Project 1 – Task 20
Study of Carboline Coating for the Protection of the HCAEX Tunnel's Concrete Walls at Savannah River Site

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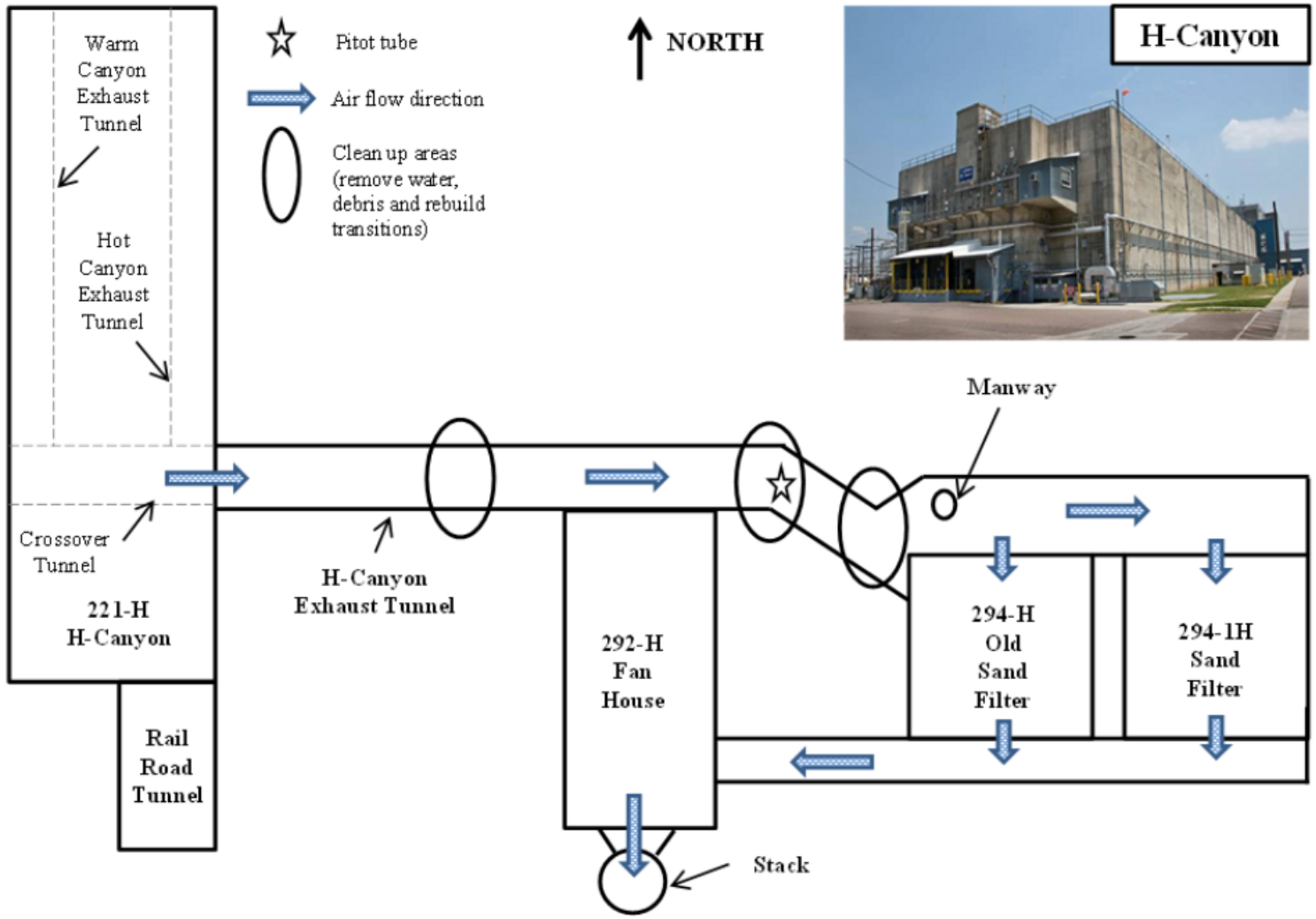
Introduction

H-Canyon

- Only facility in America which continues to reprocess radioactive material

H-Canyon Exhaust Tunnel (HCAEX)

- Allows air from chemical processes to flow into decontaminating filter system before being released into the environment
- Constructed in 1953



Schematic of the top view of the H-canyon and the tunnel.

