Agenda

• Quick recap of the regulations
• TSOs vs Airworthiness Requirements
• Use of Guidance Material
• Common Modifications, Considerations
Quick Recap

• Dynamic performance standards started with GA aircraft in 1983
  “Please regulate me”

• Study of:
  ➢ Accident data
  ➢ Analytical methods
  ➢ Full-scale aircraft impact tests
  ➢ Aircraft seat dynamic tests
  ➢ Existing pass/fail performance criteria

• Relate crash event to aircraft occupant response
Resulting Standards

Two required tests:

Test 1

combined vertical/longitudinal
spinal loads and injuries

Test 2

longitudinal
structural performance
occupant restraint system
### Seating Design Changes

#### Resulting Standards

<table>
<thead>
<tr>
<th>Dynamic Test Requirements</th>
<th>Part 23</th>
<th>Part 25</th>
<th>Part 27</th>
<th>Part 29</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Test 1</strong></td>
<td></td>
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<tr>
<td>Velocity</td>
<td>31</td>
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<td>Seat Yaw Angle</td>
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<tr>
<td>Peak Decel (Gs)</td>
<td>19/15</td>
<td>14</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Floor Deformation</td>
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<td>-</td>
<td>10° Pitch</td>
<td>10° Roll</td>
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<td></td>
<td></td>
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<td>10° Roll</td>
<td>10° Roll</td>
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</tbody>
</table>

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**Note:** The table highlights the peak decel requirements across different parts, with Part 23 having a peak decel of 19/15 Gs, and Part 29 requiring a 10° Pitch Roll.
### Seating Design Changes

#### Resulting Standards

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<tr>
<th>Dynamic Test Requirements</th>
<th>Part 23</th>
<th>Part 25</th>
<th>Part 27</th>
<th>Part 29</th>
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<tbody>
<tr>
<td><strong>Test 2</strong></td>
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<td>Velocity</td>
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<td>Seat Yaw Angle</td>
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<tr>
<td>Peak Decel (Gs)</td>
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<td>16</td>
<td>18.4</td>
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<tr>
<td>Floor Deformation</td>
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<td>10° Pitch, 10° Roll</td>
<td>10° Pitch, 10° Roll</td>
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</tr>
</tbody>
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### Seating Design Changes

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</thead>
<tbody>
<tr>
<td><strong>Quantitative Compliance Criteria</strong></td>
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<td>Max HIC</td>
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<td>Lumbar Load (lb)</td>
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<tr>
<td>Femur Load (lb)</td>
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<td>22500</td>
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</table>
Resulting Standards

Potential benefits of energy absorbing seats for occupants of survivable accidents:

Prevention of Fatalities

2%

Prevention and Reduction of Serious Neck and Back Injuries

38%
TSOs vs Airworthiness Requirements

TSO C22 series – safety belts

TSO C39 series – “static” seats

TSO C72 series – individual flotation devices

TSO C127 series – “dynamic” seats
TSOs set out a defined Minimum Performance Standard (MPS)

- TSO ≠ Installation approval
- Further substantiation required to install TSO seats onto aircraft
- TSO MPS may not be equal to the Part 2X airworthiness requirements
TSO vs Airworthiness Requirements

Examples:

TSO C127a –

• HIC and femur loading values to be reported, compliance not required

• 25.785 – injurious objects and head strikes

• 25.813 – emergency exit access

• 25.815 – width of aisle
Use of Guidance Material

• AC 25-17A – Crashworthiness Handbook
• AC 27-1B, 29-2C – Certification of rotorcraft
• AC 23.562-1, 25.562-1B – Dynamic Seating
• AC 23-2A, 25.853-1 – Flammability

Plus various policy statements, memos, orders, etc.
AC 25.562-1B

“Family” of seats

• Group of assemblies built from equivalent components in primary load path

• Intent to permit simplified test article selection

• Baseline testing may substantiate majority of seat P/Ns for compliance with FAR 25.562
AC 25.562-1B

“Family” of seats

• Defined based on design characteristics
• Most highly stressed configuration selected for dynamic tests
• Additional tests may be required to substantiate variations beyond basic family principles
Appendix 3

• Primary seat assembly components and how they can vary within a family

• Appropriate means of substantiation for each element (acceptable by analysis or test)

• Procedures depend on rigorous definition of the “family”; only valid if we adhere to that definition
AC 25.562-1B

Appendix 3

- Very useful when it comes to modifying seats that are compliant with FAR 25.562
- Lots of detail given
- If you’re going to use AC – use it in its entirety
Common Modifications & Considerations

“Dynamic” seats are tested and pass as a **SYSTEM**:

- Structure (legs, cross tubes, etc.)
- Seat track fittings
- Energy absorbers, stroking mechanisms
- Cushions & upholstery
- Restraints & anchors
Common Modifications & Considerations

Anytime one (or more) of these aspects is modified, compliance to the dynamic 2X.562 requirements MAY be affected
Common Modifications & Considerations

Dr

• Dress Covers:
  • Flammability
  • "Submarining"
  • Dynamic seats

- affect Seat Reference Point (SRP)?
Common Modifications & Considerations

Cushions:

• Flammability

• Invalidate dynamic testing?
  ➢ Still same “family”?
  ➢ Seat Reference Point (SRP)?
  ➢ Restraint response?
CAA Guidance and Expectations

Letter dated 15 September 2016

• Great deal of discussion with FAA

• Attempt to simplify and provide practical guidance for common modifications
CAA Guidance and Expectations

• In general, approach given in FAA AC 25.562-1B acceptable for use with other parts (eg. FAR 23, 27, 29)

• Change in SRP confirmed by measurement
  ➢ Change cannot be assumed
  ➢ method to be appropriate to the design change
Further Clarifications to be added:

• When using AC guidance, OEM configuration is always the baseline

• Clarification by FAA CSTA Crash Dynamics re: AC 25.562-1B - Appendix 3, Bottom Cushion
CAA Guidance and Expectations

AC 25.562-1B - Appendix 3, Bottom Cushion

• 9.b. changes acceptable by analysis: Contour variations are acceptable without additional 16g and 14g structural tests, provided the SRP does not vary by more than 0.75 inch in any direction
CAA Guidance and Expectations

AC 25.562 - Seating Design Changes

Geometry of the Cushion:

Variations in the blue area around each buttock reference point have the most influence on the SRP.

Areas of the cushion outside this zone (green area) have little influence on ATD performance.
9.c.1. Any variation in the cushion contour within the blue box of the previously tested cushion that results in a vertical change to the SRP of greater than \( \frac{1}{2} \) inch would require a 14g vertical lumbar load test.
Seating Design Changes

CAA Guidance and Expectations

0.5” SRP Change

0.5” SRP Change

BRP

BRP

3.984”

5”

2”

2”

4”

4”

2”

0.75” SRP Change

FWD
In Summary

Seats are not as straightforward as they seem...

“BFM”

Lots to consider and keep in mind
Seating Design Changes

Questions?