Marine Atmosphere Stress Corrosion Cracking
RIRP Issue

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Agenda

- RIRP Scope
- Overview of current knowledge
- Solving the near term issue
- Solving the long term issue
RIRP Problem Statement and Scope

- Problem statement: there is insufficient data available to determine under what conditions and within what time scales SCC may occur.

- The scope of the RIRP is:
  - Define the conditions defining a “coastal marine atmosphere”
  - Estimate the time scales within which SCC could be expected based upon actual atmospheric and cask conditions.
Phenomenon is understood, its significance on the safety functions of casks is not

**Knowns**
- Phenomenon
- Necessary Conditions: Corrosive Environment, Susceptible Material, Tensile Stress

**Unknowns**
- Actual Conditions:
  - Elevation, Distance
  - Sunlight, Wind
  - 304, 304L, 316
  - Cold work, Furnace sensitization
- Cask Temperature, Air Chemistry, Cask Protection
- Surface Iron, Pitting, Crevices
- Salt Deposition, Relative Humidity
- Material Condition, Residual Stress

**Existence of SCC**
- Conditions Favorable for SCC
- Time of “Wetness”
- Corrosion Rate

**Safety Significance**
- Significant Through-wall Crack, Cask Safety Functions Challenged

**References**
1. “Effects of Marine Environment on Stress Corrosion Cracking of Austenitic Stainless Steels”, EPRI-1011820, Sep. 2005
Deliquescence

- The process of dissolving or becoming liquid through the absorption of moisture in the atmosphere
- Affected by:
  - Temperature (surface and ambient)
  - Humidity
- If chlorides in solid form deliquesce on the SS canister and stress is present, SCC can occur above \(~30^\circ C\) surface temperature
Example Determination of Time Scale for Potential Marine Atmosphere SCC

References
1. “Effects of Marine Environment on Stress Corrosion Cracking of Austenitic Stainless Steels”, EPRI-1011820, Sep. 2005
Current Status

- Available data do not suggest that MA SCC has occurred or will occur soon
  - Conservative data suggest soonest initiation time is 40 years
  - Oldest loaded stainless steel canister is 22 years
  - Realistic estimates are much longer time frames

- MA SCC initiation does not equal a loss of safety function
  - Time between initiation and propagation allows for mitigation
  - Potential for through-wall crack depends on thickness

- Opportunity exists to collect and evaluate additional data
  - Preventive actions today would not be appropriate because insufficient data to support what actions would be effective
Ongoing Research and Data Collection

Investigate Actual Conditions
• Visual
• Relative humidity at cask surface
• Actual surface temperature vs. calculated
• Tensile stresses
• Lead time to acquire tool
• Affected by environment and protection

Determine which Sites are in Marine Atmosphere
• Site environment studies
• Parametric study on temperature, humidity, air chemistry, etc. profiles

Simulate SCC in laboratory
• Model air chemistry and humidity at cask surface
• Prepare samples with representative material and stress characteristics
• Reproduce actual salt deposition and other conditions
• Measure corrosion and cracking rates at different temperatures

• Data from Multiple Sites, Designs and Loading Configurations are required to determine stress threshold, salt air concentration threshold, temperature threshold, individual cask conditions
• Total scope of research estimated to take 5 or more years
Near term actions to inform the ISFSI/cask screening criteria

- Actual Field Data
- Literature Search

+ ISFSI/cask screening criteria for potential and timeframe of MA SCC
Screening Criteria to Address Time Scale

- Screening criteria under development
  - Expected broad review by ISFSIs
  - Summary results to determine
    - ISFSIs with necessary conditions
    - Commonalities of sites potentially affected
    - Grouping of ISFSIs by SCC initiation time frame

- Industry to share screening results with NRC