Background and Objective

H-Canyon Exhaust Tunnel remote inspection revealed severe degradation

Steel (arrows) and coarse aggregates exposed

Water accumulation

Concrete degradation products (e.g. nitrate salts)

Aggressive environment within tunnel includes:

- HNO_3 fumes
- Radioactive material
- Strong winds with debris (~30 mph)
- High temperatures
- High relative humidity

Application of Coatings is a potential solution which can:

- Mitigate current degradation
- Prevent further degradation
- Extend service life of the tunnel

Objective: ***Study the corrosion behavior of coating systems through accelerated aging tests.***

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Literature Review

Search and Identify Potential Coatings for Evaluation:

- Several companies were contacted and finally four were selected for the study.

carboline® Coatings - Linings - Fireproofing

SHERWIN-WILLIAMS.

BELZONA® Repair • Protect • Improve

framatome

- This presentation will focus on a Carboline coating system

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Materials & Methods

- Concrete samples with a mix design and composition similar to tunnel walls were prepared.
- Test plan developed to evaluate potential coatings.
- Three variables of interest.
- Samples exposed to accelerated aging conditions:

  0.5M HNO_3 solution and erosion
- Failures included: erosion, blistering, cracking, scaling.

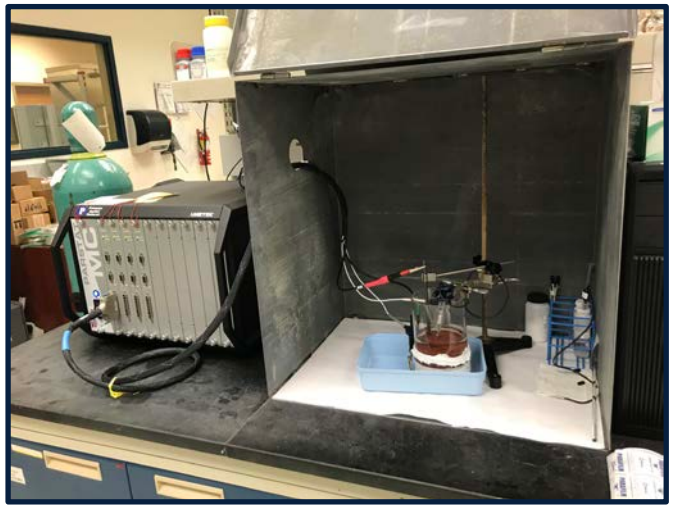
Test Plan for coatings evaluation

Test ID	Aged/Non-aged surface	Surface Preparation (Yes/No)	Steel rebar (Yes/No)
T1	Aged	Yes	Yes
T2	Aged	Yes	No
T3	Aged	No	Yes
T4	Aged	No	No
T5	Non-aged	No	Yes
T6	Non-aged	No	No
T7	Non-aged	yes	yes
T8	Non-aged	Yes	No

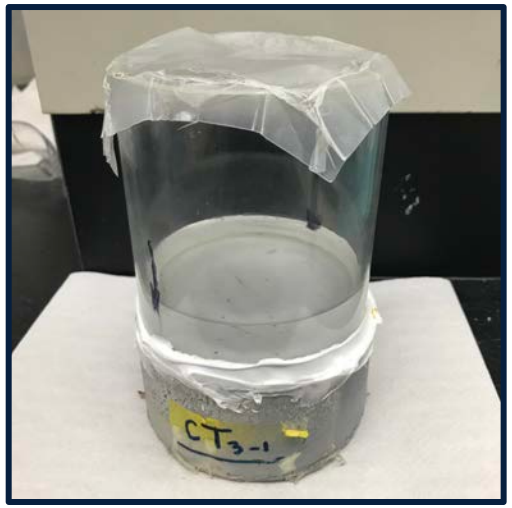
Measurements:

- Visual inspection / Failure Analysis
- Impedance
- Thickness
- pH

Positector-200 thickness Gauge



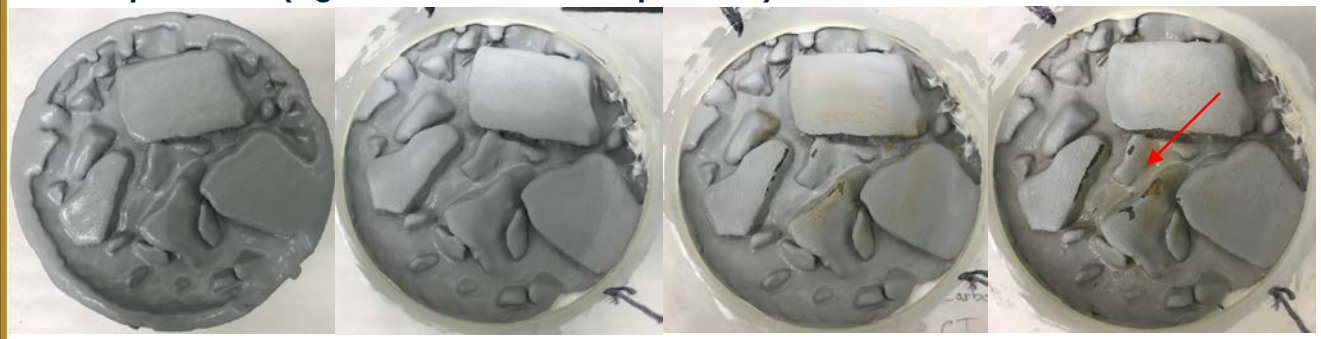
Potentiostat (left) and Faraday Cage (right) with test setup during impedance measurements



