



SRNL-L4500-2013-00034

**We Put Science To Work**

# Bulk Tritium Shipping Package

---

**Paul Blanton  
SRNL**

**Packaging Technology & Pressurized Systems**



**Tritium Focus Group Meeting Washington, DC - VTC**

---

**April 23, 2013**



## Summary

---

- **Overview / Background**
- **BTSP-1 Design Overview**
- **Contents and Configurations**
- **Fabrication / Certification**
- **SARP Revisions and Actions**



# Overview and Background

---

The Savannah River National Laboratory has developed a new radioactive shipping package for transporting tritium as a replacement for the Model UC-609, a tritium package developed and fielded in the 1970s.

The new Bulk Tritium Shipping Package, “Model BTSP-1”, was certified by the National Nuclear Safety Administration (NNSA), Office of Packaging and Transportation (OPT) on February 22, 2012 for shipments of up to 150 grams of Tritium. Tritium contents may be shipped as a gas or a solid on hydride beds.

Thirty packages have been procured and are being delivered to various DOE sites for operational readiness.

This presentation will summarize the design of the BTSP-1, including comparison to the predecessor package, associated engineered material improvements and new content configurations under evaluation for inclusion in the next revision of the Safety Analysis Report for Packaging (SARP) which include tritiated water on molecular sieves.

# UC-609 Background

## UC-609 Certification

- Originally Certified in 1978 CoC USA/9932/B(U) (DOE/NRC)
- DOE CoC Revision 13 expires August 31, 2016
  - Certificate of Compliance renewed in 2003 with reduced content (150 to 100 grams )
  - Certificate renewed in 2011 at request of NNSA

## Hypothetical Accident Condition (HAC) Crush Test required if > 100 grams (1,000 A<sub>2</sub>)

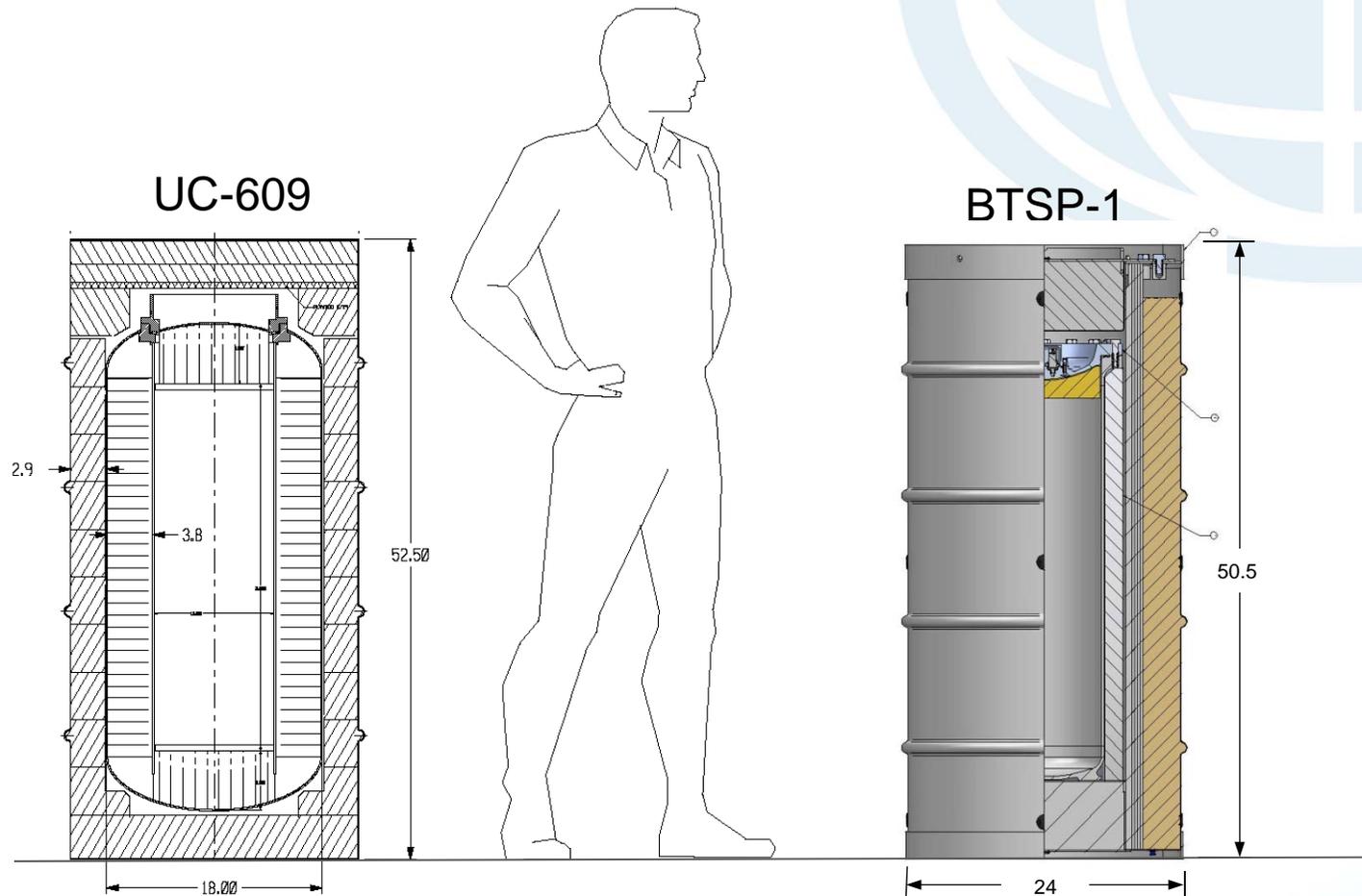
- 1100 lb. steel plate dropped from 30-ft

**Future fabrication of UC-609 is not permitted**



UC-609

# UC-609 Versus BTSP-1



CoC USA/9932/B(U)  
Certified 1978

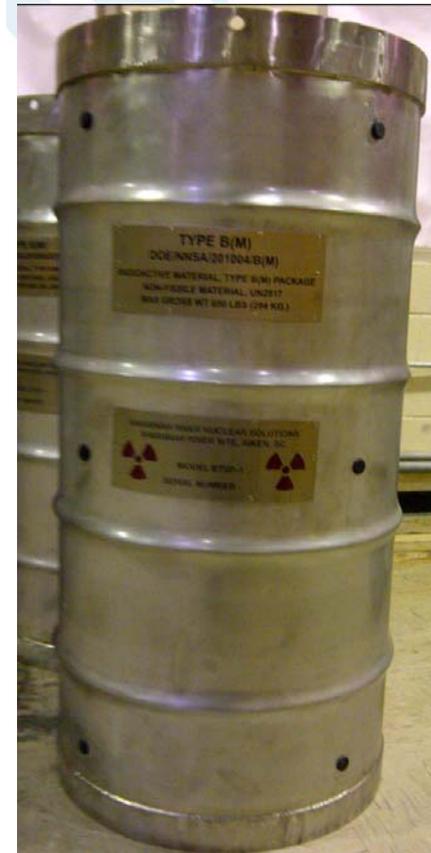
OTC DOE/NNSA/201004/B(M)  
Certified 2012

