Occupant Response in Oblique Aircraft Seat Environment

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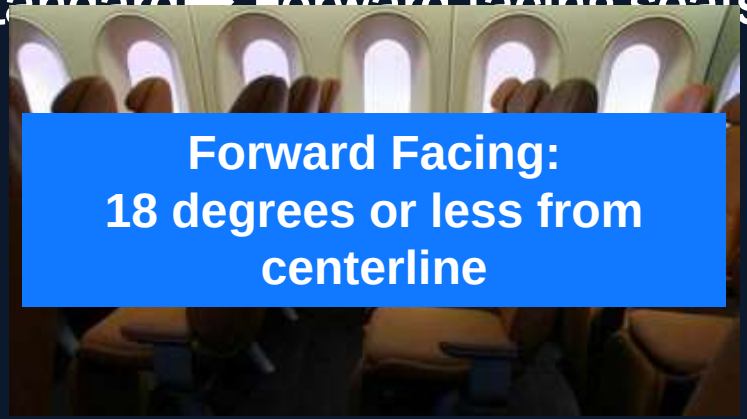
Aviation Occupant Protection

- Regulated by Federal Aviation Administration (FAA)
- Static Test→ Seat strength
- Dynamic Test → Assess occupant injury
- Original standard→ Forward facing seats



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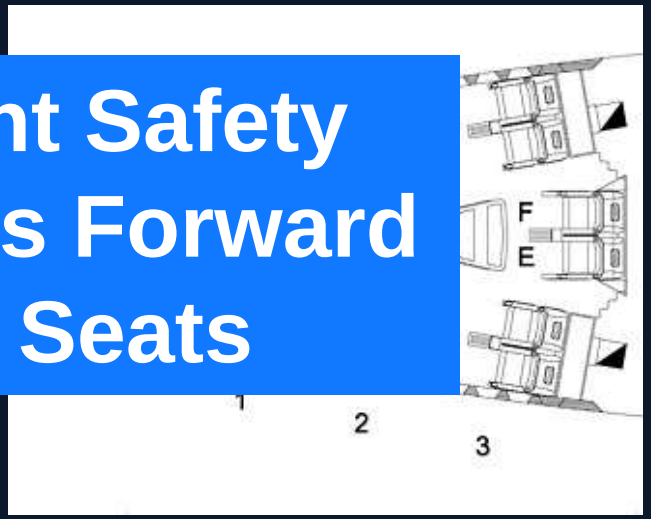
Oblique Seats

- Motivation: Increase seating density/maximize comfort
- What type of injuries can we expect?
- Injury Criteria/Suitable ATD

Equivalent Safety Standard as Forward Facing Seats



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Aircraft Environment

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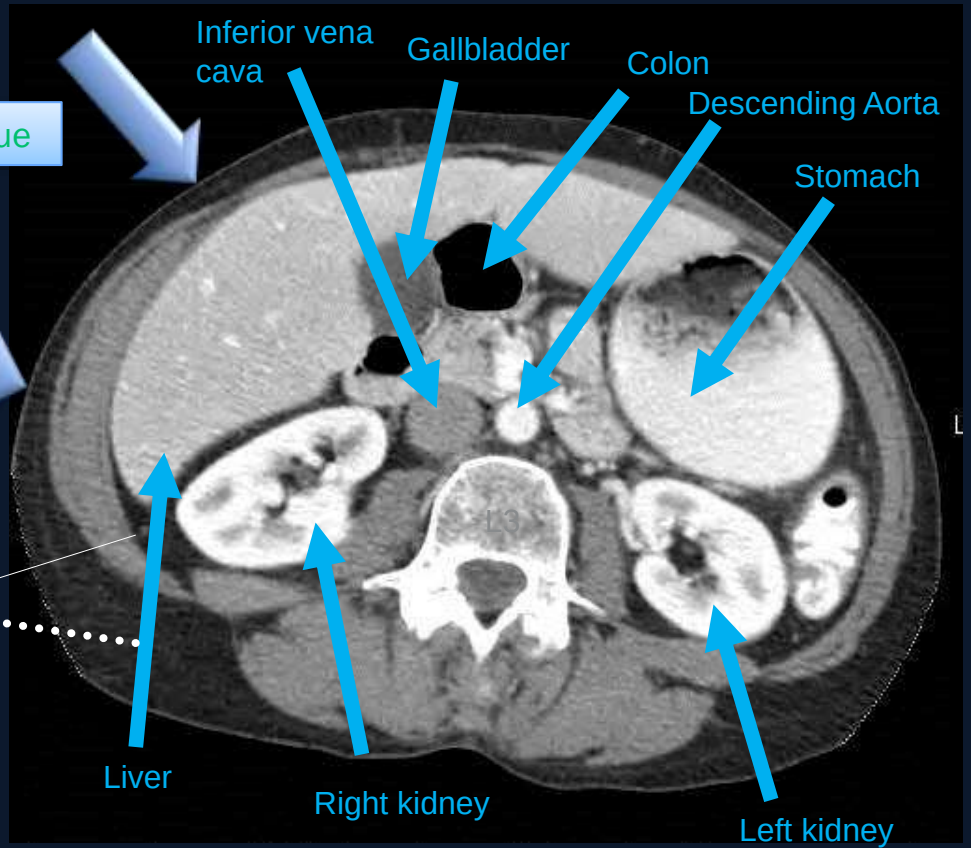
Lateral v. Oblique



