SRNL™
SAVANNAH RIVER NATIONAL LABORATORY
Operated by Savannah River Nuclear Solutions, LLC

We Put Science To Work

Bulk Tritium Shipping Package Overview and Status

Tritium Focus Group Meeting

Los Alamos National Laboratory

November 3-4th, 2015

Packaging Technology & Pressurized Systems

Bulk Tritium Shipping Package Overview

- **Project Background & BTSP Overview**
- **UC-609 History & Overview**
- **BTSP Material Evaluation Materials**
- **BTSP Design & Testing Overview**
- **Timeline/Status**

Bulk Tritium Shipping Package Overview

- **BTSP**
  - **Model BTSP-1, Type B(M)**
  - **Designed for shipment up to 150 grams of tritium**
  - **Replaces UC-609 (certified in the 1970s)**
  - **2 primary assemblies: outer drum and an inner CV**
  - **Authorized contents:**
    - tritium: free gas, contaminated water vapor on molecular sieve, as a metal on metal or as a contaminate on metal.

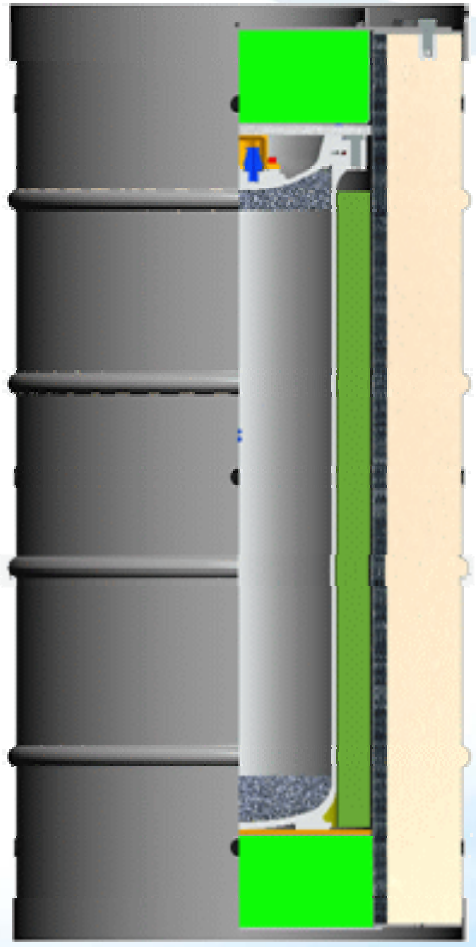
SRNL

Bulk Tritium Shipping Package Overview

- **Package Weights and Overall Dimensions**

  Maximum gross weight based on ~3% variance over the nominal weight
  (516 nominal x 1.027 + 120)

Drum Diameter	Drum Height	Nominal Packaging Weight	Maximum Payload Weight	Maximum Gross Weight
(inches)	(inches)	(lb)	(lb)	(lb)
24.5	50.5	516	120	650



SRNL™

UC609 Background

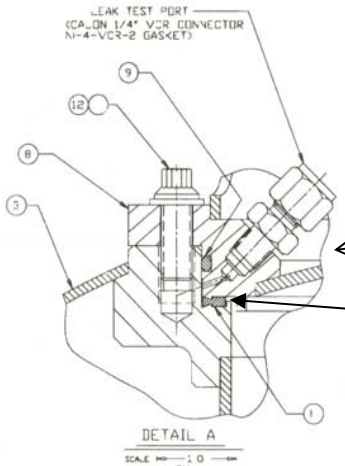
- **UC-609 Designed in early 70's**
- **Dual Certified in 1978 (CoC USA/9932/B(U))**
  - Department of Energy
  - Nuclear Regulatory Commission
- **Regulatory Changes; Mission Changes; Resulted in:**
  - Restricted Future Fabrication of Packages
  - Reduced Payload (150 grams to 100 grams of Tritium)
  - Dropped NRC Certification
- **Current DOE Certificate of Compliance**
  - Expires August 2016