# UC-609 vs BTSP-1 General Details



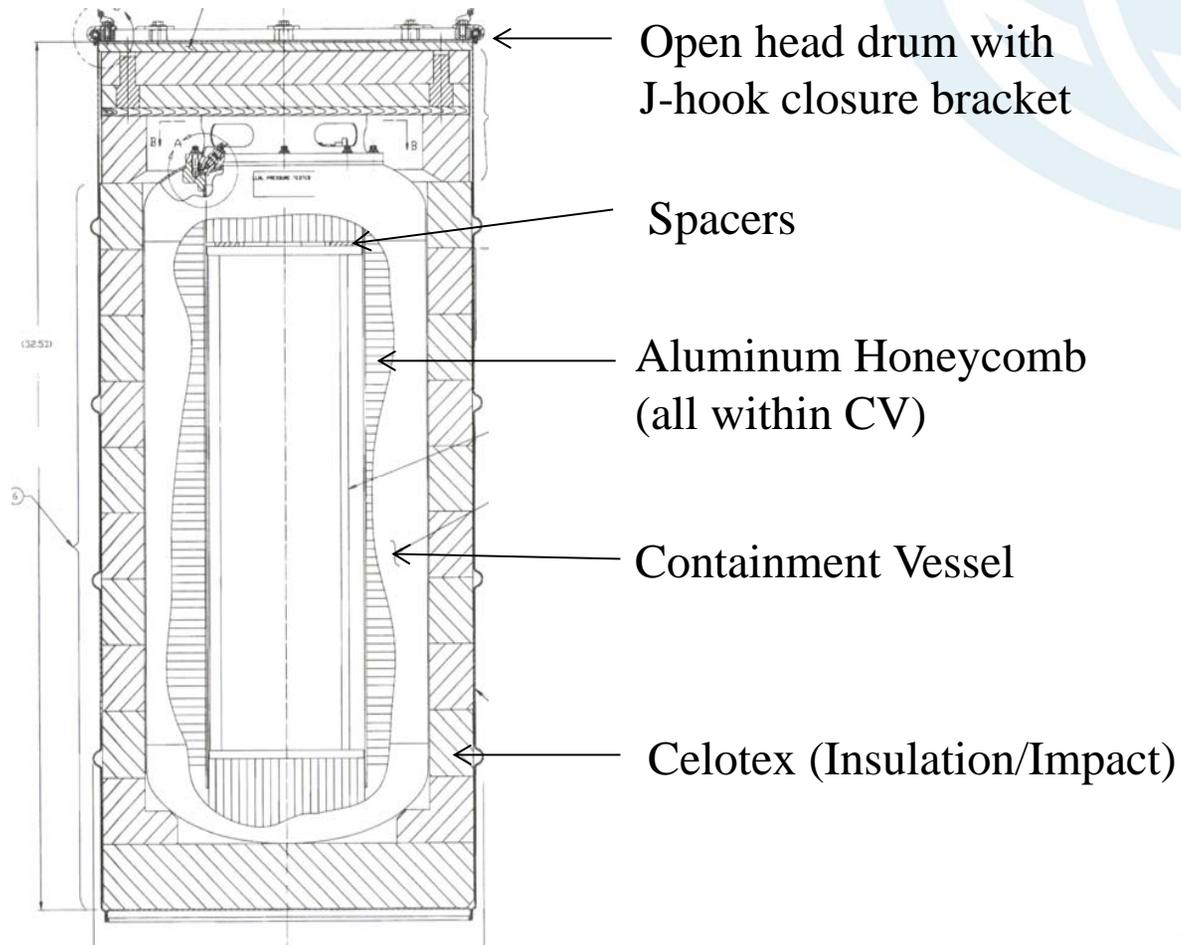
UC-609

- Gross Weight  
500 vs 650 lbs
- Max Content wt. 120 lbs;  
(same for both)
- Containment Vessel (CV)  
Usable Volume:
  - 10" diameter x 31" deep;  
(same for both)
- CV Seals  
Cu Conflat & Elastomeric  
vs. Silver plated Inconel
- Leak Testing; pressurized  
(variable 50 -120 psia) vs.  
20 psia)

