Revise the application to justify the lack of the HAC immersion test or clarify how the HAC immersion test is enveloped by the NCT reduced external pressure test.

Section 2.7.6 of CTR 2008/10, Rev. 0, states, "Stresses in the containment vessel due to this pressure differential are enveloped by the…..reduced external pressure." However, Section 2.6.3 of CTR 2008/10, Rev. 0, states, an internal pressure of 775.5 kPa was applied to model which does not equate to an immersion (external) pressure. For the immersion test, a separate, undamaged specimen must be subjected to water pressure equivalent to immersion under a head of water of at least 15 m (50 ft). For test purposes, an external pressure of water of 150 kPa (21.7 lbf/in^2) gauge is considered to meet these conditions.

This information is required to assess compliance with 10 CFR 71.73.

2-17 Clarify the following inconsistency in the application.

Section 2.6.3 of CTR 2008/10, Rev. 0, states, “The calculated values….in Table 2-23. The design margins are all greater than 0…..”. However, minimum design margins were not tabulated in Table 2-23 of CTR 2008/10, Rev. 0.

This information is required to assess compliance with 10 CFR 71.31.

2-18 Revise the application to provide the methodology and examples for determining the separation of membrane and bending stresses of cross-sections at the selected stress evaluation locations, as shown in Figure 2-1 of CTR 2008/10, Rev. 0.

There is not sufficient information to confirm the stress-linearization applications throughout the cross-sections.

This information is required to assess compliance with 10 CFR 71.71 and 71.73.

2-19 Revise the application to provide a discussion and summary of all the boundary conditions used for the finite element analysis. Discuss the boundary conditions used for the finite element analysis.

Since a half-symmetry model was used from a vertical plane through the center of the vessel, justification is needed to determine that the applied restraints had insignificant affect on the overall behavior of the model, and that the rigid-body-motion was prevented under the NCT and HAC loading conditions.

This information is required to assess compliance with 10 CFR 71.71 and 71.73.

2-20 Correct the reported units of velocity.

In Table 8 of CTR 2009/21, Issue A, the unit for the velocity was tabulated as “m/s^2.”

This information is required to assess compliance with 10 CFR 71.35.

2-21 Revise the application to provide a description of the expected method for lifting and tie-down.

In Section 2.5, the application states that the package has no lifting or tie-down devices which are a structural part of the package. The application should include a general description of how the package will be lifted, and how the package will be tied-down during transport. The description should provide information regarding the package orientation. Analysis of the safety factors and failure mechanism is only required to be a part of the description if the lifting or tie-down is effected by a structural part of the package.

This information is required to assess compliance with 10 CFR 71.45.

3.0 THERMAL

3-1 Perform the required test and/or analysis associated with the air transport of plutonium which demonstrates the packages ability to withstand the effects of a hypothetical one hour fire, as opposed to the 30 minute fire which was evaluated in the application.

Content CT-7, Table 1-4-7, proposes to ship up to approximately 50,000 A_2 of plutonium, without demonstration of the package's performance in a HAC one hour fire.

This information is needed to determine compliance with 10 CFR 71.74(a)(5) and 71.64.

3-2 Clarify the cork material's response to the temperatures encountered under the NCT and HAC tests.

The summary of temperatures given in Tables 3-2 and 3-3 for NCT and HAC, respectively, lack the temperatures reached and temperature limit of the cork material. The cork is considered an essential component in the heat transfer characteristics of the package and its response to both the NCT and HAC tests is not fully described.

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

3-3 Correct the referenced location in the application of the O-ring specification drawings.

The drawings referenced in paragraph 7 on page 3-9, in Section 3.2.2, are the calculation model drawings. They contain no material property data. The reference should be for the license drawings, Section 1.3.3.

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

3-4 Revise the thermal analysis to describe the effect of changes in the dimensions of the air gaps within the package as a result of fabrication tolerances.

