

Advanced Tank Coating Solutions for the Marine Sector

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Introduction

- This webinar provides performance requirements for coatings and linings used in marine ballast and fuel tanks.



Presentation Overview

- Evolution of US Navy tank coating technology
 - Legacy MIL-DTL-24441
 - Ultra high solids
 - Single coat, rapid cure
 - Time and cost savings/avoidance
- Optically active pigments
- Cartridges





U.S. DOD Corrosion Control

- U.S. Dept. of Defense 2014 cost of corrosion = \$21.9 billion per year
- U.S. Navy annual corrosion costs \$7.5 billion with vessel corrosion costs \$3.2 billion
- Navy Corrosion Prevention and Control Executive appointed
- Preservation of tanks is the #1 U.S. Navy fleet maintenance cost
- Cited from Matt Koch, “**Corrosion Control in the US Navy *Ships & USMC Vehicles***”, Nov 2014



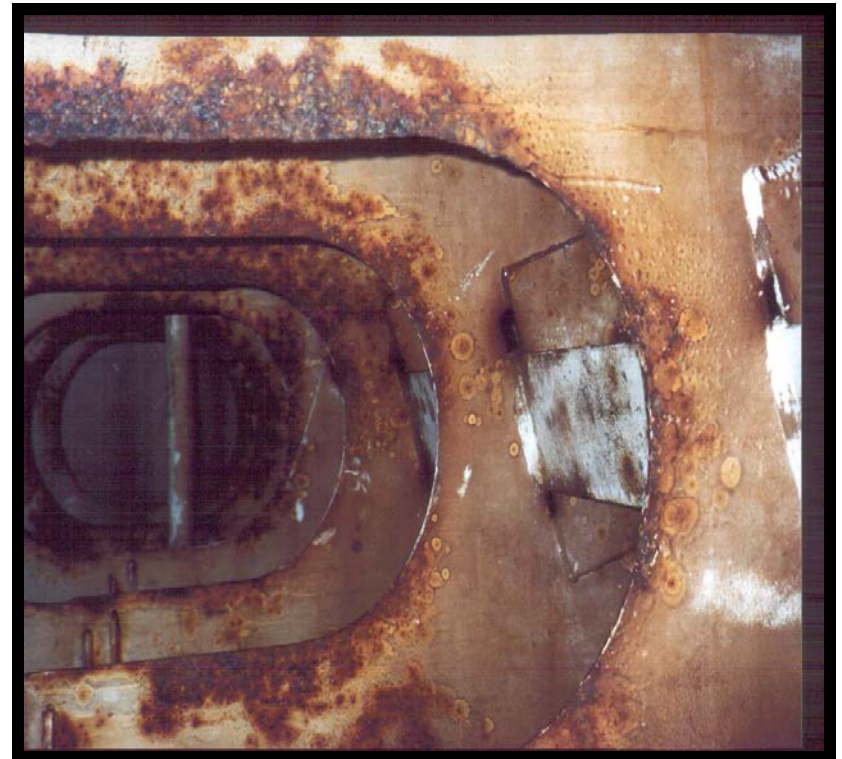
MIL-DTL-24441 (Mare Island)

- Solvent based polyamide epoxy
- Used extensively
- Average volume solids 67%
- Typical system 2 coats with total DFT 10-12 mils
- Non-edge retentive
- Dated technology
 - High in VOC
 - Better performing products desired



U.S.S. Ogden Seawater Ballast Tank

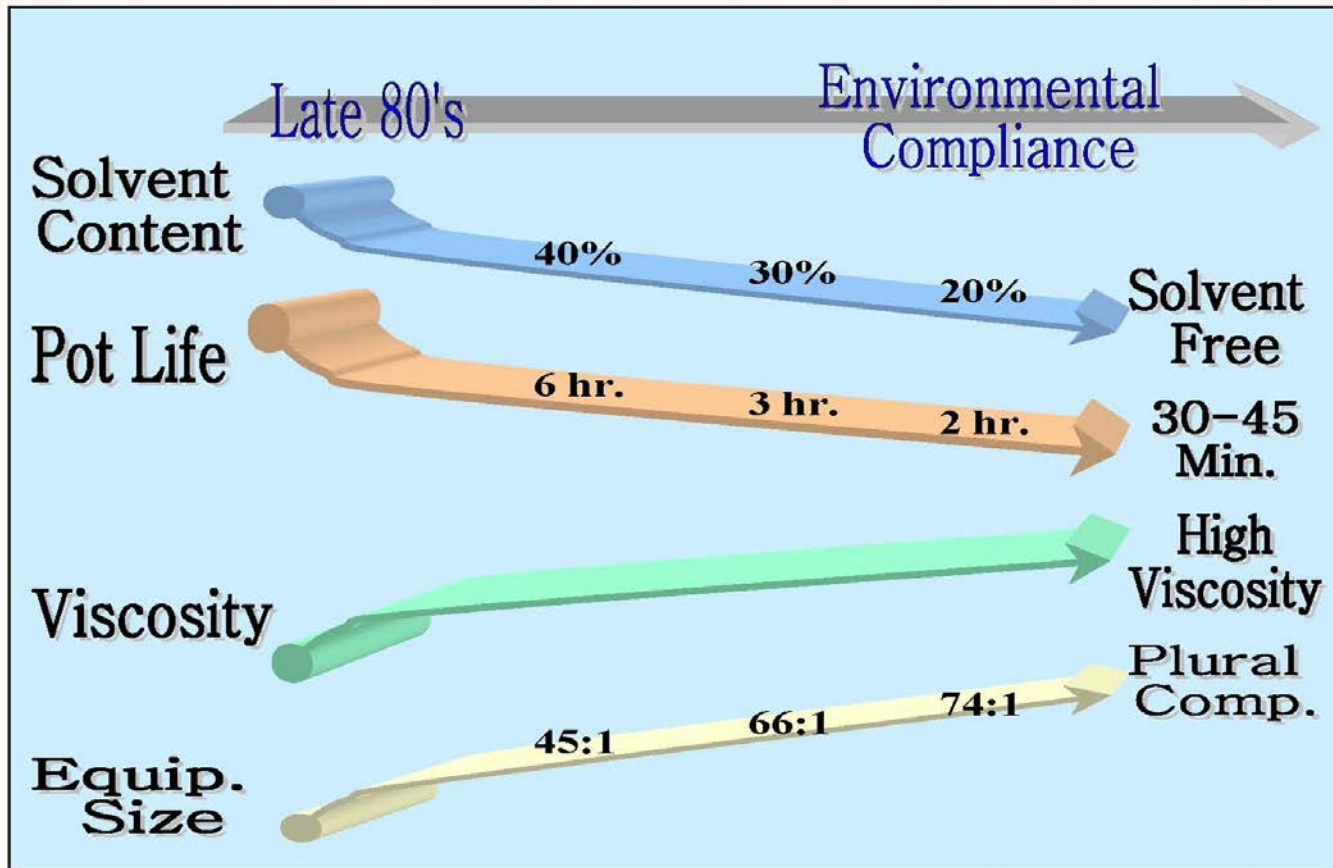
24441 Solvent Based Paint (Traditional/1994)