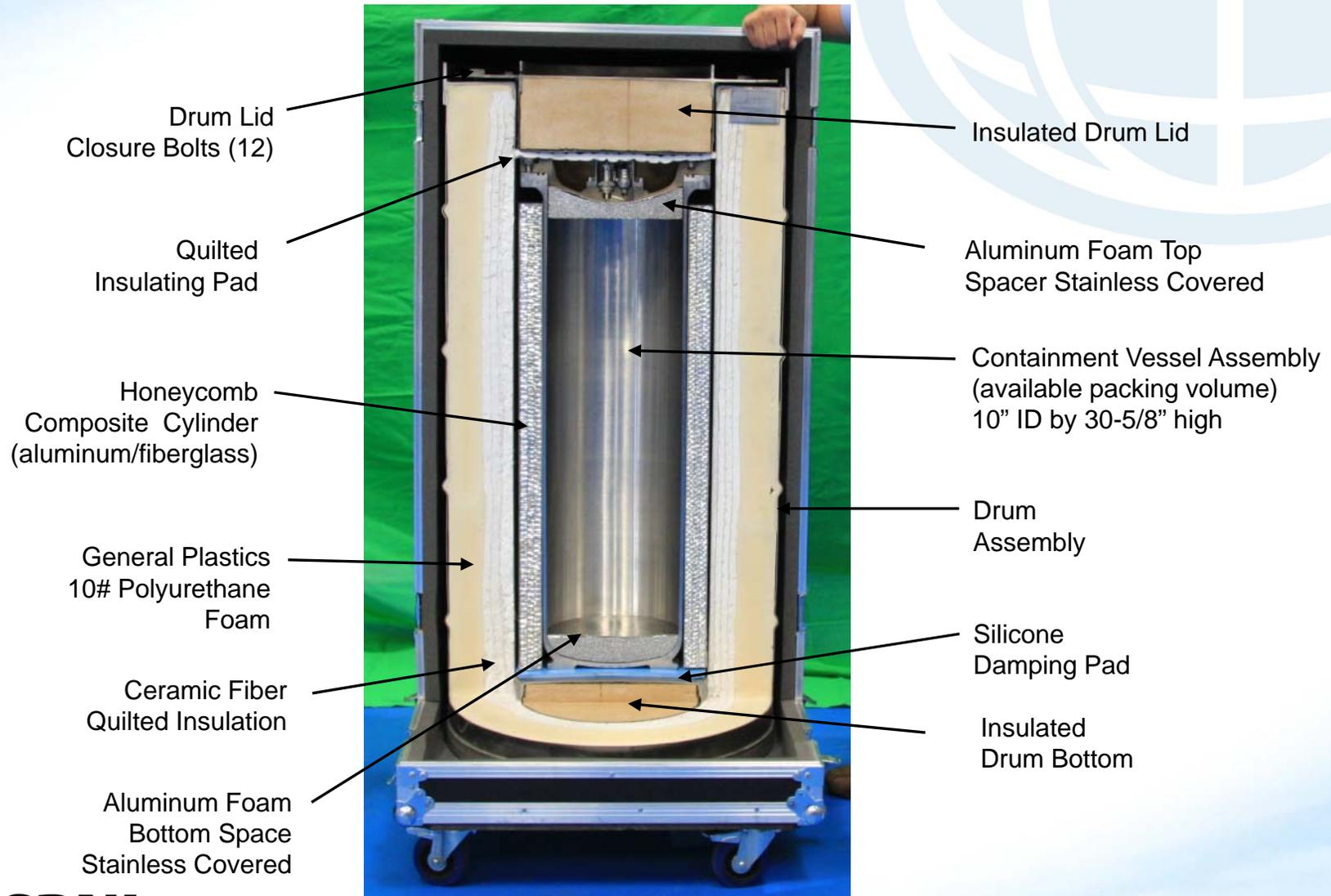


BTSP-1

# UC-609 Assembly



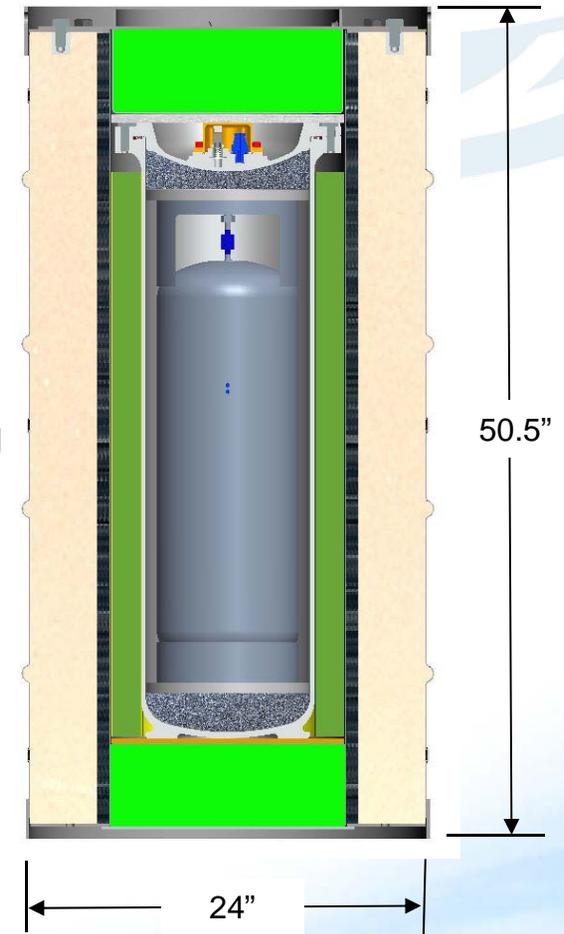
# BTSP-1 Sectioned Assembly



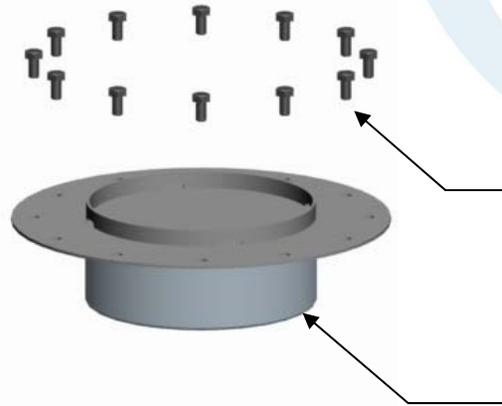
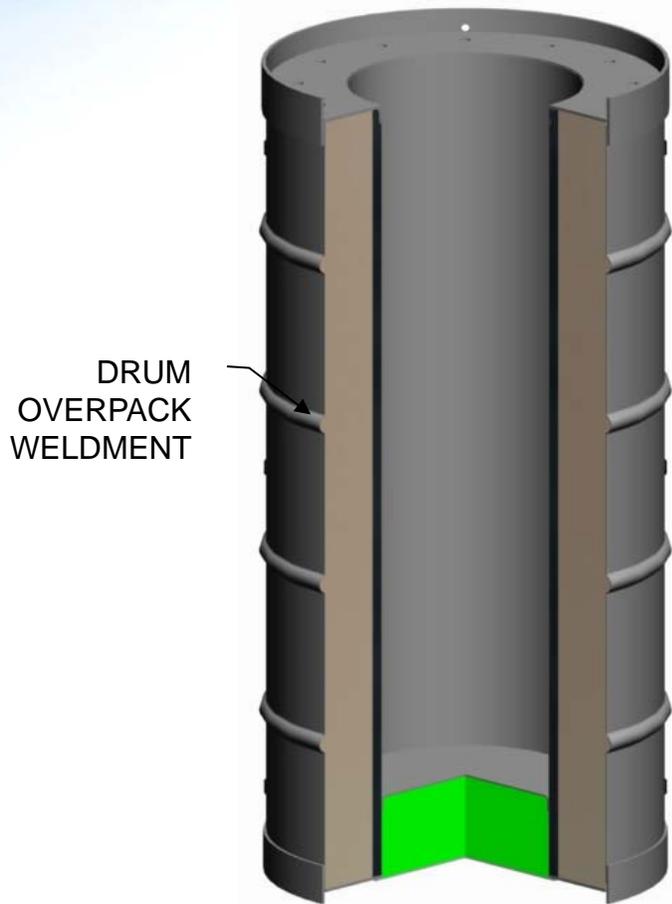
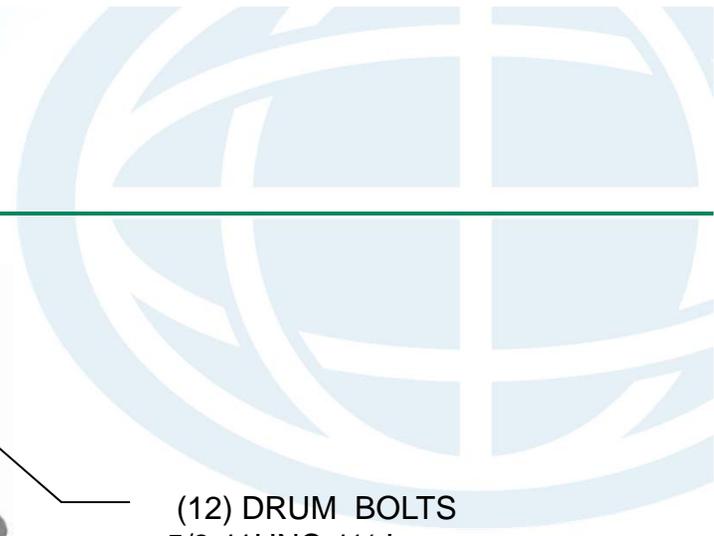
# BTSP-1 Design Summary



