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DOE Packaging Certification Program

Safety Evaluation Report for Content Amendment for Oak Ridge National Laboratory Pu-238 Oxide Fuel Shipping Configurations in the Model 9516 Package

Docket No. 16-28-9516

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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 submitted by the Idaho National Laboratory (INL) requesting an amendment to DOE Certificate of Compliance Number (CoC) 9516 to authorize two new Pu-238 Oxide Fuel content configurations in the Model 9516 package.

Summary

By letter [1] dated June 16, 2016, as supplemented [2 - 5] October 19 and November 23, 2016, and February 14, 2017, the Space Nuclear Systems and Technology of Idaho National Laboratory (INL) submitted the *Safety Analysis Report for Packaging for the 9516 Package, USA/9516/B(U)F-96 (DOE), Addendum 1*, R1033-0065-ES, Revision a (and Revision a page changes), [2, 3, & 4] and Revision b [5] page-changes, to the DOE Packaging Certification Program (PCP) for review and confirmatory analysis to authorize two new Pu-238 oxide fuel content configurations in Model 9516 package. At the conclusion of the PCP review and confirmatory evaluation, INL implemented all the document changes from Revisions "a" and "b" and submitted Revision 0 [6] of Addendum 1 as the final safety basis document in support of this request and supplement to the DOE CoC.

Addendum 1, Revision 0, adds two new Pu-238 Oxide Fuel (PuO_2) content configurations for ground transport: Shipping Configuration 7 is the Fuel Storage Assembly Powder Overpack (FSO) and Shipping Configuration 8 is the General Purpose Heat Source Fueled Clad Assembly (GPHS FCA).

Shipping Configuration 7 requires additional packaging components, but does not affect the existing package design authorized in the current CoC and evaluated in the Safety Analysis Report for Packaging (SARP). Shipping Configuration 8 uses packaging components currently authorized in the CoC that were evaluated in the SARP for Shipping Configuration 1 – GPHS FCA, except Configuration 8 is limited to five GPHS FCAs.

On the basis of the statements and representations in Addendum 1, Revision 0, and PCP staff's confirmatory evaluation as summarized in this SER, staff finds the addition of the Shipping Configurations 7 and 8 in the Model 9516 package acceptable, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

This SER will hereafter refer to the all the documents [2-6] submitted by INL for this docket as the "Addendum", unless otherwise specified, and "CoC" and "SARP" based on Revision 2 of the DOE CoC and its SARP and supplement.

Evaluation

1.0 General Information

1.1 Packaging Description

There are no changes to the existing Model 9516 package design or operational features authorized in the CoC and evaluated in the SARP; however, new packaging components are required for Shipping Configuration 7. Shipping Configuration 8 uses packaging components currently authorized in the CoC and evaluated in the SARP. The packaging components for each configuration are listed in Table 1.2 of the Addendum, and are adequately described in the Addendum.

Shipping Configuration 7 – FSO Container

Configuration 7 consists of the following new components used within the Containment Vessel (CV), for one or two FSO Containers per CV:

Configuration 7 Packaging Components (for one or two FSO per CV)	Drawing No.
Fuel Storage Assembly Power Over-Pack (Item 1)	55Y-002875-1
Pu-238 Inner Shipping Capsule	N3E020995A518
Fuel Storage Primary (Item 8) Fuel Storage Inner Container Assy.	55Y-002875 26Y1103537-1
Graphite Support Block for FSO	796848
Graphite Filler Block for FSO	796849

For this configuration, the CV can hold a maximum of two FSO Containers. The FSO Container is loaded with either a Pu-238 Inner Shipping Capsule or Fuel Storage Primary/Fuel Storage Inner Container Assy., filled with Pu-238 Oxide powder, and then placed in the recess of the Graphite Support Block for FSO. A Graphite Filler Block for FSO is placed between the two support blocks and another one at the top of the CV. One or two FSO Containers may be loaded in the CV. For the single FSO Container arrangement in the CV, it may be placed in either the top or bottom support block. The two FSO Container loading arrangement is illustrated in Figure 1-3 of the Addendum.

