Criticality Safety Analyses for Revision 5 of the 9977 SARP

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The 9977 Shipping Package

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- Single Unit Analysis
- Normal Condition of Transport Arrays
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The 9975 Shipping Package

![Diagram of the 9975 Shipping Package](image)

- Ceramic
- Min-K®
- 5/8-inch Drum Flange Bolt (x6)
- Ceramic Vermiculite TR-19® Block
- Fiberfrax® Insulation
- Drum Rim with TID and Drain and Tie-Down Holes
- 6-inch ID Containment Vessel
- Top Load Distribution Fixture
- General Plastics FR-3716 Polyurethane Foam
- Caplug®
- 35-Gallon SS Drum
- Bottom Load Distribution Fixture
- Sanitary Drum Bottom with Wear Ring
## Contents Currently Approved For Shipment

<table>
<thead>
<tr>
<th>Content Envelope</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>77C.1</td>
<td>Heat Sources</td>
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<tr>
<td>77C.2</td>
<td>Np Pieces and Spheres</td>
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<td>77C.5</td>
<td>Pu/U Metal</td>
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<td>77C.6</td>
<td>Pu/U Metal</td>
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<td>77C.7</td>
<td>Pu/U Metal in 6CV</td>
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<td>77C.8</td>
<td>U Metal - 100% 235U</td>
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<tr>
<td>77C.9</td>
<td>U Metal - 95% 235U</td>
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<td>77C.13</td>
<td>LANL OSRP</td>
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<td>77C.14</td>
<td>INL AGR Fuel Compact</td>
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<td>77C.15</td>
<td>Training Sources</td>
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<td>77C.18</td>
<td>Dual Container Pu Oxide</td>
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<td>WRM Sources</td>
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<td>77C.22</td>
<td>ZPPR Plates</td>
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<td>77C.23</td>
<td>Dual 3013 Pu Metal</td>
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## Contents Included in SARP Revision 5

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<tr>
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<td>BeRP Ball</td>
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<td>77C.14</td>
<td>INL AGR Fuel Compact</td>
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<td>77C.16</td>
<td>Pu/U Metal – dose bounding</td>
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<td>77C.17</td>
<td>Pu/U Oxide – dose bounding</td>
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<td>77C.20</td>
<td>RSTD – U-Al Alloy</td>
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Single Unit Analysis

- A single 9977 package was modeled and surrounded by 30 cm of water on all sides
- The contents of the package are analyzed with and without the 3013
- The sphere of the fissile material was modeled placed in the radial center and elevated within the aluminum plug and sleeve positioned in the CV
- The radius of the fissile sphere and its vertical center are varied based on the selection of Pu or U as metal
- Some metal cases considered the presence of 100 g polyethylene as a spherical shell around the fissile material
- Additional calculations were performed flooding the CV, foam, vermiculite, Fiberfrax®, and the Min-K® 2000, such that all non-metal regions of the package are replaced with water.
- Replace all metal outside the CV with water (CV Only cases)
- All SP cases reflected by 30 cm of water on all sides
Single Unit Analysis

Intact Single Unit

CV Only Single Unit
Normal Condition of Transport Arrays

- Infinite, triangular pitched, array of packages
- Single 9977 package inside tight-fitting hexagonal prism with mirror boundary conditions
- Same configuration as the intact SP model
- Void between packages
- Infinite array of undamaged drums
Normal Condition of Transport Arrays
Hypothetical Accident Conditions Arrays

- The HAC modelling starts with an infinite hexagonal (triangular pitched) array of damaged 9977 packages
- Each package contained a plutonium sphere, located at the bottom of the plug and sleeve, in the CV
- The reduced package dimensions used bound the maximum dents and bulges observed in localized areas on any of the packages following the completion of all accident testing
- To address the impacts of insulation damage during a fire some cases modeled the insulation replaced by void or water
Hypothetical Accident Conditions Arrays

• Several variations of the base case were modeled to examine: effects of
  – 3013 container or SAVY Container
  – location of fissile material within the CV
  – polyethylene material

• HAC models satisfy the prescribed requirements of 10 CFR 71.55.

• CV is modeled as dry based on test results that the CV tested leak tight before and after the immersion test

• Insulation conditions were studied by modeling water in the insulation regions of the package
Hypothetical Accident Conditions Arrays

6 x 6 x3 Array Section view
Hypothetical Accident Conditions Arrays

6 x 6 3 3 Array Plan View
Questions