Strategy for Cd and Cr\textsuperscript{6+} Replacement in Depots

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Overview

- The Cd and Cr\textsuperscript{6+} Challenge
- 5-Year Strategy and Roadmap
  - Objectives
  - Background and Problem Definition
  - Implementation Plans
- Progress
- Conclusions
Challenge

Why replace Cr⁶⁺ and Cd?

- Hexavalent chromium (Cr⁶⁺)
  - Known carcinogen
  - Attacks the respiratory tract, liver, kidneys, skin, and eyes
  - Exposures occur during welding, coating processes, and surface finishing processes
  - 76,074 pounds of Cr⁶⁺ used annually

- Cadmium (Cd)
  - Known carcinogen
  - Attacks the cardiovascular system, respiratory tract, reproductive system, neurological system, gastrointestinal system, and kidneys
  - Exposures occur during welding, coating processes, plating processes, and handling Cd coated fasteners and connectors
  - 684 pounds of Cd used annually
Challenge
Regulatory and Policy Drivers

- Clean Air Act (CAA)
- Clean Water Act (CWA)
- Emergency Planning and Community Right-to-Know Act (EPCRA)
- Resource Conservation and Recovery Act (RCRA)
- Toxic Release Inventory (TRI)
- DOD Instruction 5000.02
- Registration, Evaluation, Authorization and Restriction of Chemicals (REACH)
- Restriction of Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS)
- Memorandum from John Young, USD(ALT), to Secretaries of Military Departments, “Minimizing the Use of Hexavalent Chromium”

All that said…
5-Year Strategy and Roadmap

Objectives

Can we demonstrate a path to reducing and/or eliminating Cr\(^{6+}\) and Cd from our depots in a reasonable timeframe?

- Develop a strategy and roadmap to achieve >90% reduction of Cr\(^{6+}\) and Cd usage at DoD depots in 5 years

- Develop a strategy and roadmap to achieve >90% reduction of Cr\(^{6+}\) and Cd emissions, waste streams, and exposure potentials at DoD depots in 5 years

- Generate 3 depot-specific implementation plans to translate the strategy into finite, depot-level actions
5-Year Strategy and Roadmap
Background and Problem Definition

- Chromated primers
  - Aerospace primers
  - Wash primers
- Cr6+ plating
- Cd plating
- Chrome Conversion Coatings
  - Aluminum
  - Magnesium
- Stainless steel passivation
- Adhesives and sealants
- Cadmium brush plating
- Chromate sealers
- Anodize
- Phosphate coatings
- Black oxide
- Cadmium plating
- Topcoats and specialty coatings
- Coatings removal
- Stainless steel welding
5-Year Strategy and Roadmap

Background and Problem Definition

Top usage of Cr\(^{6+}\)
- Chromated Primers
- Adhesives and Sealants
- Chrome Plating

75+% of Cr\(^{6+}\) usage is chromate primers...have to replace chromated primers to meet strategic reduction goals
5-Year Strategy and Roadmap
Background and Problem Definition

Top usage of Cd
- Cd Brush Plating
- Cd Plating (tank)

Have to eliminate Cd from both processes to meet strategic reduction goals.
5-Year Strategy and Roadmap

Background and Problem Definition

- **Wastes**
  - Coatings removal
  - Solid and liquid hazardous wastes

- **Emissions**
  - Engineering controls
  - Stainless steel welding largest source of Cr\(^{6+}\) emissions

- **Exposures**
  - Engineering controls and PPE
  - Stainless steel welding

- **Infrastructure**
  - For some processes, a better reference than usage
  - Reflects burden or liability
### 5-Year Strategy and Roadmap

