



**EM Environmental Management**

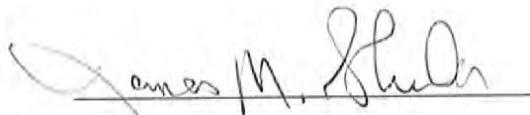
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**DOE Packaging Certification Program**

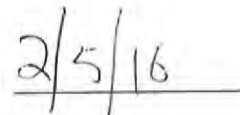
**Safety Evaluation Report for  
Request to Revise 9975 Certificate Based on SARP  
Revision 4 Page Changes for Engineered Materials and  
Revised Thermal Calculations**

**Docket No. 14-37-9975**

Prepared by:



Date:

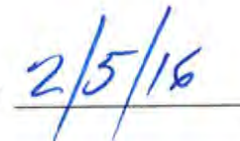


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This Safety Evaluation Report (SER) documents the U.S. Department of Energy (DOE) Packaging Certification Program (PCP) technical review of the application submitted by the Savannah River Operations Office (SR) requesting a revision to DOE Certificate of Compliance (CoC) Number 9975, Revision 12.

## Summary

By memorandum <sup>[1]</sup> dated September 30, 2014, SR submitted a request to revise the CoC for the Model 9975 package. The applicant revised Chapters 1, 2, 3 and 7 of the Safety Analysis Report for Packaging (SARP) <sup>[2]</sup> to clarify engineered metal and oxide materials with intact cladding (i.e., defined in DOE-STD-3013-2014) as authorized contents and update the thermal evaluation to include solar insolation in the initial test conditions for the thermal analysis under hypothetical accident conditions (HAC), for consistency with International Atomic Energy Agency (IAEA) regulations, SSR-6, *Regulations for the Safe Transport of Radioactive Material*.<sup>[3]</sup> This review by PCP was suspended due to a lack of funding and priority by the applicant. On October 28, 2015, SR requested <sup>[4,5]</sup> a scope change to restrict the PCP review to only SARP Chapter 1, page changes 1-15, 1-26, and 1-31, to receive a pending foreign shipment of engineered materials, and provided funding authorization to resume and complete the review. In response, DOE issued CoC Revision 12, on November 6, 2015, based on its accompanying SER.

PCP staff subsequently reviewed the remaining SARP Revision 4 page changes that implemented the results from applicant's updated thermal evaluation using the guidance in UCID-21218, Rev. 3, *Packaging Review Guide for Reviewing Safety Analysis Reports for Packagings*.<sup>[6]</sup> Based on the statements and representations in the final SARP Revision 4 <sup>[7]</sup> page changes, staff agrees that these changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

## Evaluation

The applicant added Appendix 3.22 to the SARP to document the revised thermal analysis under HAC that consider solar insolation as an initial test condition for the thermal evaluation under HAC, for consistency with IAEA SSR-6. The applicant also revised the structural evaluation, thermal evaluation, and package operations in SARP Chapters 2, 3, and 7 to implement the results of the revised thermal evaluation and to implement the use of nitrogen as diluent for the primary containment vessel. There were no changes to the packaging design, or to the applicant's evaluation of the package containment system, shielding and criticality; acceptance tests and maintenance; and quality assurance requirements.

PCP staff reviewed SARP Revision 4 page changes to assess the impact, if any on the entire SARP (Chapters 1-9). Staff confirmed the page changes did not require a revision to the applicant's evaluation of the package containment system, shielding and criticality; acceptance tests and maintenance; and quality assurance requirements in SARP Chapters 4, 5, 6, 8, and 9 respectively. Staff's review of the applicant's revised structural and thermal evaluation, and package operations in SARP Chapters 2, 3, and 7, is addressed below in this SER.

### **Structural Evaluation**

The applicant revised the calculated temperatures and pressures under Hypothetical Accident Conditions (HAC) in SARP Table 2.21, based on the results from the revised thermal analysis under HAC. The applicant used the internal pressure limits of 900 psig for the Primary Containment Vessel (PCV) and 800 psig for the Secondary Containment Vessel (SCV) for stress calculations under HAC, which bound the maximum calculated pressures for PCV (162.2 psig) and SCV (364.7 psig) under HAC.

PCP staff verified that the increases to the calculated temperatures and pressures for the PCV, SCV, and contents remain below their allowable temperatures and pressures. Therefore, the applicant's stress calculations for these components under HAC remain valid.

Based on the statements and representation in the SARP, PCP staff concludes that these changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

### **Thermal Evaluation**

SSR-6 Paragraph 726, *Tests for demonstrating ability to withstand accident conditions of transport*, requires that the specimen package is subjected to solar insolation. Insolation is not explicitly required in §71.73 as a test condition, therefore, previous revisions of the SARP did not include it in the HAC thermal evaluation. However, due to international users of the package, the applicant revised the SARP for consistency with SSR-6. The applicant added Appendix 3.22 to the SARP to document the revised HAC thermal analysis of the package with solar insolation data from §71.71(c) as an initial test condition to demonstrate compliance with §§71.73(b) and 71.73(c)(4). The applicant also revised the thermal evaluation in SARP Chapter 3 to implement the results of the revised thermal analysis, as applicable.

