

**ERDC**

Engineer Research and  
Development Center

# Nanotube Epoxy Paint

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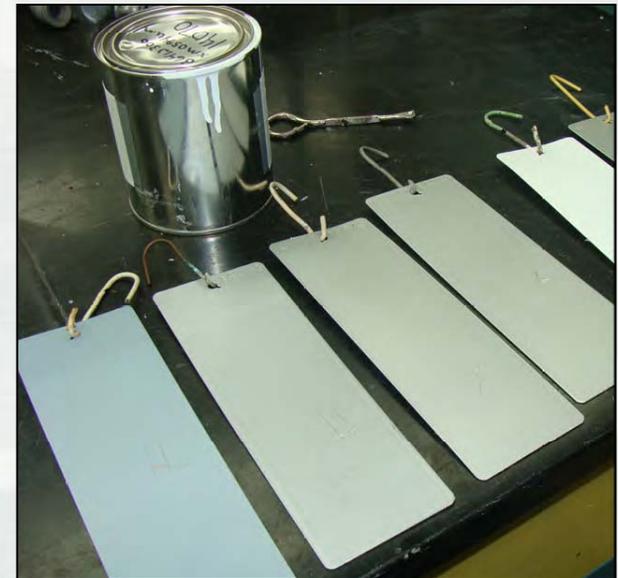
ERDC CERL

28 – 30 October 2014



# Paint Technology Center

- USACE Technical Center of Expertise
- Services:
  - ▶ QA testing of paints (200 – 400 samples/year)
  - ▶ Specification design/review
  - ▶ Inspection
  - ▶ Failure analysis
  - ▶ R&D



# Paint Technology Center

- Guide specifications and other criteria
  - ▶ UFGS 09 97 02 - Painting: Hydraulic Structures
  - ▶ UFGS 09 91 01 - Metallizing: Hydraulic Structures
  - ▶ UFGS 09 90 00 - Paints and Coatings



# Paint Technology Center

- Training
  - ▶ PROSPECT Course 084 – Paint, Coatings and Quality Verification (4.5 days, once per year)
  - ▶ 1, 2, or 3-day contract- or site-specific short courses for USACE and Contractor personnel



# Current High Performance Coating Systems for Steel in Immersion

- Vinyls for fresh water and intermittent immersion
- Coal tar epoxy for fresh or salt water immersion
- Epoxy polyamides for low to moderate velocity and abrasion
- Zinc-rich primers preferred for each

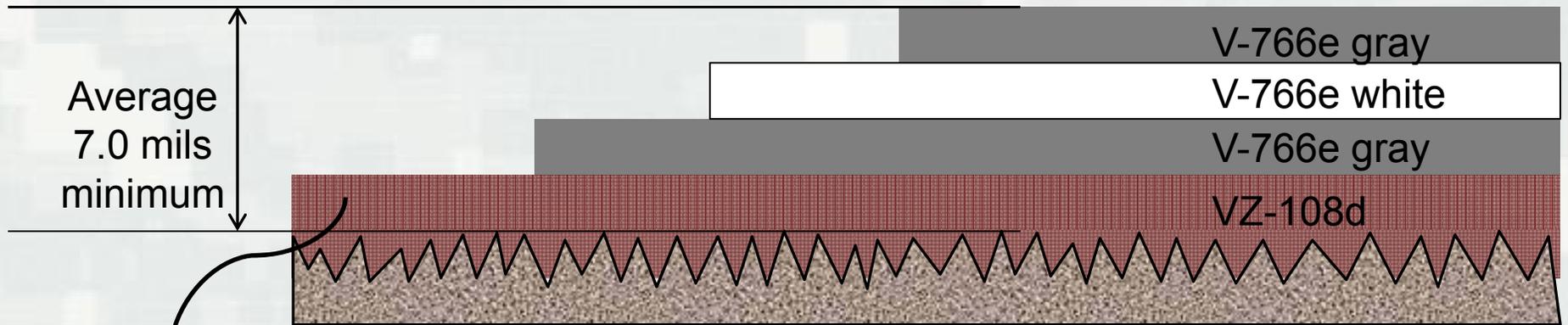
Vinyl System



Coal Tar Epoxy System



# Vinyl System 5-E-Z



2.5 mils of zinc-rich  
primer applied in one  
double spray coat

- Superior performance in turbulent, fast-moving fresh water and intermittent immersion
- High VOCs