Condition of U.S.S. Ogden ballast tank after 36 months in service

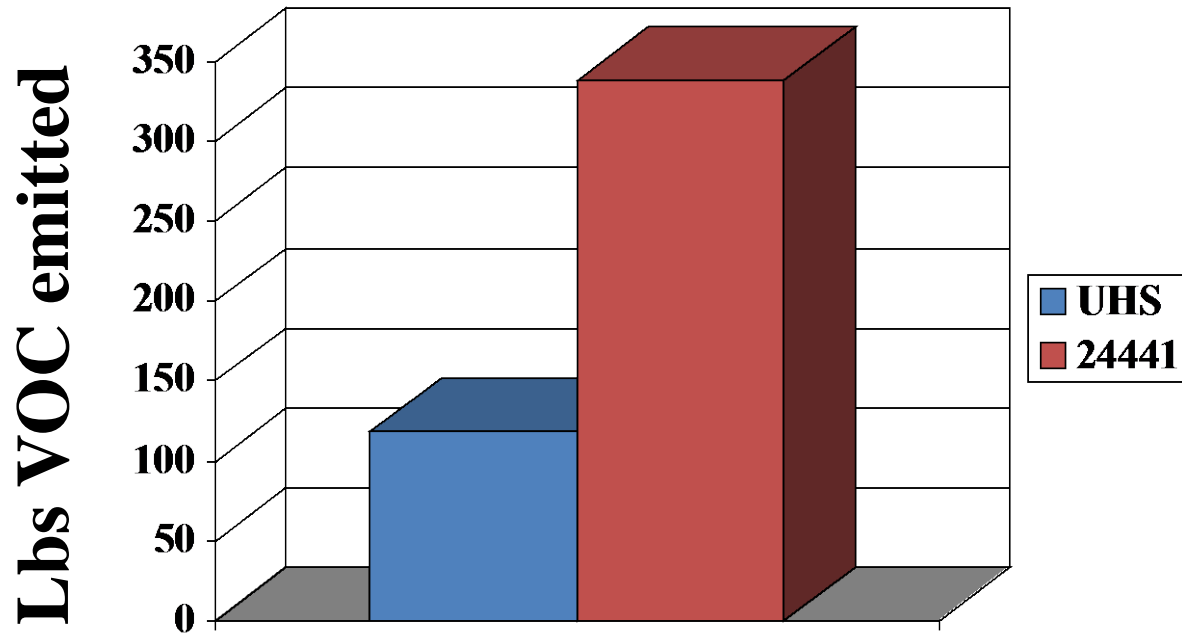
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Technology Shift in Coatings / Processes



VOC Emission Comparison

MIL-DTL-24441 (67% volume solids, 2.8 lbs/gallon VOC, 10 dry mils) versus
UHS (98% volume solids, 0.84 lbs/gallon VOC, 17 dry mils)
10,000 square foot tank, 30% loss factor

