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NUREG-2214, Managing Aging Processes in Storage (MAPS) Report

Draft Report for Comment

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U.S. NRC

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U.S. NRC HQ, Rockville, MD

NUREG-2214
Draft Report for Comment

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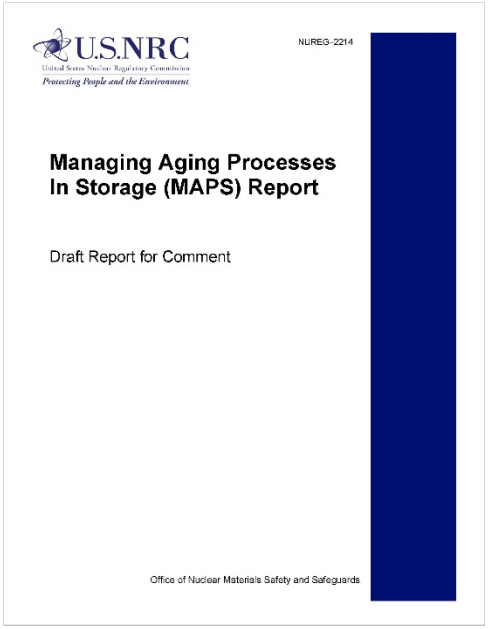
- ADAMS ML17289A237

- Public comment period ends December 26
  - Comment via website: http://www.regulations.gov, Docket ID: NRC-2016-0238
  - Mail comments to:

    May Ma
    Office of Administration, Mail Stop: OWFN-2-A13
    U.S. Nuclear Regulatory Commission
    Washington, DC 20555-0001
  - Questions about material in NUREG-2214:

    John.Wise@nrc.gov



NUREG-1927, Rev 1
Renewal Applications

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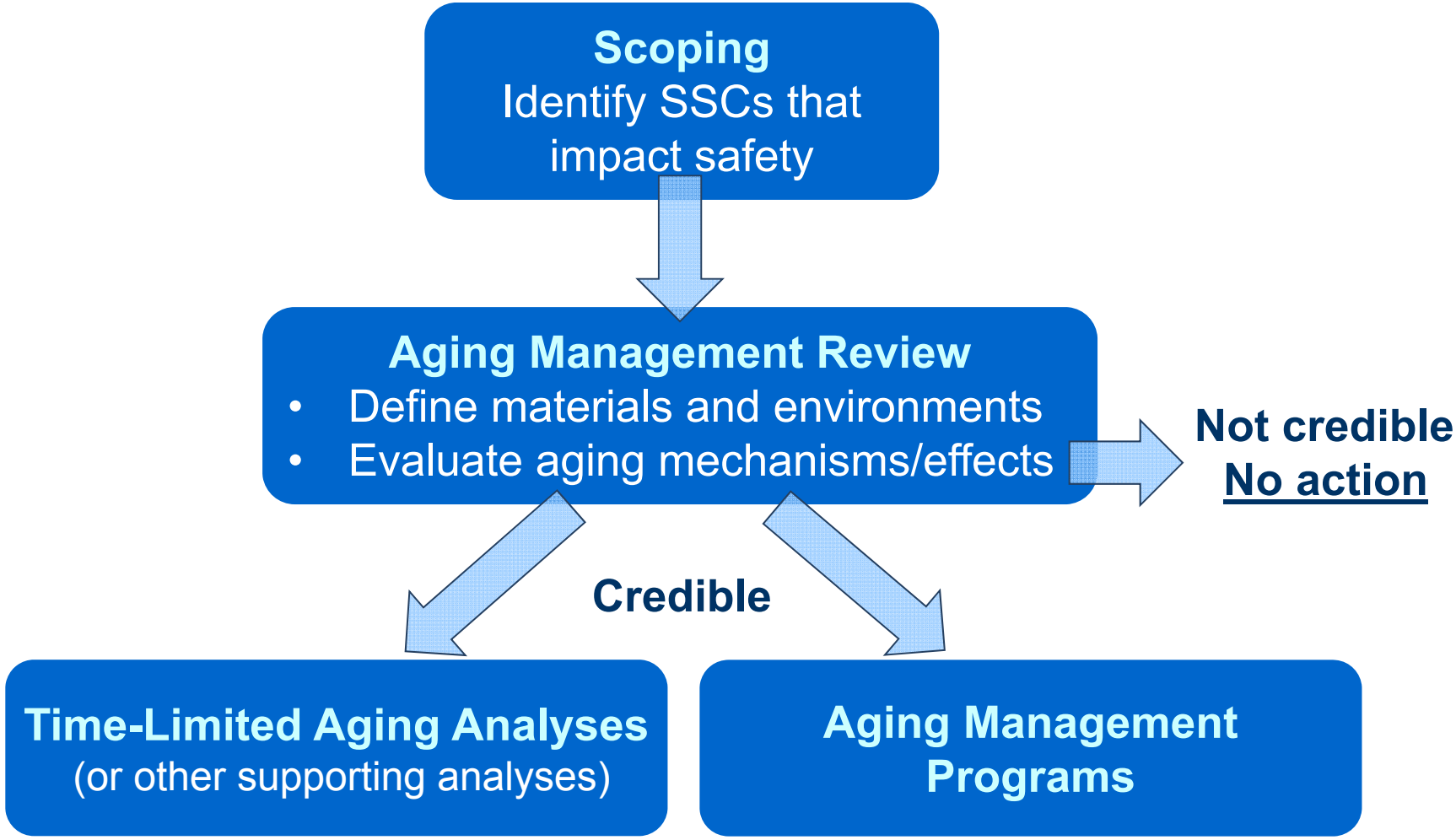

