SAND2007-3631P

PAT-1 NRC Amendment Meeting

U.S. Nuclear Regulatory Commission
Rockville, MD

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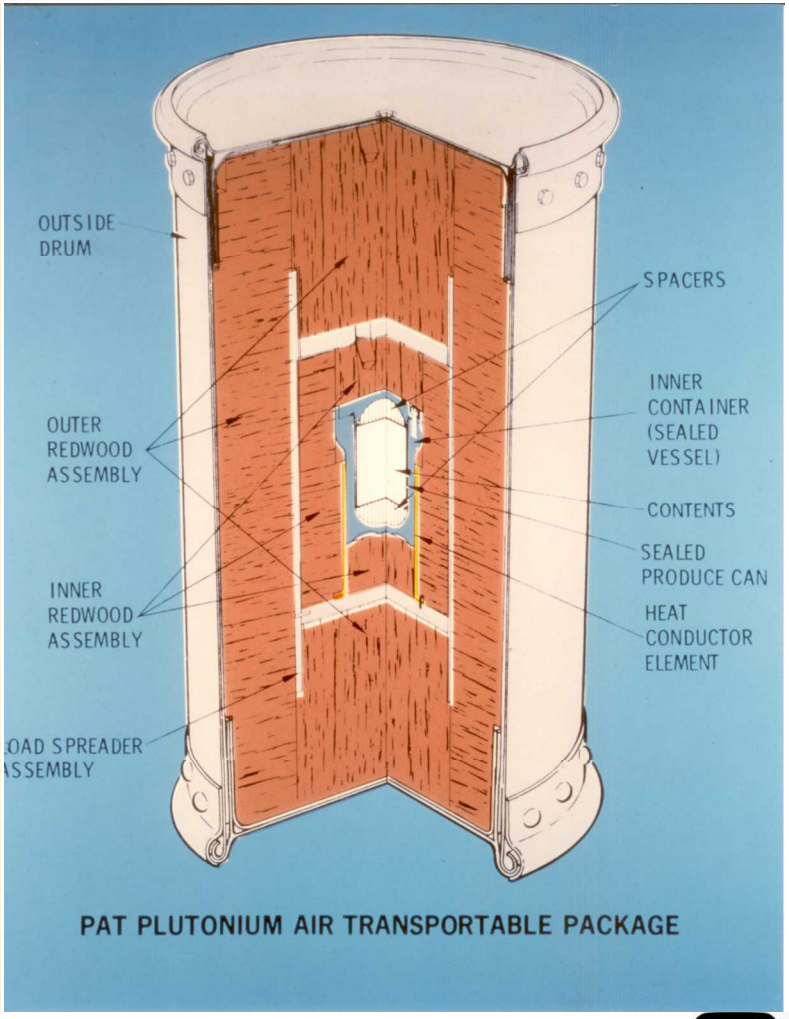
Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Outline

- Review PAT-1 package design
- SAR and package design constraints
- New plutonium metal contents
- New internal packing configuration
- Specific analysis areas for new authorized contents

PAT-1 Air Transport Package (USA/0361/B(U)F-96)



Authorized Contents: 2 kg Pu Oxide

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TB-1 Containment Vessel

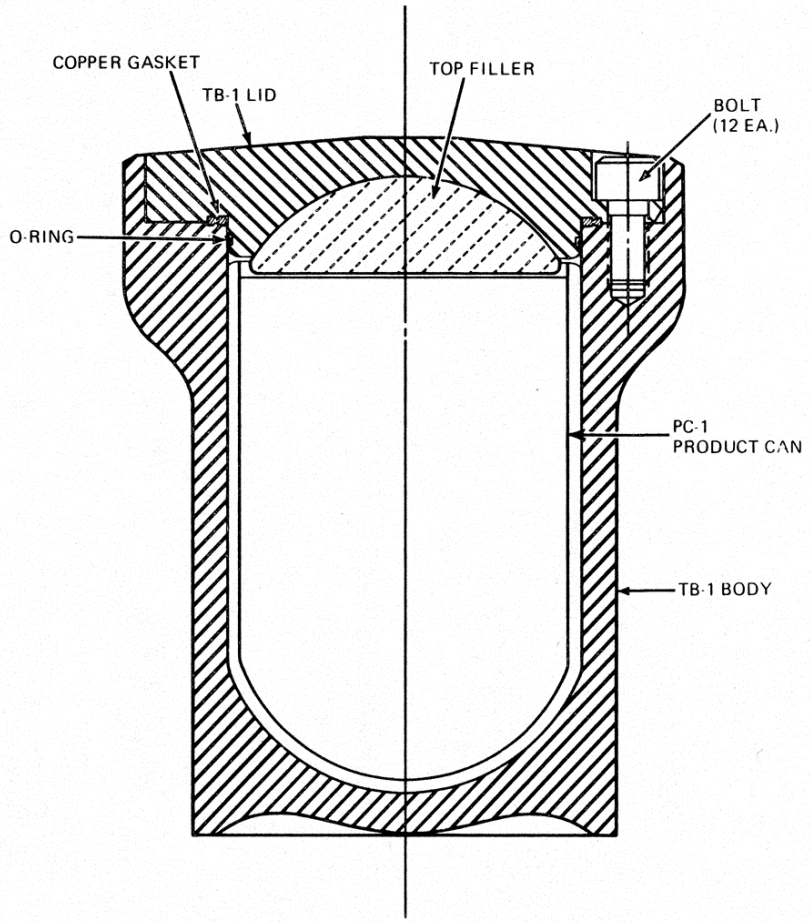


Figure 1.5 Cutaway Drawing of TB-1 Containment Vessel

- Body and lid forged from PH13-8Mo precipitation hardened stainless steel, H1075 temper, no welds, 205 ksi yield, 220 ksi ultimate
- 12 ½ in. dia. A-286 silver-plated, forged stainless steel bolts, 180 ksi tensile strength
- Copper seal (containment boundary seal, knife edge design)
- Elastomeric seal (secondary)
- Current maximum authorized contents (2 kg PuO_2, PC-1 (SS), Al honeycomb spacer, 9 gm polyethylene bag(s), 16 gm water)