The air gaps modeled in the thermal finite element analysis are essential to the thermal performance of the package. Some of the air gaps presented in the licensing drawings have tolerances while others don't. Some of the tolerance limits would allow elimination of the air gaps altogether. Since the air gaps play a vital role in the heat transfer capabilities of the package, the thermal analysis should consider both the minimum and maximum gaps that are permitted by the license drawings.

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

3-5 Justify how the air gaps modeled in the thermal finite element analysis will be maintained in the package under NCT and HAC.

The air gaps modeled in the thermal finite element analysis are essential to the thermal performance of the package. It is unclear to the staff how the air gaps will be maintained under NCT and HAC if the containment vessel is simply placed inside the cork packing, and the cork material is simply placed into the keg. Furthermore, the staff believes that the dents created under HAC tests will cause some reduction to the air gap dimensions.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

3-6 Include material property data used for air in the finite element thermal analysis performed.

The air gaps modeled in the thermal finite element analysis are essential to the thermal performance of the package. The staff needs to verify that the correct material properties were utilized for the analysis.

This information is needed to determine compliance with 10 CFR 71.35(a).

3-7 Revise the thermal analysis to include liquid contents with greater than 5 W thermal output, or revise the package contents in Tables 1-4-4 and 1-4-5 to only include liquid contents with a heat output of 5 W thermal limit.

The tables for liquid contents should just list contents with a liquid physical form. Some of the contents listed such as Se-75, Tl-201, and Lu-177 have heat outputs greater than the 5 W thermal limit for liquid contents. If the physical form of these is not liquid, they should not be included in these tables.

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

3-8 Specify the amount of time the containment seal is above its continuous operation thermal limit during and after the HAC test.

The O-rings are rated to 149°C for continuous operation and to 205°C for a duration of 2 hours. The maximum temperature the O-ring experiences is 183°C according to the thermal analyses. However, the length of time during the HAC test that the O-ring is above the continuous operation thermal limit is not clearly stated in the application.

This information is needed to determine compliance with 10 CFR 71.73.

3-9 Revise the application to correct the statement that says shipper is required to limit the contents such that "Liquid contents must be such that H_2 concentration < 5% and pressure < 7 bar g for shipment up to 1 year."

An analysis must be performed to ensure that hydrogen or other gases resulting from thermal or radiation induced decomposition comprise less than 5% by volume of the total gas inventory within the confined volume. This is the applicant's responsibility and cannot be passed on to the shipper.

This information is needed to determine compliance with 10 CFR 71.43(d).

3-10 Revise the application to provide verification that 8 bar absolute design pressure is not exceeded under HAC.

For NCT no pressure increase due to the vapor pressure of the liquid contents is expected because the liquid contents are not permitted to boil. However, under HAC the containment vessel temperatures are high enough to permit liquid contents to boil. The boiling of the liquid contents will increase containment vessel pressure. This has not been analyzed in the application.

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

3-11 Justify why thermal stresses due to thermal expansion mismatch between the stainless steel and the lead were not evaluated for the containment vessel.

Section 3.4.4 of the application states that there can be no significant thermal stresses in the containment vessel because of the small temperature gradient across the thickest part of the containment vessel. However, other factors such as thermal expansion mismatch between materials can produce thermal stresses.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

3-12 Revise the application to clarify which finite element analysis model was used for the HAC analysis.

There are conflicting descriptions of the HAC test model described in Section 3.4.2 and that of Section 5 on page 12 of SERCO/TAS/5388/001, Issue 2, in Section 3.5.2.

This information is needed to determine compliance with 10 CFR 71.73.

3-13 Clarify that the physical form of radioactive material described in Table 1-3-6 is correct.

Table 1-3-6 on page 1-21 of the application is titled, "CT-6 – Gas in light tungsten insert (LS-3x73-Tu Design No 3983)." However, the physical form of the radioactive material is described as "liquid."

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

4.0 CONTAINMENT

4-1 Revise the application to clarify the specific figure of the containment boundary.