Purpose of NUREG-2214

- Clarity of NRC staff technical position
  - Technical bases for credible aging mechanisms
  - Acceptable aging management activities

- Efficiency in the preparation and review of storage renewal applications
  - Reference to NUREG-2214 in applications will allow the staff to focus its review on those areas where the applicant proposes an alternative approach

Purpose of NUREG-2214

- NUREG-2214 is not a new set of requirements; it is one acceptable approach to demonstrate compliance with existing requirements
- NUREG-2214 does not replace an applicant's independent review of its storage system and proposed aging management activities

Scoping

- In NUREG-2214, NRC staff identified in-scope SSCs of selected storage system designs by a review of safety analysis reports; *however*,
  - NUREG-2214 tabulations of SSCs are not a replacement for a renewal applicant's independent review of its design bases documents
- NUREG-2214 is a reference to assist the staff's review of an applicant's scoping evaluation

Aging Management Review
Define materials and environments

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- NRC staff identified materials and environments of each SSC of selected storage system designs by a review of safety analysis reports; *however*,
  - NUREG-2214 evaluations are not a replacement for a renewal applicant's independent review of its storage system and operating environment(s)
- NUREG-2214 is intended to be a reference to assist the staff's review of the applicant's evaluation

Aging Management Review
Evaluate aging mechanisms

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- Chapter 3 is a literature review and evaluation of material degradation mechanisms for the 20- to 60-year period of extended operation
- Those mechanisms that have the potential to challenge an important-to-safety function (if not managed) are defined as “credible”
- A renewal applicant may reference these evaluations in its bases for its aging management review

Aging Management Review
Evaluate aging mechanisms

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Example of Chapter 3 evaluation

Material	Aging Mechanism	Credible Environments	Noncredible Environments
Steel	General corrosion	Outdoor (OD), Sheltered (SH), Demineralized water (DW), Groundwater/soil (GW), Embedded in concrete (E-C)	Helium (HE) Embedded in metal (E-M) Embedded in neutron shielding (E-NS)

Aging Management Review
Evaluate aging mechanisms

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Excerpt of Chapter 3 summary table

