



Department of Energy
Washington, DC 20585

April 6, 2017

MEMORANDUM FOR WILLIAM E. KILMARTIN
DIRECTOR, MATERIAL DISPOSITION PROGRAM
OFFICE OF FISSILE MATERIALS DISPOSITION
NATIONAL NUCLEAR SECURITY ADMINISTRATION

FROM: JOANNE D. LORENCE *Joanne D. Lorence*
HEADQUARTERS CERTIFYING OFFICIAL
DIRECTOR
OFFICE OF PACKAGING AND TRANSPORTATION

SUBJECT: Renewal of Department of Energy Certificate of
Compliance Number 9867

In response to your request to Dr. James Shuler of my staff dated March 3, 2017, Department of Energy (DOE) Certificate of the Compliance (CoC) Number 9867, Revision 1, for the Model ES-3100 package is issued for renewal with its attached Package Certification Approval Record. Changes to the CoC are indicated by vertical bars in the right page margin.

This CoC is issued by DOE under the authority of 49 CFR 173.7(d) and is conditional upon fulfilling the applicable Operational and Quality requirements of 49 CFR Parts 100-199 and 10 CFR Part 71, and the conditions specified in Item 5 of the CoC.

The expiration date of the certificate is May 31, 2022.

If you have any questions, please contact me or Dr. James M. Shuler of my staff at (301) 903-5513.

Attachment

cc: Virginia Kay, NA-233
Jeff Arbital, CNS-Y-12
James Shuler, EM-4.24



CERTIFICATE OF COMPLIANCE For Radioactive Materials Package

| | | | | |
|------------------------|------------------|--------------------------------|--------------|---------------------|
| 1a. Certificate Number | 1b. Revision No. | 1c. Package Identification No. | 1d. Page No. | 1e. Total No. Pages |
| 9867 | 1 | USA/9867/B(U)F-96 (DOE) | 1 | 9 |

2. PREAMBLE

- 2a. This certificate is issued under the authority of 49 CFR Part 173.7(d).
- 2b. The packaging and contents described in Item 5 below meet the safety standards set forth in subpart E, "Package Approval Standards" and subpart F, "Package Special Form, and LSA-III Tests" Title 10, Code of Federal Regulations, Part 71.
- 2c. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

| | | |
|---|--|--------------|
| 3. This certificate is issued on the basis of a safety analysis report of the package design or application — | | |
| (1) Prepared by (Name and Address): | (2) Title and identification of report or application: | (3) Date: |
| U.S. Department of Energy NNSA Y-12 National Security Complex P.O. Box 2009 Oak Ridge, TN 37831 | Safety Analysis Report for Packaging, Y-12 National Security Complex, Model ES-3100 Package with Plutonium Oxide Content, SRP-802006-0001, Revision 0, as supplemented [See 5(e)]. | January 2012 |

4. CONDITIONS

This certificate is conditional upon fulfilling of the applicable Operational and Quality Assurance requirements of 49CFR parts 100 – 199 and 10CFR Part 71, and the conditions specified in Item 5 below.

5. Description of Packaging and Authorized Contents, Model Number, Transport Index, other Conditions, and References:

(a) Packaging

- (1) Model Number: ES-3100
- (2) Description:

The ES-3100 packaging, which is depicted in Figure 1 below, is a cylindrical container that is approximately 43.5 inches (110 cm) in overall height, including the cover and lid and approximately 19 inches (49 cm) in overall diameter.

The packaging is composed of an outer drum assembly and an inner containment vessel (CV). The main functions of the packaging are to provide containment, shielding, and nuclear criticality safety. Table 2.6 of the Safety Analysis Report for Packaging (SARP) provides detailed material specifications for the packaging components.