The FSO Container weighs approximately 3.9 lb. (1.77 kg) is approximate 2.875 in. (7.3 cm) in diameter and 6.69 in. (17 cm) long. The container is constructed of austenitic standard grade stainless steel, Type 347H, which was selected for its strength at elevated temperatures. The wall thickness of the container body is nominally 0.125 in. (0.32 cm). The container uses an internal threaded plug and a small perfluoroelastomer O-ring seal to help prevent the spread of any potential contamination from the PuO_2 material in Capsule or Inner Container. The FSO Container has a welded closure and is manufactured according to the specifications identified in Los Alamos National Laboratory (LANL) drawing 55Y-002875, Part Number 55Y-002875-1.

The Pu-238 Inner Shipping Capsule weighs approximately 1.8 lb. (0.82 kg), is constructed of 316 stainless steel, and has a Swagelok fitting closure. The capsule is approximately 1.9 in. (4.8

cm) in diameter and 4.5 in. (11.4 cm) long and is manufactured in accordance with ORNL drawing N3E020995A518.

The Fuel Storage Primary/Fuel Storage Inner Container weighs approximately 1.1 lb. (0.5 kg), is constructed of either 304L or 316L stainless steel, and has a threaded closure on both ends. The container is approximately 1.9 in. (4.8 cm) in diameter and 3.9 in. (9.9 cm) long and is manufactured in accordance with LANL Drawing 26Y1103537, Part Number 26Y1103537-1, and called out as Item 8 on LANL Drawing 55Y-002875.

The Graphite Support Block for FSO weighs approximately 6.1 lb. (2.8 kg) and is constructed from GrafTech ATJ, Poco TM, or Poco PLS-1. The block is approximately 6.0 in. (15.2 cm) in diameter and 6.7 in. (17.0 cm) long and is manufactured in accordance with INL Drawing 796848.

The Graphite Filler Block for FSO weighs approximately 0.9 lb. (0.4 kg) and is constructed from GrafTech ATJ, Poco TM, or Poco PLS-1. The block is approximately 5.75 in. (14.6 cm) in diameter and 0.75 in. (1.9 cm) long and is manufactured in accordance with INL Drawing 796849.

The Graphite Support Block for FSO and Graphite Filler Block for FSO are classified as minor important-to-safety items and are credited only for radiation shielding (i.e., fixed spacing) under Normal Conditions of Transport (NCT). The FSO Container, ^{238}Pu Inner Shipping Capsule, and Fuel Storage Primary/Fuel Storage Inner Container are only used for convenience handling and contamination control.

The maximum fully loaded weight of the internal packaging components and convenience containers with PuO_2 powder for Shipping Configuration 7 is approximately 26.2 lb. (11.9 kg).

Shipping Configuration 8 - General Purpose Heat Source Fueled Clad Assembly (GPHS FCA)

Configuration 8 consists of the following authorized packaging components, within the CV, for one or two FCAs loaded in a Welded Product Can:

Configuration 8 Packaging Components (for one or two FCAs in a Product Can)	**Drawing No.**
Cylinder Product Can (*welded*) - Graphite Filler - Graphite Support - Graphite Cushion	756180
PuO_2 Powered Can Set - Product Can (optional threaded) - Graphite Filler Block - Graphite Support	756186

Configuration 8 Packaging Components (for one or two FCAs in a Product Can)	**Drawing No.**
Graphite Support Blocks For Product Cans	756185
Liner 5.75 High (*inches*)	756182
Graphite Filler Block (*3.38 in. high*)	756183
Optional Graphite Filler Block (replaces liner)	756183

For this configuration, the packaging components and arrangement are identical to *Shipping Configuration 1 – GPHS FCA* in the CoC and SARP, except for the arrangement discussed below: the essential difference is that the CV can only hold a maximum of five GPHS FCAs for Shipping Configuration 8, due to the plutonium mass limit of 1,000 g.

For Configuration 8, there may be one or two FCAs per Product Can, and each Product Can may be placed in any of the four recesses of the Graphite Support Block for Product Cans. For a Product Can with only one FCA, the FCA can be located in either the upper or lower position in the Product Can.

Product Cans and the Graphite Support Block for Product Cans are housed within a Liner (5.75 inches high), and two Liners, separated by the Graphite Filler Block, are allowed within the CV, as shown by Figure 1-10 of the SARP.

In the bottom Liner, only one FCA is allowed in either the upper or lower position in a Product Can and the Product Can is allowed in any of the four recesses in the Graphic Support Block. The other three recesses in the Graphic Support Block in the bottom Liner may be left empty. In the top Liner, a maximum of four FCAs are allowed.

