Transport of Shielded Devices in the LANL-B Type B Package

AREVA Federal Services LLC

under contract to

Los Alamos National Security, LLC

March 31, 2011

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Introductions

- **AREVA Federal Services LLC (AFS)**
  - Ron Burnham, LANL-B Project Manager
  - Phil Noss, Licensing Manager
  - Rick Migliore, Shielding Engineer
- **Global Threat Reduction Initiative (GTRI, NA-21, NNSA)**
  - Ioanna Iliopulos, Director North and South America Threat Reduction
  - Pete Tensmeyer, Deputy Director North and South America Threat Reduction
  - Abigail Cuthbertson, Federal Project Manager, OSRP
  - John Zarling, Staff, NNSA
  - Darcy Campbell, Staff, NNSA
- **Los Alamos National Laboratory (LANL OSRP)**
  - Julia Whitworth, OSRP Program Manager
  - Dwaine Brown, Staff Lead for Type B Container Development
  - Mike Pearson, Senior Technical Advisor
  - Randolph B. Vaughn, Project Manager for Type B Container Development

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Meeting Objectives

- Brief Review of the LANL-B Packaging
- Review of Shielded Device Payloads
- Description of Shielding Analysis Performed
- Discussion of Proposal for Certifying the LANL-B for Transport of Shielded Devices
- NRC Staff feedback

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LANL-B Packaging - General

- **The LANL-B will be used to safely transport the IAEA's Long Term Storage Shield (LTSS) or shielded devices containing sources**
- **Sources are primarily gamma- or beta-producing**
  - **Shielded devices include only Co-60 and Cs-137**
  - **LTSS may house these or other gamma or beta producing sources, or very small neutron sources**
- **Category I packaging provides leaktight containment**
- **LTSS or shielded device provides all shielding**

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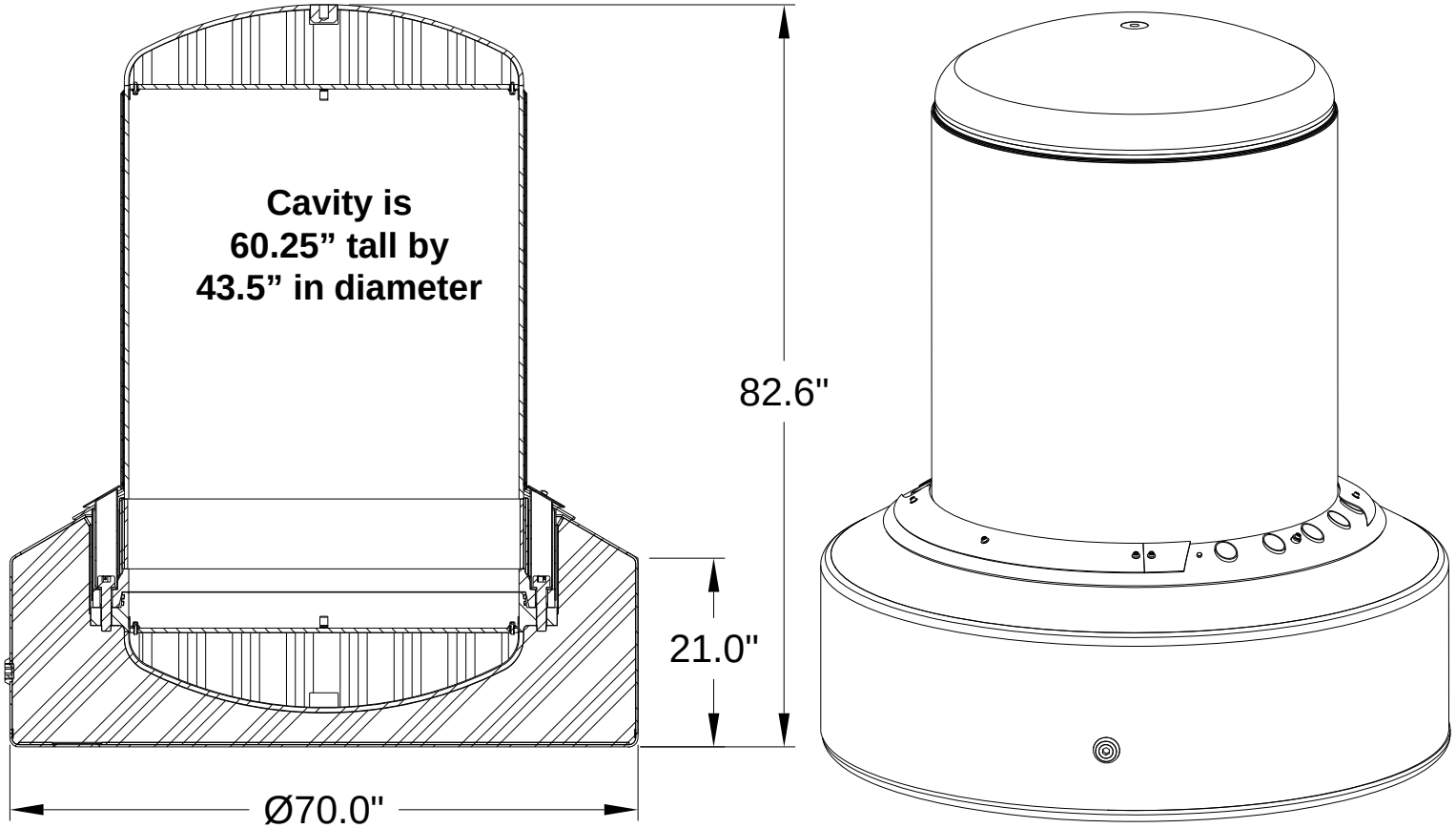
LANL-B Packaging Description