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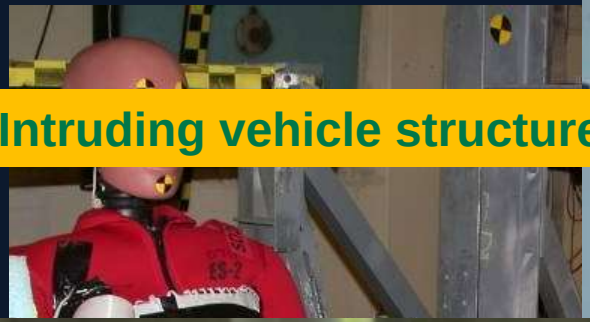
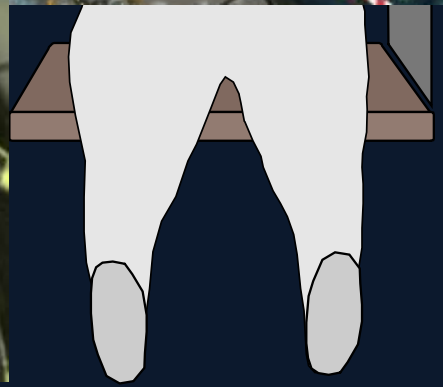
Oblique Impact Biomechanics



Intruding vehicle structure



CAMI Sled Tests

Pelvis and legs restrained but not

restrained plus

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CAMI Sled Tests

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Injury Criteria

- Post Mortem Human Surrogate (PMHS) to define human response
- Same environment/loading conditions
- “Matched-paired” test w/ATD
- Injury Assessment Reference Values (IARV)

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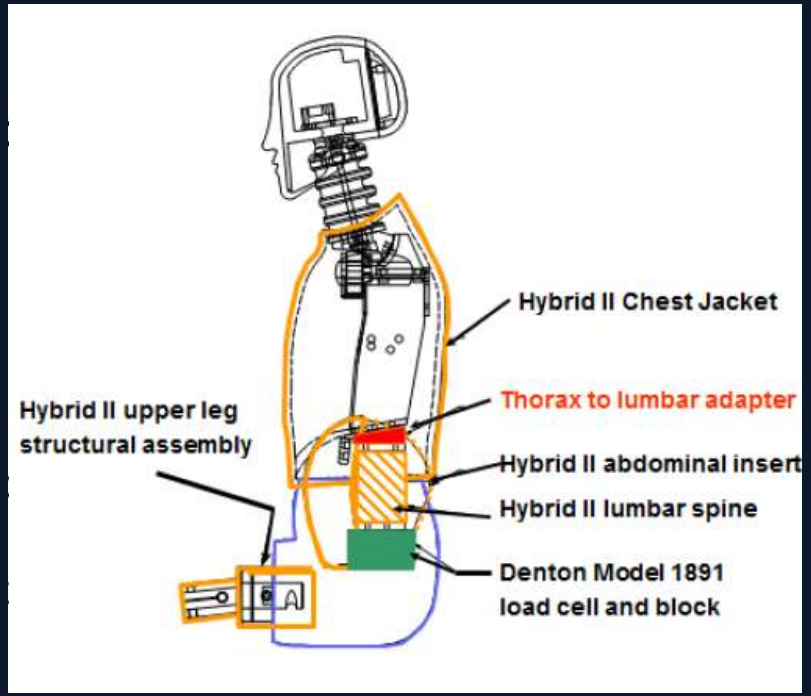
FAA-HYBRID III

FAA-Hybrid III is predominately made up of Hybrid III parts except:

- **Hybrid II lumbar spine**
- **Hybrid II abdominal insert**
- **Hybrid II chest jacket**
- **Hybrid II upper leg bone**
- **Hybrid II lumbar load cell and**
- **Pelvic adaptor block**
- **Custom thorax/lumbar adaptor →**
  - **Thoracic load cell**