1.2 Contents

The Addendum adds two new shipping configurations for PuO_2 manufactured by the Oak Ridge National Laboratory (ORNL). Shipping Configuration 7 is for PuO_2 powder produced at ORNL, while Shipping Configuration 8 is for General Purpose Heat Source Fueled Clad Assembly with PuO_2 pellets produced from ORNL PuO_2 powder for the DOE Space and Defense Power Systems Program. This Addendum is necessary because of the higher isotopic content for plutonium isotopes produced at ORNL. Specifically, the Pu-236 is increased to 6 ppm (vs. 2 ppm in the existing SARP) and the allowable Pu-238 content range is set at 80-92% (vs. 74-90% in the existing SARP). This higher isotopic content serves to provide bounding values for newly-generated PuO_2 powder, the processes of which are currently under development.

Shipping Configuration 7 – FSO Container

Approximately 150 g of the PuO_2 powder is placed in a Pu-238 Inner Shipping Capsule or Fuel Storage Primary/Fuel Storage Inner Container, and only one of these items may be placed in an

FSO Container. Each FSO Container will have a maximum heat generation rate of 70 W, for a total of 140 W per 9516 package when the maximum of two FSO Containers per package are shipped.

The loaded CV weight for the two FSO Container shipping configuration is approximately 47.2 lb., which is well below the loaded CV weight of 72.2 lb. evaluated in the SARP.

Shipping Configuration 8 - General Purpose Heat Source Fueled Clad Assembly (GPHS FCA)

The PuO_2 is encased in an iridium alloy capsule (i.e., fuel pellet). The fuel pellets are packaged in GPHS FCAs. The maximum amount of plutonium authorized in the package is 1,000 g, which limits the number of FCAs that can be shipped in one 9516 Package to five. The heat load of the FCA with PuO_2 fuel pellets is nominally 63 W. The total heat load is limited to 255 W per Liner and 350 W per package.

1.3 Criticality Safety Index

The criticality safety index (CSI) of the package is 0 (zero) for the shipping configurations authorized in the CoC. Shipping Configurations 7 and 8 are exempted from being classified as fissile material based on §71.15 and therefore no criticality evaluation is required.

1.4 Radiation Level and Transport Index

The external radiation level and transport index (TI) will be established by measurement at the time of shipment. The external radiation level must meet the §71.47 standards for exclusive use shipment.

1.5 Conclusion

Based on a review of the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff concludes that the package described in Chapter 1 of the SARP, as supplemented by the Addendum, has been adequately described in sufficient detail to provide an adequate basis for its evaluation under 10 CFR Part 71, with Shipping Configurations 7 and 8.

2.0 Structural Evaluation

PC P staff reviewed Chapter 2 of the Addendum for the effects of two new shipping configurations on the structural performance of the package. Staff also evaluated the material compatibility between the container materials for the two new shipping configurations and the existing packaging components.

2.1 Structural Evaluation Results

The weight of the CV loaded with Shipping Configurations 7 and 8 is bounded by the authorized loaded CV weight of 72.2 lb. (32.7 kg) and the center of gravity (CG) value of these two configurations is within the existing range between 13.9 in. (35.3 cm) and 14.3 in. (36.3 cm) with the minimum and the maximum content configurations. In addition, the new packaging components used for Configuration 7 are made of stainless steels with similar mechanical

properties as the authorized content containers. Therefore, the structural analysis in the existing SARP remains valid.

The FSO Container for Shipping Configuration 7 is fabricated from Type 347H stainless steel, Type 316 stainless steel, or Hastelloy C-276. The construction materials associated with Shipping Configuration 8 are the same as those for the approved Shipping Configuration 1 of the package, for which the PuO_2 pellet is encased in iridium alloy capsule within the welded or threaded Product Can made of Type 304 or 304L stainless steel. No chemical or galvanic reaction is expected to occur between the various materials of the contents, the content containers, and the package components.

2.3 Evaluation Findings

Based on review of the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the structural design and performance of the package described in Chapter 2 of the SARP, as supplemented by the Addendum, acceptable for Shipping Configurations 7 and 8, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

3.0 Thermal Evaluation

PCP staff reviewed the thermal design and performance of the package for Shipping Configurations 7 and 8, as described in Chapter 3 of the Addendum, particularly the applicant's detailed pressure calculation in Section 3.3.2 of the Addendum for the FSO Container configuration. The staff's review focused on the decay heat loads of Shipping Configurations 7 and 8, and the pressure buildup in the CV resulting from 1) the helium gas generation from the PuO_2 content and 2) offgassing of the perfluoroelastomer O-ring in the FSO Containers.

