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Technical Review Report for the Justification for ^{233}U Content Envelope Safety Analysis Report for Packaging Model 9975-85, Addendum 2

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Technical Review Report
for the
Justification for ^{233}U Content Envelope
Safety Analysis Report for Packaging
Model 9975-85, Addendum 2

S-SARA-G-00002, Revision 1
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Packaging and Transportation Safety Group
Global Security Principal Directorate
Lawrence Livermore National Laboratory

OVERVIEW

This report documents the review of *Addendum 2*, *Justification for ^{233}U Content Envelope*, *Safety Analysis Report for Packaging*, prepared by Savannah River Packaging Technology (SRPT) of Savannah River National Laboratory (SRNL),[1] — the Submittal — at the request of the Department of Energy's (DOE) National Nuclear Security Agency's (NNSA) Albuquerque Operations Office, for the shipment of ^{233}U-bearing material from Los Alamos National Laboratory (LANL), in support of the Technical Area 18 (TA-18) Materials Relocation Program. This Addendum supplements the Safety Analysis Report for Packaging (SARP), Revision 0,[2] and Addendum 1 to Revision 0 of the 9975 SARP[3] (called Revision 0 of the 9975 SARP in this Addendum). The ^{233}U-bearing items are currently stored at TA-18, awaiting shipment in the Model 9975-85 Package as a new Content Envelope, C.9.

Following acceptance of this Addendum by the DOE-Headquarters Certifying Official (EM-60), and subsequent revision to the current Certificate of Compliance (CoC),[4] the new contents will be authorized for shipment in the Model 9975-85 Package. The new Content Configuration, C.9, along with the optional Shielded-Pig Convenience Container Configuration, will be incorporated into the next revision of the Model 9975-85 Package SARP. In addition to the ^{233}U-bearing items stored at TA-18, kilogram quantities of ^{233}U-bearing materials are stored at Oak Ridge National Laboratory (ORNL). About one quarter of the items is Highly Enriched Uranium (HEU) as U_3O_8 with ^{233}U and ^{232}U. Highly Enriched Uranium implies a ^{235}U enrichment of >93%. The remaining material located at ORNL is pure ^{233}U (>90%) with varying amounts of ^{232}U. The form of the material is U_3O_8, UO_3, UO_2, and U metal. Additional DOE Sites may also have ^{233}U-bearing materials for shipment.

Technical Review Report for the Justification for ^{233}U Content Envelope Safety Analysis Report for Packaging Model 9975-85, Addendum 2

Submitted by the
Packaging and Transportation Safety Group
Global Security Principal Directorate
Lawrence Livermore National Laboratory

July 24, 2008

Chapter 1: General Information

This Technical Review Report (TRR) covers the staff's findings regarding the review of the Submittal, *Safety Analysis for Packaging, Model 9975, Addendum 2, Justification for233U Content Envelope.*[1] This section of the TRR covers the review of the General Information provided in Chapter 1 of the Submittal. Specifically, the review examined a new Content Envelope, C.9, ^{233}U-bearing oxide and metal also containing small quantities of the isotope ^{232}U, and traces of plutonium, to be shipped in the Model 9975-85 Package. In some cases, for added shielding, a Shielded-Pig Convenience Container configuration, with a machined lead pig and an engineered, aluminum convenience can, is placed inside the Primary Containment Vessel (PCV) of the Model 9975-85 Package, using top and bottom, aluminum honeycomb spacers. The PCV is accommodated inside the Secondary Containment Vessel (SCV), using top and bottom aluminum honeycomb impact absorbers, as is standard for the Model 9975-85 Package.

Nominally, the lead-pig itself is a right-circular cylinder, 3.825 inches in diameter by 7.955 inches in length, with a content cavity of 1.625 inches in diameter and 5.955 inches in depth. The Lead-Pig Assembly provides a lead-shielding thickness 1.1 inches radially, 1.25 inches on top, and 0.75 inches on the bottom. The Lead-Pig Assembly weighs 32.92 pounds.