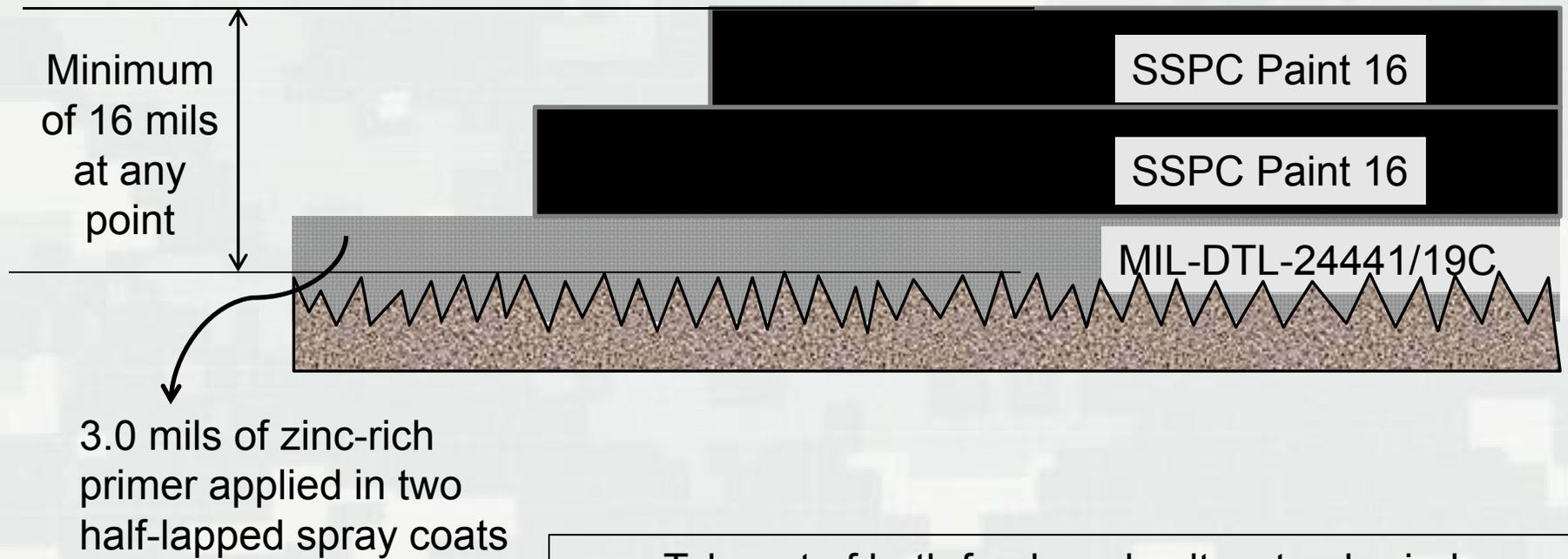


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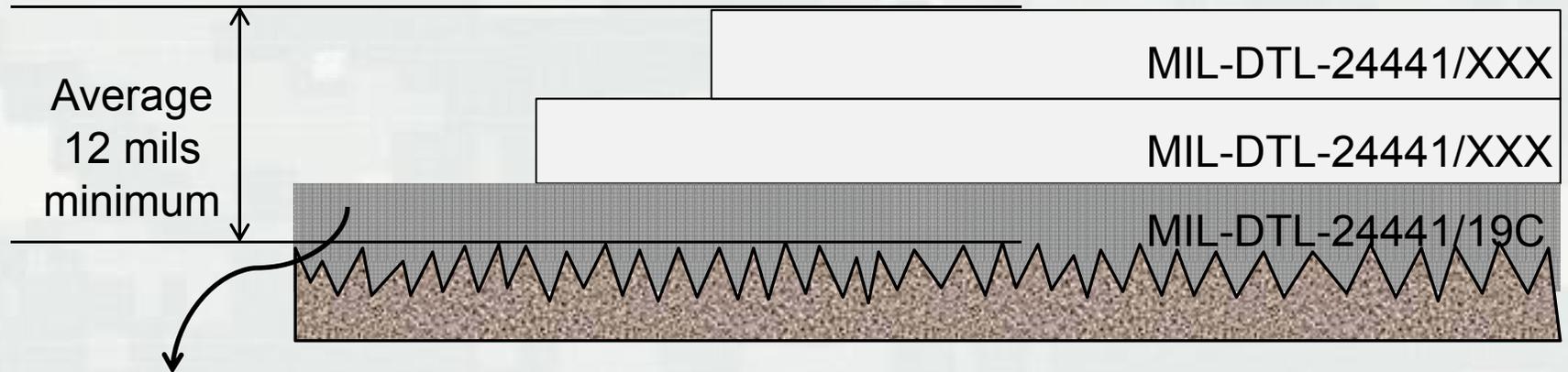
# Coal Tar Epoxy System 6-A-Z