The outer drum assembly consists of (a) a reinforced stainless steel, standard military specification 30 gallon drum with an increased length, (b) a cylindrical layer of castable refractory material (Kaolite 1600™), which is composed of concrete and vermiculite, and which acts as both an impact-absorbing and thermal-insulating material, (c) a cylindrical layer of castable refractory (277-4 special dry mix) for neutron attenuation, (d) an inner steel liner, and (e) a removable top

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| 6a. Date of Issuance: 04/06/2017 | 6b. Expiration Date: May 31, 2022 |
|----------------------------------|-----------------------------------|

FOR THE U.S. DEPARTMENT OF ENERGY

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| 7a. Address (of DOE Issuing Office) U.S. Department of Energy Office of Packaging and Transportation (EM-4.24) 1000 Independence Avenue, SW Washington, DC 20585 | 7b. Signature, Name, and Title (of DOE Approving Official) Joanne D. Lorence Headquarters Certifying Official Director Office of Packaging and Transportation |
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plug that also has a layer of the castable refractory material (Kaolite 1600™) for impact absorption and thermal insulation.

The 30-gallon drum is manufactured from 16-gauge Type 304 or 304L stainless steel. The fabrication is accomplished according to requirements specified in NUREG/CR-3854, and is in accordance with the dimensional requirements of MIL-D-6054F as modified according to Drawing M2E801580A004. The inner liner is also manufactured from Type 304 or 304L stainless steel.

