



Certification of Aircraft Seating Design Changes

2017 Design Delegation Holders' Seminar

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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:



Combined Vertical/Longitudinal

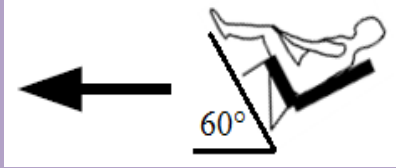
Spinal loads and injuries

Longitudinal

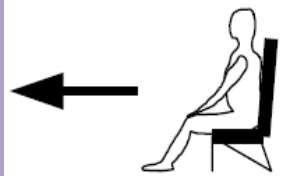
Structural performance

Occupant restraint system

Resulting Standards

Dynamic Test Requirements	Part 23	Part 25	Part 27	Part 29
<u>Test 1</u>				
Velocity	31	35	30	30
Seat Yaw Angle	0	0	0	0
Peak Decel (Gs)	19/15	14	30	30
Floor Deformation	-	-	10° Pitch 10° Roll	10° Pitch 10° Roll

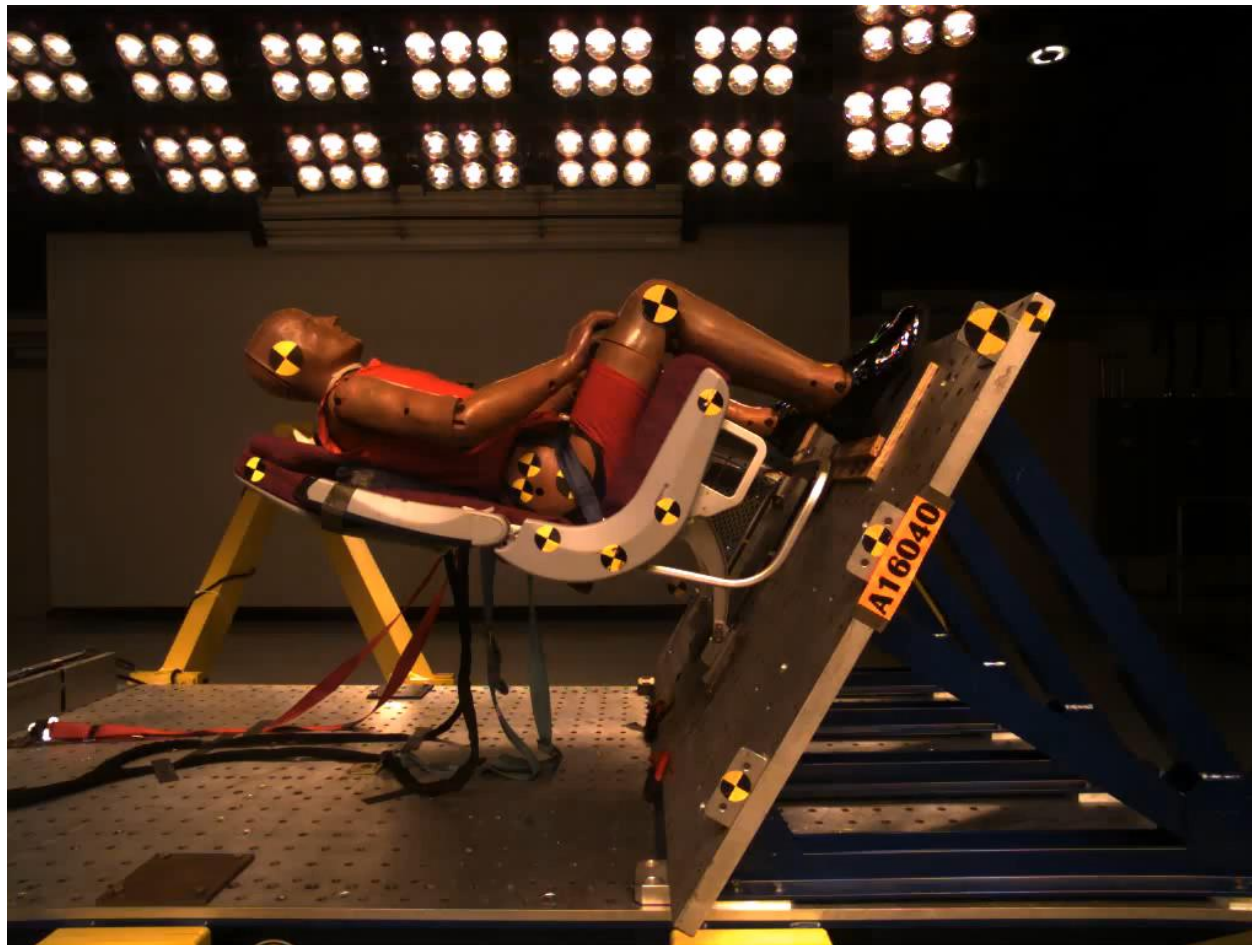
Resulting Standards

Dynamic Test Requirements	Part 23	Part 25	Part 27	Part 29
<u>Test 2</u>				
Velocity	42	44	42	42
Seat Yaw Angle	10	10	10	10
Peak Decel (Gs)	26/21	16	18.4	18.4