Test setup used for coating exposure to nitric acid solution

Results: Visual inspection / Failure Analysis

- **Sample CT2-1 (Aged With Surface Preparation)**

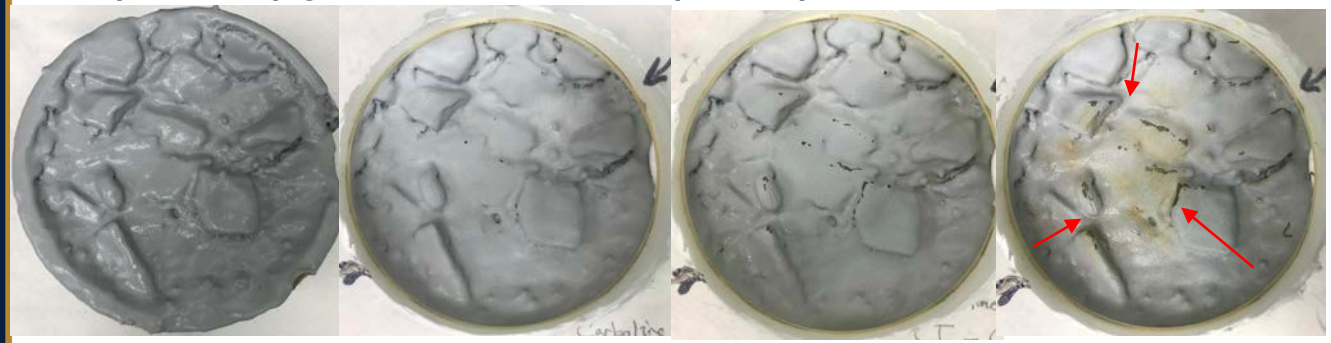


At Day 95,

Average Coating Thickness Loss:
16 µm (18%)

Failures:
- Degree of Erosion: #8

- **Sample CT4-1 (Aged Without Surface Preparation)**



Average Coating Thickness Loss:
15 µm (17%)

Failures:
- Degree of Erosion: #7

- **Sample CT7-1 (Non-aged with Surface Preparation)**

Average Coating Thickness Loss:
17 µm (19%)

Failures:
- Degree of Erosion: #9

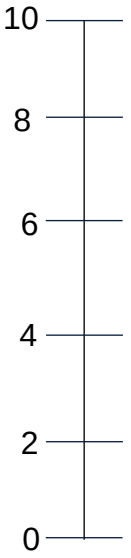
Before aging (Day 1) | **(Day 33)** | **(Day 61)** | **(Day 95)**

Evaluating Degree of Erosion

(ASTM Standard D662)

Rating Degree of Erosion:

(no erosion)



(no coating = total erosion)

