Safety Evaluation Report for the

the Letter Amendment Request for Shipment of Lawrence Livermore National Laboratory Neptunium Oxide in the 9975-96 Packaging

Docket Number: 10-60-9975

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Summary

By memorandum COR-OM-8/30/2010-278509, dated October 1, 2010, the National Nuclear Security Administration (NNSA), Livermore Site Office, requested a one-time, one-way shipment campaign of neptunium oxide in the 9975-96 packaging. Specifically, the memorandum transmitted the document, "Justification for Shipment of Lawrence Livermore National Laboratory (LLNL) Neptunium Oxide in the 9975 Packaging" (LLNL-AR-456191),[1] and formally requested an amendment to the existing Certificate of Compliance (CoC)[2] of the 9975-96 packaging for the movement of neptunium oxide in a one-time, one-way shipment campaign involving three shipments to two sites.

Although the 9975-96 packaging is currently authorized to transport neptunium oxides as Content C.8 in the existing CoC,[2] the requested shipments fall slightly outside the authorized content envelope. It is proposed that the shipments will be performed in support of NNSA's Complex Transformation, where LLNL is processing and shipping their Security Category I/II nuclear materials off-site.

The nuclear material inventory of concern must be at a Security Category III level by the end of FY 2012. As part of the de-inventory effort, LLNL needs to ship three 9975-96 Type B Radioactive Material packages with neptunium oxide content to two DOE facilities (one item to the Los Alamos National Laboratory, and two items to the Nevada Nuclear Security Site). The mass of neptunium-237 in each of these containers will be less than 1 kg.

The initial "Justification for Shipment"[1] and the reference 9975-96 Safety Analysis Report for Packaging (SARP),[3] were reviewed by the Department of Energy (DOE) Packaging Certification Program (PCP) Staff with a view to determining (a) whether the 9975-96 package design with the proposed neptunium oxide contents satisfies the relevant Department of Transportation (DOT) and Nuclear Regulatory Commission (NRC) regulatory safety requirements as specified in Title 49 of the Code of Federal Regulations (CFR) Part 173 and Title 10 of the CFR Part 71, respectively; and (b) whether the request for letter amendment was sufficient to ensure that it fully satisfies the requirements of DOE Order 460.1C.

Following the review of these two documents, one outstanding issue was identified, from which a single question (Q1) was raised. This Q1 was transmitted in a memorandum[4] by Dr. J. M. Shuler, PCP Manager, to the manager of the Livermore Site Office on March 1, 2011. The question addressed inconsistencies between Chapter 1 and Chapter 7, and requested that the necessary revisions be made in the "Justification for Shipment" document relative to the inerting requirements such that they are consistent within the document.

The applicant initially responded to the Q1 and through a series of draft documents and telephone conferences a new revision of the document was created. Based on the finalized April 12, 2011, Revision 1, "Justification for Shipment",[5] the DOE PCP determined that the applicant's response to the Q1 question appropriately resolved the outstanding issue.

Based on the statements and representations in Revision 1 of the "Justification for Shipment",[5] the SARP,[3] and the DOE PCP Staff's confirmatory evaluation as summarized in this Safety Evaluation Report (SER); the DOE PCP finds the design and performance of the 9975-96 packaging acceptable for the transport of less than 1 kg of neptunium oxide when placed inside the 9975-96 packaging elements, and will provide reasonable assurance that the regulatory

requirements of 10 CFR Part 71, 49 CFR Part 173 and DOE Order 460.1C have been met for the one-time, one-way shipment campaign of three shipments of the neptunium oxide to two sites.

Evaluations of the design and performance of the packaging for safety and regulatory compliance in structural, thermal, containment, shielding, criticality safety, operational procedures, acceptance tests and maintenance, and quality assurance with respect to the Letter Amendment Request are given in the remaining sections of this SER. This SER builds upon the SER issued for the 9975-96 packaging design in June 2008,[6] which addressed multiple contents.

Normally, modified contents are added to a revision of the CoC; however the contents identified in this request are for one-time, one-way shipment campaign and can be authorized with a letter amendment to the CoC. DOE PCP has concluded that the following conditions of approval, which are addressed in this SER, will be stated in the letter amendment:

For the one-time, one-way shipment campaign of neptunium oxide in the 9975-96 packaging, the components inside the primary containment vessel (PCV) and the spaces in the PCV and secondary containment vessel (SCV) shall be inerted as follows:

(a) the convenience can(s) shall be inerted with nitrogen to less than 3 volume percent oxygen (O_2),

(b) the space between the convenience can(s) and the 3013 inner can shall be inerted with helium to less than 3 volume percent O_2,

(c) the space between the inner and outer 3013 cans shall be inerted with helium to less than 3 volume percent O_2, and

(d) the spaces in the PCV and SCV shall be inerted with carbon dioxide to greater than or equal to 75 volume percent CO_2.

