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DOE Packaging Certification Program

**Safety Evaluation Report for
Certificate of Compliance No. 9516 Amendment for the
Model 9516 Package**

Docket No. 21-56-9516

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This Safety Evaluation Report (SER) documents the U.S. Department of Energy (DOE) Packaging Certification Program (PCP) independent technical review of the application and supplements submitted for the DOE Idaho Operations Office (ID) for amendment of DOE Certificate of Compliance (CoC) Number 9516 for the Model 9516 package design. This package is needed to support the mission of the Idaho National Laboratory (INL), Space Nuclear Power & Isotope Technologies Division.

Summary

By email ^[1] dated September 15, 2021, the certificate holder, ID requested a simple amendment of DOE CoC 9516 for the Model 9516 package design to authorize minor design changes to Shipping Configuration 7 for shipment of plutonium dioxide powder produced by the Oak Ridge National Laboratory (ORNL).

The application ^[2] for package approval in support of the ID request was Safety Analysis Report for Packaging (SARP) for the 9516 Package, Addendum No. 1, Revision 2a, dated September 2021. This application was prepared for ID and INL by the Pacific Northwest National Laboratory (PNNL) and submitted by ID to DOE PCP on October 4, 2021 for review.

On October 7, 2021, the DOE PCP Manager notified ID ^[3] that DOE PCP staff completed their independent technical review and confirmatory analysis of the application and had no regulatory compliance questions or additional comments, pending two editorial errors for correction and implementation in a final SARP Addendum. The final SARP Addendum No. 1, Revision 2 ^[4] was submitted by ID on October 25, 2021 and staff confirmed the editorial errors were corrected.

Based on the statements and representations in the final SARP Addendum No. 1, Revision 2, DOE PCP staff independently confirmed that the package design has been adequately described and evaluated for the design change to the Shipping Configuration 7 - FSO Container. Therefore, staff has reasonable assurance that the regulatory requirements of Part 71 have been met and recommends amendment of the CoC by the DOE Headquarters Certifying Official (HCO).

Evaluation

This SER documents the independent technical review by DOE PCP staff of SARP Addendum No. 1, Revision 2 (hereinafter referred to as the “Addendum” unless otherwise specified), to the requirements of 10 CFR Part 71.

1.0 General Information

1.1 Introduction

Shipping Configuration 7 –*FSO Container*. This shipping configuration is authorized in the current DOE CoC 9516, Revision 9, for shipment of plutonium dioxide (PuO₂) powder. This content configuration consists of one or two *Fuel Storage Assembly MOD-01* overpack (FSO) containers (drawing 55Y-002875, Rev. K). Each overpack loaded with a capsule or container assembly of PuO₂ powder. Only two powder capsule/container assembly designs are currently authorized for loading in the FSO Container: the *Building 7920 Pu-238 Oak Ridge Inner Shipping Capsule (ORISC)* (ORNL drawing N3E020995A518, Rev. C) or the *WR Fuel Storage Inner Container Assembly* (Los Alamos National Lab. drawing 26Y1103537, Rev. E). The CoC authorizes up to two FSO Containers per 9516 package containment vessel (CV). The FSO Container(s) is loaded in the CV with a *Graphite Support Block for FSO* (drawing 796848, Rev. 0) and a *Graphite Filler Block for FSO* (drawing 796849, Rev. 0). These blocks provide dunnage and position the contents at a fixed location within the (CV).

The purpose of the certificate amendment is to:

- authorize new FSO Container design drawing for consistency with NUREG/CR-5502, *Engineering Drawings for 10 CFR Part 71 Package Approvals*,
- authorize new ORISC powder capsule design drawing for consistency with NUREG/CR-5502,
- authorize a minor design change to the *Graphite Filler Block for FSO* (drawing 796849, Rev. 0) to account for an interference from the FSO Container lid weld pin, and
- authorize use of a colloidal graphite lubricant on the threads of the VCR Plug to install the plug in the ORISC.

There were no changes to the *WR Fuel Storage Inner Container Assembly* design.

The applicant provided a thorough description of drawing changes, administrative changes, chapter-by-chapter safety evaluation, list of page changes, and references in *Technical Evaluation - Description and Technical Justification for Revision 2 of 9516 Package SARP Addendum 1 (R1033-0065-ES)*, TEV-4335 Rev. 0. This technical evaluation is included as Reference 1.3.1.1.4 in the Addendum.

1.2 Package Description

There were no changes to the previously approved package description in the SARP.

The Model 9516 is a Type B(U)F package that is designed for transport of up to 500 watts of PuO₂ heat source material in any solid form (e.g., powder, pellets, granules, etc.).