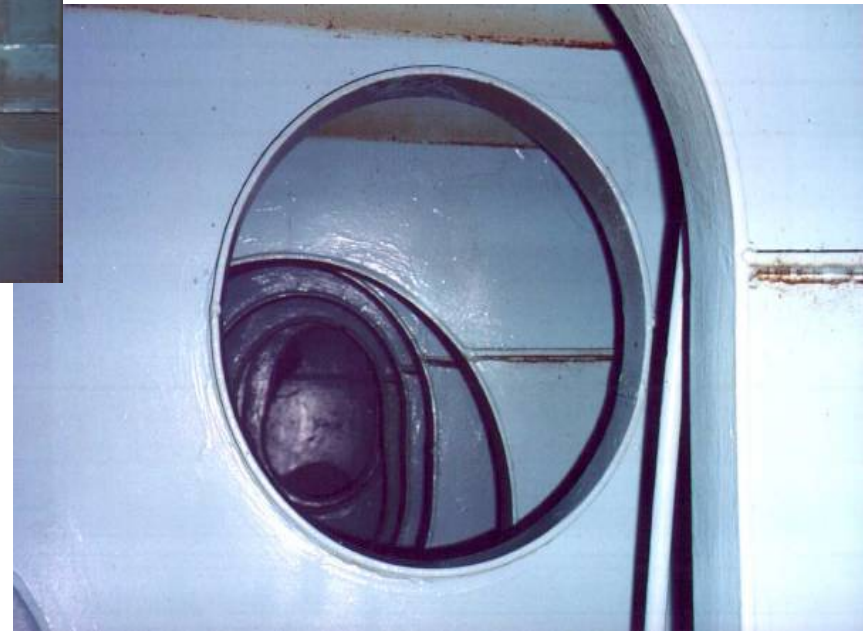


Ultra High Solids Primer & Topcoat

- Approved to MIL-PRF-23236, Type VII (<150 g/L)
 - Ballast, fuel, CHT, potable water
- Primer
 - Low viscosity penetrating primer
 - Applied at 4-8 mils DFT
- Stripe & Topcoat
 - High viscosity = edge retention
 - Stripe coat applied at 6-10 mils DFT
 - Topcoat applied at 10-12 mils DFT
- Flats are 14-20 mils, edges are 20-30 mils DFT
- Widely used on Navy ships and submarines from late 1990's into the 2000's



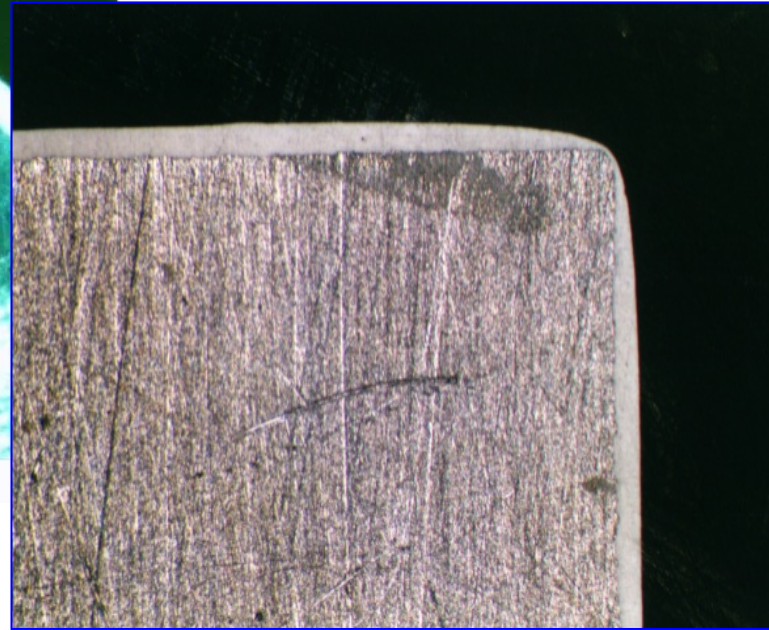
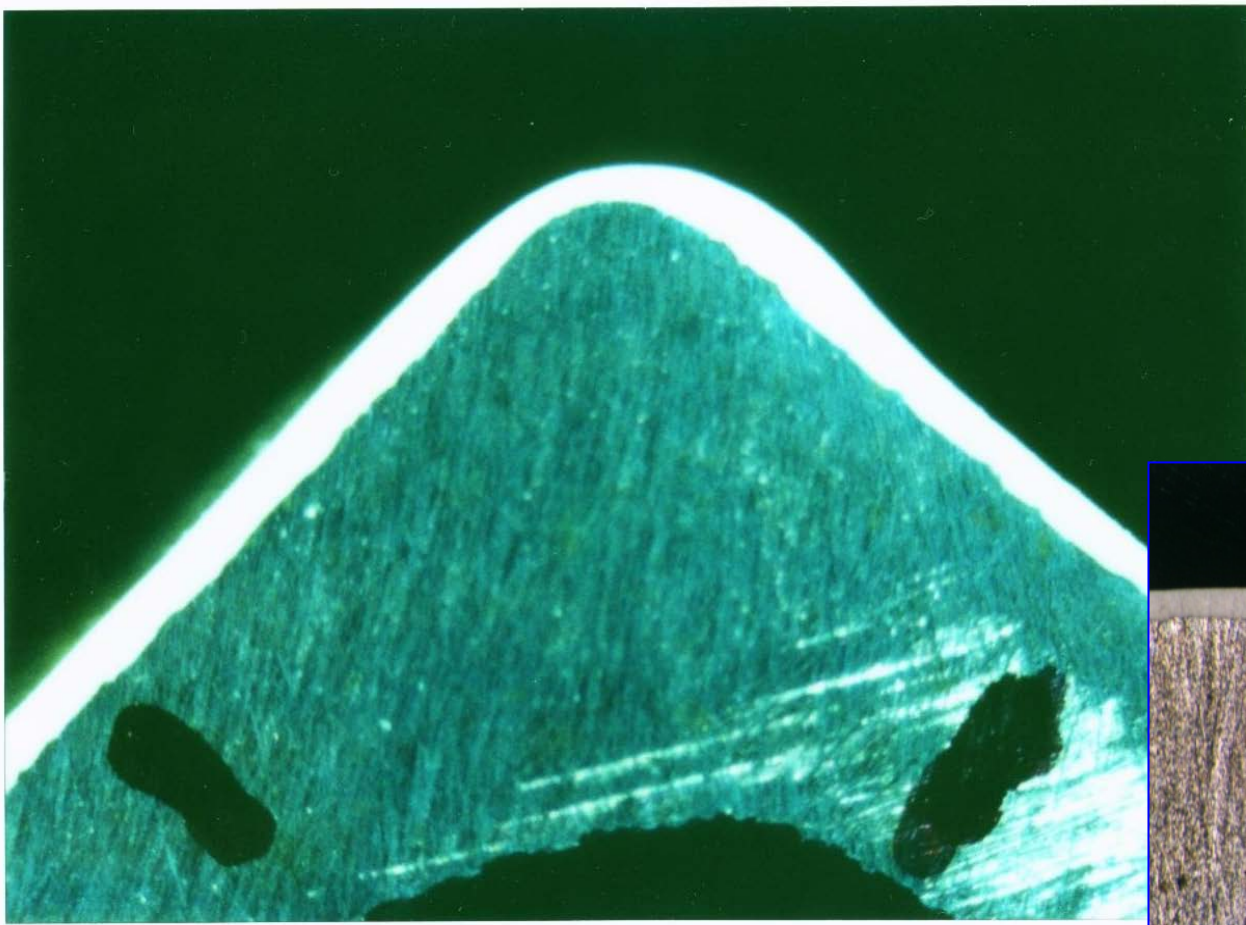
Ballast Tank UHS Edge Retentive System



