



Department of Energy
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SAFETY EVALUATION REPORT

for Addendum 1 to the Safety Analysis Report for Packaging
for the 9975 Package

Docket 05-7-9975

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PREFACE

This report documents the review of the SRNL submittal of Addendum 1^[1] to Revision 0 of the 9975 Safety Analysis for Report for Packaging (SARP).^[2] The purpose of the Addendum was to document evaluations of modified parameters for SARP Content Envelopes C.3 and C.4, plutonium/uranium metals and oxides, respectively, for later incorporation into the 9975 SARP as part of Revision 1. The modified contents' parameters were requested by 9975 Package Users to accommodate materials known to deviate somewhat from the content envelopes evaluated in Revision 0 of the 9975 SARP. The modified contents' parameters included lower bulk density and higher proportions of specific radionuclides and an increase in the mass limits for the light-element impurities other than beryllium. As a supplement to the Revision 0 SARP, the Addendum proposed to establish new supplemental Addendum Content Envelopes, AC.3 and AC.4, for plutonium/uranium metals and oxides, respectively.

Any proposal for a change in content specification relative to an existing authorization basis requires comprehensive review of the Certificate of Compliance (CoC) and each SARP Chapter supporting the CoC. This report documents the staff's review of the Addendum, and the specific review for each SARP Chapter is documented below.

Chapter 1: General Information

This Safety Evaluation Report (SER) covers the staff's findings regarding the review of the Savannah River National Laboratory (SRNL) submittal, modified content parameters for plutonium/uranium metals and oxides, for the 9975 Package (Reference 1). This section of the SER covers the review of the general information provided in Chapter 1 of the SRNL submittal. Specifically, the review encompassed the following:

- Correcting the upper limit for plutonium/uranium content bulk density from the 19.4 g/cm^3 stated in SARP Table 1.2, table note "b," to the bounding value of 19.84 g/cm^3 credited in the SARP criticality analysis.
- Reducing the lower bulk density limit for oxide below 2.0 g/cm^3 given in the SARP. (Several thermal evaluations were based on the previously stated bulk density of plutonium oxide.)
- Increasing the maximum allowed radionuclide fraction of the combination of ^{241}Pu and ^{241}Am from 11 weight percent given in the SARP to 15 weight percent (of the total radionuclide mass).
- Increasing the ^{232}Th limit from zero given in the SARP to 1,000 g as a component of the total radionuclide mass evaluated in the SARP.
- Crediting the effect of plutonium oxide particle size on package dose rates, and increasing the mass limit for the light-element impurities other than beryllium to the total content impurity limit.

The results of the transport safety assessment of each proposed change are discussed below.

Correcting the Upper Limit for Plutonium/Uranium Content Bulk Density

Reviews and analyses of the information provided were conducted in a manner similar to that used for other 9975 configurations. Due to the similarity to other previously authorized content configurations, no unusual effects on the primary containment vessel (PCV) or the packaging were found.

Reducing the Lower Bulk Density Limit of Plutonium/Uranium Oxide

Reviews and analyses of the information provided were conducted in a manner similar to that used for other 9975 configurations. The results of the review agree with those in the SARP in that the new requirements for local atmosphere dilution and decay heat in Addendum Table 3.1 must be added in Chapter 7 and the CoC.

Increasing the Maximum Allowed Radionuclide Fraction

Reviews and analyses of the information provided were conducted in a manner similar to that used for other 9975 configurations. Due to the similarity to other previously authorized content configurations, no unusual effects on the PCV or the packaging were found.

Increasing the ²³²Th Limit

Reviews and analyses of the information provided were conducted in a manner similar to that used for other 9975 configurations. Due to the similarity to other previously authorized content configurations, no unusual effects on the PCV or the packaging were found.

Crediting the Effect of Plutonium Oxide Particle Size on Package Dose Rates

Reviews and analyses of the information provided were conducted in a manner similar to that used for other 9975 configurations. The results of the review agree with those in the SARP, in that the predicted package dose rates fall under 200 mrem/hour for over half of the containers of aged plutonium and beryllium oxides. However, since the dose rates for all packages cannot be shown to comply with regulatory requirements, the dose rate at the surface of the package must be performed with extra care.^[1, 3]

Findings

Based on the review of the statements and representations in the SRNL submittal and the application, the staff has concluded that the package design has been adequately described to meet the requirements of 10 CFR Part 71.

Conditions of Approval

The reduction of the lower bulk density limit for plutonium/uranium oxide will require an amendment to the CoC (Reference **Error! Bookmark not defined.**). An outline of the amendment is included in the discussion for Chapter 7, below.

Chapter 2: Structural Evaluation

This SER covers the staff's findings regarding the review of SRNL submittal (Reference 1). This section covers the assessment of the structural evaluation information provided in Chapter 2 of the SRNL submittal.