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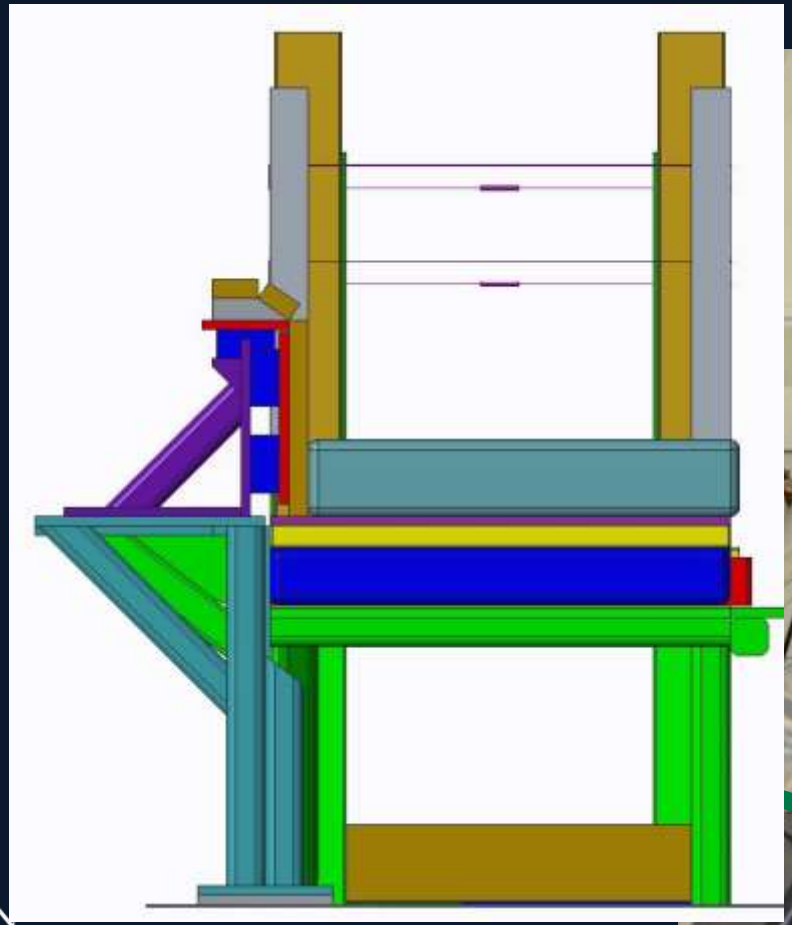
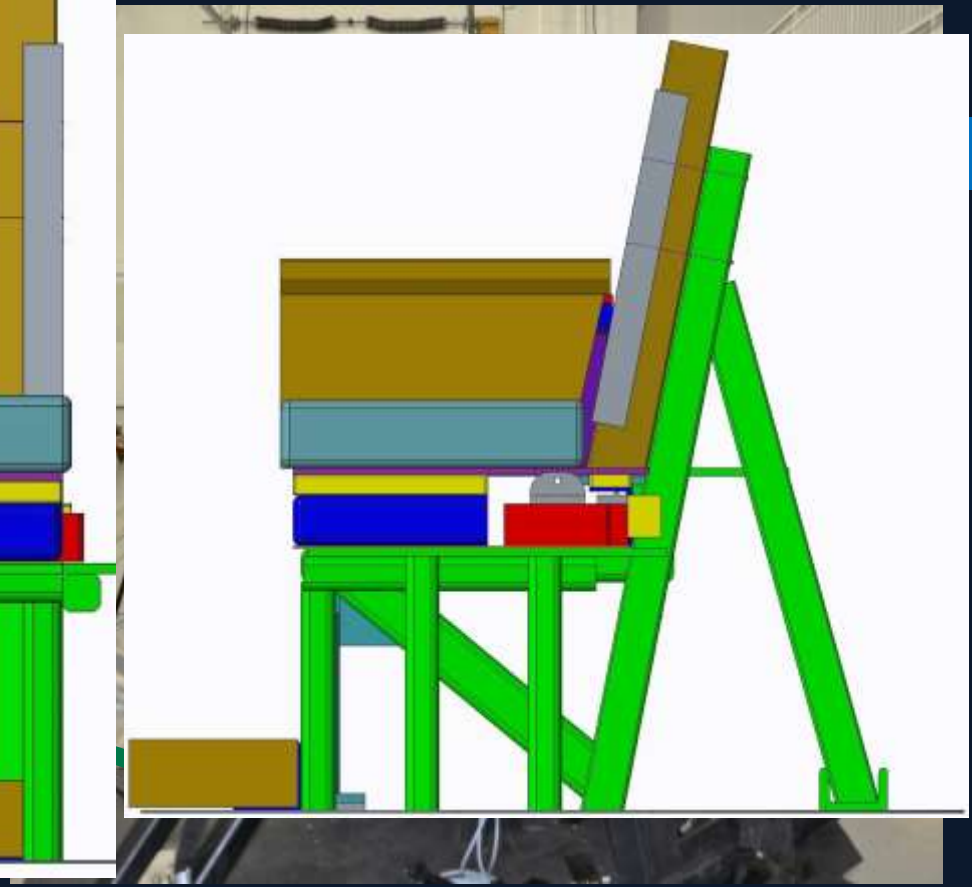
Sled Buck – Aircraft Interior





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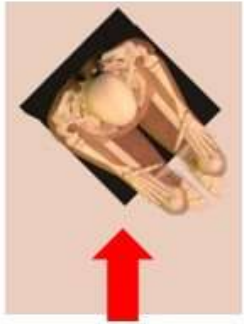
Boundary Condition #1

Boundary Condition #2

Boundary Condition #3

Summary: Test Conditions

	1	2	3
Condition				3
Angle				30
Belt				2 lap belts
Leg				Free
Loadwall	Acceleration	Acceleration	Acceleration	None

