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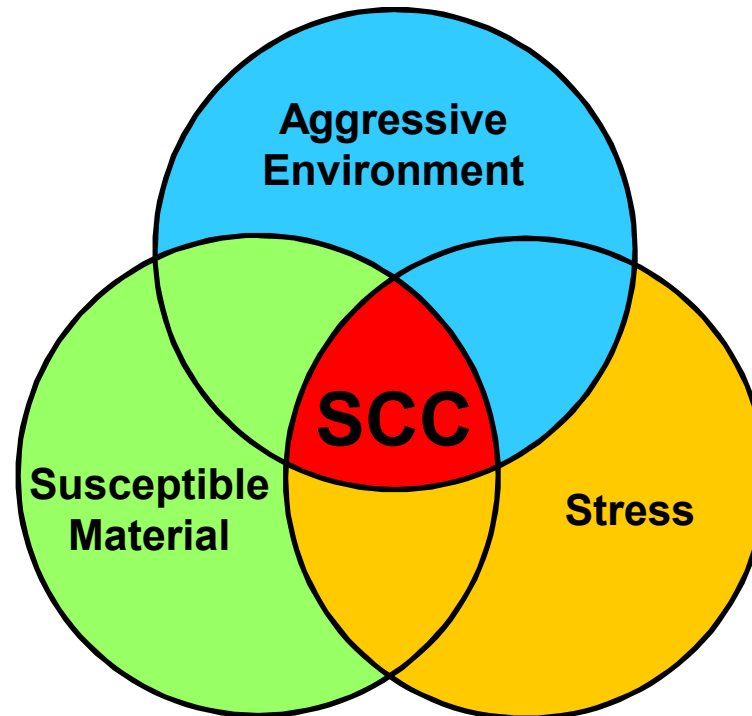
Understanding the Risk of Chloride Induced Stress Corrosion Cracking

D.G. Enos and C.R. Bryan
Sandia National Laboratories

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Understanding and Addressing Data Gaps for Chloride Induced Stress Corrosion Cracking (CISCC)



- What is the environment on the surface of dry storage canisters and how does it evolve with time?
- Is there sufficient stress to support through-wall stress corrosion cracks, and if so, what is the magnitude?
- Generically, what are the crack growth kinetics given the known physical and environmental conditions of dry storage casks?



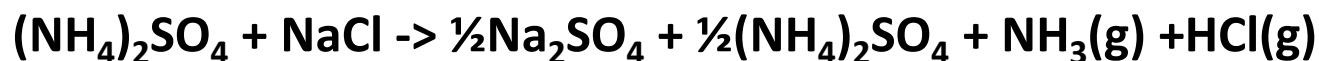
Understanding the Surface Environment: *Samples from Container Surfaces*

- **Samples acquired from three different nuclear power stations were provided by EPRI for analysis**
- **Dust and salt loads were high on canister upper surfaces, but low on vertical surfaces.**
- **Near-marine site 1 (approximately 0.5 miles from brackish water)**
 - Soluble components largely calcium and sulfate with little chloride
- **Near-marine site 2 (approximately 0.25 miles from brackish water)**
 - Soluble components largely calcium, sulfate, and nitrate with little chloride
- **Marine site (approximately 0.35 miles from the ocean)**
 - Sea-salt aerosols, occurring as aggregates of NaCl and Mg-sulfate with trace amounts of K and Ca, were a major component of the dust samples.



Understanding the Surface Environment: *Salt and Brine Stability*

- Once deposited on the surface of a storage container, there are numerous processes that will affect the composition of the species that remain
 - Gas to particle conversion reactions
 - Acid degassing
 - Ammonium mineral decomposition and brine degassing
- On a hot canister, prior to deliquescence, NH_4NO_3 and NH_4Cl will not persist. If deposited, other chloride salts will accumulate, and $(\text{NH}_4)_2\text{SO}_4$ may accumulate.
- However, upon deliquescence, brines containing NH_4^+ and NO_3^- or Cl^- will rapidly degas until either NH_4^+ or $(\text{NO}_3^- + \text{Cl}^-)$ are consumed.
- Consider a deliquesced $(\text{NH}_4)_2\text{SO}_4$ brine:





Understanding the Residual Stress State in Fielded Dry Storage Containers

■ Propagation of a stress corrosion crack requires the presence of a sufficiently large stress