Chapter 1: General Information and Drawing

Although this SER builds upon the SER issued for the 9975-96 packaging design in June 2008,[6] which addressed multiple contents, this SER focuses only on the neptunium oxide contents defined by LLNL in its final "Justification for Shipment" document.[5] The detailed evaluation as documented in the SER[6] provided a sound basis for assessing the adequacy of the proposed method of packing the neptunium oxide in 3013 container sets, where the contents will be limited to less than 1 kg per 9975-96 packaging, for transport in the one-time, one-way shipment campaign (of three individual shipments) as proposed in the "Justification for Shipment" document.[5]

The review documented in the SER[6] included "an evaluation of the SARP[3] with respect to the requirements specified in 10 CFR 71, and in International Atomic Energy Agency (IAEA) Safety Standards Series No. TS-R-1." In the SER[6], eight content envelopes, identified as C.1 through C.8 were addressed; whereas the neptunium oxide content for this SER is a variation of C.8 only.

Detailed packaging descriptions, drawings, methods of fabrication, and contents can be found in the SARP.[3] The components of the packaging include a drum outer container, insulation, bearing plates, a containment system consisting of a PCV and an SCV, lead shielding, and aluminum honeycomb spacers and impact limiting material. The neptunium oxide contents proposed for these shipments will be placed in a food can or a convenience can, which will in

turn be placed in a 3013 container set placed within the PCV. The PCV will then be placed in the SCV; the combination of which would then be placed in the drum outer container.

The PCV, which fits inside the SCV, consists of a Type 304L stainless steel pressure vessel, with a standard Schedule 40, Type 304L stainless steel pipe cap at the blind end. A stayed head, machined from a Type 304L SS bar, is welded to the pipe top end. The head is machined to include an internal thread and a female cone-seal surface. The PCV closure assembly consists of a male-female cone joint with surfaces that have been machined to identical angles so that they mate with essentially zero clearance.

Two grooves for fluoroelastomer O-rings are machined into the face of the Type 304L stainless steel male cone seal plug. A leak test port is provided between the two O-ring grooves.

The SCV consists of a Type 304L stainless steel pressure vessel and has a standard Type 304L stainless steel pipe cap at the blind end. A stayed head machined from a Type 304L SS bar is welded to the pipe top end. The head is machined to include internal threads and a female cone-seal surface. The SCV closure is virtually identical to that used on the PCV, except that SCV is one-inch larger in diameter.

The nominal net weight of the packaging ranges from 159 – 168 kg (350 – 374 lb). The maximum weight of all material (radioactive contents, product cans, spacer, etc.) inside the PCV may not exceed 20.1 kg (44.4 lb). The gross weight of the package may not exceed 183 kg (404 lbs).

The neptunium oxide contents to be shipped in the 9975-96 package under the letter amendment will be less than 1 kg per packaging. The material will be packaged according to Content C.8 as specified in Table 1.2, Table 1.3, and Section 1.2.3.2.5 of the SARP[3], except for the following, as shown in Table 1 of this SER.

Table 1. Comparison of the Requirements in the SARP with Changed Requirements in the "Justification for Shipment" document

Requirement in the SARP[3]	Requirement in the "Justification"[6]
Processing of the material to meet WSRC-TR-2003-00338 (Table 1.2, footnote 1)	Processing of the material to meet the stabilization requirements of WSRC-TR-2003-00338.
Metal mass of food pack cans being restricted to 1000 g (Section 1.2.3.2.5, and Table 1.3 of the SARP)	A DOE-STD-3013 welded container set will be used to hold the material. A DOE-STD-3013 set weighs about 7000 g.
• 9975-85: SCV, PCV and Food-Pack can maximum 5% O_2 (Ar) [Table 1.3] • 9975-96: SCV, PCV and Food-Pack can maximum 3% O_2 (Ar) [Table 1.3]	• Convenience can will be inerted to <3% O_2 with nitrogen • Inner and outer DOE-STD-3013 cans will be inerted to <3% O_2 with helium • SCV and PCV will have an atmosphere ≥ 75% CO_2

Based on the statements and representations in Revision 1 to the "Justification for Shipment,"[5] the SARP[3] and the DOE PCP Staff's confirmatory evaluation, the DOE PCP finds that the design and performance of the 9975-96 packaging is acceptable for the transport of less than 1 kg of

neptunium oxide when placed inside the other 9975-96 packaging elements; and that this will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71, 49 CFR Part 173, and DOE Order 460.1C have been met for the one-time, one-way shipment campaign of three shipments of the neptunium oxide to two sites.

