LANL-B: Type B Package for Shielded Sources

AREVA Federal Services LLC

under contract to

Los Alamos National Security, LLC

AREVA

Agenda

- Introductions
- Meeting objectives
- Technical discussions and NRC staff feedback
- Project schedule
- Summary

AREVA

Introductions

- **AREVA Federal Services LLC (AFS)**
  - Rich Smith, AFS Packaging Projects Director
  - Ron Burnham, LANL-B Project Manager
  - Alec Ross, LANL-B Project Engineer
  - Phil Noss, AFS Licensing Manager
- **Global Threat Reduction Initiative (GTRI, NA-21, NNSA)**
  - Ioanna Iliopulos, Director North and South America Threat Reduction
  - Abigail Cuthbertson, Federal Project Manager, Offsite Source Recovery Project (OSRP)
  - John Zarling, NNSA
- **Los Alamos National Laboratory**
  - Julia Whitworth, OSRP Program Manager
  - Dwaine Brown, Staff Lead for Type B Container Development, OSRP
  - Mike Pearson, Senior Technical Advisor, OSRP

Meeting Objectives

- Description of the LANL-B Packaging
- Description of the payloads
- Licensing Approach
- Preliminary Analysis Results
- NRC Staff feedback
- Project Schedule

LANL-B Mission

- **Off-Site Source Recovery Project Presentation (5 slides)**

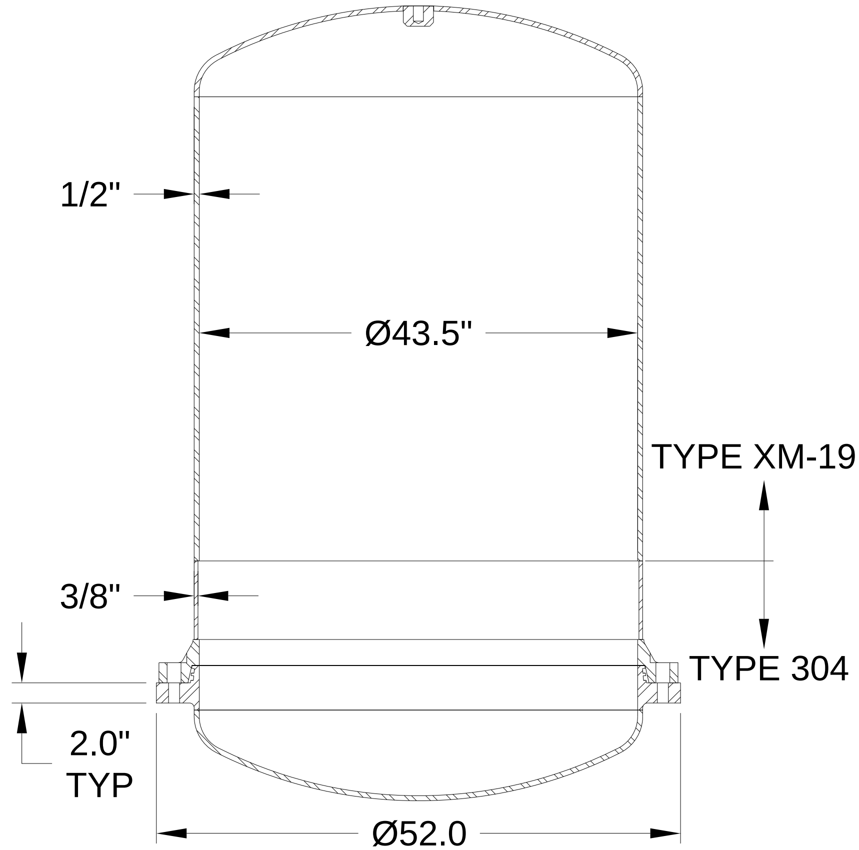
LANL-B Packaging - General

- The LANL-B will be used to safely transport the IAEA's Long Term Storage Shield (LTSS) or intact irradiators and teletherapy devices containing sources
- Sources are primarily gamma- or beta-producing, and include very small neutron sources
- Radionuclides are either non-fissile or fissile exempt
- Category I packaging provides leaktight containment
- LTSS or medical device/irradiator provides all shielding
- A principal design driver is package weight
  - Gross weight of package approximately 9,800 lb
  - Maximum payload weight approximately 5,150 lb

AREVA

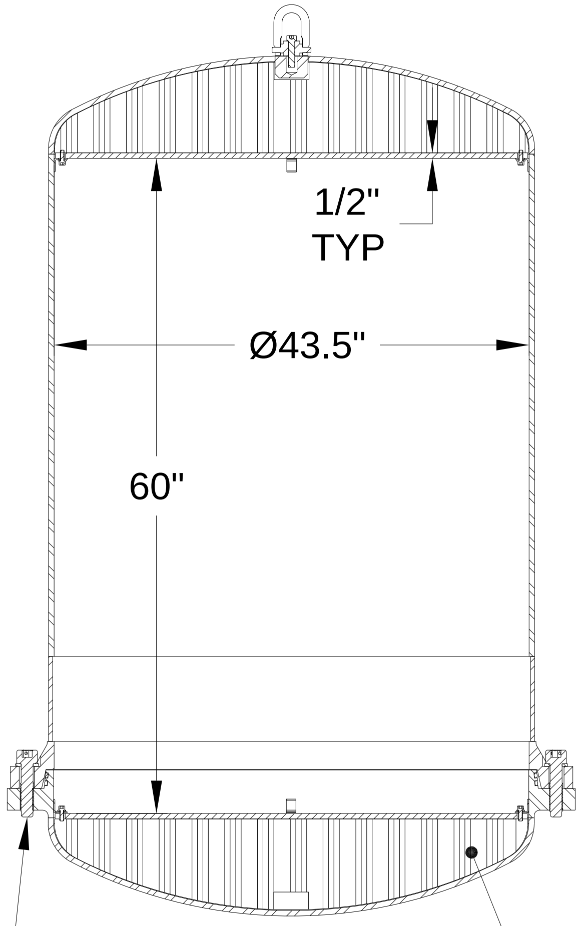
LANL-B Packaging Description

- Containment boundary consists of a vertical cylinder with torispherical ends
- Massive closure joint near lower end
- Inner diameter 43.5 inches
- Thickness ½ inch (& ⅜ inch)
- Material: Types XM-19 and 304 austenitic stainless steel



