USN FLEET CORROSION CONTROL

“Future Navy Needs for Corrosion Control & Maintenance”

Rich Hays
Naval Surface Warfare Center, Carderock Division
January 13, 2009
1. REPORT DATE  
**13 JAN 2009**

2. REPORT TYPE

3. DATES COVERED  
**00-00-2009 to 00-00-2009**

4. TITLE AND SUBTITLE  
**USN Fleet Corrosion Control ’Future Navy Needs for Corrosion Control & Maintenance’**

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

6. AUTHOR(S)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)  
**Naval Surface Warfare Center, Carderock Division, 9500 MacArthur Blvd, West Bethesda, MD, 20817-5700**

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR’S ACRONYM(S)

11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT  
**Approved for public release; distribution unlimited**

13. SUPPLEMENTARY NOTES  
**2009 U.S. Army Corrosion Summit, 3-5 Feb, Clearwater Beach, FL**

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:  
   a. REPORT  
   **unclassified**  
   b. ABSTRACT  
   **unclassified**  
   c. THIS PAGE  
   **unclassified**

17. LIMITATION OF ABSTRACT  
**Same as Report (SAR)**

18. NUMBER OF PAGES  
**19**

19a. NAME OF RESPONSIBLE PERSON

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**Standard Form 298 (Rev. 8-98)**  
**Prescribed by ANSI Std Z39-18**
The NAVSEA Strategic Business Plan: Aligned for Success!

Secretary of the Navy

- Provide Total Naval Workforce
- Prosecute Global War on Terrorism
- Build the Force for Tomorrow
- Safeguard People
- Strengthen Ethics
- Provide First-Rate Facilities

Chief of Naval Operations

- Build a Navy for Tomorrow
- Maintain Current Warfighting Readiness
- Provide for Our People

Naval Sea Systems Command

- Build an Affordable Future Fleet
- Sustain Today’s Fleet Efficiently and Effectively
- Enable Our People
Key Initiatives

- Shipyard “Back to Basics”
  - Improve SSN 688 availability execution

- Virginia Class lifecycle cost reduction

- Eliminate cumbersome work practices and introduce new technology for submarine maintenance

- Reduce the cost of specifications
Seawater Tank Condition Monitoring
For Submarine Availability Pre-Planning

USS TOPEKA - Electro-chemical reference cell and data logger installation

Prototype Instrumented Zinc

USS MINNEAPOLIS/ST PAUL – Portable Optical Inspection Device on Permanent Mounts
Tank Monitoring System

Corrosion Sensor Data

USS TOPEKA

- Sherwin Williams Duraplate – High Solids - Good Performance

USS MINNEAPOLIS ST PAUL

- Mare Island 24441 – Legacy Navy Epoxy
  Decreasing Performance

Increasing Protection

Steady electrical potential vs Time

3 weeks Surfaced

Decreasing electrical potential vs Time

Graph file: Unsaved
SSN 708-MBT 3A

Initial 3/06

Final 1.5 yrs 12/07

% Damage Analysis

Camera Location

SSN 708

MBT 3A

3/06 6/06 12/07
1: 0.2% 0.9% 1.3%
2: 0.4% 1.0% 1.2%
3: 0.7% 1.5% 1.8%

MBT 4A

3/06 6/06 12/07
1: 0.2% 0.3% 0.7%
2: 0.3% 0.5% 0.6%

MBT 2A

9/06 4/07
1: <.05% 0.1%
2: 0.4% 0.1%

MBT 3B

9/06 4/07
1: 0.3% 0.2%
2: 0.1% 0.1%

MBT 4B

9/06 4/07
1: 0.3% 0.2%
2: 0.2% 0.1%
3: 0.3% 0.2%

MBT 5A

9/06 4/07
1: 0.2% 0.2%
2: 0.2% 0.2%

Mare Island Paint Installations

SSN 708

SSN 754

SSN 754
Eliminating Cumbersome Work Practices

Induction Heat

Phased Array UT

Single Coat

Eliminate Stripe Coat

SSTG Slip Ring Resurfacing Without Steam

Surface Condition Measurement Tools

HIGH-SOLIDS
STEEL SHIP

DFT Edge Probe

Phased Array UT

SSTG Slip Ring Resurfacing Without Steam

Surface Condition Measurement Tools

Eliminate Stripe Coat
Build an affordable future Fleet by reducing the cost of our specifications