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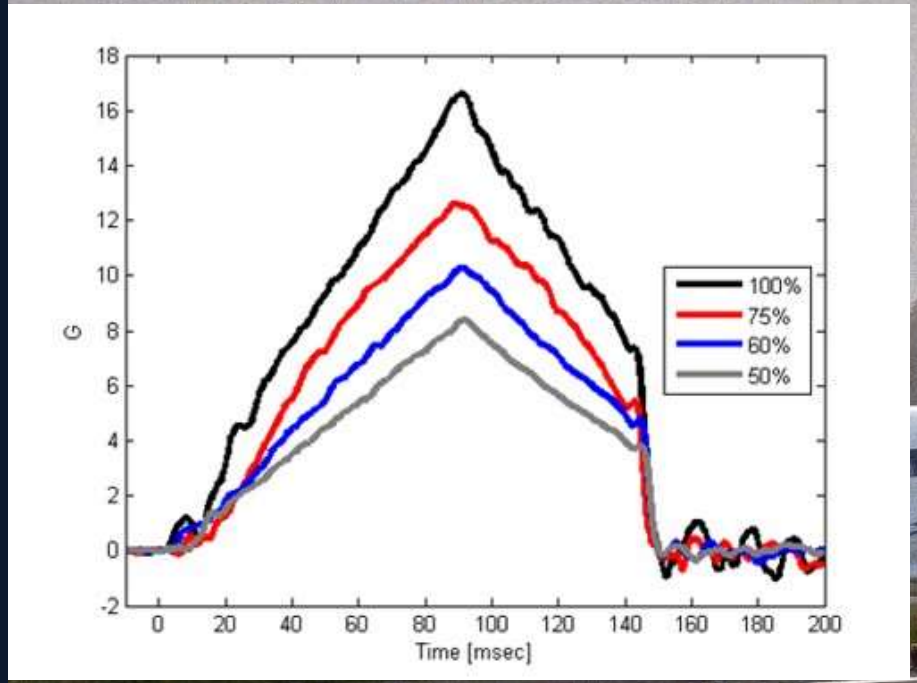
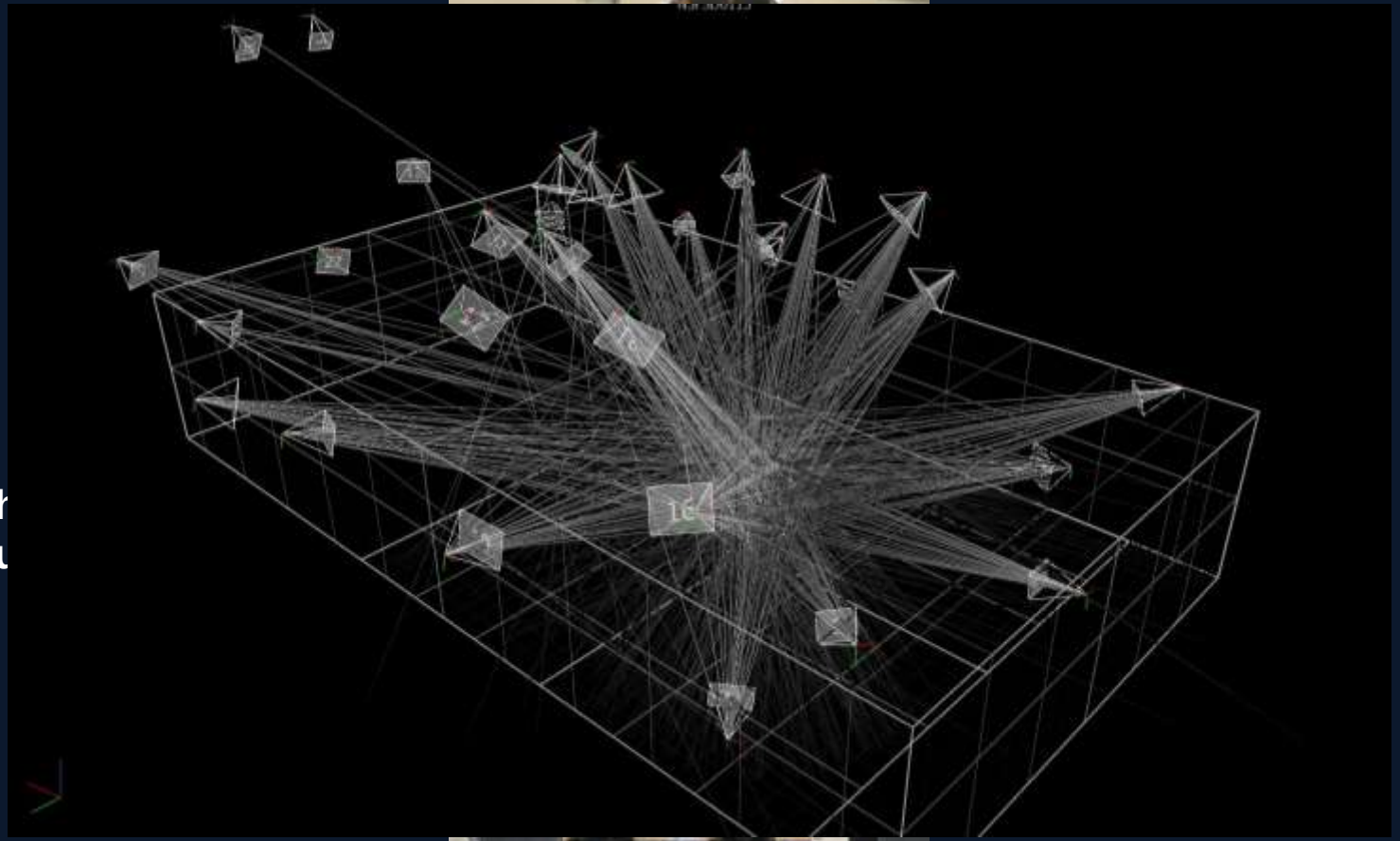
Acceleration Pulse