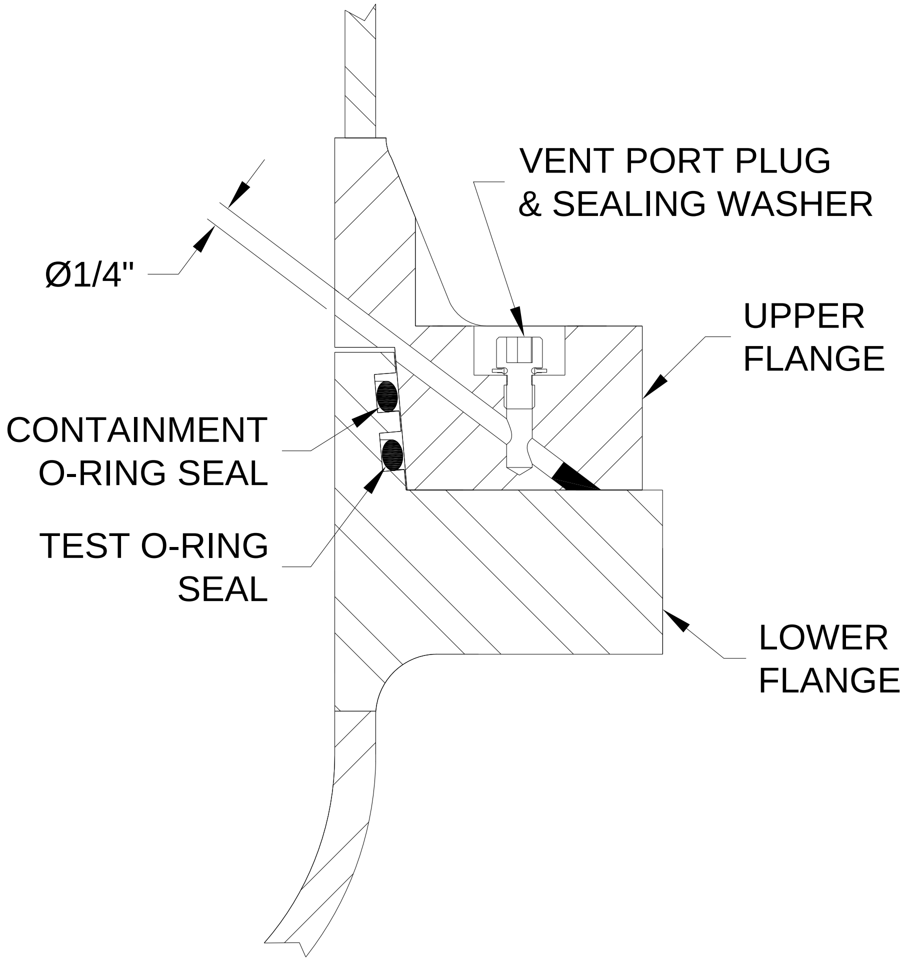
LANL-B Packaging Description

- At each end, aluminum honeycomb (with ½-inch thick aluminum plates to distribute load) creates flat ended cavity 60 inches long
- 24, 1-1/4 inch diameter closure bolts made from ASTM A320 L43 & hardened washers
- Single lift point for package at top (threaded hole)



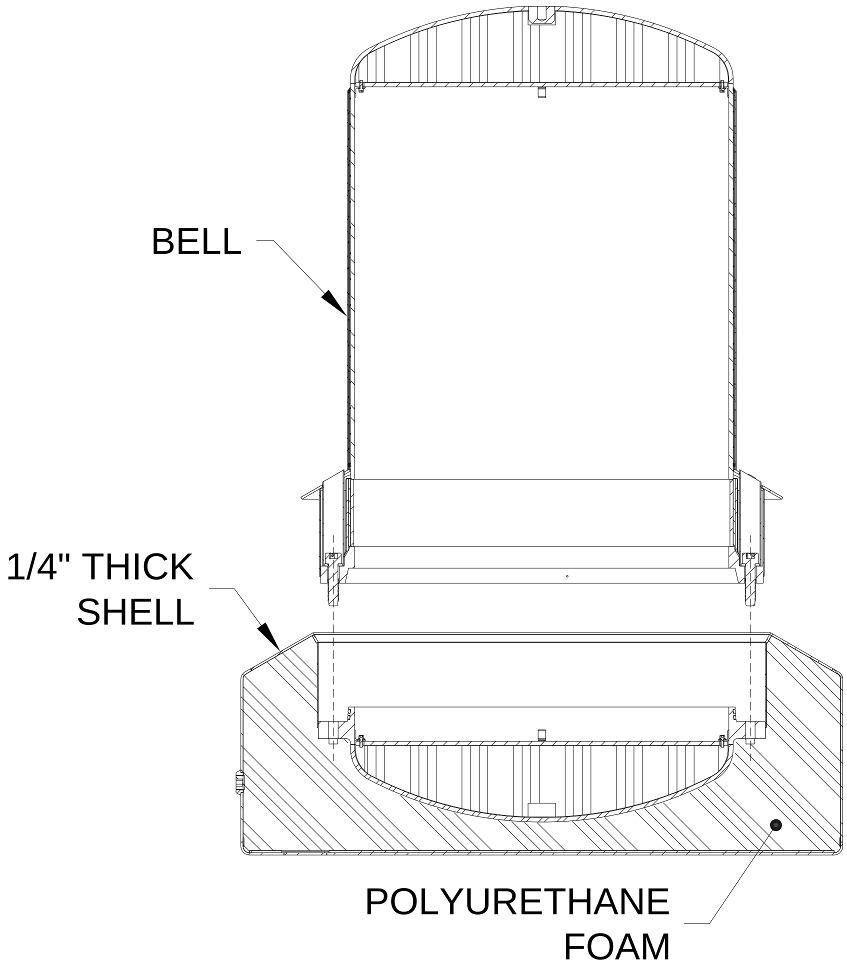
LANL-B Packaging Description

- **Containment seal and test seal ⅜-inch diameter butyl rubber on 5º tapered bore**
- **Seal material made from Rainier Rubber R-0405-70**
- **Vent port and seal test port located on bolt circle, with brass port plugs, and sealing washers using same butyl elastomer**



