Response to the NRC Request for Additional Information Dated February 26, 2010

Docket No 71-9337 and TAC No L24361

Title	Response to the NRC Request for Additional Information Dated February 26, 2010 Docket No 71-9337 and TAC No L24361	Number	CTR 2010/05
		Issue	A
		File Reference	CTR2010-05-A-v5-Response to NRC RAI 2010-02-26
Compiler	S H Marshall	Checker	R A Vaughan
Approver	R A Vaughan	Date	31 March 2010

Croft Associates Ltd, F4 Culham Science Centre, Abingdon, Oxfordshire. OX14 3DB. Tel +44 (0)1865 407740

Number	NRC Comment	Response
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).	Drawings OC-6042, IC-6045 and IC-6046 have been edited to specify that the welds be qualified in accordance with ASME Code Section IX. Note: The drawings have been edited as specified in this response matrix and also to make minor corrections not relating to the RAI - all changes are detailed on the Modification Sheet M749 which is provided with this response matrix.
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.	Drawings OC-6042, IC-6045 and IC-6046 have been edited to specify the acceptance standards for dye penetrant testing of welds to be in accordance with ASME Code Section III sub-section NB-5350. The acceptance criteria for the visual examination of welds has been added to OC-6042, IC-6045 and IC-6046 as follows: “Welded joints shall have full fusion. The surface of the welds shall be sufficiently free from cracks, coarse ripples, grooves, overlaps and ridges or valleys, to permit proper interpretation of liquid penetrant examination.”
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).	The minimum and maximum diameters for the stainless steel shell on drawing 0C-6042 are specified by the general tolerance of ±5 unless stated (see drawing title block). A tolerance for overall diameter of Item 1 has been added (Ø424±10) instead of a reference dimension.
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).	Top and bottom rims are safety related. Drawing 0C-6042 has been edited to specify “Square tube 20x20x2mm ASTM A554 type MT304' as the material spec for these items.”

Number	NRC Comment	Response
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.	The drawings have been edited to specify the annealing temperature as 1040°C to 1121°C in note 2b on drawing 1C-6046 Issue B. Note 2b on 1C-6046 issue A regarding the heat treatment applies to item 1 only (CV flange/cavity wall). After review, Croft has decided that both the CV flange/cavity wall & the CV outer wall (item 2) shall be heat treated (ie after they have been welded together prior to final machining); note 2 on drawing 1C-6046 Issue B has been revised accordingly.
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.	MT304L to ASTM A511/A511M is the correct material for the outer wall. Section 2.2.1.1 has been edited to reflect this (removed 316L).
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.	"2 Stock" means 2mm thick sheet (approx 14 gauge). After review, Croft has decided to add tolerances to both the 2 Stock and 4 Stock dimensions on drawing 0C-6042 – these have been taken from the applicable standard.
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.	The compound (Parker Compound E0740-75) for the EPM seals has been added to drawing 1C-6044.

Number	NRC Comment	Response
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).	Drawing 0C-6042 has been edited to remove “or equivalent” from nut specification.
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).	The solid contents, as specified in Tables 1-3-1 through 1-3-3, have been restricted to "Compound only for Cs, Hg, I, Na and P." as these elements are solid at the maximum temperature in the package of nominally 116^{o}C and shipment in elemental form is not required.
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)	The liquid form has been restricted in Tables 1-3-4 and 1-3-5 to HCL and, HNO_3 of maximum concentration 0.1N. Under NCT, the contents are retained in the 304L/431 stainless steel or tungsten insert, sealed with an NBR O-ring. A literature search has shown that 304L/431 stainless steel, tungsten and NBR & EPM O-rings are resistant to chemical attack at the maximum NCT temperature in the package of nominally 116oC by the above acids. Under HAC, the contents are retained in the 304L stainless steel containment vessel, sealed with an EPM O-ring. A literature search has shown that 304L stainless steel and EPM O-rings are resistant to chemical attach at the maximum HAC temperature in the package of nominally 183^{o}C for a period of a few hours by the above acids. Para 2.2.2 has been edited to reference the acidic contents as limited to HCL and, HNO_3 of maximum

Number	NRC Comment	Response
		concentration 0.1N.
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)	Evidence to show that gas generation will not cause an MNOP greater than 700 kPa, and to not generate combustible gases in the package during a period of one year exceeding 5%, by volume, will be provided separately. This will be addressed in Section 3.3.2. The last para of section 2.2.3 [which relates to this issue] will be deleted - this is duplicated in Section 3.3.2 which is the most appropriate place for this item. The MNOP for the package is 7 bar (700 kPa). This has been clarified in section 3.1.4, Table 4-4 which has been revised to show gauge pressures.
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	This item is addressed under item 1.2-2.