3.1 Thermal Evaluation Results

Decay heat load

The total maximum decay heat load is 140 watts for Shipping Configuration 7 with two FSO Containers, and 350 watts for Shipping Configuration 8 with five GPHS FCAs (four FCAs in the top Liner and one FCA in the bottom Liner), as described in the Addendum. These decay heat loads are both bounded by the maximum thermal loading limit of 500 watts for the package. Furthermore, the decay heat load for Shipping Configuration 8 is lower than the 255 W maximum per Liner.

Maximum allowable age of PuO_2 at end of shipping period

Table 3-13 of the SARP shows that the calculated maximum allowable age of PuO_2 for each authorized shipping configuration ranges from 61 to 405 months. Shipping Configuration 7 has two FSO Containers with a total decay heat load of 140 W (70 W each), which is less than the authorized decay heat load of 250 W. Furthermore, the total CV void volume for Shipping Configuration 7 is 155 in^3 (2.54 liter), which is larger than the content CV void volume of 42.7 to 47.9 in^3 (0.7 to 0.78 liter) shown in Table 3-11 of the SARP. The maximum allowable age of

PuO_2 for Shipping Configuration 7 is, therefore, conservatively set at 405 months because of the lower decay heat load and larger CV void volume, than the authorized shipping configurations listed in Table 3-13 of the SARP.

Shipping Configuration 8 is identical to the GPHS FCA Shipping Configuration 1 authorized in the CoC, which has a maximum allowable PuO_2 age of 86 months. Compared to Shipping Configuration 1, which can have eight GPHS FCAs with a maximum total decay heat load of 500W, Shipping Configuration 8 is limited to 5 GPHS FCAs and a total decay heat load of 350W. Furthermore, the void volume in the CV for Shipping Configurations 1 and 8 are the same; therefore, the maximum allowable age of PuO_2 for Shipping Configuration 8 is conservatively set at 86 months.

Maximum pressure in the CV

Under NCT, the maximum normal operating pressure for Shipping Configurations 7 and 8 is bounded by Shipping Configuration 1 in the SARP. Under Hypothetical Accident Conditions (HAC), the pressure in the CV will increase for Shipping Configuration 7 because of thermal decomposition of the perfluoroelastomer O-ring (4.1 grams) in the FSO Container. The applicant summarized the pressure increase in Section 3.3.2 of the Addendum.

PCP staff reviewed the applicant's calculations and references regarding the thermogravimetric experimental data (Sugama et. al., BNL Report BNL-107544-2014-IR, November 1, 2014) and the thermal decomposition study of the O-ring material (Wang and Legare, Journal of Fluorine Chemistry, Volume 122, Issue 1, 1 July 2003, Pages 113-119). PCP staff confirmed the calculated total pressure of 147.3 psig (1.02 MPa) in the CV is below the CV design pressure limit of 200 psig (1.38 MPa).

3.2 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds thermal design and performance presented in Chapter 3 of the SARP, as supplemented by the Addendum, acceptable for Shipping Configurations 7 and 8, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

4.0 Containment

The FSO Container with ORNL PuO_2 powder in Shipping Configuration 7 and GPHS FCA with PuO_2 pellets in Shipping Configuration 8 use the same containment system authorized in the CoC and described in the SARP. The CV is a welded stainless steel can and provides a leaktight containment boundary for the contents of the package. The new shipping configurations do not affect the containment system of the package.

4.1 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the containment design and performance described in Chapter 4 of the SARP, as supplemented by the Addendum, acceptable for Shipping Configurations 7 and 8 and

will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

5.0 Shielding Evaluation

PCP staff reviewed the shielding analysis of the package as described in Chapter 5 of the SARP and the Addendum, and the new shielding calculations based on the proposed isotopic limits for Pu-236 (6 ppm), Pu-238 (90-92%), and neutron emission rate of 18,000 n/s/g of Pu-238. Staff calculated the neutron and photon source terms using the ORIGEN module of the Standardized Computer Analysis for Licensing Evaluation (SCALE) package, Version 6.2.1 and performed Monte Carlo analyses using MCNP6 to independently verify the shielding calculations for both NCT and HAC, as well as the six-package exclusive use shipment on a single conveyance.