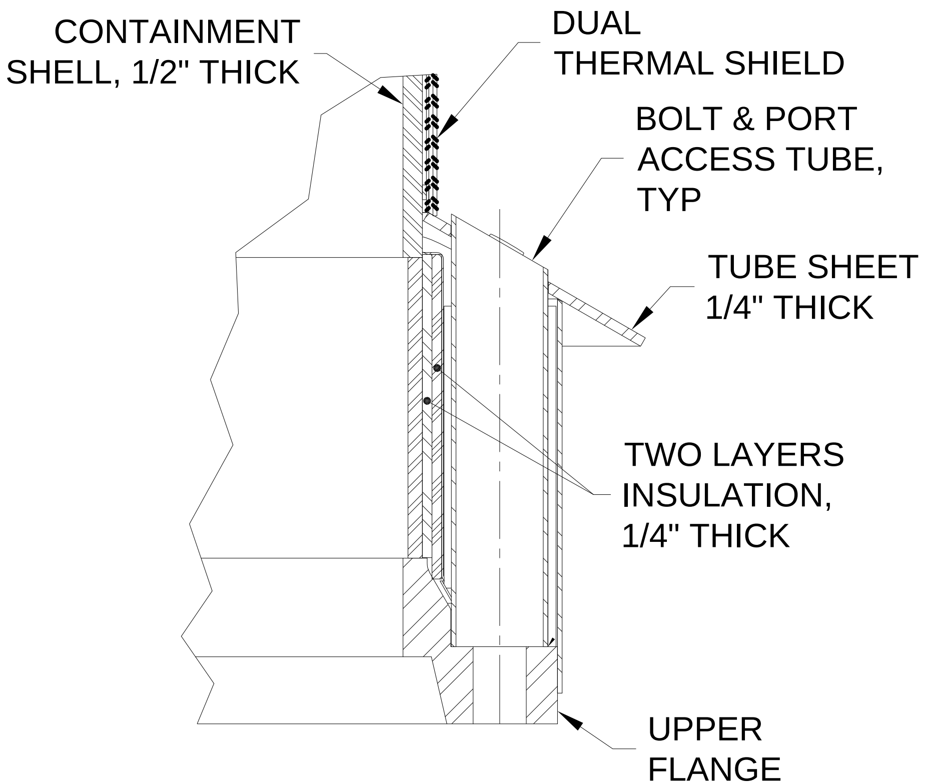
LANL-B Packaging Description

- Single impact limiter on bottom protects from direct impact on flange, provides fire protection
- Impact limiter is integral to lower head
- Polyurethane foam, approx. 13 lb/ft^3
- IL shell is ¼ inch thick, maximum use of rolled corners and full-thickness welds to improve impact performance



LANL-B Packaging Description

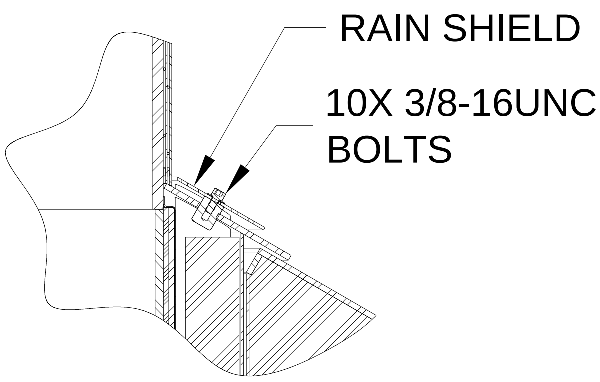
- **Upper component ("bell") has 2-1/4" I.D. tubes for access to closure bolts and ports**
- **Two layers of ¼-inch insulation reduce heat input to lower bell**
- **Tube sheet (¼-inch thick) holds tubes securely and improves puncture protection**
- **Dual thermal shield covers cylindrical outer surface**



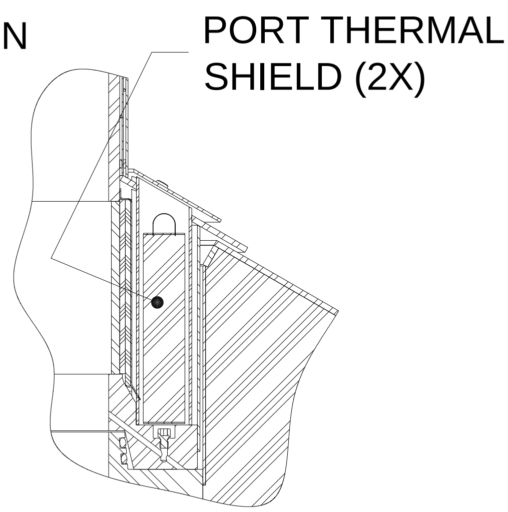
BELL DETAIL

LANL-B Packaging Description

- Rain shield keeps bolt and port tubes dry and also serves as fire shield
- Rain shield attached using 10, 3/8-16 UNC bolts
- Port thermal shields used in vent and test port tubes
- Port thermal shields retained by rain shield