UC-609

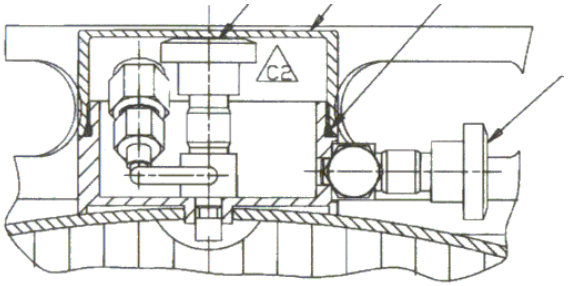
H1616

SRNL

UC-609 Packaging Details



CV Closure

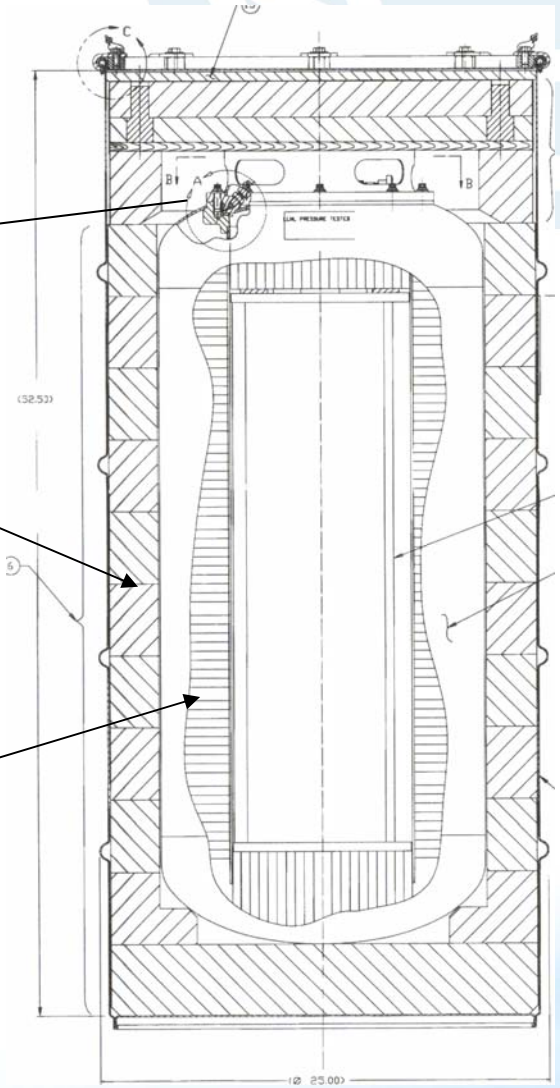


CV Valve Cap

Conflat
Copper Seal

Celotex
Fiberboard
Insulation

Aluminum
Honeycomb
Impact Absorbers

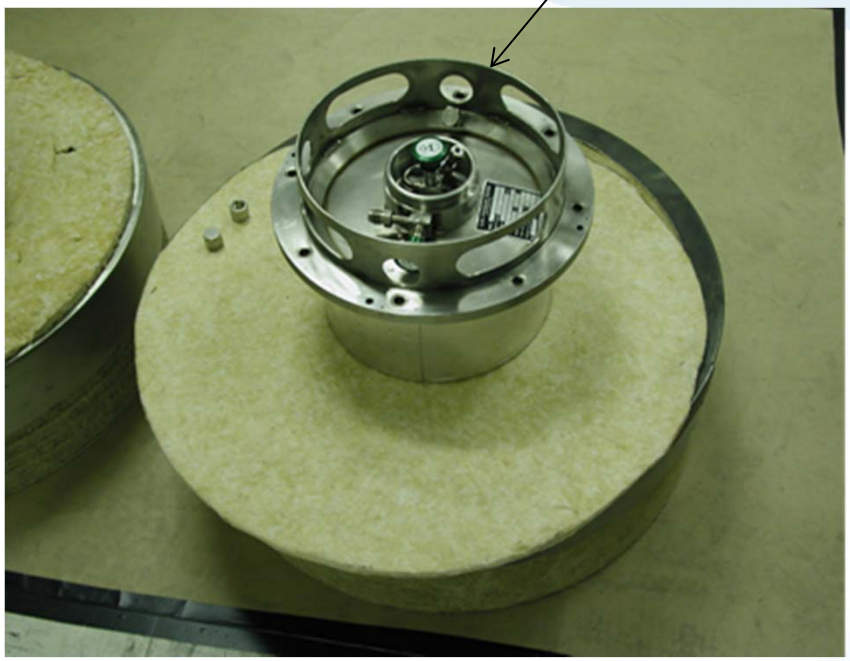


SRNL

UC-609 Disassembly

Drum Overpack

CV Closure



Aluminum Honeycomb Impact Absorber

SRNL

UC-609 Disassembly

Content
Removal →

SRNL

BTSP Material Evaluation

- **In early 2000, NNSA directed packaging designers to incorporate modern engineered materials in new packaging designs instead of Cane Fiberboard Celotex®; the principle thermal and structural material used for decades to demonstrate packaging performance under regulatory NCT and HAC events.**
  - Cited Maintenance Issues
  - Operational Handling Issues
  - New Regulatory Testing Requirements

