Department of Energy
Washington, DC 20585

MAY 9 2012

MEMORANDUM FOR BRIAN R. HERMANN
MANAGER, DEFENSE PROGRAM PACKAGING PROGRAM

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

SUBJECT: Revision 11 to DOE CoC USA/9977/B(M)F-96 (DOE)

Per the April 7, 2011, request from Paul Mann, attached is Revision 11 of Department of Energy (DOE) Certificate of Compliance (CoC) USA/9977/B(M)F-96 (DOE) for the 9977 and its Safety Evaluation Report. This revision is being issued to extend the O-ring replacement period based on the use of an ARG-US RFID tag on a 9977 packaging. For Viton GLT O-rings, the replacement period has been extended to a maximum of 5 years. For Viton GLT-S O-rings, the replacement period has been extended to a maximum of 2 years.

The expiration date of Revision 11 is October 31, 2012.

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
Steve Bellamy, SRNS

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
9977	11	USA/9977/B(M)F-96 (DOE)	1	29

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 Savannah River Operations Office P.O. Box A Aiken, South Carolina 29808	Safety Analysis Report for Packaging Model 9977 B(M)F-96 S-SARP-G-00001, Revision 2, August 2007; as supplemented [See 5.(e)]	August 2007

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: 9977

(2) Description:

The 9977 is designed to ship radioactive contents in assemblies of Radioisotope Thermoelectric Generators (RTGs), 3013 Containers, Engineered Containers, or arrangements of nested food-pack cans. The components of the package include the drum, insulation, Containment Vessel (CV), Load Distribution Fixtures (LDFs), and Contents containers. The maximum weight of the packaging is 250 lbs, with a maximum payload of 100 lbs, and a maximum gross weight of 350 lbs.

The drum design meets the performance requirements of 49 CFR 178, for an open head drum, but is modified with a bolted-flange closure. The closure does not incorporate a gasket. The drum body is a closed unit consisting of a shell, top deck plate, reinforcing rim (vertical flange), and a liner assembly, with the volume between the liner assembly and drum shell filled with shock-absorbing thermal-insulating materials. The drum shell and liner are fabricated of 18-gage (0.048-inch) Type 304L stainless steel (SS). The drum shell incorporates a

6a. Date of Issuance: MAY 9 2012	6b. Expiration Date: October 31, 2012

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

“sanitary” style drum bottom, which incorporates a radiused edge which is butt welded to the side wall. The drum bottom includes a rolled “wear ring,” 0.060-inch thick by ¾-inch inside diameter (ID), attached by welds that are external to the drum shell. The drum’s top deck plate is fabricated of $^3/_{16}$-inch thick Type 304L SS plate. The top portion of the drum incorporates a $^3/_{16}$-inch thick reinforcing rim (vertical flange) and both reinforces the drum head and protects both the closure lid and the bolts during Hypothetical Accident Condition (HAC) events. The rim includes eight (8) 1-inch diameter drain holes that are qualified as package lifting and tie-down points. Drum construction details are shown on drawings R-R2-G-00017 and R-R2-G-00018. As applicable, the drum is designed, analyzed, and fabricated in accordance with Section III, Subsection NF of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME BPVC), as listed in Table 9.6 of the SARP.

Four (4) ¾-inch diameter vent holes are drilled at locations around the drum, approximately 90° apart and at each of three elevations, for a total of twelve vent holes along the drum sidewall. Five additional holes, two 1-inch diameter fill holes and three ¾-inch diameter vent holes are located on the drum bottom. All of the holes are covered with appropriately sized Caplug® fusible plastic plugs. During an HAC fire event, the plugs combust or melt, allowing the drum to vent gases generated by intumescing foam insulation. The vent holes ensure that the drum cannot be ruptured by gas pressure.

The drum closure lid is fabricated from ⅛-inch thick Type 304L SS plate. Eight ⅝-inch by 1¼-inch long heavy hex-head bolts with ⅝-inch plain, narrow Type B washers secure the lid to the top deck plate of the drum body. The closure lid incorporates chambers above and below the Lid Plate filled with shock-absorbing thermal-insulating materials. The Lid Top and Lid Bottom chambers are fabricated of 18-gage (0.048-inch) and 14-gage (0.07-inch) Type 304L SS, respectively. The top of the Lid Top is approximately 0.275 inches below the top surface of the drum-head reinforcing rim. The Lid Bottom chamber reinforces the Lid Plate and provides additional thermal protection and shock absorption for the Containment Vessel during HAC events. The Lid Top chamber also reinforces the Lid Plate, adds thermal protection to the contents, and prevents the closure lid from shearing away from the bolts during HAC events.

Four (4) ¼-inch diameter holes through the Lid Plate allow the Lid Top and Lid Bottom volumes to exchange gases and equilibrate pressure. The Lid Top chamber is vented by four (4) ¼-inch diameter holes also covered with Caplug® fusible plastic plugs. The Caplugs® prevent water from entering the lid through the vent holes under Normal Conditions of Transport (NCT). In a HAC fire event, the plugs combust or melt, allowing the lid to vent heated air from the Lid Top and Lid Bottom chambers.

To simplify drum-closure operations, the threaded inserts that receive the drum-closure bolts are welded to the underside of the drum’s top deck plate. During installation, the bolts are tightened to a torque value of 45 (±5) ft-lb. The bolt heads are drilled through with a ⅛-inch hole to receive Tamper-Indicating Devices

(TIDs). Details are shown on Drawing R-R1-G-00020.

Two layers of insulation material fill the volume between the drum liner and shell. First, two ½-inch thick blankets of Fiberfrax® insulation are wrapped around and attached to the sides and bottom of the liner. The Fiberfrax® is backed on both sides with fiberglass cloth held in place by fiberglass thread stitched longitudinally at 4-inch intervals. The fiberglass cloth gives the Fiberfrax® composite both mechanical strength and wear resistance and helps retard gas flow during the HAC fire event. The remaining volume between the Fiberfrax® and the drum wall is filled with General Plastics FR-3716 polyurethane foam (also known as Last-A-Foam®), poured through fill holes in the drum bottom and foamed in place. The nominal densities of Fiberfrax® and FR-3716 foam are 7-to-10 lb/ft^3 and 16 lb/ft^3, respectively. The thermal-physical properties of Fiberfrax® and FR-3716 are listed in Tables 2.9, 2.10, and 3.8 of the SARP. The combined thickness of the two insulators is approximately 4.95 inches radially (i.e., between the liner and the drum shell) and approximately 4.52 inches axially (i.e., between the liner bottom and drum bottom). Details are shown in Drawings R-R1-G-00020, R-R2-G-00017, and R-R2-G-00019.

The closure lid incorporates two chambers of insulation. The Lid Top chamber contains a 1-inch thick, 14-inch diameter disk of Thermal Ceramics Min-K 2000® insulation. The Lid Bottom chamber contains a rigid disk of Thermal Ceramics TR-19® Block insulation, 4.3-inch thick by 8-inch diameter. When installed, the TR-19® disk compresses two (2) 8-inch diameter by ½-inch thick blankets of Fiberfrax® insulation to a total thickness of ½ inch. The total axial thickness of both the insulators is approximately 5.75 inches. Details are shown in Drawing R-R2-G-00018.

The 9977 is designed with a CV with a nominal ID of six (6) inches (i.e., the 6CV). The 6CV is a stainless steel pressure vessel designed, analyzed, and fabricated in accordance with Section III, Subsection NB of the ASME Code, with design conditions of 800 psig at 300°F, as listed in Table 9.5 of the SARP. The 6CV is fabricated from 6-inch, Schedule 40, seamless, Type 304L SS pipe (0.280-inch nominal wall). A standard Schedule 40 Type 304L SS pipe cap (also 0.280-inch nominal wall) is welded to the pipe segment to form a blind end. A stayed head is machined from a 7½-inch diameter by 2¼-inch long Type 304L SS bar and is welded to the open end of the pipe segment, completing the vessel body weldment. The head is machined to include 6½-12UNS-2B internal threads and an internal cone-seal surface with a 32-micro-inch finish. Both vessel body joints are Category B, full-penetration, complete-fusion, circumferential welds. A support skirt to stand the 6CV vertically is formed from a short segment of 5-inch, Schedule 40 Type 304L SS pipe welded to the convex side of the cap. Two rectangular notches milled into the bottom edge of the skirt (180° apart) can engage a rectangular key to prevent vessel rotation during removal and installation of the closure assembly.

The 6CV Closure Assembly consists of a Type 304L SS Cone-Seal Plug shaped in part like a truncated cone and a threaded Cone-Seal Nut made from Nitronic 60 SS. The two Closure Assembly components rotate freely relative to one another and are coupled by a snap-ring that also ensures unseating of the closure seal during disassembly. As the Cone-Seal Nut is threaded into the stayed head of the vessel, the Cone-Seal Plug is thrust axially against the corresponding cone-seal surface of the vessel. Both internal and external sealing surfaces are machined to the same angles, surface finishes, and with matching diameters so that they mate with radial clearance of 0.0007 inches. To minimize the potential for thread galling, the Cone-Seal Nut and the Containment Vessel body are made from dissimilar materials. Two O-ring grooves (outer and inner) are machined in the face of the external Cone-Seal Plug. Viton® GLT/GLT-S O-rings fit into these grooves to complete the leaktight closure assembly.

For operator safety, a 0.094-inch diameter vent hole is located in the stayed head between the threads and the internal sealing surface. The vent hole is clocked 90° from the notches in the vessel support skirt. Unscrewing the Cone-Seal Nut a few turns will unseat the Cone-Seal Plug from the internal cone-seal surface and route any pressurized gases from the CV through the vent hole.

A leak-test port is incorporated into the Cone-Seal Plug and connected by a drilled radial passage to the annular volume between the two O-ring grooves in the Cone-Seal Plug. The leak-test port provides a means of verifying proper assembly of the vessel closure and is itself closed by the Leak-Test Port Plug. The vessel containment boundary is formed by the vessel body weldment, the Cone-Seal Plug, the Leak Test Port Plug, and the Outer O-ring.

The internal volume of a closed 6CV is approximately 608 cubic inches. The nominal assembly weight is 52.3 lb, and the nominal overall length is 24.03 inches. The usable cavity of the 6CV is a minimum of 20.25 inches deep with a minimum diameter of 5.95 inches. Details are shown in Drawing R-R2-G-00042.