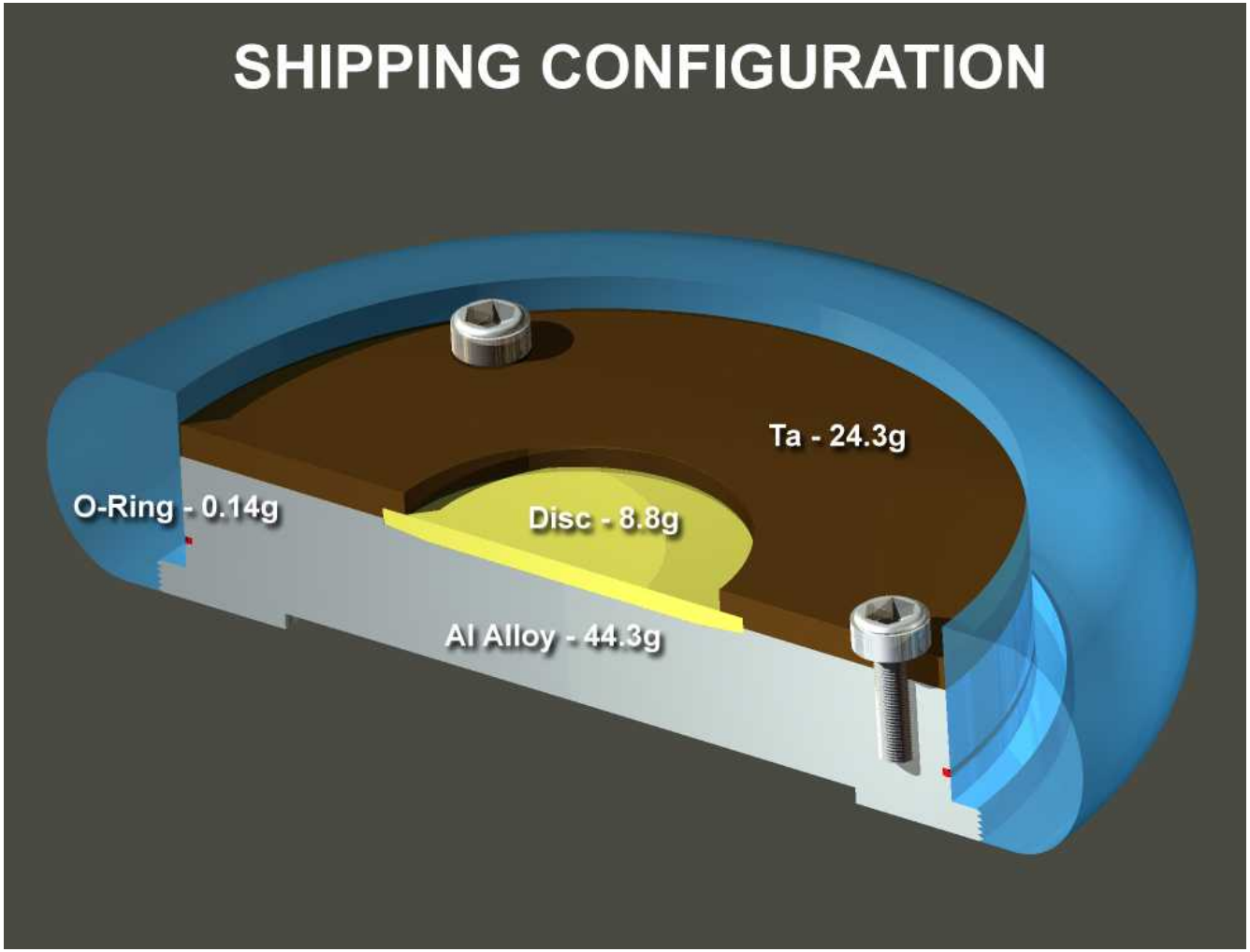
Amendment Approach and PAT-1 CoC Constraints

- No change to AQ-1 overpack
- No change to TB-1 containment vessel
- New contents and packing materials must not affect integrity of TB-1
- Total TB-1 contents weight remains same at 2.1 kg (from SAR, fissile contents (2 kg) and weight of PC-1 can/spacer (0.1 kg))
- Maximum TB-1 temperature and internal pressure same as SAR
- Heat dissipation remains at 25 watts (same as SAR)
- Contents are subcritical (considers 10CFR71.55(f))
- External radiation levels per regulations

