



# FAA Flammability Certification of Electrical and Electronic Components

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# Boeing Goals

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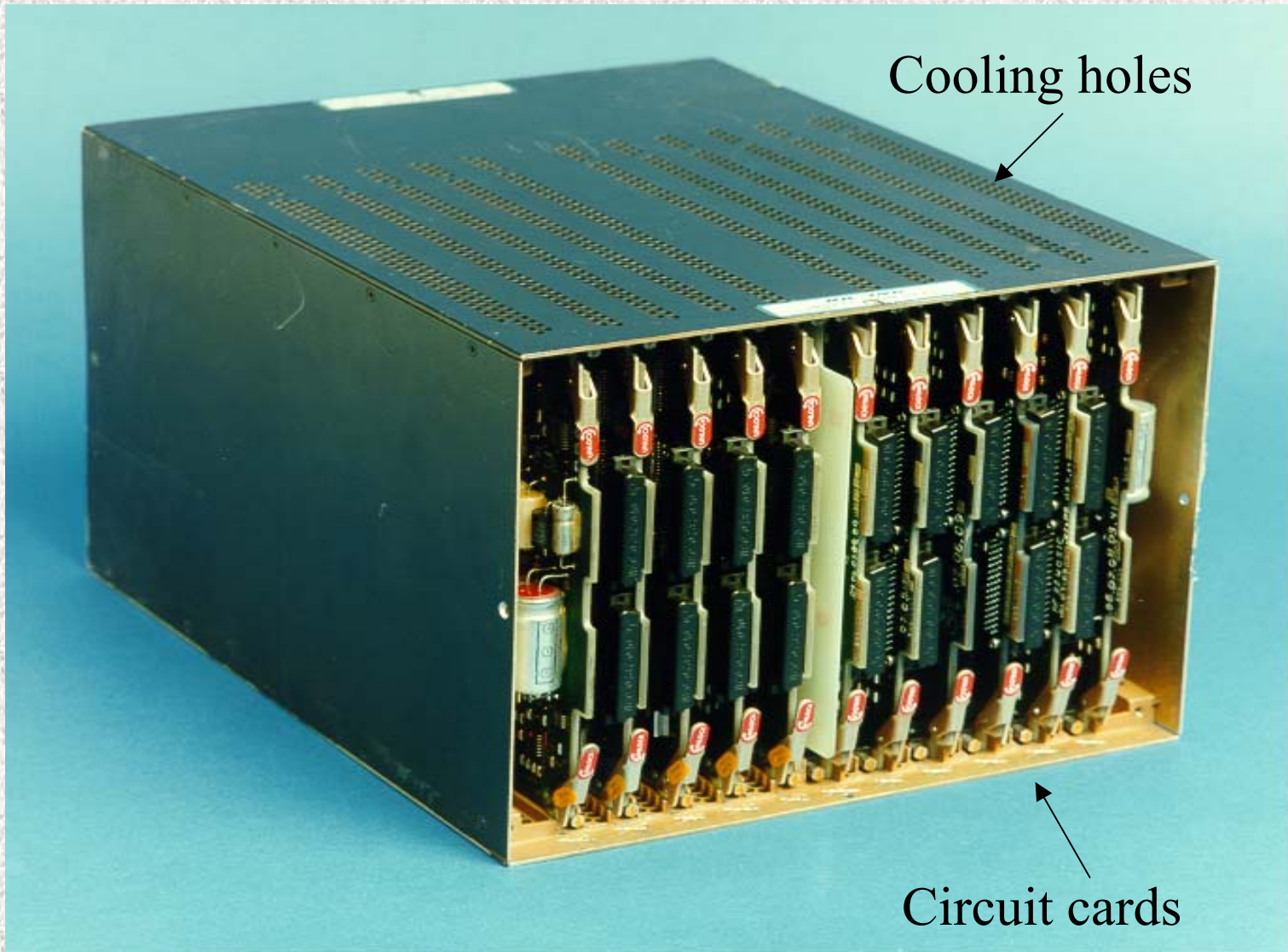
- Comply with Regulatory Requirements
- Continuously Improve Safety of Flight
- Utilize Supplementary Internal and Industry Standards
- Improve procurement cost of equipment
  - Utilize industry data
  - Use engineering skills and experience
  - Work together with our suppliers
  - Eliminate unnecessary and non-value added processes and testing

# Typical Elements of Electronic Equipment

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- Electric Wire
- Printed Wiring Boards (PWBs)
- Cathode Ray Tubes
- Liquid Crystal Displays
- Transformers
- Switches
- Small Components (Diodes, Resistors, etc.)