The package has a maximum gross weight of 900 lb. (408 kg) and consists of a cylindrical cask that is housed within a personnel shield (frame and skid). The package contents consist of various quantities of plutonium heat source material (mostly Pu-238) and fissile material that may exceed 3,000 A₂. Since the package contains Pu in excess of 0.74 TBq (20 Ci) its contents must be in any solid form to meet the requirements §71.63.

The package as offered for consignment is shown in Figure 1 of the CoC.

1.2.1 Packaging

There are no design changes to the primary packaging components. The Model 9516 packaging consists of three basic components: a cask, a one-time use CV, and personnel shield. These components are classified in SARP Table 9.1 as Quality Level A items (Quality Category A), which are critical-to-safe operation of the package.

The applicant proposed the following changes to the internal packaging components for Shipping Configuration 7:

- INL Drawing number 1009022, Rev 00A, *Fuel Storage Overpack Container (FSO)*, will become the design drawing per package description in §71.33(a)(5) and for the package evaluation per §71.35. This drawing replaces LANL Drawing 55Y-002875 for the SARP evaluation and the LANL drawing becomes the FSO Container fabrication drawing.
- INL Drawing number 1009094, Rev 00A, *Oak Ridge Inner Shipping Capsule (ORISC)*, will become the design drawing, per package description in §71.33(a)(5) and for the package evaluation per §71.35, and replaces ORNL Drawing N3E020995A518. Drawing 10094 also includes the use of lubricant (Neolube No.1 Lubricant, MIL-L-24131C) on the threads of the VCR Plug. Drawing N3E020995A518 becomes the ORISC fabrication drawing.

There were no changes to materials of construction, mass, or dimensions in these new design drawings for the FSO Container and ORISC.

- INL Drawing 796849, Rev. 001, *Graphite Filler Block* – the filler block was modified to add a 0.040 inch deep × 1.125 inches diameter recess in the center and on both sides of the filler block to account for interference from the FSO Container lid weld pin. The recess was added to both sides of the filler block so it could be installed in the CV without a specific top/bottom orientation. This drawing revision includes a note for instructions to modify filler blocks fabricated to the current drawing 796849 Rev. 0 to meet the Rev. 001 design.

These components are described in the Addendum Section 1.2.2.1.1 and shown in Addendum Figures 1-1, 1-2, and 1-3. Figure 1-1 shows the *FSO Container and Powder Can*, Figure 1-2 shows the *Loading Arrangement for One FSO Container in a CV*, and Figure 1-3 shows the *Loading Arrangement for Two FSO Containers in a CV*.

The safety function of these internal components is to restrict movement within the CV. These components are classified in Addendum, Table 9-1, *Q-List for the 9516 Packaging Design, Procurement, and Fabrication*, as Quality Level C items (Quality Category C), which are minor to the safe operation of the package.

The list and drawings of all packaging components required for Shipping Configuration 7 are defined in Addendum Table 1-2, *9516 Package Content Shipping Configurations*.

The applicant also made editorial changes throughout the Addendum to use "Type" as a prefix when referring to stainless steel, for consistency (e.g., Type 304L Stainless Steel vs. 304L Stainless Steel).

1.2.2 Contents

There are no changes to the exiting authorized radioactive contents or safety significant changes to the basic loading for Shipping Configuration 7. The applicant corrected the PuO₂ powder mass limit from 150 g to 175 g in Addendum Section 1.2.2.1.1 for consistency with the CoC and Addendum Section 5.2.1.2 *Gamma Source for Two FSO Containers*.

1.3 Evaluation Findings

Based on review of the statements and representations in the Addendum, DOE PCP staff concludes that the packaging changes in support of the CoC amendment request have been described in sufficient detail to provide an adequate basis for the package evaluation under 10 CFR Part 71.

2.0 Structural Evaluation

The objective of this structural review is to determine that the information presented in the SARP, including the description of the packaging, design and fabrication criteria, structural material properties, and structural performance of the package design for the tests under Normal condition of Transport (NCT) and Hypothetical Accident Conditions (HAC), is complete and meets the requirements of 10 CFR Part 71.

The new design drawings for the FSO Container and the ORISC do not change the material of construction, mass, or overall dimensions of these containers for its structural evaluation. DOE PCP staff also evaluated the minor design change to the Graphite Filler Block and concluded that its marginal mass and volume decrease does not affect the structural performance of the package.

DOE PCP staff confirmed the use of Neolube No.1 Lubricant (MIL-L-24131C) to lubricate the threads of the ORISC VCR Plug is compatible with packaging component materials and PuO₂ contents and does not create chemical, galvanic, or other reactions. There may be a marginal pressure increase in the CV caused by outgassing of the polymer binder contained in the lubricant under HAC; however, this potential pressure increase is very small (0.05 psi) relative to the maximum calculated HAC pressure of 147.3 psig and maximum CV design pressure of 200 psig (see discussion in Section 3 of this SER).