New Pu Metal Authorized Contents

- **Three primary nuclear weapons programs:**
  - **A. Dynamic Plutonium Experiments – Barolo**
    - **≈ 8 to 16 g Pu (disc) mounted in a metal ring assembly**
  - **B. Component Experiments**
    - **Chemical and physical Pu-239 test specimens ≤ 25 g per specimen**
    - **Specimens shapes are cylinders, flat bars, tensile coupons…**
  - **C. Material Exchange Program**
    - **Pu-239 electro-refined (ER) metal in custom shape**
    - **Pu-239 (alpha), non-alloyed, ≥ 99.8% pure**
    - **~900 g contents weight**

A. Barolo Assembly (Preliminary Design)



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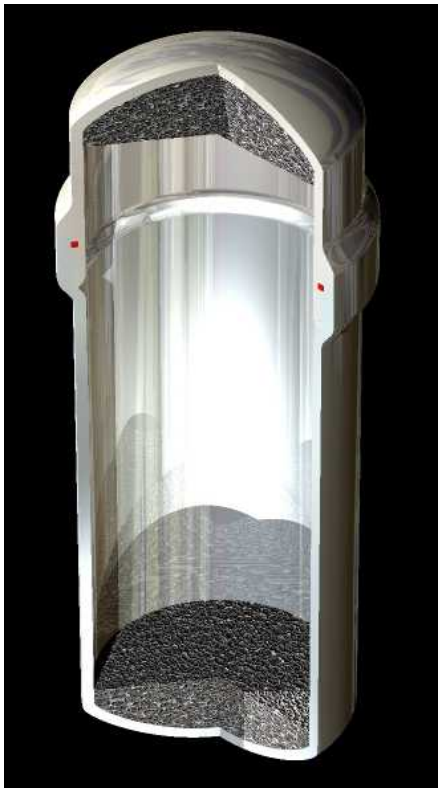
Barolo Disk Assembly

- **Disk assembly composed of three components:**
  1) **Pu metal disk**
  2) **Tantalum ring (surrounds Pu metal disk); and**
  3) **Pu metal disk/tantalum ring assembly mounted on an aluminum metal ring. Each assembly, or a group of assemblies, may be "optionally" wrapped in tantalum foil.**
- **Fissile material**
  - **∆ Pu-239 (delta phase), ~17 g/cc, alloyed, average composition: 93.78% Pu-239, 6.0% Pu-240, 0.20% Pu-241, 0.02% Pu-242, and 0.01% Pu-238.**
- **Packing**
  - **Multiple assemblies direct loaded into aluminum A-Ampoule as supported by SAR amendment**
  - **Disk assemblies packed with aluminum foam (as needed)**

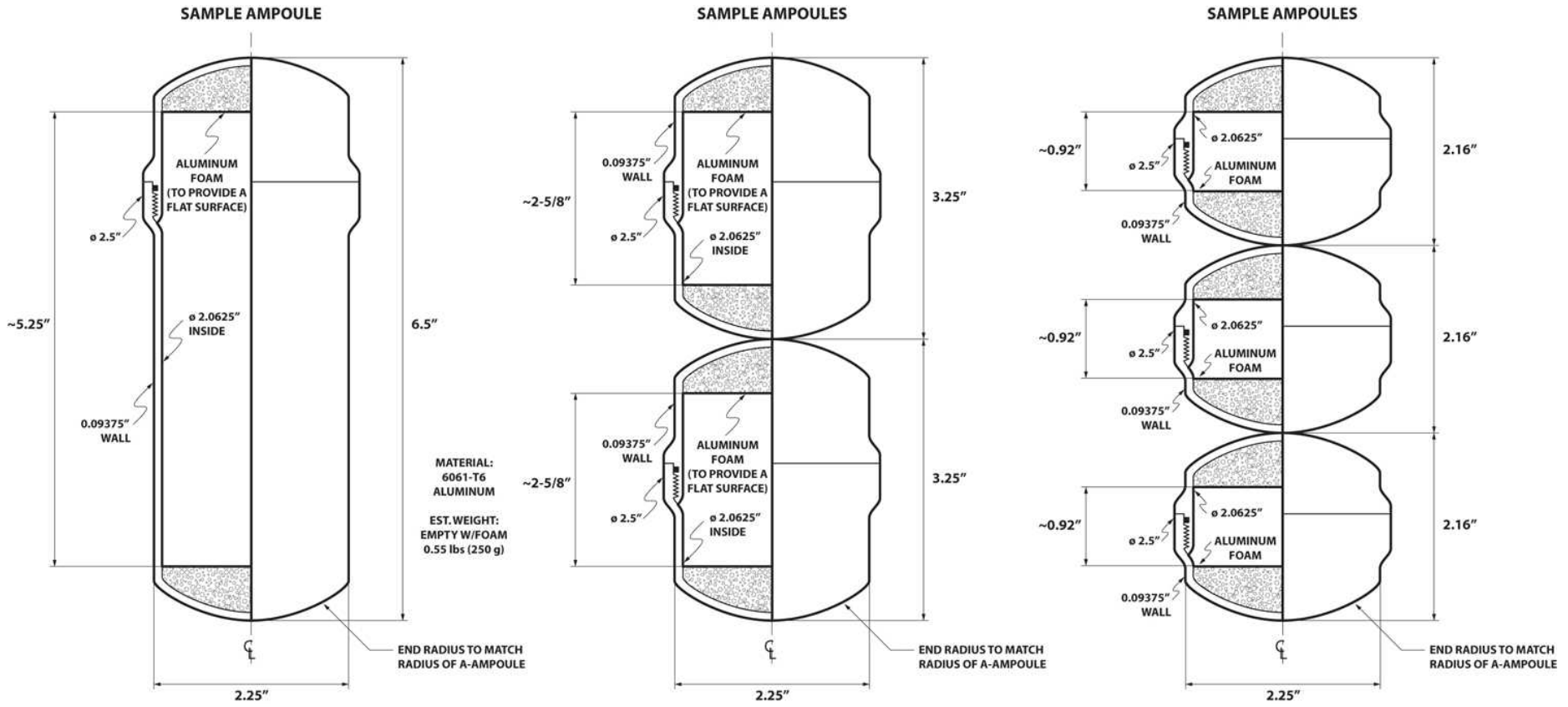
B. Component Experiment Samples

Chemical and Physical Parameters:

- **Sample Descriptions:**
  - **Ø 5 mm (0.2”) cylinder @ ≈ 1 g**
  - **Ø 13 mm (0.5”) cylinder @ ≈ 10 g**
  - **Ø 25 mm (1.0”) cylinder @ ≈ 20 g**
  - **Flat tensile specimen ≈ 10 g**
  - **Chemistry specimen ≈ 5 g**
  - **Various shaped specimen ≤ 20 g**
  - **Optionally wrapped in tantalum foil**
- **Fissile Material**
  - **∆ Pu-239 containing a small percentage of gallium**
- **Packing**
  - **Material or aluminum sample ampoule located and constrained in the A-Ampoule by aluminum foam.**



Sample Ampoule Conceptual Design (for Component Experiment Samples)



Preliminary sample ampoule designs that fit into A-Ampoule

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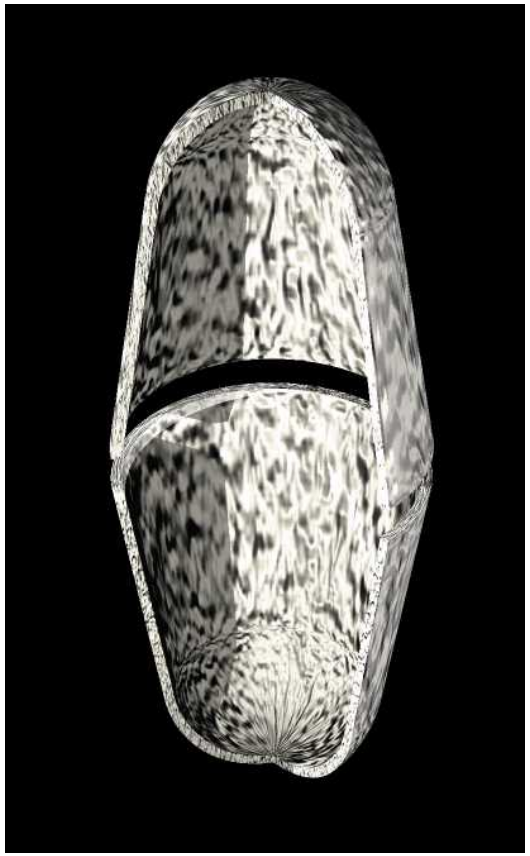
C. Pu-239 Electro-Refined Metal

Ø102 mm (4.0”) OD x 13 mm (0.5”) wall x 51 mm (2.0”) length
Weight: 3 to 3.5 kg (6.6 to 7.7 lb).



Recast in smaller geometry for PAT-1 shipments

Material Exchange Program

ER (electro-refined) Plutonium Ring[1]:

- Material to be recast (less than 1 kg) into favorable geometries for structural considerations
- Fissile Material
  - Pu-239, non alloyed ≥ 99.8% Pu-239 (alpha)
- Packing
  - Material direct loaded into aluminum A-Ampoule
  - Packed with aluminum foam
  - Optionally wrapped individually or together in tantalum foil

[1] ER Ring - Dimension: Ø102 mm (4.0”) OD x 13 mm (0.5”) wall x 51mm (2.0”) length. Weight: 3 to 3.5 kg (6.6 to 7.7 lb).