- 150 grams Tritium (50W)  
- tested with alternate insulation material, 300W
- Maximum Payload 120 lbs
- Package Gross Wt. 650 lbs
- CV Design Pressure 500 psig
- Simplified Post Load Leak Testing (not time sensitive)
- Design uses features from various certified packages



# BTSP-1 Drum Overpack Assembly



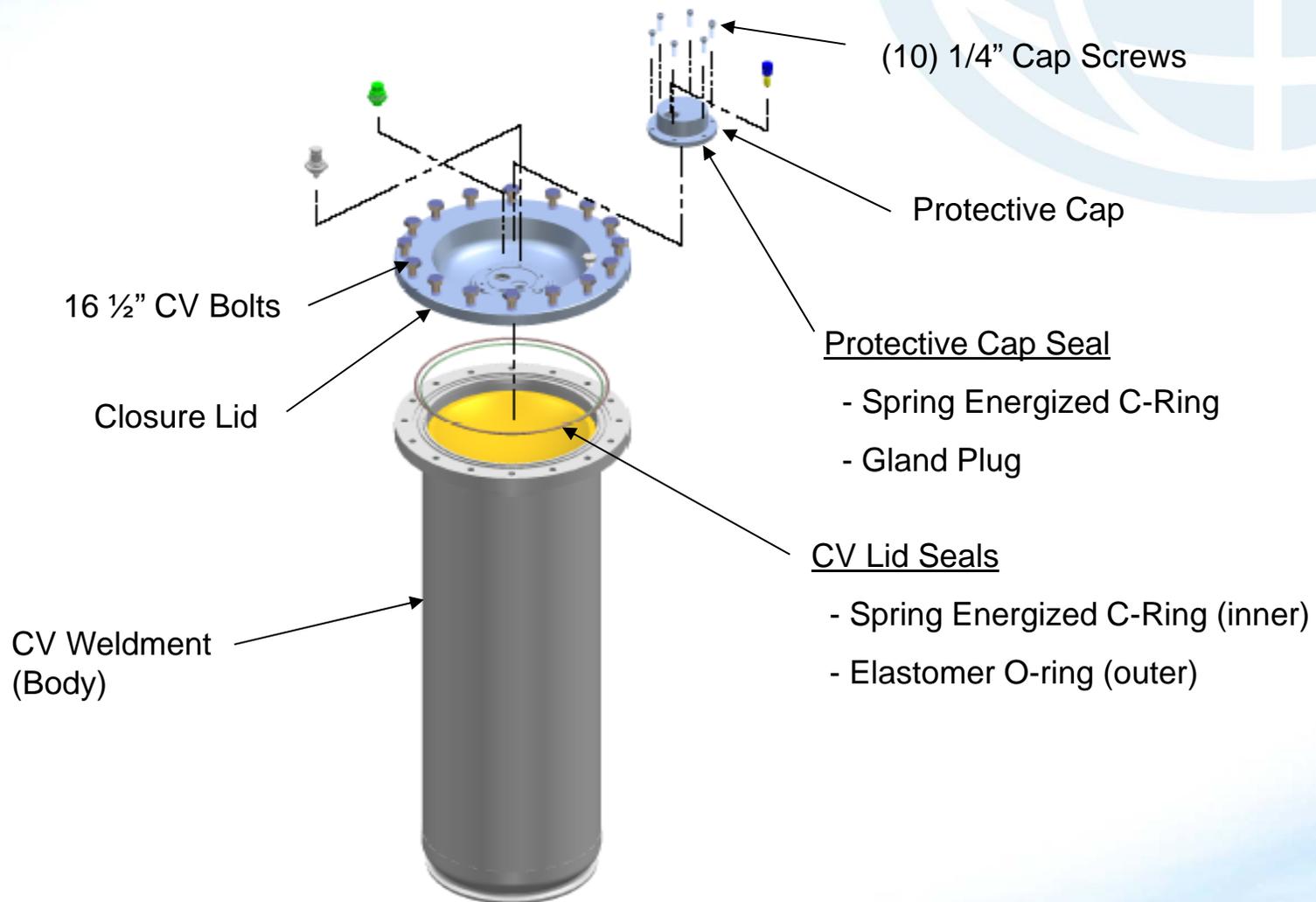
(12) DRUM BOLTS  
5/8-11UNC-1¼ Long

DRUM LID  
ASSEMBLY

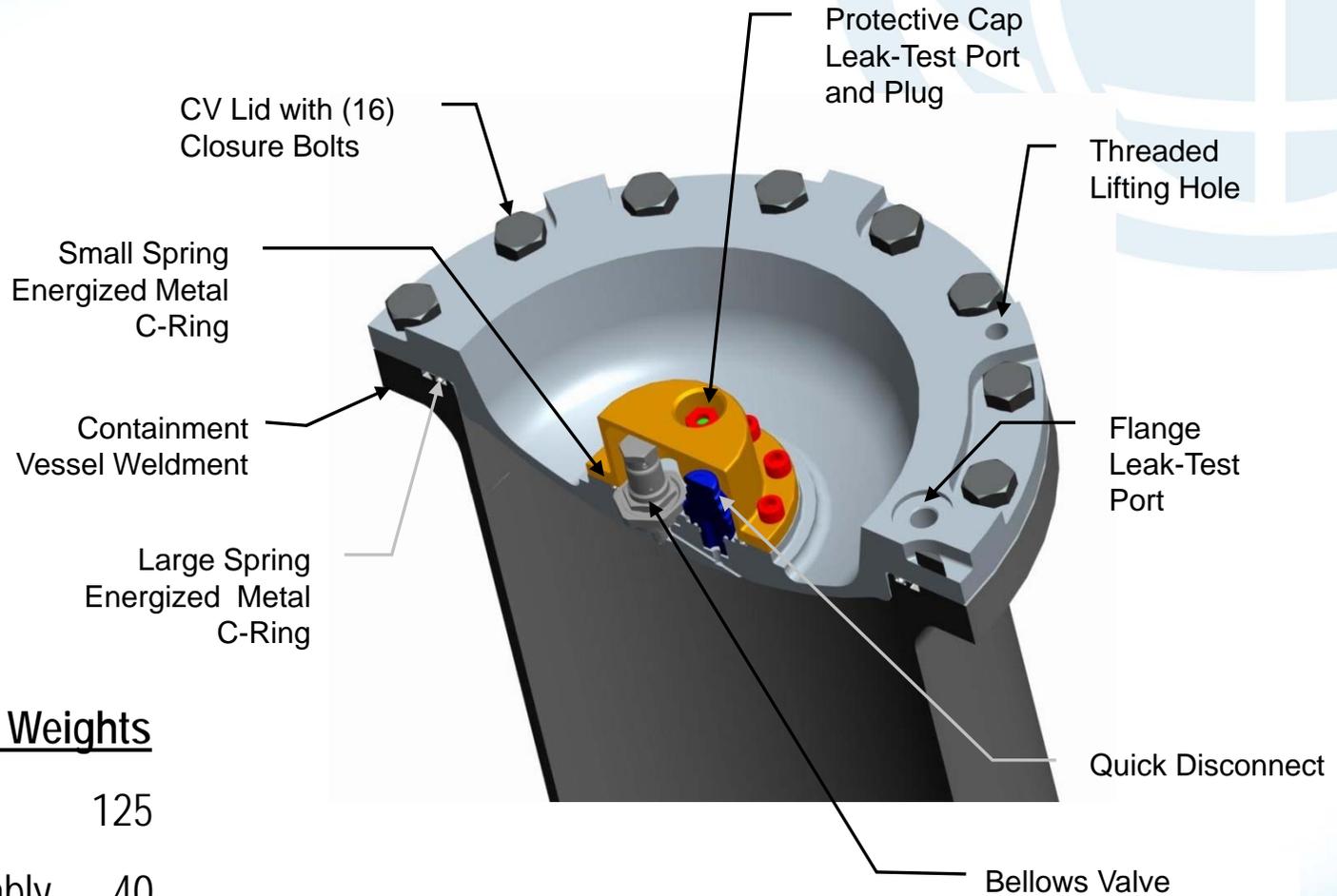
## Drum Overpack Component Weights

Drum Overpack	300
Drum Lid	<u>45</u>
	345 lbs

# BTSP-1 Containment Vessel Assembly



# BTSP-1 Containment Vessel Assembly



## CV Component Weights

CV Weldment	125
CV Lid Assembly	<u>40</u>
	165 lbs

# BTSP-1 Primary and Valving Containment Boundary

## Valving Containment

Protective Cap Body

High Pressure Plug

Metal C-Ring

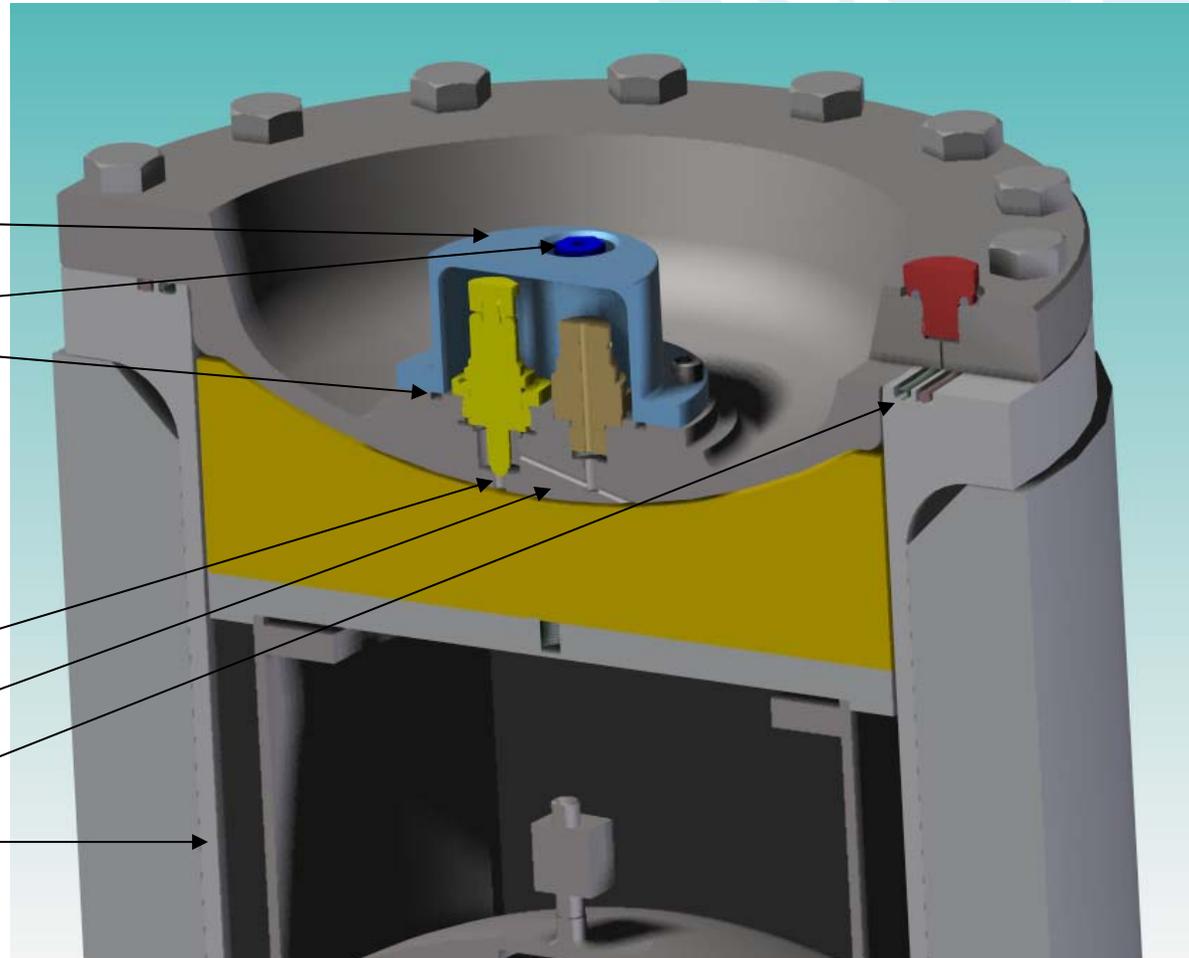
## Primary Containment

Valve Seat

CV Lid

Metal C-Ring

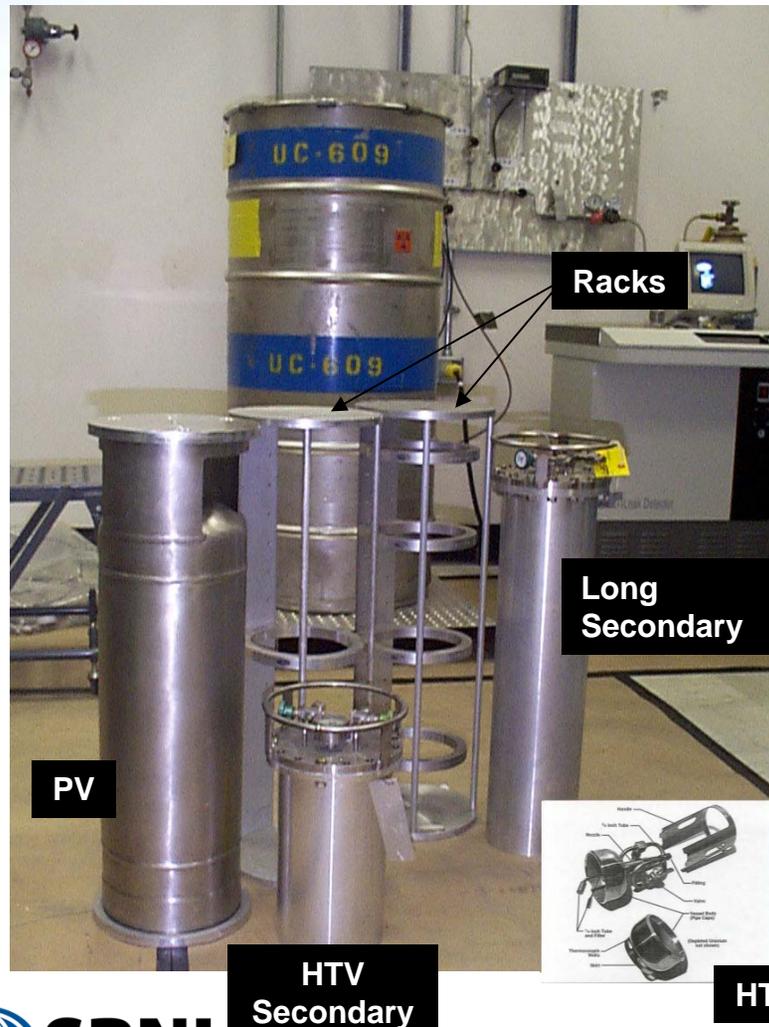
CV Body



# Package Content/Configurations

BTSP (OTC; CoC Planned) (certificate expires 2/2017)	UC609 (CoC) (certificate expires 8/2016)
Content	Content
<ul style="list-style-type: none"> <li>- 150g max tritium (50-watt)</li> <li>- 120 lbs max payload</li> <li>- Gas (pure, mixed)/Tritides</li> <li>- 75g organics</li> </ul>	<ul style="list-style-type: none"> <li>- 100g max tritium (32-watt)</li> <li>- 120 lbs max payload</li> <li>- Gas/Tritides/Tritiated Water</li> <li>- unspecified</li> </ul>
Configuration (specified)	Configuration (unspecified)
<ul style="list-style-type: none"> <li>- Hydride Transport Vessel (HTV)</li> <li>- Product Vessel (PV)</li> <li>- Hydride Storage Vessel (HSV)</li> <li>- Metals contaminated with tritium</li>   <li>- CV Loading (in or out drum)</li> </ul>	<ul style="list-style-type: none"> <li>- HTV</li> <li>- PV</li> <li>- HSV</li> <li>- Reservoir</li> <li>- Molecular Sieves</li> <li>- Other</li> <li>- CV Loading (out of drum)</li> </ul>