BTSP Material Evaluation (Overpack)

- **Celotex Material Replacement Development**
  - Polyurethane Foams (SRNL)
    - Significant Impact Resistance
    - Significant Thermal Resistance (Intumescent properties of foam extract heat during fire);
    - Polyurethane foam has tailored densities
  - Kaolite (Y-12)
    - Light Concrete
    - Increased Impact Resistance
    - Thermally Resistant (does not combust)
    - Singular density

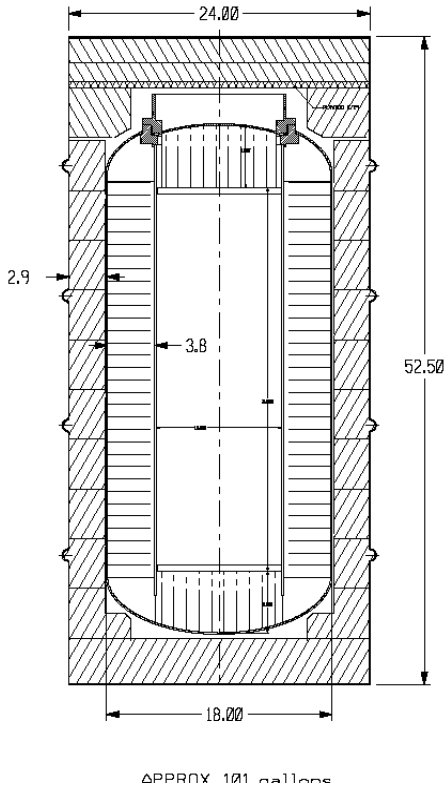
SRNL

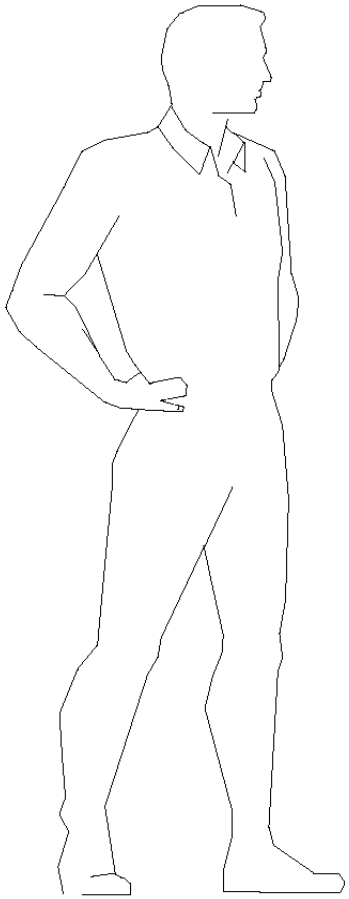
BTSP Material Evaluation (other)

- **Other Material Replacement Development**
  - Vermiculite/Ceramic Thermal Insulating Materials (unaffected by temperatures ~ 2000 ºF)
  - TR-19,
  - Min-k,
  - Fiberfrax,
  - Aluminum Foam

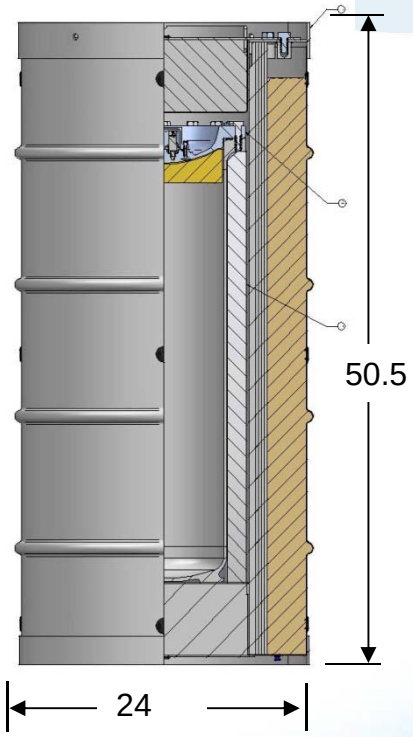
UC-609 Versus BTSP

UC-609





BTSP



BTSP Design Objectives

- **Operations**
  - **Simplify Loading and Unloading of Contents**
  - **Simplify Post Load Leak Testing**
  - **Minimize Packaging Footprint and Weight**

