F-35: REACH Replacement Projects

2016 ASETSDefense Workshop

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Overview

- REACH
- Remaining/Replacing Chrome
- Remaining/Replacing Cadmium
- Addressing other REACH impacted materials
- Risk of ‘Hidden’ or ‘Unknown’ upstream chemicals
- Summary
Baseline Non-Chrome Primer

Airframe Interior*/Exterior
Over 68,000 Flight Hours
Enables Production Moving Line
Enables ‘Shirt Sleeve’ Maintenance

* Except fuel tanks
Remaining Chrome

- **Chromium Trioxide/Chromic Acid – Henkel Alodine 1200(S)RTU conversion coating**
  - Continuously testing new products for compatibility with airframe primer
- **Chromium Trioxide Acids – Chromic Acid Anodize in supply chain**
  - JSFPO funding qualification of boric/tartaric-sulfuric acid anodize
  - AFLCMC funding TCP use as anodize seal
- **Calcium Dichromate – PPG PR-1425 Canopy Sealant**
  - PR-2061/PR-1861 adhesion promoter in final qualification/implementation
- **Strontium Chromate – PPG 833K086/930K088 Fuel Tank Coating, 3M EC 3917 adhesive film, Cytec BR-127, MIL-PRF-23377 primer used by supply chain**
  - Neutral/SO2 salt fog testing completed, starting AFLCMC-funded flight test demonstration of non-chrome fuel tank coating
  - Continuously testing non-chrome -23377 formulations esp. Hentzen 16708TEP
  - Replaced BR-127 for aluminum adhesive bonding, working on titanium
- **Zinc Chromate – PPG 515x408/910x937 Super Koropon Quick Cure Touch-up Primer**

Still Working Critical Materials
Remaining Cadmium

- **Landing Gear, Leading Edge Flap, Arresting Gear, CV Wing-fold**
  - Starting AFLCMC funded demonstration/validation projects for Dipsol IZ-C17+ LHE zinc-nickel to meet F-35 neutral/\(SO_2\) salt fog corrosion resistance requirements
  - Already implemented at OO-ALC landing gear depot

**Promising Replacement in Work**
**TCEP and DMF**

- Tris(2-chloroethyl)phosphate (TCEP) Sunset Aug 2015
- Dimethyl Formamide (DMF) on Candidate list
- Both contained in 3M EC-5817 Moisture Barrier Coating
  - Used on heating/cooling duct foam insulation
  - TCEP and DMF currently sourced from US
- Coating very specialized and low usage
- 3M re-formulated, lowered VOC, eliminated TCEP, but not DMF
  - Re-formulated version implemented in 2015
- Alternative product under AFLCMC-funding in final qualification

**Partial Reformulation – Still Risk**
Dibutyl tin Diacetate

- CLP re-classified dibutyl tin compounds as Reproductive 2 – August 2009
- Dow Corning announced re-formulation of high temperature sealant DC 93-006-1 March 2011
  - Reformulated product DC 93-006-1 RF contained Cristobalite, Titanium Dioxide, and Chromic Acid
  - F-35 decided to qualify completely new material
  - Qualification testing for DC 3145 RTV with PR-1200 Primer completed/implemented

Required Adopting Existing Material
• Decabromodiphenyl ether (DBDE)
• Initial F-35 survey did not find any DBDE
• July 2012 – Min-K thermal ceramic insulation identified DBDE in Article coating, coating reformulated/implemented 2015
• April 2013 - Hi-Temp announced re-formulation of aluminized glass cloth HT-1542 for insulation Articles
  • F-35 had six months to evaluate re-formulated product and accept in time to meet December 2012 production halt (due to EPA negotiated agreement)
  • Reformulated product contain decabromodiphenyl ethane (CAS 84852-53-9) which is on CoRAP list
  • Hi-Temp aware potential to re-formulate again to replace –ethane version

Articles and Unknown Chemicals
In addition to hex chrome sunset dates, impacts other chemicals:

- Phthalates – F-35 reformulated ClickBond 200 nutplate adhesive
- Lead compounds – explosives, flares, dry film lubes, high temperature fabrics, and of course solder
- Nonylphenols – surfactants, emulsifies, solubilizers, precursors
- Bisphenol-A – adhesive films, epoxies, coatings
- Heptylphenols – lubricant precursors
- Borates – surfactants, stabilizers
- Hydrophthalic anhydride MHHPA/HHPA - epoxy resin hardener
- Refractory Ceramic Fibers (RFC) – high temperature coatings/insulations
- Titanium Dioxide – colorant for everything
- E-Glass – fiberglass
True REACH Risk of Unknown Chemicals

- Asking Critical Suppliers to Dive Deep into Their Supply Chains and Look for CMRs/EDs/PB/vPvB/ELC etc.

Product

- Base
- Curing Agent
- Diluent

OEM Typical Visibility

Requires Upstream Knowledge

Chemicals of Concern:
- What is Chemical?
- Who Makes Chemical?
- Do they already have an alternative?
- Where is Chemical made (US/EU/other)?
Summary

- So far so good on replacements
- Still working chromate products but manufacturer’s Authorizations have bought more time
- Have cadmium path forward
- Worried about UNKNOWNS due to U.S. SDS difference