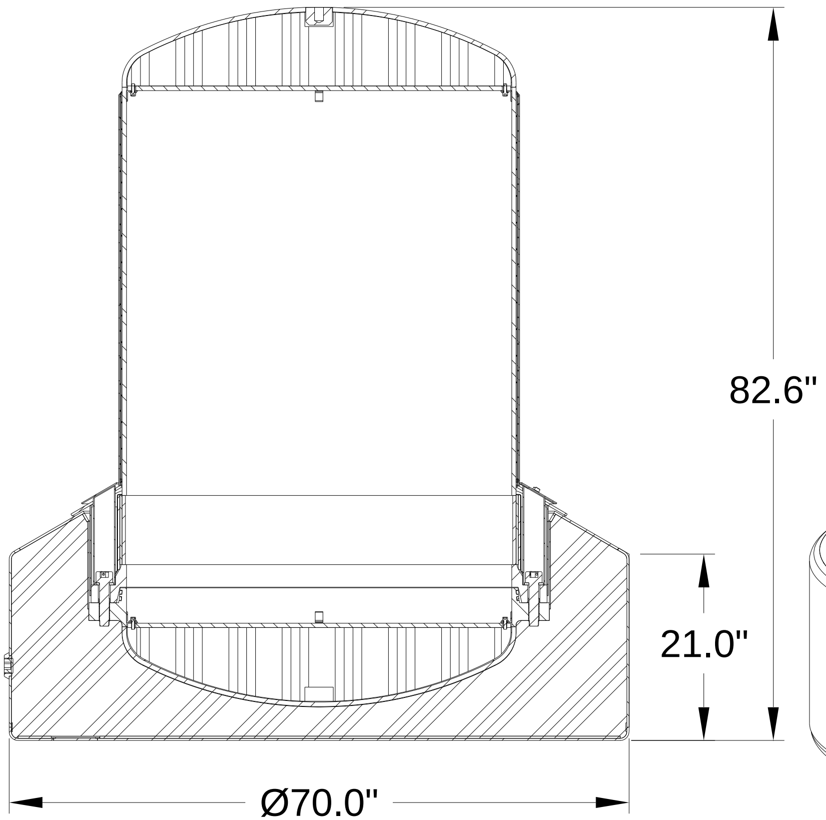


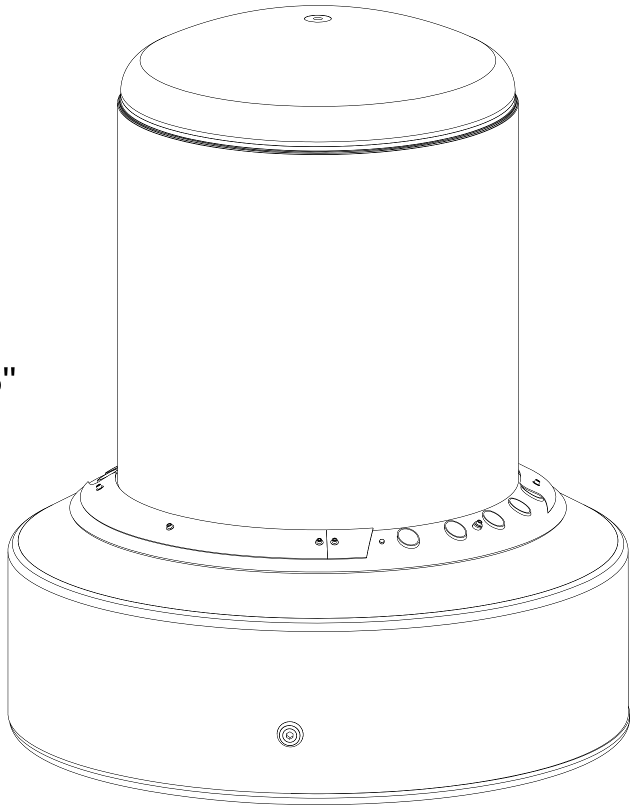
SECTION BETWEEN
BOLT TUBES



SECTION AT
VENT PORT

LANL-B Packaging Description



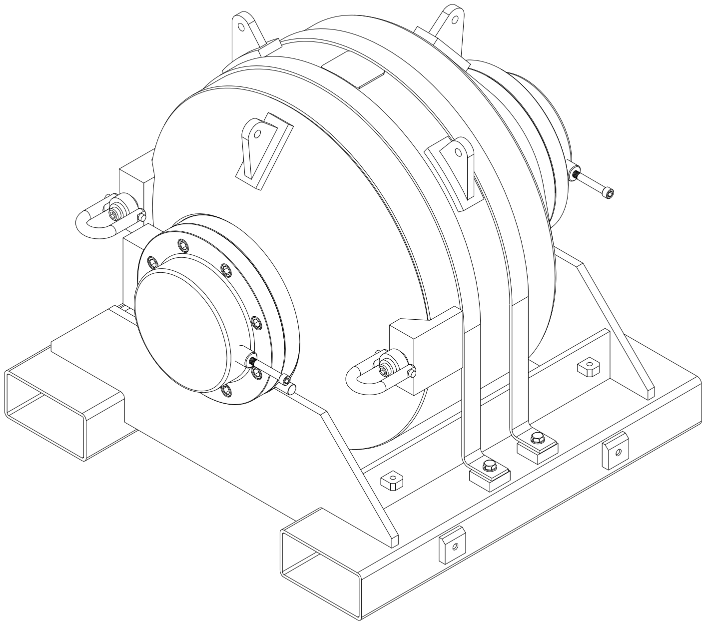


Package Design Summary

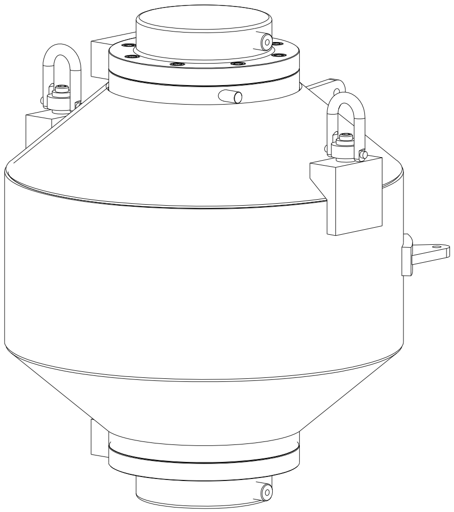
- Type B
- Leaktight containment (<1.0 × 10^{-7} std-cc/sec, air) for both NCT and HAC
- For transport by truck, rail, ship, and air
  - Payloads containing plutonium will not be shipped by air
- Weight: max. 10,000 lb including skid; approx. 9,800 lb licensed maximum weight; approx. 4,600 lb empty
- Lifted by threaded hole at top of package, design meets 10 CFR 71.45(a)
- No integral tie-down structural attachment. Flexible tie-downs go over impact limiter, anchored to conveyance, design meets 10 CFR 71.45(b)

Payloads

- **Two payload types**
  - **Long Term Storage Shield (LTSS), a lead shield developed by IAEA**
  - **Intact medical devices (i.e., teletherapy heads) or industrial irradiators containing their sources**
- **LTSS**



