Space Shuttle Program-Tin Whisker Mitigation

Labor Hour Rough Order of Magnitude (ROM) Estimate
Resources:

NASA Orbiter Avionics and Electrical Systems, Orbiter Sustaining Engineering Office

USA Space Systems Engineering, GN&C Hardware Subsystem Area Manager

http://nepp.nasa.gov/whisker


NASA Shuttle Logistics Depot - Tin Whisker Video
Background


- In March 2006, a Flight Control System (FCS) avionics box failed during vehicle testing, and was routed to the NASA Shuttle Logistics Depot for testing and disassembly
- Internal inspection of the box revealed tin whisker growth visible without magnification

- Space Shuttle Program implemented tin whisker remediation strategy following discovery of tin whiskers in Orbiter hardware
- Complex investigation and planning involved cooperation among many disciplines and geographical locations

- Whiskers grew from pure tin plated circuit card retainers, not from electrical components
  - Intent of tin plating in original design was for corrosion protection of Beryllium-Copper (BeCu) retainers
Flight Control System (FCS) avionics box with cover removed

Background Continued

- NASA formed multi-disciplinary Tiger Team to investigate extent of findings and develop recommendations
  1. Detailed investigation of Flight Controls hardware from same vendor (12 per vehicle)
  2. Broad investigation of 100+ other high-criticality Orbiter hardware
- Functional diversity: design engineering, logistics, test engineering, materials & processes (M&P), ground operations, research
- Geographical and corporate diversity: multiple NASA centers (JSC/KSC/GSFC), prime and major subcontractor sites, hardware vendor and supplier

- Flight Control System (FCS) avionics boxes:
  ▪ 52 total quantity across fleet = 12 per vehicle plus spares
  ▪ All from same manufacturer, using same card retainer design
- Sampled 15 of the 52 boxes across four different types
- Tin whiskers only growing from card retainers; up to 18 mm
- Some loose tin whiskers present
- Newer built boxes (~1989) from Endeavour’s initial assembly generally contain longer and more dense tin whisker growth
- One box found to have no tin plating on card guides
Flight Control System Remediation Plan


- Avionics Lab: Remove tin plating and tin whiskers
  - Expedite procurement of non-plated card retainer assemblies from vendor
  - Cycle boxes through lab
  - Incoming testing, disassembly / card removal
  - Assess gross order-of-magnitude quantity of loose whiskers
  - Clean chassis and circuit cards
  - Cards pass magnified inspection
  - Conformal coating touch-up via brush coatings as needed
  - Reassemble with non-plated card retainers
  - Full acceptance testing at box level: vibration, thermal, functional
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**Author:** Kurt Kessel

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