The Top and Bottom LDFs are made from 6061-T6 aluminum round bar and fit within the Drum Liner cavity, above and below the 6CV. The LDFs center the 6CV in the liner, stiffen the package in the radial direction, and distribute loads away from the 6CV. The 6CV fits directly into the LDFs. Details are shown in Drawing R-R4-G-00032.

Figure 1 is a Three-Dimensional (3D) Cut Away Illustration of the 9977.

The 9977 is evaluated for shipment of radioactive contents containing Assemblies of Radioisotope Thermoelectric Generators (RTGs), and/or Food-Pack cans, Content C1. Two different sizes of RTGs (the MC2730 and MC3500) can be shipped within a single 9977 configuration. The RTGs are placed within vibration-limiting and thermal-conducting assemblies. One RTG Assembly holds a maximum of four (4) RTGs. Either or both sizes of RTGs may be shipped in the same assembly. The RTG assembly configuration positioned in the 6CV is shown in Figure 2a and 2b.

The term “food-pack” can includes metal cans with crimped-seal closures, “slip-lid” closures, or site-specific “convenience containers.” Crimp-sealed food-pack cans are typically fabricated in accordance with Federal Specification PPP-C-96E or equivalent, and meet the size specification as defined by the Can Manufacturers Institute — Voluntary Can Standards. Convenience containers are typically application-specific designs that incorporate screw thread, crimp-sealed, or welded closures. These three types of cans are made typically from tin-plated mild steel or stainless steel.

Actinide oxides and other materials may be placed inside food-pack cans prior to placing items in the packaging. An elastomeric gasket material or polyvinyl chloride tape may be applied to the edge of the can lid. The seal material may limit the spread of contamination, but is not credited for any measure of containment within the package.

The can containing the radioactive material is typically placed inside low-density polyethylene or nylon bagging for contamination control. Multiple bags may be present, up to the mass limit for plastics. The bagged inner can is typically then nested within one or more outer cans. The nested assemblies are then placed within the 6CV.

Nesting of food-pack cans is not required (i.e., a single food-pack can is allowed). Food-pack cans may be arranged for handling convenience and contamination control into single, double, or triple-stacked configurations, provided the general requirements listed in Section 1.2.2 of the SARP are satisfied and the food-pack can requirement in Section 1.2.2.2.1 of the SARP is fulfilled.

The 9977 is also evaluated for shipment of radioactive contents from the Addendum [See 5(e)(2)]. Content Envelopes AC.1 through AC.5 include the following: Neptunium metal; either as the “Neptunium Sphere” or as metal pieces; the BeRP Ball; as a ^{239}Pu metal sphere in an aluminum heat-sink holder; plutonium and uranium metals; plutonium and uranium metals with a higher ^{240}Pu limit but with reduced total mass limit; and Highly Enriched Uranium (HEU) metal.

Content Envelopes AC.1 through AC.5 are in solid form as metals. Contents in liquid form are not permitted. Contents are authorized for shipment in 3013 Containers, Food-Pack Cans, and Engineered Containers. These content containers are used to prevent the inadvertent contamination of the package by providing a level of confinement for the radioactive material contents and to provide protection of the content being shipped. These content containers are also referred to as product containers. Descriptions, illustrations, and the packaging limitation for these configurations are provided in the Addendum [See 5.e(2)] Sections 1.2.2.1.1, 1.2.2.1.2, and 1.2.2.1.3.

The 9977 is evaluated for shipment of radioactive contents in a specialized Engineered Container configuration, the Isentropic Compression Experiment (ICE) test apparatus, which consists of a stainless steel assembly containing approximately 8 gm of ^{239}Pu or its dose equivalent, within the mass limits of the ICE Radioactive Contents [Table 1 in Reference 5.(e)(3)]. The ICE apparatus contains no plastics other than Viton® O-rings. The apparatus weighs less than 30 lb. The packing system, designed to protect the ICE apparatus from normal transport vibrations, consists of two (2) sets of Spring Mounts (6061-T6 aluminum), springs (ASTM A 288 QQW-470 steel music wire), and 2¼-inch square by 3½ inch long Foam Bumper Blocks (General Plastics Last-A-Foam®, TF-5070-10). The ICE assembly configuration positioned in the 6CV is shown in Figure 3.

The 9977 is evaluated for shipment of irradiated Advance Gas Reactor (AGR-1) Fuel Compacts shipped in the shielded container Small Gram Quantity (SGQ)-SC3. The AGR-1 Fuel Compact has less than 1 gram of radioactive material and contains no more than 1000 ppm total of ^{251}Cf, ^{249}Cf, ^{242m}Am, ^{243}Cm, ^{245}Cm, and

^{247}Cm. The AGR-1 Fuel Compact has less than 6 grams of total content mass (radioactive material plus impurities). The materials of the AGR-1 Fuel Compact are defined in Addendum 3, Appendix 1.2 [See 5.(e)(4)]. The AGR-1 Compact shall be placed in a pipe Container (consisting of a threaded pipe section closed with pipe caps) with a minimum closed length of 2.8 inches. The AGR-1 Fuel Compact in the pipe Container is then placed inside the SGQ-SC3 container. The SGQ-SC3 container provides gamma shielding and consists of tungsten shielding material encapsulated in a stainless steel container with threaded closure. The SGQ-SC3 container is able to withstand the worst case Hypothetical Accident Condition (HAC) drop without loss of its ability to shield its radioactive contents. The SGQ-SC3 permits transmission of any decay heat released by the radioactive contents. The SGQ-SC3 container is located axially within the 9977 6 inch Containment Vessel (6CV) by aluminum foam Spacers. The typical packaging configuration is shown in Figure 4. Addendum 3, Appendix 1.1 contains the drawings detailing the shielded container components [See 5.(e)(4)].

The 9977 is evaluated for shipment of Content Type 4 (i.e., Sources), which will assist with the Off Site Source Recovery Project for the disposition of radioactive sources. For Sources, various radioactive isotopes have been proposed for shipment, including ^{238}Pu, ^{239}Pu, ^{241}Am, ^{244}Cm, ^{252}Cf, ^{90}Sr, ^{226}Ra, ^{137}Cs, ^{60}Co, and ^{192}Ir, with the Special Actinide Isotopes (^{242m}Am, ^{243}Cm, ^{245}Cm, ^{247}Cm, ^{249}Cf and ^{251}Cf) limited to a total of 1,000 ppm. Three different types of Shielded Containers are used in transporting these Sources. The first, SGQ-SC1, is constructed of lead and encapsulated in stainless steel, with a threaded stainless steel closure. The lead provides gamma-radiation shielding. The second, SGQ-SC2, is constructed of high-density polyethylene (HDPE). The HDPE provides neutron radiation shielding. The third, SGQ-SC3, is constructed of tungsten and is also encapsulated in stainless steel, with a threaded stainless steel closure. An Engineered Container (SGQ-EC1) is also used for shipments of unshielded sources and pieces that do not require shielding, provided that the administrative dose rate limits of 180 mrem/hr (on contact of the unshielded source or piece) and 9 mrem/hr (at a distance of 1 meter of the unshielded source or piece) are met. Shielded sources and pieces must go in one of the appropriate approved shielded containers because the shielding integrity of the sources can not be assured in HAC for the SGQ-EC1 container. The typical packaging configuration is shown in Figures 4, 5, 6, and 7. Addendum 3, Appendix 1.1 contains the drawings detailing the shielded container components [See 5.(e)(4)].

The 9977 is evaluated for the shipment of Training Sources between DOE sites and Laboratories in support of general programs. Training Sources contents may include radioactive isotopes (^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, ^{243}Am, ^{252}Cf, ^{248}Cm, ^{237}Np, ^{232}Th, ^{234}U, ^{235}U, ^{236}U, ^{238}U), with impurities (such as Be, Al, Mg, Na, F). The Training Sources contents shall have a decay heat of 3.5 W or less, and the contents will be placed in an engineered container, a convenience container with an attached top, or a Training Source Engineered Container.

Neither 9977 materials nor component geometry provide significant radiation shielding. Dose-rate attenuation is provided primarily by the distance between the source and points external to the package.

The 9977 design does not incorporate materials specifically for the purpose of poisoning or moderating neutron radiation. Subcriticality is ensured by limiting the package fissile material mass.

<u>Option to use the radiofrequency identification (RFID) system:</u> The option to use the RFID system is justified by Addendum [See 5(e)(5)] as being within the existing safety basis. The RFID guide [See 5(e)(6)] provides procedures for installing the DOE ARG-US RFID tag to the 9977 package. The DOE ARG-US RFID tag is not considered a part of the package. The DOE ARG-US RFID tags are equipped with a suite of sensors-seal integrity, temperature, humidity, shock, and battery status. The seal sensor is a thin flexible membrane that sits under one of the lid bolts of the drum cover when installed. The DOE ARG-US RFID tag has a robust plastic front cover and the stainless-steel back plate which provide adequate protection of the tag against damage under normal handling and transport. The tag weighs approximately 2.4 lb (with four batteries) and is approximately 8 inches wide x 7 inches high x 1.5 inches tall. Appendix B of the RFID guide [See 5(e)(6)] provides documentation that the batteries used in the DOE ARG-US RFID tag are not subject to the hazardous material regulations and also contains the Material/Product Safety Data Sheet for the batteries.

<u>Option to install a DOE ARG-US RFID tag to a packaging to extend the periodic maintenance interval.</u> For a package with an extension of the periodic maintenance interval, a specific DOE ARG-US RFID tag (with a unique serial number) is installed after a new CV seal is installed and tested. Since this specific RFID tag is assigned to monitor a specific 9977 package, the tag and package shall remain together for the entire maintenance period through the use of a label on the tag that records the RFID tag/package serial numbers, the date the RFID tag is attached, the maximum allowable ambient temperature, and the maintenance expiration date. During both use (loading, shipment, and unloading) and storage (loaded and empty) of the 9977 packaging, the CV must remain sealed over the entire approved extended maintenance interval. In the event that operations require the CV to be opened, then the old O rings shall be replaced with new O-rings, all the requirements for the extended maintenance interval shall be complied with for the new O-rings, and the sealing time shall be re- initialized to zero. If the ambient temperature limit is exceeded at any time, action shall be taken by placing a “Do Not Operate” tag on the package and segregating it from the working inventory. The conditions for the use of a 9977 packaging with an installed DOE ARG-US RFID tag to extend the period of maintenance interval are stated in 5(d)(10) of this CoC.

