


Incorporating Inspection Data and Operating Experience into Aging Management Programs


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Storage Renewals

- Site specific independent spent fuel storage installation (ISFSI) and Certificate of Compliance (CoC) renewals:
 - Surry (2/2005)
 - Fort St. Vrain (7/2011)
 - Prairie Island (in hearings)
 - NUHOMS® 72-1004 CoC (in review)
 - Oconee (5/2009)
 - Calvert Cliffs (10/2014)
 - VSC-24 CoC (in review)
- Updated storage renewal framework
- Expected renewal applications from 2015 to 2025:
 - 7 site specific ISFSIs
 - 8 CoC renewals

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Aging Management Review for ISFSI and CoC Renewals

- Identify aging mechanisms and effects that could affect the ability of the systems, structures, and components (SSCs) from performing their intended functions
- Identification of relevant aging mechanisms:
 - Review of site maintenance records
 - Lead system inspection results (NUREG-1927 Revision 1 Appendix C)
 - Maintenance and inspection records from ISFSI sites with similar SSC materials and operating environments
 - Review of industry records and operational experience
 - Applicable consensus codes and standards
 - NRC reports and generic communications

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Aging Management Activities for ISFSI and CoC Renewals



- 10 CFR 72.42(a), 72.240(c)
 - Time-Limited Aging Analysis (TLAAs) that demonstrate an important to safety structure, system, or component (SSC) will continue to perform its intended function for the period of extended operation.
 - A description of the Aging Management Program (AMP) for management of issues associated with aging that could adversely affect an important to safety SSC.

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Guidance on AMPs



- Specific activities to monitor and control the degradation of SSCs so that aging effects will not result in a loss of intended functions
- Includes all activities that are credited for managing aging mechanisms or effects for specific SSCs
- An effective AMP mitigates or detects the aging effects and includes timely corrective actions

AMP Elements

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|-----------------------------------|----------------------------|
| 1. Scope of the Program | 6. Acceptance Criteria |
| 2. Preventive Actions | 7. Corrective Actions |
| 3. Parameters Monitored/Inspected | 8. Confirmation Process |
| 4. Detection of Aging Effects | 9. Administrative Controls |
| 5. Monitoring and Trending | 10. Operating Experience |

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Storage Renewal Reviews



- Review of license renewal applications revealed additional detail needed AMPs
- Requests for additional information (RAIs)
 - Scope of program not always well defined
 - Inspection methods not qualified or demonstrated
 - Inspection methods inconsistent with acceptance criteria
 - Lack of specific information on corrective actions and extent of condition assessments
 - Relevant reactor operational experience not considered
 - Missing description of how future operational experience will be collected, evaluated and incorporated into AMPs
- NUREG-1927 Revision 1 addresses these issues

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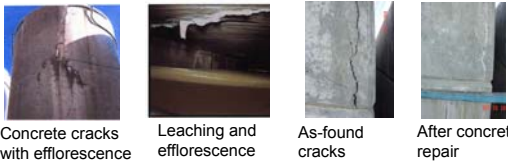
System Inspections: To Date



- Lead canister/cask and voluntary inspections to date:
 - Calvert Cliffs NUHOMS 24P (PWR)
 - Hope Creek HI-STORM MPC-68 (BWR)
 - Diablo Canyon HI-STORM MPC-32 (PWR)
 - Three Mile Island Unit 2 at INL (PWR) NUHOMS 12T
 - Palisades VSC-24 (PWR)
- Observations from dry cask storage system inspections
 - Coating degradation
 - Concrete aging
 - Evidence of water contacting the outer surfaces of welded stainless steel canisters
 - Accumulated deposits
 - Corrosion products on stainless steel canisters