- Residual stresses associated with welds
- Residual stresses associated with forming process

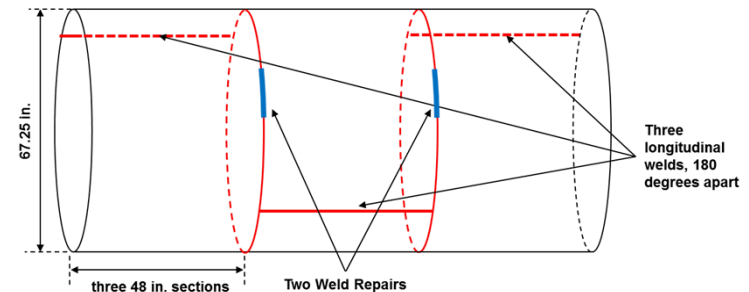
■ Stresses will vary based upon the type of weld

- Longitudinal vs. Circumferential
- Weld repairs

■ Mock container assembled and being evaluated

- Deep hole drilling
- Contour measurement + x-ray diffraction
- Electrochemical properties

■ Once analyzed, container will be sectioned and used as samples for the UFD and NEUP programs



- Wall material: 304 SS (dual certified 304/304L) welded with 308 SS
- Geometry mimics NUHOMS 24P container
- Welds are Full penetration and inspected per ASME B&PVC Section III, Division 1, Subsection NB (full radiographic inspection)

Development of a Probabilistic Stress Corrosion Cracking Model for SNF Interim Storage Canisters

■ **Goal—identify most important parameters for evaluating canister SCC performance (penetration times).** *Used to prioritize research needs.*

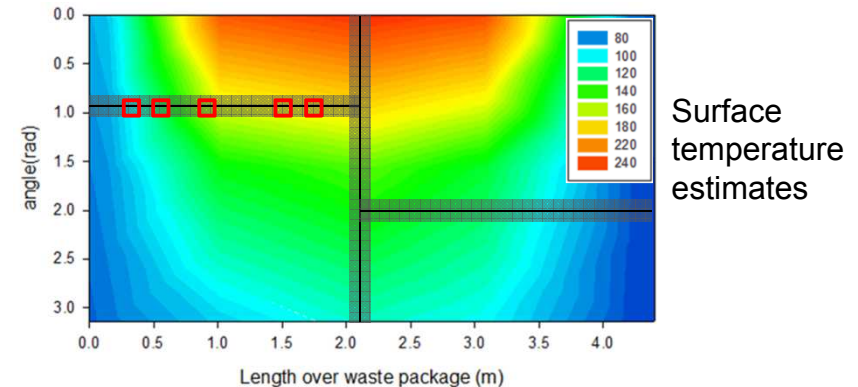
■ **Current model is simplified—not intended to accurately predict canister performance, but only to develop the functional form and data needs for the model.**

■ **SCC model based on approach by Turnbull et al. (2006a, b)**

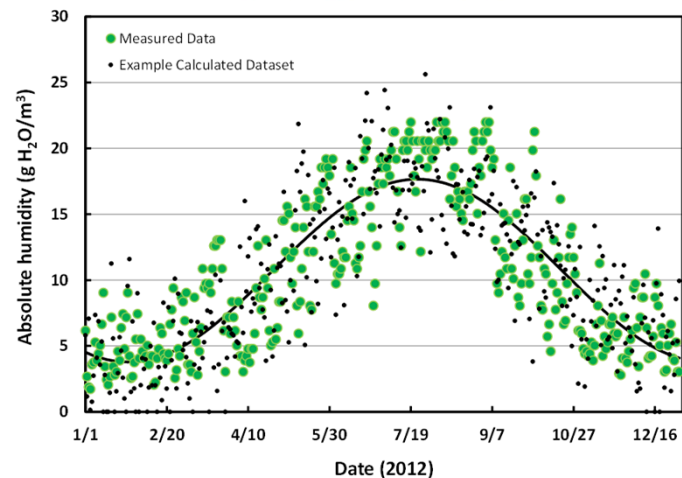
- Assumes SCC initiates from localized corrosion pre-cursors (corrosion pits)

■ **Submodels**

- Pitting initiation model
- Pitting growth model
- Model for pit-crack transition
- Model for crack growth



Surface temperature estimates



Site-specific National Weather Service data