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**
- **10,000 lb licensed maximum weight; approx. 4,870 lb empty**
- **Two payload types**
  - **Long Term Storage Shield (LTSS), a lead shield developed by IAEA**
  - **Intact devices (i.e., teletherapy heads or industrial irradiators) containing their sources ('shielded devices')**

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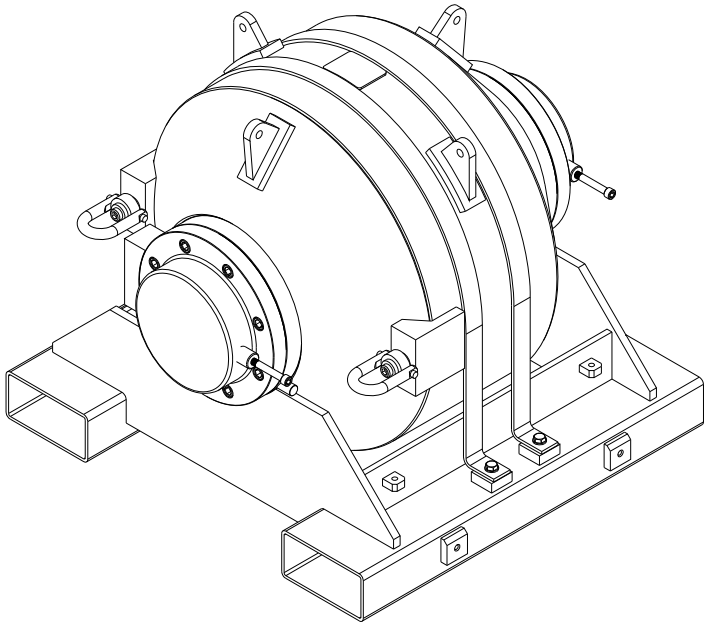
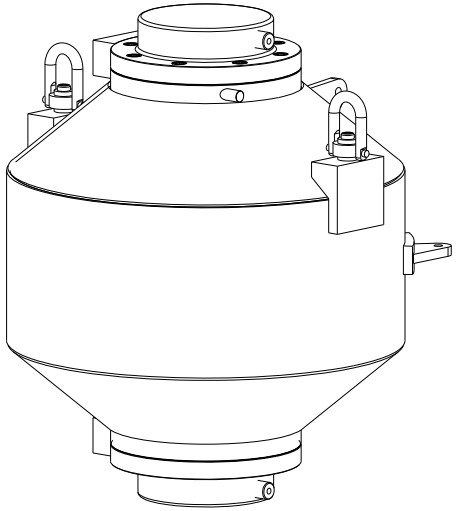
Payloads

