

# Gas Turbine Engines

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May 22, 2006

# Cadmium Plating

## Legacy Engine (Rotating Parts – shafts, blades, disks)

- Potential alternatives – Zn/Ni plating, Ni/Zn plating/diffusion coating, aluminum ceramic paint.
  - PW qualification work for PW proprietary Ni/Zn plating/diffusion coating process is in process at PW.
  - **Need to complete qualification of hex chrome free aluminum ceramic paints (existing PEWG project).**

## Legacy Engine Fasteners, Brackets, and Engine Mounts

- Potential alternatives – Zn/Ni plating, material change plus DFL, powder paint, IVD aluminum.
  - **Need to establish/update torque tension values for fasteners and complete other material testing which may be needed.**
  - **Need to establish a robust low hydrogen embrittlement Zn/Ni brush plating process for high strength steel engine mounts.**

**Note: many electroless nickel (EN) solutions contain a 1000 ppm lead and cadmium. Solutions with 0 ppm needed.**

# Anodize

## Chromic Acid Etch Prior to Phosphoric Acid Anodize

- Turco Smut-Go added as alternative in GE spec.
- Boeing is qualifying commercially available alternatives

## Chromic Acid Anodize Stripper

- Nitric/ABF alternative identified. Process needs formal qualification.
- Boeing is qualifying commercially available alternatives

## Sodium Dichromate Seal

- **Need to identify/qualify alternative sealers for AMS 2471 Sulfuric Acid Anodize.**
  - Hot water sealing will have reduced corrosion protection.
  - TCP being evaluated as an alternative

## Chromic Acid Anodize

- **Need alternative for parts with entrapped areas.**

# Conversion coatings

## Aluminum Anodize Touch-up

- Metalast TCP-HF has been added as a spray and immersion hex chrome-free alternative to the Qualified Products List of MIL-DTL-81706.
- **Need to address clear color, process control, and surface pre-treatment issues.**
- **TCP not qualified for brush applications – needed for touch up of anodize.**

## Magnesium Conversion Coating

- **Need HCF conversion coating (TCP is candidate)**

## Sealant compounds for IVD aluminum, Zn/Ni plating, Cd plating

- **Need HCF conversion coating (TCP is candidate)**

# Hard Chrome Plating

US DoD/ Industry Group - Hard Chrome Alternatives Team (HCAT) (See [www.hcat.org](http://www.hcat.org)) has qualified HVOF and Air Plasma thermal spray coatings as alternatives. HCAT and others are evaluating newer alternatives for non line-of-sight applications and other special applications.

- **Need to qualify NLOS HCF processes for dimensional restoration (potential alternatives are electroless nickel, nickel-boron, nanocobalt phosphorus.**
- **Need to improve wear resistance of tri-chrome and EN alt.**
- **Need alternative for thin dense chromium on actuators.**
- **Need to evaluate if chromium is needed in all wear applications to see if alternative materials could be used.**
- **Need to evaluate LENS process to validate that material properties can be varied within a part to**

# Primers/Paints

## Aluminum Ceramic Paints (e.g. SermeTel W®)

- New hexavalent chrome-free alternatives being tested – PEWG project. (Sermatech 1725® and Aseal 5000® systems)
- Thorough US DoD/Industry testing protocol established
- Testing to be completed June 2006. Report by August.
- Need to evaluate cost and cycle time impacts- not “drop in” system

## Zinc Chromate Primer (Galvanic Corrosion Protection)

- Alternatives identified. Application/material costs may be higher.
- Fastener torque tension testing/qualification may be required.

## Strontium Chromate Primer prior to Composite Adhesive Bonding.

- Need to identify/qualify alternative “self healing” primer/bonding system.
- Boeing, KLM and JAL are qualifying alternative commercially available products.

# Common Implementation Barriers

- Costs to qualify alternatives including material testing
- Costs to change drawings and repair manuals
- High risk/low reward for material engineers who must approve alternatives
- Legacy processes have been optimized and are time-tested
- Not invented Here (NIH) and Not Tested Here (NTH) syndromes
- OEMs may not wish to share new processes considered to be proprietary
- Industry/AMS specs are not frequently updated and new environmentally friendly alternatives must be referenced in these specs as many drawings reference these specs.
- DoD waivers can slow down or eliminate the DoD motivation to invest in qualifying alternatives.
- New processes must be better quality/improved performance, cheaper/faster, with equal or lower process risk and control requirements.

# Paradigm Shift Needs

- Wear indicating coatings
- Self-healing coatings
- Tribological studies and models to determine if wear coatings are needed
- Fresh look/review of base materials to eliminate any need for chromium in new make and repair processes (e.g., composites or ceramics instead of metal)
- Eliminate all uses of beryllium
- Qualify DFLs without any lead and antimony