AS STORED



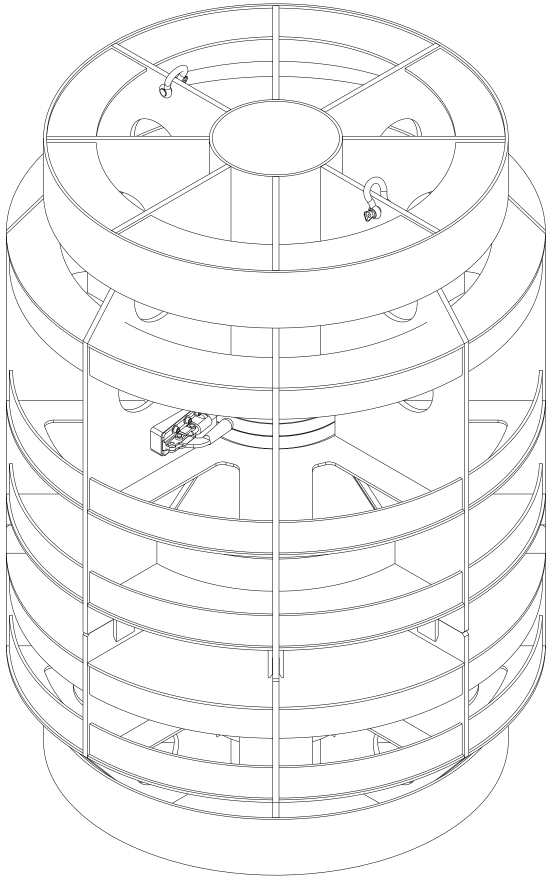
AS TRANSPORTED

Payloads

- **LTSS**
  - Base is removed for transport
  - Weight ~4,650 lb
  - Provides all of the shielding necessary for its contents
  - External radiation of LTSS meets transportation requirements for non-exclusive use (200 mrem/hr surface, TI = 10)
  - Contains ~9.5 inches of lead, stainless steel components, 6 mm outer stainless steel shell
  - Can carry up to four source-containing drawers in a central magazine
  - Bounding payload is approx. 13,000 Ci of Co-60, or 200W
  - Other payloads include: Cs-137, Sr-90, Ir-192, Se-75, Ra-226, Am-241, Pu-239 (<15g), and very small PuBe, AmBe, or RaBe neutron sources
  - Carried within package in a custom lodgment

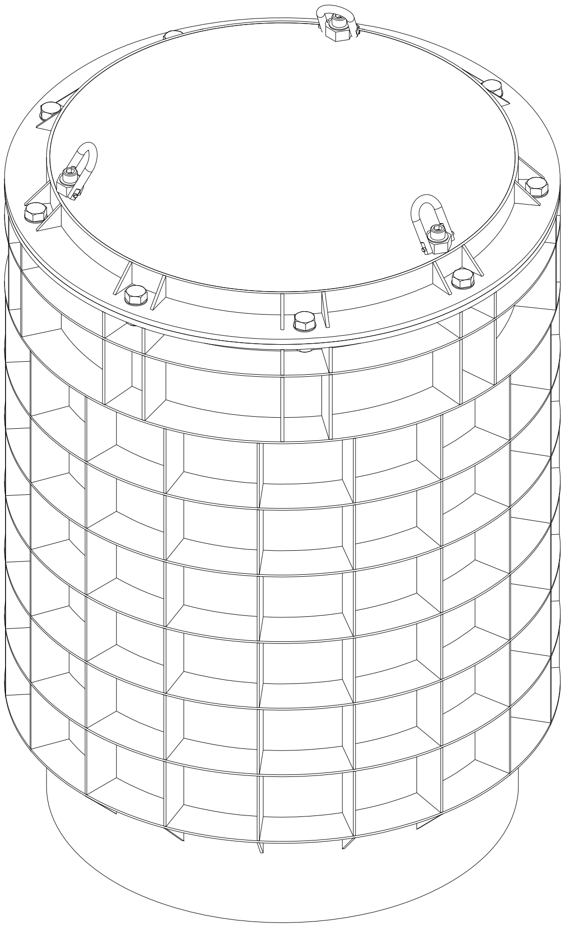
Payloads

- Aluminum weldment with upper and lower halves joined by bolts or pins
- Secures LTSS for NCT; protects packaging for HAC
- Gap to package cavity nominal ½” axial and ¼” radial
- Max. loaded weight: 5,150 lb



Payloads

- Inner Container (IC)

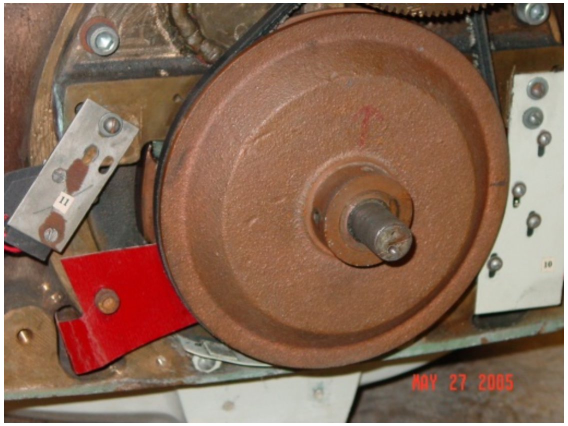


Payloads

- **Inner Container**
  - Serves as container for devices containing sources (teletherapy heads, industrial irradiators)
  - Maximum device weight of 3,500 lb
  - One device per IC, blocked and braced to provide secure position for NCT
  - The IC protects device and packaging for HAC
  - Gap to package cavity nominal ½” axial and ¼” radial
  - Internal dimensions: 36 inches I.D., 53 inches long
  - Type 304 stainless steel plate and sheet
  - Max. loaded weight: 5,150 lb
  - Designed to be lifted with full contents load

Payloads

- Devices containing sources
  - Devices provide all shielding required
  - Shielding is primarily lead, sometimes with DU or Tungsten
  - External radiation of any device meets transportation requirements for non-exclusive use (200 mrem/hr surface, TI = 10)
  - Devices may be of domestic or foreign manufacture
  - Sources will be locked and positively immobilized in the shielded position within the device



AREVA

Payloads

- **To be accepted for transport, the device must:**
  - **Be of a known source nuclide and known (as-manufactured) source activity**
  - **Be intact (i.e., shielding components, including outer shell, must be undamaged and complete)**
  - **Have source movement mechanism positively fixed (by mechanical means such as welding or bolting) in fully shielded position**
  - **External radiation must be less than 200 mrem/hr surface, TI = 10 or less**
  - **Be placed within the IC and blocked in position using timber or equivalent materials**

AREVA

Licensing Strategy

- Safety demonstration primarily by full-scale test (including some analysis)
- Full-scale test of free drop and puncture
- Cert test unit will be leaktight after testing
- Active accelerometers or high-speed photometry may be used
- LS-Dyna calculations to determine
  - Worst-case test orientations
  - Behavior at other orientations and at maximum temperature
  - Calculation model will be benchmarked against test results
- Test plan is under development
  - Cert test will include LTSS specimen
  - Qualification of devices will depend on available information