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

Correcting the Upper Limit for Plutonium/Uranium Content Bulk Density

There are no structural issues associated with the correction of the upper limit for plutonium/uranium content bulk density.

Reducing the Lower Bulk Density Limit of Plutonium/Uranium Oxide

There are no structural issues associated with the reduction of the lower bulk density limit for plutonium/uranium oxide.

Increasing the Maximum Allowed Radionuclide Fraction

There are no structural issues associated with increasing the maximum allowed radionuclide fraction of the combination of ^{241}Pu and ^{241}Am from 11 weight percent 15 weight percent (of the total radionuclide mass).

Increasing the ^{232}Th Limit

There are no structural issues associated with increasing the ^{232}Th limit from zero given in the SARP to 1,000 g as a component of the total radionuclide mass evaluated in the SARP.

Crediting the Effect of Plutonium Oxide Particle Size on Package Dose Rates

There are no structural issues associated with crediting the effect of plutonium oxide particle size distribution on package dose rates.

Findings

Based on the review of the statements and representations in the SRNL submittal and the application, the staff has concluded that the structural design has been adequately described to meet the requirements of 10 CFR Part 71.

Conditions of Approval

No additional conditions of approval are needed.

Chapter 3: Thermal Evaluation

This SER covers the staff's findings regarding the review of the SRNL submittal (Reference 1). This section covers the review of the thermal evaluation information provided in Chapter 3 of the SRNL submittal.

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

Correcting the Upper Limit for Plutonium/Uranium Content Bulk Density

There are no thermal issues associated with the correction of the upper limit for plutonium/uranium content bulk density.

Reducing the Lower Bulk Density Limit of Plutonium/Uranium Oxide

Reviews and analyses of the information provided were conducted in a manner similar to that used for other 9975 configurations. The results of the review agree with those in the SARP in that the new requirements for local atmosphere dilution and decay heat in Addendum Table 3.1 must be added in Chapter 7 and the CoC.

Increasing the Maximum Allowed Radionuclide Fraction

There are no thermal issues associated with increasing the maximum allowed radionuclide fraction of the combination of ^{241}Pu and ^{241}Am from 11 weight percent 15 weight percent (of the total radionuclide mass).

Increasing the ^{232}Th Limit

There are no thermal issues associated with increasing the ^{232}Th limit from zero given in the SARP to 1,000 g as a component of the total radionuclide mass evaluated in the SARP.

Crediting the Effect of Plutonium Oxide Particle Size on Package Dose Rates

There are no thermal issues associated with crediting the effect of plutonium oxide particle size distribution on package dose rates.

Findings

Based on the review of the statements and representations in the SRNL submittal and the application, the staff has concluded that the package design has been adequately described to meet the requirements of 10 CFR Part 71.

Conditions of Approval

The reduction of the lower bulk density limit for plutonium/uranium oxide will require an amendment to the CoC (Reference **Error! Bookmark not defined.**). An outline of the amendment is included in the discussion for Chapter 7, below.

Chapter 4: Containment

This SER covers the staff's findings regarding the review of the SRNL submittal (Reference 1). This section covers the review of the containment information provided in Chapter 4 of the submittal.

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

Correcting the Upper Limit for Plutonium/Uranium Content Bulk Density

There are no containment-related issues associated with the correction of the upper limit for plutonium/uranium content bulk density.

Reducing the Lower Bulk Density Limit of Plutonium/Uranium Oxide

There are no containment-related issues associated with the reduction of the lower bulk density limit for plutonium/uranium oxide.

Increasing the Maximum Allowed Radionuclide Fraction

There are no containment-related issues associated with increasing the maximum allowed radionuclide fraction of the combination of ^{241}Pu and ^{241}Am from 11 weight percent 15 weight percent (of the total radionuclide mass).

Increasing the ^{232}Th Limit

There are no containment-related issues associated with increasing the ^{232}Th limit from zero given in the SARP to 1,000 g as a component of the total radionuclide mass evaluated in the SARP.

Crediting the Effect of Plutonium Oxide Particle Size on Package Dose Rates

There are no containment-related issues associated with crediting the effect of plutonium oxide particle size distribution on package dose rates.

Findings

Based on the review of the statements and representations in the SRNL submittal and the application, the staff has concluded that the containment design has been adequately described to meet the requirements of 10 CFR Part 71.

Conditions of Approval

No additional conditions of approval needed.

Chapter 5: Shielding Evaluation

This SER covers the staff's findings regarding the review of the SRNL submittal (Reference 1). This section covers the review of the shielding evaluation information provided in Chapter 5 of the SRNL submittal.

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

Correcting the Upper Limit for Plutonium/Uranium Content Bulk Density

There are no shielding-related issues associated with the correction of the upper limit for plutonium/uranium content bulk density.