Number	NRC Comment	Response
	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)	Table 1-3-6 has been edited as follows: A limit for the maximum amount of gas in the package at shipment has been added to the mass limit [in the 7th row of the table]. A physical form has been corrected to "Gas" [in the 11th row of the table]. The gaseous contents produce a maximum pressure less than the MNOP of 7 bar (700 kPa). The MNOP for the package is 7 bar (700 kPa) (see section 3.1.4, Table 4-4 which has been revised to show gauge pressures).
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).	Primary containers and product containers are the same thing – the SARP has been edited to refer to product containers for clarity. No reliance is placed on the product containers in meeting the requirements of the regulations and therefore the specification of these product containers is left open to be specified by the shipper. Confinement is provided by the inserts - this has been clarified in section 2 with maintenance instructions added in section 7.

Number	NRC Comment	Response
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.	The welds are specified in drawings OC-6042, IC-6045 and IC-6046 which have been edited to clarify that only the following parts of the specify ASME code are applicable. The welds are qualified in accordance with ASME Code Section IX, and the acceptance standards for dye penetrant testing of welds to be in accordance with ASME Code Section III sub-section NB-5350. See also response to RAI 1.1-1 & 1.1-2.
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.	Sections 2.1.4, 2.3.1 and 4.1 have been edited to clarify the codes used for fabrication and design.

Number	NRC Comment	Response
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.	The last para in Section 2.1.1 3980 Containment Vessel has been edited to: "The Design Pressure for the containment vessel is 10 bar (1,000kPa) which envelopes the MNOP of 7 bar (700 kPa) gauge." Section 3.1.4, Table 3-4 and section 3.3.2 have been revised to show that the MNOP is 7 bar (700 kPa) abs. The maximum pressures have been clarified in Section 2.7.4.1 which has been split into separate sections for solid and liquid contents. The only time dependant item is gas generation in liquids - this is being assessed for shipment durations up to 1 year generally although a period of less than 1 year may be proposed for certain nuclides. Data on maximum pressures for the specified liquid contents is to be provided separately. The SARP has been edited in the sections below to clarify that the Design Pressure, which is the bounding pressure for the CV, is 10 bar (1,000kPa). Section 3-4-3 Section 3-4-4 The maximum HAC pressure specified in Section 3.1.4, Table 3-4 is the Design Pressure for the CV – this is the bounding pressure for the contents. The Vectra Report 925-3274/R1 shows that the stresses in the CV due to the Design Pressure of 10 bar (1,000kPa) are acceptable, has been added to the SARP in the supporting documents listed in section 2.12.2. Note: The pressures specified in the Rev 0 SARP used different conventions – the pressures have been revised as bar (kPa) gauge wherever appropriate in the revised SARP.

Number	NRC Comment	Response
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	For the NCT cases 1, 3, 5, 7, 9 and 11, a uniform temperature of 110℃ was applied to the model. The differential thermal expansion was due to the different materials (lead and steel) and their different coefficients of thermal expansion, which are given in the Vectra report and incorporated into the model. Section 2.6.1.2 has been modified to include a discussion regarding thermal expansion.
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.	Section 2.7 2nd para has been revised to clarify the test carried out – where, in error, the test was referred to as “penetration” test, this has been corrected to “puncture” test.
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.	The ABAQUS files requested have been sent to the NRC.