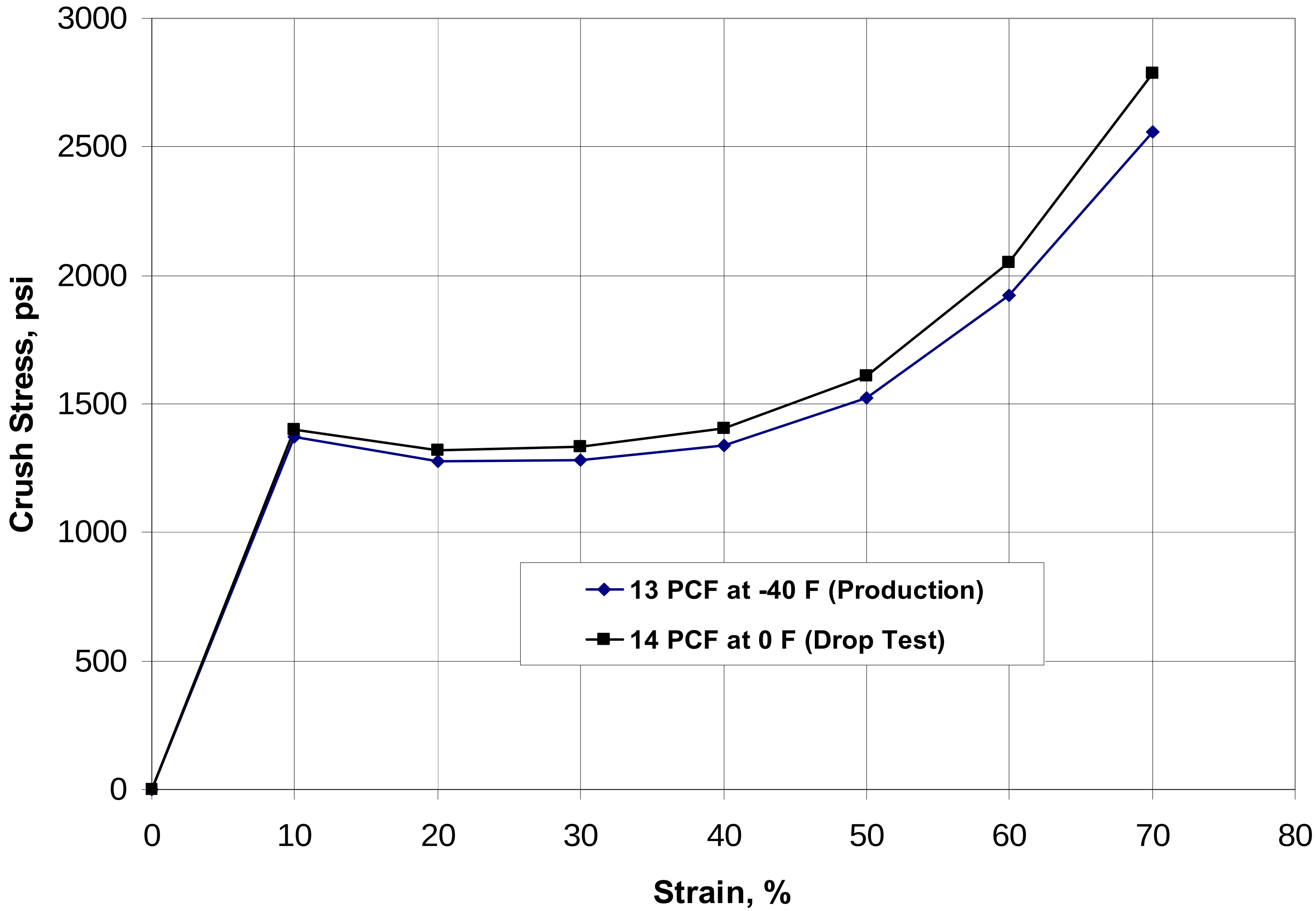
AREVA

Licensing Strategy

- -40 ºF cold free drop requirement of TS-R-1 will be addressed
- Due to difficulty of maintaining polyurethane foam at -40 ºF during drop testing, test foam density will be adjusted upward to achieve the same effect
- 14 lb/ft^3 density at 0 ºF is conservatively stronger (approx. 5%) than 13 lb/ft^3 density at -40 ºF
- 0 ºF is achievable in test, and a change of one lb/ft^3 density (13 to 14 lb/ft^3) will not alter the basic behavior of the foam
- Thus, use of 14 lb/ft^3 density at 0 ºF (test) is slightly conservative over 13 lb/ft^3 density at -40 ºF (production)

AREVA

Licensing Strategy



Licensing Strategy

- **Thermal by analysis**
  - **Heat source 200 W**
  - **Half- or quarter- symmetry model using SINDA® analysis software**
    - Same software and modeling techniques as the BEA Research Reactor Package, ATR, TRUPACT-III, etc.
  - **Model will include worst-case HAC free drop and puncture damage**
- **Structural analysis**
  - **General stress criteria per Reg. Guide 7.6**
  - **Load combinations per Reg. Guide 7.8**
  - **Bolting analysis per guidance of NUREG/CR-6007**
  - **Cask shell immersion buckling analysis per ASME B&PV Code Case N-284-2**
  - **Since payload activity will be less than 10^5A_2, deep immersion (§71.61) not required**

AREVA

Licensing Strategy

- **Shielding analysis**
  - **Shielding analysis will be performed on LTSS**
  - **Lack of drawings of devices will prevent shielding analyses for devices**
  - **Therefore, compliance with *package* external radiation dose requirements will be achieved by ensuring *device* dose measurements meet transportation requirements**