Condition after 5 years



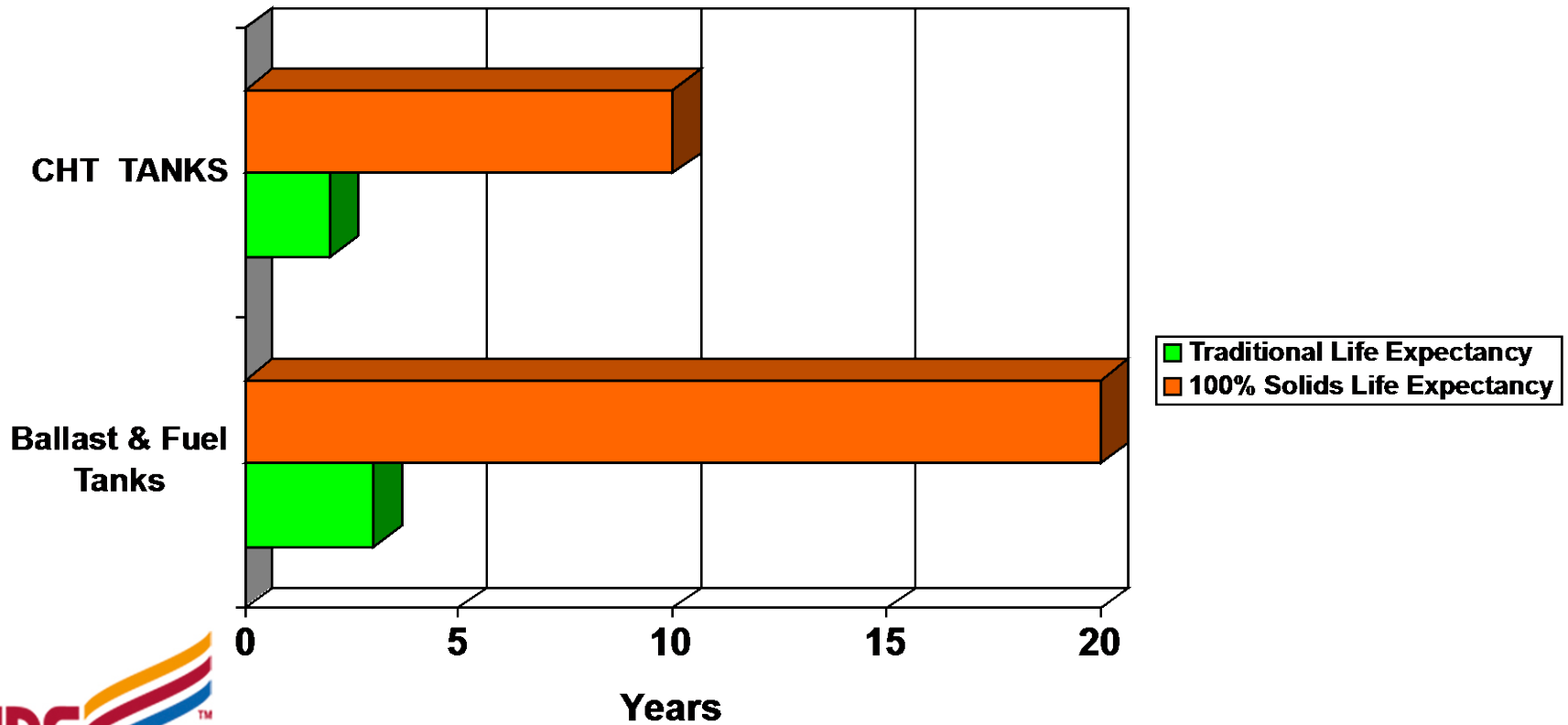
Edge Build Retention



MIL-PRF-23236 requires $> 70\%$



Increased Coating Life Cycles

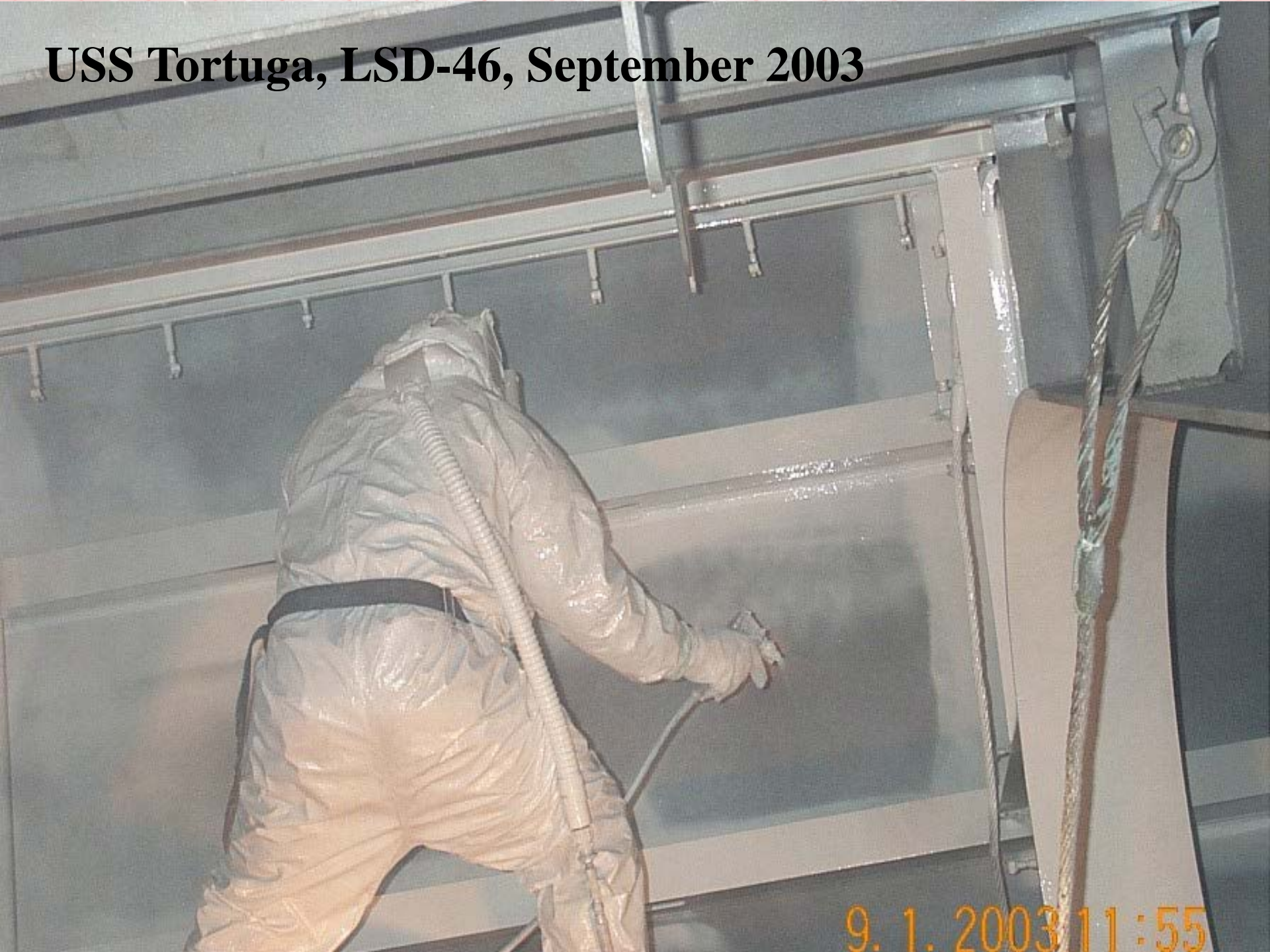


Single Coat, Rapid Cure Technology

- Next step in coating evolution
 - Equal or better performance
 - Apply quicker at reduced costs
 - Apply in single or reduced number of coats
- UHS, low VOC
- Edge retentive
- Short minimum recoat time (0-2 hours)
- Short cure to immersion time (24 hours)
- Plural pump application (short pot-life)
- Technology well received



USS Tortuga, LSD-46, September 2003



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USS Tortuga, LSD-46, September 2003



U.S.S. CARTER HALL LSD-50, PMA Fall 2006, Earl Industries Shipyard

Rapid Cure Coating Demonstration

Program Sponsor-ONR, Transition Authority-NAVSEA O5M.1, Tech Authority-NRL



Single Coat Rapid Cure Coating
with Fluorescent Additive
Total Application Time – 35 Hrs *



Two Full Coats Rapid Cure Coating
with Fluorescent Additive in base coat
Total Application Time – 70 Hrs *

***All times include touch-up**

**Application of Rapid Cure Coatings,
2 Full Coats & Stripe – est. 90 Hrs**



Standard UHS Coating,
NAVSEA Standard Item 009-32
(Prime, Stripe, Topcoat)
Total Application Time – 216 Hrs *