Figure 1-3 of CTR 2008/10, Rev. 0, illustrates the containment boundary going beneath the containment vessel lid and shielding.

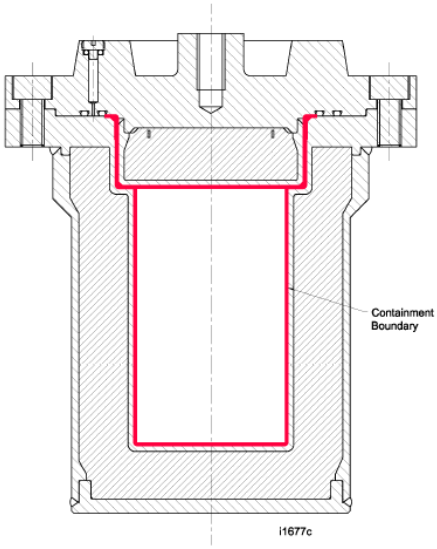

Figure 1-3 of CTR 2008/10, Rev. 0

Figure 4-1 of CTR 2008/10, Rev. 0, illustrates the containment boundary going between the containment vessel lid and the containment vessel lid shielding.

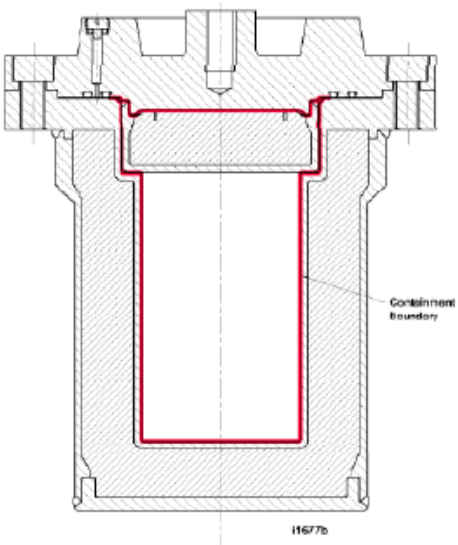

Figure 4-1 of CTR 2008/10, Rev. 0

This information is required to assess compliance with 10 CFR 71.51 and 71.64.

4-2 Revise the application to clarify the statement that no welds are used in the containment boundary.

Section 4.1 of CTR 2008/10, Rev. 0, states, “There are no welds, valves, or pressure relief devices present in the containment boundary and the package does not rely on any filter or mechanical cooling system to meet the containment requirements.”

Figure 1-3 of CTR 2008/10, Rev. 0, illustrates the containment boundary going beneath the containment vessel lid and shielding. Furthermore, Detail A of drawing 1C-6044, Issue A, illustrates a weld on the containment vessel lid, which is on the containment boundary.

This information is required to assess compliance with 10 CFR 71.51 and 71.64.

4-3 Provide the helium leak test reports for the NCT and HAC tests.

Section 4.2.5 of CTR 2009/21, Issue A, references CP 390, for the pre NCT/HAC helium leak test to the undamaged package. Section 5.16 of CTR 2009/21, Issue A, references TR 09/03/17 and TR 09/03/30. The staff requires the details of how the pre/post leak tests were performed to determine the containment boundary integrity.

This information is required by the staff to assess compliance with 10 CFR 71.51 and 71.64.

4-4 Evaluate the containment boundary for the special requirements for plutonium air shipments.

Table 9 of PCS 036, Issue A, states that there will be shipments of plutonium. Section 1.1 of CTR 2008/10 Rev. 0, states that the modes of transportation includes road, rail, sea, and air. Therefore, the accident conditions for air transport of plutonium must be considered. Furthermore, the containment boundary needs to be evaluated against the special requirements for plutonium air shipments.

This information is required by the staff to assess compliance with 10 CFR 71.64, 71.74, and 71.88.

4-5 Provide information to demonstrate that, for the liquid contents, any combustible gases generated in the package during a period of one year do not exceed 5%, by volume, of the free gas volume in any confined region of the package.