The Shielded-Pig Convenience Container aluminum convenience can (i.e., the aluminum lid and body) provides a 0.125-inch skin, holding the Lead-Pig Top and Lead-Pig Bottom together and weighs 2.45 pounds. The Top and Bottom Honeycomb Spacers (aluminum) weigh 0.40 pounds. The Shielded-Pig Convenience Container, including the Top and Bottom Honeycomb Spacers, and the lead pig, weighs 35.77 pounds. With contents, the total payload is 36.09 pounds, well under the maximum content weight of 44.4 pounds for the Model 9975-85 Package.

Food-pack cans may be used in lieu of the Shielded-Pig Convenience Container when the quantity of ^{232}U is less than 0.00184 grams. For greater than this quantity of ^{232}U, but less than 0.0101 grams, the Shielded-Pig Convenience Container is employed inside the PCV. Dose-rate measurements on the actual items to be shipped may also dictate its use. Content Envelope C.9 limits the quantity of ^{233}U to 500 grams. The isotopes ^{235}U (700-gram limit) and ^{239}Pu (415-gram limit) may also be present, as long as their sum, converted to ^{233}U

gram equivalents, added to the quantity of ^{233}U does not exceed 500 grams. The total allowed mass of all radioactive materials is 4.4 kg (the total mass of all contents is 4.4 kg).

- "Equivalent ^{233}U mass" = ^{233}U grams + ^{235}U grams/1.4 + ^{239}Pu grams/0.83

The results of the General Information review for the proposed new contents are discussed below.

Content Envelope, C.9, Items from Los Alamos National Laboratory (LANL), Technical Area 18 (TA-18)

The Submittal provided justification for amending the current Certificate of Compliance[4] for the Model 9975-85 SARP, to include a new Content Envelope, C.9, ^{233}U metal/oxide, and a new content configuration, using an optional Shielded-Pig Convenience Container. As was noted above, this Addendum supplements both, Revision 0 of the Model 9975-85 Safety Analysis Report for Packaging, and Addendum 1 to Revision 0 of the Model 9975-85 Safety Analysis Report for Packaging.[2,3]

The 25 items of Content Envelope, C.9, stored at LANL's TA-18 are enumerated in Appendix 1, *^{233}U Source Description*, including Addendum Table A.1-1, *TA-18 ^{233}U Content Geometry and Dose Rate Data*. These items will be shipped one-way to the Device Assembly Facility (DAF), where they will be stored until that facility has undergone its Operational Readiness Review. Some of the features of the stored items are:

- The items are either metallic half cylinders, cylinders, disks, or foils;
- With the exception of the metal foils, they are plated with nickel;
- In some cases, gamma ray dose rates at the item surface or at 30 cm from the item surface are reported in Addendum Table A.1-1, and, in general, where no dose rate is reported, the item is stored in a lead pig;
- The items range in mass from 1 to 118 grams.

Content Envelope, C.9, Items from Oak Ridge National Laboratory and other DOE Facilities

Kilogram quantities of ^{233}U-bearing materials are stored at ORNL. About one quarter of the items is HEU as U_3O_8 with ^{233}U and ^{232}U. Highly Enriched Uranium implies a ^{235}U enrichment of >93%. The remaining material located at ORNL is pure ^{233}U (>90%) with varying amounts of ^{232}U. The form of the material is U_3O_8, UO_3, UO_2, and U metal. Some of the items have such a large photon dose rate that they cannot be shipped in the Model 9975-85 Package. The oxide materials were calcined between 600°C and 800°C prior to encapsulation in stainless steel sleeves and welded shut. The stainless steel surface was decontaminated or nickel plated such that the contamination is fixed in place.

Other DOE facilities, such as Lawrence Livermore National Laboratory (LLNL) and Sandia National Laboratories (SNL), may also have inventories of ^{233}U-bearing materials that will require shipments from their sites.

