WEEE, RoHS, ELV, and hexavalent chromium

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WEEE

EC Directive on Waste from Electrical and Electronic Equipment

2002/96/EC Jan 2003

Required all 25 EU member states to implement into law within 18 months (Aug 2004) a requirement that appliances and electrical devices be manufactured in such a manner that they can be recycled/recovered at a recovery rate of 70-80% based on type of appliance.

As of 8-05 all EU members except Malta and UK had at least a framework regulation.

WEEE Man represents 3.3 tons of electronic waste generated by each citizen of the UK in a lifetime

"The RSA and Canon Europe hope that this electronic waste giant will illustrate the problems created through the inappropriate disposal of WEEE and encourage businesses and consumers alike to look at more effective and environmentally considerate ways of electronic and electrical waste disposal."

James Leupk
Chief of Communications and Corporate Relations, Canon Europe
RoHS

• Restriction of Hazardous Substances in Electrical and Electronic Equipment (RoHS)

• Directive (2002/95/EC)

• As of July 1, 2006, this directive bans lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs) from all new electrical and electronic equipment sold to EU companies and manufactured in the EU.

Computer Hardware is Subject to RoHS Directive
Automotive Hardware is Subject to ELV Directive
Extended Life Vehicle (ELV)

- Directive 2000/53/EC

- Pb, Hg, Cd, Cr\textsuperscript{+6} Banned from automotive coatings as of 7-2007

- Objective: prevention of waste from vehicles plus reuse, recycle, & recovery of end-of-life vehicles & components. 85% recycled by 2006, 95% by 2015

- Vintage & historic vehicles are exempted

- Components, materials, as well as spare & replacement parts are also covered

- Automotive component manufacturers to provide appropriate information to treatment facilities, concerning dismantling, & reuse
ELV Exemptions:

- **Cr⁺⁶ Allowed Until 7-1-07** For Corrosion Protective Coatings Only

- **Cr⁺⁶ Allowed Until 7-1-08** For Nut/Bolt Applications For Automotive Chassis

- **Dates May Be Extended If Workable Substitutes Can Not Be Found**
OEM Response to RoHS/ELV

RoHS: Maximum Allowable Cr$^{+6}$ in a coating is 1,000ppm

ELV: For non leachable coatings: 1,000ppm Max
For leachable coatings: 0.1 µg/cm$^2$

Note: Analytical procedure is not dictated by Directives
(It’s Fend For Yourselves!)

Leachable Coating
Non-Leachable Coating
Common Questions

- Our chemist said that there would be Cr$^{+6}$ in the end product because we use Cr$^{+6}$ in the process, but it would require breaking the metal to find the Cr$^{+6}$. Is that true?

- Ans: Yes and No
Chromium Plating

- Max Hex Chromium Allowed = 1,000 ppm

- 3 dec-chromium plated samples tested to date:
  - 119 ppm
  - 329 ppm
  - 496 ppm
  - After soak in bisulfite:
    50-60 ppm

- 2 Black Chromium plated samples tested:
  - 2040 ppm
  - 1050 ppm

Pores in chromium plating can trap hexavalent chromium
Common Questions

• If we send parts for testing to determine if our coating complies with RoHS or ELV banned substances, is the leach test performed on the coating (plating, plating plus chromate) or on the entire part?

• Ans: Confusion reigns, ELV procedures look for $\mu g/cm^2$, RoHS requirements are for % (ppm) in coating. Entire parts are being shredded by some labs.
Common Questions

• The RoHS Directive bans the presence of PBB’s and PBDE’s. We do decorative chromium plating from a hexavalent solution. Do we need to test for the presence of these substances in our plated deposit?

• Ans: **No, Unless you are requested by your customer**
Common Questions

• I just received a newsletter that states that hexavalent chromium in corrosion protective coatings has now been exempted from the ELV. Can I assume that this exemption extends also to RoHS/WEEE?

• Ans: **No (See previous slide on exemptions)**
Common Questions

• Just what does banned mean? Can I have a few ppms present in the coating and still be in compliance?