5.1 Description of the Shielding Design

The package does not contain materials specifically intended for radiation shielding. However, the stainless steel cask body, stainless steel CV, and graphite packing materials provide radiation attenuation. The external radiation level requirements in 10 CFR 71 for a single package are met by (1) restricting the isotopic content of the PuO_2 source material, (2) maintaining the distance between the source material and the external surface of the package, and (3) properly spacing multiple packages on the transport vehicle.

The drawings in the SARP and Addendum provide the dimensions of the relevant packaging components. Chapter 2 of the SARP, as supplemented by the Addendum, provides material specifications for the packaging components.

5.2 Source Specification

Table 5-3 of the Addendum shows the isotopic content of the ORNL PuO_2 powder and pellets used for the shielding calculations. Shipping Configuration 7 is loaded with a maximum of two FSO Containers in the CV, and Shipping Configuration 8 is loaded with a maximum of five GPHS FCAs in the CV. The fuel composition of the five GPHS FCAs in a single package used for the photon and neutron source term calculations is shown in Table 5-5 of the Addendum. The fuel composition of two FSO Containers in a single package used for the photon and neutron source term calculations is shown in Table 5-9 of the Addendum. The PuO_2 powder containing 80-weight % Pu-238, yields the maximum photon activity in the energy range of concern for personnel dose and occurs when the powder has decayed for 17.5 years, as shown in Tables 5-6 and 5-10 of the Addendum.

The total neutron sources calculated with ORIGEN are below the allowable limits based on the specific neutron emission rate limit of 18,000 n/s/g of Pu-238 for both the 10-day and 17-year decay times for the two fuel compositions. Therefore, the total neutron source used in MCNP6 was based on the specific neutron emission rate and the total Pu-238 loading for every case. An enrichment of 80-weight % Pu-238 yields the largest source in terms of neutrons/s due to the higher induced fission neutron source from the larger quantity of Pu-239. Because the neutron flux and, therefore, the neutron dose rate, is proportional to the source (as measured in

neutrons/s), the 80-weight % Pu-238 mixture yields the largest dose rate for a shipping container, as shown in Tables 5-12 and 5-14 of the Addendum.

PCP staff used the ORIGEN module of the SCALE package, Version 6.2.1, and the ENDF/B-VII.1 decay data to verify the neutron and photon source terms.

5.3 Shielding Model

PCP staff created MCNP models for all the source configurations shown in Figures 5-2 to 5-9 of the Addendum. Dose rates were calculated at the positions shown in Figure 5-1 of the Addendum, using point detector tallies (F5).

5.4 Shielding Analysis Results

Table 5-1 of this SER compares the Addendum (Tables 5-20 and 5-21) with PCP staff's calculated maximum dose rates for a single package under NCT and HAC. The dose rates presented are for the GPHS FCAs in Shipping Configuration 8, which is higher than that for the FSO Containers in Shipping Configuration 7.

Table 5-1 Maximum Dose Rates for Exclusive Use Shipment of a Single 9516 Package

Normal Conditions of Transport – Exclusive Use Shipment								
	Package surface [a] (mrem/h)		Outer surface of vehicle [b] (mrem/h)		2m from vehicle external surface [c] (mrem/h)		Normally occupied position in vehicle (mrem/h)	
	Addendum	Staff	Addendum	Staff	Addendum	Staff	Addendum	Staff
Photon	76.1	79.4	23.8	22.6	1.00	0.97	1.43	1.38
Neutron	116.0	114.4	49.6	50.0	1.60	1.62	2.25	2.28
Total	192.1	193.8	73.4	72.6	2.60	2.60	3.68	3.66
§71.47(b) Limit [a]	1000		200		10		2.00	
Hypothetical Accident Conditions, 1m from package surface								
	Side (mrem/h)		Top (mrem/h)		Bottom (mrem/h)			
	Addendum	Staff	Addendum	Staff	Addendum	Staff		
Photon	9.76	9.53	11.96	11.51	8.04	7.90		
Neutron	15.56	13.07	18.50	18.81	16.87	16.93		
Total	25.32	22.60	30.46	30.31	24.91	24.83		
§71.51(a)(2) Limit	1000		1000		1000			

[a] For NCT, the package surface is the personnel shield (cage) exterior.
[b] Bottom of the trailer bed.
[c] 2 m from the trailer sidewall.

Table 5-2 of this SER compares the Addendum (Table 5-24) with PCP staff's calculated maximum dose rates for an exclusive use conveyance of six 9516 packages loaded with Shipping Configuration 8.