Number	NRC Comment	Response
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.	This is addressed in a separate Vectra memo 925-3272/M2, 15/03/10.
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	Abaqus has a standard method for applying pre-loads to bolts. This is described in section 29.5 “Prescribed Assembly Loads” in the Abaqus Analysis User’s Manual. In this method, the bolts are broken at a section defined by the user. In the first step of the analysis, the bolt is shortened until the pre-load defined by the user is achieved. In subsequent steps, the length of the bolt is fixed so that the load in the bolt can vary. The torque value was converted to an axial load using the following calculation:

Number	NRC Comment	Response
	compliance with 10 CFR 71.71 and 71.73.	Bolt nominal diameter $D := 10 \cdot mm$ Thread pitch $P := 1.5 \cdot mm$ Friction Coefficient $\mu := 0.11$ Nut spot face diameter $S_d := 8 \cdot mm$ Applied torque $T := 10 \cdot N \cdot m$ Effective spot face radius $R_s := \frac{D + S_d}{4}$ Thread inclination $\theta := atan\left(\frac{P}{2 \cdot D}\right)$ $\theta = 4.289°$ Effective diameter $D_e := D - 0.65 \cdot P$ $K := \frac{P}{2 \cdot \pi} + \frac{\mu \cdot D_e}{2 \cdot \cos(\theta)} + \mu \cdot R_s$ Bolt tension $W := \frac{T}{K}$ $W = 8.120$ The friction coefficient is a typical value for un-lubricated steel-on-steel. The FEA of the containment vessel takes account of all the loads on the bolts including prying. Therefore, there is no need to perform the closed-form calculations as given in NUREG/CR-6007.
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 9m and a value of 180g was used for NCT free drop cases from 1.2m 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	The values of g's used were those taken from the initial tests of a prototype LS package. These tests occurred prior to those reported in the SARP. However the values bounded those taken during the drop test reported in the SARP and so were used in the calculations. The friction coefficient is a typical value for un-lubricated steel-on-steel.
2-11	Clarify the discrepancy of the lowest calculated design margin for 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	An incorrect value of 0.45 had been reported in the text in section 2.6.7 (14^{th} para starting "The primary membrane (Pm), primary". This section has been updated to report the correct value of 0.25 and the correct location.

Number	NRC Comment	Response
	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 the lowest minimum design margin adn 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.	There are no welds in the containment boundary. Stress calculations have only been determined on this boundary therefore detailing how they are modelled is not required.
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/m3 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.	A calculation has been included in section 2.7.2 to demonstrate the density of the package is > 1000 kg/m^3.
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	The test evidence in report CTR 2009/21 supports the conclusion that there was no lead slumping during the drop tests: Table 9, page 46, under the table section headed Containment Vessel (rows 12 - 15) reports the outside diameter of the CV body at lower and mid height of the body at reference and 90^o to reference – all are seen to be close to the nominal diameter of 118.5 mm and there are no significant changes following the drop test program. This demonstrates that there was no distortion of the CV shell due to lead slumping. Section 2.7.8 has

Number	NRC Comment	Response
	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.	been edited to report the above. Furthermore, the reason for choosing 4% antimonial lead for the shielding is that it is less susceptible to deformation. The properties of pure lead and 4% antimonial lead are given in the paper Zeitstanduntersuchungen an Blei und Bleilegierungen (Investigations on Long Term Behaviour of Lead and Lead-Alloys) K. Gerischer und C. -M. v. Meysenbug which is provided for your information together with a translation of the introduction and titles of tables. This report shows that 4% antimonial has superior properties to pure lead.
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.	The air transport limit for plutonium is A2 - this has been added to Tables 1-3-7 and 1-3-8 in the 6th row.
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/in2) gauge is considered to meet these conditions. This information is required to assess compliance with 10 CFR 71.73.	Section 2.7.6 has been rewritten - the last 2 paras have been replaced with a text par and Table 2-40. The stresses calculated for an external pressure of 140 kPa with an internal gauge pressure of -140 kPa are detailed in section 2.6.4 and Table 2-22. The design margin with this calculation is large, therefore instead of a new calculation, the stresses have been factored for an external pressure of 150 kPa: these are reported in Table 2-40.

Number	NRC Comment	Response
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.	The minimum design margins are given in the final column of Table 2-23.
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.	Abaqus has a tool for calculating the membrane and bending stresses. See section 49 "Calculating Linearized Stresses" of the Abaqus/CAE User's Manual. The user selects a section where the stress linearization is required, and selects which stress components are required. Abaqus then prints a report with the membrane, bending and peak stresses for each stress component and stress invariant. Vectra used the membrane and bending stresses for the Tresca stress invariant (which is equal to the stress intensity as required by NRC Regulatory Guide 7.6). The peak stress was taken by probing the model directly as it was found that the peak stress given by the stress linearization procedure was not always accurate. (This was discussed between Vectra and Abaqus technical support). These values were then put in a spreadsheet to determine the design margin. Only the smallest design margins were reported.
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.	The plane of symmetry was the plane Z=0. The boundary conditions on this plane were UZ=0 URX=0 URY=0 Where U is the displacement and UR is a rotation. This is standard FEA practice. As both the geometry and loading was symmetric about the plane Z=0, the use of a half-symmetry model has no effect on the results. Again, this is standard FEA practice. For the non-impact cases (NCT1-6), the flask was fixed at a single point at the centre of the bottom of the flask in the X-direction. The outer edge of the bottom of the flask was fixed in the Y-direction. These boundary conditions prevent any rigid body movement but do not affect the overall behaviour of

