Development of a Risk Framework for Spent Fuel Dry Storage

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Overview

- Background
- Scope and Implementation Plan
- Defense in Depth
- Consideration of Field Experience
- Preliminary Framework
- Metrics
- Conclusions
- Q&A

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Background

Agency activities and stakeholder interactions prompted Spent Fuel Management to evaluate risk-informing its regulatory activities.

- **SECY-13-0132**, "U.S. Nuclear Regulatory Commission Staff Recommendation for the Disposition of Recommendation 1 of the Near-Term Task Force Report," 2013.
- **NUREG-2150**, "A Proposed Risk Management Regulatory Framework", 2012.
- **NUREG/CR-7016**, "Human Reliability Analysis-Informed Insights on Cask Drops," 2012.
- **NEI PRM 72-7**, "Spent Fuel Cask Certificate of Compliance Format and Content," 2012.
- **Risk-Informed Decision making for Nuclear Material and Waste Applications**, (NMSS) Rev. 1, 2008.
- **EPRI-100969**, "Probabilistic Risk Assessment (PRA) of Bolted Storage Casks", 2004.
- **NUREG-1864**, "A Pilot Probabilistic Risk Assessment of a Dry Cask Storage System At a Nuclear Power Plant," June 2007.

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Scope and Implementation

- Focused on storage at this time
- Literature search of available information
- Defined defense in depth
- Developing metrics
- Developing the framework
- Pilot
- Finalizing the framework and incorporating training

Will be asking for stakeholder Input (Developing metrics, Developing the framework, Pilot)

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Definition of DiD

Defense-in-depth (DiD) for interim dry storage consists of element(s) within multiple, independent layers of defense to achieve the three principle functions of a DCSS.

Three Safety Functions:
- Maintain Sub-Criticality
- Prevent Radiation Exposure from Exceeding Regulatory Limits
- Prevent Release of Radioactive Materials from Exceeding Regulatory Limits

Three Layers of Defense:
- Engineered Controls
- Programmatic Controls
- Mitigating Controls

Three Phases of Operation:
- Loading and Transfer
- Storage
- Transfer and Unloading

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Maintaining Sub-Criticality During Storage

DiD Level 1 Engineered Controls		DiD Level 2 Programmatic Controls		Did Level 3 Mitigating Controls	
Element	Description	Element	Description	Element	Description
Confinement boundary	Prevents Moderator intrusion	Monitoring And Maintenance	Active Pressure Monitoring Systems	Replace the seal	Unload the cask into the spent fuel pool and Replace the seal
			Visual Inspections and corrective action programs	Restore confinement	Repackaging assemblies or confinement
			Aging Management Programs		

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Possible Risk Assessment Approach

- Operational Phase [Storage]
  - Safety Function [Confinement]
    - Layer of Defense [Engineered]
      - Element [Primary Confinement]
        - Sub-element [Lid-to-Shell Weld]
          - Data

1) Expert Opinion
2) Operating Experience
3) PRAs/HRAs

Failure Mechanism	Failure Frequency	Failure Detection	Consequence	Risk
Delayed Hydrogen Cracking	Low	High	Low	Low

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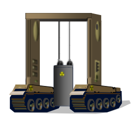
Operating Experience

- Lid-to-shell closure welds
- Mis-loaded fuel assemblies
- Wrong backfilling gas
- Crane operations
- Potential for materials degradation



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Possible Risk Assessment Approach

- System Vendor [NuWaste Inc.]
- System Name [NuStor-100]
- System Type [Canister]
- System Orientation [Vertical]
- Confinement Material [Carbon Steel]
- System Elevation [Above Ground]
- Sub-element [Lid-to-Shell Weld]

1) Expert Opinion
2) Operating Experience
3) PRAs/HRAs

Failure Mechanism	Failure Frequency	Failure Detection	Consequence	Risk
Delayed Hydrogen Cracking	Low	High	Low	Low

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Possible Risk Assessment Approach

1) Qualitative / Semi-Quantitative
2) Flexible to incorporate quantitative data as our knowledge base grows.

Question: Can user group data inform the risk assessment approach?

May need specific quantitative analyses:
1) Stress Corrosion Cracking
2) Canister Examination Frequencies
3) Risk of Unloading a Canister

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Metrics

Pilot PRA's, EPRI-1009691 and NUREG-1864, predict an extremely low risk of latent cancer fatalities to the public.

The PRA's assumed:
1) Fabricated and loaded as described in the SAR
2) No materials degradation

What are appropriate metrics?
1) Latent cancer fatalities
2) Probability of canister breach
3) Other possibilities…

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Consequences of a Dry Storage Cask Drop (Supplemental Analysis in NUREG-2161)

Metric	Consequence
Early fatalities	0
Risk of LCF to an individual within 10 miles	$7.5x10^{-8}$ to $7.1x10^{-5}$
Collective dose within 50 miles in Person-Sv	0.6 to 780
Interdicted land (square miles)	<< 1 to 24
Condemned land (square miles)	<< 1

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Conclusions

Spent Fuel Management is following its implementation plan:

- ✓ Literature search of available information
- ✓ Defined defense in depth
- Developing metrics } In Progress
- Developing the framework } In Progress
- Pilot
- Finalizing the framework and incorporating training

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