- Scaled pulse – magnitude only
- 100, 75, 60, 50 %
- 4 pulses @ 3 Conditions

Instrumentation



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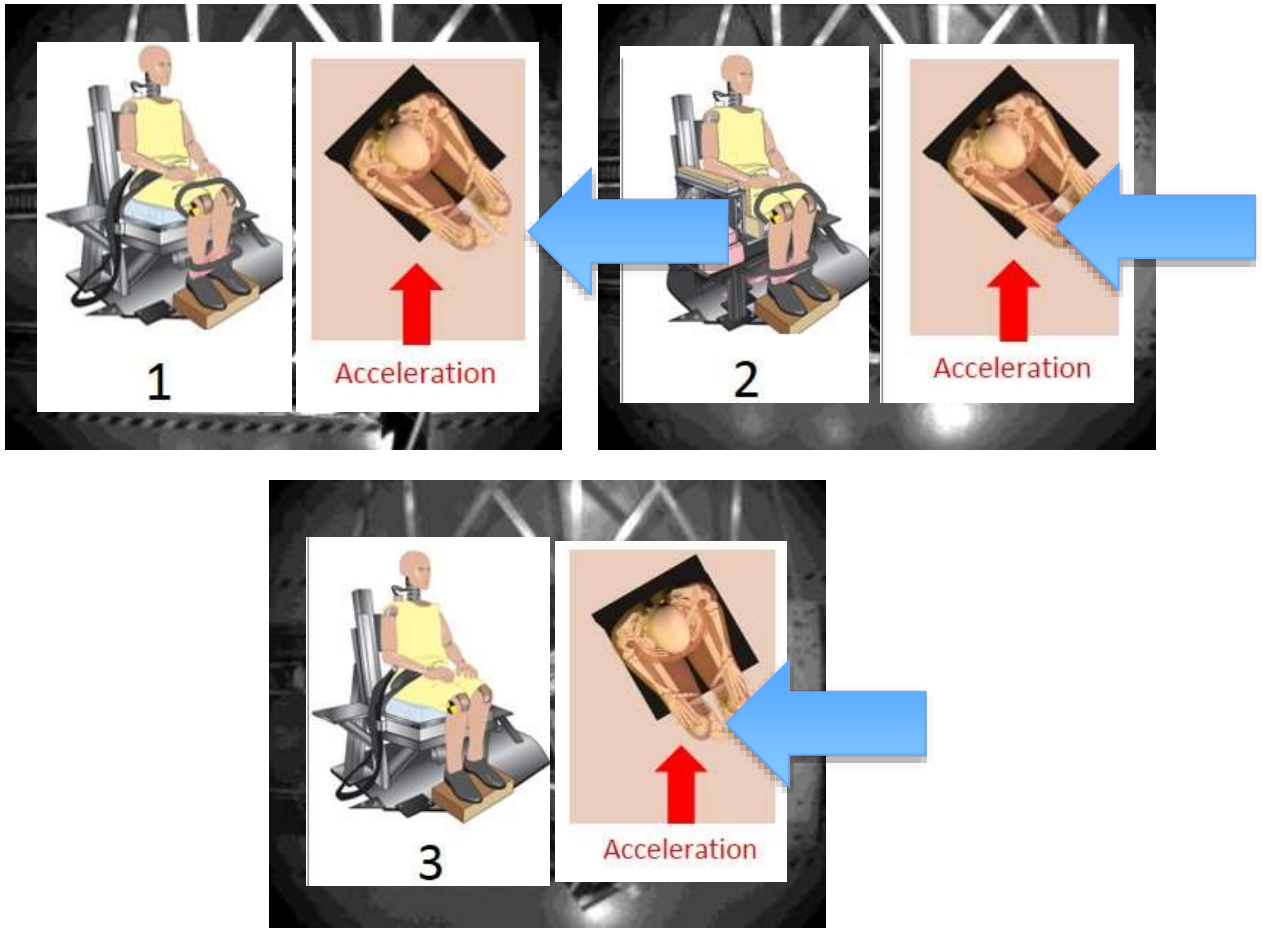
OVERHEAD: TIME 0 MSEC

