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Plans for Inspection of Stainless Steel Canisters in Service

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NRC-NEI Meeting on SCC in Marine Atmosphere RIRP
Rockville, MD
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Outline

- Background
- Preliminary Inspection Plans
- Other work

SCC of Welded Canisters – What do we know

Several studies show SCC of canister materials is possible

- NUREG/CR 7030, *Atmospheric stress corrosion cracking susceptibility of welded and unwelded 304, 304l, and 316l austenitic stainless steels commonly used for dry cask storage containers exposed to marine environments*.
- CRIEPI - S. Koizumi and K. Shirai, "*Demonstration Program of Long-Term Storage (FY2004-2008) – SCC of MPC under the Condition of Sea Salt Deposition*," presentation to the US NRC, November 8-9, 2004, Washington, DC.
- Kure Beach - INCO, "*Marine Atmospheric Corrosion*," A-1275, New York, NY, March 1978
- EPRI Report 1011820, "*Effects of Marine Environments on Stress Corrosion Cracking of Austenitic Stainless Steels*", September 2005
- EPRI Report 1013524, "*Climactic Corrosion Considerations for Independent Spent Fuel Storage Installations in Marine Environments*", June 2006.

All extreme conditions, mostly in lab

- Likely overly conservative estimations

SCC of Welded Canisters – What do we know

For stress corrosion cracking you need:

- Susceptible material (austenitic stainless steels; e.g. 304, 316)
- Tensile stress (residual weld stress)
- Corrosive environment

Environment parameters affecting susceptibility of SCC

- Salts in the air
- Deliquescence
  - Surface temperature
  - Humidity

What we don't know …

What are the conditions on actual canisters?

Preliminary Inspection Plans

Lead plant: Calvert Cliffs

- Chosen due to timing and willingness to support

Primary scope of inspections:

- Visual
- Temperature
- Surface contaminants

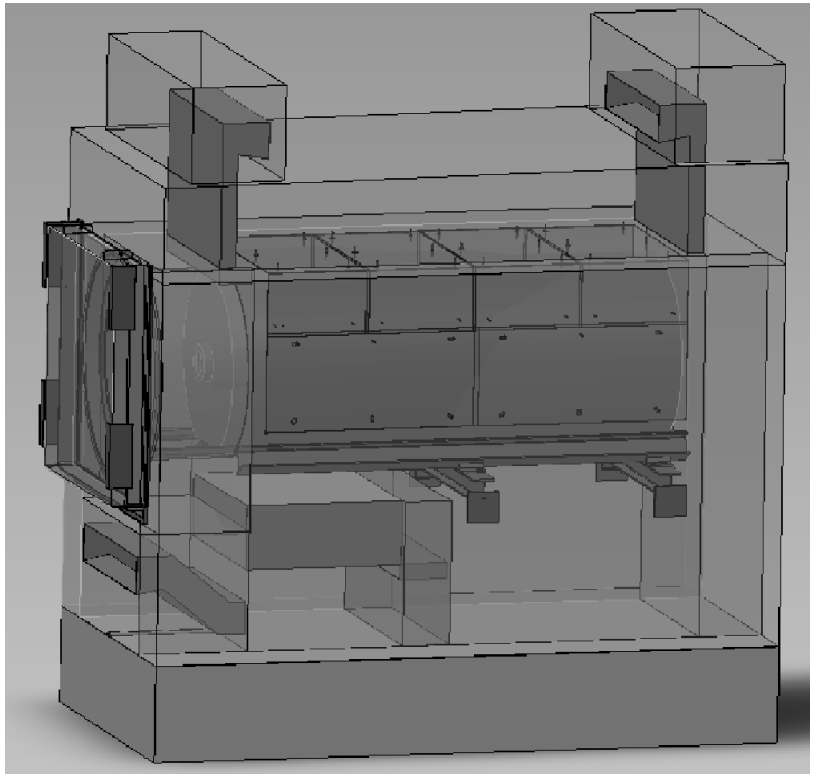
Secondary – Data collection on environment