Reducing the Lower Bulk Density Limit of Plutonium/Uranium Oxide

There are no shielding-related issues associated with the reduction of the lower bulk density limit for plutonium/uranium oxide.

Increasing the Maximum Allowed Radionuclide Fraction

There are no shielding-related issues associated with increasing the maximum allowed radionuclide fraction of the combination of ^{241}Pu and ^{241}Am from 11 weight percent 15 weight percent (of the total radionuclide mass).

Increasing the ^{232}Th Limit

There are no shielding-related issues associated with increasing the ^{232}Th limit from zero given in the SARP to 1,000 g as a component of the total radionuclide mass evaluated in the SARP.

Crediting the Effect of Plutonium Oxide Particle Size on Package Dose Rates

Reviews and analyses of the information provided were conducted in a manner similar to that used for other 9975 configurations. The results of the review agree with those in the SARP in that the predicted package dose rates fall under 200 mrem/hour for over half of the containers of aged plutonium and beryllium oxides (Reference 3). However, since the dose rates for all packages cannot be shown to comply with regulatory requirements, the dose rate at the surface of the package must be performed with extra care.

Findings

Based on the review of the statements and representations in the SRNL submittal and the application, the staff has concluded that the shielding design has been adequately described and evaluated, and that the package meets the external radiation requirements of 10 CFR Part 71.

Conditions of Approval

No additional conditions of approval needed.

Chapter 6: Criticality Evaluation

This SER covers the staff's findings regarding the review of SRNL submittal (Reference 1). This section covers the review of the criticality evaluation information provided in Chapter 6 of the SRNL submittal.

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

Correcting the Upper Limit for Plutonium/Uranium Content Bulk Density

There are no criticality-related issues associated with the correction of the upper limit for plutonium/uranium content bulk density.

Reducing the Lower Bulk Density Limit of Plutonium/Uranium Oxide

There are no criticality-related issues associated with the reduction of the lower bulk density limit for plutonium/uranium oxide.

Increasing the Maximum Allowed Radionuclide Fraction

Reviews and analyses of the information provided were conducted in a manner similar to that used for other 9975 configurations. The results of the review agree with those in the SARP in that the predicted package reactivity is reduced with increasing the maximum allowed radionuclide fraction of the combination of ^{241}Pu and ^{241}Am from 11 weight percent 15 weight percent (of the total radionuclide mass).

Increasing the ^{232}Th Limit

Reviews and analyses of the information provided were conducted in a manner similar to that used for other 9975 configurations. The results of the review agree with those in the SARP in that the predicted package reactivity is negligible.

Crediting the Effect of Plutonium Oxide Particle Size on Package Dose Rates

There are no criticality-related issues associated with crediting the effect of plutonium oxide particle size distribution on package dose rates.

Findings

Based on the review of the statements and representations in the SRNL submittal and the application, 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 Part 71.

Conditions of Approval

No additional conditions of approval needed.

Chapter 7: Operating Procedures

This SER covers the staff's findings regarding the review of the SRNL submittal (Reference 1). This section covers the review of the operating procedures information provided in Chapter 7 of the SRNL submittal.

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

Correcting the Upper Limit for Plutonium/Uranium Content Bulk Density

There are no operating procedures-related issues associated with the correction of the upper limit for plutonium/uranium content bulk density.

Reducing the Lower Bulk Density Limit of Plutonium/Uranium Oxide

The procedural requirements in Reference 2, addressing loading configurations in Section 7.2.2 (Loading Contents into the PCV), do not currently address the new requirements associated with the loading of proposed new Content Envelopes, AC.3 and AC.4, for plutonium/uranium metals and oxides, respectively. The results of the review agree with those presented in the Addendum.

As a consequence, the staff concludes that the new requirements for local atmosphere dilution and decay heat in Addendum Table 3.1 must be added in Chapter 7 and the CoC (Reference **Error! Bookmark not defined.**). This will ensure that the proper procedural requirements are followed for the loading of the newly proposed plutonium/uranium metals and oxide contents.

Increasing the Maximum Allowed Radionuclide Fraction

Reviews and analyses of the information provided were conducted in a manner similar to that used for other 9975 configurations. The results of the review agree with those in the SARP in that the predicted package reactivity is reduced with increasing the maximum allowed radionuclide fraction of the combination of ^{241}Pu and ^{241}Am from 11 weight percent 15 weight percent (of the total radionuclide mass).

Increasing the ^{232}Th Limit

There are no operating procedures-related issues associated with increasing the ^{232}Th limit from zero given in the SARP to 1,000 g as a component of the total radionuclide mass evaluated in the SARP.

