The Transport of 'Spent Fuel' Samples

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World Nuclear Transport Institute

- Established in 1998
- Founder members Areva, FEPC Japan, BNFL
- 46 Members - drawn from all sectors of the radioactive transport industry
- Several members involved in transport of SF, HLW, and Storage Technology
Unique Issues for Transport

- Public Domain
- Uncontrolled environment
- Multi-modal
- International
- Multi-agency, multi-regulator
Basis for Transport

- Transport must be safe, secure and cost effective

- Safety is vested in the Package
  - risk based packaging approach
  - high hazards are protected with ‘accident proof’ packaging
  - excellent safety record
  - no reported transport accidents resulting in serious radiological consequences
Safety Principles

Safety Principles for radioactive transport;

- Flask 'contents' drives the safety approach.
  - Accurate radionuclide inventory,
  - Heat generation, radiation protection, leaktightness, chemical form

- Regulations provide controls for
  - Activity, criticality, shielding and heat.
  - Withstanding normal transport
  - Safely withstanding 'credible' accident scenarios.
Packaging options for 'spent fuel samples'  

Transport controls apply hazard values to each nuclide - A2 Values

- Unirradiated uranium has < 1 A2
- Typically 'spent fuel' has a relatively high hazard (100's, 1000's of A2's)
- Package types suitable for 'irradiated' spent fuel are limited to
  - Type B(M)F
  - Type B(U)F
  - Type CF
- Fissile criteria will apply if there is >15g of fissile nuclides.
# Comparing the Package Types

<table>
<thead>
<tr>
<th>Package Type / Criteria</th>
<th>Type B(M)F</th>
<th>Type B(U)F</th>
<th>Type CF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mode of transport</strong></td>
<td>All</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>Road, Rail, Sea &amp; Air</td>
<td>With restrictions for air</td>
<td>With restrictions for air</td>
<td>All</td>
</tr>
<tr>
<td><strong>Hazard Rating</strong></td>
<td>Unlimited subject to safety case</td>
<td>Unlimited subject to safety case</td>
<td>Unlimited subject to safety case</td>
</tr>
<tr>
<td>(No's of A2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Air Restrictions</strong></td>
<td>&lt; 3000 A2</td>
<td>&lt; 3000 A2</td>
<td>No Limit</td>
</tr>
<tr>
<td></td>
<td>&lt; 3000 A1</td>
<td>&lt; 3000 A1</td>
<td></td>
</tr>
<tr>
<td><strong>Type of Approval</strong></td>
<td>Multilateral</td>
<td>Multilateral (unless fissile excepted)</td>
<td>Multilateral (unless fissile excepted)</td>
</tr>
<tr>
<td><strong>Testing</strong></td>
<td>Standard Accident</td>
<td>Standard Accident</td>
<td>Enhanced Accident</td>
</tr>
<tr>
<td><strong>Testing - Approx Cost</strong></td>
<td>High 10's to 100's of thousands of euros</td>
<td>High 10's to 100's of thousands of euros</td>
<td>Very High 100's to 1000's of thousands of euros</td>
</tr>
<tr>
<td><strong>Testing Experience</strong></td>
<td>High</td>
<td>High</td>
<td>Very Low</td>
</tr>
<tr>
<td><strong>Project Risk</strong></td>
<td>Low-Medium</td>
<td>Low-Medium</td>
<td>Medium to High</td>
</tr>
</tbody>
</table>
## Differences 'Bulk' vs 'Samples'

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Spent Fuel (Bulk)</th>
<th>Spent Fuel (Samples)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volume</strong></td>
<td>High</td>
<td>Very Low</td>
</tr>
<tr>
<td><strong>Frequency basis</strong></td>
<td>Campaign</td>
<td>Sporadic</td>
</tr>
<tr>
<td><strong>Contract</strong></td>
<td>Higher value contract</td>
<td>Lower value contract</td>
</tr>
<tr>
<td><strong>Dedicated flasks</strong></td>
<td>Fleet of flasks</td>
<td>Ad-hoc arrangements</td>
</tr>
<tr>
<td><strong>Dedicated infrastructure</strong></td>
<td>Dedicated</td>
<td>Hire, as required</td>
</tr>
<tr>
<td><strong>Risk of denial</strong></td>
<td>Very Low</td>
<td>Medium to high</td>
</tr>
<tr>
<td><strong>Mode preference</strong></td>
<td>Road rail and sea</td>
<td>Air?</td>
</tr>
</tbody>
</table>
Transport Challenges

In order of difficulty (easiest first):

- Irradiated/MOX samples upto 3000 A2 in a Type B flask, all modes.
- May require a dedicated new 'Type B' flask design, INF 1 vessel for sea transport

- Irradiated/MOX samples >3000 A2 by road rail & sea
  May require a dedicated new 'Type B' flask design, INF 1 vessel for sea transport

- Irradiated/MOX samples >3000 A1/A2 by all modes
- Requires a new 'Type C' flask design
Denial Issues

- Transport routes are 'strategic' and 'closely guarded'.
- Routes are very fragile and easily lost.
- Radioactives may be seen as an 'unattractive business proposition' particularly for low volumes and limited shipments.
- Many airlines opt out. Many shippers opt out!
- 'Captain' has the ultimate authority to carry or not.
Other Issues

- Securing reliable transport partners will help avoid 'denial and delay'
- Security considerations
- Safeguard considerations
- 'Transfrontier shipment of radioactive waste and spent fuel' directive
Key Objectives for me!

To better understand the problem!

- How many 'Hot Labs'? 10-15
- How many transports? 2 per lab
- Geographical locations, modes of transport required?
- Quantity of samples?
- What is the budget for a 'small inexpensive flask'?
- No's of A2's or A1's in the samples?
- Other uses for the flask design?
- Interface issues?
Thankyou