LA-UR- 11-03271

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Title: PLUTONIUM AIR TRANSPORTABLE (PAT-1) PACKAGING IMPLEMENTATION AND READINESS ACTIVITIES

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Intended for: INSTITUTE OF NUCLEAR MATERIAL MANAGEMENT 52ND ANNUAL MEETING

Los Alamos
NATIONAL LABORATORY
EST. 1943

PLUTONIUM AIR TRANSPORTABLE (PAT-1) PACKAGING IMPLEMENTATION AND READINESS ACTIVITIES

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ABSTRACT

The National Nuclear Security Administration (NNSA) recently received approval for the transport of plutonium metal by air in the Plutonium Air Transportable (PAT-1) packaging. The Nuclear Regulatory Commission (NRC) issued Revision 10 to Certificate of Compliance USA/0361/B(U)F-96 on December 23, 2010 adding plutonium metal as an authorized content. The INMM presentation will focus on the implementation activities that are currently being addressed prior to first use. Specifically, areas of discussion would include refurbishment of the PAT-1 fleet which has been inactive for many years, procurement and fabrication of specialized payload containers, authorized contents, packing configurations, leak test processes, and maintenance protocol.

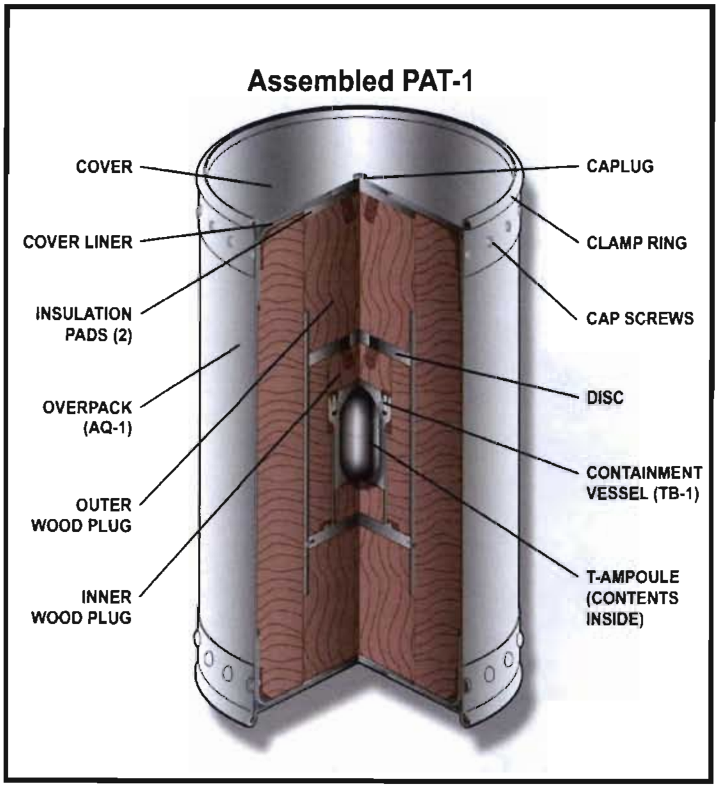

Figure 1: PAT-1 Assembly

INTRODUCTION

Shown in Figure 1, is the PAT-1 configuration for transport of plutonium metal. The PAT-1 is certified under *Title 10, Code of Federal Regulations Part 71* by the U.S. Nuclear Regulatory Commission (NRC) per Certificate of Compliance (CoC) number 0361 and is currently at Revision 10. The package identification number is USA/0361/B(U)F-96.

The PAT-1 was originally developed by Sandia National Laboratories (SNL) under contract to the NRC in the late 1970s to requirements specified in *NUREG-0360, Qualification Criteria to Certify a Package for Air Transport of Plutonium.* SNL released the first Safety Analysis Report for the PAT-1 in June of 1978.

PAT-1 ASSEMBLY OVERVIEW

The PAT-1 (see Figure 1) is comprised of a stainless steel and redwood protective overpack designated as the AQ-1, a stainless steel containment vessel designated the TB-1, and a plutonium metal content container designated as the T-Ampoule.

The AQ-1 protective overpack is a 65-gallon stainless steel drum approximately 42 ½" long by 24 ½" in diameter. The walls of the AQ-1 consist of approximately 8" of grain oriented redwood encased within double stainless steel drums. A copper heat conducting element and an aluminum load distributer are encased with the redwood. The redwood is a three-part redwood assembly consisting of the outer assembly and two plug assemblies. The lid is secured to the body with twenty-three 3/8" diameter bolts. The weight of the package is approximately 500 pounds (227 kilograms).