- Tolerant of both fresh and salt water, buried structures
- Coal tar pitch is toxic



# Epoxy Polyamide System 21-A-Z



Average  
12 mils  
minimum

MIL-DTL-24441/XXX

MIL-DTL-24441/XXX

MIL-DTL-24441/19C

4.0 mils of zinc-rich  
primer applied in two  
half-lapped spray  
coats

- Tolerant of both fresh and salt water
- Brittle, subject to impact damage



# Epoxy Polyamide System 21-A-Z

- Zinc-Rich Primer MIL-DTL-24441/19B contains:
  - ▶ 86% zinc dust by weight
  - ▶ 51% zinc dust by volume
- High pigment loading can adversely effect physical properties
  - ▶ Adhesion
  - ▶ Flexibility
  - ▶ Impact resistance

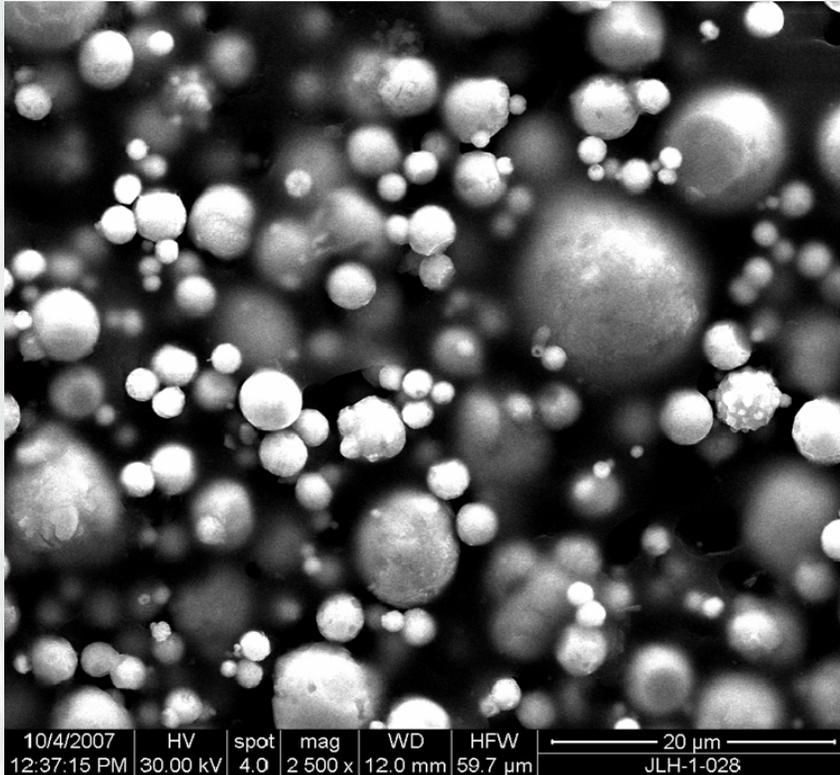


# Epoxy Polyamide Formulation with Carbon Nanotubes

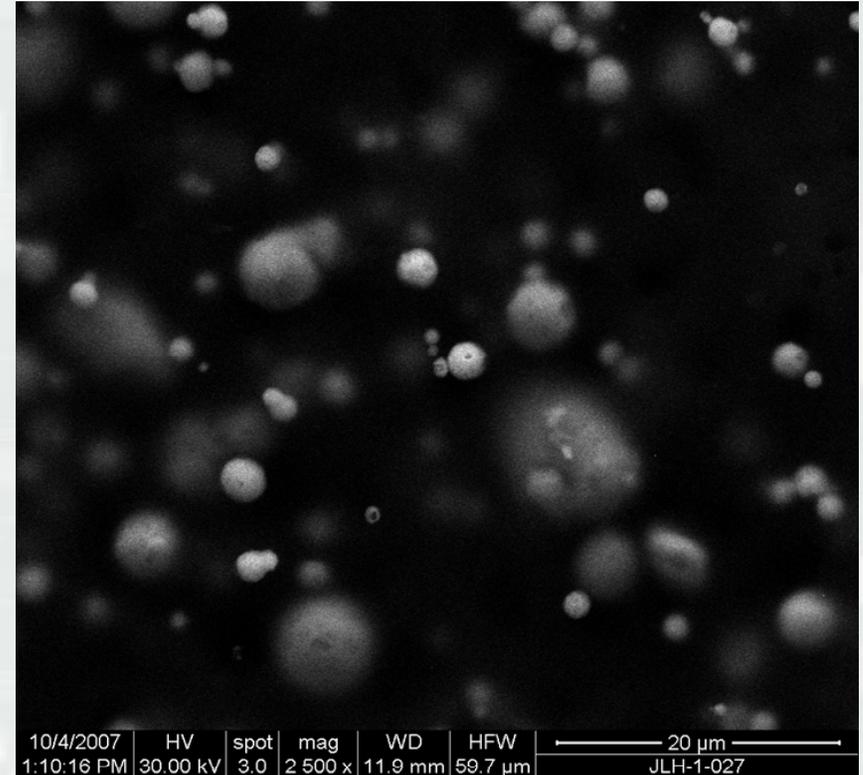
- Modification of MIL-DTL-24441/19B
- Replaces 50% of the zinc dust with a small amount of conductive carbon nanotubes
- Reducing pigment loading maintains corrosion protection while improving physical properties