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NAVSEA Business Case

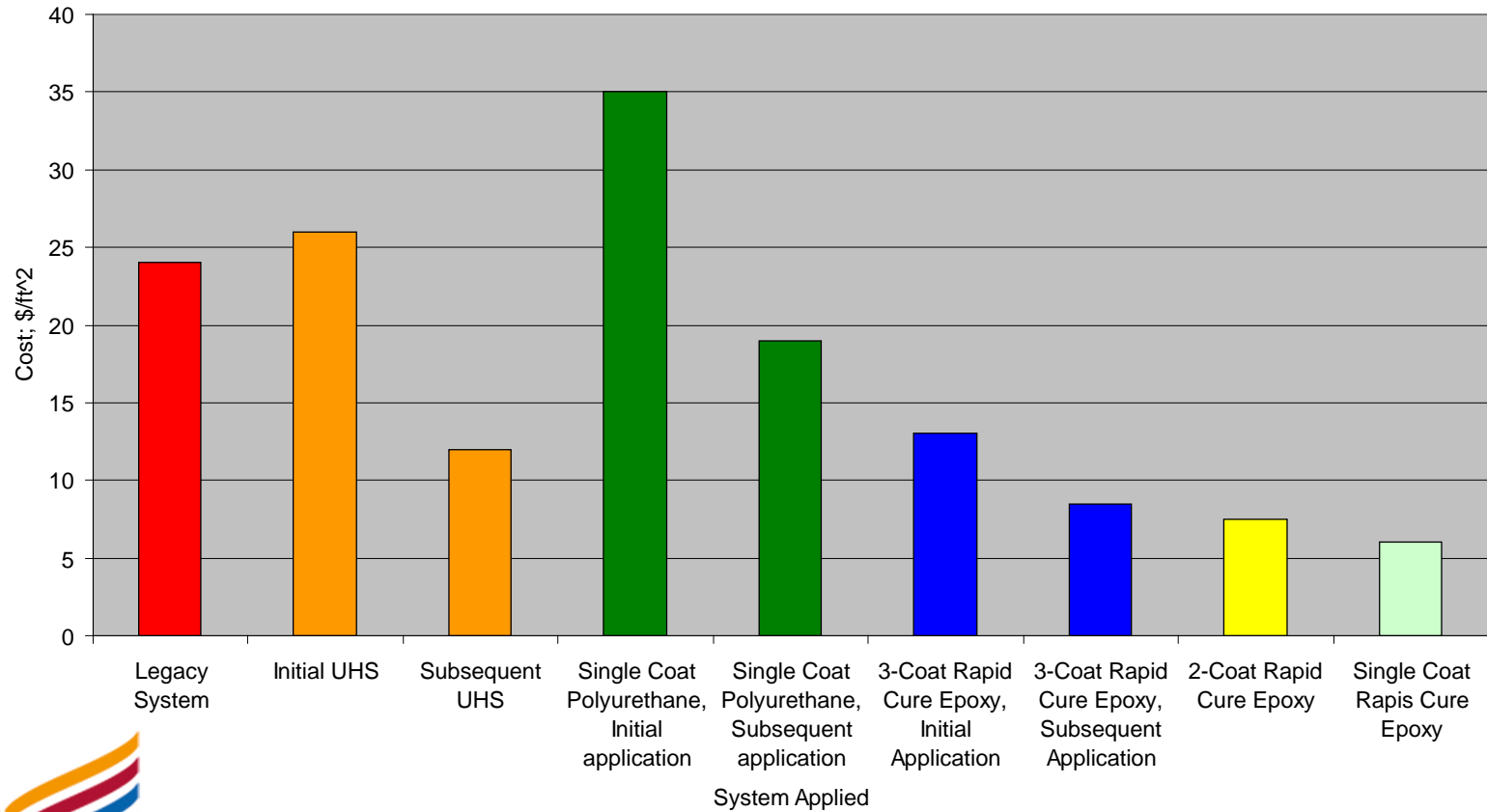
- Updated Business Case
 - Naval Shipyards Report 20% Total Paint Application Cost Reduction and 50% Schedule Savings (CWP Task Force)
- Material Cost Increased
 - 17 mil vs. 25 mil
- Facilities and Utilities Decreased
 - 12% reduction compared to UHS
 - 44% reduction compared to Legacy solvent coatings
- Labor Costs Decreased:
 - 58% reduction compared to UHS
 - 67% reduction compared to legacy solvent coatings

General Estimate: 20% Cost Savings &
50% Schedule Savings



NAVSEA Application Cost Comparison

(time savings also integral component)



USS WASP, Single Coat, Rapid Cure Coating Inspection

2 years, 2 months (Tank 5-101-1-W, Aug 30 2005)



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Tank And Void Cost Avoidance Metrics

Cost avoidance for UHS coatings due to increased service life through FY 2014

- **Ballast Tanks = \$ 956.18M**
- **Fuel/Comp Fuel Tanks = \$241.2M**
- **Potable Water Tanks = \$20.28M**
- **CHT Tanks = = \$79.31M**