Study Guides developed to assist Technical Warrant Holders (TWHs) in the investigation

Request For Information (RFI) posted on FEDBIZOPS

TWHs performing fact finding investigations

Identify cost savings while maintaining mission requirements

Perform a risk assessment and present to NAVSEA leadership for recommendations and acceptance

With consensus the documents will proceed into revision

Identify the full cost of our specifications
Documents Targeted for Technical/Cost Review

- MIL-STD-740-1 & 2 Airborne sound Measurements / Structureborne Vibratory Acceleration Measurements and Acceptance
- MIL-STD-1689 Fabrication Welding and Inspection of Ships Structure, MIL-STD-278 Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels
- MIL-M-17060 Motors, 60 Cycle, Alternating Current, Integral HP, Shipboard Use
- MIL-DTL-16036 Switchgear, Power, Low Voltage, Naval Shipboard in conjunction with use of MIL-Spec circuit breakers (MIL-C-17587, MIL-C-17361)
- MIL-STD-777 Schedule of Piping, Valves, Fittings and Associated Piping Components for Naval Surface Ships
- MIL-STD-461E Electromagnetic Interference (EMI)
- MIL-STD 464A Electromagnetic Environmental Effects (E3) Requirements for Systems
- MIL-STD-469B / NTIA Chapter 5 Radar Engineering Interface Requirements, Electromagnetic Compatibility

Identify the full cost of our specifications
Future Focus

- Affordability
- Fleet Readiness
- Effective Execution of Programs
  - Efficient Use of Tools
    - Design
    - Inspection
    - Monitoring
  - Technical Knowledge & Capability
Use of Non-traditional Alloys
- Aluminum Structure
- High Strength

New Applications
- Reduced Conservatism & Redundancy
- Mixed metals
- Extended Service Life
- Added Environmental Stressors

Reliance on Risk Analysis
- Knowledge
- Tool Sets
NAVSEA Support of S&T Efforts

- **ONR**
  - FNC CBM Tank Monitor System – *Successful Investment*
  - FNC EPE Single Ship Tank Coatings – *Successful Investment*
  - FNC EPE High Performance Coatings
    - Non-Skid Coatings for High Durability and Temperature Resistance
    - Advanced Topside Coatings for Increased Life
    - High Performance Rudder Coatings
  - FNC EPE Corrosion and Corrosion Related Signature Technologies for Improved Operational Availability
    - Real Time Hull Condition Assessment
    - Robust ICCP Anodes & Reference Cells
    - Redesign of Active Shaft Grounding
  - Proposed Innovative Naval Prototype Program for “*Maintenance Free Ship*”
    - Integrated Hull Shield
    - Transformational Interior Architecture
    - Engineered Topside & Freeboard Architecture

- **DARPA**
  - Naval Advanced Amorphous Coatings
  - Cavitation Resistant Alloys for Naval Propulsion
# Single Coat Rapid Cure

<table>
<thead>
<tr>
<th>SY</th>
<th>Ship</th>
<th>Tanks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portsmouth</td>
<td>USS Greeneville SSN 772</td>
<td>All seawater tanks &amp; voids</td>
</tr>
<tr>
<td>Norfolk</td>
<td>USS Harry S. Truman CVN-75</td>
<td>20 tanks &amp; voids</td>
</tr>
<tr>
<td></td>
<td>USS Norfolk SSN 714</td>
<td>No good candidates</td>
</tr>
<tr>
<td></td>
<td>USS Tennessee SSBN 734</td>
<td>MBT 5A</td>
</tr>
<tr>
<td></td>
<td>USS Boise SSN 764</td>
<td>No good candidates</td>
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<tr>
<td>Puget Sound</td>
<td>USS San Francisco SSN 711</td>
<td>Partially implemented - various tanks</td>
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<tr>
<td></td>
<td>USS Jimmy Carter SSN 23</td>
<td>Partially implemented - various tanks</td>
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<tr>
<td></td>
<td>USS Michigan SSGN 727</td>
<td>Partially implemented - various tanks</td>
</tr>
<tr>
<td></td>
<td>USS Seawolf SSN 21</td>
<td>Plan to fully implement in AUG 09</td>
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<tr>
<td>Pearl Harbor</td>
<td>USS Cheyenne SSN 773</td>
<td>Aux 1&amp;2, WRT 1&amp;2, FTT, Sail</td>
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<tr>
<td></td>
<td>USS Houston SSN 713</td>
<td>No painting required</td>
</tr>
<tr>
<td></td>
<td>USS La Jolla SSN 701</td>
<td>TBD</td>
</tr>
<tr>
<td>Private Yards</td>
<td>Various contract work</td>
<td>Working to implement single coat</td>
</tr>
</tbody>
</table>

