U.S. DEPARTMENT *of* ENERGY

Office of Environmental Management

*DOE Packaging Certification Program*

# SAFETY EVALUATION REPORT
# Letter Amendment of Certificate of Compliance No. 9516 for the Model 9516 Package

**Docket No. 26-01-9516**

Prepared by: CHRISTOPHER CABLE Digitally signed by CHRISTOPHER CABLE Date: 2025.11.12 08:23:36 -05'00'

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This Safety Evaluation Report (SER) documents the U.S. Department of Energy (DOE) Packaging Certification Program (PCP) independent review of a supplement to the Safety Analysis Report for Packaging (SARP) for the 9516 Package, prepared by Pacific Northwest National Laboratory (PNNL) for the Idaho National Laboratory (INL) on behalf of the Idaho Operations Office (ID) for amendment of DOE Certificate of Compliance (CoC) Number 9516, Revisions 13 (under timely renewal) and 14 (pending issuance), for the Model 9516 package design.

**Evaluation**

DOE CoC 9516, Revision 13 (under timely renewal) and Revision 14 (pending issuance), Table 1 – *Plutonium Initial Isotopic Limits*, limits individual actinide impurities, such as Am-241, Np, U, and Th, in plutonium oxide ($PuO_2$) to 1-wt.% for Shipping Configurations 1 ($PuO_2$ fuel pellets) and 7 ($PuO_2$ powder).

The applicant reported that recently produced $PuO_2$ fuel pellet encased in four General Purpose Heat Source (GPHS) Fueled-Clads (FC) prepared for Shipping Configuration 1 and $PuO_2$ powder contents packaged in one welded fuel storage overpack (FSO) container prepared for Shipping Configuration 7 exceed the 1-wt.% limit for U-234, but in all other respects meet the CoC content requirements for these shipping configurations.

By email [1] dated September 30, 2025, DOE-ID submitted a request to increase the U-234 limit for Shipping Configurations 1 and 7 to a maximum of 5-wt.% for use of the packaging for shipment of this off-spec. material. The application in support of this request is a supplement [2] to the SARP [3, 4] that demonstrates this increase of U-234 does not affect safety basis of the package certification by the DOE Certifying Official.

The applicant evaluated the impact of the U-234 limit increase with respect to each chapter of the SARP, as supplemented, to demonstrate it does not affect the safety basis of the DOE CoC. This increase does not require any change to the packaging design, shipping configuration arrangement, or any other content limit for Shipping Configurations 1 and 7 evaluated in the SARP and authorized in the CoC.

DOE PCP staff confirmed by document review that the applicant's existing evaluation in SARP Rev.2, as supplemented (safety basis for CoC Rev. 13) and SARP Rev. 6 (pending approval as the safety basis in DOE CoC Rev. 14), bounds this increase wt.% of U-234 of GPHS FC and FCO for Shipping Configurations 1 and 7 respectively.

**1. Packaging and Contents**

There were no changes requested by the applicant or required to the packaging to increase the U-234 wt.% limit to 5% of the $PuO_2$ pellets or powder for Shipping Configurations 1 and 7, respectively. The applicant did not request any other contents changes per SARP Table 1-1, *Plutonium Initial Isotopic Limits* and Table 1-2, *Maximum Specific Neutron Emission Rate and Wattage, and Approximate Fuel Density for Plutonium Dioxide in the 9516 Package*, or the package configurations authorized in the CoC.

Based on review of the statements and representations in the application, DOE PCP staff concludes that the package design has been described in sufficient detail to provide an adequate basis for its evaluation relative to the regulatory requirements in 10 CFR 71.

## 2. Structural Evaluation

There were no changes requested by the applicant or required to the packaging to increase the U-234 wt.% limit to 5% of the $PuO_2$ pellets or powder for Shipping Configurations 1 and 7, respectively. The content mass and decay heat limits authorized in the CoC remain the same. In addition, this limit increase of U-234 would not increase the maximum pressures in the package containment vessel (CV) under both normal conditions of transport (NCT) or hypothetical accident conditions (HAC), due to the age of the material, that is, there is insufficient time to generate significant pressure.