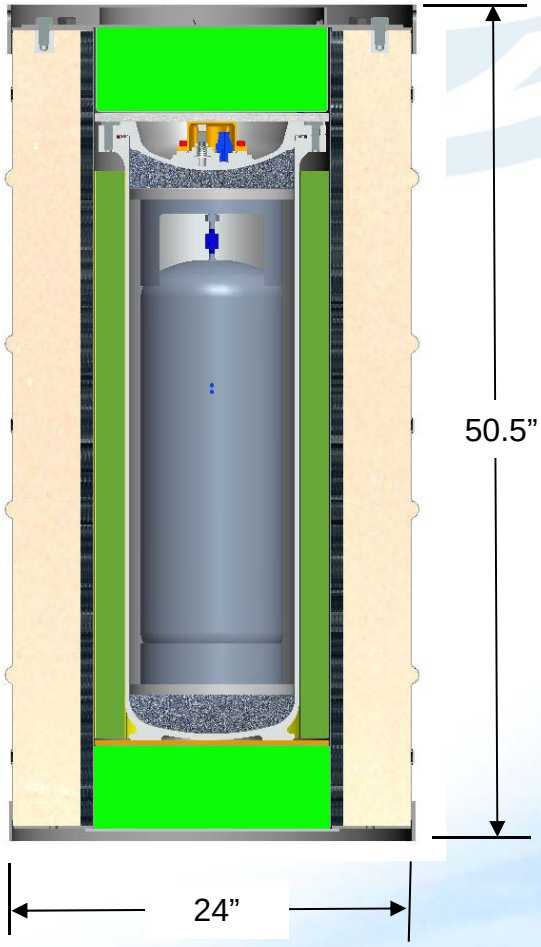
- **Drum**
  - **Impact: Incorporate Modern Engineered Materials and Structural Design Features**
  - **Insulation: Replace Celotex with Polyurethane Foam**
  - **Closure: Redesign Drum Overpack Closure**

BTSP Design Objectives

- **Containment Vessel**
  - **Satisfy B&PVC Sec III, Division 1, SubSection NB (500 psig at 300 °F)**
  - **Include valve and fittings for helium leak testing, inert gas back-filling and testing for tritium release from contents**
  - **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))**
  - **Contents shall be removable while the CV is in the drum overpack**
  - **CV Sealing Surfaces shall be protected from damage during normal operations**

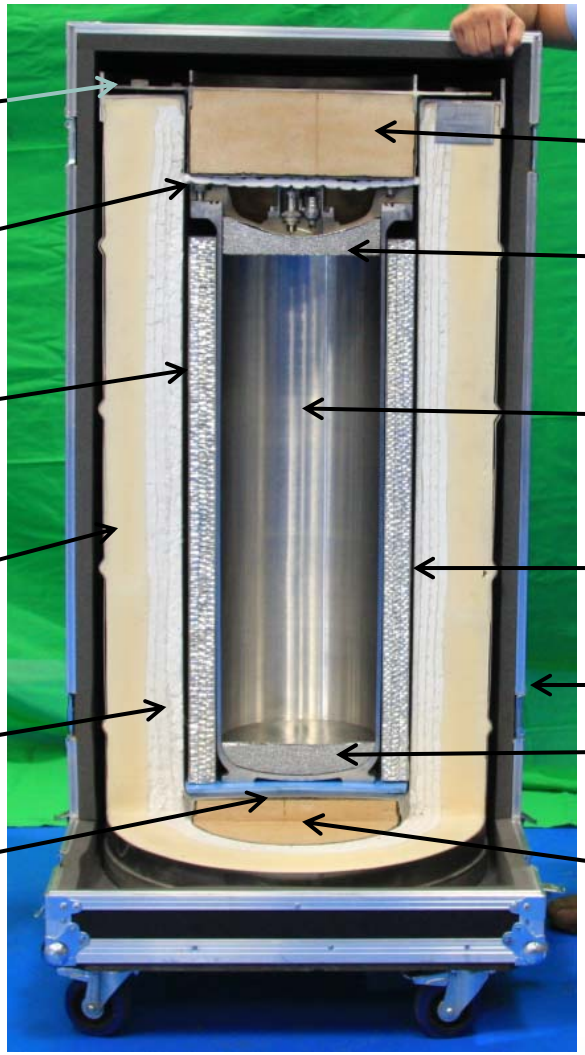
BTSP Design Summary

- **150 grams Tritium (50 watts) (~300 watts with alternate insulation material)**
- **Maximum Payload 120 lbs**
- **Package Gross Wt. 650 lbs**
- **CV Design Pressure 500 psig**
- **Simplified Post Load Leak Testing (leaktight)**
- **Design includes features from multiple certified packages**