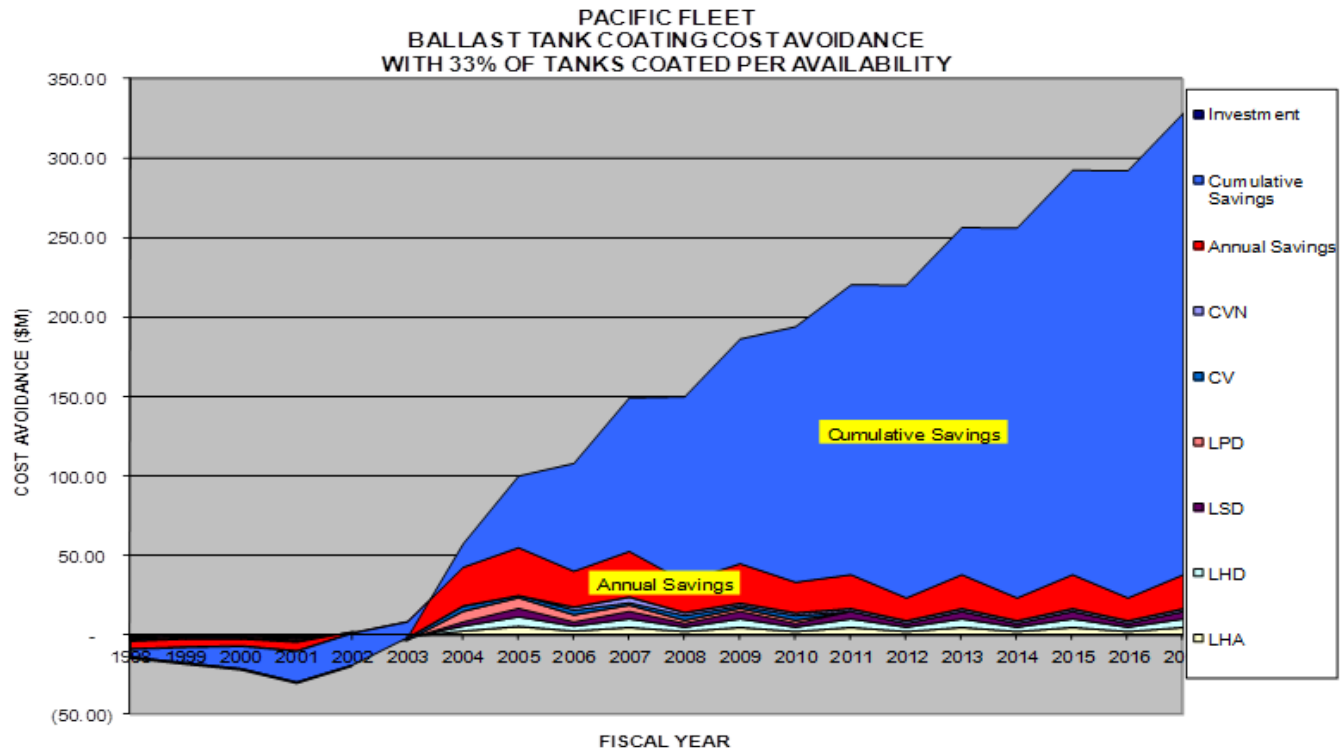
- **Total ≈ \$1.297 B**

- ❖ **Additional cost avoidance from single coat application**
- ❖ **≈ \$47.5M through March 31, 2015.**



NAVSEA 1997 Business Plan for High Solids, Edge Retentive Coatings

- 1997 plan to shift from a 3-5 year tank recoating periodicity for Mare Island to a 20 year service life (i.e., 80% of the population being in an **EXCELLENT** or **GOOD** condition at end of service period) by:
 - Qualifying ultra-high solids, edge-retentive paints.
 - Improving coating application process (e.g., surface cleanliness, profile, environment, and oversight).



Single Coat, Rapid Cure Markets

- US Navy
- Foreign Navies
- Commercial Marine
- Petrochemical Industry
- External Pipeline
- Municipal Water – NSF approved versions
- Derivations of base technology
 - Low temp application
 - High temp service
 - Glass flake and ceramic filled



Petrobras, QWHI Shipyard in Qingdao, China



Holiday Detection Goals

- Navy shipboard tanks
 - Small spaces
 - Complex geometry
- Holiday detection in ship tanks
 - Visual inspection with flashlight
 - Non-line-of-sight with mirror
- Goal
 - Enhanced tools to guarantee uniform holiday-free film
- **Critical with reduced # of coats**

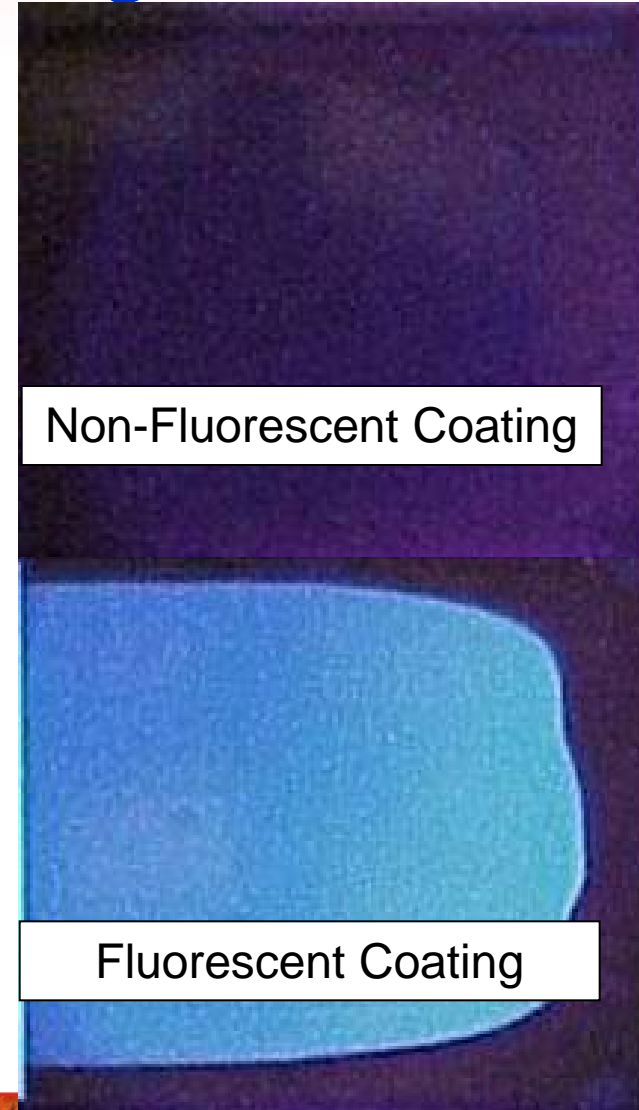


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Enhancing Visual Inspection with Fluorescent Coatings