Number	NRC Comment	Response
		the model. No stress concentrations were observed at these locations. For impact cases NCT7, NCT8, HAC1 and HAC2 (drop on lid), the X and Y boundary conditions were maintained during the pre-loading steps. During the impact loading step, the Y boundary conditions were removed. Excessive movement in the Y direction and rotation about the Z axis was prevented by contact between the flask and the cork. Rigid body motion of the cork was prevented. For impact cases NCT9, NCT10, HAC3 and HAC4 (drop on side), the X and Y boundary conditions were maintained during the pre-loading steps. During the impact loading step, the X boundary condition was removed. The Y boundary condition was changed so that it just applied to the centre of the bottom of the flask. This prevented rigid body motion in the Y direction but about allowed rotation about the Z axis. Excessive movement in the X direction was prevented by contact between the flask and the cork. Rigid body motion of the cork was prevented. For impact cases NCT11, NCT12, HAC5 and HAC6 (drop on top corner), the X and Y boundary conditions were maintained during the pre-loading steps. During the impact loading step, the X and Y boundary conditions were removed. Excessive movement in the X and Y directions was prevented by contact between the flask and the cork. Rigid body motion of the cork was prevented.
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/s2.” This information is required to assess compliance with 10 CFR 71.35.	The units of velocity have been corrected in CTR 2009/21 issue A and also in table 2-27 of CTR 2008/10.

Number	NRC Comment	Response
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.	Section 2.5 has been updated to include a more detailed description of the methods that will be employed to lift and tie down the package. The lifting and tie-down methods would not affect the structural part of the package.
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 A2 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.	Not required, plutonium is limited to the quantity specified in 10 CFR 71.88. This limit has been clarified in section 1.
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).	Data for cork has been added to Table 3-2 and Table 3.3.
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.	The reference has been corrected in section 3.2.2 7^{th} para.

Number	NRC Comment	Response
	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).	A sensitivity analysis has been conducted to show the affect of air gaps on the thermal performance of the package. The results of this analysis are in the attached Serco letter dated the 31 March 2010 from Chris Fry to Croft Associates.
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.	A sensitivity analysis has been conducted to show the affect of air gaps on the thermal performance of the package. The results of this analysis are in the attached Serco letter dated the 31 March 2010 from Chris Fry to Croft Associates. This analysis details the effect no air gaps has on the package thermal performance.
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).	The properties of air have been added to table 3-5
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	Tables 1-4-4 and 1-4-5 in Section 1.2.2 and Tables 6 and 7 in PCS 036 have been revised to only include liquid contents with a heat output of 5 W thermal limit.

Number	NRC Comment	Response
	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℃ for continuous operation and to 205℃ for a duration of 2 hours. The maximum temperature the O-ring experiences is 183℃ 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.	The HAC temperature calculation shows that the containment seal in the CV is above the continuous operation temperature rating of 149℃ for 8 ¼ hours. This information has been added to the footnotes of table 3-3 and discussed in para 7 of section 3.2.2. EPM O-rings peak temperature is calculated to be 183℃: EPM is rated for short term service up to 204℃ in the Parker catalogue. However, as the O-rings will be procured under CGD under which the critical characteristic s will be verified, the following has been added to the licensing drawing 1C-6044. “The critical characteristic of ability to remain leaktight, after 24 hours in a test rig representing the CV at 200 degC, shall be established by a batch test on procurement.” This test is described in section 8 of the SARP.
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 H2 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).	The loading restrictions (last row) in Tables 1-3-4 and 1-3-5 have been removed. Evidence to show that gas generation will not cause an MNOP greater than 7 bar g, and to not generate combustible gases in the package during a period of one year exceeding 5%, by volume, will be provided separately. See RAI # 1.2-3
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	The maximum NCT pressure is the MNOP of 7 bar g. The maximum HAC pressure is the Design Pressure which has been added to the SARP and for which stresses are shown to be within allowable limits in the following sections:

