

# EXTENDED STORAGE & **BEYOND**

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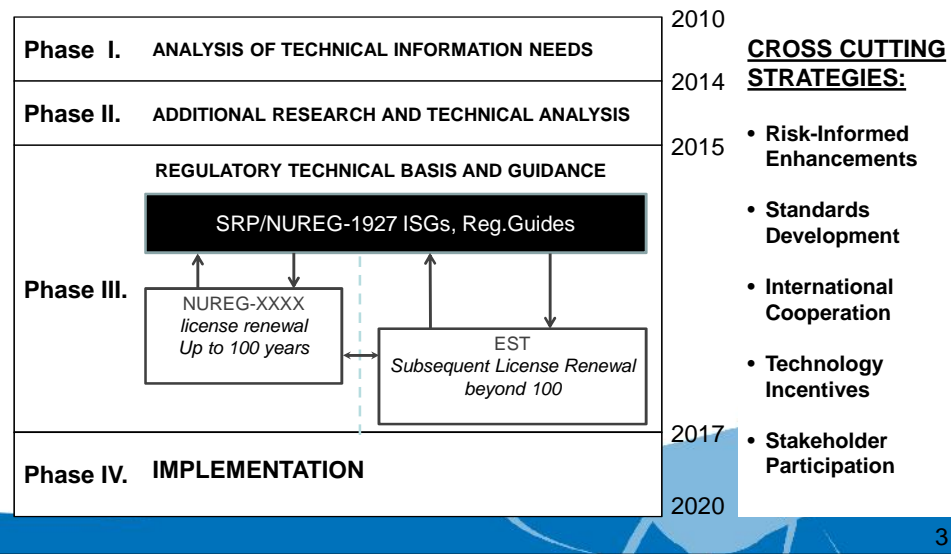
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# OVERVIEW



## EST Regulatory Program Review



# NMSS RESEARCH



## Road Map

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
<i>Regulatory Activity</i>											
Fatigue testing at ORNL											Cladding Integrity
Consequence Analysis											
Cladding Stress Analysis											Criticality Safety
DWR Burnup Credit											
Scale beyond design basis accidents											Beyond Design Basis
Review of CFD methods											Peak Cladding Temperature
Fluent CFD code validation											
Concrete Degradation (H)											Cask system component integrity
Long term functional monitoring											
Aging Management Program											
Thermal Analysis for Horizontal Cask											
Thermal Analysis for Vertical Cask										Pending DOE	

## PAST EFFORTS



### Analysis of Technical Information Needs

- PRIORITY 1

- Degradation mechanisms

- Stress corrosion cracking of SS canister body and welds
    - Cladding Stress due to fuel pellets swelling and gas release

- Crosscutting areas

- Thermal calculations
    - Effects of residual moisture after normal drying
    - In-service monitoring methods for dry storage systems

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## PAST EFFORTS *(Continued)*



### Analysis of Technical Information Needs *(Continued)*

- PRIORITY 2

- Propagation of existing flaws in cladding
  - Wet corrosion, SCC, and metal fatigue of fuel assembly hardware
  - Structural and Thermal Fatigue, and Aging Effects
    - Cladding, Neutron absorbers, Fuel Basket
  - Low temperature creep and galvanic corrosion of cladding
  - Microbiologically induced corrosion
  - Concrete degradation

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## PAST EFFORTS *(Continued)*



### Work Completed

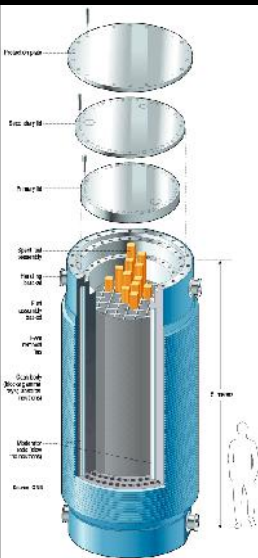
- Stress corrosion cracking analysis
  - NDE on atmospheric SCC, *(PNNL-22495, ML13276A196)*
  - SCC on chloride and non-chloride atmosphere *(NUREG/CR-7171, ML14051A417)*
- Potential residual moisture after vacuum drying
  - Evaluation of drying adequacy, *(ML13169A039)*
  - Factors that could affect the quantity of residual water, *(ML13192A125)*
  - Potential test plan, *(ML13192A127)*
- Analysis on Technical Information Needs *(ML14043A402)*
- Horizontal DCSS Thermal Analysis *(NUREG/CR-7191)*

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## ONGOING ACTIVITIES



### Vertical DCSS Thermal Analysis



#### MOTIVATION

- Flow pattern varies between the vertical and the horizontal cask
- Conduction and radiation inside the canister are the predominant heat transfer modes
- Convection and radiation are the predominant heat transfer modes at the outside wall of the dry casks system
- DOE-Demo will provide measured data to validate the 3D-CFD analysis

Illustration: Steve Stankiewicz  
<http://spectrum.ieee.org/energy/nuclear/canned-heat>

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## ONGOING ACTIVITIES *(Continued)*



### In-service Monitoring and Cladding Stress Analyses

- Literature review of in service monitoring for
  - temperature and relative humidity
  - chloride concentration and microbial activity
  - internal pressure
  - materials degradation inside and outside the system
- Cladding Stress Analyses
  - FRAPCON-SFMOD, modified to predict up to 300 years
  - Fuel swelling & decay gas production were analyzed
  - The potential for delayed hydride cracking was assessed

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## POTENTIAL NEW INITIATIVES



### Future Work

- Potential internal corrosion and long term fatigue
- Neutron absorber potential long term degradation
- Microbiological corrosion
- Effects of thermal fluctuations

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## ONGOING ACTIVITIES *(Continued)*



### Aging Management Tables

ELEMENT	DESCRIPTION
Structure, system, or component (SSC)	SSC subject to aging-related degradation
Intended safety function	(e.g., criticality control, shielding, confinement, heat transfer, structural integrity, retrievability)
Material	(e.g., stainless steel, concrete)
Environment	SSC operating environment during normal conditions (e.g., air, water)
Aging mechanism	Degradation phenomenon potentially affecting the SSC
Relevant timeframe	Judgment on whether the aging mechanism is relevant to the first 60 years of operation, or is potentially manifested

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## ONGOING ACTIVITIES *(Continued)*



### Renewal Spent Fuel Management Strategy

- Enhancement of Standard Review Process (NUREG-1927)
- Coordinated review of aging management & regulations
- Development of learning, proactive, and responsive aging management by:
  - considering operating experience in Aging Management Programs
  - incorporating results of long term confirmatory research
- Development of a storage aging management report (2015) by:
  - creating inspection guidance
  - engaging stakeholder throughout 2014-15 to discuss proposed changes

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# QUESTIONS?

