Reliable Implementation of COTS Parts and Assemblies into Aerospace Systems

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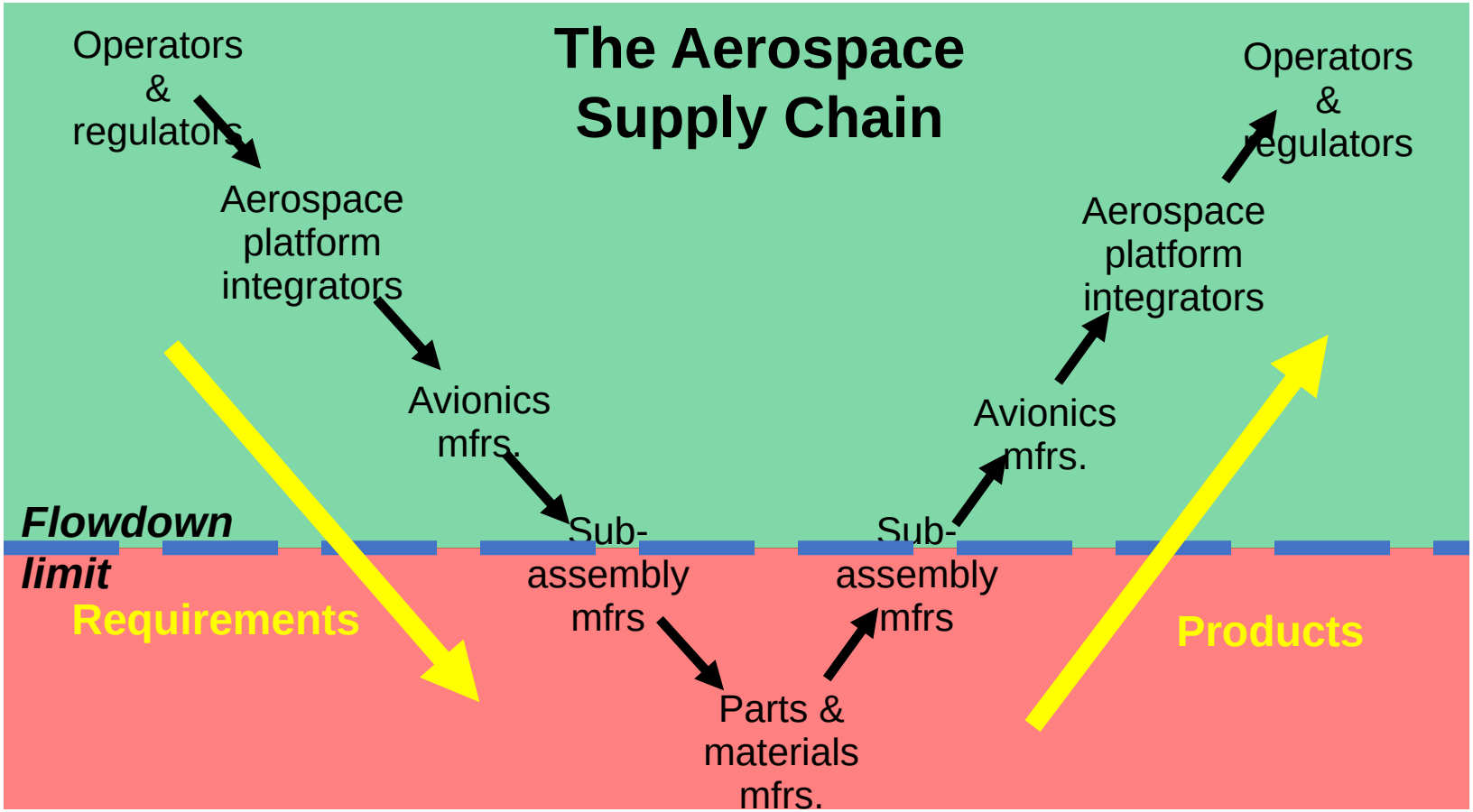


Within aerospace control

Not within aerospace control

"It's COTS, and I can't be expected to assure its configuration, or its performance, or its reliability, or……."