The TB-1 containment vessel, shown in Figure 2, is approximately 8 ½" long by 6 ¾" outside diameter. The minimum wall thickness of the TB-1 is approximately ½". The interior cavity is approximately 7 ½" long by 4 ¼" in diameter with hemispherical ends. The body and lid are constructed of PH13-8Mo precipitation hardened forged stainless steel. The TB-1 is closed by twelve ½" diameter closure bolts and sealed with a copper gasket and knife edges. The weight of the TB-1 when loaded with 4.4 pounds (2 kilograms) of contents is approximately 41.7 pounds (19 kilograms).

The T-Ampoule, also shown in Figure 2, is a plutonium metal content container machined from Ti-6Al-4V titanium alloy billet. The T-Ampoule is sized to closely fit within TB-1 for a diametrical and axial clearance of approximately 0.030". The T-Ampoule is sealed by a threaded lid and body containing an elastomeric O-ring in a bore-seal configuration.

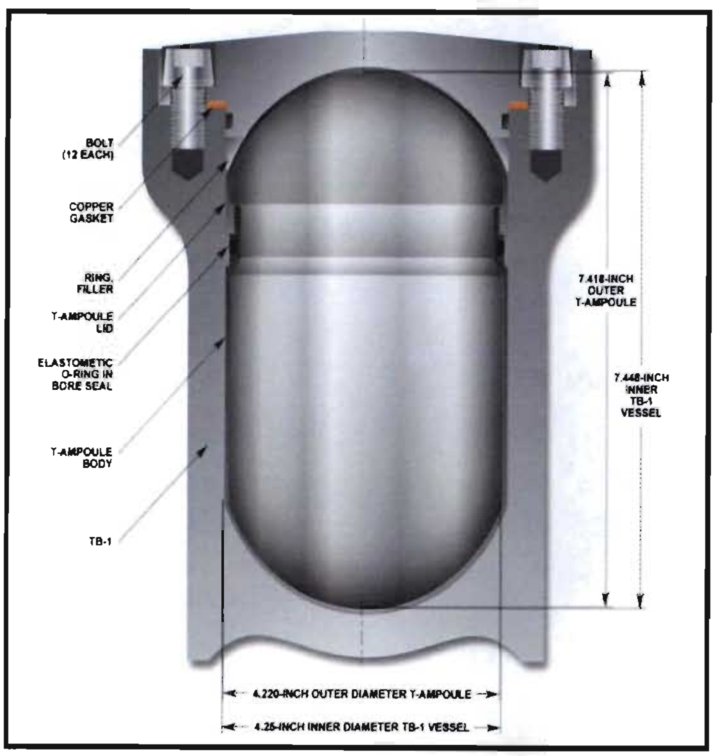

Figure 2: TB-1 and T-Ampoule Assembly

Several protective functions are provided by the T-Ampoule to the TB-1 during the accident conditions stated in 10 CFR 71.74, Accident Conditions for Air Transport of Plutonium. First, it provides a physical barrier between the plutonium metal and the TB-1 interior surface resulting from the 129 meters per second (288 miles per hour) impact accident condition. Secondly, it also provides a eutectic reaction barrier between the plutonium metal and the iron TB-1 alloy at the elevated temperatures resulting from the 1-hour fire test. Lastly, it provides an enclosure for maintaining an inert cover gas over the plutonium metal to minimize oxidation during normal conditions of transport.

AUTHORIZED CONTENTS

In addition to plutonium oxide, the PAT-1 is now authorized to transport alloyed or non-alloyed plutonium metal in various isotopic compositions and composites. The maximum decay heat load of the contents is limited to a maximum of 25 watts.

PLUTONIUM METAL CONTENT

The NRC CoC allows the following plutonium metal configuration and masses:

<u>Content 1:</u> Figure 3 details plutonium metal cast or machined into a hollow cylinder form. The allowable mass of the plutonium metal cylinder is limited from 731 to 831 grams. Prior to loading the plutonium metal cylinder into the T-Ampoule, the metal is wrapped in tantalum foil. Additional tantalum foil is crumpled to fill the void space around the cylinder which is roughly centered in the T-Ampoule. In addition to cushioning the plutonium cylinder, the tantalum foil also precludes any transfer of surface contamination between the plutonium cylinder and the T-Ampoule titanium metal.

