Department of Energy
Washington, DC 20585

MAY 1 0 2012

MEMORANDUM FOR KELLY N. CUMMINS
ASSOCIATE ASSISTANT DEPUTY ADMINISTRATOR FOR
FISSILE MATERIALS DISPOSITION

FROM: STEPHEN C. O'CONNOR
HEADQUARTERS CERTIFYING OFFICAL
DIRECTOR, OFFICE OF PACKAGING AND
TRANSPORTATION

SUBJECT: Revision 0 to DOE CoC USA/9867/B(U)F-96 (DOE)

Per the October 20, 2010, request from Dean Tousley, attached is Revision 0 of Department of Energy (DOE) Certificate of Compliance (CoC) USA/9867/B(U)F-96 (DOE) for the ES-3100 and its Safety Evaluation Report. This new DOE CoC is being issued to allow the shipment of plutonium oxide in the ES-3100 package that was originally designed for shipment of highly enriched uranium contents. This ES-3100 packaging is based on the ES-3100 packaging approved for shipment of the uranium under the DOE CoC USA/9315/B(U)F-96 (DOE).

The expiration date of Revision 0 is May 31, 2017.

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

Attachment

cc w/att.:
Yung Li, ANL
Kenneth Sanders, NA-261
Becky Eddy, YSO

DOE F 5822.1
(5-85)
(Formerly EV-618)

U.S. DEPARTMENT OF ENERGY
CERTIFICATE OF COMPLIANCE
For Radioactive Materials Packages

OMB Approval
No. 1910-2000

1a. Certificate Number	1b. Revision No.	1c. Package Identification No.	1d. Page No.	1e. Total No. Pages
9867	0	USA/9867/B(U)F-96 (DOE)	1	8

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.	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 plug that also has a layer of the castable refractory material (Kaolite 1600™) for impact absorption and thermal insulation.

6a. Date of issuance: MAY 10 2012	6b. Expiration Date: June 1, 2017

FOR THE U.S. DEPARTMENT OF ENERGY

7a. Address (*of DOE Issuing Office*)	7b. Signature, Name, and Title (*of DOE Approving Official*)
U.S. Department of Energy Office of Packaging and Transportation, EM-33 1000 Independence Avenue, SW Washington, DC 20585	Stephen C. O'Connor Headquarters Certifying Official

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.

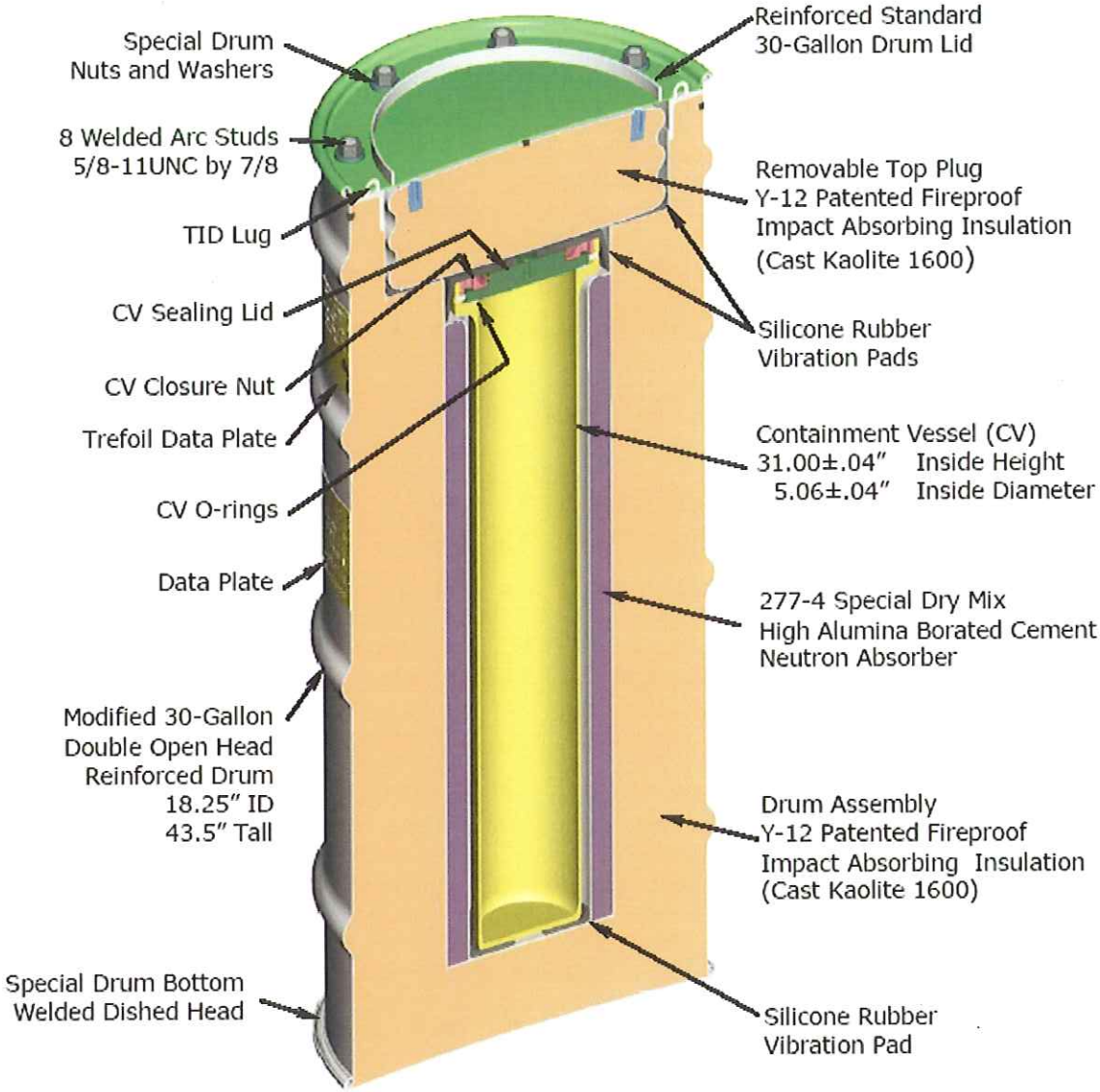

Figure 1. Schematic of the ES-3100 shipping package.