Table 3-2 Casks and internals aging mechanism evaluations

Material	Aging Mechanism	Credible Environments	Noncredible Environments	Section
Steel	General corrosion	OD, SH, DW, GW, E-C	E-M, E-NS, HE	3.2.1.1
	Pitting and crevice corrosion	OD, SH, DW, GW, E-C	E-M, E-NS, HE	3.2.1.2
	Galvanic corrosion*	OD, SH		3.2.1.3
	Microbiologically influenced corrosion (MIC)	GW, E-C	OD, SH, DW, E-M, E-NS, HE	3.2.1.4
	Stress corrosion cracking (SCC)		OD, SH	3.2.1.5
	Creep		OD, SH, DW, GW, E-M, E-NS, HE	3.2.1.6
	Fatigue	Evaluate design code TLAA, if applicable		3.2.1.7
	Thermal aging		OD, SH, DW, GW, E-M, E-NS, HE	3.2.1.8
	Radiation embrittlement		OD, SH, DW, GW, E-M, E-NS, HE	3.2.1.9
	Stress relaxation	SH	OD	3.2.1.10
	Wear	OD		3.2.1.11

Aging Management Review Results

- Chapter 4 combines the results of the scoping and aging mechanism reviews and identifies aging management activities for selected storage system designs
- Excerpt of Chapter 4 table

Table 4-7 HI-STORM / HI-STAR multipurpose canister

Structure, System, or Component	Intended Safety Function	Material	Environment	Aging Mechanism	Aging Effect	Aging Management	Technical Basis (Section)
Shell	CO, SH, SR, TH*	Stainless steel (welded)	Sheltered	Stress corrosion cracking	Cracking	Localized Corrosion and Stress corrosion Cracking of Welded Stainless Steel Dry Storage Canisters AMP	3.2.2.5

- A renewal applicant may reference these tables; the staff will reference them as a check against the application

Time-Limited Aging Analyses

- Chapter 5 summarizes the recommendations of NUREG-1927 regarding the re-evaluation of design bases calculations that are time-dependent
  - demonstrate that existing analyses remain valid for the 20- to 60-year period, or
  - revise analyses to evaluate for 60 years, or
  - manage the aging via an aging management program
- Applicants can introduce new analyses to support the aging management review and aging management programs; however, those are not TLAAs as defined in 10 CFR 72.3

Aging Management Programs

- Chapter 6 provides example aging management programs (AMPs) that are considered acceptable to address the in-scope SSCs with credible aging mechanisms
- In the Chapter 4 aging management review tables, most SSCs with a credible aging mechanism reference one of the provided example AMPs
- An applicant may propose alternative approaches

Aging Management Programs

- Localized Corrosion and Stress Corrosion Cracking of Welded Stainless Steel Dry Storage Canisters
- Reinforced Concrete Structures
- External Surfaces Monitoring of Metallic Components
- Ventilation Systems
- Bolted Cask Seal Leakage Monitoring
- Transfer Casks
- High Burnup Fuel Monitoring and Assessment

Corrective Actions

- Example AMPs use the licensee's corrective action program to address monitoring and inspection results that do not meet acceptance criteria
- Licensees are responsible for determining appropriate corrective actions (e.g., analysis, mitigation, repair) to assure continued safe storage
- NRC oversight of corrective actions:
  - Daily resident inspector review of identified conditions
  - Periodic regional and resident inspections of storage sites
  - AMP-specific inspections (NRC Temporary Instruction→ Inspection Procedure)

Corrective Actions

- Example AMPs also include periodic evaluations of industry-wide operating experience and AMP effectiveness
- The staff is evaluating NEI 14-03, Rev. 2, "Format, Content, and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management":
  - includes "tollgates", or periodic points within the period of extended operation when licensees evaluate operating experience and assess AMP effectiveness
  - references the ISFSI Aging Management INPO Database, which provides a clearinghouse of aging-related information

Next Steps

- Evaluate comments
- Publish final report and document comment resolution: May 2018

Abbreviations

- ADAMS – Agencywide Documents Access and Management System
- AMP – Aging Management Program
- INPO – Institute of Nuclear Power Operations
- ISFSI – Independent Spent Fuel Storage Installation
- MAPS – Managing Aging Processes in Storage
- NEI – Nuclear Energy Institute
- SSC – Structure, System, and Component
- TLAA – Time-Limiting Aging Analyses