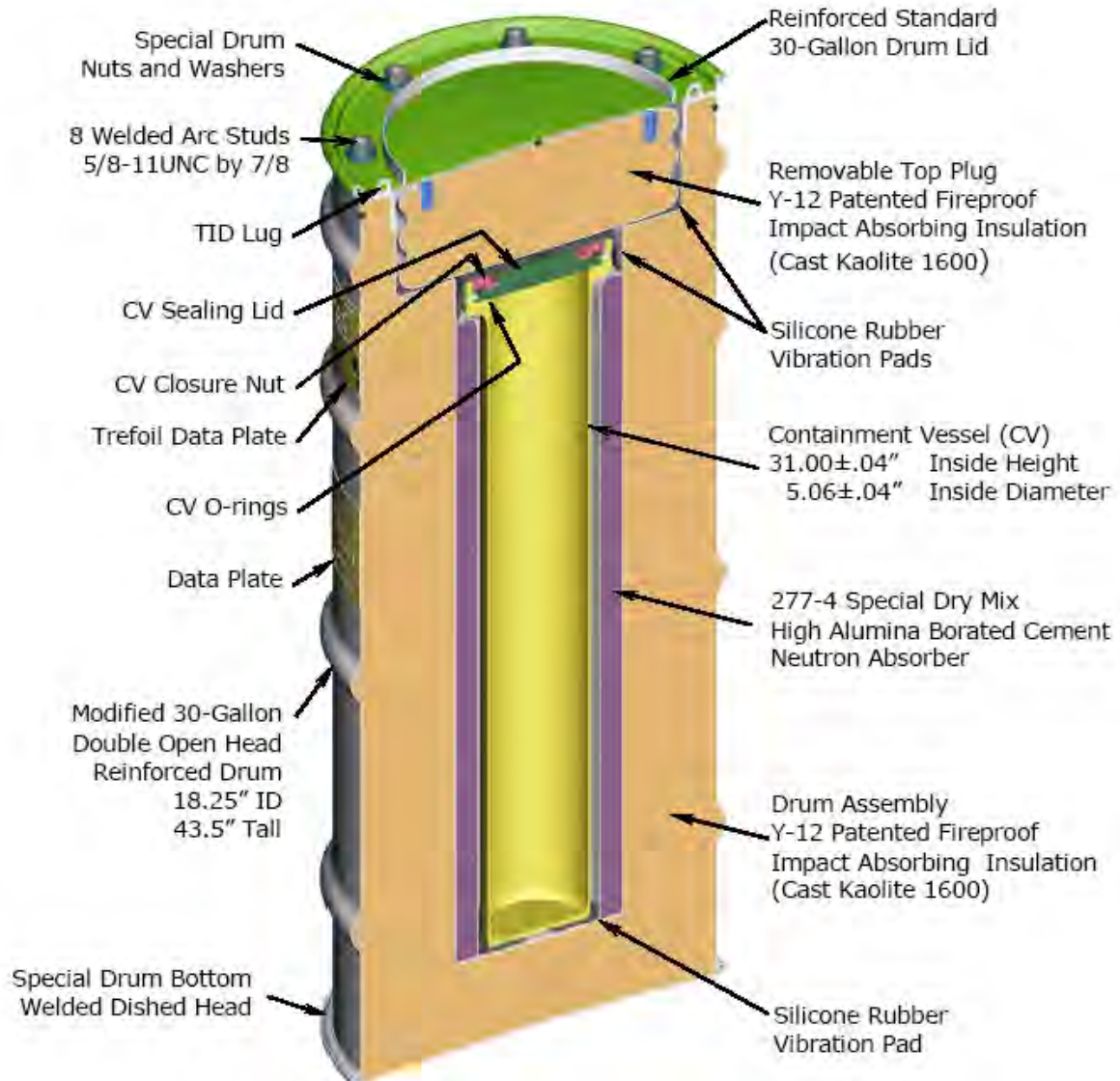


Figure 1. Schematic of the ES-3100 shipping package.

The CV is placed inside the outer drum assembly, surrounded by the neutron-attenuating, impact-absorbing and thermal-insulating materials. It is approximately 32 inches (82 cm) in overall height and 5 inches (13 cm) in overall diameter, and is constructed of Type 304L stainless steel. The lid assembly consists of a sealing lid, a closure nut, an external retaining ring that holds both the assembly and closure nut together, and double ethylene-propylene elastomer O-rings. The double O-rings in the top flange of the CV permit leak testing of the CV. The containment boundary consists of the 0.1 inch (0.254 cm) thick CV body, the CV sealing lid assembly, and the inner ethylene-propylene elastomer O-ring.

(3) Drawings:

The drawings that pertain to the ES-3100 package are listed in Table 1.

Table 1. List of Drawings Pertaining to the ES-3100 Package

| Drawing No. | Revision | Title |
|---------------|----------|---|
| M2E801580A001 | C | Drum Assembly |
| M2E801580A002 | B | Body Weldment |
| M2E801580A003 | B | Inner Liner Weldment (2 sheets) |
| M2E801580A004 | B | Double Open Head Reinforced Drum |
| M2E801580A005 | D | Misc. Details |
| M2E801580A006 | B | Drum Lid Weldment |
| M2E801580A007 | B | 18.25" Diameter Drum Lid |
| M2E801580A008 | B | Top Plug Weldment |
| M2E801580A009 | C | Pad Details |
| M2E801580A010 | F | Data Plate Details |
| M2E801580A013 | C | Containment Vessel O-ring Details |
| M801580-0001 | A | Main Assembly |
| M801580-0002 | A | 5.25 & 10.00 in. Spacer Detail |
| M801580-0003 | 0 | Containment Vessel Assembly |
| M801580-0004 | 0 | Containment Vessel Body Assembly (2 sheets) |
| M801580-0005 | 0 | Containment Vessel Lid Assembly |
| M801580-0006 | 0 | Containment Vessel Sealing Lid |
| M801580-0007 | 0 | Containment Vessel Closure Nut |
| M801580-0009 | 0 | Containment Vessel Leak Test Assemblies |
| T2E801827A008 | A | Leak Check Flange Assembly |

(b) Contents

The ES-3100 shipping package will be used to ship plutonium oxide in 3013 containers (per DOE-STD-3013). The maximum amount of plutonium oxide allowed in the package is 10 kg (22.05 lb) (5 kg [11.02 lb] per 3013 container assembly per DOE STD 3013). The amount of fissile material allowed in the package is 8.8 kg (19.4 lb) [4.4 kg (9.7 lb) per 3013 container assembly per DOE-STD-3013]. The maximum weight of all materials in the containment vessel (including 3013 containers, aluminum spacers, and other packing materials) shall not exceed 40.82 kg (90 lb). The mass limits and concentration basis for radionuclides permitted in each 3013 container assembly are listed in Table 2. In addition to the radionuclides shown in Table 2, various impurities may be present as shown in Table 3.