Floor Deformation	10° Pitch 10° Roll	10° Pitch 10° Roll	10° Pitch 10° Roll	10° Pitch 10° Roll

Resulting Standards

Dynamic Test Requirements	Part 23	Part 25	Part 27	Part 29
<u>Quantitative Compliance Criteria</u>				
Max HIC	1000	1000	1000	1000
Lumbar Load (lb)	1500	1500	1500	1500
Strap Load (lb)	1750/2000	1750/2000	1750/2000	1750/2000
Femur Load (lb)	-	22500	-	-

Resulting Standards



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

TSO vs Airworthiness Requirements

- TSOs set out a defined Minimum Performance Standard (MPS)
- TSO \neq 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

AC 25.562-1B

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**:

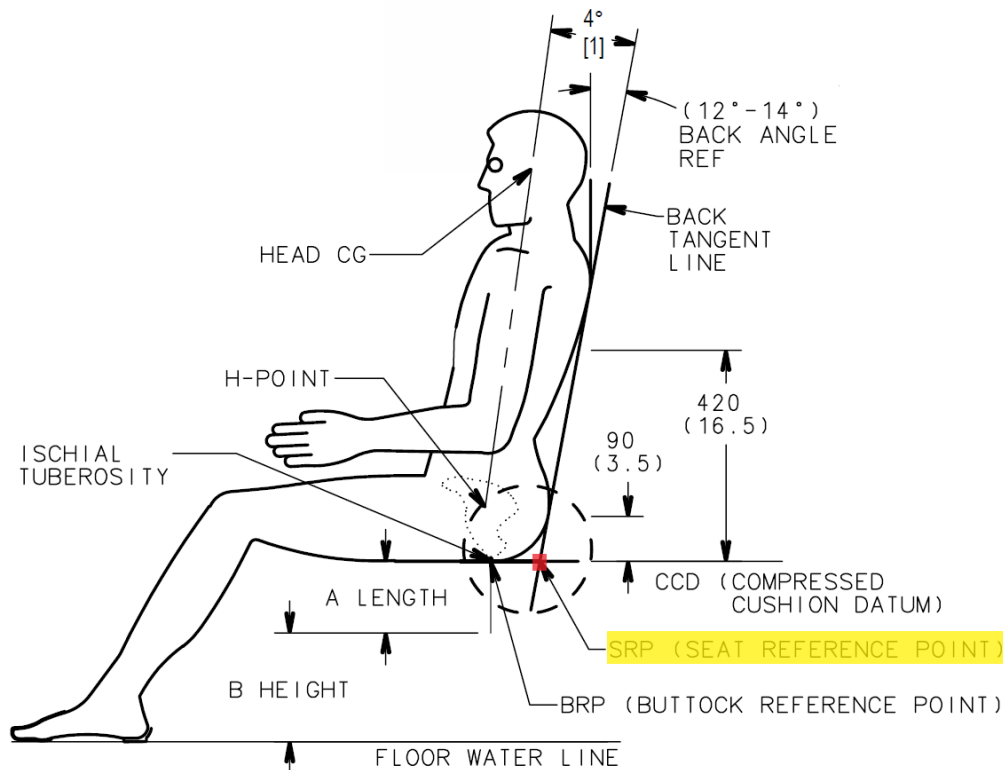
- Structure (legs, cross tubes, etc.)
- Seat track fittings
- Energy absorbers, stroking mechanisms
- Cushions & upholstery
- Restraints & anchors