Based on review of the statements and representations in the application, DOE PCP staff concludes that the existing package structural design is sufficient to meet the requirements of 10 CFR Part 71 for shipment of these contents.

## 3. Thermal Evaluation

There were no changes requested by the applicant or required to the packaging to increase the U-234 wt.% limit to 5% of the $PuO_2$ pellets or powder for Shipping Configurations 1 and 7, respectively. The decay heat limits authorized in the CoC remain the same.

DOE PCP staff confirmed by document review that this increase of U-234 does not change the parameters affecting the maximum allowable fuel age per SARP Section 3.3.2.2, Appendix 3.5.7, and authorized in the CoC. Since these $PuO_2$ pellets and powder with increased U-234 were only recently produced, helium gas generation from decay heat will be limited.

Based on review of the statements and representations in the application, DOE PCP staff concludes that the existing package thermal design is sufficient to meet the requirements of 10 CFR Part 71 for shipment of these contents.

## 4. Containment Evaluation

There were no changes requested by the applicant or required to the packaging to increase the U-234 wt.% limit to 5% of the $PuO_2$ pellets or powder for Shipping Configurations 1 and 7, respectively. The applicant did not request any other changes to the contents. The estimated activity (Ci) for the package is described in SARP Section 4.3.4, *Special Requirements* and shown in SARP Table 4-1. *Determination of $A_2$ in Payload*, based on 500 W generated from Pu-238 at 0.568 watts/gram (approximately 880.3 grams of Pu-238 at 74 wt.%) and then applying the result to the isotopic distribution in SARP Table 1-1. The estimated maximum activity for the package is 15,930 Ci, per the SARP and CoC.

If added to SARP Table 4.1, 5 wt.% U-234 would result in 59.5 grams of U-234, which would increase the package activity by approximately 0.6 Ci.

Based on review of the statements and representations in the application, DOE PCP staff concludes that the existing package containment design is sufficient to meet the requirements of 10 CFR Part 71 for shipment of these contents.

## 5. Shielding Evaluation

There were no changes requested by the applicant or required to the packaging to increase the U-234 wt.% limit to 5% of the $PuO_2$ pellets or powder for Shipping Configurations 1 and 7, respectively. The applicant did not request any other changes to the contents. The existing shielding evaluation of the package is driven by two primary radiation sources, neutrons and gamma-photons.

The dominant neutron source is from (α, n) reactions and spontaneous fission, both of which are overwhelmingly attributed to Pu-238 (99.96% and 99%, respectively). U-234 is not a significant contributor to the neutron production mechanisms. Since the limits for Pu-238 are not changing, increasing the U-234 limit from 1 wt.% to 5 wt. % will have a negligible impact on the neutron source term and the external neutron dose rate.

The external gamma dose rate is primarily dictated by high-energy gamma rays (2.61 MeV) originating from the decay of Pu-236 to Tl-208. U-234 emits predominantly low-energy gammas with a very low yield, which cannot penetrate the stainless-steel walls of the CV and the cask. Since the limits for Pu-236 are not changing, increasing the U-234 limit from 1 wt.% to 5 wt. % will have a negligible impact on the external gamma dose rate.

Based on review of the statements and representations in the application, DOE PCP staff concludes that the existing package shielding design is sufficient to meet the requirements of 10 CFR Part 71 for shipment of these contents.

## 6. Criticality Evaluation

There were no changes requested by the applicant or required to the packaging to increase the U-234 wt.% limit to 5% of the $PuO_2$ pellets or powder for Shipping Configurations 1 and 7, respectively. The applicant did not request any other changes to the contents.