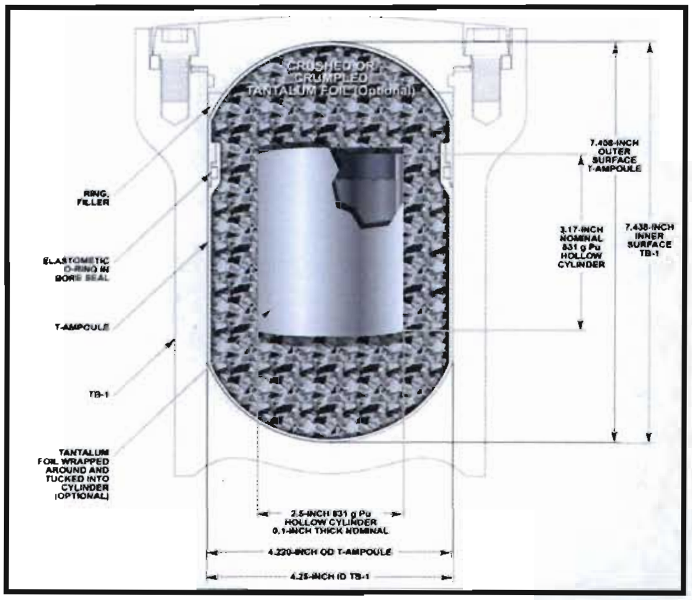

Figure 3: 731 to 831 gram plutonium cylinder

<u>Content 2:</u> Figure 4 introduces the use of sample containers. The smallest of the sample containers is the SC-1. Three SC-1 sample containers can be loaded into the T-Ampoule utilizing the titanium cradle assembly shown in Figure 6. Each SC-1 sample container has a maximum allowable plutonium metal mass of 174 grams. The T-Ampoule is therefore limited to a maximum mass of 522 grams (3 x 174 grams). When beryllium is a part of the metal matrix, the maximum mass is reduced to 60 grams in the SC-1 and 180 grams in the T-Ampoule.

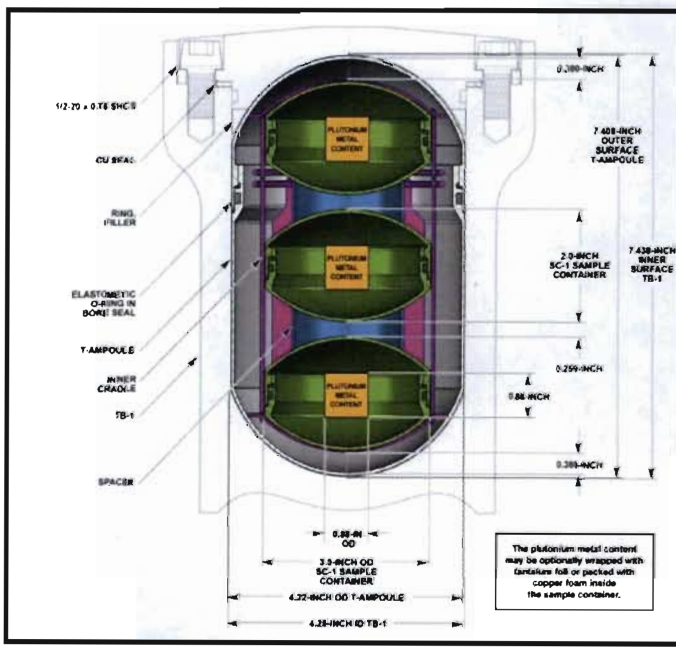

Figure 4: SC-1 Assembly Configuration

<u>Content 3:</u> The largest sample container is the SC-2 shown in Figure 5. Two SC-2 sample containers can be loaded with plutonium metal contents and then securely located into the T-Ampoule using a titanium cradle assembly. Each SC-2 sample container has a maximum allowable plutonium metal mass of 338 grams. The T-

Ampoule is therefore limited to a maximum mass of 676 grams (2 x 338 grams).

Also show in Figure 4 and 5 in the titanium Inner Cradle that is used to securely locate the sample containers within the T-Ampoule. The use of the inner cradle assembly is important in establishing and maintaining a specific position for the SC-1 and SC-2 sample containers. This positional certainty provides a known distance for potential velocities in the structural finite element analysis.

