EUROPEAN AVIATION SAFETY AGENCY
AGENCE EUROPÉENNE DE LA SÉCURITÉ AÉRIENNE
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Composite Materials:

Composite Seats

- Developing Standardisation

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Your safety is our mission.

Composite Seats

Background:

Recent interest in composite seat structures (STCs for A318-21/B737):
(differing levels of project maturity and development work)

- 'static' '9g'seats pre JAR 25 chg 13,
('dynamic' '16g' seats to follow, 25.561 & 562)

30-50% weight saving

Proposed configurations: various

- composite and/or bonded (metal and composite) structures
- seats and plinths (no pallets)
- some with crash energy attenuation features

first ETSO
– issued April 2014

Historically: Seats are ETSO* items (Certification icw with product)

- well established metallic structures providing current 'acceptable' level of safety
- very limited mention of materials or structures
- limited 'Expert' involvement, e.g. some discussion regarding use of Magnesium alloys
- use of composites, including bonding, new

* European Technical Standard Order

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Generic Issues: (Certification icw with product)

- need to bridge ETSO to product gap - meet appropriate certification standards, e.g. CS25
- no CRI mechanism for ETSO (note: Rulemaking being developed)
- 'CRI' developed for these projects (to become ETSO supplements/SAE standards)

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Generic Issues: (Certification icw with product)

- Key points: Follow **AMC 20-29**
  - material and process (paying particular attention to bonding)
  - F&DT (impact threat, environment etc)
  - Post test residual load (25.561?) application
    - find hidden damage?
    - support pax weight during escape, no sharp edges etc?
    - address secondary impact?
  - Instructions for Continued Airworthiness (ICA)

needs standardisation

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Issues: **material and process** – further to AMC 20-29

Some of these organisations have no experience regarding material, process, qualification etc…

- look for use of material and suppliers with appropriate aviation history
- reinforce importance of repeatability (sampling, testing programmes etc)
- use appropriate statistics, e.g. CMH-17

needs standardisation

- require POA (Part 21.609 subpart O, requires subpart F or G)

Bonding:

- consider most critical bond totally failed for each test case
- ensure appropriate bond degradation defined and addressed for other bonds (desert storage?)

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Issues: **F&DT** – further to AMC 20-29

needs standardisation

- no standardised impact damage threats, e.g. 35J probably not appropriate
- Non-Visible Impact damage – consider sharp and blunt impactors

CRI considers for these projects:

Fork lift truck impact, impact with airframe , or other mishandling upon removal from aircraft for maintenance

- sharp and blunt impactors (1/2 – 4.in radii) - show consistent repeatable damage mode (throughout energy range)
- show initial damage is readily detectable (will allow validated witness if not readily detectable)
- include BVID level of damage in tests ('engineering judgement' – various hot spot locations)
- some Residual Strength (RS) pyramid work expected (static and dynamic) – particularly if analysis is to be used for a seat family – ensure likely loading case RS's are addressed, e.g. compression, bending etc

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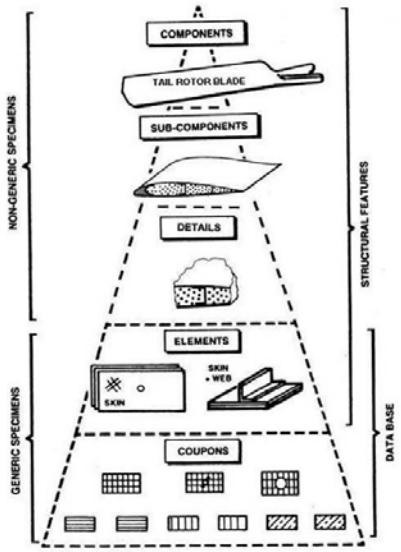
What criteria, e.g. config complexity, margins, etc make static margins acceptable to address dynamic events?

Mid-Pyramid Test and Analysis work:
(static or dynamic?)



Tube compression tests (undamaged and damaged)

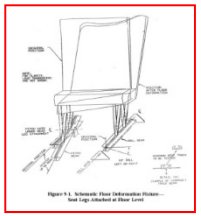
- damage of negligible/small significance
- static margin mins >4 (> 3 damaged)

(FEM analysis of CS load case + strain gauge validation)

- must not be too stiff (potential excess pulse)
- 'equivalent' stiffness to typical existing design

Note: design detail may override such seat level comparisons

Note: Seats scheduled for dynamic ETSO



'equivalence' required wrt typical existing design

Note: competing damage modes - satisfy survivability criteria

- maintain living space
- maintain escape routes
- no loose items of mass
- no excessive pax. loads

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Issues: **Post Test RS**:

needs standardisation

Post test residual load (9g forward, following 16g for dynamic ETSO) application

- address secondary impact issue
- help to determine if damage has occurred when NDI may not be appropriate
- second load application repeats same, or different, load case?

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Issues: **ICA**:

needs standardisation

Inspection required:

- upon installation
- upon removal
- following any known impact event
- following storage (particularly if desert storage remaining installed in aircraft)

These projects:

- **fleet leader inspection programme** and report after 2-6 years:
  - validate impact threat assumptions
  - gain confidence regarding robustness

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Conclusion/comment – developing carbon seat standardisation:

For the impact damage issue to be a concern, it would need:

- Impact (or multiple disbonds)
- > BVID level of damage
- damage remains undetected
- be subject to a survivable crash, excessive gust (if this is a driving case) etc

The greater concern could be overall 'robustness' – for this reason, the fleet leader review requirement has been placed on these projects. This will also uncover any big errors regarding impact threat assumptions, e.g. trolley impacts, luggage under seats impact etc

Approach to competing failure modes (i.e. survivability criteria, e.g. strength v stiffness) and 'equivalence' (i.e. wrt typical metallic experience) need to be standardised

In order to encourage standardisation :

- these organisations have been requested to work together, e.g. within SAE to define common standards – material and process management, impact threat definition etc

- SAE has also been requested to encourage discussion within the seat WG