# Tesla NanoCoatings Epoxy Primer



**Traditional Zinc-Rich Primer**



**TESLAN™ Primer**

**Lower Pigment Loading = Better Adhesion & Stronger Film**



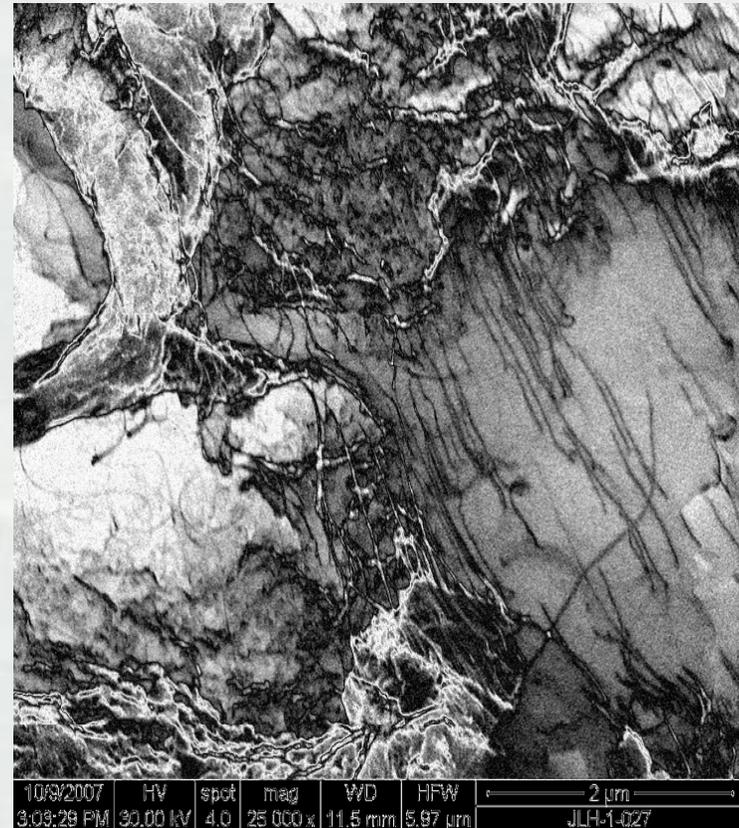
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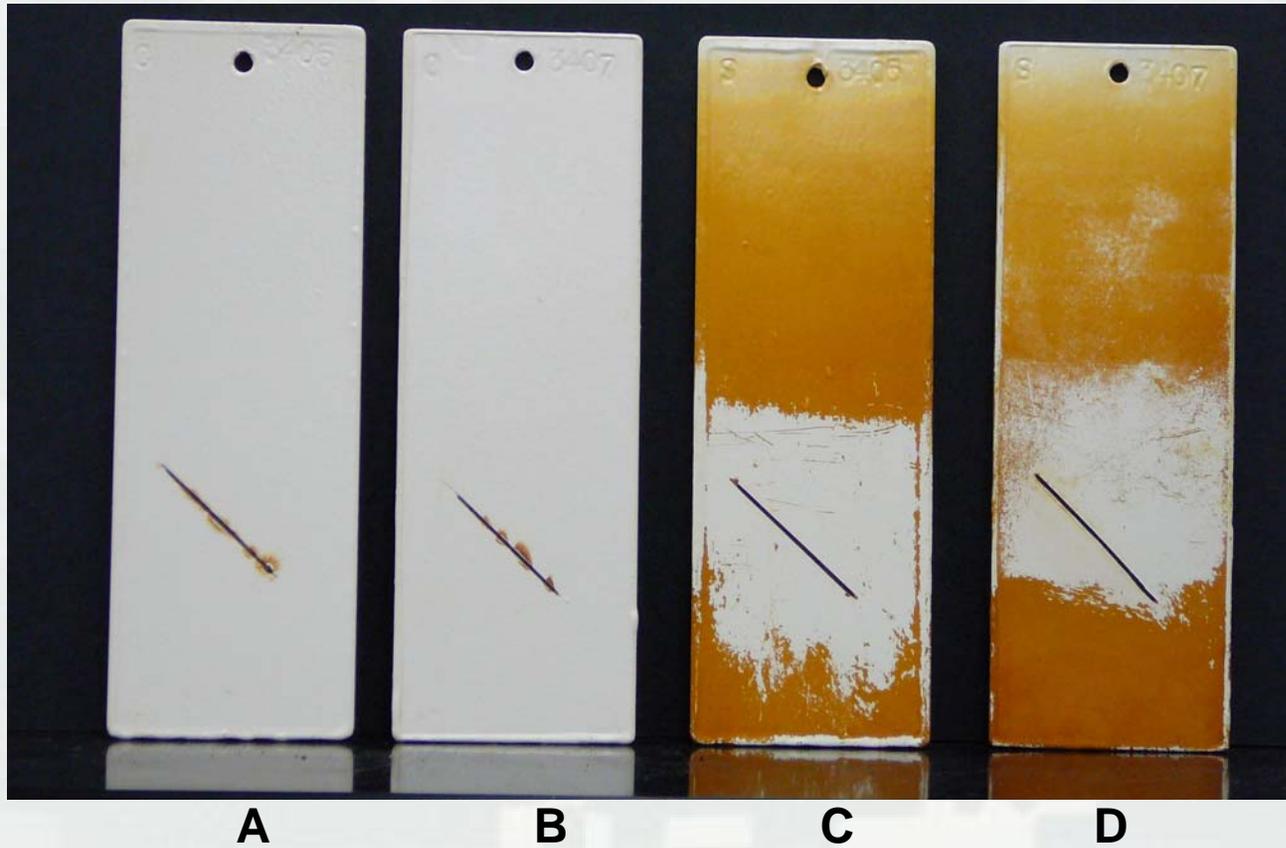
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# Functions of the Nanotubes

- Form Carbon Nanotube Ropes in the coating
  - ▶ strength of the carbon-carbon bonds builds an extended network of Carbon Nanotube Ropes
- Electron Path
  - ▶ through the binder
  - ▶ between the substrate and metal pigment particles
- Reinforce / Stiffen / Toughen the coating