- **LTSS**



AS STORED



AS TRANSPORTED

Payloads

- **LTSS**
  - **Base is removed for transport**
  - **Weight bounded by 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**

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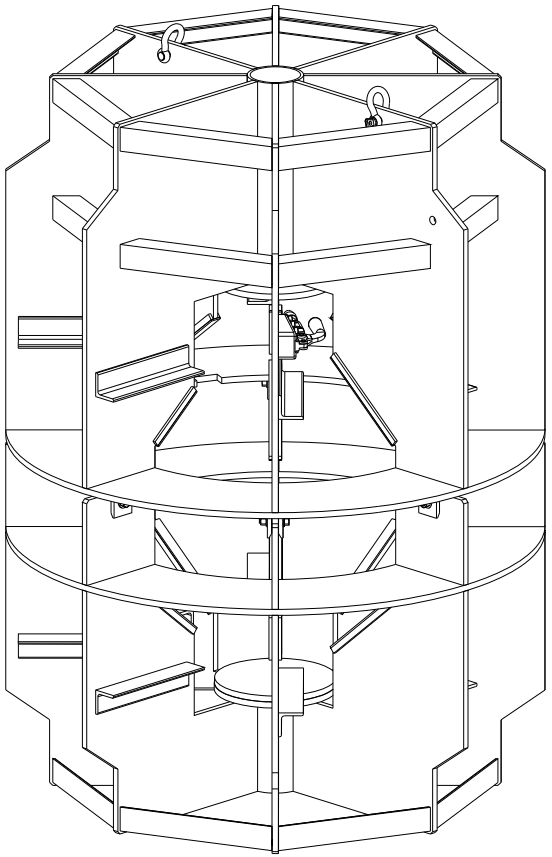
Payloads

- **LTSS lodgment**
- **Aluminum weldment with upper and lower halves joined by bolts or pins**
- **Secures LTSS for transport**
- **Max. loaded weight: 5,130 lb**



Payloads

- **Shielded devices**
  - **Medical or industrial irradiators**
  - **All devices are in the Sealed Source Device Registry (SSDR)**
  - **Maximum weight of 3,500 lb**
  - **Isotopes only Cs-137 or Co-60**
  - **A fixed maximum activity is established for each design**
  - **Shielding is primarily lead, sometimes with DU or tungsten**
  - **Engineered to safely contain sources in a human environment (treatment room, laboratory)**
  - **External radiation on device meets transportation requirements for non-exclusive use (200 mrem/hr surface, TI = 10)**
  - **Carried within package in the Inner Container (IC)**

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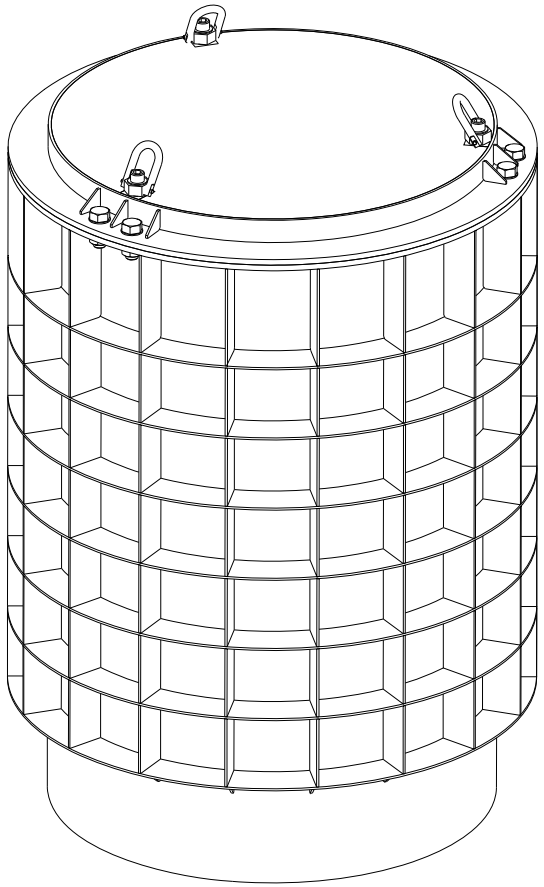
Payloads