Table 5-2 Maximum Dose Rates for Exclusive Use Shipment of a Six 9516 Packages

Normal Conditions of Transport – Exclusive Use Shipment						
	Outer surface of vehicle [a] (mrem/h)		2m from vehicle external surface [b] (mrem/h)		Normally occupied position in vehicle (mrem/h)	
	Addendum	Staff	Addendum	Staff	Addendum	Staff
Photon	27.9	27.6	3.47	3.33	1.44	1.40
Neutron	56.3	60.5	5.48	5.51	2.39	2.43
Total	84.2	88.1	8.95	8.80	3.83	3.80
§71.47(b) Limit [a]	200		10		2.0	

[a] Bottom of the trailer bed.
[b] 2m from the trailer sidewall

PCP staff verified that the calculated dose rate for the nearest normally occupied position (i.e., the truck cab) exceeds the 2 mrem/h limit per §71.47(b)(4) and 49 CFR 173.441(b)(4); therefore, Condition 7 of the current CoC is also applicable for Shipping Configurations 7 and 8. Note that these dose rates are based on PuO_2 containing 6.0 ppm Pu-236 and aged for 17.5 years, with a specific neutron emission rate of 18,000 n/s/g of Pu-238, which is the bounding case for the photon and neutron dose, respectively.

5.5 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the shielding design and performance described in Chapter 5 of the SARP, as supplemented by the Addendum, acceptable for Shipping Configurations 7 and 8, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met, subject to the Condition 7 of the CoC.

6.0 Criticality Evaluation

PCP staff reviewed and evaluated the criticality safety design and performance of the package in the SARP and the criticality evaluation for Shipping Configurations 7 and 8 documented in the Addendum.

6.1 Criticality Evaluation

§71.15, "Exemption from classification as fissile material", states, "Fissile material meeting the requirements of at least one of the paragraphs (a) through (f) of this section are exempt from classification as fissile material and from the fissile material package standards of §§ 71.55 and 71.59." Paragraph (f) of §71.15 states "Packages containing, individually, a total plutonium mass of not more than 1000 grams, of which not more than 20 percent by mass may consist of plutonium-239, plutonium-241, or any combination of these radionuclides." For Shipping Configurations 7 and 8, the maximum plutonium mass is 769.6 g and the maximum concentration of the fissile isotopes plutonium-239 + plutonium-241 is no more than

20-weight %; therefore, both shipping configurations are exempted from being classified as fissile material and no criticality evaluation is required.

6.2 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the criticality safety design and performance described in Chapter 6 of the SARP, as supplemented by the Addendum, acceptable for Shipping Configurations 7 and 8, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

7.0 Operating Procedures

PCP staff reviewed the operating procedures described in Chapter 7 of the SARP and Addendum. Procedures for package loading, package unloading, preparation of empty packages for transport, and other operations associated with the age of the authorized content were implemented in the Chapter 7 of the Addendum for Shipping Configurations 7 and 8.

7.1 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the package operating procedures described in Chapter 7 of the SARP, as supplemented by the Addendum, acceptable for Shipping Configurations 7 and 8, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

8.0 Acceptance Tests and Maintenance Program

PCP staff reviewed the acceptance tests and maintenance program described in Chapter 8 of the SARP and Addendum. For the new packaging components of Shipping Configuration 7, the package acceptance tests and maintenance program is the same as outlined in Chapter 8, Section 8.1.1.3 *Internal Components* of the SARP, except that the FSO Container does not utilize a Liner (i.e., Drawing 756182). Therefore, none of the items in the SARP referencing the Liner are applicable to the FSO Container. Shipping Configuration 8 uses packaging components authorized in the CoC and SARP. The addition of the FSO Container and GPHS FCA shipping configurations do not require any additional acceptance tests or maintenance procedures.

8.1 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the acceptance tests and maintenance program described in Chapter 8 of the SARP, as supplemented by the Addendum, acceptable for Shipping Configurations 7 and 8, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

9.0 QUALITY ASSURANCE

PCP staff reviewed Chapter 9 of the Addendum for the Applicant's Quality Category assignment of the packaging components that are important to safety for Shipping Configuration 7 – FSO

Container (i.e., FSO Container, Graphite Support and Filler Blocks for FSO, Pu-238 Inner Shipping Capsule, and Fuel Storage Inner Container powder cans) and Shipping Configuration 8 0 – GPHS FCA with ORNL PuO2 (i.e., Liner, Graphite Support and Filler Blocks, and Product Cans).