**Strategy and Roadmap Example**

<table>
<thead>
<tr>
<th>Actions/Initiatives</th>
<th>Depot(s)</th>
<th>Priority</th>
<th>Initiation</th>
<th>Alternative Technologies</th>
</tr>
</thead>
</table>
| **Goal 1** – Reduce the use of Cd and Cr\(^{6+}\) containing compounds in DoD depots by 90% in 5 years. | OC-ALC, OO-ALC, WR-ALC, FRCSE, FRCE, FRCSW | 1 | Ongoing | **Rare Earth Primers**  
- PPG Deft 02GN084  
- Hentzen 17176KEP**  
**Mg-Rich Primers**  
- Aerodur 2100  
**Al-Rich Primers**² |
| 1.1.1 Non-Chromate Primer on Aircraft OML | OC-ALC, OO-ALC, WR-ALC, FRCSE, FRCE, FRCSW | Ongoing |  | **Rare Earth Primers**  
- PPG Deft 02GN084  
- Hentzen 17176KEP**  
**Mg-Rich Primers**  
- Aerodur 2100  
**Al-Rich Primers**² |
| 1.1.2 Non-Chromate Primer on Aircraft non-OML Surfaces | OC-ALC, OO-ALC, WR-ALC, FRCSE, FRCE, FRCSW | Ongoing |  | **Rare Earth Primers**  
- PPG Deft 02GN084  
- Hentzen 17176KEP**  
**Mg-Rich Primers**  
- Aerodur 2100  
**Al-Rich Primers**² |

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**Goal**

1. Reduce the use of chromated primers in DoD depots by 90% within 5 years.

**Objective**

- Reduction in pounds of Cr\(^{6+}\) species (e.g., strontium chromate, barium chromate) as compared to the baseline established in this Strategy and Roadmap.

**Priority**

1

**Initiation**

Ongoing

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**Impacted Depots**

- OC-ALC
- OO-ALC
- WR-ALC
- FRCSE
- FRCE
- FRCSW

**When should the action be initiated?**

Ongoing

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**Potential Alternatives**

- Rare Earth Primers
- Mg-Rich Primers
- Al-Rich Primers²
5 Year Strategy and Roadmap

Priority Tiers

- **Tier 1 Priority Actions/Initiatives**
  - Critical to meeting strategic reduction goals
  - High impact to readiness

- **Tier 2 Priority Actions/Initiatives**
  - Moderate impact to strategic reduction goals
  - Moderate to high impact to readiness

- **Tier 3 Priority Actions/Initiatives**
  - Not critical to meeting strategic reduction goals
  - Low to moderate impact to readiness
5-Year Strategy and Roadmap

Tier 1 Initiatives

- Non-chromate primer on aircraft outer mold line (OML)
- Non-chromate primer on aircraft non-OML surfaces
- Non-chromate primer on off-aircraft components and commodities
- HAP-free, non-Cr$^{6+}$ wash primer
- Alternative to chrome plating
- Non-chrome chemical conversion coating for aluminum
- Alternative coatings removal processes to reduce Cr$^{6+}$-containing waste streams
- Implementation of engineering controls for stainless steel welding operations
- Alternative to cadmium plating
- Alternative to cadmium brush plating
Depot-Specific Implementation Plans
Overview

- Letterkenny Army Depot (LEAD)
- Fleet Readiness Center Southeast (FRCSE)
- Oklahoma City Air Logistics Complex (OC-ALC)
Depot Specific Implementation Plans

LEAD – Priority Initiatives

Tier 1 initiatives
- HAP-free, non-Cr(VI) wash primer
- Non-chromate conversion coatings for Aluminum
- Alternative to Cadmium brush plating
- Reduction of Cr\(^{6+}\) and Cd Spent blast media

- Specialty Coatings - CHOShield
- Chromate Conversion Coatings - Tank
- Cadmium Brush Plating
- Chromated Primers - Wash Primers
- Specialty Coatings - Silk Screen Red
- Chromate Conversion Coatings - Touch-up Pens
- Chromium Seal
- Chromated Primers - Other
Depot Specific Implementation Plans  
**LEAD – Past and Current Efforts**

- **Wash Primers**
  - Replacement Alternatives to the Chromate Wash Primer DOD-P-15328 (ARL)
  - Cr (VI)-Free, Low VOC Alternatives for Spray-in-Place, Mixed Metal Pretreatment (TMR 12-01)
  - Validation/Demonstration of a Zero-VOC/HAPS-NC Wash Primer for Department of Defense Weapons Platforms (WP-201621)
  - Non-Chromate, ZVOC Coatings for Steel Substrates on Army and Navy Aircraft and Ground Vehicles (WP-200906)

- **Chromated Conversion Coatings**
  - Cr(VI)-Free Conversion Coatings (TMR 14-02)
Depot Specific Implementation Plans