Findings
Based on the review of the statements and representations in the Submittal, the staff has concluded that the packaging design has been adequately described to meet the requirements of 10 CFR 71.[5]

Conditions of Approval
The staff has concluded that the following conditions of approval need to be added to the existing CoC[4] for the approval of this request:

- *Addendum Table 1-SARP Addendum Content Envelope C.9 and Addendum Table 1 Notes*, and
- *Addendum Table 2-Summary of Requirements by Content Envelope and Packaging Configuration*, and
- Drawings for the Shielded-Pig Convenience Container Configuration:
  R-R4-G-00047, Revision 1, *U-233 Lead Pig Details and Subassembly*
  R-R4-G-00048, Revision 1, *U-233 Container Details and Subassembly*
  R-R4-G-00051, Revision 1, U-233 Honeycomb Parts

Chapter 2: Structural Evaluation

This TRR covers the staff's findings regarding the review of the Submittal. This section covers the assessment of the Structural Evaluation information provided in Chapter 2 of the Submittal.

Details of the items reviewed are noted above in the introduction to Chapter 1. The results of the structural review are discussed below.

^{233}U Metal/Oxide Containing Small Quantities of the Isotope ^{232}U
In agreement with Addendum 2, Revision 1, the staff has determined that the new Content Envelope, C.9, i.e., ^{233}U Metal/Oxide, containing small quantities of the isotope ^{232}U, will not significantly change the structural performance of the Package and its compliance with the requirements of 10 CFR 71. This determination is based on the following considerations:

- The new Content Envelope, C.9, will be shipped either in food-pack cans or Shielded-Pig Convenience Container based on the threshold quantity of ^{232}U, 0.00184 grams.
- In the case of Content Envelope, C.9, shipping within the Shielded-Pig Convenience Container, the applicant has conducted structural evaluations documented in M-CLC-A-00316.[6] Additionally, the applicant has provided further supporting calculations [7] evaluating the structural integrity of the Shielded-Pig Convenience Container.
- The Staff has performed confirmatory calculations [8] further demonstrating the structural integrity of the Shielded-Pig Convenience Container.

Consequently, no degradation in the structural performance of the Package is expected due to Content Envelope C.9.

Findings
The original structural calculations on the Shielded-Pig Convenience Container in the Submittal (M-CLC-A-00316) were not adequate to demonstrate the structural integrity under Normal Conditions of Transport (NCT). However, the subsequent supporting calculations from the applicant, combined with the confirmatory calculations of the Staff, leads the staff to conclude that the structural design of the modified content configurations has been adequately described and evaluated.

Conditions of Approval
The staff has concluded that no additional conditions of approval need to be added to the existing CoC for the approval of this request.

Chapter 3: Thermal Evaluation

This TRR covers the staff's findings regarding the review of the Submittal. This section covers the review of the Thermal Evaluation information provided in Chapter 3 of the Submittal and Appendices of the Submittal.

Details of the items reviewed are noted above in the introduction to Chapter 1. The results of the thermal review are discussed below.

^{233}U Metal/Oxide Containing Small Quantities of the Isotope ^{232}U
In agreement with Addendum 2, Revision 1, the staff has determined that the new Content Envelope, C.9, i.e., ^{233}U Metal/Oxide, containing small quantities of the isotope ^{232}U, will not significantly change the thermal performance of the Package and its compliance with the requirements of 10 CFR 71. This determination is based on the following considerations:

- The new Content Envelope, C.9, will be shipped either in food-pack cans or a Shielded-Pig Convenience Container based on the threshold quantity of ^{232}U, 0.00184 grams. The maximum decay heat generated in Content Envelope, C.9, is very low, less than 1 watt, and is calculated in the document G-CLC-A-00166, Revision 0.[9] The thermal performance is bounded by the current 19-watt limit for the Model 9975-85 Package.
- In the case of Content Envelope, C.9, shipping within the Shielded-Pig Convenience Container, the applicant has conducted additional calculations documented in M-CLC-A-00333, Revision 0.[10] The maximum temperature of the Shielded-Pig Convenience Container in NCT with insolation is much below the materials' functional thermal limit. The thermal performance of the other components of the package in NCT and Hypothetical Accident Conditions (HAC) should be equivalent to that in the Model 9975-85 Package with 19-watt contents.