# BTSP-1 Package Contents and Configurations



## Contents Authorized for Shipment

- Gas (mixed, pure)
- Solids (tritides)
- Contaminated metal

## Content Vessels

- Product Vessel (PV),
- Hydride Transport Vessels (HTV)
- Hydride Storage Vessels (HSV)

# BTSP-1 Contents and Configurations continued



PV



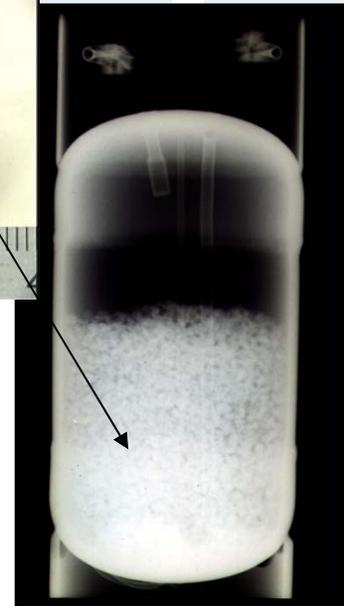
CCV



HTV



Titanium



HSV X-ray



Rack

# BTSP-1 Development Summary

---

- Ten Prototype Packages Procured; Nine NCT And HAC Tested
- Evaluation Of Deuterium Permeation through Metal C-rings
- Dimensional Evaluation Of C-ring Height And Width
- Breakaway Torque of CV And Protective Cap Bolts
- Multiple Leak Tests were Performed On each CV, Cap Seal and Bellows Valve
- Containment Vessel Test Flange Development
- Benchmark Thermal Chamber Testing
- Aluminum Honeycomb Composite Structural Testing
- Fire Test with Ceramic vs Foam (300W)

# BTSP-1 Design Requirements, Criteria & Objectives

---

## General

- **Certify to ship the existing UC-609 contents**
- **Simplify Content Loading Operations and Leak Testing**
- **Incorporate New Engineered Materials for Drum Impact and Thermal Insulation**

## Containment Vessel

- **Satisfy B&PVC Sec III, Div 1, SubSection NB (500 psig at 400 °F)**
- **Comply with requirements of 10CFR 71.41 through 10CFR 71.47**
- **Include valve and fittings for helium leak testing, inert gas back-filling and testing for tritium release from contents (ANSI N14.5-1997)**
- **CV Inside Volume to be NO SMALLER than UC-609**
- **Include Protective cap to prevent unauthorized operation valve and to retain any leakage (10CFR 71.43(e))**
- **Materials of construction shall be used to minimize tritium permeation**
- **Contents shall be removable while the CV is in the drum overpack**
- **CV Sealing Surfaces shall be protected from damage**

# BTSP-1 Prototype Production

Major Tool & Machine, Inc.

