Implementing New Non-Chromate Coatings Systems

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Craig Matzdorf
Materials Engineering Division
NAVAIR

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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.

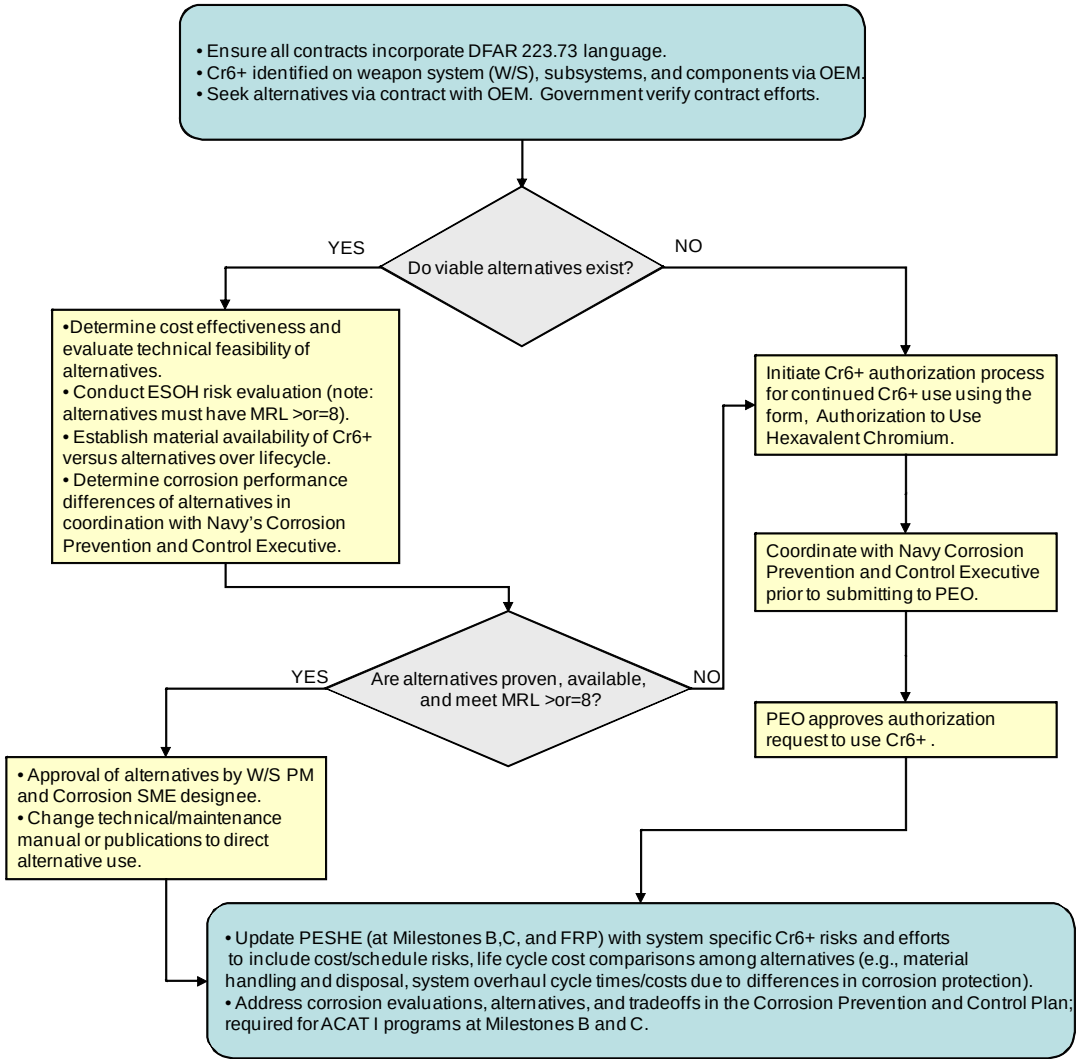
- **Performance across multiple alloys/substrates, with and without topcoats per MIL-PRF-85285 and TT-P-2760; in combination with specialty coatings**
- **Across all exposure conditions for all the materials currently protected by Class C materials.**
- **Galvanic Corrosion Protection – faying surfaces, 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**



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.
  - 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)

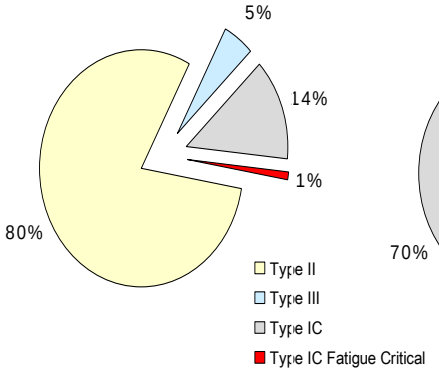
- NESDI N-0086-02: Low HAP Coatings, Solvents and Strippers.
  - Integration of Metalast Process Control technology for producing Type II, IIB & III coatings within one tank system for Depot-Level maintenance
    - Metalast Process Control Technology to include Interface Controller, Process Controller & 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