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 A_2s 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)
	Plutonium	
^{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
	Uranium	
^{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
	Other radionuclides	
^{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 ^{233}U 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 StabilizationcDeferred 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/cm^3 and <11.46 g/cm^3.

[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 ^{232}U and ^{236}Pu 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
Colbalt (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) $\leq$ 22.0
Nickel (Ni)	66.0
Niobium (Nb)	15.4
Nitrogen (N)	22.0
Oxygen (O)	—[d]
Phosphorus (P)	(P + S) $\leq$ 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) $\leq$ 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) $\leq$ 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, $CaCl_2$, and $MgCl_2$).

[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.

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 ≥80% by volume. This backfill reduces the oxygen concentration in the containment vessel to <5% such that detonation is not a concern during transportation

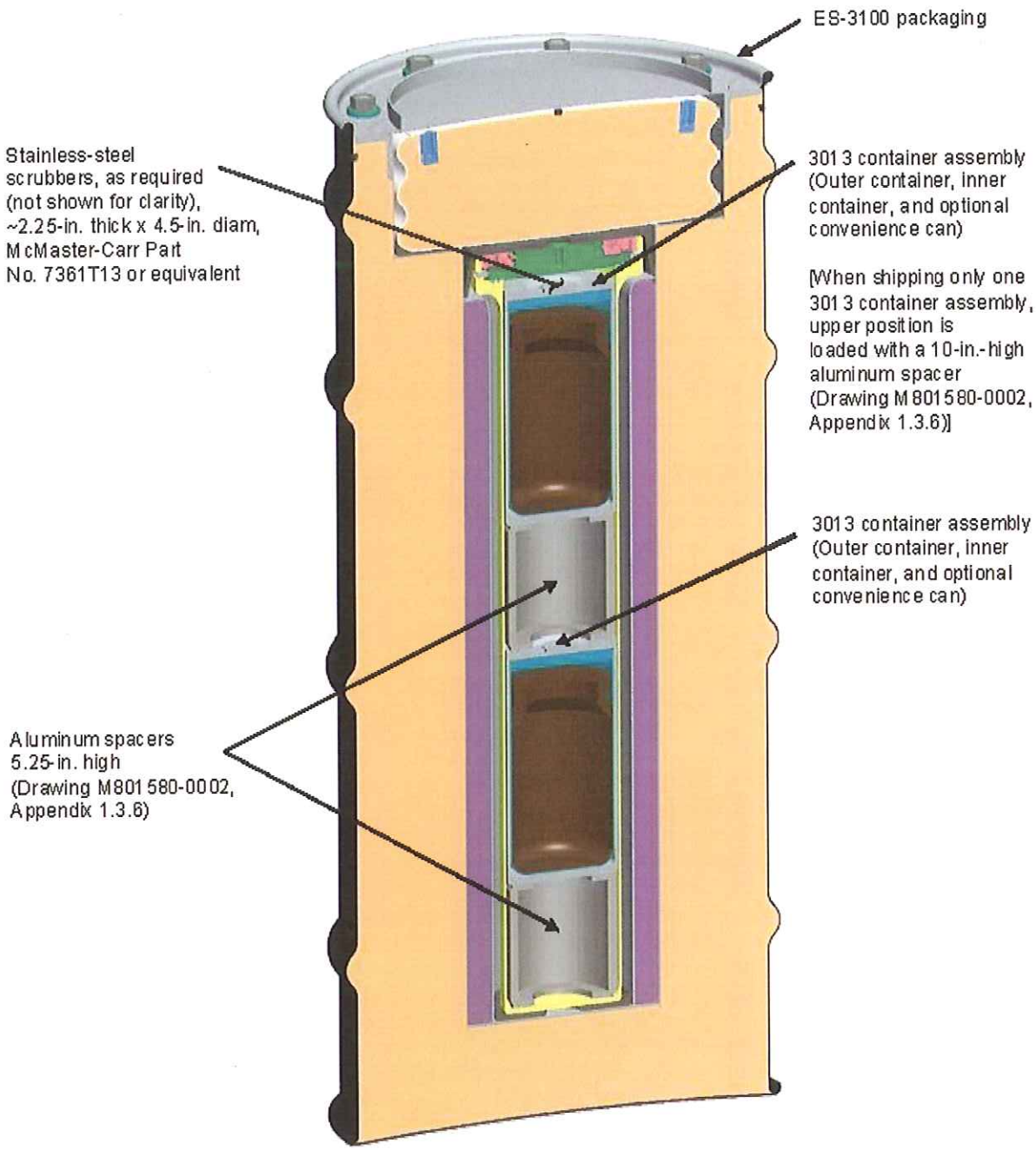

Figure 2. Typical shipping configuration for the ES-3100 package with plutonium oxide contents in 3013 container assemblies.

(c) Criticality Safety Index

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

(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 g/cm^3 and <11.46 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 ≥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.