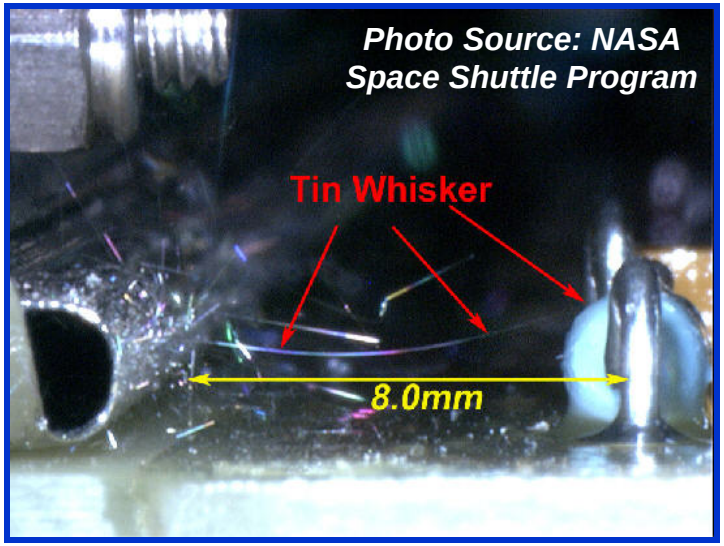
Pb-free Electronics Risks

EU Restriction of Hazardous Substances (RoHS) Directive banned use of lead (Pb) in commercial electronics sold in EU as of 7/1/06, impacting global COTS electronics market

Unintended Consequences

- **"Tin Whisker" Short Circuits**
  - Electrically conductive
  - Can metal vapor arc
- **Pb-free Solder Issues**
  - Fractures in high shock & vibration environments
  - Has higher melting temps
  - Incompatibilities with SnPb Solder
  - Less repairable assemblies
- **Configuration Control Nightmare!**
  - Unidentified component alloys
  - Mixed Pb & Pb-free inventory
- **Unable to Quantify Reliability in Harsh Operating Environments**



Electromagnetic Relay Vapor Arc Damage

Pb-Free Solder Joint

Have Tin Whiskers Caused Failures?

- **Multiple Documented Occurrences (NASA/Industry/Academic Publications)**
  - Nuclear Utilities
  - 7 Satellites ($100M Boeing Loss)
  - Patriot (PAC-2)
  - 6 Missile Programs
  - Heart Pacemaker
  - F-15 Radar
  - Military Airplane
  - Telecom. Equip.
  - Heart Defibrillators
  - New Commercial Autos

$1B Worth of Satellites, Missiles & Other Equipment

Catastrophic Damage Due to Tin Whisker Induced Metal Vapor Arc

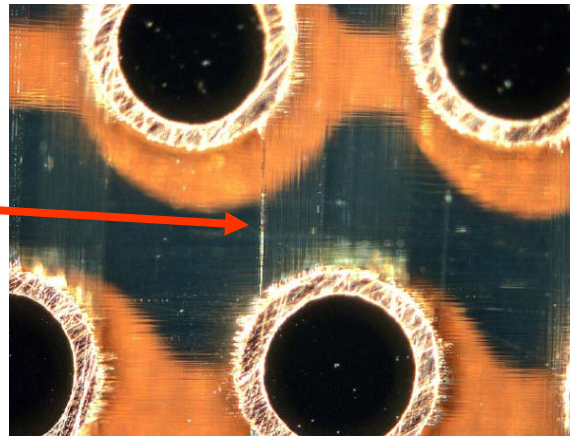
NOTE: Electromagnetic Relay Was Purchased to MIL Spec Prohibiting Pure Tin Finish Inside, But IT WAS Pure Tin

Ref: http://nepp.nasa.gov/whisker/failures/index.htm

Pb-free Electronics Technical Impact

- **No universally acceptable technical solutions in sight to replace SnPb in Aerospace & Defense (A&D) applications**
  - Conformal coatings only mitigate tin whiskers
  - Pb-free solder joint reliability decreased for shock; some have corrosion issues and incompatibilities with tin-lead
  - SAC305 solder dissolves copper, impacting rework and repair
  - Conductive Anodic Filament (CAF) problem is re-emerging due to higher Circuit Card Assembly processing temperatures using Pb-free solders

Conductive Anodic Filament (CAF) in Circuit Card Assembly (CCA)



Ref: "Lead Free PCB Projects Update," Advanced Research of Electronic Assemblies Consortium, February 2008

Current technical approaches are all still "mitigations" and not "elimination" of the Pb-free electronics issues