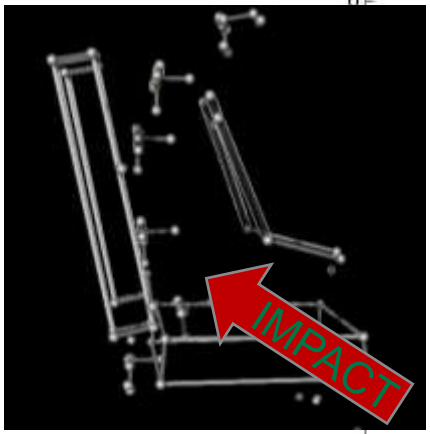


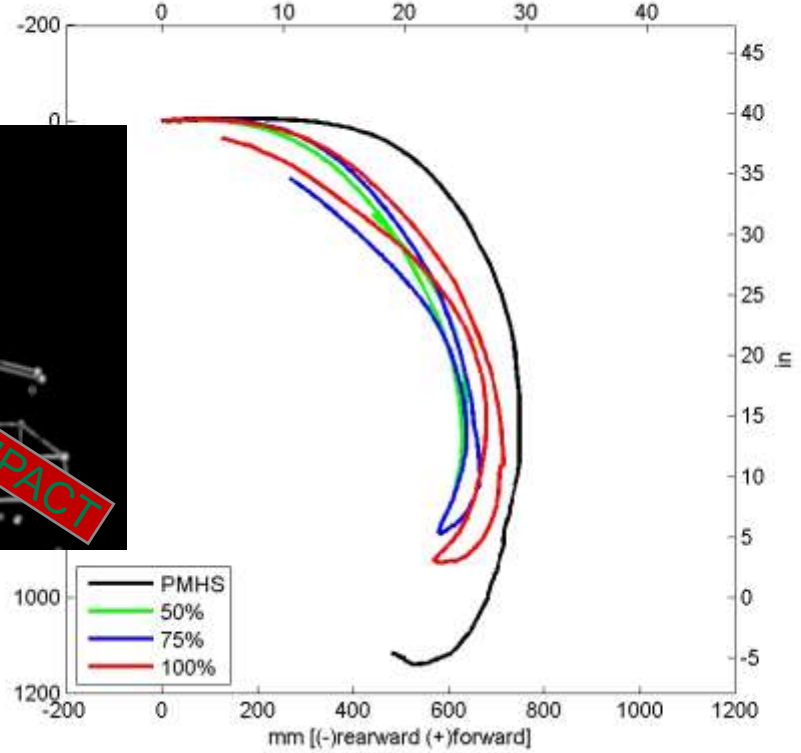
Overhead: Time 125 msec

OVERHEAD: TIME 225 MSEC

LATERAL: TIME 175 MSEC

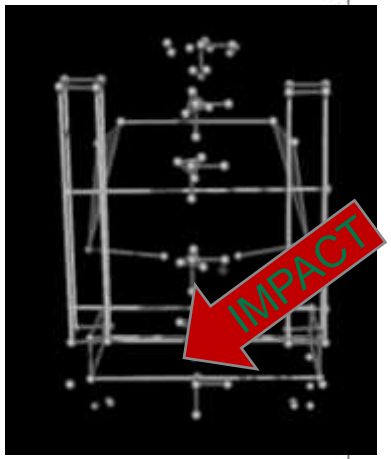
CONDITION 1-HEAD WRT SEAT - SAGITTAL PLANE