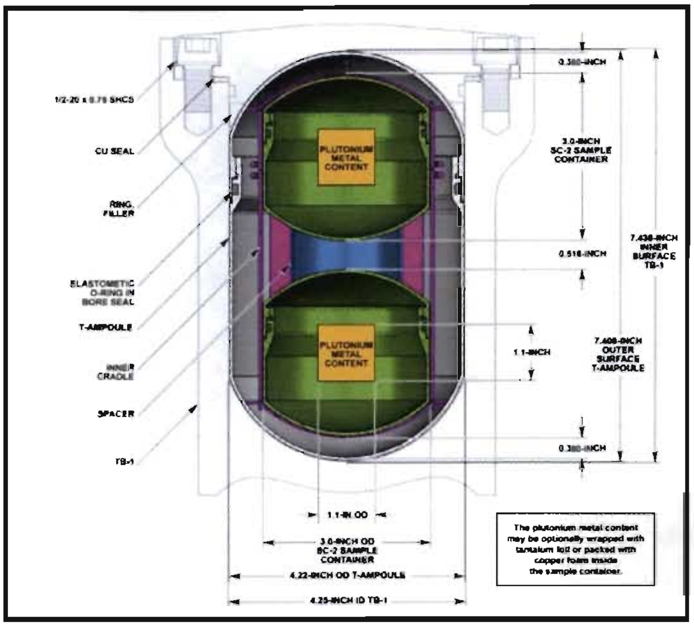

Figure 5: SC-2 Assembly Configuration

IMPLEMENTATION AND READINESS EFFORTS

<u>Refurbishment:</u> The current inventory of the PAT-1 containers consists of two complete packagings and one partially packaging. Of the two complete packagings, refurbishment will consist of replacing gaskets, O-rings, and bolts. The third packaging is being assessed for extent of refurbishment and a cost/benefit analysis is underway.

<u>Fabrication of Payload Containers, Cradles, and Ring Filler:</u> SNL has placed several fabrication orders for the payload containers, cradles, and ring fillers. The initial order consists of:

Component	Drawing	Order
Ring Filler	2A0262	3
T-Ampoule	2A0261	6
Inner Cradle	2A0385	3
Sample Container-1	2A0268	18
Sample Container-2	2A0265	12

All component used for the plutonium metal contents are constructed of titanium alloy. The strength, weight, and eutectic barrier features of the titanium alloy are required to ensure performance under regulatory testing. The figures below show various components in construction:

Figure 6: T-Ampoule Lids and Bodies

Figure 7: Sample Container, Spacer, and Retaining Ring

Figure 8: Sample Containers Size 1 (SC-1)

Figure 9: Sample Containers Size 2 (SC-2) and T-Ampoule with Cradle Assembly Installed

Figure 10: T-Ampoule with Cradle Assembly

Leak Testing of the Containment Vessel – TB-1: During the lifetime of the PAT-1, the packaging will have to undergo periodic inspection and maintenance tasks. Of these tasks, the leak testing of the TB-1 containment vessel will have to be performed prior to shipment. To facilitate the leak test, a specialized test chamber has been designed as shown in Figure 11. The test chamber is precision machined to accept the TB-1 containment vessel which reduces the void volume between the outer surface of the TB-1 containment vessel and the inner surface of the test chamber. Figure 12 shows the TB-1 containment vessel located in the body of the test chamber.

Figure 11: Leak Test Chamber

Figure 12: TB-1 Containment Vessel inside Test Chamber

Because the TB-1 containment vessel is a single copper gasket seal, a specific leak test protocol has been developed and qualified. The process involves backfilling the T-Ampoule with helium prior to closure which provides a secondary reservoir of helium. Once the helium filled T-Ampoule is placed into the TB-1 containment vessel body, the gasket and TB-1 containment vessel lid is set into a resting position. The test chamber is then evacuated to a predetermined vacuum and then back filled with helium. Once the helium back fill is complete, the test chamber lid is removed and the TB-1 lid is secured with its fasteners.

The test chamber's lid is reinstalled and the vacuum pump reconnected. The test chamber is evacuated and allowed to remove any residual helium in the void space between the TB-1 containment vessel and test chamber. Once the helium is evacuated, the leak test machine is connected and the leak test is initiated. The acceptance criterion prior to shipment is 1.0×10^{-5} atm cc/sec. Figure 13 shows the schematic for the evacuation and backfill process and Figure 14 shows the schematic for the leak test process.