Therefore, the existing structural evaluation in Chapter 2 of the Addendum remains bounding under NCT and HAC.

2.1 Evaluation Findings

Based on review of the statements and representations in the Addendum, DOE PCP staff has reasonable assurance that the package structural design continues to meet the requirements of 10 CFR Part 71.

3.0 Thermal Evaluation

The objective of this thermal review is to verify that the thermal performance of the package has been adequately evaluated for the tests specified under NCT and HAC and that the package design satisfies the thermal requirements of 10 CFR Part 71.

There was no PuO₂ content change, so the maximum heat load remains at 140 W per CV for the Shipping Configuration (i.e., two FSO Containers at 70 W each).

The new design drawings for the FSO Container and the ORISC do not change the material of construction, mass, overall dimension of these containers for its thermal evaluation. DOE PCP staff also evaluated the minor design change to the Graphite Filler Block and concluded that its marginal mass and volume decrease does not affect the thermal performance of the package.

The applicant introduced a new material in the ORISC in the form of Neolube No.1, a colloidal graphite lubricant consisting of 75% graphite with 25% polymer binder suspended in isopropanol (MIL-L-24131C). The applicant included offgassing of the residual polymer binder mass in a thermal HAC evaluation, using the same methodology and assumptions as the evaluation for the ORISC O-rings, and determined that the maximum CV pressure under HAC would increase by approximately 0.05 psi, from 147.3 psig to 147.4 psig, which is still below the CV design pressure of 200 psig.

Therefore, the existing thermal evaluation in Chapter 3 of the Addendum remains bounding under NCT and HAC.

3.1 Evaluation Findings

Based on review of the statements and representations in the Addendum, DOE PCP staff has reasonable assurance that the thermal design of the package continues to meet the requirements of 10 CFR Part 71.

4.0 Containment Evaluation

The objective of this containment review is to verify that the package design satisfies the containment requirements of 10 CFR Part 71 under NCT and HAC.

The package containment boundary is a one-time use CV, which is a welded stainless steel can. The CV provides a tested leaktight containment boundary for the contents of the package under NCT and HAC.

There were no changes to the radioactive contents or the containment performance features of the package design to use the package for Shipping Configuration 7.

The new design drawings for the FSO Container and the ORISC do not change the material of construction, mass, or dimensions of these containers for its containment evaluation. DOE PCP staff also evaluated the minor design change to the Graphite Filler Block and concluded that its marginal volume decrease does not affect the containment performance of the package.

Therefore, the existing containment evaluation in Chapter 4 of the Addendum remains bounding under NCT and HAC.

4.1 Evaluation Findings

Based on review of the statements and representations in the Addendum, DOE PCP staff has reasonable assurance that the containment design of the package continues to meet the requirements of 10 CFR Part 71.

5.0 Shielding Evaluation

The purpose of the shielding review is to confirm that the package (the packaging together with its contents) meet the external radiation requirements in 10 CFR Part 71.

The personnel shield is a cage-like engineering control that provides a physical barrier (i.e., fixed distance) from heat and radiation generated at the cask surfaces.

There were no changes to the radioactive contents or the shielding performance features of the package design to use the package for Shipping Configuration 7.

The new design drawing for the FSO Container and the ORISC do not change the material of construction, mass, or overall dimensions of these containers for its shielding evaluation. DOE PCP staff also evaluated the minor design change to the Graphite Filler

Block and concluded that its marginal mass and volume decrease does not affect the shielding performance of the package.

Therefore, the existing shielding evaluation in Chapter 5 of the Addendum remains bounding under NCT and HAC.

5.5 Evaluation Findings

Based on review of the statements and representations in the Addendum, DOE PCP staff has reasonable assurance that the package shielding design continues to meet the requirements of 10 CFR Part 71, subject to Condition 7 of the CoC.

6.0 Criticality Evaluation

The purpose of the criticality review is to confirm that the package together with its contents meet the requirements in 10 CFR Part 71 for nuclear criticality safety (NCS).

There were no changes to the radioactive contents for Shipping Configuration; therefore, this package shipping configuration is exempted from being classified as fissile material per §71.15(f) and no criticality evaluation is required.

7.0 Operating Procedures

The SARP provides a description of package operations, including package loading and unloading operations, and the preparation of an empty package for shipment. Loading and unloading procedures show a general approach to perform operational activities because site-specific conditions may require the use of different equipment and loading or unloading steps.

There were no changes in the Addendum to the basic operating procedures or loading steps for Shipping Configuration 7.

7.1 Evaluation Findings

Based on review of the statements and representations in the Addendum, DOE PCP staff concludes that the combination of the engineered safety features of the package and the operating procedures provide adequate measures and reasonable assurance for safe operation of the package in accordance with 10 CFR Part 71.