Radioactive/Fissile Constituents

For the package with plutonium oxide content, the maximum number of A₂s is 44,390 (at 40 years) and the maximum activity is 369.90 TBq (at initial fabrication).

Table 2. Radioactive material mass limits per 3013 container assembly^{a, b}

| Radionuclide ^c | Concentration basis | Bounding mass limit (g) |
|----------------------------|-------------------------------------|-------------------------|
| <i>Plutonium</i> | | |
| ²³⁶ Pu | 1 ppb Pu | 0.0000044 |
| ²³⁸ Pu | 0.05 wt % Pu | 2.2 |
| ²³⁹ Pu | 100 wt % Pu | 4400.0 |
| ²⁴⁰ Pu | 9 wt % Pu | 396.0 |
| ²⁴¹ Pu | 1 wt % Pu | 44.0 |
| ²⁴² Pu | 0.1 wt % Pu | 4.4 |
| <i>Uranium</i> | | |
| ²³² U | 12 ppb U | 0.0000528 |
| ²³³ U | 0.5 wt % of total mass ^a | 25.0 |
| ²³⁴ U | 2 wt % U | 88.0 |
| ²³⁵ U | 100 wt % U | 4400.0 |
| ²³⁶ U | 40 wt % U | 1760.0 |
| ²³⁸ U | 100 wt % U | 4400.0 |
| <i>Other radionuclides</i> | | |
| ²⁴¹ Am | 7000 µg/g Pu | 30.8 |
| ²³⁷ Np | 1000 µg/g Pu | 4.4 |
| ²³² Th | 300 µg/g Pu | 1.32 |

^a Material loading limits and safety-related requirements for the 3013 container assembly are stipulated in DOE-STD-3013 (*Stabilization, Packaging, and Storage of Plutonium-Bearing Materials*, DOE-STD-3013-2004, U.S. DOE, April 2004), which include the following criteria:

- 1) Plutonium-bearing materials stabilized and packaged to meet earlier versions of DOE-STD-3013 are acceptable without further evaluation as to whether they meet the 2004 version. (DOE-STD-3013, "Foreword")
- 2) The mass of plutonium plus uranium shall be ≥ 30 wt % of the total material mass. (DOE-STD-3013, Sect. 1, "Scope")
- 3) The mass of ²³³U shall be ≤ 0.5 wt % of the total material mass. (DOE-STD-3013, Sect. 1, "Scope")
- 4) Oxide materials shall be stabilized in accordance with DOE-STD-3013, Sect. 6.1.2, "Oxides."
- 5) The moisture content of the oxide materials shall be < 0.5 wt % of the total material mass. (DOE-STD-3013, Sect. 6.1.2, "Oxides", and Sect. 6.1.4, "Storage after Stabilization/Deferred Packaging")
- 6) The mass of plutonium and other fissile species shall not exceed 4.40 kg (9.70 lb), and the total mass of contained materials shall not exceed 5.00 kg (11.02 lb). [DOE-STD-3013, Sect. 6.3.2, "Mass of Contained Materials"]
- 7) The mass of contained materials shall be limited to ensure that the maximum decay heat will not exceed 19 W at any time during storage or transportation. (DOE-STD-3013, Sect. 6.3.2, "Mass of Contained Materials")
- 8) Contained materials shall not corrode or otherwise adversely affect the structural integrity of the 3013 inner or outer container. (DOE-STD-3013, Sect. 6.3.3, "Packaging Process")

^b The bulk density of the oxide materials shall be > 2.31 g/cm³ and < 11.46 g/cm³.