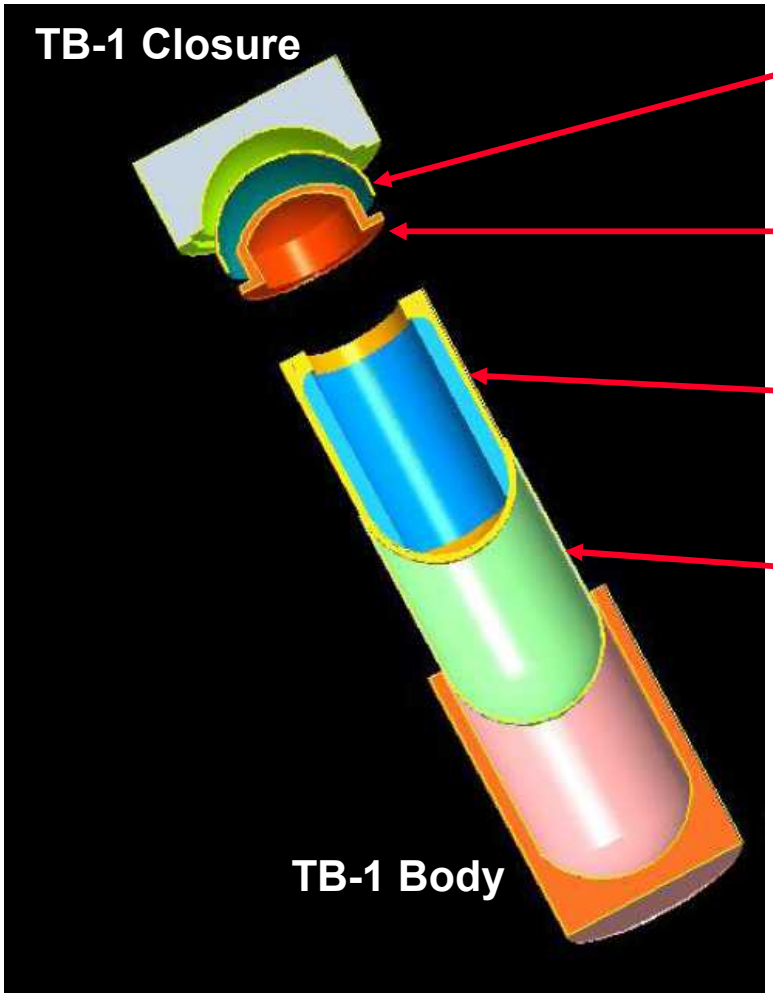
Proposed Packing Components Within TB-1

- **Stainless Steel Contamination Barrier (Jar)**
  - Cap to body slip-fit with taped seam
- **Aluminum Ampoule (A-Ampoule), Eutectic Barrier**
  - Threaded fastener closure w/elastomeric O-ring
  - Gas tight seal (maintains inert atmosphere)
  - Sealed in standard glovebox line atmosphere: Nitrogen/argon/helium with an oxygen content not exceeding 0.5% and a water content not exceeding 20 ppm (sample integrity only)
- **Aluminum Foam Inserts**
  - Custom machined for specific payloads
- **Aluminum Sample Ampoules**
  - For smaller (component experiment) samples, handling convenience

Preliminary Weights

Item	(lb)	(gram)
Stainless Steel Contamination Barrier		
Body	0.52	235
Lid	0.36	88
Total	0.71	323
Aluminum A-Ampoule		
Body	1.01 to 1.05	457 to 476
Lid	0.36 to 0.56	164 to 252
Total	1.37 to 1.61	621 to 729

