Air Force Successes & Challenges in Cr(VI) Minimization

1st Lt Nicholas Herr
Materials Chemist
AF Corrosion Prevention and Control Office
AFRL/RXSSR
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**Air Force Research Laboratory, AF Corrosion Prevention and Control Office (AFRL/RXSSR), 325 Richard Ray Blvd, Bldg 165, Robins AFB, GA, 31098-1639**

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Why Use Cr(VI)?

- **Very Effective Corrosion Inhibitor**
  - Arrests surface corrosion on legacy aircraft
  - Used in most demanding applications

- **Established Track Record**
  - Used in corrosion control for 40+ years

- **Organizational Inertia/Resistance to Change**
  - New specs/standards, processes, training
  - Multiple new technologies to replace Cr(VI)
Why Eliminate Cr(VI)?

• Long Known to be a Carcinogen
  – Inhalation causes lung cancer
  – Recognized by ACGIH, EPA, IARC
• Increasingly Stricter OSHA regulations
  – PEL reduced 52 µg/m³ to 5 µg/m³
• International Pressure
• OSD Policy (Young Memo)
  – Extraordinary action to eliminate Cr(VI)
• DFARS Clause
• Diminished Manufacturing

Change is coming
prepare for a world without hex chrome
AF Challenges - General

• Technical Order ≠ Use
  – SPOs, OEMs are independent

• Lack of continuity

• Cr(VI) on legacy systems
  – Cr(VI) is familiar, arrests corrosion

• Organizational Barriers
  – Risky: few want to be first, accountable for failure
AF Successes – Non-Chrome Aluminum Pretreatments

- Outer Mold Line Repainting
- Pantheon PreKote™ SP
  - Adhesion promoter
  - C-130, C-5, F-16, T series
- DEFT
  - RECC 1015/3021
- Boeing Commercial - 737
  - Boegel EP II/AC 131
AF Challenges – Non-Chrome Aluminum Pretreatments

• Outer Mold Line only
  – Cr(VI) used elsewhere

• Approved for use only under chromate primers
  – Bulk of Cr(VI) volume contained in primer
  – Cr still relied upon for corrosion protection

• No New Specs/Standards
  – Alternatives are sole source
  – Non-Cr alternatives added to Cr(VI) spec (MIL-DTL-81706), weapon system approval required
AF Successes – Non-Chrome Primer

- DEFT Non-Cr Primers
  - F-35 44GN098 applied to interior/exterior at LMA
  - F-22 02GN084 approved for OML
  - F-15 02GN093 full PDM production, >25 a/c complete
    - Total Non-Cr System (RECC 1015+3021/02GN093/99GY013)

- AkzoNobel Mg-rich Primer (Aerodur 2100)
  - Promising so far
PreKote / Mg Rich Primer

- PreKote™ SP Adhesion Promoter
- Akzo Nobel Magnesium-rich Primer (Aerodur 2100)
  - Cathodic protection mechanism - sacrificial
- Performance equal to Cr(VI)
  - Lab/beach/flight testing
- Full C-130 test in planning stages
- MIL-PRF-32239 Qualification
- CTIO’s choice to meet USD(AT&L), Mr. Young letter

| Aluminum Alloy | AE 2100 Primer (~1 mil thick) | APC Grade Topcoat | PreKote |
AF Challenges – Non-Chrome Primer

• **Matching Cr(VI) performance**
  – Cr(VI) has 40+ years history

• **Legacy aircraft**
  – Pre-existing corrosion (KC-135, B-52)

• **Cost of Rework**
  – KC-135 JGAPP coating failure/repaint

• **Interior applications**
  – Legacy Cr(VI) for years to come
AF Challenges – Non-Chrome Primer

• **MIL-PRF-23377**
  – Originally QA for Cr(VI) primer
  – Non-Cr Type N added later (w/ SPO approval)

• **New technology = New spec**
  – Each Non-Cr substitute would require new spec

• **MIL-PRF-32239**
  – System spec, no mixing-and-matching components
AF Successes - Sealants

• SAE AMS 3265 as Non-Cr substitute to MIL-S-81733
  – T.O. 1-1-691 and 35-1-3

• Increasing use of AVDEC pre-cured gaskets
  – Virtually eliminates corrosion due to dissimilar metal contact
  – T.O.s
    • 1-1-691 Cleaning and Corrosion Prevention and Control, Aerospace and Non-Aerospace Equipment
    • 1-1-689 Cleaning and Corrosion Control
    • 35-1-3 Corrosion Prevention and Control, Cleaning, Painting, and Marking of USAF Support Equipment (SE)
Testing

• Testing to Failure
  – MIL-PRF-23377 only 2000 hrs neutral salt spray
  – New samples – galvanic couples

• Testing Under Real World Conditions
  – Laboratory ≠ Exposure/Flight Testing
  – Improvements to ASTM B117
  – Accelerated Outdoor Testing
The Road Ahead

• Sealant T.O. Changes
  – T.O.s 35-1-3 and 1-1-691
  – SAE AMS 3265, Non-Cr alternative for MIL-S-81733

• Support Equipment
  – MIL-PRF-53022 replacing MIL-PRF-23377 in 35-1-3

• Mg-Rich Primer Field Test

• MIL-PRF-32239 Coating System, Advanced Performance, For Aerospace Applications
Questions?