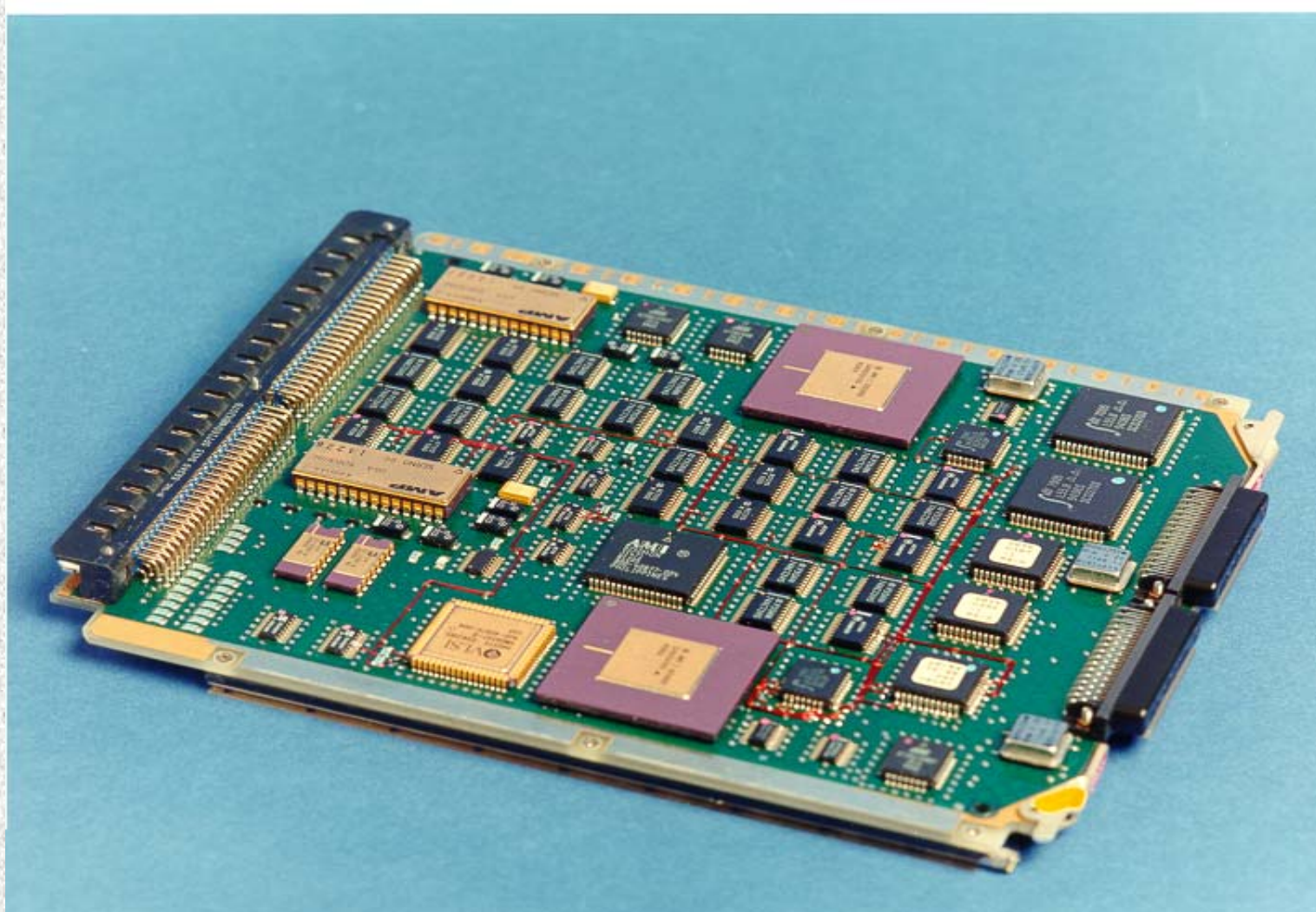
# Typical Electronic Equipment in a Jet Transport