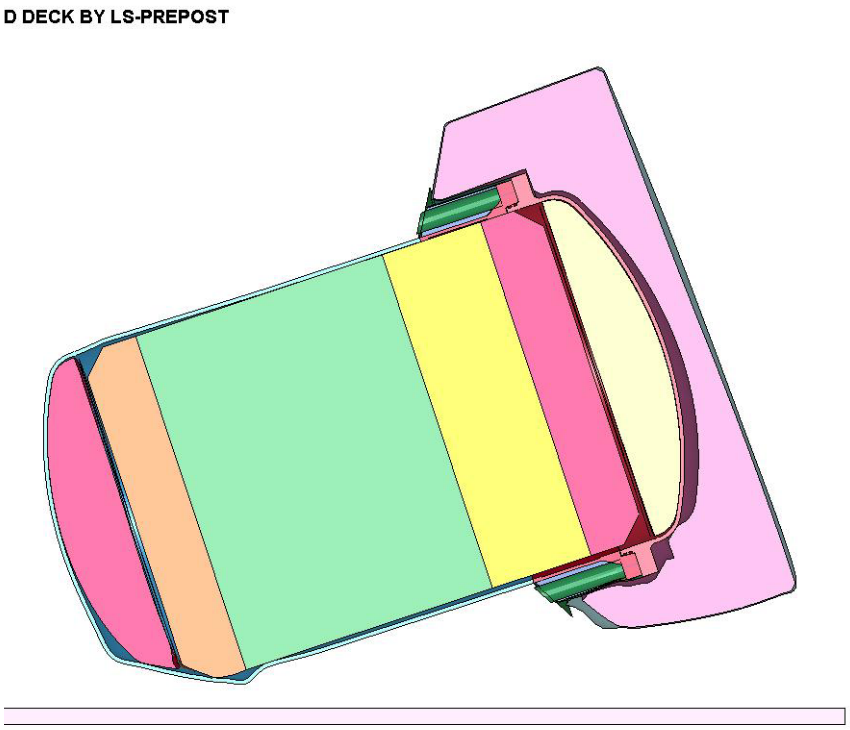
AREVA

Preliminary Analysis Results

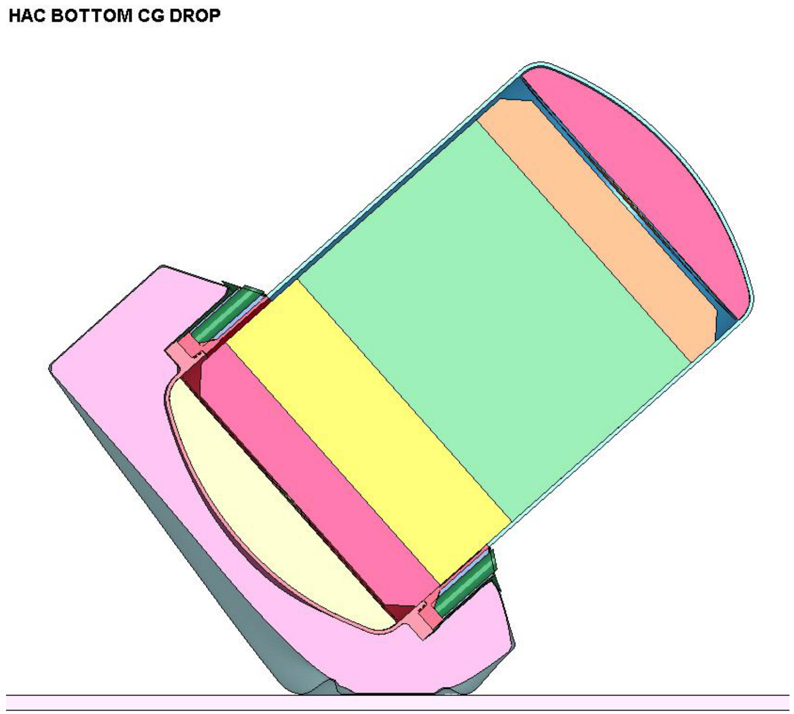
- LS-Dyna model of free drop and puncture
- Used rigid representation of contents (some cases included deformable ends)
- Model now being finalized
- Preliminary structural results
  - Bottom end drop, payload impact <200g (package <300g; difference due to honeycomb)
  - Side drop (simultaneous or slapdown), impact <150g
  - No significant change in containment O-ring compression