Is <u>not</u> an acceptable EEE Parts and sub-assembly management Plan

If you integrate an item into an aerospace application, it's your responsibility to demonstrate that it will operate reliably in the application.

Recent technical developments:

- Pb-free electronics is still an issue, but it's being managed
- Atmospheric radiation risks have increased
  - *Single event latchup and other types of SEE*
  - *Multiple-bit and multiple-cell upsets*
- Microcircuit wearout risks require attention
- Counterfeit risks demand attention
  - *48 CFR 252.246 – Contractor Counterfeit Electronic Part Detection and Avoidance*
- AFE 75 has been completed
- Physics-of-failure methods are more critical

AVSI AFE 75, "*COTS AEH Issues and Emerging Solutions*"

1. COTS assemblies
2. Derating
3. Sparing reliability
4. Commodity memory
5. Atmospheric radiation
6. Life-limited semiconductors
7. Outdated reliability methods
8. Pb-free electronics
9. Errata
10. Counterfeit electronics
11. Undocumented features
12. Multiple, global electronics supply chain
13. Usage domain analysis
14. Production follow-up
15. Intellectual property
16. Unknow changes
17. Embedded controllers
18. Technology & component maturity
19. Component pkg. & mounting
20. Device uprating
21. Handbook considerations
22. Obsolescence management
23. Acceptable evidence of compliance
24. Multiple supply chains
25. Safe use of complex COTS in AEH
26. System-on-chip devices

The problem is……

- Manufacturers of electronic equipment and systems for the aerospace, defense, and high-performance (ADHP) industries must use EEE parts and sub-assemblies targeted for other markets.
- The other-market requirements typically are not as rigorous as ADHP, e.g., rugged environments, long lifetimes, high consequences of failure, configuration control, etc.

Therefore……..

ADHP manufacturers must assure *and demonstrate* reliable performance of parts and sub-assemblies in ADHP applications

The good news is……..

The aerospace industry has developed standards, methods, and tools provide the necessary assurance.

Legal Advice from a Long Time Ago

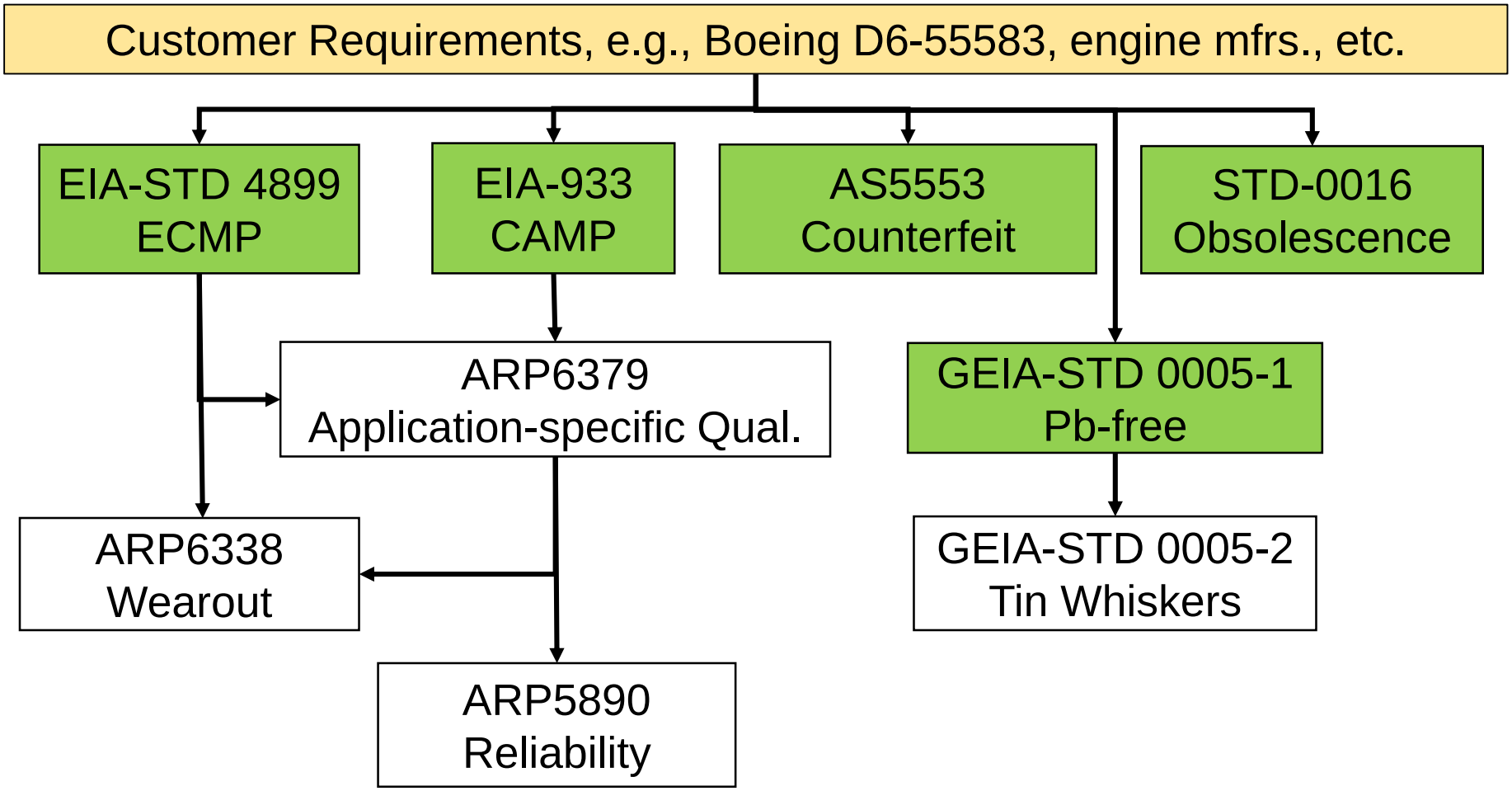
What do you do when you're forced to integrate a new or unknown technology into an ADHP product before you "have all the facts?"