Tank	Process	Volume (gals)
3	Conv Coat	390
8	Conv Coat	600
9	Andz Sealer	1,885
12	Deox	1,885
30	Mag Treat	730
205	Deox	260
212	Andz Sealer	260
	Total	6,010

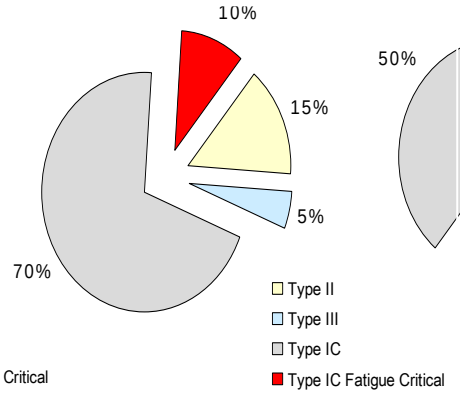
Potential Replacement with TCP

NESDI Project will lead to >35% volume reduction of Cr^{+6} usage in FRC-SE Treatment Shop

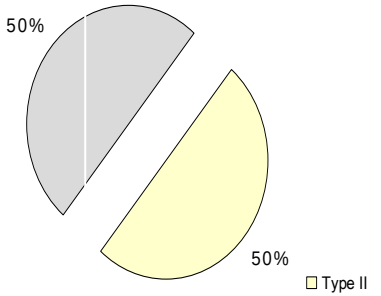
- Capabilities gained:
  - Reduces Operator error and Supervision of Process
  - Improved quality, accuracy and repeatability
  - Reduces defects and rejects
  - Accountability of Work Performed
- Efficiencies achieved:
  - Reduces cycle & throughput times
  - At least 15% more efficient than conventional 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



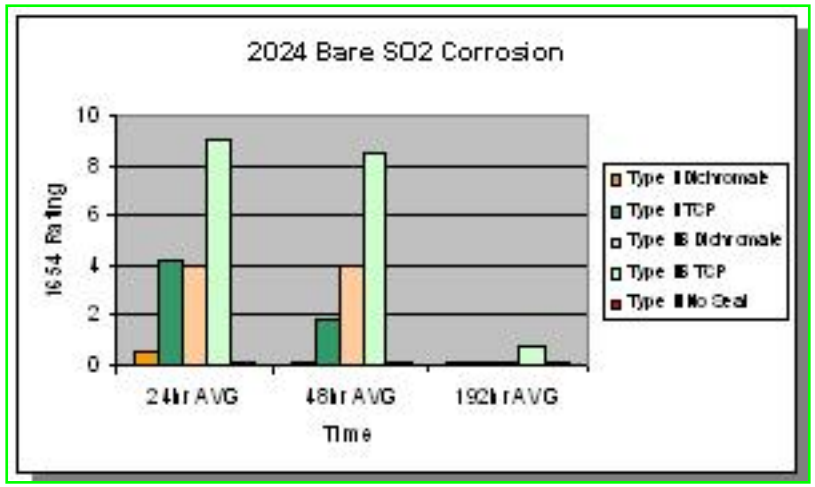
FRC-E (CP)
Fully Integrated



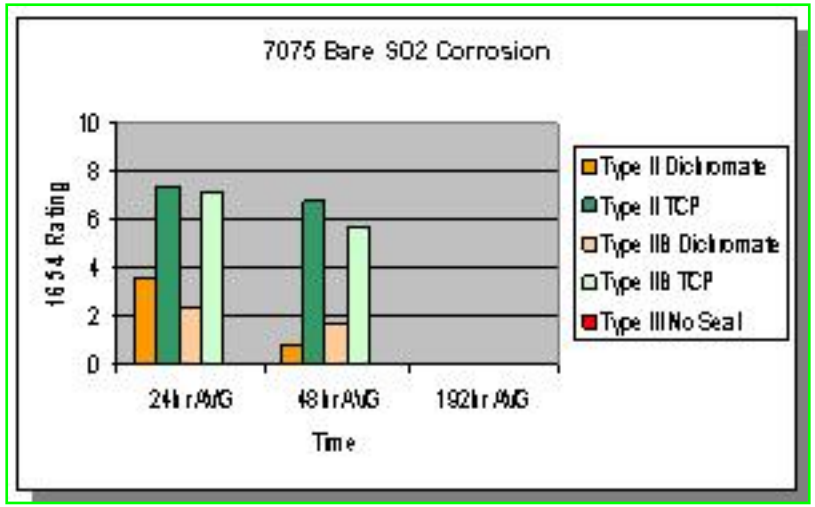
FRC-SW (NI)
Integration in Process

Advanced Anodizing using Process Control Technology

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



TCP shows better performance than Dichromate Sealing



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

TCP-HF (1:1)
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

Dichromate Seal (5% wt)
Panels A2-B2C (1 – 5)
15 minute seal @ 203°F

7,272 Hrs NSF

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

Average Coating Weight:
2,880 mg/ft2 (~1 2.7 µm)

Current Density used:
12 ASF for 40 min

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)