

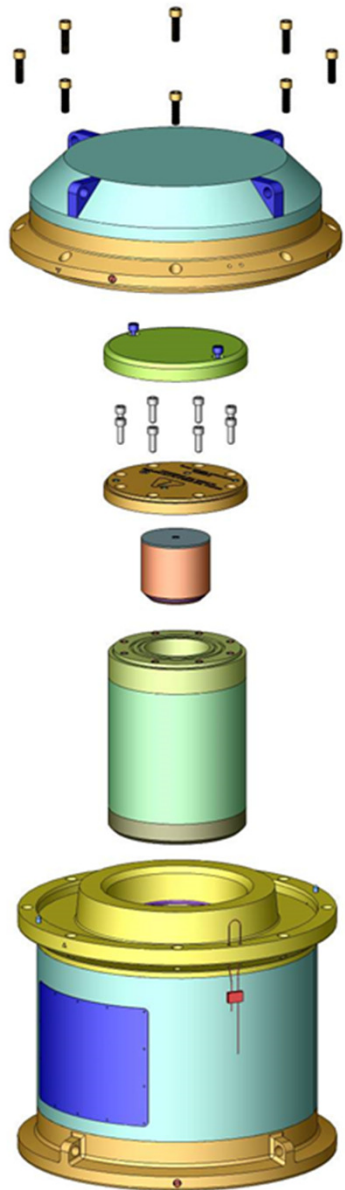


MIDUS License Amendment Request Pre-Submittal Meeting

December 10, 2015
NRC Headquarters
Rockville, MD

- Nature of the request
- Comparison of current and proposed contents
- Summary of SAR changes
- Closing discussion

MIDUS Background



- Design initiated July, 2005
- Customer was Mallinckrodt (Netherlands)
- Confirmatory drop/fire testing completed September, 2006
- SAR submitted November, 2006
- CoC granted May, 2007
- Units 1-30 delivered, Aug-Dec 2007



- Purpose is to accommodate NorthStar Mo-99 shipments.
 - New solid contents
 - Change to depleted uranium (DU) specification
- Existing authorized content is a Mo-99 solution.
 - 4,400 Ci Mo-99, 60 Ci/ml
 - 0 to 150 ml product volume
 - Steel product vessel with polymeric dunnage
- Proposed additional content is solid Mo-99 target material.
 - No changes to activity or specific activity specification
 - Solid volume is not a safety parameter
 - Solid Mo-99 targets in sealed aluminum casings
 - Aluminum casings in polymeric carriers
- DU specification change due to material availability

Contents Comparison - Specifications

| Item | Existing CoC | Proposed Change | Safety Impact |
|-------------------|--|---|--|
| Form | Molybdenum-99 with its daughter products as sodium molybdate (NaNO_3 1M / NaOH 0.2M) in liquid form | Add solid irradiated target material as additional authorized form. | Increases safety margin because solid form does not liberate hydrogen. |
| Amount | 4,400 Ci molybdenum-99 | No change | N/A |
| Specific Activity | The maximum specific activity is 60 Ci/ml Mo-99 | No change | N/A |
| Volume | The product volume may vary from 0 to 150 ml. | Change to "...liquid product volume..." | None- volume of solid payload does not affect safety because solid form does not generate gas. |

Contents Comparison – Design Issues

| Design Challenge | MIDUS Mitigating Feature | Solid Source Impact |
|--|---|--|
| Package internal pressure, combustible gas limit | Liquid payload gas generation based on actual test data. Payload volume and activity limited to assure pressure within Type B(U) limit. | Increases safety margin because solid form does not liberate hydrogen. |
| Source migration | Liquid payload assumed to wick up and around the shield plug in HAC. Extra DU shield plate added for additional shielding in HAC. | Increases safety margin because solid source has same specific activity limit, and is much less likely to migrate. |
| Shielding design | Shielding analyzed for fluids in any orientation (NCT), plus capillary flow in HAC. | Solid sources are bounded by existing analyses, NCT & HAC. |
| Thermal design | Thermal analysis performed for 4,400 Ci heat load. | No impact because the activity limit is unchanged. |
| Containment | Packaging is designed to leaktight criterion | No impact because the criterion is unchanged. |
| Structural | MIDUS evaluated for 1.1 Kg payload. | No impact because the mass is unchanged |
| Materials | Liquid payload and product container were evaluated for chemical and galvanic reaction potential. | Proposed materials are compatible with MIDUS. Dry payload minimizes chem/galv reactions. |

- DU Charpy V-notch acceptance criteria reduced from 10 ft-lb to 7 ft-lb at 70°F
 - DU manufacturer advised that 10 ft-lb at 70°F is no longer achievable (Safkeg-HS)
- Change does not alter MIDUS safety evaluation
 - Flaw in DU exceeding critical flaw size not likely
 - Maximum SI in DU $< 40\% S_y$ for HAC free drops $\rightarrow a = 17$ mm
 - SER concludes DU is acceptable based on critical flaw size of 2.64 mm (based on yield?)
 - Reasonable assurance that package meets 71.51(a)(2)
 - In unlikely event that DU does fracture in an accident, dose rates would not exceed regulatory limit (1 rem/hr at 1 meter)
 - Space between DU shield and steel shells is small \rightarrow small streaming gaps

- Chapter 1 – General Information
 - Revise contents description (§1.2.2.1) for solid Mo-99 targets.
 - Revise description of “payload internals (§1.2.2.2) to generically encompass either the product bottle for liquids or the target disk capsule/carrier for solid payloads. Remove or revise Figure 1-1.
 - SAR Drawings
 - TYC01-1601, General Arrangement Dwg
 - Revise notes 2-5 for added contents
 - Remove or revise Detail 1 (payload)
 - Make nameplate company/address data generic

- Chapter 2 – Structural Evaluation
 - No impact to safety analyses
 - Change references to Charpy V-notch test criteria
 - General revision where necessary for solid payload
- Chapter 3 – Thermal Evaluation
 - No impact to safety analyses (liquid payload is bounding due to gas generation)
 - General revision where necessary for solid payload
- Chapter 4 – Containment
 - No impact to safety analyses
 - General revision where necessary for solid payload

- Chapter 5 – Shielding Evaluation
 - No impact to safety analyses
 - General revision where necessary for solid payload (analysis for liquid payload is bounding due geometry).
- Chapter 6 – Criticality Evaluation (*N/A: non-fissile*)
- Chapter 7 – Package Operations
 - General revision where necessary for solid payload
- Chapter 8 – Acceptance Tests and Maintenance Program
 - No changes anticipated

- Conclusion
 - Need for Amendment
 - Safety Impact of Added Contents
- Schedule
 - Intend to begin fabrication before CoC amendment issued
 - Notification per 71.93(c)? (not 1st packaging under CoC)
- Concluding Discussion