1. Access the best technical knowledge, information, and technology available
2. Develop industry-wide consensus
3. Agree on, and publish standards, methods, and tools to incorporate "best practices"

Aerospace Industry Documents

- IEC 62396 series on atmospheric radiation
- IEC TS 62239-1, Part 1: *…..electronic components management plan*
- **SAE EIA-STD-4899, *….Electronic Components Management Plan+***
- **SAE AS5553, *(R) Fraudulent/Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition+***
- **SAE GEIA-STD-0005-1, *…. Lead-free Solder****
- IEC TS 62647-1, *…….Preparation of a lead-free control plan*
- **SAE STD-0016, *….Preparing a DMSMS Management Plan****
- **SAE EIA-933, *….Preparing a COTS Assembly Management Plan****
- SAE ARP 5890, ….Preparing Reliability Assessment Plans….*
- SAE ARP 6338, *….Assessment and Mitigation of Early Wearout……*
- SAE ARP 6379, *Application-specific Qualification of EEE Parts and Sub-assemblies*

***Required in Boeing D6-55583**


Customer Requirements, e.g., Boeing D6-55583, engine mfrs., etc.
EIA-STD 4899 ECMP
EIA-933 CAMP
AS5553 Counterfeit
STD-0016 Obsolescence
ARP6379 Application-specific Qual.
GEIA-STD 0005-1 Pb-free
ARP6338 Wearout
GEIA-STD 0005-2 Tin Whiskers
ARP5890 Reliability

For each part and sub-assembly:

1. *Understand the System requirements allocated to the item.*
2. *Understand the capability of the "as-received" item, with respect to the allocated System requirements;*
3. *Prepare a System risk analysis, based on (1) and (2); and*
4. *Document appropriate risk mitigation methods….to assure that the item accomplishes its allocated System requirements reliably throughout the specified System lifetime.*

The application requirements……can be satisfied only by the integrator of the item; they cannot be flowed down to a supplier, subcontractor, or other organization that is not responsible for the integration of the item into the system.

