U.S. DEPARTMENT OF ENERGY

Integrated Waste Management
Office of Spent Fuel and Waste Disposition
Nuclear Energy

Long Term Storage and Transportation Issues

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Disclaimer

This is a technical presentation that does not take into account contractual limitations under the Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste (10 CFR Part 961). Under the provisions of the Standard Contract, DOE does not consider spent fuel in multi-assembly canisters to be an acceptable waste form, absent a mutually agreed to contract amendment.

This presentation reflects research and development efforts to explore technical concepts which could support future decision making by DOE. No inferences should be drawn from this presentation regarding future actions by DOE.

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Long Term and Transportation Gap Analyses

- **Initial Long Term Storage and Transportation Gap Analysis in 2012**
  - 26 High and Medium gaps
- **Long Term Storage and Transportation Gap Analysis Research and Development Review and Plan in 2014**
- **Updated Long Term Storage and Transportation Gap Analysis – 2018**
  - 14 High and Medium gaps
- **High priority gaps in six major areas**
  - Thermal Profiles – Predict accurate and realistic temperatures
  - Stress Profiles – Determine external loads from normal cask handling, drops, seismic events, cask tipover, normal transportation
  - Drying Issues – Determine amount, form, location of water remaining in canisters after drying
  - External Monitoring – Remote inspection of welded canisters
  - Atmospheric Corrosion of Welded Canisters – Chloride induced stress corrosion cracking of canisters in marine or near-marine environments
  - Hydride Reorientation and Embrittlement
- **Research and development activities and funding concentrated in these areas**
  - The highest priority R&D task is to complete the loading of the Research Project Cask, collect the temperature data during drying and initial heat up, and collect the gas samples to help determine if water vapor is present after drying.

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Thermal Profiles Activities

- Perform a pre-loading thermal analysis of the Research Project Cask
- Complete the BWR Dry Cask Simulator experimental work
- Perform Round Robin Thermal Analyses
  - Phase I modeling of aboveground configuration of the BWR Dry Cask Simulator
  - Phase IIa calculations of decay heat using multiple methodologies
  - Phase IIb thermal analysis of the Research Project Cask using the as loaded configuration and actual ambient conditions
  - Phase IIc sensitivity studies on mesh size variability and Grid Convergence Index
  - Phase IId generic model of the Research Project Cask
  - Planning for Phase III internal convection experiments and modeling
- Update UNF-ST&DARDS as new data is available

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Stress Profiles Activities

- Complete the ENSA/DOE multi-modal transportation test and analyze data
  - Perform follow-up tests as necessary
- Continue modeling of external loads and effects on structures, systems, and components (SSCs) during normal conditions, off-normal conditions, and design basis accidents (DBAs) for extended storage
- Begin development of cumulative effects models for each SSC

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Drying Issues Activities

- Complete *Experimental Determination and Modeling of Used Fuel Drying by Vacuum and Gas Circulation for Dry Cask Storage* Integrated Research Project (IRP) and analyze data together with gas samples from the Research Project Cask
  - If warranted, begin planning for larger-scale drying tests

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Monitoring – External Activities

- While this is a High rank and has a high priority, DOE will not be funding work because of the large investment in Nuclear Energy University Programs/Integrated Research Project (NEUP/IRP) and the large body of work being performed by EPRI/industry.

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Welded Canister – Atmospheric Corrosion Activities

- Continue gathering data on environmental conditions to determine when chloride induced SCC may initiate
- Continue performing tests under relevant conditions to determine SCC initiation and crack propagation rates
- Initiate studies for how to detect potential gas or particulate release from a through-wall SCC
- Initiate studies for repair and mitigation techniques to address degradation of stainless steel canisters

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Hydride Reorientation and Embrittlement Activities

- Complete non-destructive examinations on the sister rods
- Obtain EOL rod internal pressure (RIP) on select sister rods
- Begin destructive examinations of sister rods to establish the baseline properties to compare against rods when the Research Project Cask is opened
- Begin testing (ring compression test – RCT, cyclic integrated reversible bending fatigue test – CIRFT, and materials properties) as part of the integrated approach for closing cladding gaps