**Eliminate Cumbersome Work Practices**
Disposable Paint Cartridge Dispensing Systems

DESCRIPTION: Transition commercially developed disposable paint cartridges dispensing systems for Fleet and or Depot use. Provide Fleet/Depot with advanced coating technology, coupled with ease of disposal configuration. Replace current equipment and HAZMAT disposal methods.

APPLICATION: Surface ships, submarines, and vehicles.

ROI ESTIMATE: 23.27

IMPLEMENTATION SCHEDULE

<table>
<thead>
<tr>
<th></th>
<th>1 QTR</th>
<th>2 QTR</th>
<th>3 QTR</th>
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<tbody>
<tr>
<td>Schedule Demonstration Visits at Depots</td>
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<tr>
<td>Visit Depots</td>
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<tr>
<td>Calculate Metrics</td>
<td></td>
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<tr>
<td>Issue Progress Report</td>
<td></td>
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<tr>
<td>Issue Final Demonstrations Report</td>
<td></td>
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</tr>
<tr>
<td>Transition Technology</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Issue CID “Manual Dispensing Gun”</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Identify “Paint Sprayer” Feasability</td>
<td>X</td>
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<tr>
<td>Identify “Power Roller” Feasability</td>
<td>X</td>
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<td>Draft Update for NAVSEA Std Item 009-32</td>
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<td>Draft Update for USMC Specifications</td>
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<tr>
<td>Issue NSNs</td>
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</table>

ACCOMPLISHMENTS/HIGHLIGHTS

• ESTABLISHED PROJECT TEAM
  • NSWCCD\NRL
  • PUGET SOUND NAVAL SHIPYARD
  • PORTSMOUTH NAVAL SHIPYARD: Visited 10 SEPT’08 reviewed developments/issues.

• DEVELOPED DEPOT AND SHIPBOARD EVALUATION PLAN

• WORKING CARTRIDGE APPLICATION TECHNOLOGIES (CAT) WITH SPRAY SYSTEMS OCTOBER

ASSESSMENT

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Apr</th>
<th>Jul</th>
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<tr>
<td>OVERALL</td>
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</table>
Corrosion Performance of AA5xxx and AA6xxx Alloys in Naval Environments

Background

Sea Power 21 requirements for high speed craft
- Littoral Combat Ship (LCS)
- Ship-to-Shore Connector (SSC)

Aluminum 5xxx alloys suffer from various forms of corrosion including exfoliation, intergranular corrosion, sensitization, weld/heat affected zone (HAZ) corrosion, and environmentally assisted cracking

Objective

Develop a set of laboratory tests that quantitatively characterize the performance of selected aluminum alloys in the Navy operational marine environment

APPROACH

Perform accelerated laboratory testing on base material and welds
- ASTM G66 and ASTM G67
- Potentiodynamic characterization

Characterize corrosion performance of alloys in natural seawater environment

Determine relationships between accelerated tests and long term performance

Develop capability to predict long term performance from laboratory tests

IMPACT

Reduce risk associated with the use of aluminum alloys in Naval structural applications

Rapid evaluation of new aluminum alloys

Basis for non-destructive method to determine degree of sensitization in service

PROGRESS

Performed G66, G67 and potentiodynamic testing on base metal and welds in as-received and sensitized conditions

Analyzing characteristics of potentiodynamic curves indicative of degree of sensitization

Initiated long term natural seawater exposures

Sensitized microstructure of AA 5383

Potentiodynamic scan for sensitized AA5383
DESCRIPTION: Replace metallic conduits/connectors that: corrode, require frequent repainting, & cause electrical equipment failure with composite connectors/conduits that do not corrode & require no topside maintenance.