• Ans: GM/EC consider a coating compliant when:
  – Chromium$^{+6}$ < 1000 ppm (0.1%)
  – Cadmium < 100 ppm (0.01%)
  – Lead < 1000 ppm (0.1%)
  – Mercury < 1000 ppm (0.1%)

• GM: $< 0.1 \, \mu g \, Cr^{+6}/cm^2 = \text{pass (ELV)}$
In What Coatings Can Cr\(^{+6}\) Be Found?

• Chromate Conversion Coatings (Cad, Zinc, Aluminum, Magnesium)
• Hard Chromium Plated Deposits
• Decorative Chromium Plated Deposits
• Black Chromium Plated Deposits (1 test = 2,000ppm)
• Passivation of Stainless Steel
• Chromic Acid Anodize Coatings
• Sulfuric Anodized Aluminum (Dichromate Seal, Dyes)
• Phosphate Coatings (Chromic Acid Seal)
Common Questions

In What Coatings Can Cr+6 Be Found?

• Colored Stains on Copper/Alloys
• Thermal Sprayed Coatings
• Electroless Nickel (Post Treatment)
• Painting with Chromated Primers and Topcoats
• Anodize on magnesium
• Passivation of copper, brass, bronze, tin, silver in dichromate based solutions
• Chromic acid passivation dip after trivalent chromium plating
• Some Cermaseal™ and Dacromet™ Coatings
Common Questions

Is Trivalent chromium banned too?

- Chromium exists in at least four valence states:
  - $\text{Cr}^0$
  - $\text{Cr}^{+3}$
  - $\text{Cr}^{+2}$
  - $\text{Cr}^{+6}$

- $\text{Cr}^0$, $\text{Cr}^2$, $\text{Cr}^3$ are NOT regulated in the European ELV Directive at present.
Common Test Methods for US Automotive Suppliers

- **Delphi: DX900359** “Test Method for the Quantitative Determination of Hexavalent Chromium on Parts (Aluminum and Aluminum Alloys Excluded)”

- **GM: GMW3034** “Absence of Hexavalent Chrome (VI) Coatings”

- **ISO 3613:** “Chromate Conversion Coatings on Zinc, Cadmium, Aluminum-Zinc alloys, and Zinc Aluminum alloys”

**Other Test Methods**

- ASTM D 5257/5281/6492
- Ford: WSS-M1A343-A2/ESF-M21P6-
- Delphi: DX551300/DX51600
- European method validated by members of VDA (Verband der Automobilindustrie in 2003
- Many More
Basic Test Method (GM)

GMW3034

• Sample Preparation
  – Measure parts for surface area (50cm$^2$ desired for test)
    • From direct dimensional measurements
    • CAD drawings
    • Math-based CAD models
  – Remove any topcoat with scalpel, add particles to test water

• Part(s) boiled in water for (exactly) 5 minutes & removed

• Calibration Curve Prepared for Colorimeter/Spectrophotometer

• Analysis (diphenylcarbazide indicator)
  – Spectrophotometer
  – Colorimeter
  – Visual

• Calculations & Reporting in $\mu$g Cr$^{+6}$/cm$^2$ (<0.1 $\mu$g Cr$^{+6}$/cm$^2$ = pass)
Challenges of Test Methods

- Procedures Vary With OEM
- Interferences
- Instrumentation/Calibration
- Different reporting units \(\%\), \(\text{ppm}\), \(\mu\text{g Cr}^+6/\text{cm}^2\):
  - GMW 3034 allows for pass/fail reporting
  - Visual Observation is permitted in lieu of analysis
  - Replicates/no replicates
- Topcoats are a problem
  (Cut with scalpel???)
Interferences

• Positive (Fail)
  – Dyes
  – Contamination (in coating process or lab)
  – Re-oxidation of Trivalent Chromium
  – Turbidity in Extraction Liquid
  – Hexavalent molybdenum
  – Mercury
  – Vanadium
  – Iron
  – Copper

Note: GMW3034 Does not provide for interference removal or adjustment
Interferences

Negative (Pass)

- Invalid Extraction
- Oil and Waxes on Parts (negative)
- Top-coats

• Can use ion chromatography to resolve interference issues
Re-Testing Requirements

- Chemistry Changes
- Process Line Changes
- Customer Request
- Annually
The End

Thank you!

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