Consequently, no degradation in the thermal performance of the Package is expected due to Content Envelope C.9.

Findings
Based on the review of the statements and representations in the Submittal, the staff has concluded that the packaging design has been adequately described to meet the requirements of 10 CFR 71.

Conditions of Approval
The staff has concluded that no additional conditions of approval need to be added to the existing CoC for the approval of this request.

Chapter 4: Containment

This TRR covers the staff's findings regarding the review of the Submittal. This section covers the review of the containment information provided in Chapter 4 of the Submittal.

Details of the items reviewed are noted above in the introduction to Chapter 1. The results of the containment review are discussed below.

^{233}U Metal/Oxide (Content Envelope C.9) Contents
The containment boundaries of the Model 9975-85 Package were not changed to accommodate the proposed contents. Content Envelope C.9 does not increase the impact loading on the containment vessels, does not increase the temperatures that must be sustained, nor does it increase the pressure to be contained.

Findings
Based on the review of the statements and representations in the Submittal, the staff has concluded that the packaging design has been adequately described to meet the requirements of 10 CFR 71.

Conditions of Approval
The staff has concluded that no additional conditions of approval need to be added to the existing CoC for the approval of this request.

Chapter 5: Shielding Evaluation

This TRR covers the staff's findings regarding the review of the Submittal. This section covers the review of the Shielding Evaluation information provided in Chapter 5 of the Submittal.

Details of the items reviewed are noted above in the introduction to Chapter 1. The results of the shielding review are discussed below.

^{233}U Metal/Oxide (Content Envelope C.9) Contents
The SARP Addendum provides details of the external dose rates as a result of including Content Envelope C.9 in the Model 9975-85 Package. Since the production of ^{233}U creates ^{232}U impurities, shielding is a serious concern due to the production of ^{208}Tl, a daughter product in the ^{232}U decay chain that produces a 2.6 MeV gamma ray. The SARP shielding analyses were performed to demonstrate compliance with regulatory limits for both a specific set of shipments from LANL of 25 metallic ^{233}U components as well as a generic limit for ^{233}U metal/oxide with ^{232}U impurities.

The limiting component from the LANL shipments consisted of 118 g of metallic ^{233}U with 0.0101 g of ^{232}U. The Model 9975-85 Package has a lead shield of 0.47" nominal thickness to attenuate the gamma dose rate. However, for this combination, additional lead shielding was

required. This is provided by the inclusion of a Shielded-Pig Convenience Container of thickness 1.1" on the side, 0.75" at the bottom and 1.25" at the top. A lead pig is inserted into the PCV after the contents are placed in the pig and the pig has been placed in its aluminum convenience can. The SARP analyses demonstrate that this arrangement provides sufficient margin to the regulatory limits for a non-exclusive use shipment.

In addition to the specific set of shipments from LANL, the Addendum also addresses the issue of generic limits of both oxide and metallic ^{233}U shipments. The approach taken here uses earlier calculations that had 4.4 kg of uranium oxide coupled with up to 1 g of beryllium producing a limiting dose rate of 10.85 mrem/hr at the package surface. Using this as the limiting dose rate from uranium oxide, the Addendum back calculates the maximum allowable amount of ^{232}U impurity to be set at 0.001843 g. This value is rounded down to 0.0018 g for conservatism. Additionally, it is noted that the fissile contents are limited to 500 g (see Chapter 6 of the Addendum). Thus the use of 4.4 kg of uranium in these analyses adds a further measure of conservatism. The Addendum also provides results from analyses to evaluate the effects of self-shielding by the contents and the effect of lead-shield thinning. These analyses demonstrate that the combined effect of these two opposing shielding features leads to a smaller dose rate when compared with the point source model with the nominal lead thickness.