AREVA

Preliminary Analysis Results

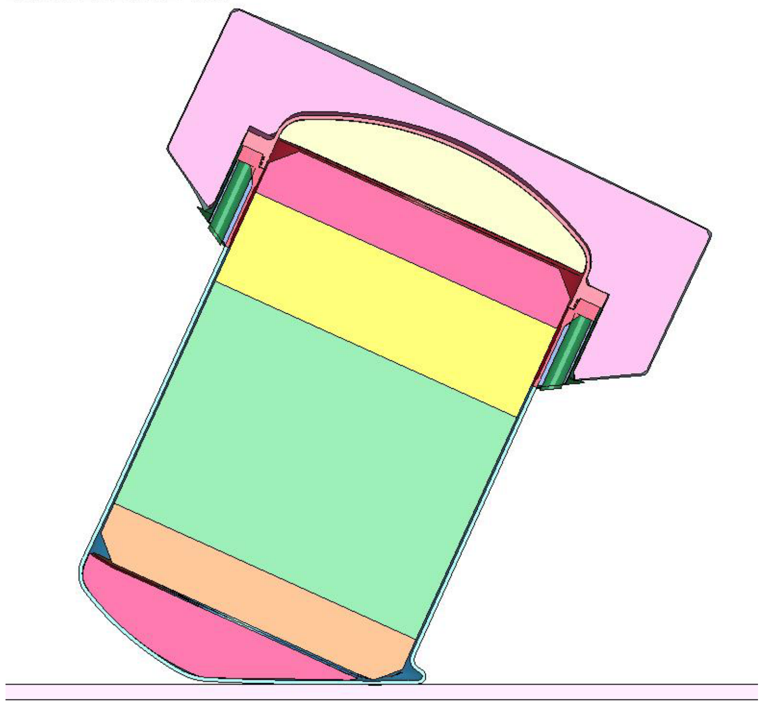


Slapdown, knuckle primary

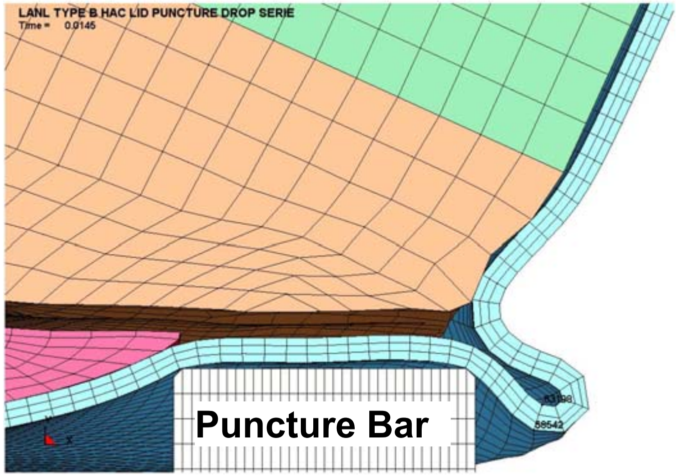


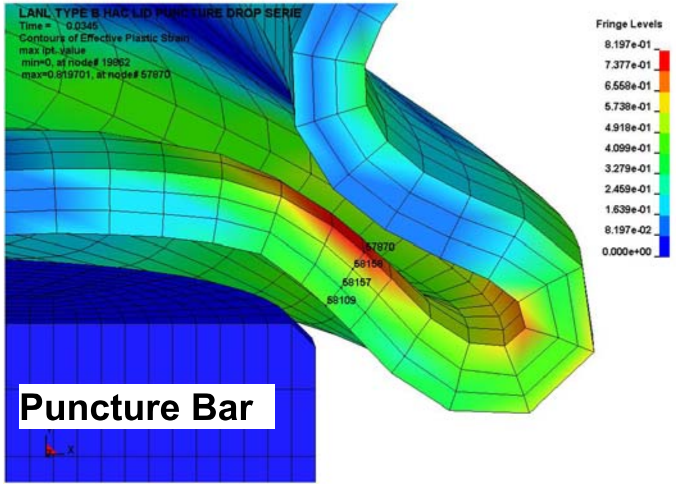
CG over lower corner

Preliminary Analysis Results



CG over top knuckle



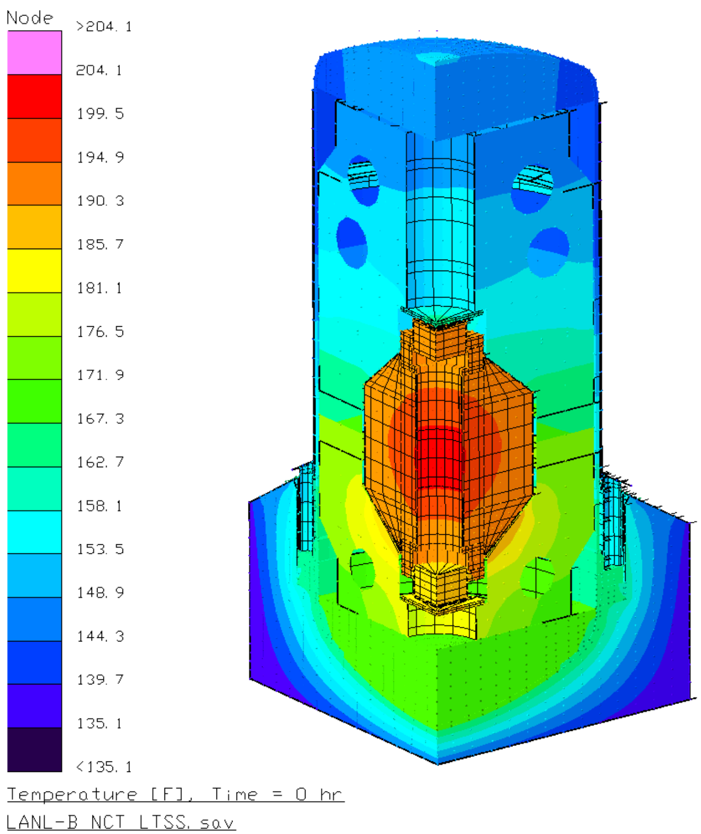


Max true strain ~80% (austenitics capable of ~100%)

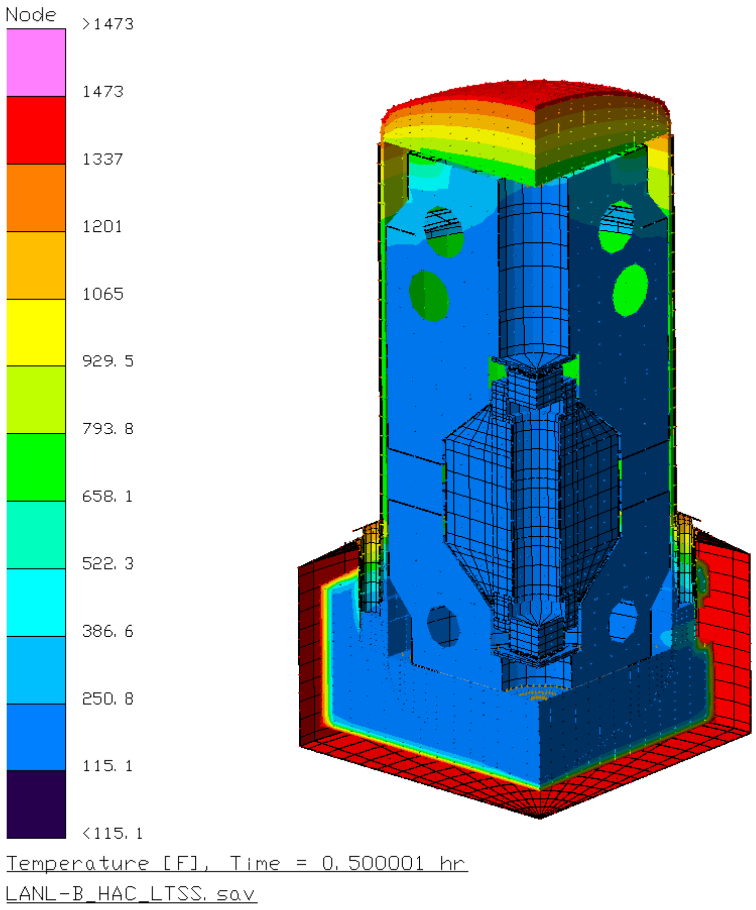
Preliminary Analysis Results

- **Preliminary thermal results**
  - **NCT hot with solar, containment elastomer seal temperature ~165 ºF (Long term limit is 250 ºF)**
  - **HAC maximum seal temperature (~1.2 hrs after fire start) ~300 ºF (Elastomer material tests leak tight after 8 hours at 400 ºF)**
  - **HAC maximum lead temperature (inside LTSS) <200 ºF (Lead melts at 620 ºF)**
  - **HAC result includes conservatively estimated free drop and puncture damage on the impact limiter**

Preliminary Analysis Results



NCT Hot with Solar



HAC with Drop & Puncture Damage

NRC Staff Comments & Suggestions

AREVA

Project Schedule

- Full scale certification tests – March 2011
- Licensing application submittal – May 2011
- RAIs – by approx. November 2011
- CoC – by approx. March 2012

AREVA