PCP staff reviewed SARP, Chapter 3, Appendix 3.22, and other supporting references. Staff checked the detailed implementation of the applicant's Normal Conditions of Transport (NCT) and HAC simulations, for which solar insolation was modeled with ANSYS/Fluent 14.0 computer codes. Staff found the applicant's material properties, zone definition, boundary conditions, and solution method adequate in the simulations; however, staff notes that the applicant assumed a solar absorptivity value of 0.5 at the drum surface for realistic component temperature results, as compared with the conservative values of 0.65 (experimental) or unity used in Appendix 3.13. In addition, the solar insolation value used in the SARP, Table 3.8, from §71.71(c) of 800 g-cal/cm<sup>2</sup> for 12 hours (i.e., 775 W/m<sup>2</sup>), is approximately 3% less than SSR-6 Paragraph 657 (i.e., 800 W/m<sup>2</sup>).

PCP staff conducted confirmative thermal analyses using ANSYS/Fluent 14.0, and assumed an absorptivity value of 0.7 for the drum surface. A steady state thermal simulation under NCT with solar insolation was conducted, followed by simulation under HAC that used the NCT results as the initial conditions. Staff used the SSR-6 solar insolation data of 800 W/m<sup>2</sup> in the confirmatory analyses. Staff's confirmative evaluation considered only uniformly distributed heat source because it bounds the highly localized heat source at the bottom of PCV in terms of O-ring temperatures, which are the primary concern for maintaining package integrity.

Under NCT with solar insolation, PCP staff calculated peak temperatures of the Viton O-rings for PCV and SCV are 112.8 and 111.1°C (235 and 232°F) respectively, which are higher than the corresponding values of 102.8 and 101.1°C (217 and 214°F) in SARP Revision 4. However, they are all well below the allowable temperature limit of 204.4°C (400°F) of the Viton O-ring with a substantial margin. Staff calculated peak temperature of the Celotex insulation is 112.2°C (234°F), which is higher than the corresponding value of 101.7°C (215°F) in SARP Revision 4. Again they are both below the allowable limit of 121.1°C (250°F). Staff calculated peak temperature is 112.8°C (235°F) for the lead shield, which is well below the 327.8°C (622°F) melting temperature.

Under the HAC fire, PCP staff calculated peak temperatures of the Viton O-rings for PCV and SCV are 116.1 and 115°C (241 and 239°F) respectively, which are all higher than the corresponding values of 115 and 113.9°C (239 and 237°F) in Table 3.2 of the SARP Revision 4. They are all well below the allowable temperature limit of 204.4°C (400°F). Staff calculated peak temperature of 127.8°C (262°F) for the lead shield, which is also below the 327.8°C (622°F) melting temperature.

PCP staff calculated peak temperatures of the gas in the PCV are 125 and 128.3°C (257 and 263°F) under NCT and HAC, respectively. They are below 156.1°C (313°F), the calculated PCV temperature in Appendix 3.17 of the SARP Revision. 2. The maximum operating pressure is bounded by the maximum pressure calculated in the SARP Revision 2. Accordingly, the pressure build-up in the PCV is below the allowable pressure limit when solar insolation is included as an initial test condition under HAC.

Based on the statements and representation in the SARP, and confirmatory analysis by PCP staff, staff concludes that these changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

### **Package Operations Evaluation**

The applicant revised SARP Section 7.2.1 to clarify that inerting applied to the large vented food-pack cans; Section 7.2.2 to include nitrogen as an approved diluent; and Appendix 7.2 to implement changes to the inerting gas procedure for nitrogen.

PCP staff reviewed the Chapter 7 page changes for the large vented food-pack can configuration requirements added into SARP Table 1.3. Staff's review and evaluation focused on the nitrogen dilution procedures of the PCV presented in Chapter 7 and Appendix 7.2 of the SARP.

PCP staff concludes that the changes to the operating procedures are adequate and provide reasonable assurance for safe operation of the package in accordance with 10 CFR Part 71.

### **Conditions of Approval**

The following changes to CoC Revision 12 are required to implement the conditions in this SER.

1. Revise Reference 7: Safety Analysis Report for Packaging Model 9975, S-SARP-G-00003, Revision 4, Pages Changes (final), December 17, 2015 (approval date).
2. Revise Condition 13 to allow the use of CoC Revisions 9, 10, 11, and 12 until June 30, 2018, when endorsed by DOT Competent Authority Certification (certificate), for international shipments to the USA.

### **Conclusion**

Based on the statements and representations in the SARP Revision 4 page changes, PCP staff concludes that the changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

### **References**

- [1] *Request Revision to the 9975 Certification of Compliance (CoC)*, submitted to US Department of Energy Packaging Certification Program, by the Savannah River Operations Office (SR), September 30, 2014
- [2] *Safety Analysis Report for Packaging Model 9975*, S-SARP-G-00003, Revision 4, Pages Changes (1-15, 1-26, and 1-31), September 9, 2014 (approval date)
- [3] *Regulations for the Safe Transport of Radioactive Material*, Specific Safety Requirements, No. SSR-6, 2012 Edition, International Atomic Energy Agency (IAEA)
- [4] Email, H. Gunter (DOE/Srs) to James Shuler (PCP/EM33), dated October 28, 2015 10:15 AM.
- [5] Email, H. Gunter (DOE/Srs) to Dan Leduc (SRNL/Srs), dated October 28, 2015 03:39 PM
- [6] *Packaging Review Guide for Reviewing Safety Analysis Reports for Packagings*, UCID-21218, Revision 3, February 2008
- [7] *Safety Analysis Report for Packaging Model 9975*, S-SARP-G-00003, Revision 4, Pages Changes (final), December 17, 2015 (approval date)