^c Except as stated in Table 2, actinides, fission products, decay products, and neutron activation products are permitted at concentrations < 1000 ppm each. Assessment of these impurities may be based on process knowledge. The ²³²U and ²³⁶Pu concentrations are understood to be below normally available detection capability and are not measured; however, they are assumed present for conservatism in the appropriate SARP evaluations.

Table 3. Impurity mass limits per 3013 container assembly^a

| Element ^b | Bounding mass limit (g) |
|----------------------|-------------------------|
| Aluminum (Al) | 66.0 |
| Barium (Ba) | 44.0 |
| Beryllium (Be) | 22.0 |
| Boron (B) | 13.2 |
| Calcium (Ca) | 528.0 |
| Carbon (C) | 44.0 |
| Chlorine (Cl) | 1452.0 |
| Chromium (Cr) | 35.2 |
| Cobalt (Co) | 44.0 |
| Copper (Cu) | 13.2 |
| Fluorine (F) | 30.8 |
| Gallium (Ga) | 83.6 |
| Hydrogen (H) | — ^c |
| Indium (In) | 11.0 |
| Iron (Fe) | 79.2 |
| Lanthanum (La) | 22.0 |
| Lead (Pb) | 22.0 |
| Lithium (Li) | 44.0 |
| Magnesium (Mg) | 308.0 |
| Manganese (Mn) | 8.8 |
| Molybdenum (Mo) | (Mo + Zr) ≤ 22.0 |
| Nickel (Ni) | 66.0 |
| Niobium (Nb) | 15.4 |
| Nitrogen (N) | 22.0 |
| Oxygen (O) | — ^d |
| Phosphorus (P) | (P + S) ≤ 50.0 |
| Potassium (K) | 968.0 |
| Rubidium (Rb) | 22.0 |
| Silicon (Si) | 72.6 |
| Silver (Ag) | 44.0 |
| Sodium (Na) | 572.0 |
| Strontium (Sr) | 44.0 |
| Sulfur (S) | (P + S) ≤ 50.0 |
| Tantalum (Ta) | 44.0 |
| Tin (Sn) | 44.0 |
| Titanium (Ti) | 13.2 |
| Tungsten (W) | 44.0 |
| Vanadium (V) | 30.8 |
| Yttrium (Y) | 44.0 |
| Zinc (Zn) | 44.0 |
| Zirconium (Zr) | (Mo + Zr) ≤ 22.0 |

^a Total impurity mass shall be #3.5 kg. The total impurity mass is calculated by subtracting the total mass of plutonium and uranium from the total material mass and counting the remaining mass as impurities. After stabilization in accordance with DOE-STD-3013, Sect. 6.1.2 (*Stabilization, Packaging, and Storage of Plutonium-Bearing Materials*, DOE-STD-3013-2004, U.S. DOE, April 2004), the dominant impurity phases consist of binary and compound metal oxides in addition to binary chloride salts (i.e., NaCl, KCl, CaCl₂, and MgCl₂).

^b Except as stated in Table 3, other impurities are permitted at concentrations <1000 ppm each. Assessment of these impurities may be based on process knowledge.

^c Hydrogen due to adsorbed water, which is limited in accordance with the DOE-STD-3013 moisture criterion (i.e., <0.5 wt % of the total material mass).

^d Oxygen due to binary and compound oxides formed during the stabilization process plus the contribution from the adsorbed water.

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Chemical and Physical Form

The fissile material content is in solid form.

Weights and Contents Descriptions

The maximum allowable gross shipping weight is 190.5 kg (420 lb). The largest nominal gross shipping weight with plutonium oxide content is 171.77 kg (378.69 lb). The maximum weight of plutonium oxide allowed is 10 kg (22.05 lb). The maximum allowable payload weight (3013 container assemblies with plutonium oxide, aluminum spacers, and stainless steel scrubbers) is 40.82 kg (90 lb).