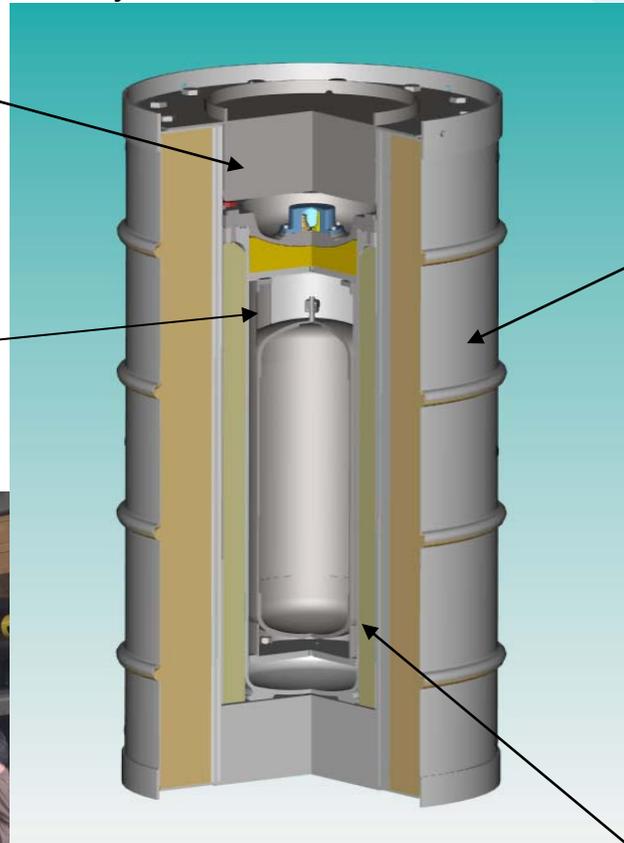
Drum Lid  
TR-19



CV, Honeycomb Spacer,  
Silicone & Thermal Pads



CV  
Lifting



DRUM



CV Lid

CV  
Honeycomb



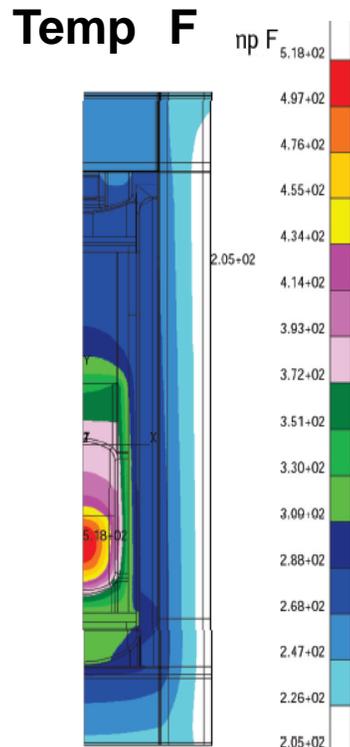
# BTSP-1 Regulatory Testing

---

## Prototype Package Code of Federal Regulation (CFR) Tests

- **Normal Conditions of Transport (NCT): 10CFR71**
  - Water Spray, Compression (5X)
  - Vibration, Penetration, Heat (100°F, Solar)/Cold (-40°F)
  - Drop (4-ft)
- **Hypothetical Accident Conditions (HAC): 10CFR71.73**
  - Drop (30-ft), Crush (1,100 lb plate from 30-ft), Puncture
  - Immersion (50-ft)
  - Pool Fire (1,475°F, 30-min)

# BTSP-1 Thermal Analysis & Benchmark Testing



Analytical Results are Compared to Instrumented Test Packages to Benchmark FEA Thermal Models



Environmental Chamber Test; 100 F, 50W  
Maximum Content Heat Load – Steady State