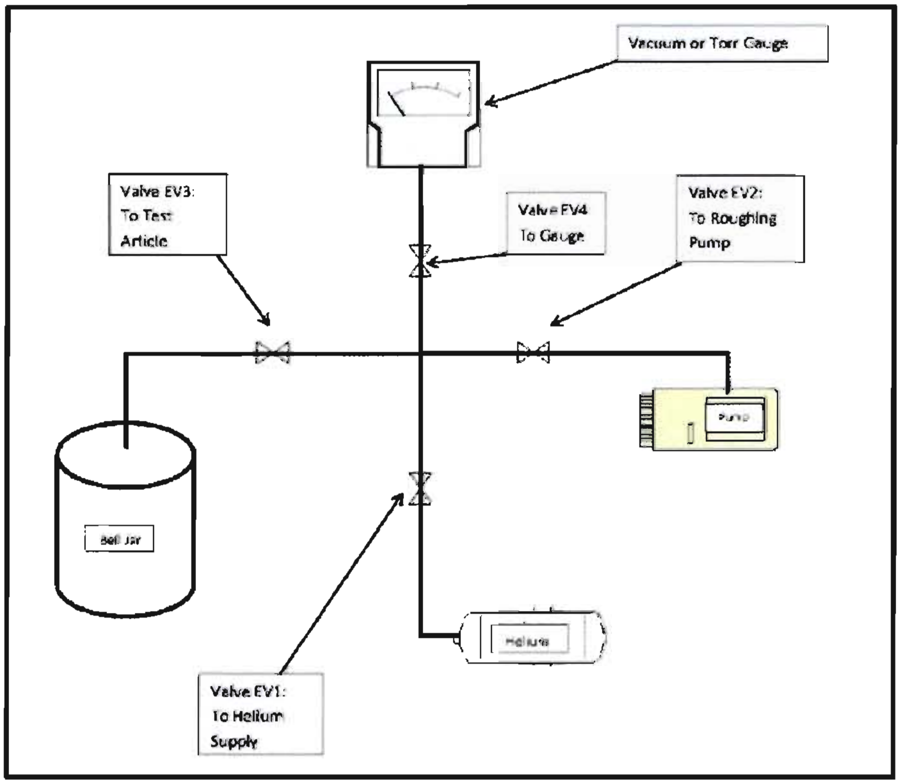

Figure 13: Evacuation and Backfill Manifold Schematic

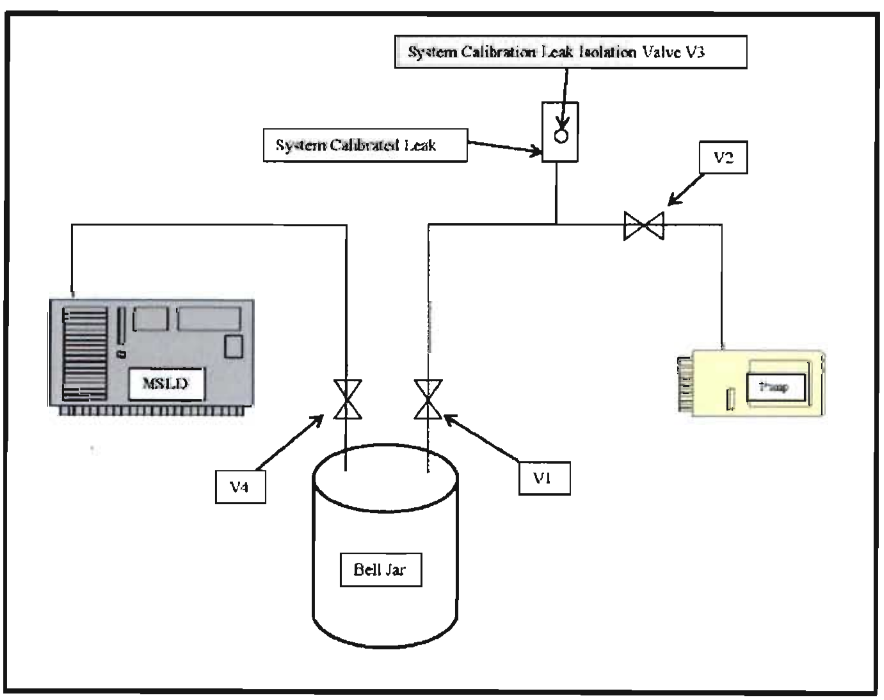

Figure 14: Leak Test Process Schematic

Regulatory Approval for Other Users: The PAT-1 will be utilized by an array of users, including non-domestic users. For domestic users, the user will have to have a packaging quality program and develop site-specific procedures for the PAT-1 packaging. The user will have to be approved by the DOE prior to the use of the PAT-1.

For non-domestic users, the country of use will have to sponsor the review and approval of the PAT-1 with their specific competent authority. The DOE regulatory organization will support the review with the competent authority resulting in the appropriate approvals for shipments.

In summary, the PAT-1 will become a fully compliant air transport packaging specifically for domestic and non-domestic plutonium metal and oxides. The timeframe for the implementation and use of the PAT-1 is 2013, provided regulatory approvals and hardware availability is complete. The use of the PAT-1 will provide a safe and secure method for movement of these special nuclear materials.