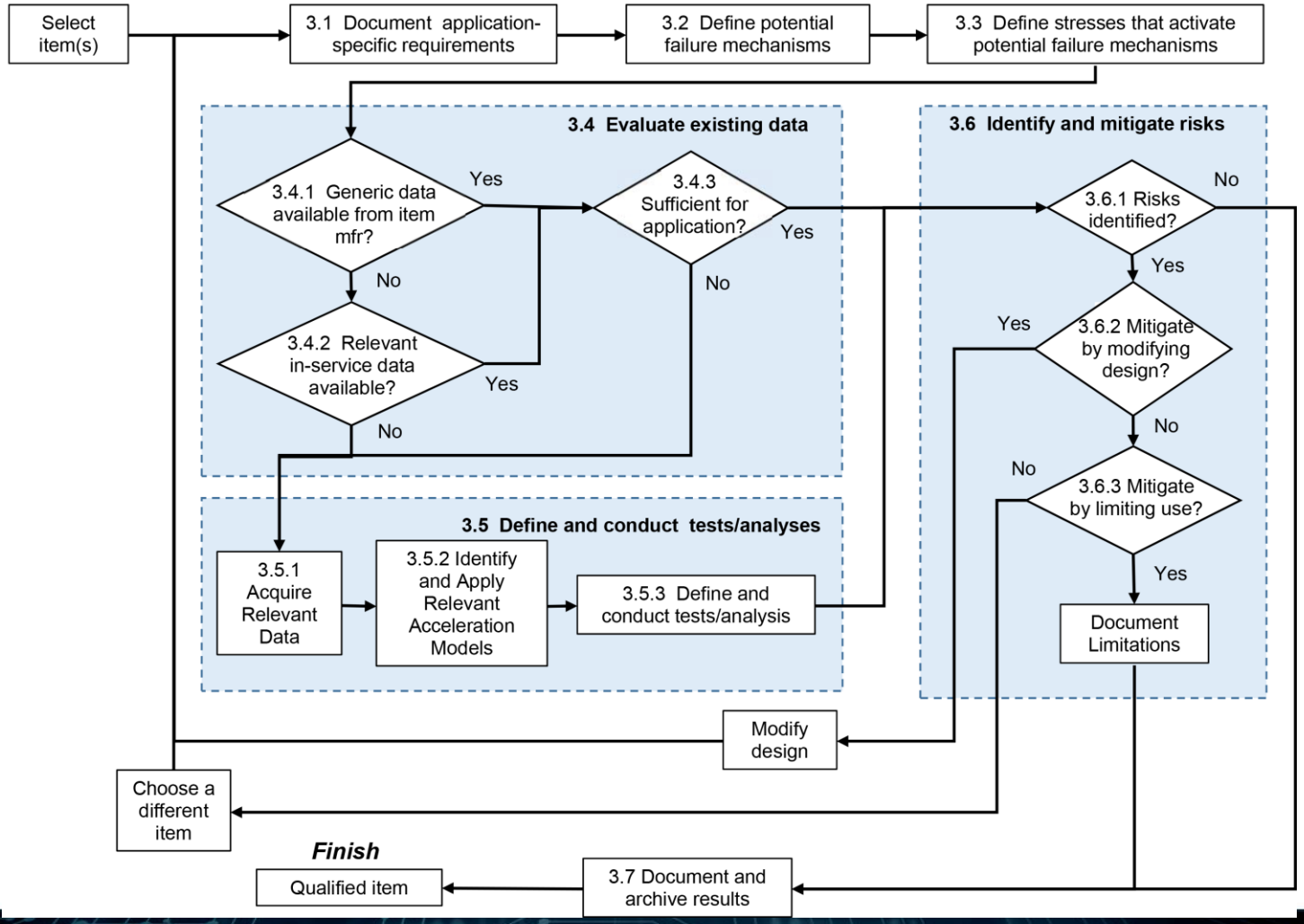
The Hard Parts

- Qualification
  - Both parts and sub-assemblies, including COTS
  - Application-specific (see SAE ARP6379)
  - Based on
    - Credible data (in-service, testing, etc.)
    - Rational analysis (acceleration models)
    - Responsible conclusions
- Configuration control (mostly due to obsolescence)
  - Need to qualify replacement parts
- Flowdown to sub-tier suppliers