# BTSP-1 Normal Condition of Transport (NCT) Tests



Low and High Frequency

VIBRATION

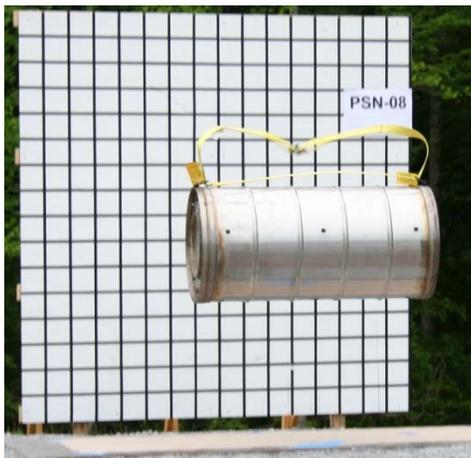


WATER  
SPRAY

BTSP

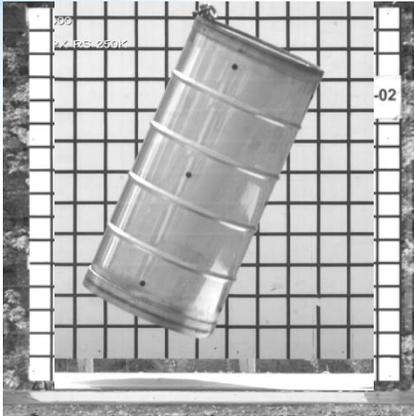
4-FT  
FREE DROP

STACKING

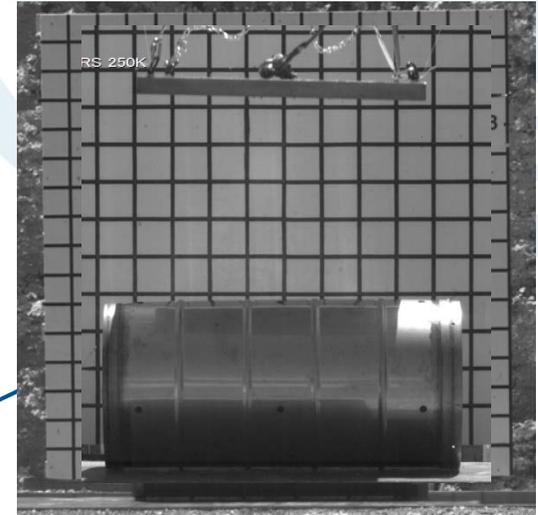


Penetration, Heat/Cold Tests not shown

# BTSP-1 Hypothetical Accident Condition (HAC) Tests



30-FT DROP

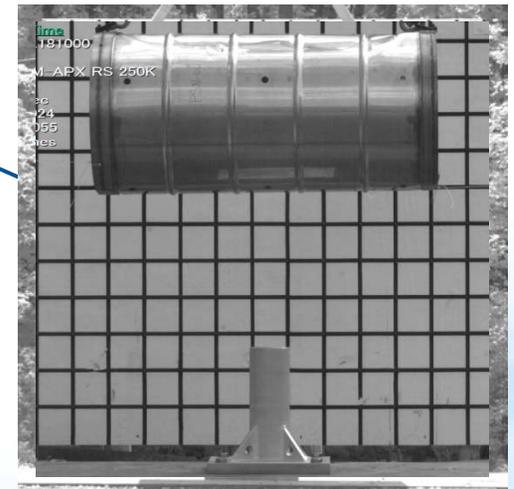


CRUSH



30-MIN  
1,475°F FIRE

PUNCTURE



BTSP

Immersion test not shown

# Post-HAC: BTSP-1 Drum Disassembly



LID REMOVED



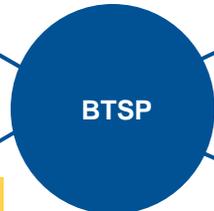
CV READY TO EXTRACT



INSULATING DISK ON CV



TEMP LABEL ON CV



# BTSP-1 Post HAC: Destructive Examination



FIBERFRAX



LINER



LAST-A-FOAM



FIBERFRAX



# BTSP -1 Post-HAC: Helium Leak Testing



CAP BELL JAR

**CAP LEAK TEST**

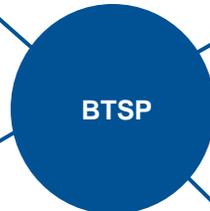


VALVE

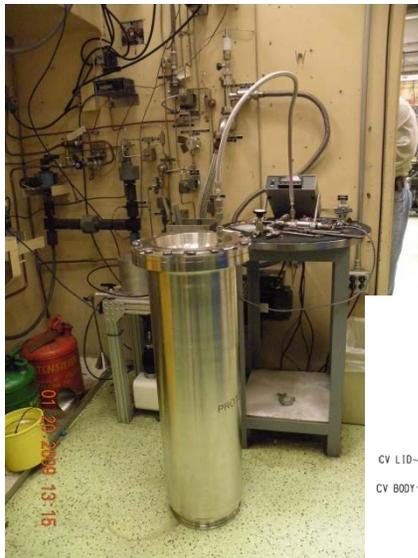
**CV COMPONENTS**



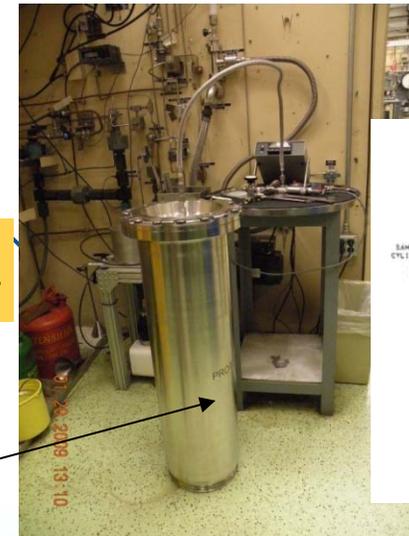
FLANGE C-RING



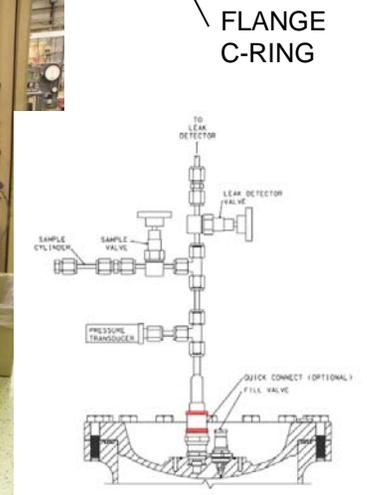
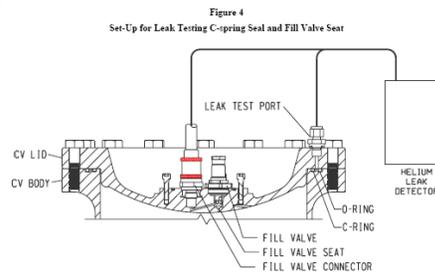
**CV FLANGE C-RING TEST**



**CV VALVE LEAK TEST**



CV



# BTSP-1 Post-HAC Disassembly



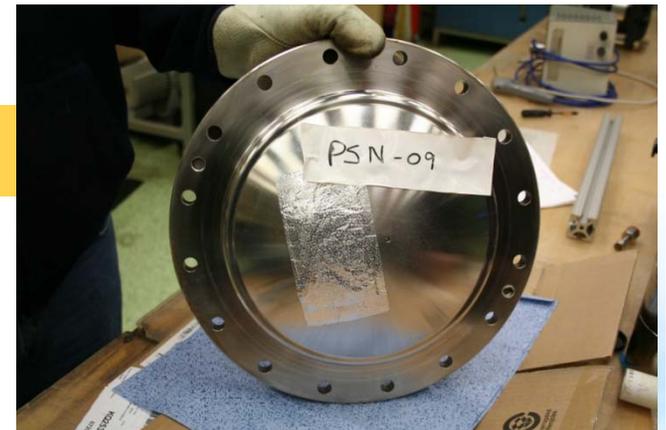
DISASSEMBLY

CV &  
ALUM. FOAM

BTSP

LID

CV LID  
REMOVED

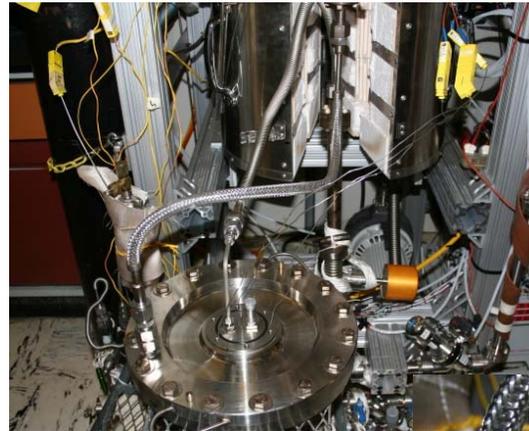


# BTSP-1 Post-HAC: D<sub>2</sub> PERMEATION TESTING

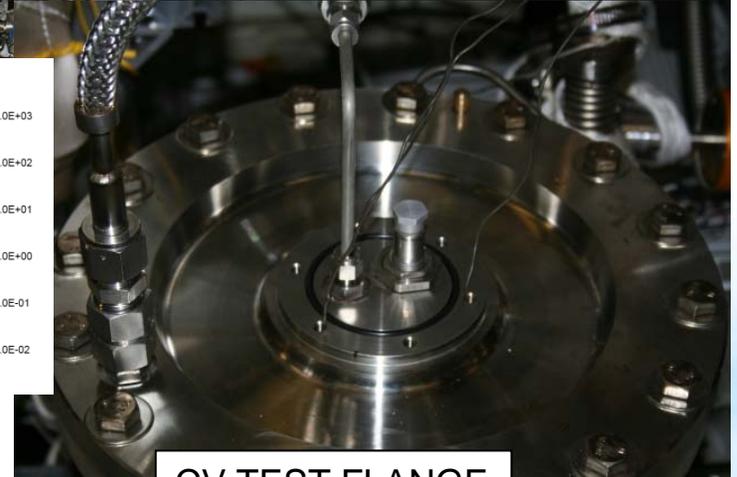