For nuclear criticality safety, U-234 is a non-fissile radioisotope and an effective neutron poison by absorbing neutrons without causing fission. Increasing the amount of U-234 in Shipping Configurations 1 and 7 would reduce the overall neutron multiplication factor (max $k_{eff}$ = 0.85773 per SARP Table 6-1, *Summary of Criticality Safety Evaluation Results*) of the package.

Based on review of the statements and representations in the application, DOE PCP staff concludes that the existing package criticality design is sufficient to meet the requirements of 10 CFR Part 71 for shipment of these contents.

## 7. Package Operations

There were no changes requested by the applicant or required to the packaging to increase the U-234 wt.% limit to 5% of the $PuO_2$ pellets or powder for Shipping Configurations 1 and 7, respectively. The applicant did not request any other changes to the contents.

There are no changes to the loading configurations per SARP Table 1-4, *9516 Package Content Shipping Configurations.* SARP Section 7.1.1, *Preparations for Loading*, Steps 3 and 4, and SARP Section 7.1.2, Loading of Contents, Step 1, are superseded to prepare and load the contents referenced in Table 1-1, *Plutonium Initial Isotopic Limits* of the application, which added the U-234 wt.% limit.

Based on review of the statements and representations in the application, DOE PCP staff concludes

that the operating procedures meet the requirements of 10 CFR Part 71 and that these procedures are adequate to assure the package will be operated in a manner consistent with its evaluation for approval.

**8. Acceptance Tests and Maintenance Program**

There were no changes requested by the applicant or required to the packaging to increase the U-234 wt.% limit to 5% of the $PuO_2$ pellets or powder for Shipping Configurations 1 and 7, respectively.

Based on review of the statements and representations in the application, 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. Quality Assurance**

There were no changes requested by the applicant or required to the packaging to increase the U-234 wt.% limit to 5% of the $PuO_2$ pellets or powder for Shipping Configurations 1 and 7, respectively.

Based on review of the statements and representations in the application, DOE PCP staff concludes that the applicant's QA program has been adequately described and meets the QA requirements of 10 CFR 71.

**Conclusion**

Based on the statements and representations in this application to supplement the SARP, and the conditions listed in this SER, DOE PCP staff independently confirmed by document review that the package content change has been adequately described and evaluated. Therefore, the staff has reasonable assurance the Model 9516 package design continues to meet the requirements of 10 CFR Part 71, recommends approval and issuance of a letter amendment to the CoC by the DOE Headquarters Certifying Official (HCO).

**Conditions of Approval**

The following conditions are required in a letter of authorization issued by the DOE HCO to authorize use of the package for limited shipments of Shipping Configurations 1 and 7.

DOE CoC No. 9516, Revision 13 (under timely renewal) and Revision 14 (pending issuance), are amended to authorize use of the Model 9516 package for limited shipments subject to the conditions below:

1. The plutonium oxide contents for Shipping Configurations 1 and 7 must not exceed 5-wt.% U-234.
2. For all other individual actinide impurities (Am-241, Np, U, and Th) in Shipping Configurations 1 and 7, the limit remains at 1-wt.%.
3. All other conditions of DOE CoC No. 9516 shall remain the same.
4. This authorization expires on November 30, 2027.

**References**

[1] *FW: CCN 258982 9516 Request for Amendment*, Email, N. McBride to J. Shenk, dated September 30, 2025.

[2] *Safety Analysis Report for Packaging (SARP) for the 9516 Package - Safety Evaluation for the 9516 Package Certificate of Compliance Letter Amendment for Shipping Configurations 1 and 7 with an Increased $^{234}U$ Content*, Application, dated September 2025.

[3] *Safety Analysis Report for Packaging (SARP) for the 9516 Package*, R1033-0062-ES, Rev. 2, January 2020, as supplemented per DOE CoC Rev. 13, Section 5.e.

[4] *Safety Analysis Report for Packaging (SARP) for the 9516 Package*, R1033-0062-ES, Revision 6, June 2025 (pending approval in DOE CoC 9516, Revision 14).