The application, in Section 2.2.3, identifies that the details of liquid contents are not known and therefore an analysis of gas generation is not possible. This is not an acceptable approach. Only contents which can be shown to comply with all regulatory requirements will be authorized for transport. Therefore, the liquid contents must be analyzed for gas generation before inclusion as an authorized content. The analysis may be specific to the contents, or bounding. If a bounding analysis is provided, the bounding conditions must be clearly identified and should be included as limits for the package operation.

This information is required to assess compliance with 10 CFR 71.43(d).

5.0 SHIELDING

5-1 Provide the method for determining the 1 meter dose rate in the application.

Page 5-4 indicates that due to package geometry, given a dose rate of less than 200 mrem/hr at the surface, the dose rate at 1 m will be about 5 mrem/hr, and may actually be much, much less than (as indicated by the use of '<<') 5 mrem/hr.

This information is necessary to determine compliance with 10 CFR 71.47.

5-2 Clarify the maximum dose rate location in the application.

Table 5-3 lists a summary of maximum dose rate locations for the reference source. It was determined that the point of highest dose is bottom of the package with the source modeled as a point in the middle of the bottom of the cavity. The dose rate in this summary table for the o-ring location is higher than the analyzed point. Explain the purpose of the o-ring calculation in more detail and provide a post-installation dose rate.

This information is necessary to determine compliance with 10 CFR 71.47.

5-3 Provide a more detailed explanation of tally assumptions, photon and neutron energy grouping, and name or describe the libraries used in the shielding evaluation.

Enclosure SERCO/TAS/003191/001 names the software suite used and the methodology. While the software used in the analysis is acceptable, no sample input was provided, nor were the nuclide and source libraries used in the Monte Carlo analysis listed.

This is necessary to determine compliance with 10 CFR 71.31.

5-5 Revise the application to describe how the shielding analysis is bounding for all liquid contents.

Activity limits are given in Tables 1-4-1 through 1-4-7 for a wide range of radionuclides. The shielding analysis was performed using one five liquid sources, Mo-99, Se-75, Ho-166, and Lu-177, and Tl-201, and gram limits were derived. However, there are no density or volume limits on the liquid contents. It is not explained what controls are in place to determine source material eligibility for use with this package.

This information is necessary to determine compliance with 10 CFR 71.47.

6.0 CRITICALITY

6-1 Clarify the maximum quantities of fissile material permitted in the container and composition limits, demonstrate how the package meets the special requirements for plutonium shipments and if necessary, include a criticality analysis.

Table 1-4-7 lists activity limits for the proposed package contents. The maximum mass of all plutonium isotopes except Pu-238 is listed as 800 g. The fissile exemption in 10 CFR 71.15(f) limits total plutonium mass to 1000 g, of which not more than 20 wt% may be Pu-239 or Pu-241. The nuclide limit for both or these nuclides is listed as 800 g in Table 1-4-7. This quantity is not exempt from consideration as fissile material, nor will it qualify to be shipped under a general license.

Table 1-3-7 references 10 CFR 71.15, 71.22 and 71.23; however, the applicability of these sections means the mass limits in Table 1-4-7 are irrelevant and potentially confusing. If the intent is to ship fissile material under a general license, the nuclide activity limit table should reflect the appropriate limits.

This information is necessary to determine compliance with10 CFR 71.33, 71.55, 71.63, 71.64, 71.73, and 71.74.

7.0 PACKAGE OPERATIONS

7-1 Correct the reference to survey requirements in Chapter 7.

The application currently contains references to 10 CFR Part 835. This is reference to the Department of Energy's requirements. The application should list the requirements of 10 CFR Parts 20 and 71.

This is necessary to determine compliance with 10 CFR 71.87.

7-2 Clarify that the visual examination of the package exterior in Section 7.1.1, “Preparation for Loading” and in Section 8.2.3.2, “Maintenance Program - Keg” will include inspection of accessible welds on the package.