Packing Assembly



Contamination barrier cap

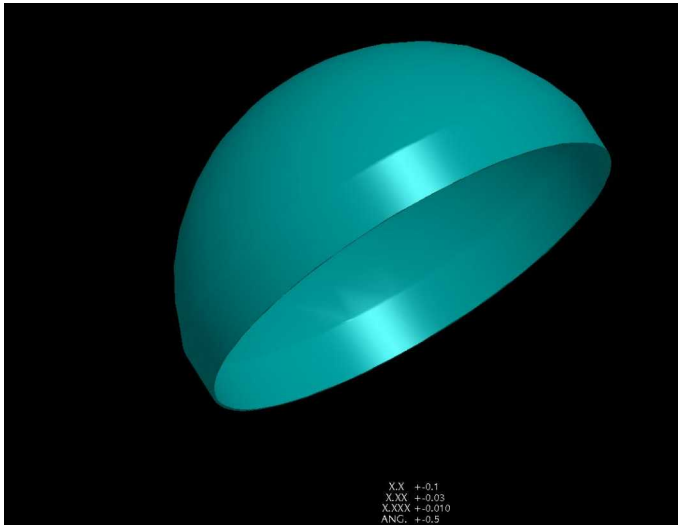
A-Ampoule head closure

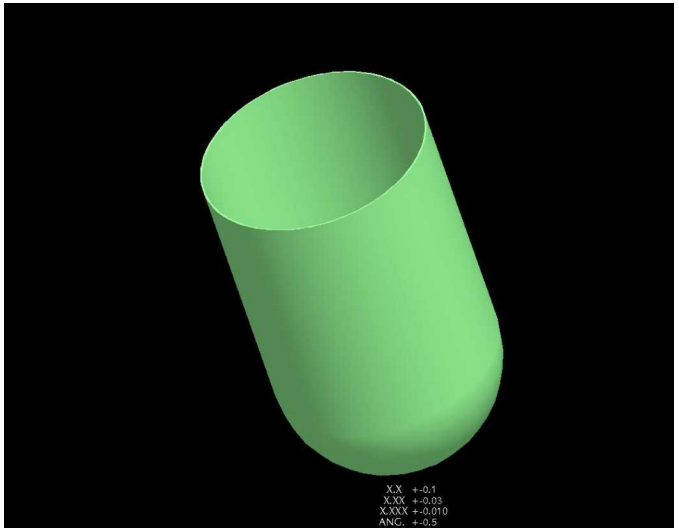
A-Ampoule body

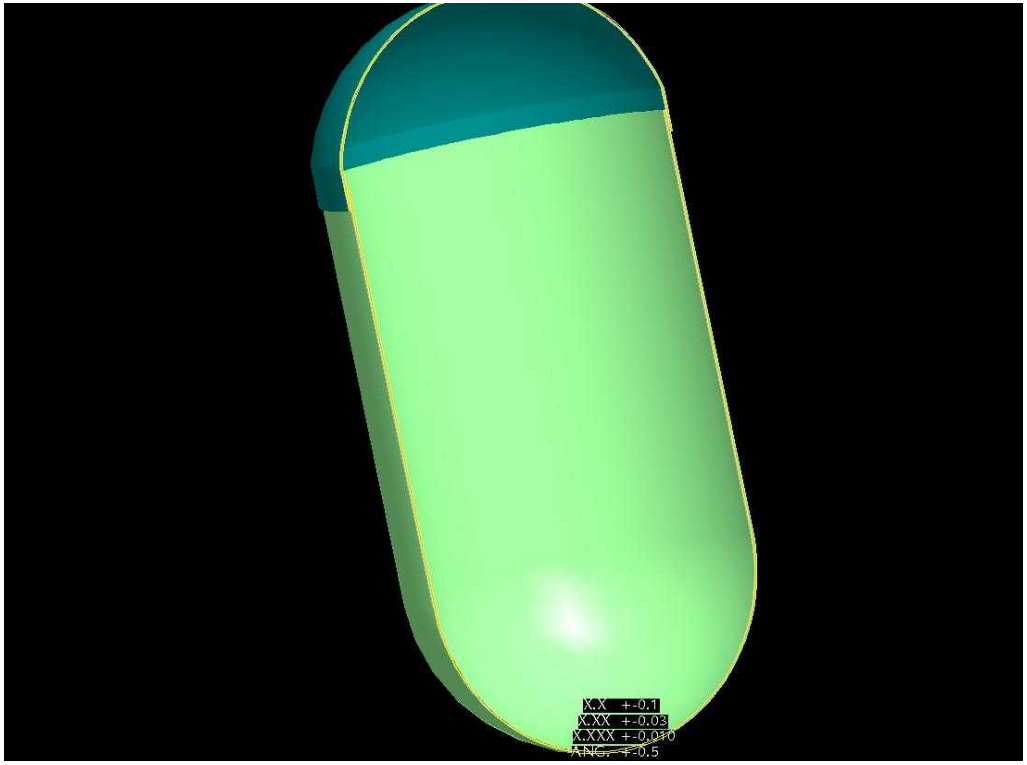
Contamination barrier body

A-Ampoule assembly is placed in a stainless steel contamination control jar (facility contamination control practice).

Stainless Steel Contamination Barrier







End cap and body are taped together

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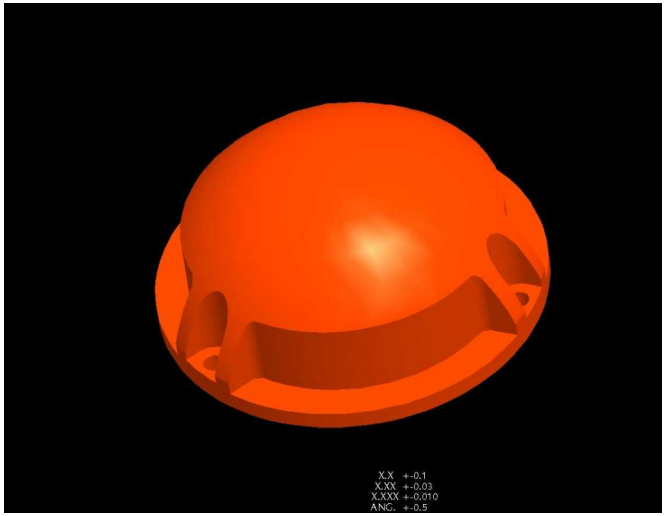
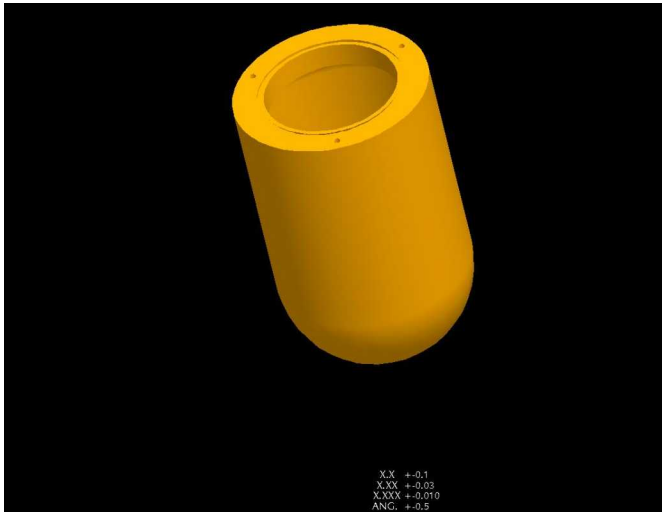
Aluminum Ampoule (A-Ampoule)