9.1 QA Evaluation

Table 9-1 of the SARP lists the function, failure effect, and quality level of the 9516 packaging items (components), based on their importance to safety. Likewise, Table 9-1 of the Addendum, lists the function, failure effect, and quality level of Shipping Configuration 7 and 8 packaging items (components), based on their importance to safety. The applicant assigned all Shipping Configurations 7 and 8 components as Quality Level 3 items (i.e., minor impact on safety). PCP staff concurs with these assignments.

Note: Quality level classifications used by INL for the 9516 packaging are Quality Levels 1, 2, and 3, which correspond to Categories A, B, and C in Regulatory Guide 7.10, *Establishing Quality Assurance Programs for Packaging Used in Transport of Radioactive Material* and NUREG/CR-6407, *Classification of Transportation Packaging and Dry Spent Fuel Storage System Components According to Importance to Safety.*

9.2 Evaluation Findings

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff finds the quality assurance program described in Chapter 9 of the SARP, as supplemented by the Addendum, acceptable for Shipping Configurations 7 and 8, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

Conditions of Approval

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

- Packaging Description 5.(a)(2), last paragraph was revised from "All contents …" to "All contents for Shipping Configurations 1 through 6, and 8 …"
- Packaging Description 5.(a)(2), new paragraph added to describe the packaging components for the contents of Shipping Configuration 7.
- Drawings 5.(a)(3) was revised to add the Graphite Filler Block and Graphite Support Block drawings for Shipping Configuration 7.
- Contents 5.(b)(1) and Table 1 were revised to delineate the Shipping Configuration groupings and add the ORNL PuO_2 for Shipping Configurations 7 and 8.
- Contents 5.(b)(2) was revised for Shipping Configurations 7 and 8.
- Contents 5.(b)(2) was revised to correct the density for Shipping Configuration1 from "9.53" to "9.63", ref. SARP, page 5-8.
- Condition 5.(d)(2) was revised to include for Shipping Configuration 8 with Shipping Configuration 1 through 6, and to add Shipping Configuration 7 with 405 month age.
- Condition 5.(d)(3) was revised to refer to Chapter 7 of Addendum 1.

- Condition 5.(d)(8) was revised from "... of Chapter 9 of the SARP " to "...of Chapter 9 of the SARP, as supplemented by Addendum 1."
- Condition 5.(d)(13) was added to authorize the use of Revision 2 of the certificate until September 30, 2017.
- Conditions 5.(d)(14)-(15) were added to clarify the basis for the DOE CoC and user restrictions.
- Supplement 5.(e) was renumbered to 5.(e)(1)
- Supplement 5.(e)(2) was added for this Addendum, "Safety Analysis Report for Packaging (SARP) for the 9516 Package, Addendum 1, Revision 0, May 2017."

Conclusion

Based on the statements and representations in the Addendum and PCP staff's confirmatory evaluation, staff concludes that the package design described in the SARP, as supplemented by the Addendum, has been adequately described and evaluated for the Model 9516 and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met, subject to the Conditions in the CoC and listed above.

References

[1] *Contract No. DE-AC07-05ID14517 – Safety Analysis Report for Packaging for the 9516 Package, USA/9516/B(U)F-96 (DOE), Addendum 1, Revision a, Docket 16-28-9516,* CCN 238357, Stephen G. Johnson, Space Nuclear Systems and Technology of Idaho National Laboratory, to Alice Caponiti, NE-75, Office of Space and Defense Power Systems, U.S. Department of Energy, June 16, 2016.

[2] *Safety Analysis Report for Packaging (SARP) for the 9516 Package, Addendum 1,* R1033-0065-ES, Revision a, June 2016.

[3] *Safety Analysis Report for Packaging (SARP) for the 9516 Package, Addendum 1,* R1033-0065-ES, Revision a, revised Chapter 3, October 19, 2016.

[4] *Safety Analysis Report for Packaging (SARP) for the 9516 Package, Addendum 1,* R1033-0065-ES, Revision a revised Chapter 5, November 11, 2016.

[5] *Safety Analysis Report for Packaging (SARP) for the 9516 Package, Addendum 1,* R1033-0065-ES, Revision b, Chapter 3 and 9 page-changes, February 2017.

[6] *Safety Analysis Report for Packaging (SARP) for the 9516 Package, Addendum 1,* R1033-0065-ES, Revision 0, May 2017.