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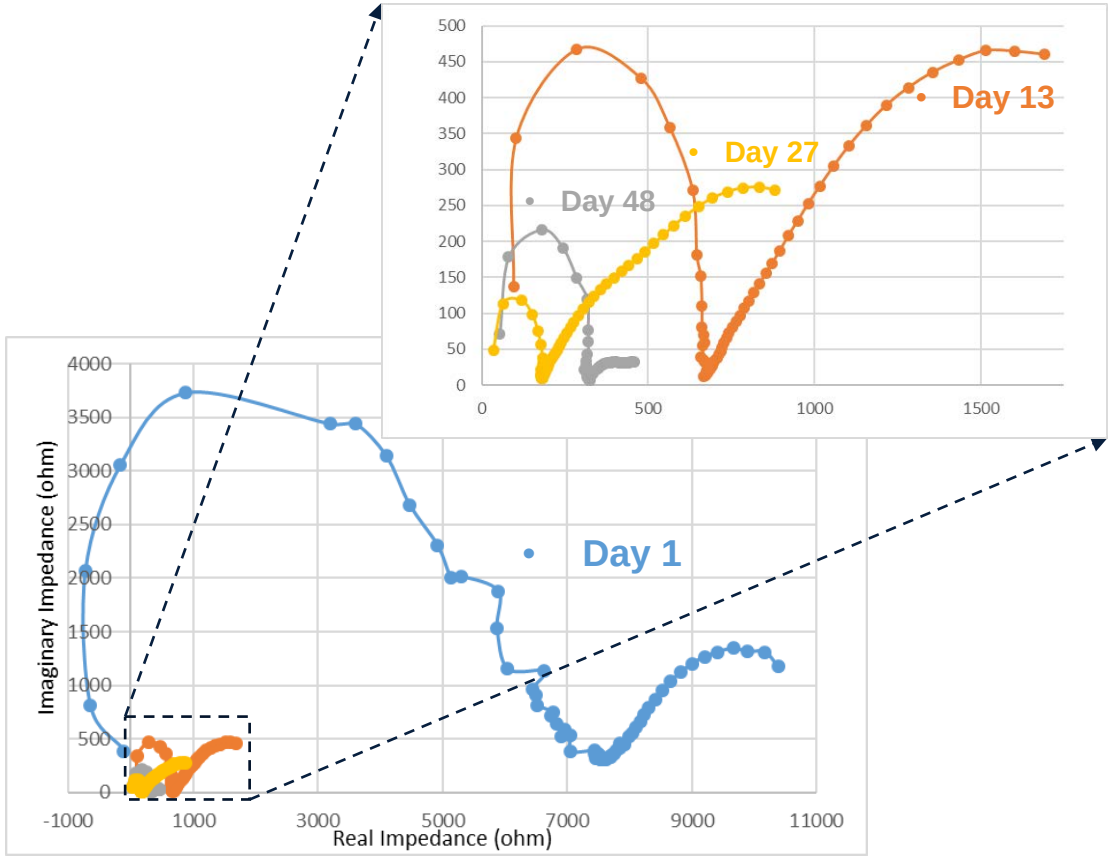
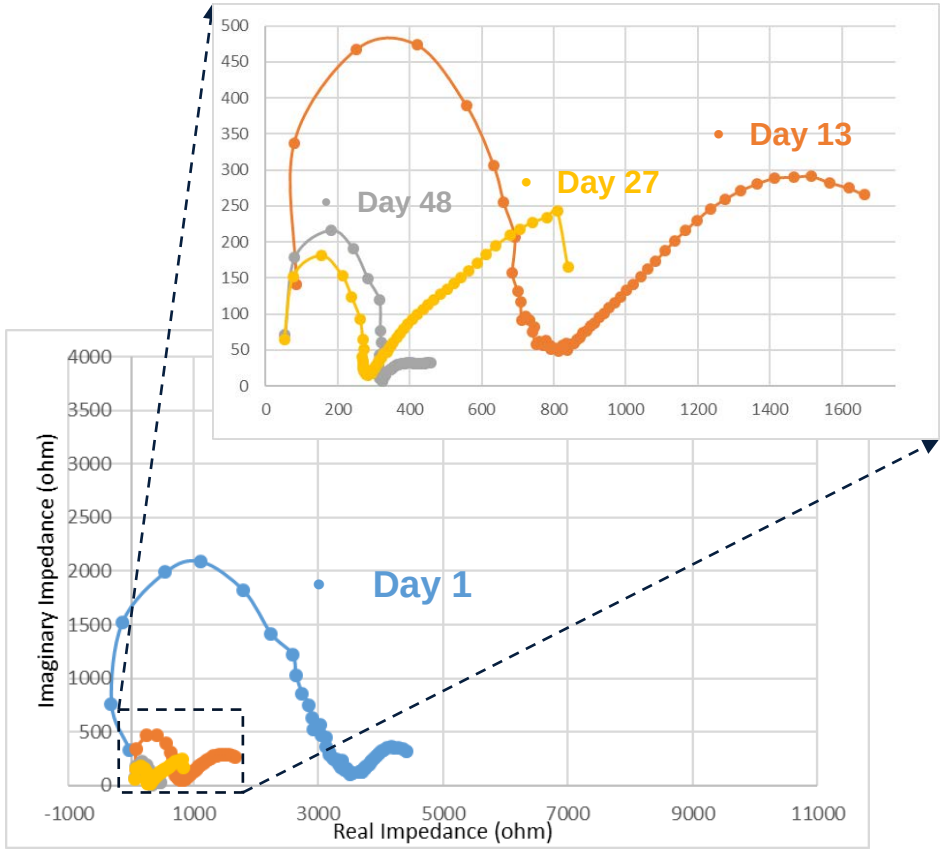
Results: Impedance Measurements – Nyquist Plots

- **Sample CT2-2 (With Surface Preparation)**



Sample CT4-1 (Without Surface Preparation)



- Taller, wider curves indicate less penetration of HNO_3 solution, better chemical resistance
- In both cases, a similar decrease of the impedance with time is observed, meaning the deterioration of the coating's protective properties

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Thank You. Questions?