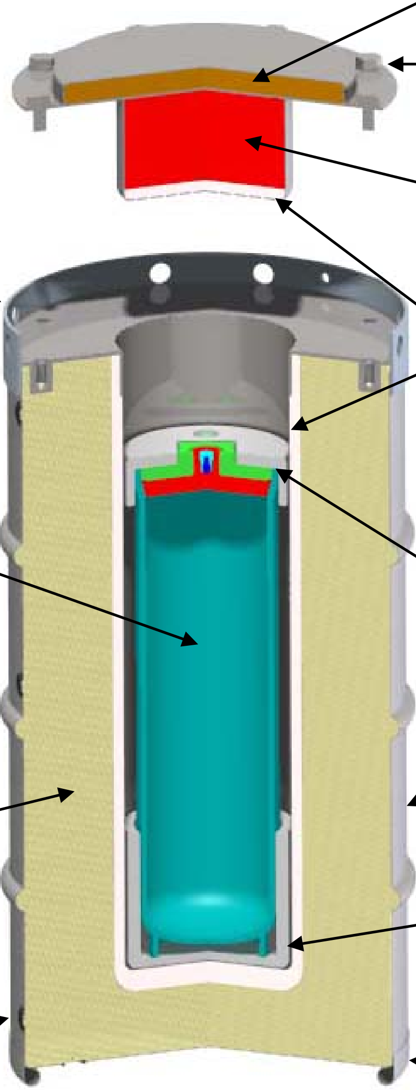

Figure 1: Three-Dimensional Cut Away Illustration of the 9977

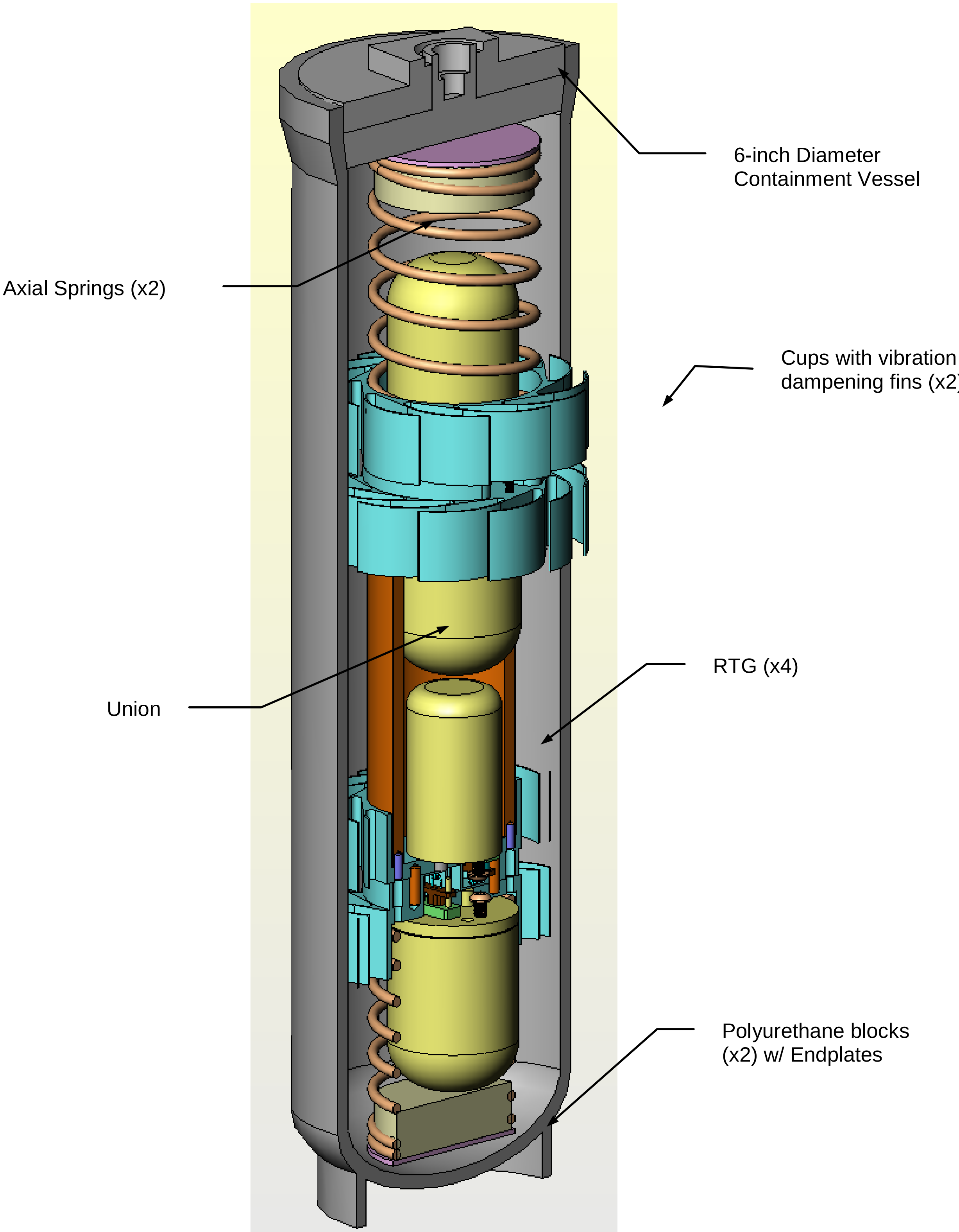

Figure 2a: 6CV w/Radioisotope Thermoelectric Generator (RTG) Assembly

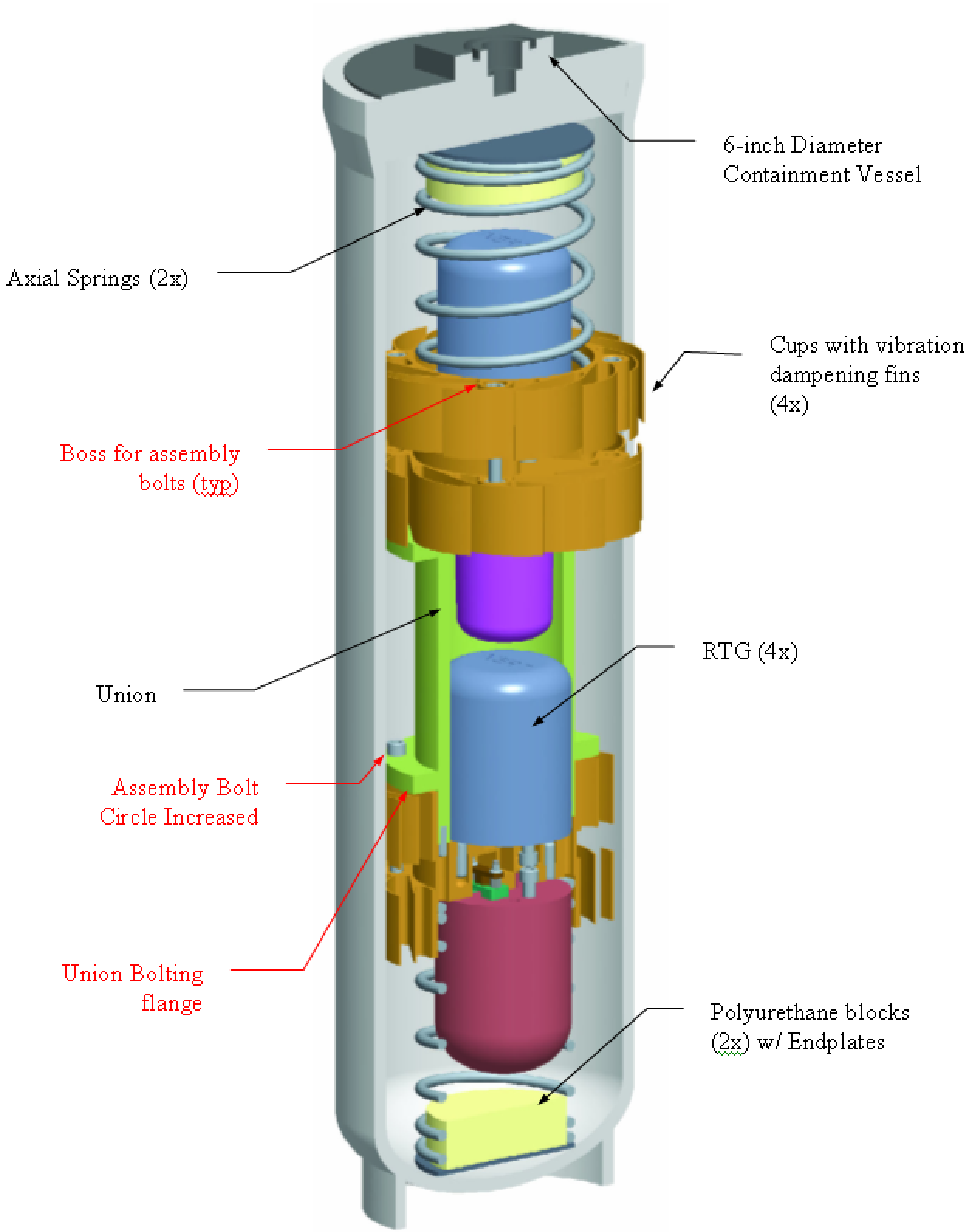

Figure 2b: 6CV w/Alt. Radioisotope Thermoelectric Generator (RTG) Assembly