8.0 Acceptance Tests and Maintenance Program

The objective of this review is to verify that the acceptance tests for the packaging meet the requirements of 10 CFR Part 71 and that the maintenance program is adequate to assure packaging performance during its service life.

There were no changes in the Addendum to the acceptance test and maintenance program for the Shipping Configuration 7 packaging components. The components internal to the CV for Shipping Configuration 7 are listed in Addendum Table 1-2 and classified in

Addendum Table 9-1 as minor to safety (Q-Category) and their safety function is to restrain the contents within the CV.

The acceptance criteria for these components consist of visual and dimensional inspections, and material verification per the drawings listed Addendum Appendices 1.3.1 and 1.3.2.

8.1 Evaluation Findings

Based on the review of the statements and representations in the Addendum, DOE PCP staff concludes that the acceptance tests for the packaging meet the requirements of 10 CFR Part 71, and that the maintenance program is adequate to assure packaging performance during its service life.

9.0 Quality Assurance

The objective of this review is to verify that the SARP, as supplemented by the Addendum demonstrates that the applicant's Quality Assurance (QA) program description and package specific QA requirements comply with the requirements of 10 CFR Part 71, Subpart H, Quality Assurance.

The applicant's 10 CFR 71 Subpart H Quality Assurance Program (QAP) is approved by DOE (https://rampac.energy.gov/docs/default-source/qa/approval_0010_r1.pdf).

The new design drawings for the FSO Container and ORISE, and the minor design change to the Graphite Filler Block for Shipping Configuration 7 did not affect the existing QA Program of the packaging. The Quality Level for the components internal to the CV for this shipping configuration are all classified as Quality Level C items (Q-Cat C), as shown in Addendum Table 9-1. The primary safety function of these components is to "restrict movement" of the contents or content overpacks within the CV under NCT. These components are credited in the shielding model to evaluate package dose rates under NCT but omitted from shielding model to evaluate package dose rates under HAC. DOE PCP staff finds the shielding model assumptions consistent with the applicant's Q-Cat-C classification of these components.

9.1 Evaluation Findings

Based on review of the statements and representations in the Addendum, DOE PCP staff has reasonable assurance that the package-specific requirements are consistent with their DOE approved QAP, meet the requirements of 10 CFR 71 Subpart H, and are therefore adequate to assure the package will be operated in a manner consistent with its evaluation for approval.

Conditions of Approval

The following changes to the CoC are required to implement Addendum No. 1, Rev. 2 changes evaluated in this SER.

- Drawings 5(a)(3) revise as follows:
 - Change 796849 to Rev 001 for Graphite Filler Block for FSO (Drawing change required for the minor design change).
 - Add 1009022, Rev. 001, Fuel Storage Overpack (FSO) Weldment (2 Sheets) (new design drawing for FSO Container).
 - Add 1009094, Rev. 001, Oak Ridge Inner Shipping Capsule Weldment (2 Sheets) (new design drawing for ORNL PuO₂ powder capsule).
 - Add 26Y1103537, Issue E, WR Fuel Storage Inner Container Assembly (3 Sheets) (authorized container drawing for ORNL PuO₂ powder).
- Contents 5(b)(2), revise Shipping Configuration 7 as follows:
 - **“Shipping Configuration 7—FSO Container.** Up to 175 g of ORNL PuO₂ powder will be placed in a powder capsule or container (Drawing 1009094 or 26Y1103537) and one powder capsule or container will be placed in an FSO Container. Each FSO Container ...” (Added authorized PuO₂ powder capsule/container for the FSO Container).
- Conditions 5.(d) revised:
 - (10) “... Revisions 8 and 9 of this certificate may be used until July 31, 2022.”
- Supplements 5.(e) added:
 - (5) “Safety Analysis Report for Packaging (SARP) for the 9516 Package, Addendum No. 1, R1033-0065-ES, Rev. 2, October 2021”

Conclusion

Based on the statements and representations contained in SARP Rev. 4, Addendum No. 1, Rev. 2, and the conditions listed above, DOE PCP staff concludes that the package design has been adequately described and evaluated, and the Model 9516 package continues to meet the requirements of 10 CFR Part 71.

References

- [1] *FW: DOE-EM docket request*, Email Carl Friesen to Shuler, September 15, 2021.
- [2] *Safety Analysis Report for Packaging (SARP) for the 9516 Package, Addendum No. 1, R1033-0065-ES, Rev. 2a*, dated September 2021 (submitted October 4, 2021)
- [3] *Docket 21-56-9516 Technical Review Complete*, Memorandum Shuler to Friesen, October 7, 2021.
- [4] *Safety Analysis Report for Packaging (SARP) for the 9516 Package, Addendum No. 1, R1033-0065-ES, Rev. 2*, dated October 2021 (submitted October 25, 2021).