All plutonium oxide contents will be packed in accordance with DOE-STD-3013 inside a 3013 container assembly. The 3013 container assembly consists of a minimum of two individually sealed, nested containers. The 3013 outer container has a leak-tight welded closure and provides the pressure boundary to prevent release of the contents. None of the components of the 3013 container assembly is considered as a part of the ES-3100 containment boundary. Everything inside the containment vessel is considered to be content. The 3013 outer container is constructed of Type 316 stainless steel and has an external diameter of 12.5 cm (4.92 inches) and a height of 25.4 cm (10 inches). Inside each 3013 outer container is a 3013 inner container with a leak-tight welded closure. The 3013 inner container provides an additional isolation boundary and an internal pressure indicator. The 3013 inner container is constructed of stainless steel that is compatible with Type 316 stainless steel. The use of an additional convenience can inside the 3013 inner container is optional.

Either one or two 3013 container assemblies will be shipped inside the containment vessel. If two 3013 container assemblies are shipped, a hollow cylindrical aluminum spacer (Part M801580-0002-1) will be placed below each 3013 container assembly. These aluminum spacers have an outer diameter of 12.07 cm (4.75 inches), an inner diameter of 10.16 cm (4.00 inches), and a height of 13.34 cm (5.25 inches) (Drawing M801580-0002). A typical configuration with two 3013 container assemblies and two 5.25 inch-tall aluminum spacers inside the containment vessel is shown in Figure 2. Stainless-steel scrubbers may be added on top of the upper 3013 container assembly to minimize vertical movement of the 3013 container assemblies and aluminum spacers during transport.

If only one 3013 container assembly is shipped in the containment vessel, a 5.25 inch-tall aluminum spacer (Part M801580-0002-1) will be placed both below and above the 3013 container assembly and a taller cylindrical aluminum spacer (Part M801580-0002-2) will be placed above the upper 5.25 inch-tall aluminum spacer. The taller aluminum spacer has an outer diameter of 12.07 cm (4.75 inches), an inner diameter of 10.16 cm (4.00 inches), and a height of 25.4 cm (10 inches) [Part M801580-0002-2]. As in the two 3013 container assembly configuration, stainless steel scrubbers may be added on top of the tall aluminum spacer to minimize vertical movement of the 3013 container assembly and aluminum spacers during transport.

The existing void volume in the containment vessel is backfilled with carbon dioxide to $\geq 80\%$ by volume. This backfill reduces the oxygen concentration in the containment vessel to $< 5\%$ such that detonation is not a concern during transportation.