The limiting dose rate at 1 m from the external surface of the package was demonstrated to be below 10 mrem/hr under NCT and well below 1 rem/hr under HAC.

The staff performed independent calculations to confirm that the analyses, presented in the Addendum, adequately demonstrate compliance with 10 CFR Part 71 limits on external radiation limits for non-exclusive use shipments.

Findings

Based on the review of the statements and representations in the Submittal, the staff has concluded that the shielding design has been adequately described and evaluated for the content limits described in Addendum Table 1 as well as the 25 components identified for shipment from LANL and that the Package meets the external radiation requirements of 10 CFR 71.

The staff recommends revising the statement in Reference 5.1[11] of the Addendum that the dose rates from uranium oxide contents are lower than that from uranium metal. The cited reference for this statement[12] correctly indicates that the opposite is true. The staff also recommends adding a footnote to Addendum Table 4 stating that the dose rates presented for the case with the lead pig are based on the nominal dimensions of the lead pig and not on the minimum dimensions required to meet the shipping requirements as stated in the text of Chapter 5. These changes can be incorporated into the next revision of the SARP.

Conditions of Approval

The staff has concluded that no additional conditions of approval need to be added to the existing CoC for the approval of this request.

Chapter 6: Criticality Evaluation

This TRR covers the staff's findings regarding the review of the Submittal. This section covers the review of the Criticality Evaluation information provided in Chapter 6 of the Submittal.

Details of the items reviewed are listed above in the introduction to Chapter 1. The results of the criticality review are discussed below.

^{233}U Content Envelope

The new Content Envelope, C.9, is comprised of ^{233}U metal/oxide, and the new Content Configuration consists of a new Shielded-Pig Convenience Container.

The 25 items of Content Envelope, C.9, stored at LANL's TA-18 are described in Table 1 and Table 8 of the Model 9975-85 Package SARP, Addendum 2. These items will be shipped one-way to the Nevada test Site (NTS) Device Assembly Facility (DAF). The items range in mass from 1 to 118 grams. The isotopic composition of each item is primarily ^{233}U. The twenty five items range in shapes from thin foils to a cylinder. The total mass of all 25 items is 388 grams.

Kilogram quantities of ^{233}U material are also located at ORNL. About one quarter of the items is HEU as U_3O_8 with ^{233}U and ^{232}U. Highly Enriched Uranium implies a ^{235}U enrichment of >93%. The remaining material located at ORNL is pure ^{233}U (>90%) with varying amounts of ^{232}U. The form of the material is U_3O_8, UO_3, UO_2, and U metal. Small plutonium contamination is present.

The criticality evaluation examines the TA-18 ^{233}U items for shipment and also determines the amount of HEU items with ^{233}U that could be safety shipped in a Model 9975-85 Shipping Package.

Criticality Evaluation

The criticality evaluation was preformed using the subcritical limits from ANSI/ANS-8.1-1998[13] for single package (to conform 10 CFR 71.55) and the ANSI/ANS-8.7-1998[14] for NCT and HAC array (to conform 10 CFR 71.59). A conservative estimate of ^{233}U mass limit was proposed. Equivalency factors for ^{233}U were calculated for items with significant quantities of ^{235}U and/or ^{239}Pu mixed with ^{233}U. No detailed criticality calculations were performed.

Single-Package Evaluation

The subcritical mass limit for non-uniform aqueous solution of ^{233}U is 500 grams. This will conservatively bound the subcritical mass limit for ^{233}U metal and ^{233}U oxide. The ^{233}U mass limit applies to mixtures of this isotope with ^{234}U, ^{236}U, or ^{238}U, provided that ^{234}U is considered to be ^{233}U in computing the mass. It is noted that no solution items are being shipped, and all items are solid metal or oxide which have significantly higher mass limits. Therefore, in any moderation or reflection scenarios with the Model 9975-85 Package, a TA-18 ^{233}U item or a combination of several TA-18 items will remain subcritical as long as the total mass of ^{233}U in a single package is less than or equal to 500 grams.

