

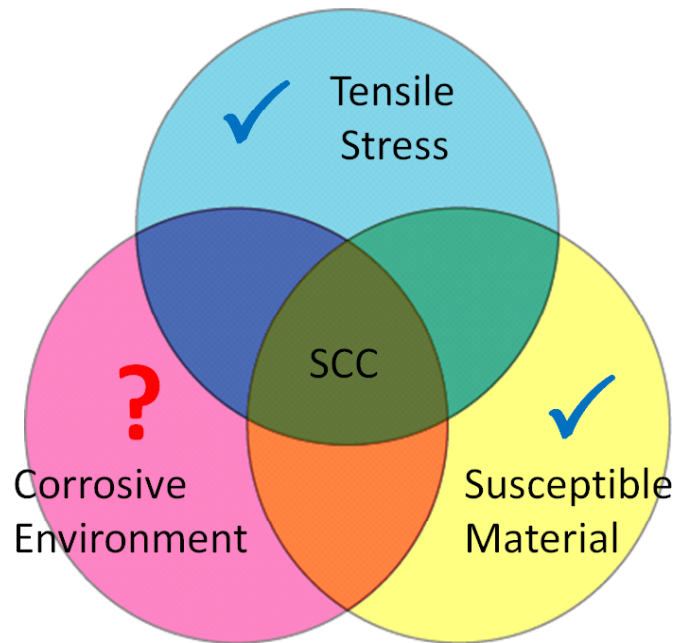
Aging Management Program Example for Stress Corrosion Cracking

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Meeting to Obtain Stakeholder Input on Potential
Changes to Guidance for Renewal of Spent Fuel Dry
Cask Storage System Licenses and Certificates of
Compliance

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Stress Corrosion Cracking Background Information



2/3 of the requirements for SCC are present in welded stainless steel canisters

- 304 and 316 Stainless steels are susceptible to chloride stress corrosion cracking (SCC)
 - Sensitization from welding increases susceptibility
 - Crevice and pitting corrosion can be precursors to SCC
 - SCC possible with low surface chloride concentrations
- Welded stainless steel canisters have sufficient through wall tensile residual stresses for SCC
- Atmospheric SCC of welded stainless steels has been observed
 - Component failures in 11-33 years
 - Estimated crack growth rates of 0.11 to 0.91 mm/yr

Regulatory Basis

- **10 CFR 72.42(a), 72.240(c):**
 - TLAAAs that demonstrate that ITS SSCs will continue to perform their intended function for the period of extended operation.
 - A description of the AMP for management of issues associated with aging that could adversely affect ITS SSCs.
- **Guidance: NUREG-1927 AMP Elements:**
 1. Scope of the Program
 2. Preventive Actions
 3. Parameters Monitored/Inspected
 4. Detection of Aging Effects
 5. Monitoring and Trending
 6. Acceptance Criteria
 7. Corrective Actions
 8. Confirmation Process
 9. Administrative Controls
 10. Operating Experience

AMP Element 1

Scope of the Program



NUREG-1927: The scope of the program should include the specific structures and components subject to an AMR

- Welded stainless steel dry storage canisters
 - Fabrication and closure welds
 - Weld heat affected zones
 - Locations where temporary supports or fixtures were attached by welding
 - Crevice locations
 - Surface areas where atmospheric deposits preferentially occurs
 - Surface areas with a lower than average temperature

AMP Element 2

Preventative Actions



NUREG-1927: Preventive actions should mitigate or prevent the applicable aging effects

- Aging Management Program (AMP) is for condition monitoring.
 - Preventative actions are not presently incorporated into existing dry storage canister designs
- Future designs or amendments could include
 - Surface modification to impart compressive residual stresses on welds and weld heat affected zones
 - Materials with improved localized corrosion and SCC resistance

AMP Element 3

Parameters Monitored/Inspected



NUREG-1927: Parameters monitored or inspected should be linked to the effects of aging on the intended functions of the particular structure and component

- Canister surfaces, welds, and weld heat affected zones for discontinuities and imperfections
- Size and location of localized corrosion (e.g., pitting and crevice corrosion) and stress corrosion cracks
- Appearance and location of atmospheric deposits on the canister surfaces