FRCSE – Priority Initiatives

Tier 1 Initiatives
- Chrome-free primer on OML
- Non-chrome primer on non-OML applications
- Non-chromate conversion coatings for Aluminum
- Alternative to hard chrome plating
- Alternative to coatings removal processes to reduce Cr\textsuperscript{6+} containing waste streams
- Alternative to cadmium brush plating
- Alternative to cadmium plating

- Chromated Primers
- Chrome Plating
- Cadmium Plating
- Chromate Conversion Coating
- Stainless Steel Passivation
- Adhesives and Sealants
- Cadmium Brush Plating
- Chromated Sealers
- Topcoats and Specialty Coatings
- Coatings Removal
- Stainless Steel Welding
Depot Specific Implementation Plans
FRCSE – Past and Current Efforts

- Chromated Primers
  - Non-Chrome Primers on OML of Gloss-Finish Aircraft
  - Non-Chrome Primers on OML of Tactical Aircraft
  - Comprehensive Evaluation and Transition of Non-Chromated Paint Primers (ESTCP WP-201132)

- Chrome Plating
  - Electrodeposition of Nanocrystalline Co-P Coatings as a Hard Chrome Alternative (ESTCP WP-200936)
  - Nanocrystalline Cobalt Alloy Plating for Replacement of Hard Chrome and Thin Dense Chrome on Internal Surfaces (ESTCP WP-200411)

- Cadmium Plating
  - LHE ZnNi for Cd Replacement at Jacksonville Navy Aviation Depot
Depot Specific Implementation Plans
OC-ALC – Priority Initiatives

Tier 1 initiatives
- Non-chrome primer on aircraft Outer Mold Line (OML)
- Non-chrome primer on non-OML Aircraft, components and commodities
- Non-chrome primer on composite parts
- Non-chrome electro-deposited E-Coat on KC-135 and E-3 parts
- Alternative to cadmium brush plating
- Non-cadmium containing safety red paint
- Alternative coatings removal processes to reduce Cr6+-containing waste streams

CCC
Primers
Specialty Coatings (Cr6+)
Cadmium Brush Plating
Specialty Coatings - Safety Red Paint (Cd)

Chrome Plating
Adhesive/Sealant
Cleaners + Coating removal
Specialty Coatings - Sealant/Adhesive (Cd)
Depot Specific Implementation Plans
*OC-ALC – Past and Current Efforts*

- **Chromated Primers**
  - Prototype Non-Chromate Coating System on E-3
  - Prototype Non-Chromate Coating System on KC-135
  - Evaluate Chemical Stripping Properties of the Non-Chrome Mg-rich Coating System
  - Prototype Non-Chrome Electro-deposited E-Coat on KC-135 and E-3 Parts

- **Chromated Conversion Coatings**
  - Non-Chromate Conversion Coating on Outer Mold-Line
  - Non-Chromate Conversion Coating on Flight Controls

- **Chromate Sealers**
  - Non-Chrome Sealer and Primer for Anodized Parts
  - Trivalent Chrome Dipsol IZ-264 for Post Treatment of Zinc-Nickel Plating
Progress
Program Synergies

- SERDP and ESTCP
- Toxic Metals Reduction (TMR) Program
- Naval Sustainability Development to Integration (NESDI) Program
- Various Air Force Research Laboratory (AFRL) efforts
- Various Army Research Laboratory (ARL) efforts
- Various Naval Research Laboratory (NRL) efforts
- Small Business Innovative Research (SBIR) programs
- Defense Logistics Agency (DLA)
- Air Force Life Cycle Management Center (AFLCMC) efforts
- Naval Air Systems Command (NAVAIR) programs
- Depot-specific efforts
Progress

Next Steps

- Update and continue to evolve the Strategy
  - Update existing data
  - Collect usage data from the remaining Army, Navy, and Marine Corps depots

- Additional implementation plans
  - Shipyard
  - Rotary wing aircraft maintenance depot
  - Marine Corps Logistics Base
Conclusions

- Dynamic Strategy…it will continue to change
- The Strategy compliments other DoD and Services programs
- In many cases, programs have been initiated to address high-impact needs
- There remain barriers to implementation
- Still need additional outreach and collaboration to ensure all stakeholders needs are addressed

Collectively, we are addressing a critical challenge
Questions?