Number	NRC Comment	Response
	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).	Section 2-7-4-3 Section 2-7-4-4 The details for liquid contents under NCT of pressurisation due to gas generation, and limited combustible gases in the package during a period of one year to not exceed 5%, by volume for 1 year [or the maximum shipping period] - will be provided later. For liquid contents under HAC, the pressure will increase from maximum NCT pressure of MNOP [=7 bar g] to 10 bar g due to the temperature increase of the CV following the HAC thermal test [the dominant effect is steam pressure where the maximum CV temp of 183^{o}C = 10 bar g].
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.	The thermal expansion stresses have been corrected throughout the report to clarify this information. Section 3.4.4 has been updated accordingly.
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.	Section 3.4.2 of CTR 2008/10 has been revised to clarify HAC test model description. This description now matches that of the thermal report.
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).	The physical form as specified in Table 1-3-6 has been corrected to "Gas".
4.0	Containment	

Number	NRC Comment	Response
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 4-1 of CTR 2008/10, Rev. 0, illustrates the containment boundary going between the containment vessel lid and the containment vessel lid shielding. This information is required to assess compliance with 10 CFR 71.51 and 71.64.	The figure 1-3 has been corrected to match that in figure 4-1.
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.	Figure 1-3 has been corrected and this shows that the containment boundary does not contain any welds.
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.	The helium leak test reports TR 09/03/17 and TR 09/03/30 have been provided.

Number	NRC Comment	Response
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.	Not required, plutonium is limited to the quantity specified in 10 CFR 71.88. This limit has been clarified in section 1 [Tables 1-3-7 and 1-3-8 in the 7th row].
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).	Evidence to show that gas generation will not cause an MNOP greater than 700 kPa, and to not generate combustible gases in the package during a period of one year exceeding 5%, by volume, will be provided separately. This will be addressed in Section 3.3.2. The last para in Section 2.2.3 has been deleted.
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.	The dose rate at 1m from the surface of the package is approximately determined by the r^2 rule: the package surface radius is 191 mm therefore the dose rate at 1 m from the surface is the surface dose rate x 0.026 (given by $[0.191/1.191]^2$). This has been added to section 5.2. In the 2nd sentence, 2nd para in section 5.2, the "<<" has been changed to "<" which correlates with "if the package surface dose rate is < 2 (200) mSv/h" at the beginning of the sentence.

Number	NRC Comment	Response
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.	The title of Table 5-3 has been edited to add "and maximum O-ring dose rate". The position of the maximum external dose rate is as specified: i.e. the bottom of the package. The dose rate evaluated for the O-ring is used in Section 2.2.3 in the 2nd para which has been edited to add clarification.
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.	All calculations were run using the standard MCBEND photon cross-section library (Gamma03b.dat), which is based on UKNDL (UK Nuclear Data Library) data in a continuous energy representation (GAMBLE format). Gamma fluxes were scored over the full energy range. Gamma dose-rate conversion factors based on recommendations of ICRP74, integrated over a 641 energy group scheme, were folded into the fluxes to give dose-rates in mSv/hour. A sample input deck for the LS Container with No tungsten insert with an Ir192 source is provided. A summary of the gamma sources used in the calculations are given in Table 2 of the report. The gamma sources were put in as single energy lines. No separate source libraries were used.
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.	The liquid contents are limited by the restrictions specified in Tables 1-3-4 and 1-3-5-with the activity limits specified in Tables 1-4-4 and 1-4-5. The shielding analysis covers all liquid radionuclides to be carried. The liquid was assumed to be aqueous, with the density of water. The shielding analysis performed was for worst case configuration of the liquid contents. For NCT [ref para 5.4.1.2], the liquid contents are modeled by a point source positioned at the centre of the bottom of the insert within the CV – as for solid contents. This configuration had been shown