AMP Element 4

Detection of Aging Effects (1/2)



NUREG-1927: Define method or technique, frequency, sample size, data collection, and timing to ensure timely detection of aging effects

- Qualified and demonstrated technique to detect evidence of localized corrosion and SCC:
 - Remote visual inspection, e.g. EVT-1, VT-1, VT-3, or Eddy Current Testing (ET) may be appropriate
- Pending detection findings, sizing SCC would require volumetric methods

AMP Element 4

Detection of Aging Effects (2/2)

- Sample size
 - Minimum of one canister at each site
 - Canisters with the greatest susceptibility
- Data Collection
 - Documentation of the examination of the canister
 - Location and appearance of deposits
- Frequency
 - Every 5 years
- Timing of Inspections
 - Within 25 years of initial loading

AMP Element 5

Monitoring and Trending

NUREG-1927: Should provide for prediction of the extent of the effects of aging and timely corrective or mitigative actions

- Document canister condition particularly at welds and crevice locations using images and video that will allow comparison in subsequent examinations
- Changes to the size and number of any corrosion product accumulations
- Location and sizing of localized corrosion and stress corrosion cracking

AMP Element 6

Acceptance Criteria (1/2)



NUREG-1927: Acceptance criteria, against which the need for corrective action will be evaluated; should ensure that SSC functions are maintained

- No indications of
 - Pitting or crevice corrosion
 - Stress corrosion cracking
 - Corrosion products near crevices
 - Corrosion products on or adjacent to fabrication welds, closure welds, and welds for temporary supports or attachments

AMP Element 6

Acceptance Criteria (2/2)

- Locations with corrosion products require additional examination for localized corrosion and/or SCC
- Size of the area affected and the depth of penetration if localized corrosion and/or SCC is identified
- Canisters with localized corrosion and/or SCC must be evaluated for continued service in accordance with ASME B&PV Code Section XI IWB-3514.1 and IWB-3640

AMP Element 7

Corrective Actions



NUREG-1927: Corrective actions, including root cause determination and prevention of recurrence, should be timely

- Supplemental inspections to determine the extent of condition at the site
- Subsequent inspections of canisters with indications
- Canisters that do not meet the prescribed evaluation criteria must be repaired or removed from service

AMP Element 8

Confirmation Process



NUREG-1927: Confirmation process should ensure that preventive actions are adequate & appropriate corrective actions have been completed & are effective

- Licensee Quality Assurance Program consistent with 10 CFR 72 Subpart G, or 10 CFR 50 Appendix B
- Ensure that inspections, evaluations, and corrective actions are completed in accordance with the Site Specific or General Licensees Corrective Action Program (CAP)
 - Extent of condition
 - Evaluation for continued service
 - Repair, replace, mitigation actions

AMP Element 9

Administrative Controls



NUREG-1927: Administrative controls should provide a formal review and approval process

- Licensee Quality Assurance Program consistent with 10 CFR 72 Subpart G, or 10 CFR 50 Appendix B
- Training requirements for inspectors
- Records retention requirements

AMP Element 10

Operational Experience

NUREG-1927: Include past corrective actions; provide objective evidence to support a determination that the effects of aging will be adequately managed so that the SSC intended functions will be maintained during the period of extended operation

- No reported cases of localized corrosion or SCC in welded stainless steel canisters
- Atmospheric deposits on canister surfaces have been observed
- Several reported cases of chloride induced SCC from atmospheric deposits observed in operating reactors (NRC Information Notice 2012-20)
- Laboratory and field test data on conditions necessary for chloride induced SCC and SCC growth rates

Acronyms

AMP: Aging management program

TLAA: time limiting aging analysis

AMR: Aging management review

ITS: Important to safety

ASME B&PV code: American Society of Mechanical Engineers Boiler and Pressure Vessel code

SCC: Stress corrosion cracking

SSC: Structures systems and components

CAP: Corrective action program

CFR: Code of Federal Regulations

VT-1: Visual Testing-1 (ASME B&PV code Section XI, Article IWA-2200)

EVT-1: Enhanced visual testing-1 (Boiling water reactor vessels and internals project, BWRVIP-03)

VT-3: Visual Testing-3 (ASME B&PV code Section XI, Article IWA-2200)