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Concrete Aging Examples



- Potential aging effects
 - Cracking, loss of material (spalling and scaling), loss of strength, loss of bond, increase in porosity/permeability, distortion
- Potential mechanisms
 - Freeze-thaw, cement aggregate reactions, chemical attack, high temperature dehydration, gamma and neutron irradiation, corrosion of embedded steel, long-term settlement, leaching of $\text{Ca}(\text{OH})_2$

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Canister Observations



- Potential aging effects
 - Loss of material, cracking, loss of ductility, coating delamination
- Potential mechanisms
 - Pitting and crevice corrosion, chloride-induced stress corrosion cracking (CISCC), neutron irradiation, fatigue, microstructural alteration, thermal embrittlement

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Updating AMPs to Incorporate Operating Experience

- Future reviews of site-specific and industry-wide operating experience to:
 - Confirm the effectiveness of aging management programs
 - Develop new aging management programs
- Revise the existing AMPs as necessary to address:
 - Deficiencies of the existing AMPs
 - Create new AMPs to address emerging needs
 - Incorporate new knowledge and data from operating experience, analyses, and experiments

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Aging Management Program for Reinforced Concrete Structures

- Scope: Reinforced concrete structures
 - Above-grade and below-grade (underground) concrete areas
- Parameters Monitored/Inspected: Concrete condition
 - Cracking, material loss (spalling and scaling), loss of bond, increased porosity/permeability
- Detection of Aging Effects: Visual inspection
 - Commensurate with American Concrete Institute (ACI) 349.3R
 - Alternative inspection frequencies require a valid technical basis (i.e., engineering justification, operational experience data)
- Acceptance Criteria: Evaluation of concrete visual inspection
 - Commensurate with the 3-tier quantitative criteria in ACI 349.3R
- Corrective Actions: Repair, replace or mitigate
 - Maintain compliance with 10 CFR 72 regulatory requirements

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Aging Management Program for Welded Stainless Steel Canisters

- Scope: Welded stainless steel canisters
 - Fabrication and closure welds, heat affected zones, crevices
- Parameters Monitored/Inspected: Canister condition
 - Localized corrosion, CISCC, and atmospheric deposits
- Detection of Aging Effects: Canister inspection
 - American Society of Mechanical Engineers Boiler and Pressure Vessel (ASME B&PV) Code Section XI - Rules For Inservice Inspection Of Nuclear Power Plant Components
- Acceptance Criteria: Evaluation of canister inspection
 - Based on and supported by consensus codes and standards
- Corrective Actions: Repair, replace or mitigate
 - Maintain compliance with 10 CFR 72 regulatory requirements

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Ongoing Efforts



- Further guidance development
 - Managing Aging Processes for Storage (GALL-like report)
 - Guidance for NRC inspections of licensees' AMA
- Department of Energy (DOE) High Burnup Dry Storage Cask Research and Development Program
- ASME Section XI inspection requirements
- Continuing stakeholder engagement:
 - NEI 14-03 Guidance on Operations-Based Aging Management
 - License Renewal Application Format and Content Guidance
 - Additional inspections / Operational experience / Data collection
 - EPRI activities, research, and reports

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Acronyms



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| <ul style="list-style-type: none"> • ACI: American Concrete Institute • AMA: Aging management activity • AMP: Aging management program • ANSI: American National Standards Institute • ASCE: American Society of Civil Engineers • ASME: American Society of Mechanical Engineers • BWR: Boiling water reactor • CFR: Code of Federal Regulations • CISC: Chloride-induced stress corrosion cracking • CoC: Certificate of Compliance | <ul style="list-style-type: none"> • DCSS: Dry cask storage system • DOE: Department of Energy • EPRI: Electrical Power Research Institute • GALL: Generic Aging Lessons Learned • INL: Idaho National Laboratory • ISFSI: Independent spent fuel storage installation • NEI: Nuclear Energy Institute • NRC: Nuclear Regulatory Commission • PWR: Pressurized water reactor • RAI: Request for additional information • SSC: Structure, system or component • TLAA: Time-limited aging analysis |
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