For ORNL items or other potential items that have significant amounts of ^{235}U or ^{239}Pu, a ^{233}U equivalency factor was derived. A conservative equivalency factor of 1.4 was applied to ^{235}U

and that of 0.83 was applied to ^{239}Pu. Therefore, a ^{233}U-bearing item or items will remain subcritical, where the total ^{233}U equivalent mass is less than or equal to 500 grams.

Evaluation of Model 9975 Package Array with ^{233}U content under NCT and HAC Scenarios

The NCT and HAC array evaluations were performed by using the ANSI/ANS-8.7-1998 standard. Per the ANSI/ANS standard, up to a mass of 3.7 kg of ^{233}U is subcritical, when the center to center distance of the fissile mass is less than 38.1 cm for a 1000-unit array. The minimum drum diameter is 46.2 cm (see SARP, Table 6.6[2]) and the drum height is 90.17 cm (see SARP, Table 1.1[2]). The HAC model drum diameter is 38.47 cm (see SARP, Table 6.6). The Model 9975 Package SARP criticality analyses show that Celotex™ and /or water within or between the drums decreases reactivity. Optimum interspersed moderation is essentially no moderation for the array, as was also noted in the SARP analysis.

There is a substantial safety margin between the fissile mass of 3.7 kg of ^{233}U and the 500 grams to be used for Content Envelope C.9. Therefore, a 1000-unit drum array of Model 9975-85 Packages is subcritical under the NCT and HAC scenarios.

Findings

No detailed calculations with a computer code were performed. Comparison with ANSI/ANS-8.7-1998 standard shows that considerable safety margin exists for the NCT and HAC scenarios using 1000-unit array (*e.g.*, a 10x10x10 array), if the fissile mass limit does not exceed 500 grams of ^{233}U. No proper justifications were given for extending the array size to infinity, and thereby reducing the Criticality Safety Index (CSI) to zero, although detailed calculations might demonstrate such a possibility. It is not evident to the staff that the applicant wants to use different CSI values for different Content Envelopes. It is preferable to use the same CSI value of 2.0 for Content Envelope C.9 as is used with other approved contents for the Model 9975 Package.

Based on a review of the statements and representations in the Submittal, the staff has concluded that the nuclear criticality safety design has been adequately described and evaluated, and that the package meets the nuclear criticality safety requirements of 10 CFR 71. The staff has also noted the analyses demonstrate that there is a considerable margin of safety for this package.

Conditions of Approval

The Model 9975 Package with the Content Envelope C.9 must be shipped with a CSI of 2.0 like all previously approved contents as stipulated in the existing CoC. The staff has concluded that no additional conditions of approval need to be added to the existing CoC for the approval of this application.

Chapter 7: Operating Procedures

This TRR covers the staff's findings regarding the review of the Submittal. This section covers the review of the Operating Procedures information provided in Chapter 7 of the Submittal.

Details of the items reviewed are noted above in the introduction to Chapter 1. The results of the operating procedures review are discussed below.

^{233}U Metal/Oxide (Content Envelope C.9) Contents
The Submittal provides for changes to the Operating Procedures, where Content Envelope C.9 would lead to the use of the Shielded-Pig Convenience Container for radiation levels exceeding the levels specified in 10 CFR 71.47, and/or for purposes of ALARA (As Low As Reasonably Achievable).[15] The changes pertain to Section 7.2.1.1, *Shielded-Pig Packaging Inspection*, Section 7.2.1.2, *Shielded-Pig Loading*, and Section 7.2.2, *Loading Contents into the PCV*, in the SARP. Warnings are provided in the text with respect to the potential for high dose rates for this Content Envelope.