Furthermore, the DOE PCP has concluded that the following conditions of approval will be added to the letter amendment to the CoC:

> For the one-time, one-way shipment campaign of neptunium oxide in the 9975-96 packaging, the components inside the PCV and the spaces in the PCV and SCV shall be inerted as follows:
>
> (a) the convenience can(s) shall be inerted with nitrogen to less than 3 volume percent O_2,
>
> (b) the space between the convenience can(s) and the 3013 inner can shall be inerted with helium to less than 3 volume percent O_2,
>
> (c) the space between the inner and outer 3013 cans shall be inerted with helium to less than 3 volume percent O_2, and
>
> (d) the spaces in the PCV and SCV shall be inerted with carbon dioxide to greater than or equal to 75 volume percent CO_2.

Chapter 2: Structural

This section of the SER covers the Structural review. The review focused on the weight of the content and the material compatibility of the proposed content with the packaging materials.

Based on the statements and representations in the "Justification for Shipment" document,[5] the SARP[3] and the DOE PCP Staff's confirmatory evaluation, the DOE PCP finds that the weight of the 9975-96 package with the proposed neptunium oxide contents is bounded by the authorized maximum package weight, and there are no materials incompatibilities or any other structural-related issues that need to be addressed relative to the request. Thus, the "Justification for Shipment" document[5] provides reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met relative to structural performance.

Chapter 3: Thermal

This section of the SER covers the Thermal review. The review focused on the decay heat of the content, and the probability of H_2/O_2 reaction under the proposed configuration for which different inert gases will be contained.

Based on the statements and representations in the "Justification for Shipment" document,[5] the SARP[3] and the DOE PCP Staff's thermal-related confirmatory evaluation, the DOE PCP finds that the newly proposed inerting and the related procedures will provide a safe environment to prevent the occurrence of any deflagration/detonation in the 9975-96 package. Thus, the "Justification for Shipment" document[5] provides reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met relative to thermal performance.

Chapter 4: Containment

This section of the SER covers the Containment review. The review focused on the use of the food or convenience cans placed in a 3013 container set, the inerting of the containers, and the package containment leaktight performance.

Based on the statements and representations in the "Justification for Shipment" document,[5] the SARP[3] and the DOE PCP Staff's containment-related confirmatory evaluation, the DOE PCP finds that there are no inerting issues in the 9975-96 package including the proposed content that adversely affect containment, and that the leaktight performance of the proposed package would be acceptable. Thus, the "Justification for Shipment" document[5] provides reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met relative to containment.

Chapter 5: Shielding

This section of the SER covers the Shielding review. The review focused on the effects of the proposed changes on radiological safety of the 9975-96 package.

Based on the statements and representations in the "Justification for Shipment" document,[5] the SARP[3] and the DOE PCP Staff's shielding-related confirmatory evaluation, the DOE PCP finds that the shielding aspects of the proposed changes have been adequately described and evaluated and that the package with the proposed changes in the content envelope satisfies the radiological dose rate requirements of 10 CFR 71. Thus, the "Justification for Shipment" document[5] provides reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met relative to shielding.

Chapter 6: Criticality

This section of the SER covers the Criticality review. The effects of the proposed changes on criticality safety of the 9975-96 packaging were analyzed. It was noted that the isotopic content, impurity levels and mass limit of the neptunium oxide contents are not modified by the proposed changes and therefore fall within the existing 9975-96 SARP envelope for Content C.8.[3]

Based on the statements and representations in the "Justification for Shipment" document,[5] the SARP[3] and the DOE PCP Staff's criticality-related confirmatory evaluation, the DOE PCP finds that the nuclear criticality aspects of the proposed changes have been adequately described and evaluated and that the package with the proposed changes in the content envelope meets the nuclear criticality safety requirements of 10 CFR 71.

Chapter 7: Package Operations

This section of the SER covers the Package Operations review. The effects of the proposed changes on operations of the 9975-96 packaging were analyzed. The assessment focused on the procedure for inerting the spaces in the food or convenience cans, and the associated spaces between the 3013 container set, the PCV and the SCV.

Section 7.2.1 of the SARP[3] describes packaging loading, a procedure for the shipment of neptunium oxide that is to be followed except for Step 3, which requires argon inerting. Based on the "Justification for Shipment" document[5] the neptunium oxide is packaged in food cans or convenience cans. These cans are loaded and closed in a glove box that is inerted to less than 3

volume percent O_2 with nitrogen. As a result of this procedure, the food can containers will contain O2 at a ppm level, which is less than the required 3 volume percent oxygen threshold.