- Inner Container (IC)
- Type 304 SS reinforced shell weldment with bolted lid
- Inner cavity is 36” dia by 53” long
- Secures device for transport using blocking and bracing
- Max. loaded weight: 5,130 lb



Payloads

Payloads

- Three different device configurations:
  - Fixed source
  - Telescoping source
  - Rotating source
- Categorized into approx. 11 Groups by source design, isotope, and manufacturer
- Examples:
  - Group 1: MDS Nordion, Gammator and Gammacell irradiators
  - Group 3: Best Theratronics, GC-40 irradiator
  - Group 8: Picker, teletherapy heads (various models)

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Shielding Analysis

- To support licensing, shielding analyses of a representative device model from Group 1 and Group 3 have been performed
  - Models for analysis chosen to illustrate procedure for two different device configurations, fixed and telescoping
- Group 1: MDS Nordion Gammacell 3000
  - Fixed source, 3,246 Ci of Cs-137
- Group 3: Best Theratronics GC 40
  - Telescoping source, 2,250 Ci of Cs-137
- Since design drawings are not generally available, shielding analysis information was taken from de-sourced specimens by sectioning
- Analysis sequence: Section – Measure – Sketch – Model – Result

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Shielding Analysis

Gammacell 3000

Security-Related Information
Withhold under 10 CFR 2.390

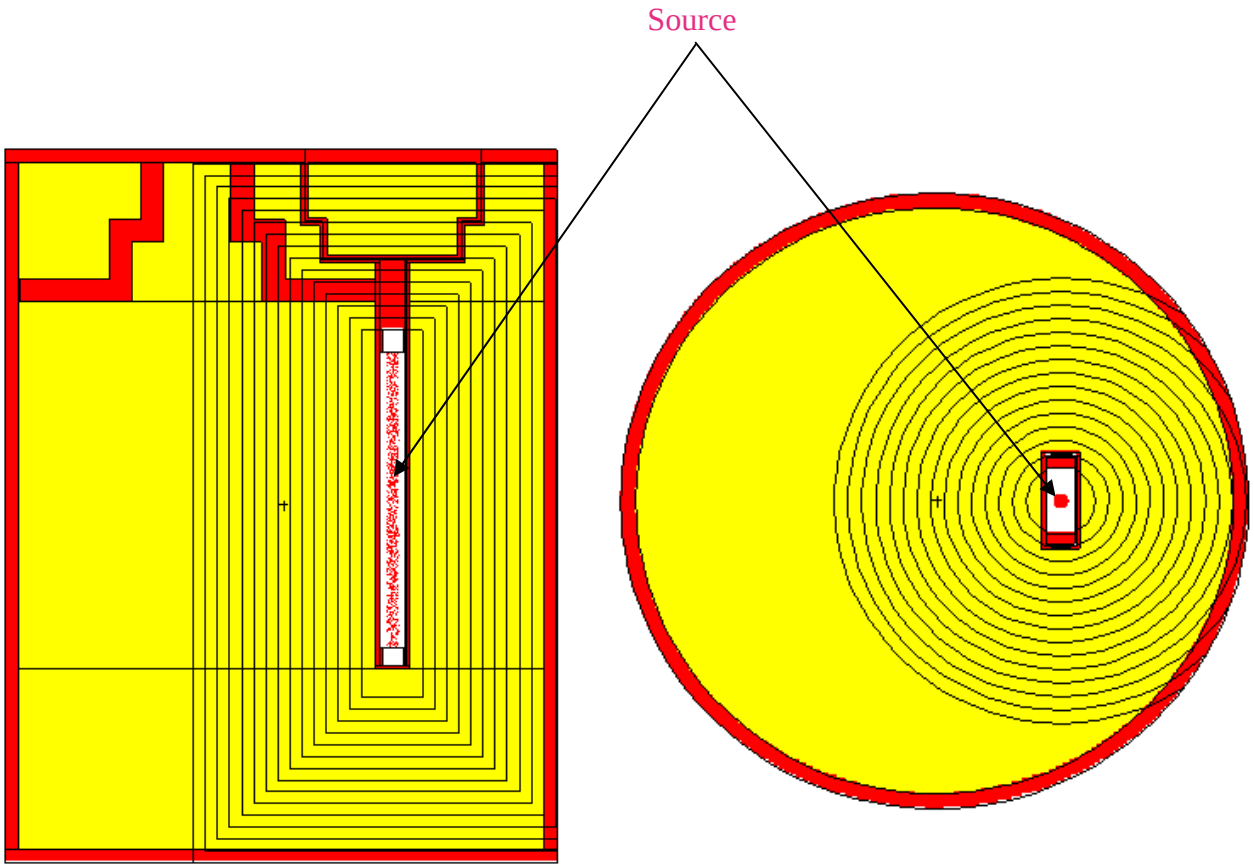
Shielding Analysis

Gammacell 3000

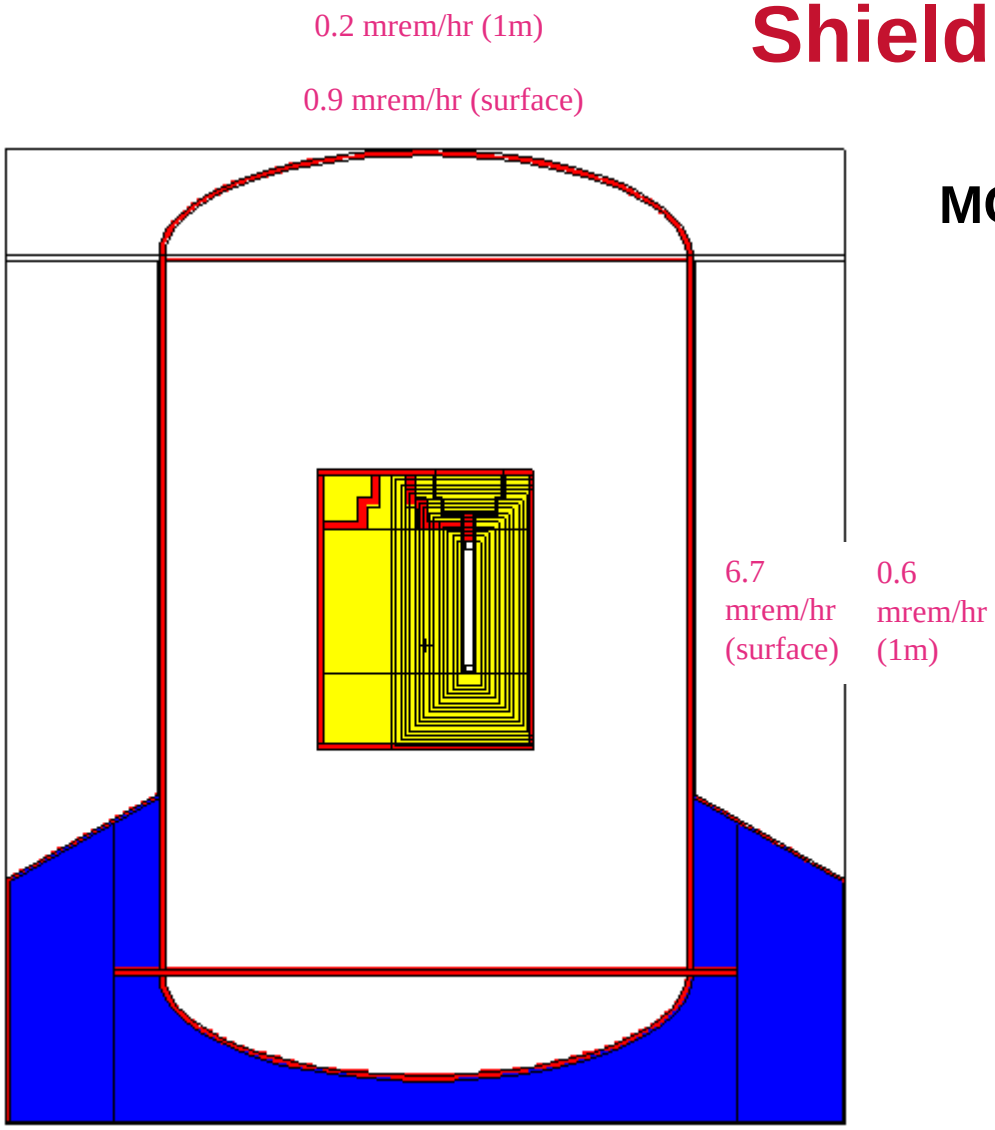
Security-Related Information
Withhold under 10 CFR 2.390

