Transport Considerations for SMR Fuel Cycle and TNPPs

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Nuclear Transport Overview

- Transport connects the nuclear fuel cycle
- Transport faces distinct challenges to that of a site
- Case by case approach is often necessary accounting for:
  - Safety
  - Security
UK Overview

• Approval of 1 new reactor per year until 2030

• UK SMR expected early 2030s

<table>
<thead>
<tr>
<th>Power Output (MWe)</th>
<th>470</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Type</td>
<td>UO2 pellet</td>
</tr>
<tr>
<td>Fuel Enrichment</td>
<td>4.95% (max)</td>
</tr>
<tr>
<td>Refuelling Cycle (months)</td>
<td>18-24</td>
</tr>
</tbody>
</table>

• Potentially more licensed sites across UK (UK SMR looking to deploy on previously licensed sites)
International insight from SMR fuel data...

- **Energy Well**
  - UO2 Triso (15%)
  - Spent fuel transported loaded in reactor container

- **ELENA**
  - UO2 (15.2%) / MOX
  - Transported loaded with fuel

- **MicroURANUS**
  - UO2 (12%)
  - Transported encapsulated with spent fuel after lifecycle

- **eVinci**
  - UO2 Triso (up to 19.75%)
  - Module transported loaded with fuel

*land based*
Safety Approach - SMR Applicability

Assess the contents of SMR Spent Fuel i.e. <5% enriched UO₂, TRISO, HALEU etc.

Using the IAEA SSR-6 Regulations determine the type of package required, i.e. Type B package

Determine if a new package or repurposing of an existing package is required. This package requires a Package Design Safety Report (PDSR)

Package Design Safety Report (PDSR)

Licensing
Design and Analysis
Shielding
Criticality
Transport Security Approach - SMR Applicability

• Categorise material (type, form and quantity) adopt the Graded Approach.

• Sabotage considerations (especially for back-end)

• Incorporate Design Basis Threat (DBT) / Threat Assessment

• Implement Defence in Depth

• Remote transport and siting:

  ![Diagram showing Deter, Detect, Delay, Respond stages with: Delay Time > Response Time]
Transport Gaps

• Transport safety substantiation of fuel characteristics:
  - SSR-6 Normal Conditions of Transport
  - Accident Conditions of Transport

• Data availability
  - Package Design Safety Report requirements
  - Package availability unknown

• Inherent security characteristics? **Theft** vs **Sabotage**
  - How recoverable is the fissile material within the fuel type?
  - How attractive is this material to a malicious actor?
  - Potential to cause URCs?
  - How dispersible is this material?
Transportable Nuclear Power Plants (TNPPs)

<table>
<thead>
<tr>
<th>Safety</th>
<th>Security</th>
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</thead>
<tbody>
<tr>
<td>Applicability of safety assurances designed in module (+25yr lifecycle)</td>
<td>Fissile content i.e. categorisation, drives security requirement</td>
</tr>
<tr>
<td>Assurances of subcriticality safety features in transport</td>
<td>Sabotage vulnerability (use of Vital Area Identification (VAI) analysis for transport)</td>
</tr>
<tr>
<td>Testing against Accident Conditions of Transport (ACTs) – SSR 6</td>
<td>International transports will need appropriate security handovers</td>
</tr>
<tr>
<td>Regulatory changes over the core lifecycle</td>
<td></td>
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<tr>
<td>Type R licensing for land transport?</td>
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</table>
Thank you.

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