Cooling holes

Circuit cards

# Typical Printed Wiring Assembly



# History of Electronic Equipment Usage in Commercial Transport Airplanes

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- In the early years, electronic equipment consisted primarily of simple avionics in the flight deck and E/E bay
- Later, additional electronic units and sensors were added all over the airplane
- In recent years, there has been a great expansion of in-flight passenger entertainment systems, up to Internet access on seat-powered laptop computers

# Electronic Equipment Design Criteria

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- Military specifications used to control the fire properties of electronic equipment.
- Many of these military specifications have been recently canceled.
  - Example older requirement - *Printed Wiring Board material shall be epoxy/glass (Type GF) or other material with equivalent or better temperature, arc, and flame resistance, in accordance with MIL-P-13949.*

# FAA Flammability Requirements

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- FAA regulations were changed in 1967, and new flammability requirements and test methods were added
  - New standards for side-walls, ceilings, etc.
- Small parts did not have to be tested
  - **Except for small parts** (such as ..... *small electrical parts*) that would not contribute significantly to the propagation of a fire...
- Electronic components were viewed as “small parts”



# FAA Flammability Requirements (cont)

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- In the 1960's, there were only a few electronic components in the EE bay and flight deck.
  - Only materials compliant to the Military Standards (self-extinguishing) were used
- Today significantly more electrical/electronic components are used
- Military production standards have been canceled and replaced by industry production standards

# FAA Flammability Requirements (cont)

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- Aerospace industry standards require either
  - IPC 4101 flammability test be done on laminates making up a PWB before board is assembled or
  - UL 94 V0 test on the finished PWB
  - No industry requirement for 12-sec vertical
- FAA clarified that regulatory testing of electronic components requires
  - FAR tests - 12-sec vertical Bunsen burner test (e.g., printed wiring boards, PWBs)
  - or approved alternatives

# FAA Flammability Requirements (cont)

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- Aerospace PWBs built to industry standards always pass FAA test with high margin
- FAA receptive to “equivalent safety finding” to approve PWBs meeting industry standards without requiring FAR 12-sec vertical test
- FAR 21, § 21.21(b)(1)
  - .... any airworthiness provisions not complied with are compensated for by factors that provide an equivalent level of safety ...

# Equivalent Safety Finding

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- Plan for establishing equivalent safety finding
  - Analysis of IPC, UL, and FAR test procedures
  - Analysis of the sample testing by suppliers (i.e. the on-going process control)
  - Test a representative sample of IPC and UL compliant PWB materials using the FAR 12-sec vertical test
    - Bare printed wiring board laminates
    - Complete multilayer printed wiring boards
    - Printed wiring assemblies with conformal coat

# FAA Flammability Requirements (cont)

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- When an “equivalent safety finding” is granted, PWBs will be FAA-approved by process control
- Showing compliance by process control is a significant need for electronics
  - Electronics are in constant *redesign*
    - Testing by part number is inefficient and extremely expensive in the long run
  - Continuous process control provides better assurance
    - As opposed the current one time test
  - Most electronics redesign does not change materials
    - Re-layout of PWBs and microcircuits
    - Software updates

# Reasons for Electronic Redesign

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- Airline requests for increased functionality
  - More features and options
  - In-flight entertainment
- Product improvements
  - Updates, problem resolution, production improvements
- Component obsolescence
  - Cancellation of the military specifications
  - Commercial components have a shorter production life due to high volume users

# PWBs are the Most Frequently Changed Item

Typical Materials	Redesign Impacts
Small electrical components: Microcircuits, resistors, capacitors, switches, etc.	Frequently change but small are parts
Flexi-cables, small wire cables	Seldom change
Displays	Seldom change
Gaskets	Seldom change
Connectors	Seldom change
Sheet metal, screws, etc.	No impact on the flammability analysis
Printed wiring boards	Frequently change