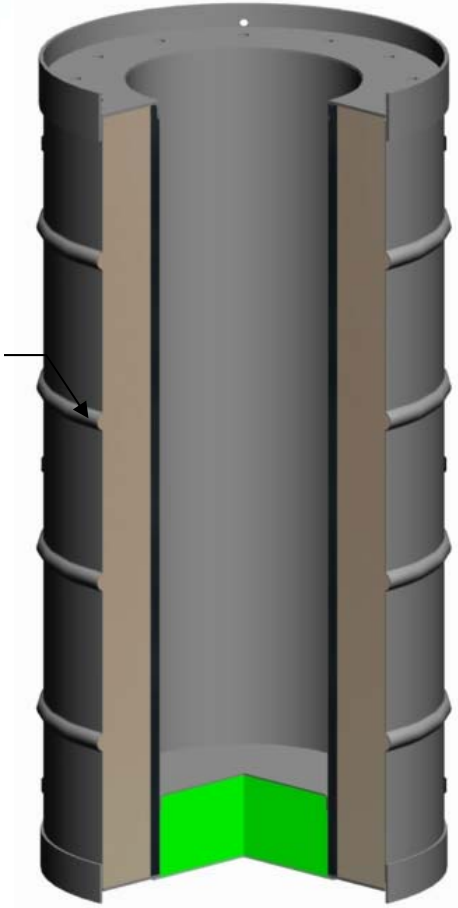
SRNL

BTSP Package

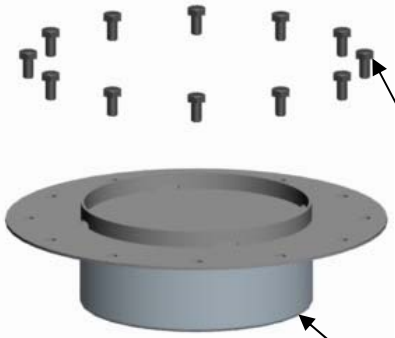


SRNL

BTSP Drum Overpack Assembly



DRUM
OVERPACK
WELDMENT



(12) DRUM BOLTS
5/8-11UNC-1¼ Long

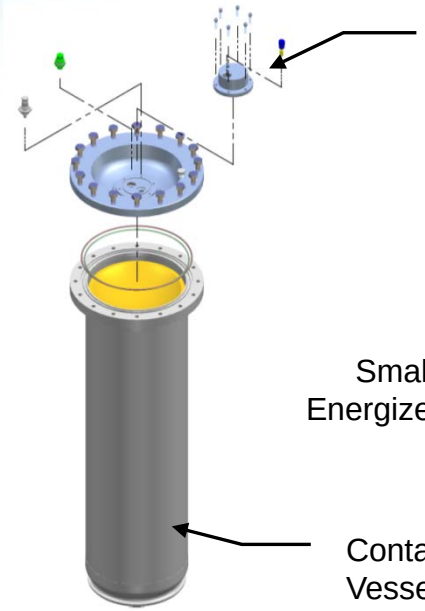
DRUM LID
ASSEMBLY

Drum Overpack Component Weights

Drum weldment	300 lbs
Lid Assembly	45
	345 lbs

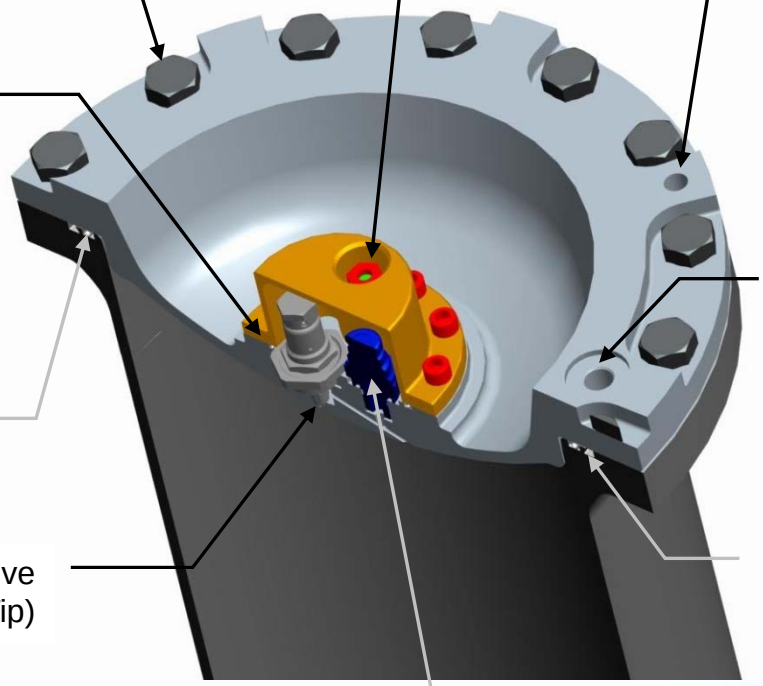
SRNL

BTSP Containment Vessel Assembly



Protective Cap with
(10) Closure Bolts

Containment
Vessel Weldment



Protective Cap
Leak-Test Port
and Plug

CV Lid with (16)
Closure Bolts

Threaded
Lifting Hole

Small Spring
Energized Metal
C-Ring

Flange
Leak-Test
Port

Large Spring
Energized Metal
C-Ring

Bellows Valve
with Stellite Tip)

Flange O-ring
(Elastomeric)

