Implementing New Non-Chromate Coatings Systems
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**Implementing New Non-Chromate Coatings Systems**

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

**Unclassified**
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**

**Diagram:**
- Determine cost effectiveness and evaluate technical feasibility of alternatives.
- Conduct ESOH risk evaluation (note: alternatives must have MRL \(\geq 8\)).
- 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.

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

**No:**
- Do viable alternatives exist?
- Are alternatives proven, available, and meet MRL \(\geq 8\)?
- 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.

**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+.**

**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; alinged 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- accerated 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.
  – 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
(slides 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

- FRC-SE (JAX)
  Fully Integrated

- FRC-E (CP)
  Fully Integrated

- FRC-SW (NI)
  Integration in Process
Advanced Anodizing using Process Control Technology

(slides courtesy of FRC-SE/R. Prado)

TCP shows better performance than Dichromate Sealing

**2,033 Hrs NSF**

Average Coating Weight: 450 mg/ft² (~2.6 µm)
Current Density used: 8 ASF for 13 min

**Type II TCP sealed coupons went well beyond 3,000 hrs before significant pitting corrosion was visible**

**7,272 Hrs NSF**

Average Coating Weight: 2,880 mg/ft² (~12.7 µm)
Current Density used: 12 ASF for 40 min

**Dichromate Seal (5% wt)**
Panels A2-BS1C (1–5)
15 minute seal @ 203°F

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

**TCP-HF (1:1)**
Panels A2-B2C (1–5)
15 minute seal @ 203°F

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