Physics-of-Failure (PoF)Methods

- PoF methods have been around for at least 25-30 years
- Aerospace has been skeptical of PoF (still not implemented widely)
- Testing and acquiring in-service data for each application are becoming cost-prohibitive (need to leverage across multiple applications)
- PoF tools (e.g., Sherlock) are becoming more accurate, easier to use, and more widely accepted in high performance industries
- PoF can help avionics OEMs and their supply chains in qualifying and using COTS EEE parts and assemblies
- We need to leverage (and standardize) PoF to satisfy our requirements more cost-effectively, and efficiently

SAE ARP6379, Application-Specific Qualification



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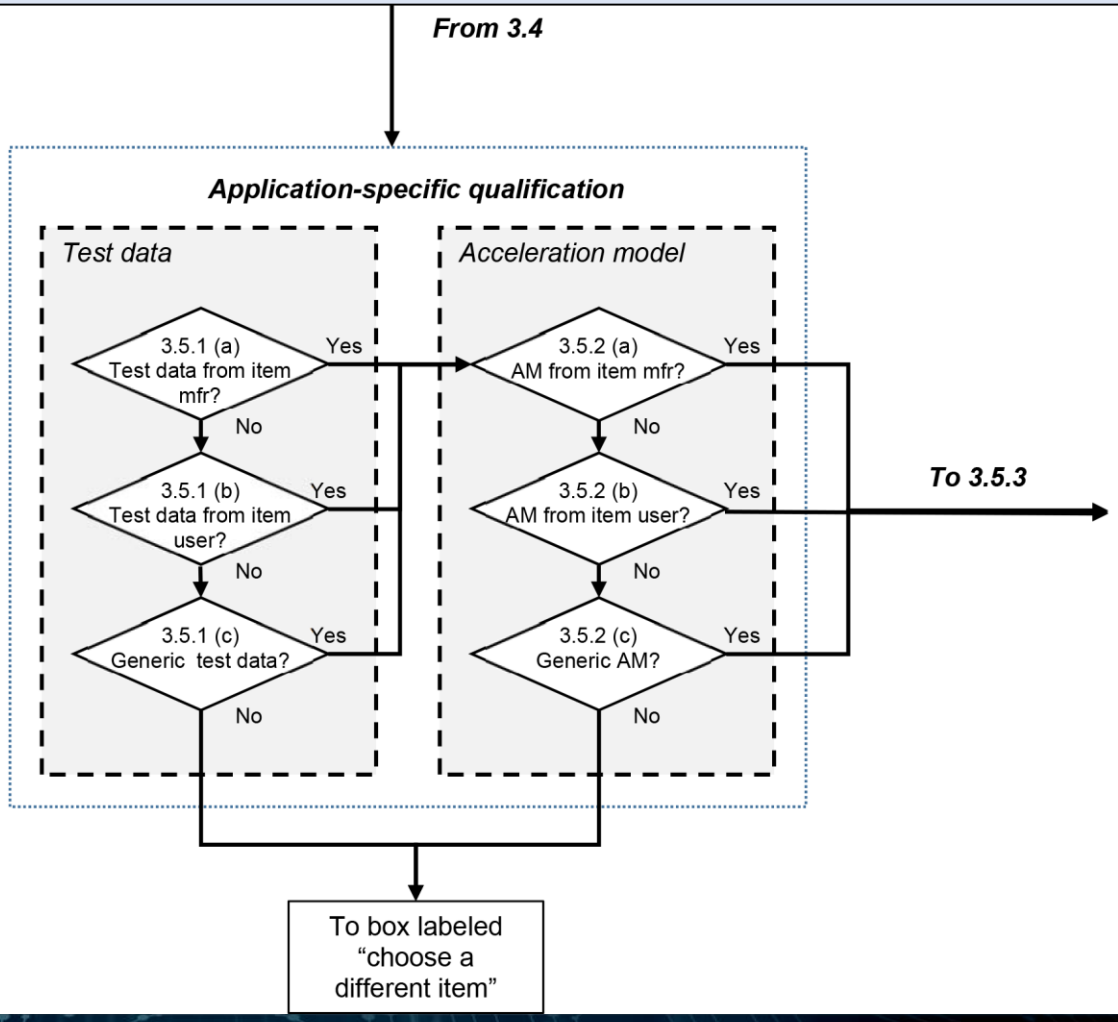

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