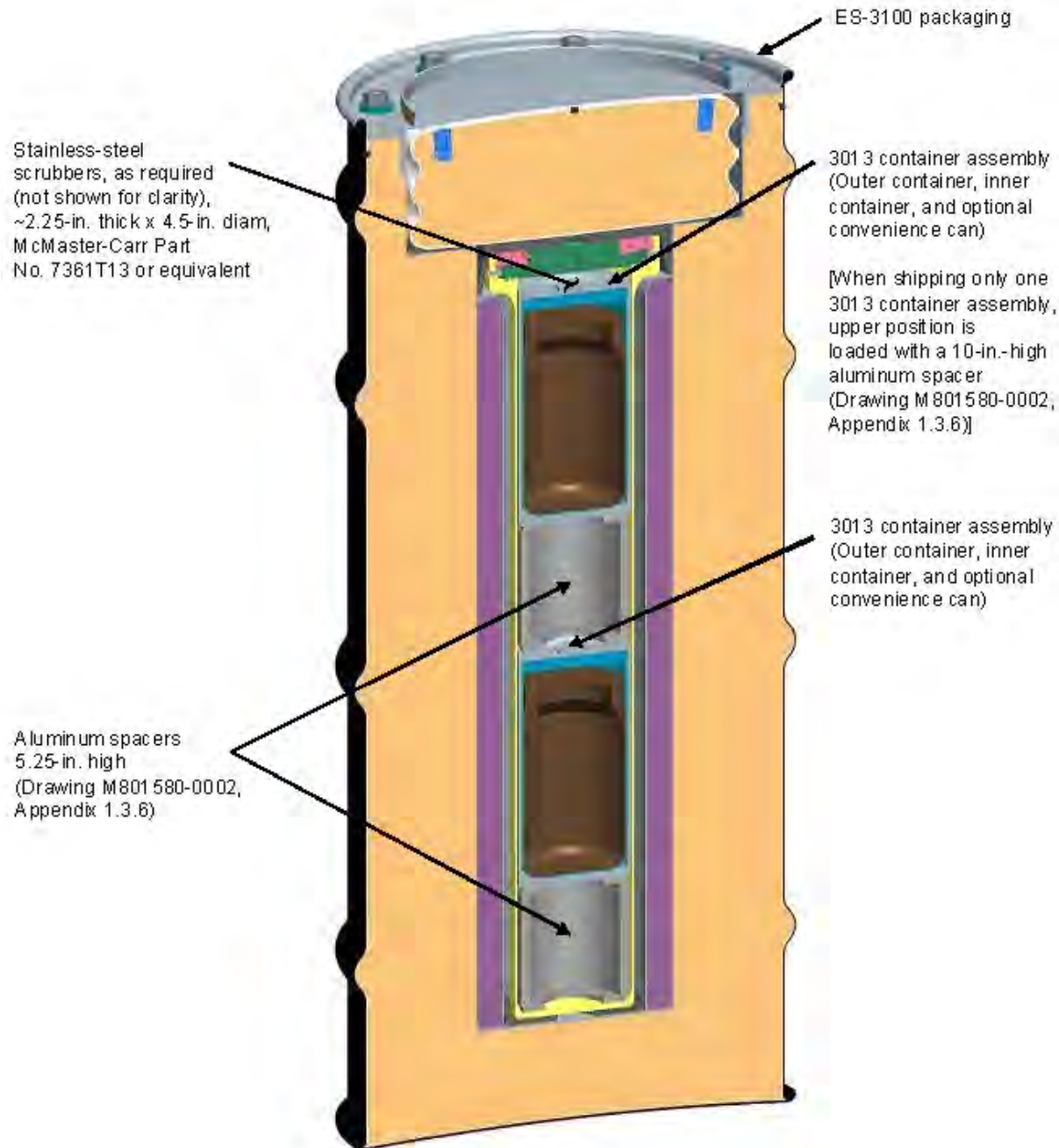


Figure 2. Typical shipping configuration for the ES-3100 package with plutonium oxide contents in 3013 container assemblies.

(c) Criticality Safety Index

A Criticality Safety Index (CSI) value of 0 (CSI=0) has been assigned for the ES-3100 package with plutonium oxide contents.