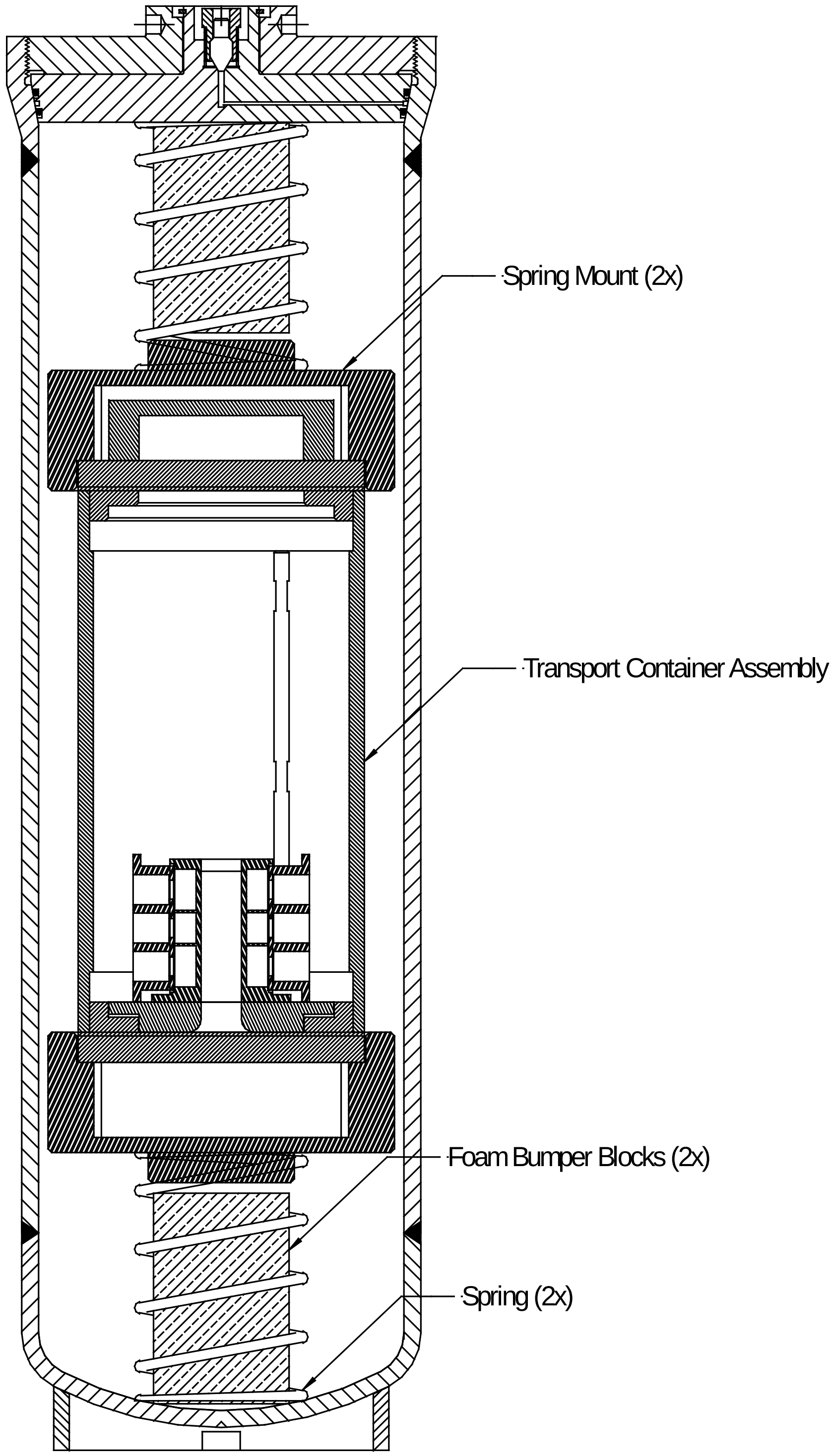

Figure 3: 6CV w/ICE Apparatus Transport Container Assembly

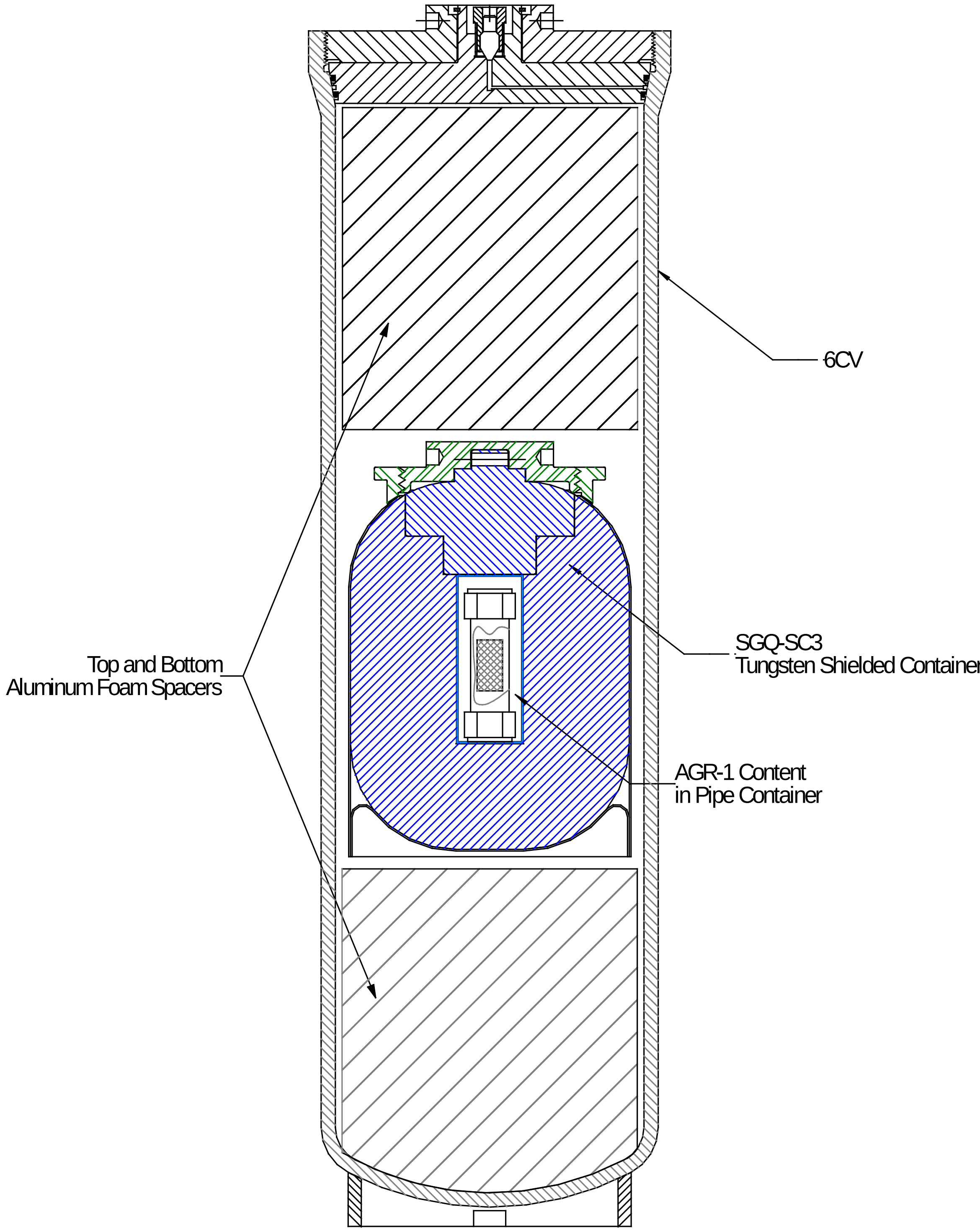

Figure 4: SGQ-SC3 Configuration in 9977 (Tungsten Shielding)

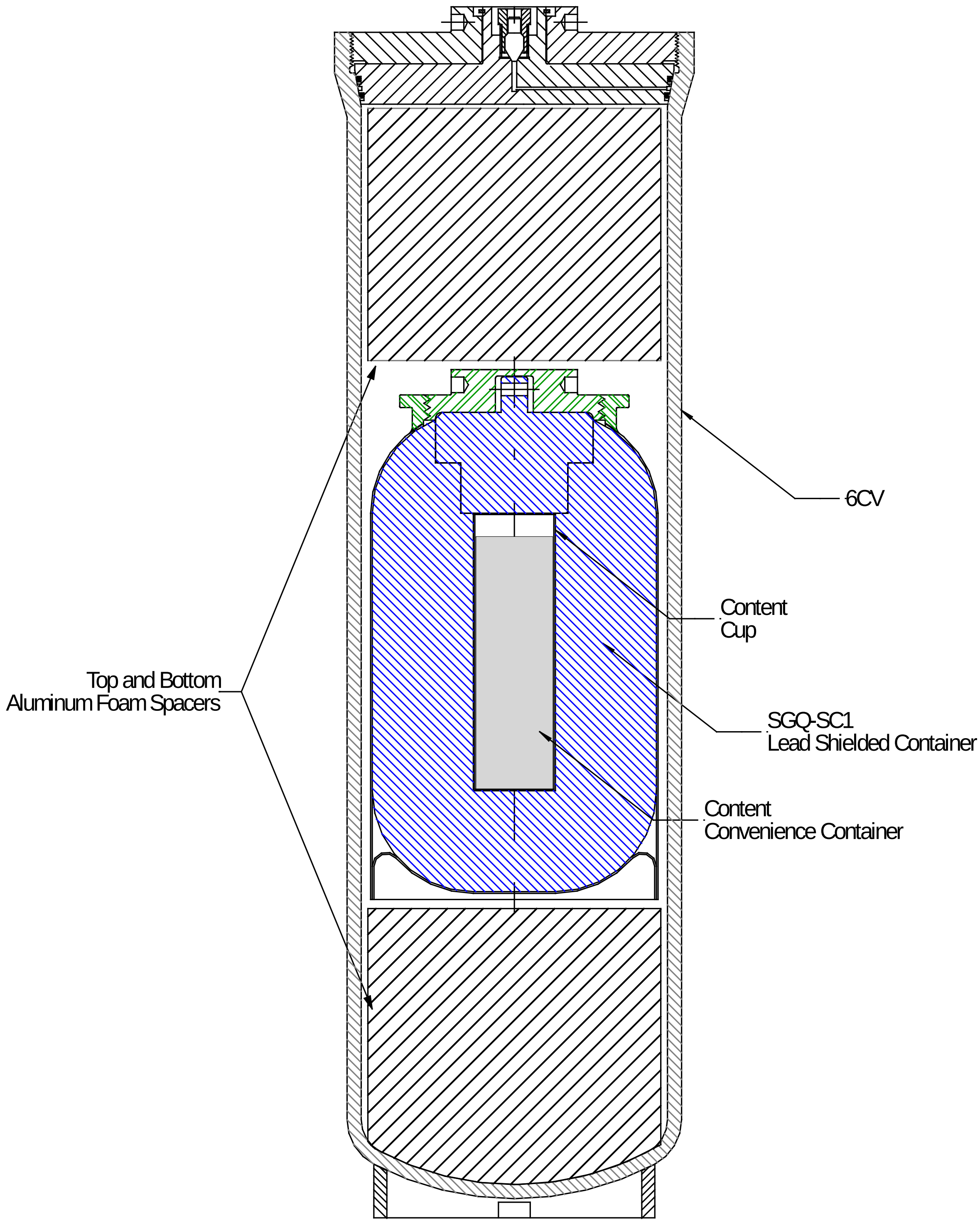

Figure 5: SGQ-SC1 Configuration in 9977 (Lead Shielding)