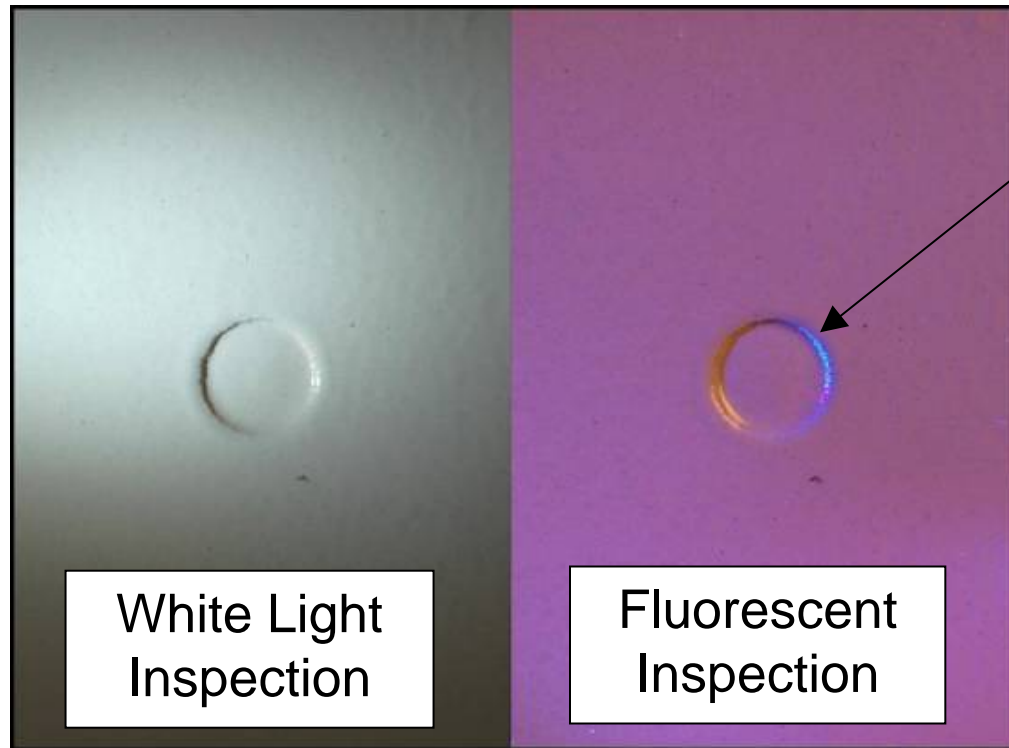
- Simple coating change to enhance defect contrast
 - Pigment addition
 - Illuminate with deep purple, eye safe light (> 400 nm)
- Implemented in coatings specification MIL-PRF-23236
- Detailed instructions in SSPC Technology Update Number 11 – Inspection of Fluorescent Coating Systems



Imagine if you could walk into a tank...turn on a light and have holidays or pinholes simply show up



Topcoat over Fluorescent Primer Holiday in Pit



Topcoat holiday-
blue crescent is prime
coat fluorescence

White Light
Inspection

Fluorescent
Inspection





- **U.S.S. Carter Hall**
- **Rapid cure, single and double coat, OAP**
- **OAP light source**



Inspecting Fluorescent Coat

- Inspection protocol
 - Experienced coatings inspector
 - 1st pass: white light inspection
 - 2nd pass: purple light inspection
- Inspection Results
 - 50% to 75% faster area scan rate
 - 25% more defects found
 - Pinhole defects seen from 2X standoff
 - 2 ft. with white light
 - 4 ft. with purple light
 - Brightness did NOT vary with film thickness from 4 mil to 20 mil



Cartridge Touch-Up Equipment

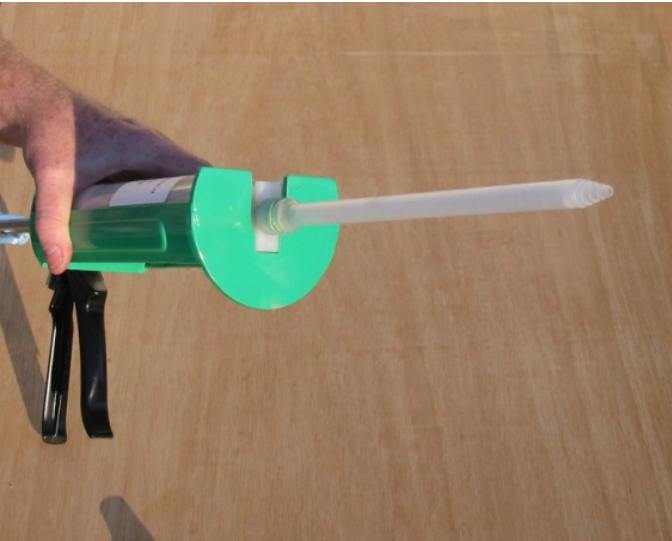
- Ideal for short pot life materials
- Variety of mix ratios (300 x 300, 750 x 750 mL)
- Variety of MIL-Spec and commercial coatings
- Transportable
- Easy to use - productivity
- Minimize waste
- Ensure proper mixing



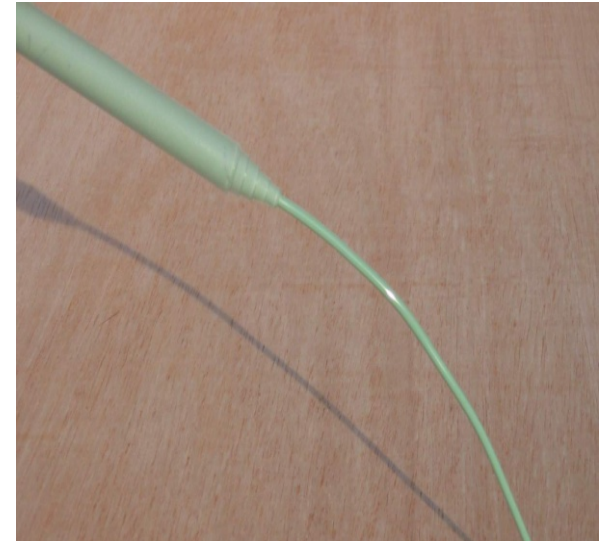


Cartridge Systems

Cartridge Manual Mixing & Dispensing



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Acknowledgements

- NAVSEA 05P2
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 - Dr. Paul Gossen
- Navy shipyards
- Private shipyards and contractor base



Summary

- Tank coating technology
 - Legacy MIL-DTL-24441
 - UHS
 - Single coat, rapid cure
 - Time and cost savings
- Optically active pigments
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