Implementing New Non-Chromate Coatings Systems
February 9, 2011

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1. REPORT DATE  
**09 FEB 2011**

2. REPORT TYPE

3. DATES COVERED  
**00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE  
**Implementing New Non-Chromate Coatings Systems**

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 Air Warfare Center, Materials Engineering Division, 22347 Cedar Point Road, Patuxent River, MD, 20670**

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  
**ASETSDefense 2011: Sustainable Surface Engineering for Aerospace and Defense Workshop, February 7 - 10, 2011, New Orleans, LA. Sponsored by SERDP/ESTCP.**

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  
**12**

19a. NAME OF RESPONSIBLE PERSON

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*Standard Form 298 (Rev. 8-98)  
Prescribed by ANSI Std Z39-18*
NAVAIR Non-Chromate Coatings Goal

Identify, test, validate and implement non-chromate primers and surface preparations which are as broad in capabilities and performance as current chromated primers and surface preparations.

- Performance across multiple alloys/substrates, with and without topcoats per MIL-PRF-85285 and TT-P-2760; in combination with specialty coatings
- Across all exposure conditions for all the materials currently protected by Class C materials.
- Galvanic Corrosion Protection – faying surfaces, dissimilar materials interfaces, wet installation of fasteners and bushings, SCC, exfoliation, etc.
- Surface Prep/Primer Compatibility –
  - Type I and Type II conversion coatings per MIL-DTL-81706/MIL-DTL-5541
  - Type I, IC, II, or IIB anodized aluminum per MIL-A-8625
  - Sacrificial coatings (such as IVD-Al, Cd, Zn-Ni, etc.)
  - Fe alloys, other conversion coated or anodized light metals such as Ti and Mg and composite substrates
  - Adhesion, filiform, humidity, and fluid resistance properties
NAE Position on Cr6+ and Path Forward

• Cr6+ is used in 10 major metal finishing and corrosion protection processes, with many sub-processes
  – Cost impact is highest for compliance when removing Cr6+ containing coatings, especially sanding at FRCs
  – Application of most materials can be achieved while complying with regulations

• Alternatives can be implemented during design and production by OEMs and subcontractors and at Navy and contractor facilities which carry out O, I and D-level maintenance.

• Many uses include critical engineering applications including adhesive bonding, wear surfaces and corrosion protection on high-strength steels, and protection of critical structure

• Compliance with memos and expected DFARs contract language will increase cost of acquisition environmental and corrosion support

• Implementation of alternatives is not trivial and requires a risk reduction approach, especially for primers

• RDT&E needs to be prioritized and linked to Cr6+ goals
Cr6+ Waiver Process

• NAVAIR has established a waiver process

• Process in place to meet requirements of Cr6+ DFARs, once released

• Actions likely to originate with EPAT leads

- Determine cost effectiveness and evaluate technical feasibility of alternatives.
- Conduct ESOH risk evaluation (note: alternatives must have MRL >or=8).
- Establish material availability of Cr6+ versus alternatives over lifecycle.
- Determine corrosion performance differences of alternatives in coordination with Navy’s Corrosion Prevention and Control Executive.

Do viable alternatives exist?

YES

NO

- Initiate Cr6+ authorization process for continued Cr6+ use using the form, Authorization to Use Hexavalent Chromium.

Coordinate with Navy Corrosion Prevention and Control Executive prior to submitting to PEO.

PEO approves authorization request to use Cr6+.

- Ensure all contracts incorporate DFAR 223.73 language.
- Cr6+ identified on weapon system (W/S), subsystems, and components via OEM.
- Seek alternatives via contract with OEM. Government verify contract efforts.

Are alternatives proven, available, and meet MRL >or=8?

YES

NO

- Approval of alternatives by W/S PM and Corrosion SME designee.
- Change technical/maintenance manual or publications to direct alternative use.

- Update PESHE (at Milestones B.C, and FRP) with system specific Cr6+ risks and efforts to include cost/schedule risks, life cycle cost comparisons among alternatives (e.g., material handling and disposal, system overhaul cycle times/costs due to differences in corrosion protection).
- Address corrosion evaluations, alternatives, and tradeoffs in the Corrosion Prevention and Control Plan; required for ACAT I programs at Milestones B and C.
**Implementation Points**

- **Design- Implemented at OEMs/Suppliers**
  - New design: finish specifications
  - Easiest to implement, lowest cost, difficult to validate alternatives

- **Production- Implemented at OEM/Suppliers**
  - Engineering Change Proposal (ECP): drawings
  - Medium difficulty to implement, variable cost, validation on fielded assets possible

- **Fielded- Implemented at Gov’t and Contractor Facilities**
  - ECP and Local Process Specification modifications; Contract changes; 01-1A-509 and other General Series manual changes
  - Medium difficult to implement for immersion processes, easier for spray and touch up; validation on fielded assets typical
Implementation Progress

- Use of Chromates in Inorganic Coatings and Processes
  - Alternatives authorized for
    - Aluminum and magnesium anodizing
    - Hard Chrome Plating
    - Type II conversion coating on aluminum alloys under chromated primer
    - Type II conversion coating on Alumiplate under chromated primer
    - Sealing of Type IC, IIB, II and III anodize using Type II conversion coatings (TCP)
  - Alternatives pending authorization
    - Conversion coating magnesium and titanium
    - Sealing of phosphate coatings
  - Alternatives being assessed in demonstration and validation projects
    - Type II conversion coating on aluminum alloys with Class N primers
    - Post treatment of IVD aluminum
    - Post treatment of IZ-C17+ ZnNi
    - Type II conversion coatings on aluminum: Class 3 applications
Implementation Progress

