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$_2$)

- 1100 lb. steel plate dropped from 30-ft

Future fabrication of UC-609 is not permitted
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

• 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)
UC-609 Assembly

Open head drum with J-hook closure bracket

Spacers

Aluminum Honeycomb (all within CV)

Containment Vessel

Celotex (Insulation/Impact)
BTSP-1 Sectioned Assembly

- Drum Lid
- Closure Bolts (12)
- Insulated Drum Lid
- Aluminum Foam Top
- Spacer Stainless Covered
- Containment Vessel Assembly (available packing volume) 10" ID by 30-5/8" high
- Drum Assembly
- Silicone Damping Pad
- Insulated Drum Bottom
- Honeycomb Composite Cylinder (aluminum/fiberglass)
- Quilted Insulating Pad
- General Plastics 10# Polyurethane Foam
- Ceramic Fiber Quilted Insulation
- Aluminum Foam Bottom Space Stainless Covered
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

Drum Overpack Component Weights

- Drum Overpack: 300
- Drum Lid: 45
- Total: 345 lbs

(12) DRUM BOLTS
5/8-11UNC-1¼ Long

DRUM OVERPACK WELDMENT

DRUM LID ASSEMBLY
BTSP-1 Containment Vessel Assembly

- 16 ½" CV Bolts
- Closure Lid
- CV Weldment (Body)
- Protective Cap Seal
  - Spring Energized C-Ring
  - Gland Plug
- CV Lid Seals
  - Spring Energized C-Ring (inner)
  - Elastomer O-ring (outer)
- (10) 1/4" Cap Screws
BTSP-1 Containment Vessel Assembly

CV Lid with (16) Closure Bolts

Small Spring Energized Metal C-Ring

Containment Vessel Weldment

Large Spring Energized Metal C-Ring

Protective Cap Leak-Test Port and Plug

Threaded Lifting Hole

Flange Leak-Test Port

Quick Disconnect

Bellows Valve

CV Component Weights

CV Weldment 125

CV Lid Assembly 40

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
<table>
<thead>
<tr>
<th>Package Content/Configurations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BTSP (OTC; CoC Planned)</strong></td>
<td><strong>UC609 (CoC)</strong></td>
</tr>
<tr>
<td>(certificate expires 2/2017)</td>
<td>(certificate expires 8/2016)</td>
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<tr>
<td><strong>Content</strong></td>
<td></td>
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<tr>
<td>- 150g max tritium (50-watt)</td>
<td>- 100g max tritium (32-watt)</td>
</tr>
<tr>
<td>- 120 lbs max payload</td>
<td>- 120 lbs max payload</td>
</tr>
<tr>
<td>- Gas (pure, mixed)/Tritides</td>
<td>- Gas/Tritides/Tritiated Water</td>
</tr>
<tr>
<td>- 75g organics</td>
<td>- unspecified</td>
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<tr>
<td><strong>Configuration (specified)</strong></td>
<td></td>
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<tr>
<td>- Hydride Transport Vessel (HTV)</td>
<td>- HTV</td>
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<tr>
<td>- Product Vessel (PV)</td>
<td>- PV</td>
</tr>
<tr>
<td>- Hydride Storage Vessel (HSV)</td>
<td>- HSV</td>
</tr>
<tr>
<td>- Metals contaminated with tritium</td>
<td>- Reservoir</td>
</tr>
<tr>
<td>- CV Loading (in or out drum)</td>
<td>- Molecular Sieves</td>
</tr>
<tr>
<td></td>
<td>- Other</td>
</tr>
<tr>
<td></td>
<td>- CV Loading (out of drum)</td>
</tr>
</tbody>
</table>
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

Drum Lid
TR-19

CV, Honeycomb Spacer, Silicone & Thermal Pads

CV Lifting

Major Tool & Machine, Inc.

DRUM

CV Lid

CV Honeycomb

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

Analytical Results are Compared to Instrumented Test Packages to Benchmark FEA Thermal Models
BTSP-1 Normal Condition of Transport (NCT) Tests

Low and High Frequency

VIBRATION

WATER SPRAY

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

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: Helium Leak Testing

- CAP LEAK TEST
- CV FLANGE C-RING TEST
- CV VALVE LEAK TEST

CV COMPONENTS
BTSP-1 Post-HAC Disassembly

- **CV Lid Removed**
- **CV & Alum. Foam**
- **Lid**
- **Disassembly**

Image descriptions:
1. A close-up of the BTSP with a lid removed, labeled "PSN-09".
2. An interior view of the BTSP showing CV & Alum. Foam, labeled "PSN-02".
3. Two views of CV lids labeled "PSN-07" and "PSN-09".
4. A view of the BTSP with a lid removed, showing the interior details.
5. Close-ups of individual components, highlighting their removal and placement.
BTSP-1 Post-HAC: $\text{D}_2$ PERMEATION TESTING

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

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