- Air temperature & humidity
- Salt content in air

Preliminary Inspection Plans

Through outlet

- Visual



Preliminary Inspection Plans

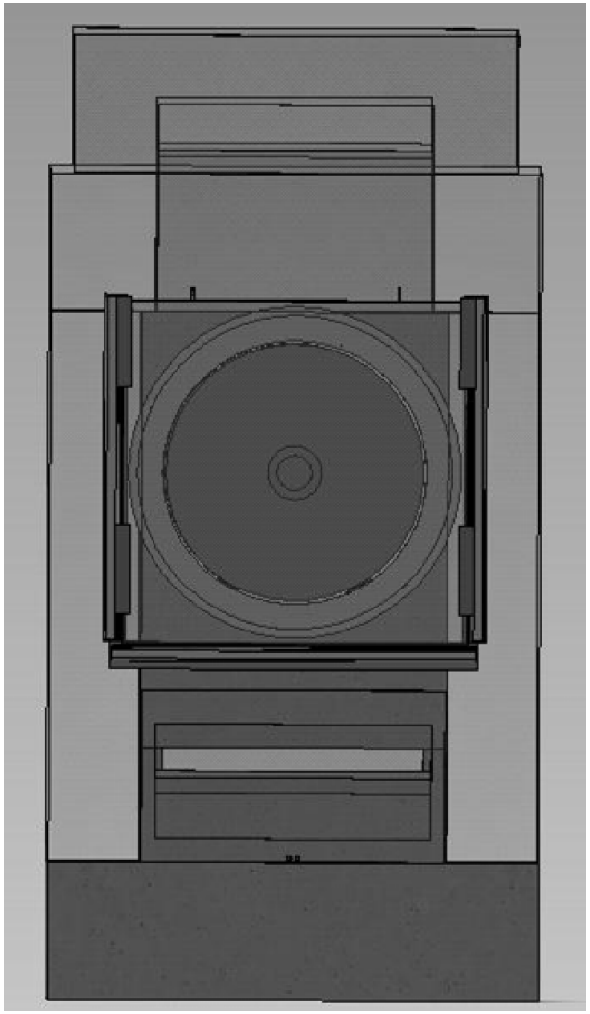
Visual

- Simple camera on a cable with articulation
- Limited area of visibility
- Scaling back concept of intricate tool delivery system due to schedule
- Plan to focus on weld areas
- Visual also through front door
  - Evaluating mini-camera through temporary door access way

Preliminary Inspection Plans

Through front

- Temporary door with access port(s)
- Surface contaminants
- Temperature
- Visual



Preliminary Inspection Plans

Surface contaminants

- Wet (e.g., “Salt Smart®”)
  - Temperature limitation
  - May not work on upper surfaces that have a layer of “dust”
- Dry (scraping, brushing, vacuum)
  - More complicated tool design and construction
  - Space and weight constraints
  - Best for upper surfaces to collect “dust”
  - May not acquire any measureable results for lower or vertical surfaces
- May need to use both

Preliminary Inspection Plans

Canister surface temperature

- Developing use of thermocouple
- Will work with access way for surface sample collection
- Questions about accuracy of thermography techniques

Air temperature & humidity

- Use devices located at inlet and outlet

Evaluation of Data Collected

Visual

- Signs of corrosion
- Location

Surface contaminants

- What type
- Concentrations

Temperature

- Actual temperature compared to calculated temperature and to threshold temperature for SCC

Humidity

- Combined with temperature data, compare to deliquescence threshold
- Unexpected differences between humidity locally vs. general area

Other Work

Thermal models

- Develop best estimate thermal
- Benchmark models to measurement

Gather other relevant atmospheric data – temperature and humidity

- Analyze archived filters
- Set up monitoring equipment

Other Research – DOE Labs

- Identify corrosion susceptibility conditions via:
  - Deliquescent brines and corrosion products chemical evolution models
  - Independent lab experiments to define window of susceptibility (is NEUP, CRIEPI, SwRI work repeatable?)
  - Salt composition analyses (salt collected by EPRI/industry)
- Develop “best estimate” thermal models
- Obtain or recreate “prototypic” canister weld material
- Co-fund EPRI inspections
  - Potential: develop micro camera with good resolution, and temperature/radiation resistant

Other Research – NEUP (Nuclear Energy University Program)

- SS corrosion “relevant” literature search
- Characterize chemical environment
  - Independent lab experiments to define window of susceptibility (is DOE, CRIEPI, SwRI work repeatable?)
- Characterize mechanical environment
  - Weld residual stresses (samples obtained by industry and/or DOE)

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