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(d) Conditions

- (1) The Model ES-3100 package with plutonium oxide content is for domestic use only
- (2) The vent holes on the outer steel drum shall be capped closed during transport and storage to preclude entry of rain water into the insulation cavity of the drum.
- (3) Seal time must be 12 months or less, where seal time is defined as the length of time that the shipment must be complete after the ES-3100 containment vessel is sealed.
- (4) The package content includes either one or two 3013 container assemblies and associated packing materials (aluminum spacers and stainless steel scrubbers). For two 3013 container assemblies, a 5.25 inch-tall aluminum spacer shall be placed below each 3013 container assembly. For a single 3013 container assembly, an additional 10 inch-tall aluminum spacer shall be placed on top of the 5.25 inch-tall aluminum spacer. Stainless-steel scrubbers may be added on top of the upper 3013 container assembly or the 10 inch-tall aluminum spacer to minimize vertical movement of the 3013 container assemblies and aluminum spacers during transport.
- (5) In addition to the radioactive material and impurity mass loading limits per 3013 container assembly (Tables 2 and 3), the plutonium oxide in the ES-3100 package shall be limited to a total of 10 kg (22.05 lb) and the maximum amount of fissile material allowed in the package shall be 8.8 kg (19.4 lb).
- (6) As prescribed in Table 3, the mass of impurities in the plutonium oxide to be loaded into the ES-3100 package will be counted against the fissile mass loading limit. The plutonium oxide will not contain unevaluated moderating materials.
- (7) The bulk density of the plutonium oxide shall be $>2.31 \text{ g/cm}^3$ and $<11.46 \text{ g/cm}^3$.
- (8) The maximum allowable payload weight in the ES-3100 package (which includes 3013 container assemblies with plutonium oxide, aluminum spacers, and stainless steel scrubbers) may not exceed 40.82 kg (90 lb). The maximum allowable gross shipping weight is 190.5 kg (420lb).
- (9) The void space within the containment vessel shall be backfilled with $\geq 80\%$ by volume carbon dioxide gas prior to shipment.
- (10) The maximum decay heat of the contents in the package shall be limited to a total of 30 W, with no more than 19 W per 3013 container assembly.
- (11) Transport by air or water is not authorized.
- (12) Shippers must have a methodology for assuring that the pressure in each of the 3013 cans does not exceed 50 psig at the time of loading and does not exceed 50 psig during transportation. This methodology must be approved in writing by the Headquarters Certification Official prior to shipment.
- (13) All CV assemblies used to transport plutonium oxide in the ES-3100 package shall be hydrostatically pressure tested at 250 ± 5 psig (See Chapter 8 of the SARP).
- (14) In addition to the requirements of Subparts G and H of 10 CFR Part 71, each package must be fabricated, acceptance tested, loaded, operated, and maintained in accordance with the Operating Procedures requirements of Chapter 7, the Acceptance Tests and Maintenance requirements of Chapter 8, and the packaging-specific Quality Assurance requirements of Chapter 9 of the SARP.

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- (15) Only DOE or persons working under contract to DOE shall consign the package for shipment under this certificate.
- (16) NRC or Agreement State licensees shall not consign a DOE certified package for shipment, but can transfer the material on-site to DOE or persons working under contract to DOE for consignment of the package.

(e) References:

- (1) Request for Renewal of US DOE Certificate of Compliance USA/9867/B(U)F-96 (DOE), Revision 1, dated March 3, 2017.



EM Environmental Management

safety ❖ performance ❖ cleanup ❖ closure

DOE Packaging Certification Program

PACKAGE CERTIFICATION APPROVAL RECORD

Certificate of Compliance Number 9867

Package Identification No. USA/9867/B(U)F-96 (DOE)

Model No. ES-3100

Docket 17-13-9867

Department of Energy (DOE) Certificate of Compliance (CoC), Certificate Number 9867, Revision 1, Package Identification No. USA/9867/B(U)F-96 (DOE), for Model ES-3100 is issued to authorize use of the package for offsite shipments of DOE materials.

There were no changes to the package since Revision 0 of the certificate was issued on May 5, 2012, and the package continues to meet the requirements of 10 CFR Part 71.

The expiration date for DOE Certificate Number 9867, Revision 1, is May 31, 2022.

This certificate constitutes authority for DOE to use the Model ES-3100 package for shipment of the authorized contents under 49 CFR 173.7(d).

Only DOE or persons working under contract to DOE shall consign the package for shipment. Nuclear Regulatory Commission or Agreement State licensees shall not consign a DOE certified package for shipment, but can transfer the material on-site to DOE or persons working under contract to DOE for consignment of the package.

Joanne D. Lorence
Headquarters Certifying Official
Director
Office of Packaging and Transportation

Date: 04/06/2017