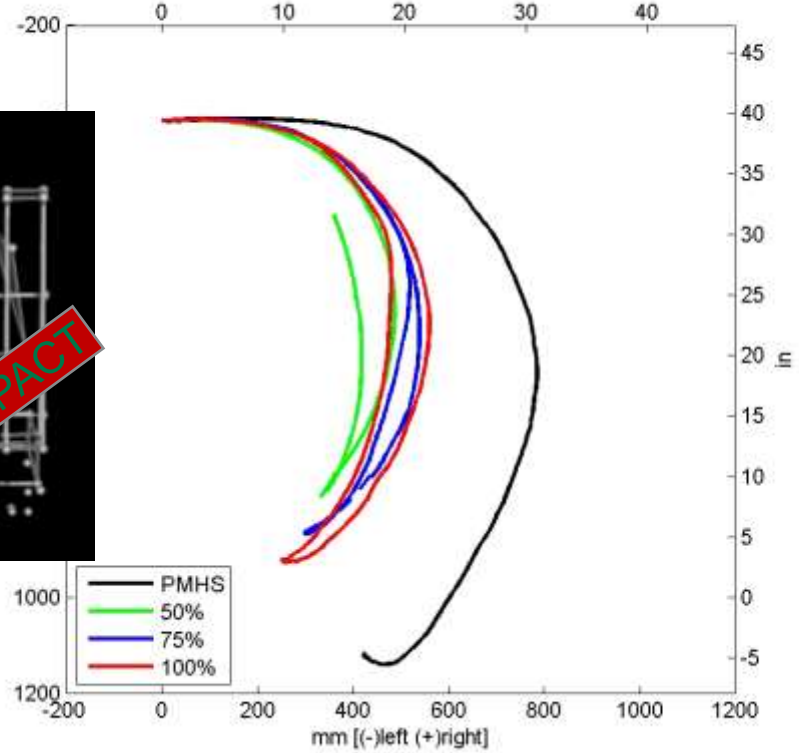




1

CONDITION 1-HEAD WRT SEAT - CORONAL PLANE

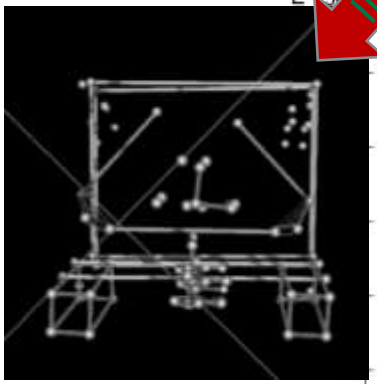


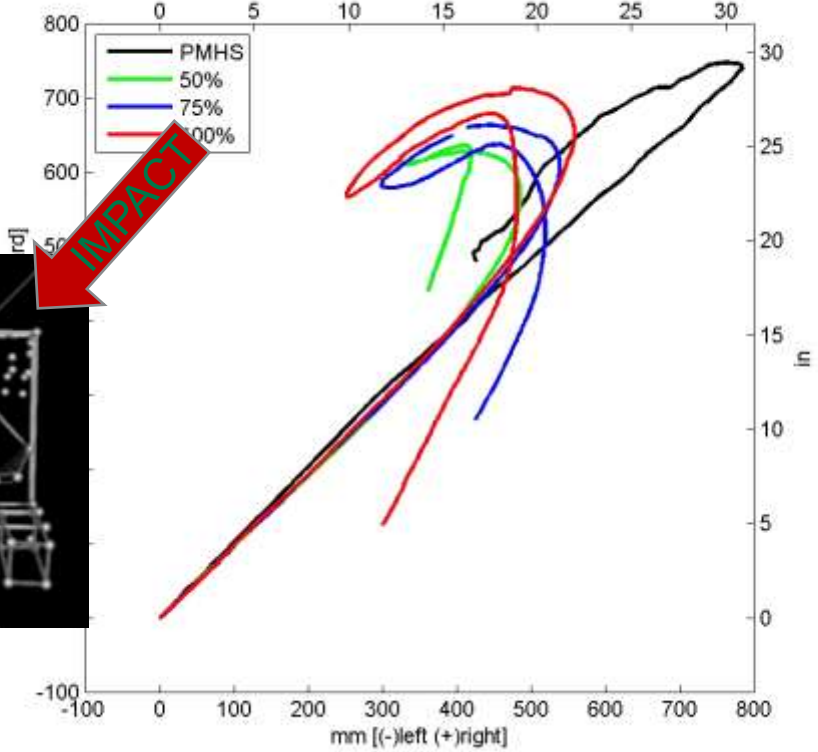


1

Acceleration

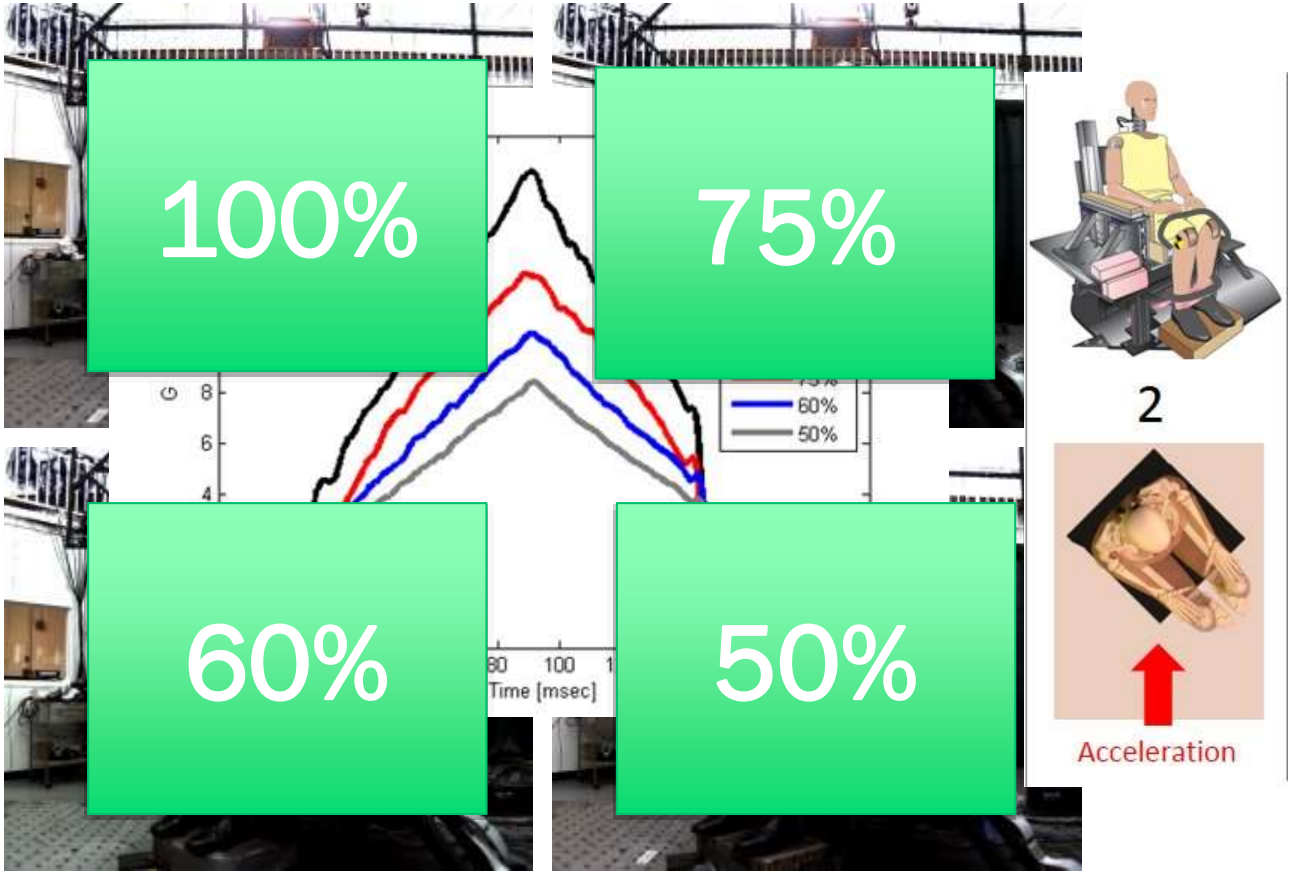
CONDITION 1-HEAD WRT SEAT - TRANSVERSE PLANE