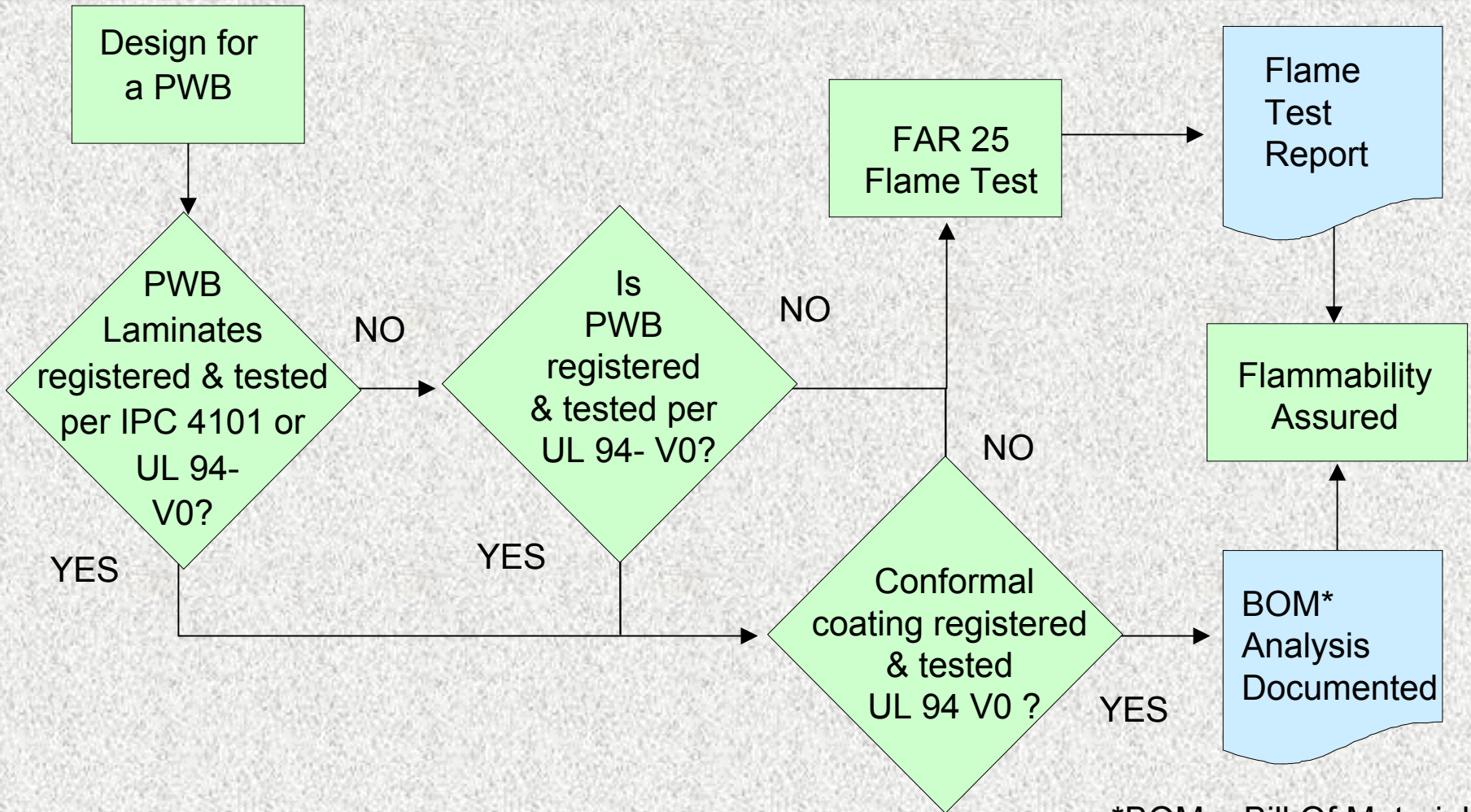
# Process Control Methods

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- Boeing is incorporating process control methods for design and manufacturing
  - DO-178 (Example of Software process control)
  - DO-254 (Example of hardware process control)
  - ISO-9000 (Example of quality by process control)
  - AS-9000 (Example of quality by process control)
- Process control provides
  - Improved quality, reliability, and performance
  - Lower costs
  - Shorter design cycle times



# Use of Industry Standards



\*BOM = Bill Of Materials

# Conclusions

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- The FAA requires data for flammability certification of electronics before E/E components can be delivered on airplanes.
- Currently, all affected parts must be tested to 12-sec vertical for flammability certification
- Suppliers of E/E equipment need to put a priority on acquiring acceptable data far upstream of delivery.

## Conclusions (cont.)

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- An alternative method for flammability certification is urgently needed
- Boeing is working with the FAA to establish an equivalent safety finding to enable certification by *process control* using existing industry standard test processes instead of testing each PWB