Test series objective

We know much through testing and analyses about how spent fuel packages respond to external loadings. We don’t have much data regarding how the spent fuel itself responds to external loadings.

Data will be gathered in order to estimate loadings on spent fuel during normal conditions of transport (NCT).

This data can then be used with SNF material property data to estimate the integrity of SNF during NCT.
A little history: The Surrogate PWR Assembly Test Series

2013 SNL Shaker
- Truck NCT vibration and shock
- Only Vertical accelerations
- Greater than 3.5 Hz
- Lead Rope only

2014 Over-The-Road Truck
- Over-the-road truck test
- All acceleration directions
- All Hz
- Lead Rope only

2015 Multi-Axis Shaker for Truck and Rail
- Multi-axis (6)
- Truck NCT vibration and shock
- Rail NCT vibration and shock
- All Hz
- Lead Rope, Lead Pellets, and Mo Pellets

However,
these tests...
...are only simulations of the real conditions during actual UNF transport operations:
So, we are planning a more realistic full-scale test

- Equipos Nucleares (ENSA) will provide an ENUN 32P dual purpose rail cask, basket, and cradle
  - The ENUN 32P is similar to an existing NRC-licensed cask currently in use in the USA

- Testing and analysis to be conducted by DOE laboratories, in cooperation with ENSA and ENRESA, and Korea’s KORAD and KAERI:
  - 3 surrogate PWR assemblies: SNL, ENRESA, KORAD (KNF)
  - Remaining 31 basket cells to be populated with surrogate concrete assemblies to properly represent the mass of a fully loaded basket
  - Individual assembly rods will be instrumented with accelerometers and strain gages

- These tests are significantly different than the previous tests:
  - instrumented surrogate assemblies will be...
    - within a rail-cask basket...
    - within a rail dual-purpose cask which will be transported on...
      1. a heavy-haul truck, then
      2. two different ships, and then
      3. a railcar
    - various lifting operations to simulate cask transfer conditions
  - All tests will be conducted under NCT conditions

Routing of the Test

1. Heavy-haul truck from within Spain.
2. Coastal sea shipment from Santander to a large northern European port.
3. Ocean transport from Europe to an eastern U.S. port (e.g., Baltimore).
4. Commercial rail shipment from East Coast to Pueblo.
5. Testing at the Transportation Technology Center, Inc.
6. Return trip to ENSA will be the same.

Data will be collected throughout all legs of the transport (with the exception of the ocean part of the return trip) as well as the transfers between legs.
20 Batteries (1.5 tons), 2 Data Acquisition Systems, and lots of cable

It’s all about the power!

Box for batteries and data acquisition system to sit behind the cask.
Cable Connection Box for 80 Instrumentation Channels

**Tentative Instrumentation Plan:**

<table>
<thead>
<tr>
<th>Surrogate Assemblies</th>
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<tbody>
<tr>
<td>Sandia: 18 strain gages</td>
<td>6 accelerometers</td>
</tr>
<tr>
<td>ENRESA: 18 strain gages</td>
<td>6 accelerometers</td>
</tr>
<tr>
<td>Korea: 1 strain gage (3) tri-axial accel</td>
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<table>
<thead>
<tr>
<th>Cask basket/cradle/platform</th>
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<tbody>
<tr>
<td>Basket: 3 accelerometers</td>
<td></td>
</tr>
<tr>
<td>Cask: 6 accelerometers</td>
<td></td>
</tr>
<tr>
<td>Cradle: 8 accelerometers</td>
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<tr>
<td>Skid: 7 accelerometers</td>
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</table>

<table>
<thead>
<tr>
<th>Data Acquisition System</th>
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<tbody>
<tr>
<td>Trigger: 2 channels</td>
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<tr>
<td>GPS: 2 channels</td>
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</tbody>
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**Tamper-proof hardware**
2017 Schedule

- Heavy haul truck tests in Spain; May-June
- Ocean transport, Spain-Belgium-US; June-July
- Rail transport, Baltimore-Pueblo, Co.; July-August
- Rail testing @ TTCI in Pueblo, Co.; August-Sept
- Return cask to Spain; Sept-Oct

- Data analysis will be initiated immediately
  - ENSA raw data will be proprietary
  - Results of data reduction and subsequent analyses, plus DOE raw data, will be open