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30 cm Drop Test

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Purpose

- Complete the NCT mechanical testing environment
  - 10CFR71.71 (c)(5) Vibration normally incident to transportation (done during MMTT)
  - 10CFR71.71 (c)(7) Free drop of 0.3 meters onto a flat essentially unyielding horizontal surface

- Hypothesis: handling incidents will not fail spent fuel rods

- Hypothesis: the transfer function from the cask through the basket to the fuel is the same for more severe impacts as was measured for shocks in the over-the-rail tests
Proposed Test (Part 1: Cask Drop)

- Drop test of the 1/3-scale ENSA ENUN-32P (the same cask design used in the over-the-rail tests) at BAM

- 1/3-scaled cask includes scaled impact limiters, cask body, and basket

- 1/3-scaled cask does not include scaled fuel assemblies, but mass mock-ups of the fuel

- Measure accelerations on the cask body, the basket, and the fuel mock-ups
Proposed Test (Part 2: Drop Assembly)
Strains in the fuel cladding

- 1/3-scale drop test will not provide cladding strains.

- This can be obtained by dropping an instrumented full-scale assembly onto programming material to provide the same shock pulse as the mock fuel assemblies experienced in the 1/3-scale cask drop test.

- Test would be performed at Sandia.

- Instrumentation the same as on the MMTT.
Test did not include accelerometers on the basket or mass-mock fuel assemblies
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30 cm Drop Test Acceleration Pulse Results

Filtered (300 Hz) Average Acceleration Pulse and Accelerations from High-Speed Video Analysis

~30-35g
Max acceleration on the cask
~ 1.3 g

Max full-scale acceleration on the cask in the 30 cm drop test
~ 10-12g
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Coupling Impact at 8mph
We learned how energy moves through the system

Coupling_Impact 08/24/2017
SRS

Platform
Assembly
Basket
Cask

May 23, 2018 Presentation or Meeting Title
For exact geometric scale models there is a clear relationship between scale model results and full-scale results.

Accelerations in the scale model are higher by the inverse of the scale factor.

Stresses and strains are the same in the scale model and prototype (but we do not have a scale model fuel assembly).

Time is shorter by the scale factor.
  - This means that strain rates are higher in the scale model
Vertical Drop Test: Rigid Body Impact Response

Specimen after 9.3 m vertical impact ...

Prototype

Model
9.3 m Vertical Drop Test: Results of the Comparison in Regard to Scaling Law

Rigid body impact response of the scaled model

- Maximum translation $\uparrow +9\%$
- Impact duration $\uparrow +24\%$
- Maximum and average deceleration $\downarrow -17\%$

The scaled model tends to represent the impact of the prototype model as softer.

Structural impact response of scaled model

- Cask body axial strain $\downarrow -26\%$
- Primary lid bending strain $\downarrow -80\%$
- Primary lid bolt axial strain $\downarrow -94\%$

The scaled model undervalues the response of the prototype.
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Why are there differences?

- Impact limiter material grain size is not scaled.

- Scale model should be tested in a scaled acceleration field.

- Compressed time in the scale model means that timing of secondary impacts is incorrect (the larger the gaps in the model, the more significant this difference is).
BAM has demonstrated the validity of scale-model testing for this type of environment.

We are familiar with this cask and can compare results from these tests to both the earlier certification drop tests as well as the MMTT.

We can revisit the need for the assembly drop test after the cask drop test is completed.
It is important because

- These tests will provide data to show that spent fuel does not fail during a handling accident.

- This allows operators to open a package after a handling accident without the use of a hot cell.

- The test will also provide data to compare with the modeling effort.