The food or convenience cans are loaded into a 3013 inner can and the space between the cans and the 3013 inner can is inerted with helium to less than 3 volume percent O_2. The 3013 inner can is, in turn, loaded into a 3013 outer can and the space between the inner and outer can is also inerted with helium to less than 3 volume percent O_2. The use of helium as an inerting agent facilitates leak testing. Both the inner and outer cans are welded shut.

Section 7.2.2 of the SARP[3] describes the loading procedure of the contents into the PCV. This procedure is followed, except for step 6, which requires argon inerting. The sealed and inerted 3013 container set is loaded into a 9975-96 PCV and the space between is inerted with CO_2, instead of with argon, to a value greater than or equal to 75 volume percent CO_2. The leak testing of the PCV is done per Section 8.2.2.1 of the SARP.

Section 7.2.3 of the SARP[3] describes loading and closing of the package, a procedure that is followed except for Sep 5, which requires argon inerting. The PCV is loaded into a 9975-96 SCV and the space between the PCV and SCV is inerted with CO_2, instead of with argon, to a value greater than or equal to 75 volume percent CO_2. The leak testing of the SCV is done per Section 8.2.2.1 of the SARP.

Based on the statements and representations in the "Justification for Shipment" [5]document, the SARP[3] and the DOE PCP Staff's confirmatory evaluation, the DOE PCP finds that the operating procedure requirements presented in Chapter 7 of the SARP, as modified by the April 12, 2011, revision of the "Justification for Shipment" [5]document, are acceptable and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met. However, the procedural steps are summarized and set forth in the Summary and Chapter 1 of this SER shall be complied with for these shipments.

Chapter 8: Acceptance Tests and Maintenance Program

This section of the SER covers the Acceptance Tests and Maintenance review. The "Justification for Shipment" document[5] states that the "acceptance tests and maintenance program documented in the 9975-96 SARP is valid for this packaging of neptunium oxide." The DOE PCP Staff concurs with this assessment

Based on a review of the acceptance tests and maintenance program presented in Chapter 8 of the SARP and the "Justification for Shipment" document;[5] the DOE PCP finds that this program is acceptable for the use of this packaging for the transport of neptunium oxide, and will provide reasonable assurance that the regulatory requirements of 10 CFR Part 71 have been met.

Chapter 9: Quality Assurance

This section of the SER covers the Quality Assurance (QA) review. The LLNL "Justification for Shipment"[5] describes content modification of the neptunium oxide along with package processing and canning of the neptunium oxide. The DOE PCP Staff concluded that the content modification does not affect QA requirements for important-to-safety items and activities that were established in Chapter 9 of the SARP[3]. The content modification does not affect QA for the packaging design or operational activities.

Based on the statements and representations in the "Justification for Shipment" document,[5] the SARP[3] and the DOE PCP Staff's confirmatory evaluation, the DOE PCP finds that the QA requirements identified in Chapter 9 of the SARP adequately control the operational aspects of loading and shipping of the modified neptunium oxide contents in the Model 9975-96 Packaging. The information provided in the "Justification for Shipment" document[5] is acceptable and provides reasonable assurance that the regulatory requirements in 10 CFR 71, Subpart H, have been met.

References

1. Riley, D. C., and Dodson, K. E., Justification for Shipment of Lawrence Livermore National Laboratory Neptunium Oxide in the 9975 Packaging, LLNL-AR-456191, Lawrence Livermore National Laboratory, Livermore, CA, September 21, 2010.
2. U.S. Department of Energy Certificate of Compliance for Radioactive Materials Packages, Certificate Number 9975, Revision 4, USA/9975/B(M)F-96 (DOE), Washington, DC, January 2008 (expiration date of June 30, 2013).
3. Safety Analysis Report for Packaging Model 9975 B(M)F-96, S-SARP-G-00003, Revision 0, January 2008.
4. Shuler, J. M., "Q1 Comments on Justification for Shipment of Lawrence Livermore National Laboratory Neptunium Oxide in the 9975 Packaging", memorandum to A. C. Williams, Manager, Livermore Site Office, dated March 1, 2011.
5. Riley, D. C., and Dodson, K. E., Justification for Shipment of Lawrence Livermore National Laboratory Neptunium Oxide in the 9975 Packaging – Revision 1, LLNL-AR-456191-REV-1, Lawrence Livermore National Laboratory, Livermore, CA, April 12, 2011.
6. Safety Evaluation Report for the Safety Analysis Report for Packaging 9975-96, S-SARP-G-00003, Revision 0, January 2008, Office of Packaging and Transportation, Office of Environmental Management, U.S. Department of Energy, June 2008.