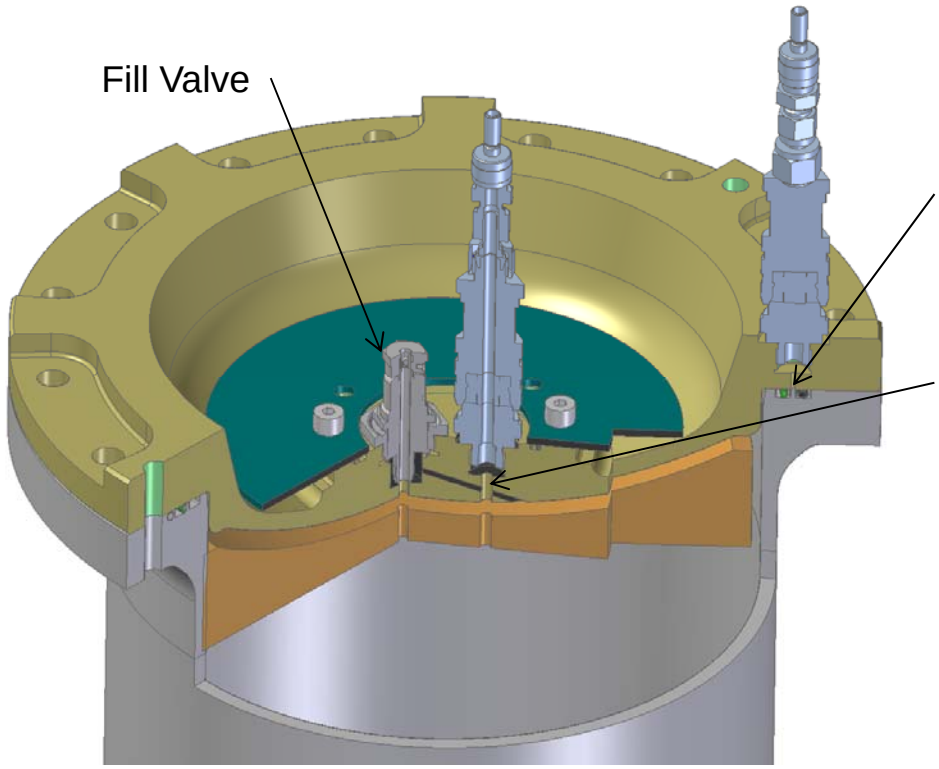
Quick Disconnect

CV Component Weights

CV weldment	125 lbs
Lid Assembly	40
	165 lbs

SRNL

BTSP Containment Vessel Leak Testing

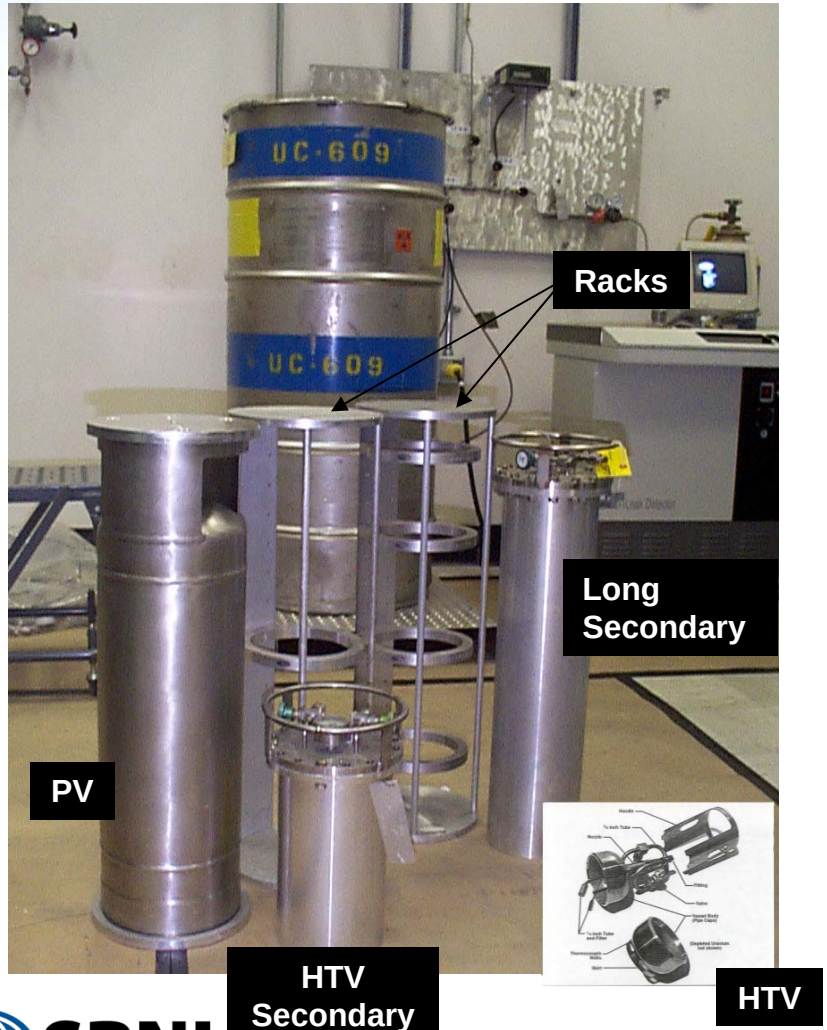


CV Lid Flange Seal
- Small Volume Between Inner Metal C-Ring and Outer Viton O-Ring

Fill Valve Seat Leak Test
- Small Volume and All-Metal seals

SRNL

BTSP Package Contents and Configurations



What it can ship:

- **Gas (Pure/Mixtures)**
- **Solids (UT_3, etc.)**
- **Contaminated metal**

