An Update on NRC Activities for Aging Management and Storage Renewals

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Storage Renewal Surge

Updated Guidance Infrastructure
Key to Managing Workload

Steady 2021-2025
Updated Storage Renewal Guidance Framework

- Operations-focused approach for renewals and aging management, that is learning, proactive, and responsive
  - Based on achievable operational methodologies
  - Condition based monitoring and/or in-service inspections (ISI) based on technically defensible criteria
  - Assessment of monitoring and ISI findings and data
  - Criteria for action (no action, repair, replace, other mitigation)
  - Aggregate, trend, and report operating experience (OpE)
  - Learning Aging Management Programs (AMPs) that consider and respond to OpE

Infrastructure for Updated Storage Renewal Guidance Framework

- TI/IP Inspections
- SRP 1927R1
- MAPS
- RG NEI 14-03
- Technical Issue Resolution
- Consensus Codes
- Storage/Reactor OpE
- SRP NUREG-1927R0
- NEI 14-03
- DOE/ANL Report

Updated Storage Renewal Guidance Framework

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Updated Storage Renewal Guidance Infrastructure Goals

- Stable, predictable, reliable, and consistent NRC reviews
- Clear, open, and transparent regulatory expectations
- Efficient review process

Infrastructure for Updated Storage Renewal Guidance Framework

- NRC guidance infrastructure development:
  - NUREG-1927, Rev. 1 (Standard Review Plan for Storage Renewals, Issued June 2016)
  - Managing Aging Processes in Storage (MAPS, under development)
  - Temporary Instruction for inspectors (under development)
  - Inspection Procedure for licensees’ aging management activities (will be developed based on Temporary Instructions)
  - Regulatory Guide that discusses guidance framework and is a vehicle for potential endorsement of industry guidance (will be developed)
Infrastructure for Updated Storage Renewal Guidance Framework (cont.)

- External stakeholder infrastructure development:
  - Consensus American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Section XI Code Case for In-Service Inspection (ISI) of dry cask storage canisters (under development)
  - Consensus American Concrete Institute (ACI) Guide for ISI of concrete storage overpacks (under development)
  - Nuclear Energy Institute (NEI) 14-03, Rev.2 “Format, Content & Implementation Guidance for Dry Cask Storage Operations-Based Aging Management” (under development)
  - Development of in-situ Non-Destructive Examination (NDE) capabilities (under development)

Managing Aging Processes in Storage (MAPS) Report

- Provide an acceptable generic approach to the identification of credible aging effects in dry storage systems and appropriate aging management activities
  - Descriptions of storage systems
  - Technical bases for determining credible aging effects
  - System-specific tables of subcomponents, their environments, and aging effects
  - Example aging management programs
- Comparable to NUREG-1801 (Generic Aging Lessons Learned Report) for the renewal of reactor licenses
- Increase efficiency by allowing the staff to focus review in areas where applicants propose an alternative approach
Managing Aging Processes in Storage (MAPS) Report (cont.)

• Path Forward for MAPS:
  – Publish draft guidance for public comment (June 2017)
  – Address public comments and finalize guidance
  – Engage ACRS on final guidance (Fall 2017)
  – Publish final guidance (December 2017)
  – Stakeholder engagement: public meetings

ASME Section XI
Code Development

• NRC requested ASME to develop consensus code case
• Leverage extensive experience to develop methodology to inspect, assess, & require corrective actions (repair, replace, and/or mitigate)
• ASME Section XI created a new Task Group on ISI of Spent Fuel Storage and Transportation Containments
  – Inaugural Meeting April 27, 2015
  – All 4 vendors participated along with licensees and DOE
• NDE ISI technical criteria, frequency, & protocol development
  – Applicable techniques
  – Qualification requirements
  – Sampling/frequency protocol
  – Demonstration methodology
• Acceptance Criteria/Aging Assessment Methodologies:
  – Flaw Evaluation procedures (CISCC)
  – General / localized / crevice corrosion assessment methodologies
Development of in-situ NDE capabilities

- EPRI initiated development of inspection system robots in 2014

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- Inspection Demonstrations
  - Palo Verde: September 2-3, 2015
  - McGuire: May 16-19, 2016
  - Maine Yankee: July 12-13, 2016

Palo Verde ISFSI Inspection Demonstration

<table>
<thead>
<tr>
<th>Date</th>
<th>Meeting</th>
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<tbody>
<tr>
<td>NAC System</td>
<td>EPRI Inspection Robot with Eddy Current Array</td>
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<td>Mockup at the Energy Education Center, Buckeye, AZ</td>
<td>EPRI Inspection Robot with Electromagnetic Acoustic Transducers (EMATs) probe</td>
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Canister Inspections

- Canister inspections (Remote Visual)
  - Calvert Cliffs NUHOMS 24P (PWR) (+Surface Samples)
  - Three Mile Island Unit 2 at INL NUHOMS 12T (PWR)
  - Palisades VSC-24 (PWR)
  - Big Rock Point EnergySolutions W74(BWR)
  - Trojan (PWR)
  - Hope Creek HI-STORM MPC-68 (BWR) (+Surface Samples)
  - Diablo Canyon HI-STORM MPC-32 (PWR) (+Surface Samples, Temp)
  - Maine Yankee NAC-UMS (PWR-GTCC) (+Surface Samples, Temp, )

- Observations from dry cask storage system inspections
  - Coating degradation
  - Concrete aging
  - Accumulated deposits
  - Corrosion products on canisters
  - Evidence of water intrusion on welded stainless steel canister surfaces

Visual Inspection

Fiber optic visual inspection equipment
Canister coating degradation at the TMI-2 fuel ISFSI
Iron contamination and water staining of canisters at the Calvert Cliffs ISFSI
Temperature Measurement and Surface Sample Collection

Fiber Optic Visual Inspection at Diablo Canyon ISFSI

Collection of surface deposits

Temperature measurements

Diablo Canyon Stainless Steel Dry Storage Canister Inspection. EPRI-3002002822, 2016.

Surface Deposit Analyses

Dry samples
- Scanning electron microscopy energy dispersive x-ray spectroscopy (SEM/EDS)
- X-ray fluorescence (XRF)
- X-ray diffraction (XRD)

Wet Analysis
- Inductively coupled plasma optical emission spectroscopy (ICP-OES): Ca$^{2+}$, Mg$^{2+}$, Na$^+$, and K$^+$
- Ion chromatography (IC): NH$_4^+$, F$^-$, Cl$^-$, Br$^-$, NO$_2^-$, NO$_3^-$, SO$_4^{2-}$, and PO$_4^{3-}$

SEM images of sea salt (intergrown NaCl cubes with interstitial Mg-SO$_4$) aggregates sample 123-012 from canister top.

Diablo Canyon Stainless Steel Dry Storage Canister Inspection. EPRI-3002002822, 2016.
Summary

• NRC’s plan for 2017:
  – Expect to receive two site-specific license renewal applications
  – Complete development of Temporary Instruction (TI) for inspectors
  – Perform initial inspections of sites with aging management programs for dry cask storage systems using TI
  – Completing storage license renewal for North Anna
  – Issue final MAPS report