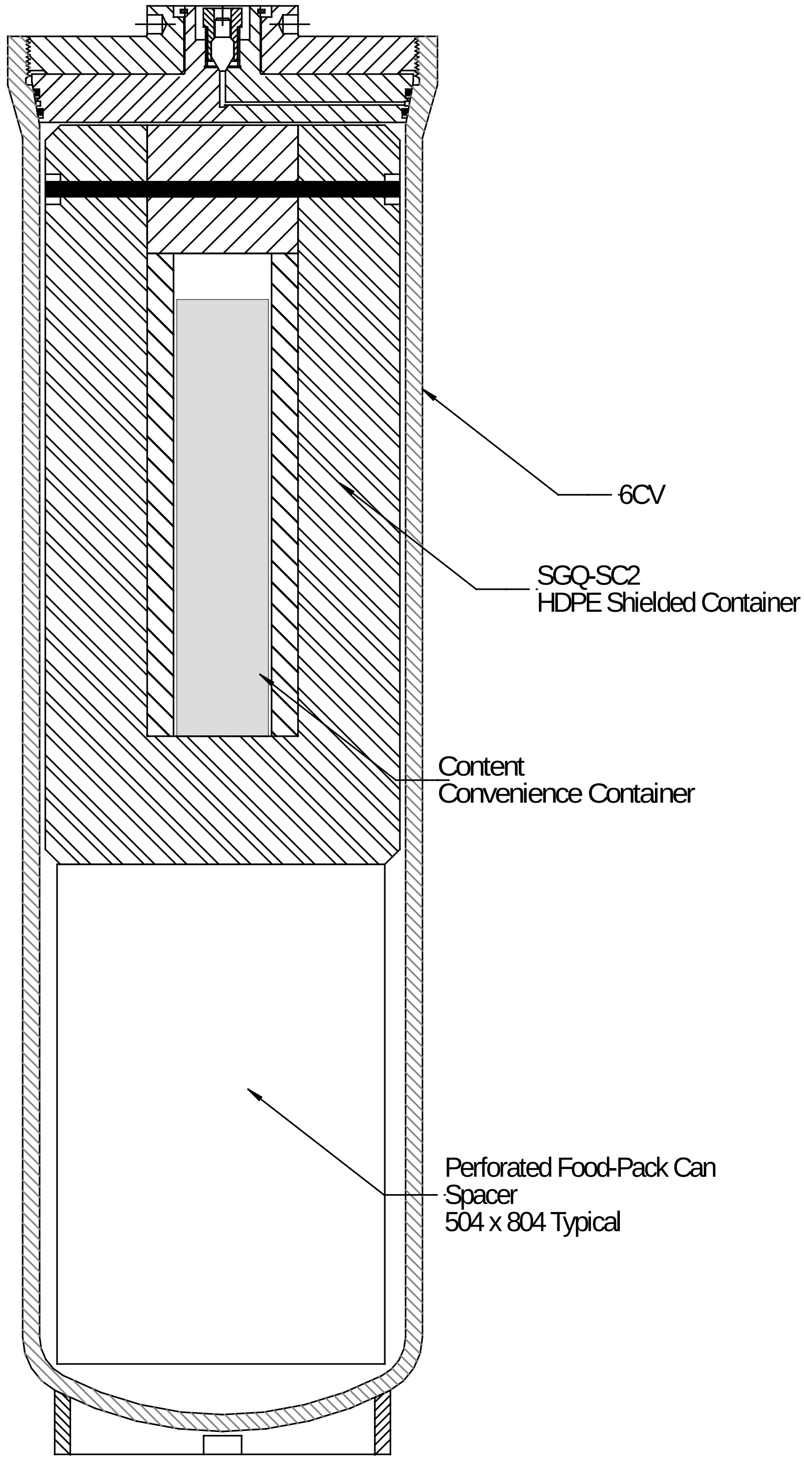

Figure 6: SGQ-SC2 Configuration in 9977 (HDPE Shielding)

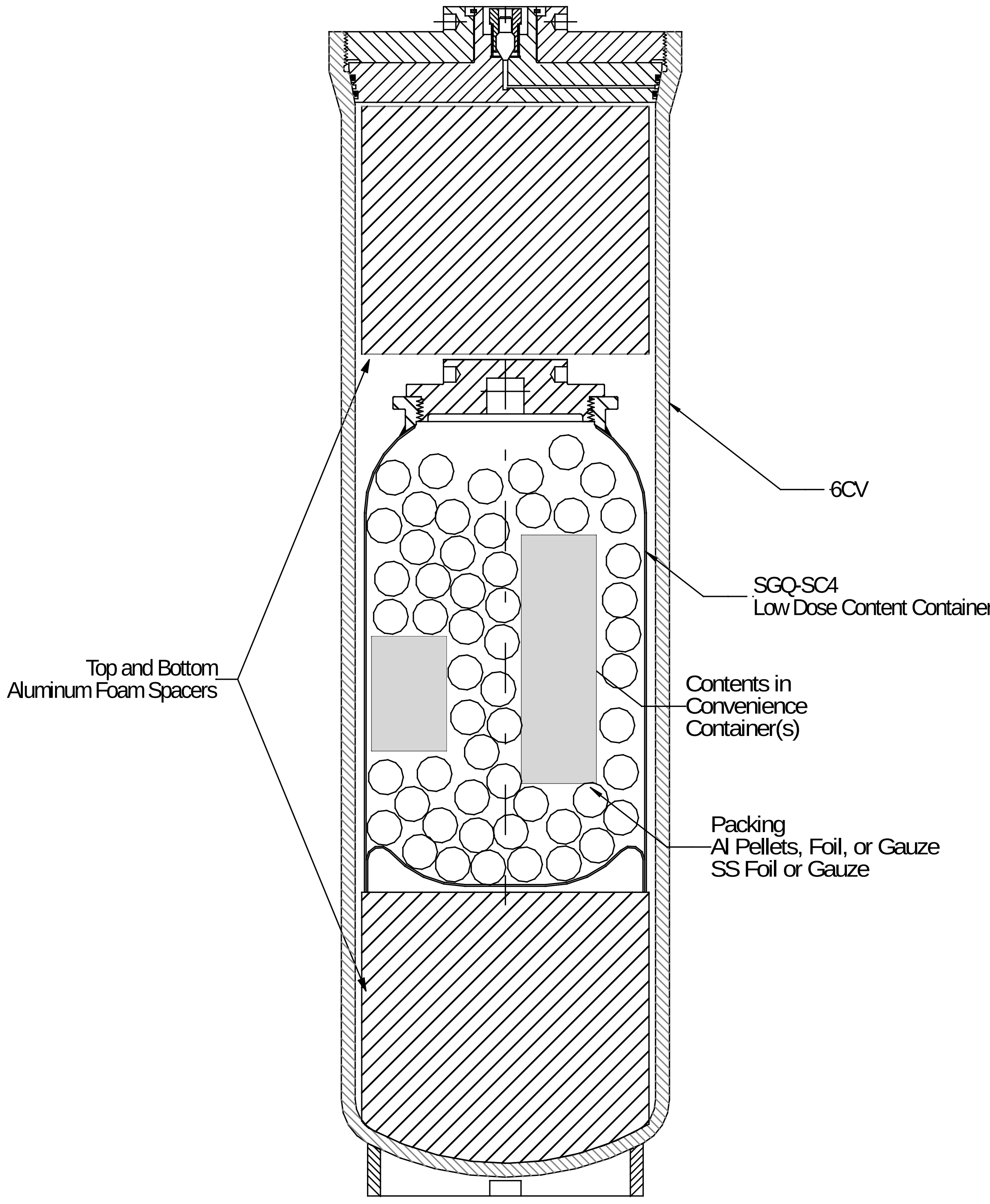

Figure 7: SGQ-EC1 Configuration in 9977 (Confinement)

(3) Drawings:

The packaging design is defined by the following Savannah River Site drawings:

R-R1-G-00020, Revision 2; 9977-Assembly with 6-inch Diameter Containment Vessel (U)

R-R2-G-00017, Revision 1; 9977-Drum and Liner Subassembly (U)

R-R2-G-00018, Revision 2; 9977- Drum Lid Subassembly (U)

R-R2-G-00019, Revision 1; 9977-Insulating Blanket Subassembly (U)

R-R2-G-00042, Revision 2; 9977-Six Inch Diameter Containment Vessel Subassembly (U)

R-R4-G-00032, Revision 1; 9977-Load Distribution Fixtures Details (U)

R-R4-G-00053, Revision 2; 9977-Sleeve and Plug Details (U)

Drawings for the ICE Container Assembly:

R83700, LANL Transport Container Assembly

1001-0269-0000, Platform, Pu Anode, Inner

1103-0355-0000, Panel, ICE, Floor

1103-0388-0000, Panel, 17mm Spacer, ICE

1103-0389-0000, Plug, Panel, 17mm Spacer

1350-2333-0000, Fitting, 1/8 to 1/8, Custom

1350-2357-0000, 90º Adaptor Fitting

1350-2495-0000, Probe Nut

1350-2496-0000, Mount, Probe Body, 3-Point

R83710, Transport Container Handle

R83711, Transport Container Anode Mount

R83712, Transport Canister Body

R83722, Transport Container Strain Relief

2-045, Viton O-Ring

502-440-716-AAA2, Socket Head Cap Screw, alloy steel

502-1420-1-AAA2, Socket Head Cap Screw, alloy steel

R-R1-G-00037, Revision 1, 9977 Small Gram Quantity-Shielded Container Type1 (U)

R-R1-G-00038, Revision 1, 9977 Small Gram Quantity-Shielded Container Type 2 (U)

R-R1-G-00039, Revision 1, 9977 Small Gram Quantity-Shielded Container Type 3 (U)

R-R1-G-00045, Revision 0, 9977 Small Gram Quantity-Engineered Container Type1 (U)

R-R4-G-00073, Revision 1, 9977 Small Gram Quantity-Shielded Container Type 1 Spacers (U)

R-R4-G-00074, Revision 1, 9977 Small Gram Quantity-Shielded Container Type 3 Spacers (U)

(b) Contents

(1) Type and Form of Radioactive Material:

Package contents identified as Content Envelope C.1 and ICE are defined in Table 1 and packaging contents identified as Content Envelopes AC.1 through AC.5 are defined in Table 3. The materials of the AGR-1 Compact are defined in Addendum 3, Appendix 1.2 [See 5.(e)(4)]. Packaging contents identified as Type 4 contents are defined in Addendum 3, Table A.1.1 [See 5.(e)(4)]. The Training Sources are defined in Addendum 5, Table A.1.1 [See 5(e)(7)]. The contents are in solid form as metal pieces or oxides. In addition, when shipped in a Sealed Source configuration the Type 4 contents may include materials of several other chemical forms, including but not limited to, fluorides, chlorides, titanates, and sulfates. Contents in liquid form are not permitted.