Content Vessels

- **Product Vessel (PV)**
- **Hydride Transport Vessel (HTV)**
- **Hydride Storage Vessels (HSV)**
- **Secondary Containers - Contamination Control Vessels (CCVs) required for some contents with racks**

New Contents Under Review

- **Molecular Sieves**
- **Experimental Reservoirs**

SRNL™

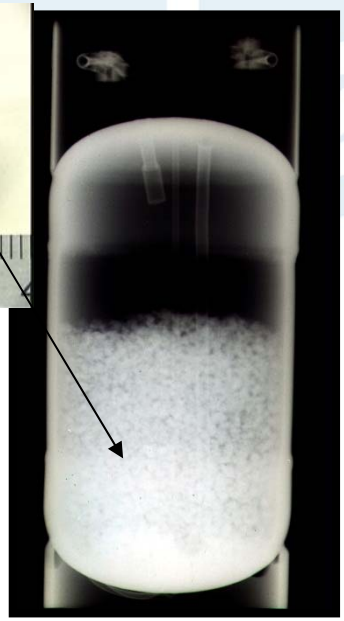
BTSP Content and Configuration continued

PV

CCV

HTV

Titanium

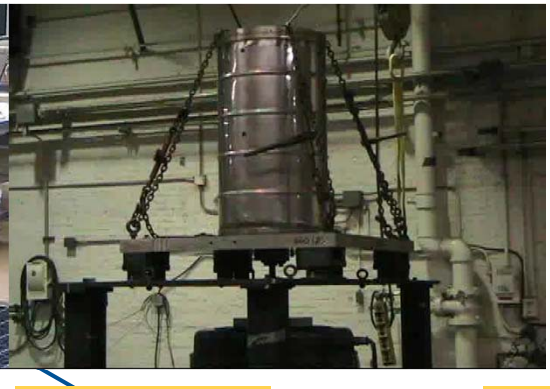


HSV X-ray

Rack
(HTV/HSV)