Number	NRC Comment	Response
		to be worst case in the calculations reported in para 5.4.1.1. The title of para 5.4.1.2 has been edited to include liquids. There are no restrictions necessary for liquids under NCT regarding the density or volume, as the analyses assumed worst case (point source). For HAC [ref para 5.4.1.3], it has been assumed that the liquid contents have leaked from the insert (and that the insert is no longer present), the package is upside down on its lid, and the liquid has flowed into the gap between the CV Lid and CV Body. This appears to be a worst case set of assumptions in terms of determining dose rates at the package surface. The liquid was assumed to be aqueous, with the density of water. The only restrictions necessary for liquids in the package regarding the density or volume to ensure that the shipped liquids are enveloped by the conditions assumed for the HAC shielding analysis are the maximum specific activities which have been added to Tables 1-3-4 and 1-3-5. Any restrictions regarding gas generation will be provided separately.
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	Section 1.2.2.3 Contents Types has been edited as follows. The 2nd para has been edited to clarify that in Tables 1-3-1 to 1-3-8 specify the shipping limits for the package. The 3rd para has been edited to clarify that the limits in Tables 1-4-1 to 1-4-8 specify the limits based on heat output, mass limit, shielding limit and, for gas contents, the limit based on allowable leakage under NCT or HAC. The para has been added to enforce the criteria for the shipping limit - that is: "Note that the shipping limits must not exceed any of the limits in Tables 1-3-1 to 1-3-8." Table 1-2 has been edited to add CT-8. Table 1-3-7 has been restricted to Normal Form material.

Number	NRC Comment	Response
	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.	Table 1-3-8 has been added for Special Form material. Table 1-4-7 has been restricted to Normal Form material. Table 1-4-8 has been added for Special Form material. Reference to the general license limits has been added in the 7th and 8th rows in Tables 1-3-7 and 1-3-8, together with the air transport limit of A2 in the 7th row. The clarifications are intended to ensure that the shipper properly interprets the shipping limit for any contents with proving a large number of tables for different limits for different situations.
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.	This check was included to ensure the operators carrying out the pre loading checks were not exposed to radiation from any contents left within the containment vessel. It was not intended as a radiation check for transport as required by 10 CFR 71. Section 7.1.1 point 2 has been updated to clarify the purpose of this test and the reference has been removed.
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).	Point 12 in section 7.1.1 has been modified to include a check of the accessible welds.
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).	Points 8 and 13 in section 7.1.1 have been modified to include a check for fatigue cracks in the fasteners.

Number	NRC Comment	Response
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.	Error has been corrected.
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.	A review of the NCT testing indicated that the largest dent produced was 8.9 mm. Therefore it is conceivable that this is the largest dent expected during normal use. A keg with this size of dent then underwent HAC testing and was shown to maintain containment. Therefore an acceptable dent has been reduced to 8.9 mm as now noted in section 7.1.1 and a justification has been included in section 2.6.10.
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 perfomed following package loading. This information is needed to determine compliance with 10 CFR 71.87	An extra step [6)] has been added to section 7.1.3 to include the requirements of the contamination survey. The radiation survey step now references 10 CFR 71.47. Section 7 has been edited to show both 10 CFR and 49 CFR applicable paras for radiation and contamination checks.
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).	Section 8.1.1 has been corrected to reference the correct section for the drawings.

Number	NRC Comment	Response
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.	A review of the NCT testing indicated that the largest dent produced was 8.9 mm. Therefore it is conceivable that this is the largest dent expected during normal use. A keg with this size of dent then underwent HAC testing and was shown to maintain containment. Therefore an acceptable dent has been reduced to 8.9 mm as now noted in section 7.1.1 and a justification has been included in section 2.6.10.
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 x 105 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).	The preamble in section 8.2 has been clarified to specify that the periodic maintenance has to be carried out annually. Under step 6 of section 8.2.3.3 the user is given the instruction to change all the o-rings thus ensuring they will be changed annually. A note has been added to step 6 of section 8.2.3.3 to clarify that they must be changed annually. The word "annually" has also been inserted into table 8-1 to clearly demonstrate the O-rings will be changed annually. The requirement that "The periodic maintenance activities, as specified in Section 8.2, shall have been performed not more than 1 year prior to shipment." has also been added tp section 7.1.
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.	The helium leak test that will be carried out during periodic and post maintenance has been clarified in section 8.2.2.

Number	NRC Comment	Response
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.	Drawings 0C-6042, 1C-6045 and 1C-6046 have been updated and now contain acceptance criteria. See RAI response 1.1-2.