• Use of Chromates in Organic Coatings and Processes
  – Alternatives authorized for
    • Priming of support equipment (MIL-DTL-53022)
    • Sealing- various specifications
    • Priming aircraft/components: scuff sand and overcoat applications
  – Alternatives pending authorization
    • None currently
  – Alternatives being assessed in demonstration and validation projects
    • Primer “direct to metal/conversion coating” in coating systems with chromated or non-chromated conversion coatings
    • Galvanic primers in total NC systems
  – Alternatives requiring additional research and development
    • Adhesive bond primers
    • Combination of NC primers with other NC finishing options in most applications
NAVAIR Primer Issues

• “Silver” Standard – MIL-DTL-5541 Type II/MIL-PRF-23377 Class N
  – Most applications covered – 95+% solution (Type I and Type II)
  – Next Gen Primers needed for Type I and II to meet/exceed chromated coating system performance: just about all Class N work is on Type I products
  – Robustness is Key – Most robust surface preparations + most robust organic coatings = Most robust coating systems
  – Misconception regarding resins – both primer specs are 340 g/L

• Resin Properties often overlooked –
  – Inhibitor is not the only functional component, adhesion and barrier properties controlled by resin system
  – Impacts pigment loading and inhibitor release function
  – 23377 High-solids “solvent-borne”: superior resin system for total protection
  – 85582 “water-borne”: better application characteristics
  – Effect more pronounced in Class N primers, but diminishing as Class N primers are improving
    • Rely more on surface preparation performance
NAVAIR Non-Cr6+ Efforts

• **Ongoing**
  - AERMIP- Dem/Val Class N primer/ZVOC topcoat; GSE focused on aluminum
  - ESTCP WP-201010- eCoat primer; aligned with new ESTCP NC Primer project
  - ESTCP WP-201011- self sealing fasteners (non-chromate sealers/primers)
  - ESTCP WP-200906- NC ZVOC coatings (ARL lead); GSE focused on steel
  - SERDP WP-1673- accelerated dynamic corrosion test method (SWRI lead)
  - SERDP WP-1620- scientific understanding of NC inhibitors (Ohio State lead)
  - ESTCP- CoP electroplating
  - DLA- Type II conversion coating touch up pens
  - NAVAIR/NISE- NC primer development and characterization

• **New**
  - NESDI NC Primer Dem/Val– Supports implementation of qualified Type I and Type II Class N primers at NAVAIR user sites. Includes Type I and II conversion coatings.
  - ESTCP WP-201037- Folds in efforts on e-Coat, Magnesium Rich Primer, Crosslink Primer, and others in development. Will streamline investment in NC primer maturation and dem/val.
  - OSD– Type II, Class 3 Conversion Coatings; electronics requirements
  - NESDI IZ- C17+ zinc-nickel, with non-chromate passivations
  - NAVAIR/NISE- Type II conversion coating dem/val of Surtec 650V
Advanced Anodizing using Process Control Technology
(slide courtesy of FRC-SE/R. Prado)

- NESDI N-0086-02: Low HAP Coatings, Solvents and Strippers.
  - Integration of Metalast Process Control technology for producing Type II, IIB & III coatings within one tank system for Depot-Level maintenance
  - Metalast Process Control Technology to include Interface Controller, Process Controller & Bath Additive
  - Evaluate TCP as a non Cr+6 post anodize sealer for all coating types.
  - ROI: 30.7 or Payback Period of 2.1 Yrs

**Capabilities gained:**
- Reduces Operator error and Supervision of Process
- Improved quality, accuracy and repeatability
- Reduces defects and rejects
- Accountability of Work Performed

**Efficiencies achieved:**
- Reduces cycle & throughput times
- At least 15% more efficient than conventional anodizing

**Environmental benefits achieved:**
- Extends life of bath chemistry/ Reduced Waste
- Energy savings due to use of aluminum cathodes
- Allows for consolidation of anodizing processes
- Elimination of Hexavalent Chromium

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<tr>
<td><strong>Total</strong></td>
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FRC-SE (JAX) Fully Integrated
FRC-E (CP) Fully Integrated
FRC-SW (NI) Integration in Process
TCP shows better performance than Dichromate Sealing

TCP-HF (1:1)
Panels A2-B2C (1 – 5)
15 minute seal @ 203°F
7,272 Hrs NSF
Average Coating Weight: 2,880 mg/ft² (~1.27 µm)
Current Density used: 12 ASF for 40 min

TCP-HF (1:1)
Panels A2-B2T (1 – 5)
10 minute seal @ 80°F

Dichromate Seal (5% wt)
Panels A2-BS1C (1 – 5)
15 minute seal @ 203°F
2,033 Hrs NSF
Average Coating Weight: 450 mg/ft² (~2.6 µm)
Current Density used: 8 ASF for 13 min

Dichromate Seal (5% wt)
Panels A2-BS1T (1 – 5)
10 minute seal @ 80°F

Type IIB TCP sealed coupons went well beyond 3,000 hrs before significant pitting corrosion was visible
Conclusions & Path Forward

• Alternatives available for most applications- authorization and transition underway in many areas

• Implementation of qualified NC primers on low risk applications/aircraft underway

• Field testing of qualified NC primers/coating systems on higher risk applications and aircraft underway with more to come

• An Engineering Circular was recently completed which documents NAVAIR Materials Engineering Division policy for NC Coating Systems and contain information on:
  – State-of-the-art products & processes
  – Transition drivers
  – Testing requirements
  – Demonstration and validation requirements
  – Transition approach
  – Risk analysis
  – Implementation recommendations

(see talk on Thursday for more details on the NC engineering circular)