Shielding Analysis

MCNP Model - Detail



Shielding Analysis



MCNP Model – Including Packaging

Shielding Analysis

- **Gammacell 3000 governing dose rate 1 m from package surface is 0.6 mrem/hr, << NCT non-exclusive use limit of 10 mrem/hr**
- **To explore sensitivity, 2 cm (0.79”) of lead was removed from model all around source, simulating a measurement error or lead gap**
- **Result: dose rate increases to 6.1 mrem/hr – still acceptable**
- **Demonstrates that egregious measurement errors or large voids (nearly 1”, or 18% of total minimum thickness) will not cause dose to exceed NCT limits**

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Shielding Analysis

GC-40

Security-Related Information
Withhold under 10 CFR 2.390

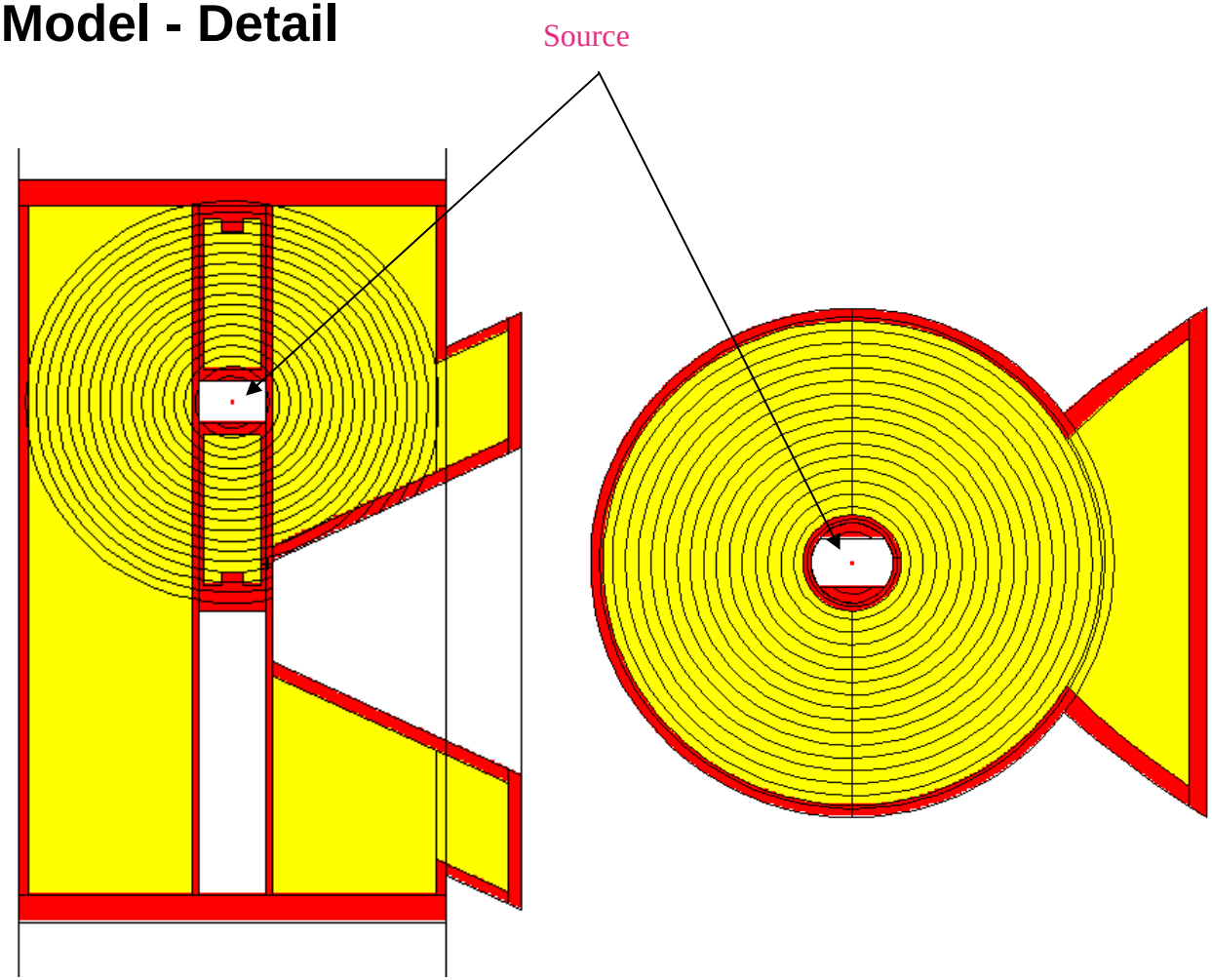
Shielding Analysis

GC-40

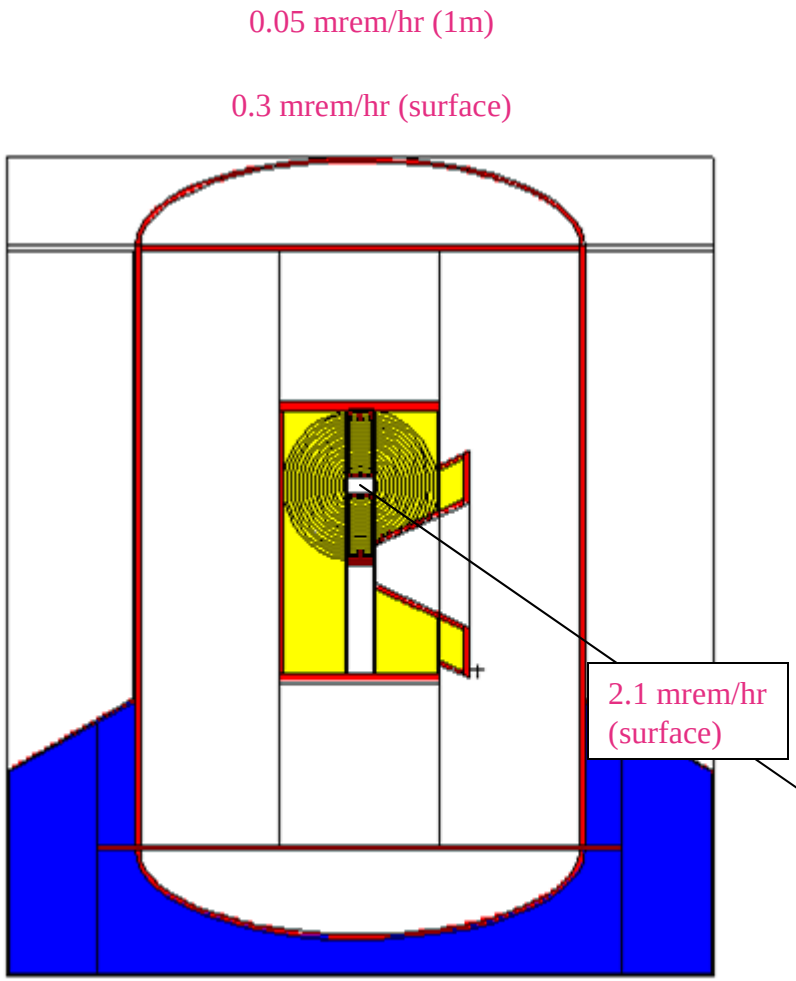
Security-Related Information
Withhold under 10 CFR 2.390