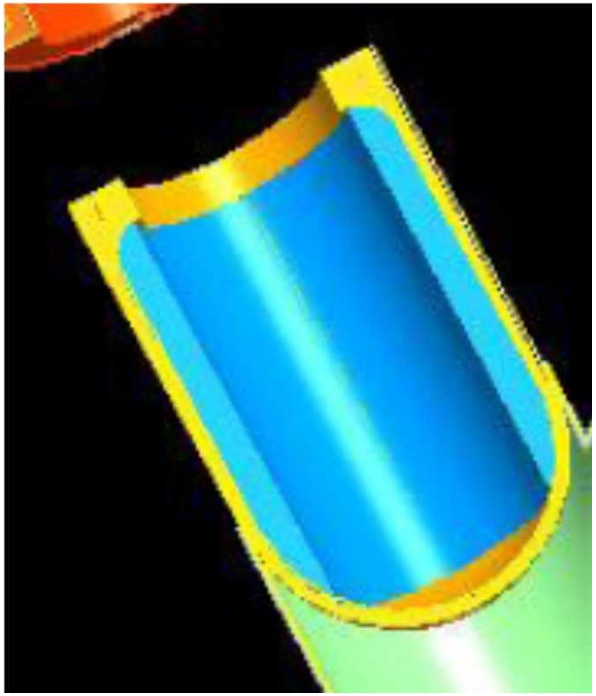




A-Ampoule provides the eutectic barrier

Aluminum Foam Packing Material

Example components made from aluminum foam



Foam – blue area

Pu metal contents are packed in custom made foam shapes

Pu Air Transport Test Environments

71.71 Normal conditions of transport

71.73 Hypothetical accident conditions

71.74 Accident conditions of air transport of plutonium

- Right angle 129 m/s (422 ft/sec) impact onto an unyielding surface in most damaging orientation
- 2-inch wide steel bar static beam compressive load of 31,800 kg (70,000 lbs) to result in maximum damage
- 227 kg (500 lb) pointed solid probe (right circular cone) dropped from 3 m (10 ft) on most vulnerable point
- 1.8 m (6 ft) structural steel angle (legs 13 cm (5 inch) long, 1.3 cm (½ inch) thick) from height of at least 46 m (150 ft) onto package two times
- One hour JP-4 pr JP-5 pool fire test, package cooled naturally or water cooled, most damaging environment
- 0.9 m (3 ft) immersion test for 8 hours

PAT-1 Air Transport Impact and Thermal Conditions (SAR)

- **Structural - PAT-1 Air Transport Impact Tests**
  - **Five 129+ m/s (422+ ft/sec) impacts onto unyielding target in most damaging orientation**
  - **Consider inertia conditions**
- **Thermal - TB-1 Air Transport Fire Response (Page 4-6, NUREG-0361 SAR), Post Fire Response**
  - **Maximum temperature: 580ºC/1080ºF**
  - **Post-fire duration at maximum temperature: 4 days**
  - **Maximum pressure: 1110 psia, same duration**

Demonstrate that neither environment damages the integrity of the TB-1 containment boundary.

TB-1 Temperature/Pressure Profile for Air Transport Fire Environment

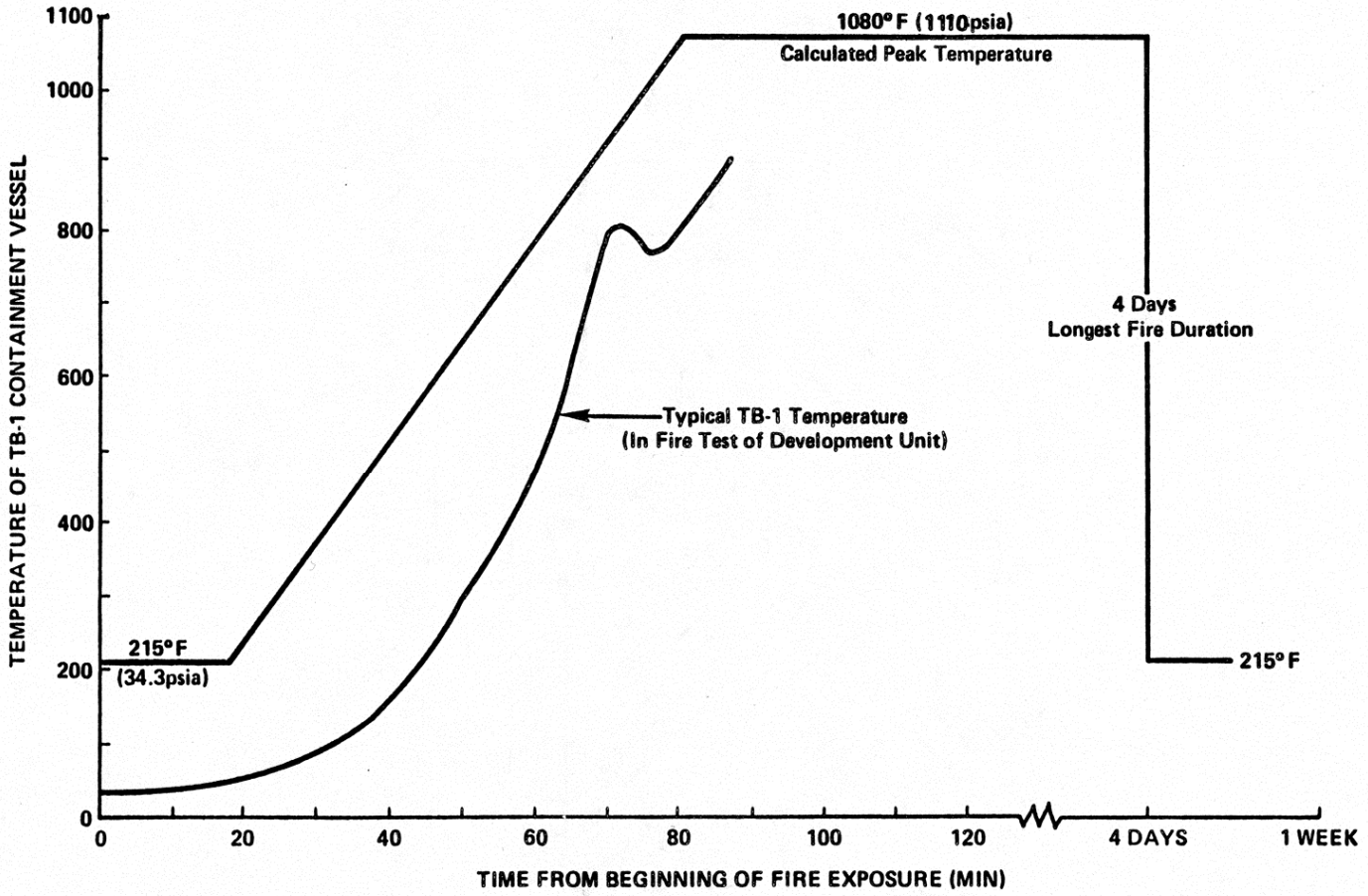


Figure 4.2 Maximum TB-1 Temperature and Pressure Profile During NRC Qualification Criteria Fire Test