Findings
Based on the review of the statements and representations in the Submittal, the staff has concluded that the packaging design has been adequately described to meet the requirements of 10 CFR 71.

Conditions of Approval
Because the requirements specified in the Operating Procedures Chapter of the SARP are normally incorporated, in their entirety, as Conditions of Approval in the CoC, the staff has concluded that the new requirements specified in Chapter 7 of the Submittal must be included as new Conditions of Approval in the CoC for the approval of this request.

The contents shall be placed in the Shielded-Pig Convenience Container in either solid metal, sintered oxide, or confined in a metal shell. Powdered materials shall not be placed directly into the Shielded-Pig Convenience Container. The staff has concluded that no additional conditions of approval need to be added to the existing CoC for the approval of this request.

Chapter 8: Acceptance Tests and Maintenance Program

This TRR covers the staff's findings regarding the review of the Submittal. This section covers the review of the Acceptance Tests and Maintenance Program information provided in Chapter 8 of the Submittal.

Details of the items reviewed are noted above in the introduction to Chapter 1. The results of the acceptance tests and maintenance review are discussed below.

^{233}U Metal/Oxide (Content Envelope C.9) Contents
Based on ALARA considerations, the Submittal proposes to substitute the *Gas Pressure Rise* leak test method, as described in Section A5.2 of the American National Standards Institute Standard, ANSI N14.5[16]) for the Gas Pressure Drop leak test method (as described in Section A5.1 of ANSI N14.5, for testing both the O-ring, and Leak-Test Port Plug, in Section 8.2.2.1, *Containment Vessel Post-Load Leak-Rate Test*, of the SARP. The Gas Pressure Drop leak test method is used for testing both the O-ring and Leak-Test Port Plug at present.

The Submittal also proposes to use dimensional inspections and visual verifications for the Lead Shielding Body of the Model 9975-85 Packaging and the Lead Shielded-Pig, in Section 8.1.5, *Tests for Shielding Integrity*, of the SARP, in lieu of nondestructive evaluation techniques.

Also, per Addendum Appendix 2, *Packaging Independent Verification Items*, as noted in Section 8.1.1.3, *Shielded-Pig*, items essential to the shielding function of the Shielded-Pig Assembly are documented as acceptable by providing evidence the attributes, specified on the engineering drawings, have been satisfied.

Findings
Based on the review of the statements and representations in the Submittal, the staff has concluded that the packaging design has been adequately described to meet the ALARA requirements specified in 10 CFR 20 and the operational requirements specified in 10 CFR 71, provided that the change in leak-rate test methodology for the O-ring and the Leak-Test Port Plug applies only to Content Envelope C.9.

Conditions of Approval
Because the requirements specified in the Acceptance Tests and Maintenance Program Chapter of the SARP are normally incorporated, in their entity, as Conditions of Approval in the CoC, the staff has concluded that the new requirements specified in Chapter 8 of the Submittal must be included as new Conditions of Approval in the CoC for the approval of this request.

Chapter 9: Quality Assurance

This TRR covers the staff's findings regarding the review of the Submittal. This section covers the review of the Quality Assurance (QA) program description and packaging-specific QA requirements provided in Chapter 9 of the Submittal.

Details of the items reviewed are noted above in the introduction to Chapter 1. The results of the quality assurance review are discussed below.

The applicant stated in the *Justification for U233 Content Envelope* that Chapter 9 of the Model 9975 Package SARP[2] is the applicable description of the QA program, and there are no changes to it as result of this change of contents, except for changes to the Q-list resulting from the addition of the Shielded-Pig Convenience Container. The staff concurs, as Chapter 9 contains a reasonably up-to-date description of the applicant's QA program and packaging-specific QA requirements.

Findings
Based on review of the statements and representations in the Submittal, the staff concludes the QA program has been adequately described and meets the QA requirements of 10 CFR 71, Subpart H. Packaging-specific requirements are adequate to assure the packaging is designed, fabricated, assembled, tested, used, maintained, modified, and repaired in a manner consistent with its evaluation.