APPLICATION: Weapon systems:
Navy surface ships, MSC ships, & Army watercraft.

ROI ESTIMATE: 12:1

MILESTONE SCHEDULE

<table>
<thead>
<tr>
<th></th>
<th>FY 07</th>
<th>FY08</th>
<th>FY09</th>
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<tbody>
<tr>
<td>Establish Working Group</td>
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<tr>
<td>Formulate Preliminary Design</td>
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<tr>
<td>Initial Shipcheck</td>
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<td>Approve Design</td>
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<td>Manufacture Prototype</td>
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<td>Conduct Certification testing</td>
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<tr>
<td>Conduct ship demonstrations</td>
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<tr>
<td>Draft changes to MIL-PRF-24758A</td>
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<tr>
<td>Conduct Final ship installation check</td>
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ASSESSMENT

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ACCOMPLISHMENTS/HIGHLIGHTS

- COMMERCIAL ITEM DESCRIPTION (CID) COMPLETED FOR CONDUIT INSTALLATION. SHIPCHECK OF SHIP DEMONSTRATION JUNE 2008
- DESIGN AND MANUFACTURING OF CORROSION RESISTANT, LIGHT WEIGHT COMPOSITE CONNECTOR HAS BEEN COMPLETED
- TESTING OF COMPOSITE CONNECTOR FOR MIL-PRF-24758A REQUIREMENTS ARE COMPLETED. ONE TEST NEEDS TO BE REPEATED
- INSTALLATION OF SHIP DEMONSTRATIONS ON DDG-52 AND CG-72 IS COMPLETE AND SHIPS HAVE DEPLOYED. NEED TO COMPLETE RETURN INSPECTION
SELF CLEANING COATINGS

DESCRIPTION: To determine if commercially available self-cleaning coatings and materials will be cost effective and eliminate need for cosmetic painting in areas where running rust is a problem.

APPLICATION:
Weapon systems: *Navy* surface ships, *Army* and *U.S. Marine Corps* vehicles

ROI ESTIMATE: 1074:1

MILESTONE SCHEDULE

<table>
<thead>
<tr>
<th>Implementation Schedule</th>
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<th>Q2</th>
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<tr>
<td>Identify commercially available candidate coating systems</td>
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<tr>
<td>Review coating system’s MSDS for compliance with environ,</td>
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<tr>
<td>Gather preliminary coating data from manufacturers and</td>
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<tr>
<td>Testing 5 coatings, 1 powder coat, and two polyurethane tapes</td>
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<tr>
<td>Modify performance specification sections for Mil-Prf 24635 and submit for approval</td>
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ASSESSMENT

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*Funding received on first week of January 08

Green: No disruption on costs, scheduling, and performance.
Yellow: Potentially may cause some disruptions (e.g. scheduling, increases in cost, degradation of performance, etc.).
Red: Likely to cause disruptions (e.g. scheduling, increases in costs, etc.).

ACCOMPLISHMENTS/HIGHLIGHTS

- Draft the end of FY08 technical report for reporting test results and analyses.
Summary

- Historically the Corrosion Community is well aligned with Program and Fleet needs
- Investment in Technical Capability is essential and dependent on S&T Programs
- Focus
  - Reduce Costs of Future & Legacy Fleet
  - Improve Our Understanding of Risk Factors

New in 2009

Corrosion Prevention and Control (CPC)
Cross Functional Team (CFT)
Sec. 903, signed 14 Oct 2008, & 10 USC 2228

NAVY Corrosion Prevention & Control Executive

“designate…the corrosion control and prevention executive within 90 days.”

OSD
CPC Office

NAVY Corrosion Prevention & Control (CPC) Team

ASN/RDA CHSENG

CFT Lead

NAVY Corrosion Prevention & Control Executive

NAVAIR
NAVSEA
MARCOR
ONR

NAVFAC
SPAWAR
NAVSUP

Cross Functional Team (CFT)

Membership