Visual inspection of the accessible welds on the package should be done prior to shipping as part of the maintenance program, to ensure that no weld cracks developed during transportation.

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

7-3 Specify visual examination of the fasteners which are removed during loading and unloading of the package in Section 7.1.1.

Examination of the fasteners (bolts) should be conducted prior to shipping to ensure that no fatigue cracks have developed in the fasteners, and that the fasteners are in good condition.

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

7-4 Correct the typographical error in step 7.1.3(9).

The requirement for temperature survey should be to 49 CFR 173.442.

This is needed to determine compliance with 10 CFR 71.87.

7-5 Justify and/or revise the maximum permissible defect size on the surface of the keg.

Section 7.1.1(12) of the application permits dents up to 25 mm (1 in.) in depth on the surface of the exterior overpack, or “keg.” The staff is concerned that a 25 mm (1 in.) dent may be excessive and could jeopardize the integrity of the package under hypothetical accident conditions. Chapter 2 of the application should include a justification to support the maximum permissible defect size and Section 7.1.1(12) should reflect the maximum value as described in Chapter 2. [See also RAI 8-2.]

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

7-6 Revise Section 7.1 to include the regulatory requirements for radiation and contamination surveys.

Step 7.1.3(6) does not provide a reference to the regulatory requirements for radiation survey, nor is there a requirement for contamination survey to be performed following package loading.

This information is needed to determine compliance with 10 CFR 71.87.

8.0 ACCEPTANCE TESTS AND MAINTENANCE

8-1 Correct the reference to drawings in Section 8.1.1 of the application.

The drawings referenced in paragraph 1 of Section 8.1.1 on page 8-1, are the calculation model drawings. They do not contain fabrication data such as tolerances

and surface finishes for each of the packaging components. The correct reference should be to Section 1.3.3, “Licensing Drawings.”

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

8-2 Justify and/or revise the maximum permissible defect size of the surface of the keg.

Section 8.2.3.2 of the application permits dents up to 25 mm (1 in.) in depth on the surface of the exterior overpack, or “keg.” The staff is concerned that a 25 mm (1 in.) dent may be excessive and could jeopardize the integrity of the package under hypothetical accident conditions. Chapter 2 of the application should include a justification to support the maximum permissible defect size and Section 8.2.3.2 should reflect the maximum value as described in Chapter 2.

This information is needed to determine compliance with 10 CFR 71.71 and 71.73.

8-3 Specify the minimum regular replacement schedule of the containment seals in Section 8.2.3.3 of the application.

The maximum radiation dose for the elastomeric containment seals is 1.71×10^5 rads, assuming the package was loaded with Ir-192 for one year. In order to ensure containment with a margin of safety, these seals should be replaced on an annual basis followed by leak testing. Step 8.2.3.3 does not specify the periodicity for replacement of the O-ring seals.

This information is needed to determine compliance with 10 CFR 71.43(d).

8-4 Revise Section 8.2, “Maintenance Program,” to provide information regarding the test methods for the periodic and post maintenance leak tests.

Section 8.2.2 of CTR 2008/10, Rev. 0, discusses the periodic and post maintenance tests for the containment boundary. Indicate the intended test that will be performed for the periodic and post maintenance tests which are done in accordance with ANSI N14.5 “Radioactive Materials - Leakage Tests on Packages for Shipment.”

This information is required by the staff to assess compliance with 10 CFR 71.51 and 71.64.

8-5 Revise Section 8.1.2 to include a reference to provide the acceptance criteria for visual and dye penetrant testing of welds.

This section specifies that welds are examined according to drawings OC-6042, IC-6045 and IC-6046. However, Section V of the ASME Code specifies the procedures, but not the acceptance criterion for non-destructive examination of welds. It should be noted that Section VIII, Division I, of the ASME Code does not contain acceptance criterion for visual examination.

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