Shielding Analysis

MCNP Model - Detail



Shielding Analysis



MCNP Model – Including Packaging

GC-40 governing Dose Rate: 0.1 mrem/hr

Shielding Analysis

- **Shielding analysis result summary:**
  - **Gammacell 3000 maximum dose rates: 6.7 mrem/hr surface, 0.6 mrem/hr at one meter (TI = 0.6)**
  - **GC 40 maximum dose rates: 2.1 mrem/hr surface, 0.1 mrem/hr at one meter (TI = 0.1)**
- **Dose rates governed by the TI, which is very low (recall these devices are engineered for stationary use in a human environment)**
- **Because devices are grouped by isotope and general design configuration, other devices in the group will have similarly low dose rates with large margins of safety**
- **Source decay has been conservatively neglected (significant for Co-60 sources)**

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Source Position Integrity

- **To take advantage of the integral shielding, the sources must be maintained in the fully shielded position**
- **Manual calculations performed to ensure that structure which maintains position is adequate for HAC impact loads**

Source Position Integrity – Gammacell 3000

- **Shield plug retains the source holder**
- **Shield plug is welded to the outer steel shell**
- **To expose the source, the shield plug weld must fail**

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Source Position Integrity – Gammacell 3000

- Calculate adequacy of weld knowing the weight of the plug, the bounding HAC impact, the diameter of the circular weld
- The weld penetration is not generally known. However, using:
  - Plug + holder + source weight = 40 lb (bounding value)
  - Weld diameter of 5.75 inches (measured)
  - Maximum impact of 200g (from test or analysis)
  - Weld stress allowable for austenic stainless steel (shell material)
- Result: required depth of weld penetration = 0.024 inches
- 0.024 inches << than minimum penetration in 0.44 inch-thick base metal
- Therefore, Group 1 sources are secure

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Source Position Integrity – GC 40

- Source is in drawer
- Drawer is positioned by shipping tube
- Movement blocked by shipping retainer at each end
- Shipping retainer is massive steel plate attached by four bolts

Source Position Integrity – GC 40

- To expose the source, all four bolts must fail
- Calculate adequacy of bolts knowing the weight of the components, the bounding HAC impact, the size of the bolts
  - Drawer + shipping tube + one retainer plate = 50 lb (bounding value)
  - Bolts are 3/8-16 UNC (measured)
  - Maximum impact of 200g (from test or analysis)
  - Assume bolt ultimate strength of 60 ksi (weakest commercial bolt)
- Result: bolt stress of 32.3 ksi, much less than conservative allowable stress
- Therefore, Group 3 sources are secure

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Safety Analysis Report

- **Transport of devices will be implemented in the SAR via the following key items:**
- **Acceptable devices for transport will be listed in Chapter 1 by Group no., model name, source isotope, maximum activity, and weight**
  - **Maximum device weight: 3,500 lb**
  - **Maximum loaded IC weight: 5,150 lb (same as LTSS + lodgment)**
- **Chapter 1 will also define the acceptable configuration**
  - **Unnecessary hardware and protrusions will be removed**
- **Chapter 2 will include a safety analysis of the source immobilization load path for each Group**
- **Certification testing will include the IC and a conservative representation of a device (simulated device)**

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Safety Analysis Report

- **Chapter 5 will include a shielding analysis of one model from each Group**
  - **Use measurements taken from a sectioned specimen as shown above**
- **Chapter 7 will define pre-loading inspections: each device will:**
  - **Receive a comrehensive gamma scan. Criteria: 200 mR/hr surf., TI=10**
  - **Receive a careful inspection for physical integrity and integrity of source immobilization per written procedure**
- **Chapter 7 will include a sketch showing configuration of blocking/bracing for each model**
  - **Blocking/bracing expected to be primarily wood/plywood, assembled with bolts/screws/nails, per written procedure**
- **Comprehensive gamma scan of package prior to shipment**

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Safety Analysis Report

- **Initial submittal to include:**
  - **Group 1 (represented by Gammacell 3000)**
  - **Group 3 (represented by GC 40)**
  - **LTSS**

NRC Staff Comments & Suggestions

Project Schedule

- **Full scale certification tests – 10/10/11**
  - **NRC invited to send staff to test – site is TBD**
- **Licensing application submittal – 5/1/12**
- **RAIs – by approx. 11/1/12**
- **CoC – by approx. 3/1/13**