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



5

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

CAA Guidance and Expectations

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 25.56

Geometrical
each but
influence

Areas of
(area) have
performance



Cushion

area around
the most

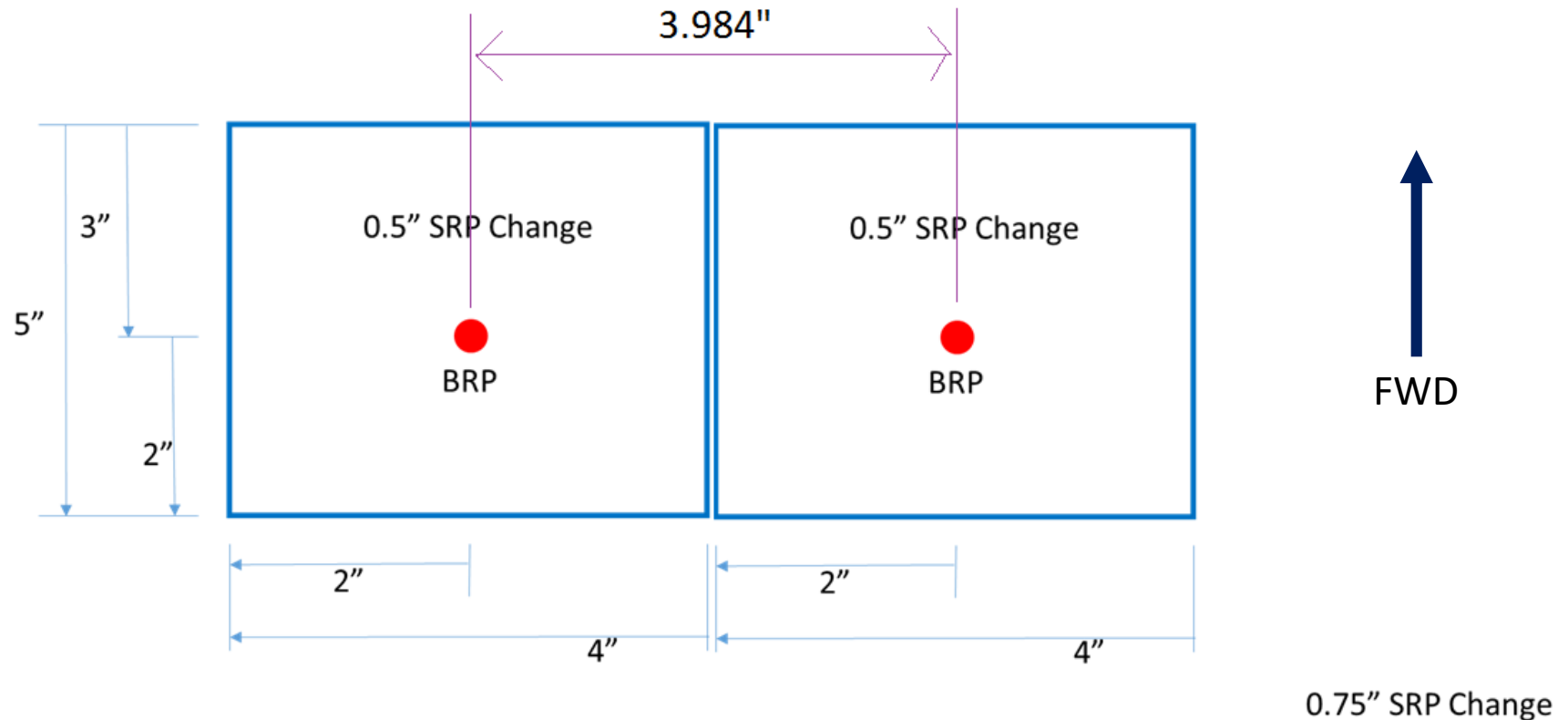
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CAA Guidance and Expectations

AC 25.562-1B - Appendix 3, Bottom Cushion

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 ½ inch** would require a 14g vertical lumbar load test.

CAA Guidance and Expectations



In Summary

Seats are not as straight forward as they seem...

“BFM”

Lots to consider and keep in mind

Questions?

