

Air Force Successes & Challenges in Cr(VI) Minimization



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Report Documentation Page

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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 $52 \mu\text{g}/\text{m}^3$ to $5 \mu\text{g}/\text{m}^3$
- **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 \neq 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**





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



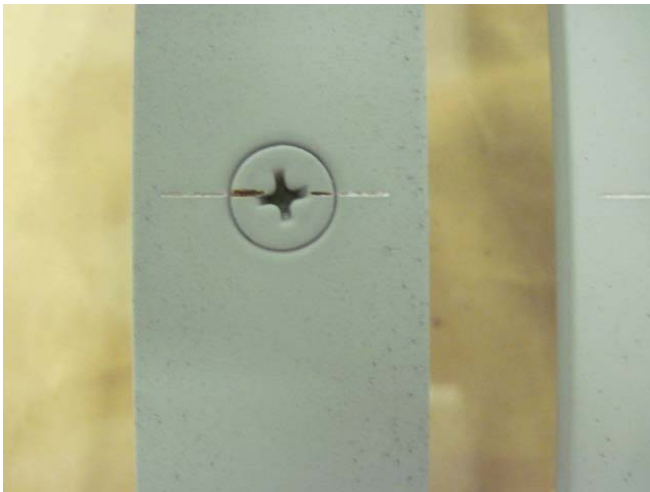
- **SAE AMS 3265 as Non-Cr substitute to MIL-S-81733**
 - T.O. 1-1-691 and 35-1-3
- **Increasing use of AVDEC pre-cured gaskets**
 - Virtually eliminates corrosion due to dissimilar metal contact
 - T.O.s
 - 1-1-691 *Cleaning and Corrosion Prevention and Control, Aerospace and Non-Aerospace Equipment*
 - 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 \neq 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?