Breakout Session 3, Day 2

"Cd plating (line-of-site and non-line-of-site)."

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Current Usage

- Weapons systems.
- **Most steel** with cadmium plating (for applications up to 450 F)
    - Bushings
    - Bearings
    - Fasteners
    - Hinges/hinge pins
    - Landing Gear
    - Socket-head cap screws
    - Gears
    - Springs
- Beryllium copper bushing
- Brush plating on aircraft
- Cadmium is default coating for fasteners, as noted in specs
- Coupling of aluminum with non-aluminum material; use cadmium plating to prevent galvanic issues. (e.g., steel hinges with aluminum pin)
- Ballast, mounted on bulkheads

Requirements for a New Coating Material

- Corrosion prevention/control
- Compatible with aluminum.
- Lubricity
- Need a portable touchup system or self-healing ingredient
- Adhesion to substrate and organic coatings
- **Waste Disposal**
    - Wash down
    - Demasking (rags, mask)
    - Cd plating risk tank
- **Exposure**
    - Handling fasteners, applying wrench to fasteners
    - Paint-strip, sanding

Adoption of Alternatives

- IVD Aluminum:
    - Gaining acceptance for bushing, bearings, fasteners
    - Limited torque tension
    - Applied by sputtering
- Alumiplate:
    - Not too much fatigue debt.
    - Very positive test results
    - Very expensive; hazardous process.
    - CVD (chemical vapor deposition): potential for landing gear
    - Needs to be 350 F to react for aluminum plating.
- Zinc/Nickel:
    - More potential for fasteners, barrel plating
    - Possible use in a switchover
    - Most potential for replacing cadmium
    - Air Force: uses for aluminum houses
    - Boeing: new test routes
        - Careful about surface prep and coating
    - Good for HSS, but not low-strength steel
    - Slight fatigue debt compared to cadmium; need for more fatigue tests
- Base Metal Changes: materials inherently resistant to corrosion
    - Titanium and titanium alloys
    - Stainless Steel
    - S50
- Possible change to non-cadmium plated materials through regular maintenance and attrition

Barriers and Drivers

Barriers

- Environment not a driver→ need for a *business* case. Mission-readiness always considered more important than environmental benefits of plating technology.
- Fastener coatings: depend on what industry is willing to supply
- Funding the #1 issue:
    - Only services funding at Air Force
    - Difficult to predict source of funding needed in five years, after researching alternatives
    - Depots under pressure from budget cuts (10% a year)
    - Cost of changing paper work after making changes to design specifications
    - Costs of training with new materials
    - Ultimately, due to price competition among vendors and costs, PMs will choose the cheapest—cadmium coating
    - Cadmium is still relatively cheap compared to alternatives

- **Bureaucracy**
    - State Department contract procedures with local governments establishing fines for waste disposal. These fines are used to fuel local governments, hindering the acceptance of less-polluting alternatives.
    - Lack of communication between lower-level implementers and upper-level decision-makers and policy-makers
    - Because of short tenure of jobs, individuals who start a project do not see results and are not responsible for risks
    - Lack of cohesive policy across many different localities

Drivers

- Executive Order 13148 (not strongly enforced)
- EU regulations creating diminishing availability of cadmium; EU demanding Cd-free systems
- Health and environmental costs: waste disposal fees, permits, OSHA-required medical surveillance, PPE, etc.
- Alternative solves a problem, such as a leakage event
- Alternative enhances performance
- Class action lawsuits, greater OSHA enforcement, more liability with continued use
- Potential for overexposure, especially at unionized depots
- Local environmental regulations, public action. (e.g., public hearing on dumping)
- Competition among PMs for promotions→ innovation

Research Needs

- Qualification of alkaline zinc/nickel for use on both high- and low-stress steel
- Data on exposure, costs/benefits/risks
- Education for PMs, designers, maintenance personnel
- Attention to non-nickel alternatives
- Continued support for Al coatings, cold spray, dry processes
- Alkaline zinc/nickel: need dem/val analysis and field testing on HSS
- Research touchup and repair of alternatives, including conversion coatings
- Look at non-metallic options