(2) Maximum Quantity of Radioactive Material per Package:

(a) Envelope C.1, Heat Sources and ICE. The total content mass listed in Table 1 excludes material containers and packing materials (i.e., RTG containers, springs, cups and union). Contents containers and content-specific configuration requirements are listed in Sections 1.2.2.1 and 1.2.2.2 of the SARP [See 5.(e)(1)].

Compatibility of the packaging materials of construction, packing materials, and the contents is discussed in Section 2.2.2 of the SARP [See 5.(e)(1)]. There are no material incompatibilities in the package. Since the 6CV is leaktight, it may become pressurized by heating of gases contained at the time of closure and pressurized further by gases generated from radioactive decay of the contents. The contents do not generate fission gases. The Maximum Normal Operating Pressure (MNOP) for the 6CV is 41.2 psig.

Except as stated in Table 1, small concentrations (<1000 ppm each) of other actinides, fission products, decay products, and neutron activation products are permitted. Assessment of these impurities may be based on process knowledge.

Except as stated in Table 1, inorganic material impurity quantities of less than 100 ppm each are permitted as long as the total mass is less than 0.1 weight percent of the total content mass. Assessment of these impurities may be based on process knowledge.

Content Envelope C.1 and ICE requirements are summarized in Table 2 by content envelope and container configuration.

Table 1- Contents

	Material [a, b]	**C.1 Heat Sources weight%**	**C.1 Heat Sources grams**	**ICE Weight%**	**ICE grams**[e]
Radioisotope	^{238}Pu	100	100	0.04	0.03
	^{239}Pu [c]	40	40	100	8
	^{240}Pu [d]	13	13	6	2.2
	^{241}Pu [c]	1	1	0.2	0.005
	^{242}Pu	1.5	1.5	0.06	8[f]
	^{241}Am			g	0.14
	^{232}U [c]	1.4×10^{-4}			
	^{233}U [c]	0.2			
	^{234}U	40			
	^{235}U [c]	40			
	^{236}U	16			
	^{238}U	40			
Impurities (grams)	Ca	15			
	Fe	5			
	Cr	2			
Total Mass (kg)	Radioactive Materials	0.1	100		8
	Impurities	0.02	20		
	All Contents	0.1	100		8

Notes

- a All contents shall be dry.
- b Pu/U content bulk density shall be no greater than 19.84 g/cc and no less than 2.0 g/cc.
- c Nuclide classified as “fissile” per DOE Good Practices Guide, Criticality Safety Good Practices Program, Guide For DOE Nonreactor Nuclear Facilities, DOE G 421.1-1, 3.79 Fissile Nuclide, 8-25-99.
- d ^{240}Pu shall be greater than ^{241}Pu.
- e Mass limit based on 8-gram ^{239}Pu dose equivalence.
- f The ^{239}Pu dose equivalent mass is 125 grams; the content Total Mass limit takes precedence.
- g ^{241}Am exists at the 9977 SARP Rev.2 impurity limit of 100 ppm.

Table 2- Summary of Requirements by Content and Configuration

Content Envelope	Container Configuration		
	Food-Pack Can	**SNL RTGs**	**ICE Assembly**
C.1	maximum 100 g plastic (low-density polyethylene, nylon, and/or polyvinyl chloride tape)	manufactured per drawings listed packing configuration control maximum 100 grams polyurethane	
ICE			maximum 8 g radioactive materials maximum 100 g plastic manufactured per drawings listed
All	19 watts maximum radioactive decay heat rate less than 1000 ppm other radionuclides (unless otherwise stated in Table 1.2) less than 100 ppm other inorganic impurities with total mass less than 0.1 weight percent (unless otherwise stated in Table 1.2) 100 lb maximum content weight (radioactive contents, convenience cans, contamination control devices, packing materials, spacers, etc.)		

(b) Envelope AC.1, Neptunium Metal. Section 1.2.2.2.1 of the Addendum [See 5.e(2)] provides figures and drawing numbers of Neptunium Metal Spheres and Storage Containers.

The two possible neptunium content configurations are shown in Figure A.1.2. of the Addendum [See 5.e(2)]. One configuration for this content envelope is the Neptunium Sphere which is a solid sphere of neptunium metal with cladding and shielding around the sphere, aluminum foil as dunnage, and a Vollrath convenience can. Additionally, this content may incorporate a configuration within the convenience can where an aluminum Storage Container is placed around the neptunium sphere assembly. The masses of the tungsten shielding shell and the two (2) nickel cladding shells are added to the mass of neptunium for a total assembly mass of 8026.9 grams.

The mass of the aluminum Storage Container is estimated at 3100 grams. Assuming that the density of crushed aluminum foil is about ½ that of a cast billet, the mass of aluminum foil inside the Vollrath can is estimated to be 790 grams. Additional aluminum foil will serve as dunnage outside the Vollrath Can, but its mass depends on the size of the empty dunnage can. Assuming the shipper selects a standard 404 x 700 food-pack can (4.25" diameter by 7" tall); the estimated mass of additional aluminum foil needed to fill the axial space above and/or below is 540 grams. The estimated maximum mass of aluminum, including fixture and foil, is 4430 grams. The mass of the alternative packaging configuration (aluminum foil dunnage only without the handling convenience fixture) will be less.

The Vollrath 88020 can serves as a handling convenience. The stainless steel can will be sealed by a wrapping of tape where the lid rests on the can body. The loaded Vollrath Can will be placed into the 6CV in the Sleeve and Plug configuration. The remaining space above the Vollrath Can may be packed with an empty food pack can and/or aluminum foil as final dunnage.

Neptunium metal pieces to a maximum mass of 188 grams may be shipped under this content envelope. These pieces must be packaged in Food-Pack Cans or Engineered Containers.

(c) Envelope AC.2, BeRP Ball. Section 1.2.2.2.2 of the Addendum [See 5.e(2)] provides figures and drawing numbers of Plutonium Ball and heat-sink fixture drawing.

The BeRP Ball is a Beryllium Reflected Plutonium Ball that contains 4484 grams of alpha-phase plutonium. Radioactive decay heat from the plutonium sphere is 10.656 watts which is much less than the package limit of 19 watts. Added to the mass of plutonium is the mass of the stainless steel shell for a total assembly mass of 4.5 kg. Table 4 presents configuration requirements for the Plutonium Ball content.

The mass of the aluminum heat-sink fixture is estimated conservatively at 3100 grams. Conservatively assuming that the density of crushed aluminum foil is about half that of a cast billet, the mass of aluminum foil inside the Vollrath Can is estimated to be 790 grams. Additional aluminum foil will serve as dunnage outside the Vollrath Can, but its mass depends on the size of the empty dunnage can. Assuming the shipper selects a standard 404 x 700 food-pack can (4.25” diameter by 7” tall) as dunnage, the estimated mass of additional aluminum foil needed to fill the axial space above and/or below the food-pack can is 540 grams. The estimated maximum mass of aluminum, including fixture and foil, is 4500 grams.

The Vollrath 88020 is a slip lid convenience can. The stainless steel can will be sealed by a wrapping of tape where the lid rests on the can body. The loaded Vollrath Can will be placed into the 6CV, followed by one empty and perforated food-pack or empty and unsealed slip-lid can to serve as dunnage. The space between the Vollrath Can and the dunnage can and between the dunnage can and the top of the vessel will be packed with aluminum foil as final dunnage.

(d) Envelopes AC.3 and AC.4, Pu/U Metals. Section 1.2.2.2.3 of the Addendum [See 5.e(2)] provides figures and more details for these content envelopes.

Content Envelopes AC.3 and AC.4 must be loaded into the containment vessel with the incorporation of an aluminum Sleeve and Plug. The (one-piece) aluminum Sleeve and Plug component reduces the volume of the containment vessel in order to meet the Single Package Flooded condition requirement for sub-criticality found in 10 CFR 71.55, General Requirements for Fissile Material Packages. For array analyses, the aluminum Sleeve and Plug also provides spacing in order to meet the requirement for sub-criticality. The aluminum Sleeve and Plug also provides spacing in order to meet the requirement NCT Dose limit requirements.

These contents are packaged in 3013 containers, Food-pPack cans, or eEngineered Containers and the product container is loaded into the containment vessel after the Sleeve and Plug has been installed. The general requirements for all packages as documented in Addendum Section 1.2.2 apply to these contents.

For Content Envelope AC.3, if the radionuclide content mass is equal to or greater than 3 kg per innermost material container, the following restrictions apply:

- The sum of the radial wall thicknesses of all nested cans shall not exceed 0.26 inch.
- The sum of the thicknesses of the tops and bottoms of all nested cans shall not exceed 1.77 inches.
- The innermost material container shall be at least 4 inches in diameter and at least 4 inches long (i.e., minimum can size 400 x 400).

For Content Envelope AC.4 material with a mass less than or equal to 450 grams, the requirement to use of the aluminum Sleeve and Plug does not apply. Contents meeting these conditions and packaged in 3013 containers, Food-Pack cans, or an Engineered Container are permitted to be loaded into the containment vessel with no additional packaging requirements. Aluminum foil may be placed around the product container as dunnage to restrict movement within the containment vessel.

(e) Envelope AC.5, U Metal. Section 1.2.2.2.4 of the Addendum [See 5.e(2)] provides figures and more details for this content envelope.

Content Envelope AC.5 maximizes the Highly Enriched uranium metal, alloyed with up to 10% molybdenum, which may be shipped in the 9977. This content must be packaged in a 3013 container, a Food-Pack can, or an Engineered Container. The convenience container must be placed within a (one-piece) aluminum Sleeve and Plug component followed by an empty, perforated food-pack can, followed by aluminum foil dunnage. Aluminum foil may be placed around the product container as dunnage to restrict movement within the containment vessel. Requirements applicable to all packages as documented in Addendum [See 5.5(2)] Section 1.2.2 apply to this content envelope.

