

Breakout Session 2

“Turbine Engines for Vehicles, Ships and Aircrafts.”

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Cadmium

- I. Current Uses and Alternatives of Cadmium on Turbine Engines**
 - a. Legacy Engines
 - i. Rotating parts (shafts, spacers, blades), disks. Zn/Nickel or Nickel/Zinc.
 - b. Fasteners (e.g., nuts, bolts) – Legacy
 - i. Zinc/Nickel
 - ii. Chromate Seal
 - iii. Material Change + Dry Film Lube (DFL)
 - c. Brackets – Legacy
 - i. IVD Aluminum
 - ii. Zinc/Nickel
 - iii. Material Change (**Low-hanging fix!**)
 - iv. Paint System – Powder (**Low-hanging fix!**)
 - d. Engine Mounts (Air Frame) High Strength Steels (HSS)
 - i. Zn/Ni Brush Plating

- II. Stripping of Cadmium Plated Parts at Depots, also –**
 - a. Grinding
 - b. Issue of wash down (Eng. Wash (gas path), country specific)

- III. Barriers/Remaining Needs - Why not Implemented?**
 - a. Rotating Parts
 - i. Need qualified alternative to aluminum, ceramic coatings
 - ii. Disappointed with Sermetel
 - iii. Need to qualify Ni/Zn (diffused) (in process at PW)
 - b. Fasteners
 - i. Need to establish/update torque tension values in manuals, and other material testing. Cost to do drawing/manual changes.
 - c. Engine Mounts
 - i. Obtain low hydrogen embrittlement approval. Currently not consistently passing test. Samples are difficult to brush plate.
[potential project]
 - d. Electroless Nickel – Solution without any lead or cadmium
 - i. Some contain approx. 1000 ppm lead and cadmium
 - ii. Not considered cadmium and lead free (though, some vendors claim to meet this need)
 - e. General Comments on barriers
 - i. Cadmium performs very well - other alternatives may not perform as well.

- ii. Money needed for manual changes
- iii. Difficult to change AMS and other specifications requirements (low participation by industry).

Chromium

IV. Needs for Hard Chrome Plating

- a. ID NLOS for Dim. Restoration
 - i. Thick electroless nickel and nickel boron
 - ii. Nano Cobalt Phosphorus (short term solution)
 - iii. Trichrom – no good, not hard enough
- b. Eliminate Need for Coating
 - i. Make new part with LENS process – vary material as needs vary (so we don't need coating).
 - ii. Evaluate if Cr is needed or if other material can be used
 - 1. Alt. thin dense chromium on actuators

V. Chromic Acid/Anodize

- a. Need – see Gaydos, page 8, tab 8.
 - i. Sodium dichromate (AMS 2471)
 - ii. Seal for sulfuric acid anodize that meets MIL-A-8625 Salt Spray Regulations (Boeing testing TCP)
 - iii. Alternatives for chromic acid anodize for parts with entrapped areas
 - 1. Potential Alt. Boric Sulfuric Acid

VI. General Needs for Chromate Conversion Coatings (CCC)

- a. Need equivalent data to chromate coatings
 - i. More robust process to eliminate variability in corrosion test results with TCP products
 - 1. TCP solution is difficult to maintain, pH needs to be precise
 - 2. Susceptible to surface pretreatment
 - 3. Suppliers chemistry diverging
- b. Need Colored coatings, TCP is clear
- c. Brushable CCC qualified to MIL-DTL-81706.
- d. For magnesium – need a hexavalent chromium free touch up for anodize
 - i. Potential alternative – Hamilton PF process (chromate free)
 - ii. Need – DOW 18 process
- e. Magnesium CCC alternatives
 - i. Potential alternative – Hamilton PF process (chromate free)
 - ii. Or others - e.g., DOW 18 process
- f. Hexavalent Chromium Free (HCF) Plating Seals for Zn/Ni, Cd, IVD Aluminum.
 - i. TCP is a candidate for all of these, needs to be qualified

VII. Common Barriers (Cadmium, Chromium)

- a. Cost to qualify alternatives (including material testing)
- b. Cost to change drawings and manuals
- c. Material eng. risk/reward concern
- d. Legacy processes time tested and optimized
- e. Not invented here (NIH) and Not tested here (NTH)
- f. Commercial pressure - OEMs may not want to share proprietary processes
- g. Industry/AMS specs not kept current/not updated fast enough
- h. DoD waivers can slow down changes – reduces motivation to change
- i. New processes must be
 - i. Better quality/performance
 - ii. Cheaper/Faster
 - iii. Equal/Lower risk and process control requirements

VIII. Common Needs (Cadmium, Chromium)

- a. Smart/Wear indicating coating and/or self healing
- b. Tribological studies and models to verify wear in coating
- c. Fresh look/review of base materials (e.g., composites or ceramics instead of metals) to eliminate chromium in new make and repairs
- d. Lead and antimony free Dry Film Lubricants (DFL)

IX. Discussion Section Comment – May 23, 2006

- a. Gas turbine engines are a primary focus – not just for aircrafts, but also for ships and tanks.