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Backup Slides: Example AMPs

Localized Corrosion and Stress Corrosion Cracking of Welded Stainless Steel Dry Storage Canisters

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Scope: External surfaces of the welded stainless steel canister confinement boundary, focused on areas near welds, crevices, where deposits may accumulate, and relatively cold surfaces

Detection of Aging Effects:

- Method: Visual examination for deposits and corrosion products (ASME Code Section XI VT-1, VT-3); Surface and volumetric methods to characterize extent and severity of localized corrosion and cracking
- Sample Size: Minimum of one canister per site (most susceptible)
- Frequency: site-specific determination, based on susceptibility

Acceptance Criteria: No indications of corrosion pits, etching, crevice corrosion, SCC, red-orange colored products at crevices or welds

Reinforced Concrete Structures

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Scope: Above-grade and below-grade concrete areas; groundwater chemistry; radiation (shielding effectiveness)

Detection of Aging Effects:

- Method: Visual examinations; Chemical analysis of groundwater; Radiation surveys
- Sample Size: Visual: 100% of all readily accessible surfaces / subset of normally inaccessible surfaces
- Frequency: Visual per ACI 349.3R (at least once every 5 years for above-grade / opportunistic for below-grade); chemistry and radiation survey as justified

Acceptance Criteria: Visual per ACI 349.3R (e.g., pop-outs/voids less than 20mm in diameter, cracks less than 0.4 mm in width); groundwater per ASME Code Section XI, IWL; radiation as justified

External Surfaces Monitoring of Metallic Components

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Scope: External surfaces of metallic components (e.g., metallic overpack surfaces, canister support structures, heat shields)

Detection of Aging Effects:

- Method: Visual examination in accordance with ASME Code Section XI, VT-3
- Sample Size: All readily accessible surfaces of all casks and overpacks; extent of inaccessible surfaces sufficient to characterize their condition
- Frequency: Once every 5 years (readily accessible)

  Opportunistic (normally inaccessible – within overpacks)

Acceptance Criteria: No detectable loss of material, red-orange colored corrosion products, coating defects, loose or displaced parts

Ventilation Systems

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Scope: Air inlet/outlet vents

Detection of Aging Effects:

- Method: Visual inspections for obstructions during periodic walkdowns; Temperature monitoring as an alternative to verifying thermal conditions
- Sample Size: All directly observable vent areas
- Frequency: Per the design bases (typically daily)

Acceptance Criteria: As defined in the approved design bases

Bolted Cask Seal Leakage Monitoring

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Scope: Confinement boundary seal

Detection of Aging Effects:

- Method: Pressure monitoring; Visual (VT-3) examination under the protective weather cover
- Sample Size: Pressure monitoring of all casks; visual inspections as justified
- Frequency: Continuous monitoring of pressure; Visual inspections under the protective cover on an opportunistic basis – at a justified minimum frequency

Acceptance Criteria: Pressure within the range allowed by the design bases; visual inspections find no indications of coating degradation, corrosion, loose/missing/displaced parts.

Transfer Casks

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Scope: Transfer cask subcomponents

Detection of Aging Effects:

- Method: Visual (VT-3) examination of accessible surfaces; Normally inaccessible surfaces (in contact with liquid neutron shield) assessed with ultrasonic techniques or inspections for leakage
- Sample Size: All transfer casks
- Frequency: At least once every 5 years, or prior to loading campaign

Acceptance Criteria: No detectable loss of material, red-orange colored corrosion products, or coating defects; no evidence of shield water leakage or loss of shield wall thickness beyond established limit

High-Burnup Fuel Monitoring and Assessment

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Scope: Surrogate demonstration program

Acceptance Criteria:

- Maximum hydrogen content of cover gas less than the design-bases limit
- Moisture content less than the expected upper bound per the design-bases drying process
- No changes to the analyzed fuel configuration as defined in the design bases