Conditions of Approval
The staff has concluded that no additional conditions of approval need to be added to the existing CoC for the approval of this request.

References

[1] *Justification for ^{233}U Content Envelope*, *Safety Analysis Report for Packaging*, *Model 9975*, *Addendum2*, Savannah River Packaging Technology, Savannah River National Laboratory, S-SARA-G-00002, Revision 1, May 2008. (See also, *Justification for ^{233}U Content Envelope*, *Safety Analysis Report for Packaging*, *Model 9975*, *Addendum2*, Savannah River Packaging Technology, Savannah River National Laboratory, S-SARA-G-00002, Revision 0, January 2008.)

[2] *Safety Analysis Report for Packaging-Model 9975*, WSRC-SA-2002-00008, Revision 0 (December 2003).

[3] *SAR for Packaging Model 9975 (Addendum 1)*, S-SARA-G-00001, Revision 0 (April 2005).

[4] USA/9975/B(M)F-85 (DOE), *U.S. Department of Energy Certificate of Compliance for Radioactive Materials Packages, Model 9975*, Rev. 18, U.S. Department of Energy, Washington, D.C, October 3, 2007.

[5] Nuclear Regulatory Commission, 10 CFR Part 71, *Compatibility with IAEA Transportation Standards (TS-R-1) and Other Transportation Safety Amendments; Final Rule*, 69 F.R. 3698, pp. 3698–3814, January 26, 2004, as amended.

[6] C.A. McKeel, 9975 U-233 Shielding Package NCT Drop Test Analysis, M-CLC-A-00316, Revision 1, Savannah River National Laboratory (May 2008).

[7] E-mail from Paul Blanton, Savannah River National Laboratory, to Lisle Hagler, Lawrence Livermore National Laboratory, July 3, 2008 with attachment, *Stress_strain_hist q3.doc*, E-mail from Charles McKeel, Savannah River National Laboratory, to Lisle Hagler, July 7, 2008, and E-mail from Glenn Abramczyk, Savannah River National Laboratory, to Al DiSabatino, Lawrence Livermore National Laboratory, and Marvin Bennett, Eagle Research Group, Inc., July 10, 2008, with attachment, *U233 Acceleration History.doc*.

[8] Personal Communication, Lisle Hagler, Lawrence Livermore National Laboratory (July 2008).

[9[D.S. Hoang, *Decay Heat Generation 233U Contents in the 9975*, G-CLC-A-00166, Revision 0, Savannah River National Laboratory (April 2008).

[10] N.K, Gupta, *Thermal Analysis of 9975 Shielding Package (233U) for the Normal Conditions of Transport (NCT)*, M-CLC-A-00333, Revision 0, Savannah River National Laboratory (April 2008).

[11] A.H. Bridges and R.L. Reed, *Shielding Analysis of the 9975 Shipping Container with U-233 Items (U)*, N.CLC-G-00129, Revision 1, Washington Safety Management Solutions, LLC, Aiken, SC (April 2008).

[12] M.H. Barnett, 9975 *Shipping Container-Impurity Shielding Analysis*, N-CLC-G-00102, Revision 0, November 12, 2002.

[13] *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors*, ANSI/ANS-8.1-1998, American Nuclear Society, La Grange, Illinois, September 9, 1998.

[14] *Guide for Nuclear Criticality Safety in the Storage of Fissile Materials*, ANSI/ANS-8.7-1998, American Nuclear Society, La Grange Park, Illinois, December 2, 1998.

[15] Nuclear Regulatory Commission, 10 CFR Part 20, *Standards for Protection Against Radiation*, 72 F.R. 55921, October 1, 2007, as amended. See, in particular, the definition of *ALARA* in § 20.1003.

[16] *American National Standard for Radioactive Materials—Leakage Tests on Packages for Shipment*, ANSI N14.5, American National Standards Institute, Inc., New York, NY (1997).