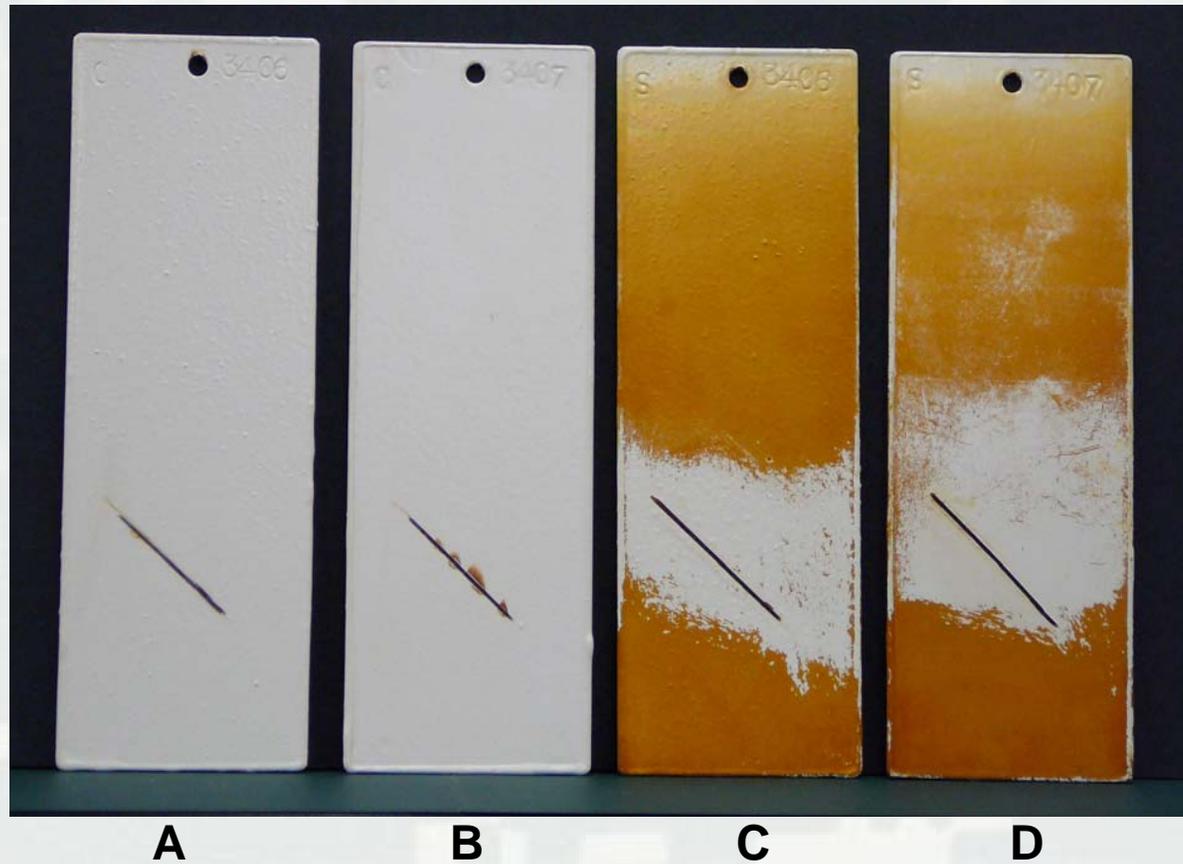
## Zinc SWNT Primer on Steel - Immersion 44 months



- A: SWNT zinc primer in fresh water  
C: SWNT zinc primer in synthetic seawater  
B & D: Standard zinc rich system as controls



## Aluminum SWNT Primer on Steel - Immersion 44 months



- A: SWNT aluminum primer in fresh water  
C: SWNT aluminum primer in synthetic seawater  
B & D: Standard zinc rich system as controls



# 2008 Field Evaluation – Fuel Tank

- 3-Coat epoxy/polyurethane system applied December 2008 to the exterior of a fuel tank at Ft. Bragg, NC
- Coating and coupons monitored for 2 years +



# Coming Civil Works Implementation

- Wilbur Mills Dam, Arkansas River
- Tainter gate will receive the Tesla Primer, and a CNT-reinforced epoxy topcoat
- Implementation coming soon
- Vinyl System 5-E-Z on adjacent gate as a control



# Laboratory Testing

- Concurrent lab work is evaluating all of the USACE immersion systems side by side with Tesla systems



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# Future Implementations

- Olmstead – 1 or 2 Wicket Gates
- Kwajalein – Extreme marine environment – structure to be determined



# Questions???

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