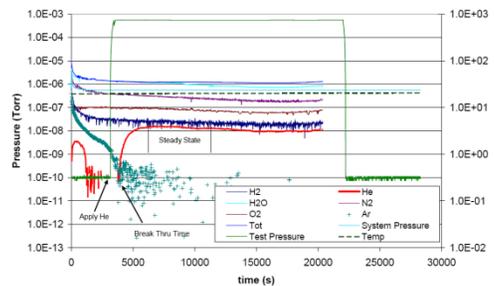
- EVALUATION OF DUETERIUM PERMEATION OF C-RINGS
  - Test Flange
  - CV Flange C-Ring



CV



Leak Test of Flange Mock-up  
Room Temperature 740 Torr He



CV TEST FLANGE

# BTSP Production Fabrication / Site Certification

---

## Fabrication

- **30 Packages Fabricated by Joseph Oat Corporation, Camden NJ**
- **23 Packages Delivered to SRS**
- **Remaining 7 expected to be delivered June 2013**

## Package Procedure Certification

- **SRNL procedure development complete April 2013**

# BTSP-1 Path Forward

## **BTSP SARP Revision 5**

- **Certificate of Compliance (CoC)**
  - Replaces OTC
- **New Contents**
  - AL-M1 Tritiated molecular sieves
  - Experimental bottles
- **Rev 5 Submittal to NNSA - Scheduled July, 2013**

# BTSP Path Forward

---

## **SRNL Current Actions**

- **Receipt Inspection of BTSP-1 Production Units**
- **Distribute Packages to users for operating procedure development**
- **Hold Operations Training Class**

## Questions ?

---

### **If any questions contact:**

**Paul Blanton**

**Program Manager, PT&PS**

**Savannah River National Laboratory**

**Bldg., 730-A**

**Aiken, SC 29808**

**[paul.blanton@srnl.doe.gov](mailto:paul.blanton@srnl.doe.gov)**

**[paul.blanton@srnl.gov](mailto:paul.blanton@srnl.gov) (classified)**

**office ph. (803)725-3738**

**cell ph. (803)507-5343**