SRNL

Normal Condition of Transport (NCT) Tests



Low and High Frequency

VIBRATION

WATER SPRAY

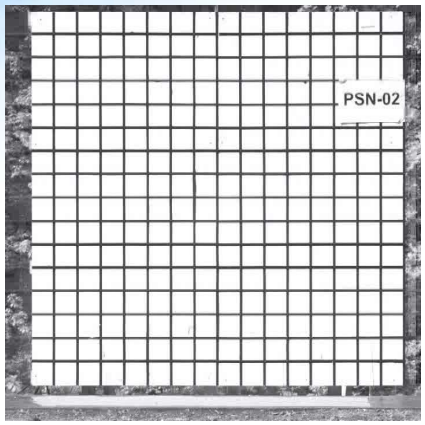
BTSP

4-FT FREE DROP

STACKING

SRNL

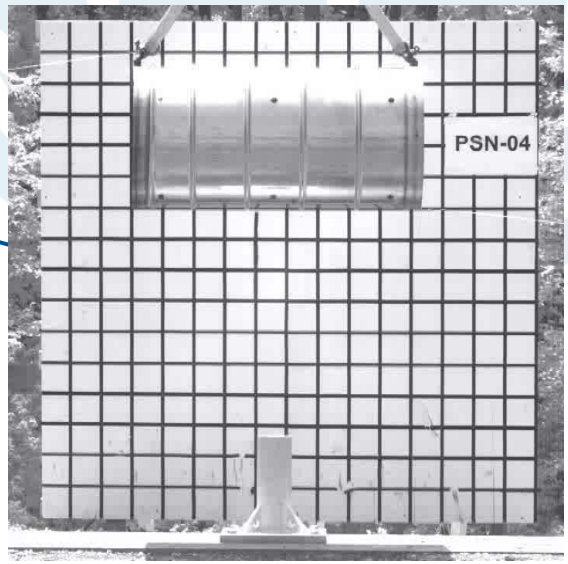
Hypothetical Accident Condition (HAC) Tests



30-FT DROP

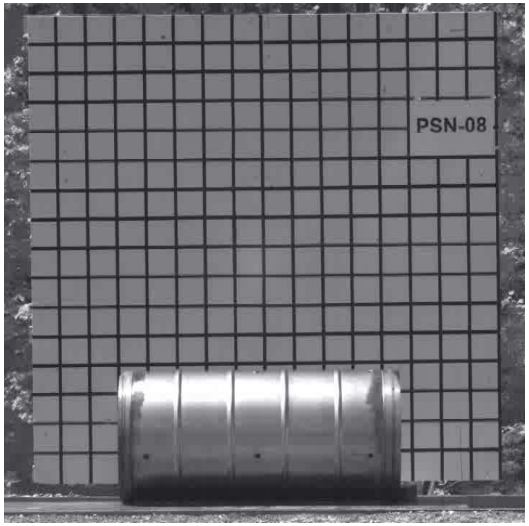
BTSP

PUNCTURE



CRUSH

30-MIN
1,475ºF FIRE



SRNL

Post HAC: Destructive Examination

FIBERFRAX

LINER

LAST-A-FOAM

FIBERFRAX

SRNL

Operating Advantages of BTSP vs UC-609

BTSP	UC-609
Containment Vessel can remain in the drum for loading and unloading.	Containment Vessel must be removed from the drum. (Revised)
Protective Cap has metal seal: no helium permeation.	Protective Cap has elastomer seal: helium permeation and high helium backgrounds slow down leak tests.
Protective Cap leak tested with helium belljar method.	Protective Cap leak tested with helium hood test method.
Ten inch diameter CV	Eighteen inch diameter CV
No “shims”; two aluminum foam Drop-in impact absorbers	Measured “shims” required when loading contents
No loose materials (all clad); ease of radiological swipes	Lose fibrous materials; radiological swipes not practical
No inspection for water	Inspection for water

SRNL

BTSP Timeline/Status

- Mid 2000: NNSA Directs SRNL to Develop BTSP
- Winter 2007: Preliminary Design/Analysis
- Fall 2007: Prototype Fabrication
- 2008/2009: Prototype Testing/Destructive Examination
- Fall 2009: Rev. 0 SARP Submitted for Review
- Spring 2012: NNSA Issues OTC (SARP Rev. 4)
- Summer 2013: SARP Rev. 5 Issued for New Contents
- 2014-2015: Training at SRNL(SRS/LANL) & at LLNL
- Fall 2015: SRS Readiness Review Complete
- 2016: SARP Rev. 6; NNSA CoC; First SRS Shipment
- Future: 2-6 per year to LLNL/NIF; LANL (AL-M1): Other