(Page 4-6, NUREG-0361 SAR)

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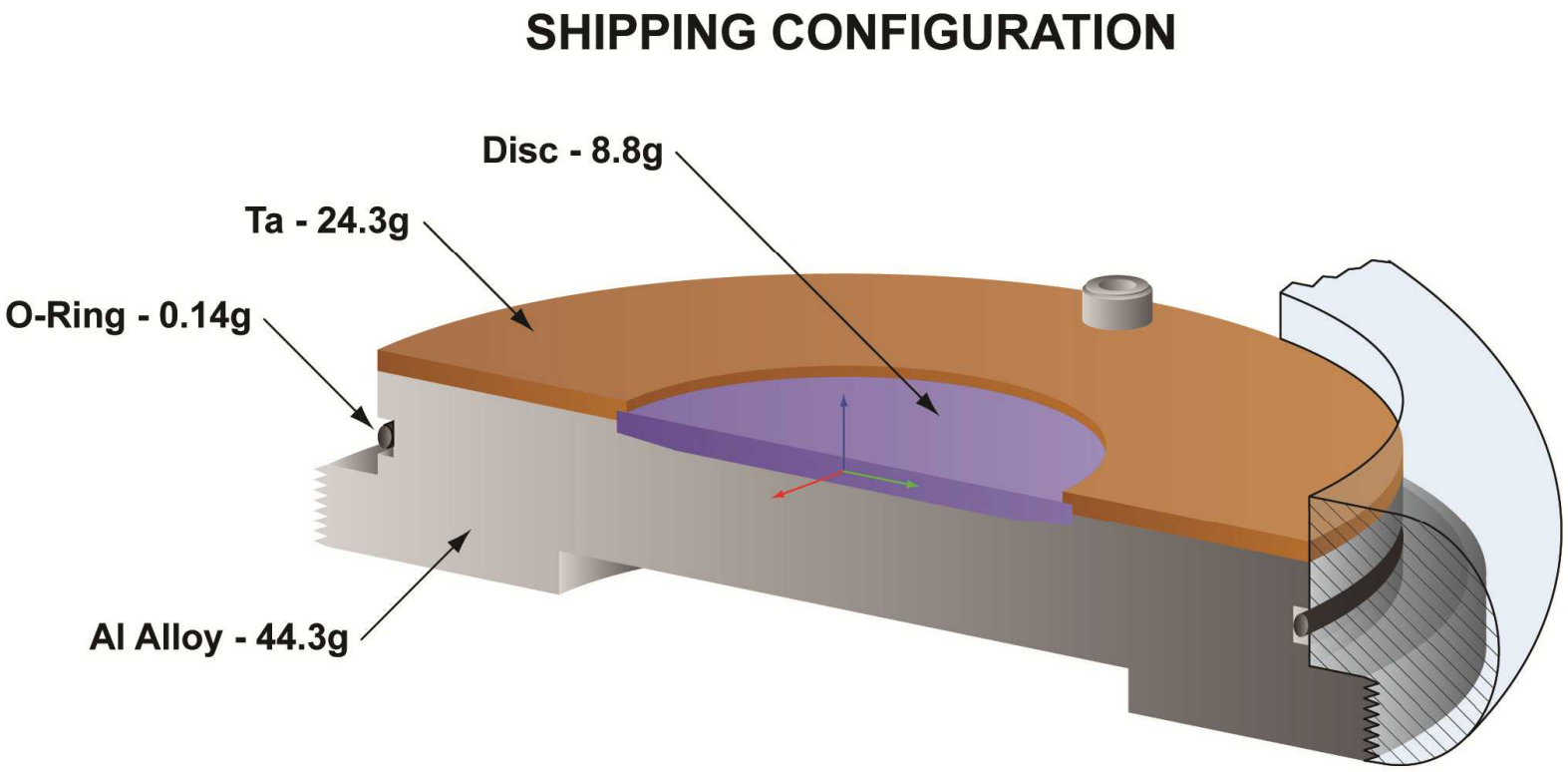
Two Major Technical Issues to be Addressed

- **PuFe Eutectic**
  - TB-1 post fire temperature is 582ºC (1080ºF), four days
  - Plutonium melting temperature is 639.4°C (1182.9°F)
  - Aluminum melting temperature is 660°C (1221°F), alloys lower
  - PH13-8Mo melting temperature range is 1404 to 1471°C (2560 to 2680°F)
  - PuFe eutectic theoretically exists as low as 410ºC (770ºF)
- **Contents Response with TB-1**
  - Internal component impacts must be considered
  - PuO_2 density ranges from 1.62 gram/cc and higher (occupies most of the volume within TB-1)
  - Pu metal density is about 17 gram/cc (results in compact geometry)
  - Maintain 2.1 kg total internal contents weight

Extra Slides

Barolo Disk Assembly



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