The Content Envelope AC.5 separate mass limit is dependent upon its percent enrichment. Contents with less than 95% ^{235}U have a mass limit of 18 kg. Content with enrichment greater than 95% (to a maximum of 100 %) ^{235}U have a mass limit of 16 kg. For Content Envelope AC.5, if the radionuclide content mass is equal to or greater than 3 kg per innermost material container, the following restrictions apply:

- The sum of the radial wall thicknesses of all nested cans shall not exceed 0.26 inch.
- The sum of the thicknesses of the tops and bottoms of all nested cans shall not exceed 1.77 inches.
- The innermost material container shall be at least 4 inches in diameter and at lease 4 inches long (i.e. minimum can size 400 x 400).

Table 3 - Content Envelopes

	Material [a,b]	AC.1 Neptunium Metal	AC.2 BeRP Ball Metal	AC.3 [c] Pu/U Metal	AC.4 [c] Pu/U Metal	AC.5 [c] U Metal
Radioisotope (Weight Percent of Radioactive Material Mass)	^{238}Pu	1.6×10^{-3}	0.02	2	2	
	^{239}Pu [d]	3.2×10^{-2}	93.74	100	100	
	^{240}Pu [e]	2.3×10^{-3}	5.94	25	50	
	^{241}Pu [d]	6.2×10^{-5}	0.272	15	15	
	^{242}Pu	3.2×10^{-4}	0.028	5	5	
	$^{241}Am + ^{241}Pu$	7.2×10^{-4}	0.272	15	15	
	^{243}Am	0.18				
	^{237}Np	98.8 [f]				
	^{232}U [d]			1×10^{-7}	1×10^{-7}	1×10^{-7}
	^{233}U [d]	3.5×10^{-3}		0.5	0.5	0.5
	^{234}U	5.7×10^{-4}		100	100	100
	^{235}U [d]	2.8×10^{-2}		100	100	100/95 [g]
	^{236}U	1.6×10^{-4}		40	40	40
	^{238}U	3.1×10^{-3}		100	100	100
Impurities [h] (%)	Al, B, F, Li, Mg, Na					
	Be					
	Mo					10
	C					
Total Mass (kilograms)	Radioactive Materials	0.188/6.07 [i]	4.48	4.4	0.45/2 [j]	16/18 [g]
	Impurities		0.0215	3.08 [k]		
	All Contents	0.188/6.07 [i]	4.5	4.4	0.45/2 [j]	16/18 [g]

a. All contents shall be dry.
b. Pu/U content bulk density shall be no greater than 19.84 g/cc and no less than 2.0 g/cc.
c. Contents shall be stabilized in accordance with DOE-STD-3013, Section 6.1.1.
d. Nuclide classified as “fissile” per DOE Good Practices Guide, Criticality Safety Good Practices Program, Guide For DOE Nonreactor Nuclear Facilities, DOE G 421.1-1, 3.79 Fissile Nuclide, 8-25-99
e. ^{240}Pu shall be greater than ^{241}Pu
f. 100-year accumulation of daughter products incorporated into thermal and nuclear safety evaluations.
g. The content mass limit is based on the percentage of ^{235}U. 16 kg of Content with up to 100 wt% ^{235}U are allowed. 18 kg of Content with up to 95 wt% ^{235}U are allowed.
h. Less than 0.005 grams of (α, n) impurities {aluminum, beryllium, boron, fluorine, lithium, magnesium, and sodium} are permitted.
i. The mass limit is based on the content configuration. 6.07 kg is allowed as the Np Sphere configuration. 188 grams is allowed if the content consists of pieces.
j. The mass limit is based on the content packing configuration. 2 kg of Content in the Sleeve and Plug configuration is allowed. 450 grams of Content placed directly into the 6CV is allowed.
k. The impurity limit is based on the DOE-STD-3013 requirement that plutonium plus uranium mass shall not be less than 30 weight percent of the total content mass

Table 4 - Summary of Packaging Configuration Requirements

<table>
<tr><th rowspan="2">Content Envelope</th><th colspan="2">Configuration</th></tr>
<tr><th>Food-Pack Cans or Engineered Containers</th><th>3013</th></tr>
<tr><td>AC.1
Neptunium Metal
Sphere
Or
Pieces</td><td>• aluminum Sleeve and Plug required
• maximum content 188 grams if pieces
• maximum 100 grams plastic
• maximum 2000 grams stainless steel cans (Vollrath)
• maximum 4500 grams aluminum (heat-sink fixture and/or foil)</td><td>NA</td></tr>
<tr><td>AC.2
BeRP
Ball</td><td>• maximum 100 grams plastic
• maximum 2000 grams stainless steel cans (Vollrath)
• maximum 4500 grams aluminum (heat-sink fixture and/or foil)</td><td>NA</td></tr>
<tr><td>AC.3
Pu Metal</td><td>• aluminum Sleeve and Plug required
• maximum 100 grams plastic
• if ≥ 3kg per food-pack can
* sum of can walls < 0.26 inches
* sum of can tops & bottoms < 1.77 inches
* 400 x 400 can or bigger</td><td>• aluminum Sleeve and Plug required
• if ≥ 3kg per inner/material can
* sum of can walls < 0.26 inches
* sum of can tops & bottoms < 1.77 inches
* 400 x 400 can or bigger</td></tr>
<tr><td>AC.4
Pu Metal</td><td>• aluminum Sleeve and Plug required
(unless total radioactive contents mass is less than 450 grams)
• maximum 100 grams plastic</td><td>• aluminum Sleeve and Plug required
(unless total radioactive contents mass is less than 450 grams)</td></tr>
<tr><td>AC.5
U Metal</td><td>• aluminum Sleeve and Plug required
• maximum 100 grams plastic
• if ≥ 3kg per food-pack can
* sum of can walls < 0.26 inches
* sum of can tops & bottoms < 1.77 inches
* 400 x 400 can or bigger</td><td>• aluminum Sleeve and Plug required
• if ≥ 3kg per inner/material can
* sum of can walls < 0.26 inches
* sum of can tops & bottoms < 1.77 inches
* 400 x 400 can or bigger</td></tr>
<tr><td>All</td><td colspan="2">• 19 watts maximum radioactive decay heat rate
• less than 1000 ppm other radionuclides (unless otherwise stated)
• less than 100 ppm other inorganic impurities with total mass less than 0.1 weight percent (unless otherwise stated)
• 100 lb maximum content weight (radioactive contents, product cans, Sleeve and Plug, etc.)</td></tr>
</table>

Note: Can wall thickness limits are driven by criticality concerns and do not apply to the Neptunium Metal Sphere or Parts

(f) The AGR-1 Fuel Compact has less than 1 gram of radioactive material and contain no more than 1000 ppm total of ^{251}Cf, ^{249}Cf, ^{242m}Am, ^{243}Cm, ^{245}Cm, and ^{247}Cm. The AGR-1 Fuel Compact has less than 6 grams of total content mass (radioactive material plus impurities). The materials of the AGR-1 Compact are defined in Addendum 3, Appendix 1.2 [See 5.(e)(4)].

The AGR-1 Fuel Compact shall be placed in a pipe Container (consisting of a threaded pipe section closed with pipe caps) with a minimum closed length of 2.8 inches. The AGR-1 Fuel Compact in the pipe Container is then placed inside the SCQ-SC3 container. The SGQ–SC3 container provides gamma shielding and consists of tungsten shielding material encapsulated in a stainless steel container with threaded closure. The SGQ-SC3 container is located axially within the 9977 6 inch Containment Vessel (6CV) by aluminum foam Spacers. The typical packaging configuration is shown in Figure 4. Addendum 3, Appendix 1.1 contains the drawings detailing the shielded container components [See 5.(e)(4)].

The maximum allowable radioactive decay heat rate is 19 watts.

(g) For the Type 4 content (i.e., Sources) various radioactive isotopes have been proposed for shipment, including ^{238}Pu, ^{239}Pu, ^{241}Am, ^{244}Cm, ^{252}Cf, ^{90}Sr, ^{226}Ra, ^{137}Cs, ^{60}Co, and ^{192}Ir, with the Special Actinide Isotopes (^{242m}Am, ^{243}Cm, ^{245}Cm, ^{247}Cm, ^{249}Cf and ^{251}Cf) limited to a total of 1,000 ppm. The content limits for Type 4 contents are shown in Table 5 below and in Addendum 3, Tables A.1.1 *Small Gram Contents* [See 5.(e)(4)]. A summary of the requirements by content and configuration is shown in Table A.1.2 of Addendum 3 and Appendix 1.2 of Addendum 3 contains the drawing details for the three shielded containers, engineered container, and container components [See 5.(e)(4)].

Table 5: Type 4 (Sources) Contents

Isotope	**Maximum Mass Limit [g]**	**Maximum Activity [Ci]**
Co-60	1.0E-04	0.11
Cs-137	1.0E-01	8.70
Ir-192	3.8E-03	35.00
Sr-90/Y-90	1.0E+00	281.80
Ra-226	2.0E-01	0.20
Am-241	1.0E+00	3.43
Cf-252	6.7E-06	0.0036
Cm-244	1.0E+00	80.90
Pu-238	2.0E-01	3.42
Pu-239	6.6E+01	4.09

Gamma-sources will be placed in the lead-shielded containers (SGQ-SC1), which will then, in turn, be placed into the 6CV in accordance with the allowable content configuration, defined in Table A.1.2 of Addendum 3 [See 5.(e)(4)]. Gamma-sources can also be placed in the tungsten-shielded containers (SGQ-SC3), as the tungsten-shielded containers are an acceptable substitute for the lead-shielded containers. The decay heat load for the SGQ-SC1 and SGQ-SC3 containers are limited to 6 watts and 19 watts, respectively.

The neutron-sources will be placed in the HDPE shielded container (SGQ-SC2), which will then, in turn, be placed into the 6CV in accordance with the allowable content configuration, defined in Table A.1.2 of Addendum 3 [See 5.(e)(4)]. The decay heat load for the SGQ-SC2 container is limited to 3 watts.

An Engineered Container (SGQ-EC1) can be used for shipments of unshielded sources and pieces that do not require shielding, provided that the administrative dose rate limits of 180 mrem/hr (on contact of the unshielded source or piece) and 9 mrem/hr (at a distance of 1 meter of the unshielded source or piece) are met following the procedures in section 7.1.1.2 of Addendum 3 [See 5.(e)(4)]. Shielded sources and pieces must go in one of the appropriated approved shielded containers because the shielding integrity of the sources can not be assured in HAC for the SGQ-EC1 container. The unshielded source(s) and pieces not requiring shielding are placed in the SGQ-EC1 container, which will then, in turn, be placed into the 6CV in accordance with the allowable content configuration, defined in Table A.1.2 of Addendum 3 [See 5.(e)(4)]. The decay heat load for the SGQ-EC1 is 19 watts.