Crediting the Effect of Plutonium Oxide Particle Size on Package Dose Rates

The primary operating procedures-related concern associated with this issue is that additional care will have to be taken during the pre-shipment dose measurements for the package. Since these types of considerations have long since been factored into the requirements specified in the existing CoC, no additional requirements are deemed necessary.

Findings

Based on the review of the statements and representations in the SRNL submittal and the application, the staff has concluded that the package design has been adequately described to meet the requirements of 10 CFR Part 71. However, the loading procedures for the plutonium/uranium metals and oxides configuration will be amended as described above.

Conditions of Approval

The requirements specified in Chapter 7 of the SRNL submittal have already been incorporated into the existing CoC for the 9975 package (Reference **Error! Bookmark not defined.**). Specific sections of the CoC will be amended as outlined above, for clarification.

Chapter 8: Acceptance Tests and Maintenance

This SER covers the staff's findings regarding the review of the SRNL submittal (Reference 1). This section covers the review of the acceptance tests and maintenance information provided in Chapter 8 of the SRNL submittal.

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

Correcting the Upper Limit for Plutonium/Uranium Content Bulk Density

There are no acceptance test- or maintenance-related issues associated with the correction of the upper limit for plutonium/uranium content bulk density.

Reducing the Lower Bulk Density Limit of Plutonium/Uranium Oxide

There are no acceptance test- or maintenance-related issues associated with the reduction of the lower bulk density limit for plutonium/uranium oxide.

Increasing the Maximum Allowed Radionuclide Fraction

There are no acceptance test- or maintenance-related issues associated with increasing the maximum allowed radionuclide fraction of the combination of ^{241}Pu and ^{241}Am from 11 weight percent to 15 weight percent (of the total radionuclide mass).

Increasing the ^{232}Th Limit

There are no acceptance test- or maintenance-related issues associated with increasing the ^{232}Th limit from zero given in the SARP to 1,000 g as a component of the total radionuclide mass evaluated in the SARP.

Crediting the Effect of Plutonium Oxide Particle Size on Package Dose Rates

There are no acceptance test- or maintenance-related issues associated with crediting the effect of plutonium oxide particle size distribution on package dose rates.

Findings

Based on the review of the statements and representations in the SRNL submittal and the application, the staff has concluded that the package design has been adequately described to meet the requirements of 10 CFR Part 71.

Conditions of Approval

No additional conditions of approval needed.

Chapter 9: Quality Assurance

This SER covers the staff's findings regarding the review of the SRNL submittal (Reference 1). This section covers the review of the quality assurance information provided in Chapter 9 of the SRNL submittal.

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

Correcting the Upper Limit for Plutonium/Uranium Content Bulk Density

There are no quality assurance-related issues associated with the correction of the upper limit for plutonium/uranium content bulk density.

Reducing the Lower Bulk Density Limit of Plutonium/Uranium Oxide

There are no quality assurance-related issues associated with the reduction of the lower bulk density limit for plutonium/uranium oxide.

Increasing the Maximum Allowed Radionuclide Fraction

There are no quality assurance-related issues associated with increasing the maximum allowed radionuclide fraction of the combination of ^{241}Pu and ^{241}Am from 11 weight percent to 15 weight percent (of the total radionuclide mass).

Increasing the ^{232}Th Limit

There are no quality assurance-related issues associated with increasing the ^{232}Th limit from zero given in the SARP to 1,000 g as a component of the total radionuclide mass evaluated in the SARP.

Crediting the Effect of Plutonium Oxide Particle Size on Package Dose Rates

There are no quality assurance-related issues associated with crediting the effect of plutonium oxide particle size distribution on package dose rates.

Findings

Based on review of the statements and representations in the SRNL submittal and the application, the staff concludes the quality assurance plan has been adequately described and meets the quality assurance requirements of 10 CFR Part 71, Subpart H. Package-specific requirements are adequate to assure the package is designed, fabricated, assembled, tested, used, maintained, amended, and repaired in a manner consistent with its evaluation.

Conditions of Approval

No additional conditions of approval needed.

References

- [1] Safety Analysis Report for Packaging, Model 975, Addendum 1, Justifications for Modified Contents Parameters, Addendum 1, Revision 1 to WSRC-SA-2002-00008, April 2005.
- [2] Model 9975 B(M)F-85 Safety Analysis Report for Packaging, WSRC-SA-2002-00008, Revision 0, December 2003.

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- [3] Boles, J. L., Hafner, R. S., and Fischer, L. E., *Neutron Source Strength Estimates from (α, n) Reactions in Binary Mixtures of Actinide Particles and Light Element Particles*, ASME Pressure Vessels and Piping Conference, Paper PVP2005-71741 (2005).
- [4] U.S. Department of Energy Certificate of Compliance USA/9975/B(M)F-85 (DOE), Revision 11, May 17, 2004.