Decommissioning and Radwaste Transportation

EESI Congressional Briefing
Rm 2318 Rayburn Bldg
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Cs-137 Quantity as Hiroshima Release

<table>
<thead>
<tr>
<th>PWR</th>
<th>High Burnup (60 GWd/MTU)</th>
<th>Medium Burnup (40 GWd/MTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 PWR cask</td>
<td>662</td>
<td>445</td>
</tr>
<tr>
<td>37 PWR cask</td>
<td>1020</td>
<td>686</td>
</tr>
</tbody>
</table>

Hiroshima Cs-137 release: 89 teraBq, 2405 Ci
Empty Canister Installed in HI-TRAC
LOWER THE CANISTER INTO CONCRETE CASK
Figure II.10: HI-STORM Lifted from the top using the Vertical Cask Crawler
Figure II.9: Cooling by Natural Convection in the HI-STORM 100S
CT Yankee Dry Storage
San Onofre NUHOMS
San Onofre Dry Storage Cask System
## Irradiation/Storage Conditions for PWR Fuel

<table>
<thead>
<tr>
<th>Category</th>
<th>Reactor</th>
<th>Pool</th>
<th>Dry Strge</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID Clad T</td>
<td>340-370</td>
<td>30-60</td>
<td>360</td>
</tr>
<tr>
<td>Water T</td>
<td>300-330</td>
<td>20-50</td>
<td></td>
</tr>
<tr>
<td>In Rod Pressure</td>
<td>38-150</td>
<td>38-150</td>
<td></td>
</tr>
<tr>
<td>Coolant Pressure</td>
<td>140-160</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
Nuclear Power Plants in the United States

- Nuclear units with operating licenses
- Nuclear units with construction permits
Representative Transportation Routes

This map depicts the state-specific impacts (number of casks) and route maps evaluated in the 2008 U.S. Department of Energy (DOE) Final Supplemental Environmental Impact Statement for Yucca Mountain (DOE/EIS-0250-F), Appendix G, Section G.10.

The number in each state shows the combined rail and truck high-level nuclear waste cask shipments that DOE estimated would traverse each state en route to Yucca Mountain.
Transportation System (2008 SEIS)

- 21,909 rail casks (about 6,700 trains) & 5,025 truck casks [p.8-41]
- Average 1-3 trains (3-5 casks per train) & 1-2 trucks (1 cask per truck) per week for 50 years
- Every day, for 50 years, one or more loaded casks on rail or road, from 76 shipping sites to a single national repository or storage site
TRANSPORTATION ISSUES

• NRC hypothetical accident conditions (impact, fire)
• Cask tested by computer simulation, not physical
• Changed rail conditions (tank cars from North Dakota vs. oil pipeline)
• DOE EIS (size cask: 21 vs. 37 PWR fuel assemblies)
• Rail preferred, but Indian Point, CT Yankee, Yankee Rowe and others may require heavy haul transport or barge
Regulatory Drop Test

- Drop height: 30 ft
- Impact speed: 30 mph
- Unyielding surface
Potential Side Impact

30 mph

Bridge abutment
Seals Damage in Fire

No Impact Limiter

Fire $T = 1000^\circ C$

t = 24 min
for seal failure
The train rolled downhill for seven miles (11km) before derailing at Lac-Megantic.
## Flame Temperatures

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Flame Temperature (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>2160-7072</td>
</tr>
<tr>
<td>Diesel</td>
<td>1740-1839</td>
</tr>
<tr>
<td>Propane</td>
<td>2242-6487</td>
</tr>
<tr>
<td>Vinyl Chloride</td>
<td>2552-11,142</td>
</tr>
</tbody>
</table>
Cesium in Gap

Study Cs in Gap
Modal 0.3%
Gray 9.9%
High Burnup Fuel

- Previously, every year 1/3 reactor core removed. Fuel burnup to 35 GWd/MTU
- More recently, fuel in reactor longer, now up to 72 GWd/MTU.
- For fission products like Cs-137 and Sr-90, transportation cask inventory is proportional, 72/35 = 2.06
- While buildup of fission products is roughly proportional to burnup, buildup of higher actinides like Pu, Am and Cm is greater. The subsequent decay of Pu-241 (14 yr half-life) with beta emission leads to buildup of Am-241 (432 year half-life) which has an alpha decay, accounting for greater heat production up to year 70 after fuel removal, then decline. This is not taken into account by the NRC.
Figure 5-1. The time variation of $^{241}\text{Pu}$ and $^{241}\text{Am}$ over a 200 year time span.
• This increased heat production means cask must remain at reactor longer before shipping, at least 40 years (if CoC remains the same).

• In 2008 FSEIS for Yucca Mountain, cask contained 21 PWR fuel assemblies. Now Holtec’s HI-STAR 190 contains 37 PWR fuel assemblies. With HBF, the new inventory of Cs-137 and Sr-90 can be 3.63 as much. This is important for accident analysis.

• Cladding can be more brittle and 15% thinner. Vibrations on rail may cause major degradation.