(h) The Training Sources contents may include radioactive isotopes (^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, ^{243}Am, ^{252}Cf, ^{248}Cm, ^{237}Np, ^{232}Th, ^{234}U, ^{235}U, ^{236}U, ^{238}U), with impurities (such as Be, Al, Mg, Na, F). The maximum masses for the Training Sources contents are limited to masses noted in Table 6. The packaging configuration requirements specified in Table A.1.2 of Addendum 5 [See 5.(e)(7)], *Summary of Requirements*, must be followed. The packaging configuration requirements specified in Addendum 5 Section 1.2.2 [See 5.(e)(7)] must be followed.

Table 6 – Training Sources Contents

	Material [a, b]	**Training Sources** (grams)
Radioisotope	^{238}Pu	3.5
	^{239}Pu [c]	190
	^{240}Pu [d]	25
	^{241}Pu [c]	7
	^{242}Pu	10
	^{241}Pu + ^{241}Am	7
	^{243}Am	6.63
	^{252}Cf	2.6×10^{-7}
	^{248}Cm	5.7×10^{-6}
	^{237}Np	10
	^{232}Th	10,000
	^{232}U [c]	
	^{233}U [c]	
	^{234}U	10
	^{235}U [c]	500/350 [f]
	^{236}U	1
	^{238}U	2,000
Impurities [e]	(unit) ➔	(ppm)
	Be	1,500
	Al	150
	Mg	500
	Na	300
	F	200
	Ca	
	Fe	
	Cr	
Total Mass (kg)	Radioactive Materials	12.75
	Impurities	0.034
	All Contents	12.78

Notes for Table 6

a All contents shall be dry.

b Pu/U content bulk density shall be no greater than 19.84 g/cc and no less than 2.0 g/cc.

c Nuclide classified as "fissile" per DOE Good Practices Guide, Criticality Safety Good Practices Program, Guide For DOE Nonreactor Nuclear Facilities, DOE G 421.1-1, 3.79 Fissile Nuclide, 8-25-99.

d ^{240}Pu shall be greater than ^{241}Pu.

e The Al, Mg, Na, and F limits may be increased on a ppm basis for an equal decrease in the Be content limit.

f The 350 gram limit is imposed if the combined total ^{239}Pu mass plus ^{241}Pu mass equals or exceeds 10 grams

(c) Criticality Safety Index (CSI)

The CSI for package with Content Envelope C.1 or ICE is zero (CSI=0).

The CSI for the package with Content Envelope AC.1 through AC.5 is 1.0 (CSI=1.0).

The CSI for package with AGR-1 Compact is zero (CSI=0).

The CSI for package with Type 4 (Sources) contents is zero (CSI=0).

The CSI for package with Training Sources contents is 1 (CSI=1)

(d) Conditions:

(1) The maximum allowable radioactive decay heat rate is 19 watts

(2) The maximum weight of the payload (everything that goes into the 6CV, including radioactive contents, convenience cans, contamination control devices, packing materials, spacers, etc.) is not to exceed 100 lb.

(3) The Model 9977 Package must be shipped in a closed conveyance.

(4) Transport of fissile material by air is not authorized.

(5) In addition to the requirements of Subparts G and H of 10 CFR Part 71, and except as specified in section 5(d) of this certificate, each package must be fabricated, acceptance tested, operated, and maintained in accordance with the Operating Procedures requirements of Chapter 7, Acceptance Tests and Maintenance Program requirements of Chapter 8, and packaging-specific Quality Assurance requirements of Chapter 9 of the SARP [See 5.(e)(1)] as supplemented by the Addendum [See 5.(e)(2)] , the Application [See 5.(e)(3)],and the Addendum [See 5.(e)(4)].

(6) For the AGR-1 fuel compacts, the requirements specified in Section 1.2.2.2.2, and in Table A.1.2, of the Addendum [5(e)(4)], must be followed, along with the specific procedures outlined in Steps 1, 2, 6, 8, and 12 of Section 7.1.1.2 of the Addendum [5(e)(4)]. The documentation packages for the Q items, numbered as 17–20, in Table A.App.8.2.1 of the Addendum [5(e)(4)], Dimensions/Materials Requiring Independent Verification Records, must be supplied by the Site directing fabrication, to Savannah River National Laboratory as the Design Authority/Design Agency.

(7) If the option is chosen to attach a DOE ARG-US RFID tag to the 9977 packaging, the operating procedures must follow the additional steps per Chapter 7 in Addendum [See 5(e)(5)], and the guide to RFID monitoring system [See 5(e)(6)]. The RFID guide contains a copy of the Material/Product Safety Data Sheet for the batteries used in the DOE ARG-US RFID tag, which provides guidance on the safe use of the batteries.

(8) For the Type 4 (Sources) contents, the requirements specified in Section 1.2.2.2.1, and in Table A.1.2, of the Addendum [5(e)(4)], must be followed, along with the specific procedures of Section 7.1.1.2 of the Addendum [5(e)(4)]. The documentation packages for the Q items, numbered as 17–30, in Table A.App.8.2.1 of the Addendum [5(e)(4)], Dimensions/Materials Requiring Independent Verification Records, must be supplied by the Site directing fabrication, to Savannah River National Laboratory as the Design Authority/Design Agency.

(9) Verification of the pre-shipment containment integrity of the containment system, on both the O-ring seal and the Leak Test Port Plug, shall be accomplished using either the pressure rise method or the pressure drop method of testing as specified in ANSI N14.5-1997.

(10) The following conditions apply to the installation of an DOE ARG-US RFID tag on a 9977 packaging to allow for the extension of the maintenance interval:

(a) The maximum allowable radioactive decay heat rate for the 9977 package is 19 watts, except for extension of the packaging periodic maintenance interval, in which case the maximum allowable radioactive decay heat rate is limited to 15 watts.

(b) The user shall verify the installation of proper O-rings (i.e., GLT vs. GLT-S) and record the date of installation, e.g., 9977/GLT (or GLT-S)/xx/xx/201x, in the memory of the ARG-US RFID tag.

(c) During both use (loading, shipment, and unloading) and storage (loaded and empty) of the 9977 packaging, the containment vessel (CV) must remain sealed over the entire approved extended maintenance interval. In the event that operations require the CV to be opened, then the old O rings shall be replaced with new O-rings, all the requirements for the extended maintenance interval described in the SARP Addendum 4 shall be complied with for the new O-rings, and the sealing time shall be re-initialized to zero.

(d) The extension of the packaging periodic maintenance interval is to a maximum of five (5) years for the 9977 packaging using the Viton GLT O-rings; and to a maximum of two (2) years for the 9977 packaging using the Viton GLT-S O-rings as shown in Drawing R-R2-G-00042, Item 8. If the ongoing O-ring fixture long-term leak performance testing shows any GLT and GLT-S O-ring failures at 200^{o}F, notify the Headquarters Certifying Official within 72 hours.

(e) The user of this CoC for extension of packaging periodic maintenance interval shall complete the prescribed training to become qualified and to be certified for operation of the RFID temperature monitoring system. The training course will be administered by Argonne National Laboratory on behalf of the Headquarters Certifying Official.

(f) When a temperature-sensing DOE ARG-US RFID tag is attached to a 9977 packaging, it shall be verified to be functional in accordance with the Operating Procedures requirements of Addendum 4 [See 5(e)(12)]. If a failure of the RFID tag or the temperature recording system results in a loss of temperature data for a duration ≥72 hours, then the packaging shall have a Nonconformance Report issued against it and be tagged and segregated until the disposition of the Nonconformance Report has been approved by both the 9977 Design Authority and Headquarters Certifying Official.

(e) References

(1) *Safety Analysis Report for Packaging, Model 9977 B(M)F-96*, S-SARP-G-00001, Revision 2, August 2007

(2) *Safety Analysis Report for Packaging, Model 9977 Addendum 2, Justification for Metal Contents,* S-SARA-G-00005, Revision 1, December 16, 2008.

(3) *Application for Contents Amendment for Shipping Isentropic Compression Experiment (ICE) Apparatus in 9977 Packaging*, National Nuclear Security Agency Memorandum from Paul T. Mann, Facility Operations Division, NA-172.1, to James M. Shuler, Office of Packaging and Transportation Safety, EM-63, Revision 2, February 20, 2009.

(4) *Safety Analysis Report for Packaging, Model 9977 Addendum 3, Justification for Small Gram Quantity Contents,* S-SARA-G-00006, Revision 4, March 2010.

(5) *Safety Analysis Report for Packaging, Model 9977Addendum 4, Justification for Use of the Radio Frequency Identification (RFID) System*, S-SARA-G-00010, Revision 0, February 2010

(6) Guide to the RFID Monitoring System (Models 9975, 9977, and 9978 Packages), Argonne National Laboratory, ANL/DIS-09-5, December 3, 2009 and its Supplements.

(7) *Safety Analysis Report for Packaging, Model 9977Addendum 5, Justification for Training Sources Contents*, S-SARA-G-00009, Revision 2, May 2010

(8) Application for Amendment for Shipping Revised Sleeve and Plug Design in the 9977 Packaging, NNSA memorandum from Paul Mann to James M. Shuler, Manager DOE PCP, June 29, 2010.

(9) Memo from Paul Mann to J. Shuler, “ACTION: Application for Contents Amendment for Shipping Alternate Radioisotopic Thermoelectric Generator (RTG) Assembly Configuration in 9977 Packaging,” November 22, 2010.

(10) Memo from Paul Mann to J. Shuler, “ACTION: Application for Contents Amendment for Shipping Training Source Contents in 9977 Packaging,” November 22, 2010.

(11) Letter Amendment Request for the 9975-85, 9975-96, 9977, and 9978, COR-OM-11/15/2010-301010, submitted to Dr. Jim Shuler, Environmental Management, by the National Nuclear Security Administration (NNSA), Livermore Site Office (November 17, 2010).

(12) *Justification for Use of the Radio Frequency Identification (RFID) System and Extension of Packaging Periodic Maintenance Interval*, Safety Analysis Report for Packaging Model 9977, Addendum 4, S-SARA-G-00010, Revision 5, February 2012, Savannah River National Laboratory.