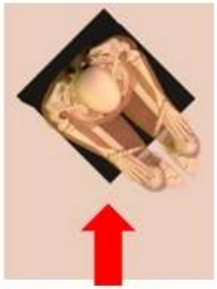
1

Onboard Oblique: Time 0 msec



Onboard Oblique: Time 100 msec

2

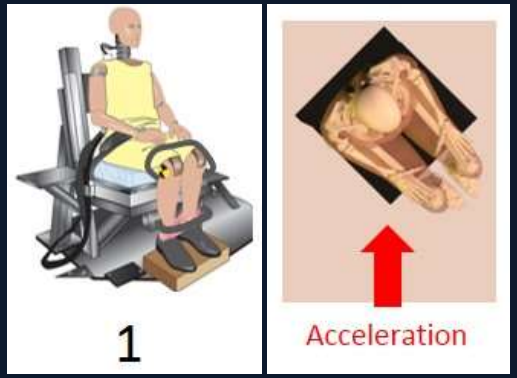


Onboard Oblique: Time 160 msec

Onboard Oblique: Time 220 msec

100% Pulse

Injury Summary Condition 1



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Coronal (spine) CT

Sagittal (spine) CT

Transection of vertebral column C5-C6

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sagittal CT

Transection of vertebral column at L5-S1

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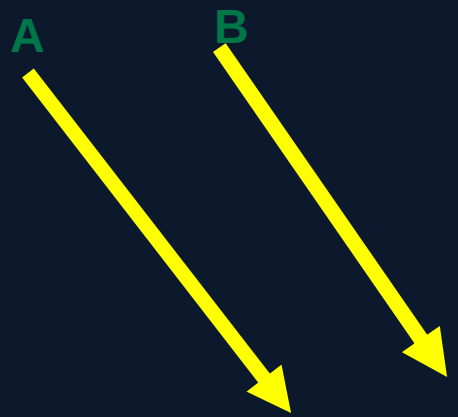

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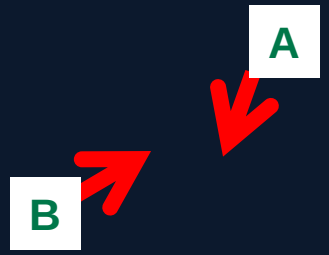
A Transection of vertebral column at L5-S1; **B** Left pelvis ala fx

Sagittal CT

Coronal CT



A Linear fracture, left pelvic ala; **B** chip fx left sacral body

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Injury Summary Condition 2

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Sagittal (spine) CT

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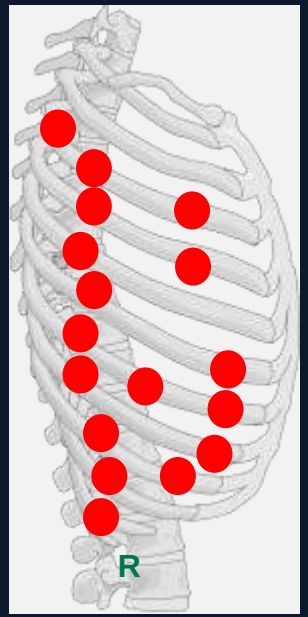
A Transection of vertebral column C6-C7 **B** Transection T3-T4



Lateral aspect, right thorax

Injury Summary Condition 3

Sagittal CT

Coronal CT

A Spinal fracture-dislocation, T5

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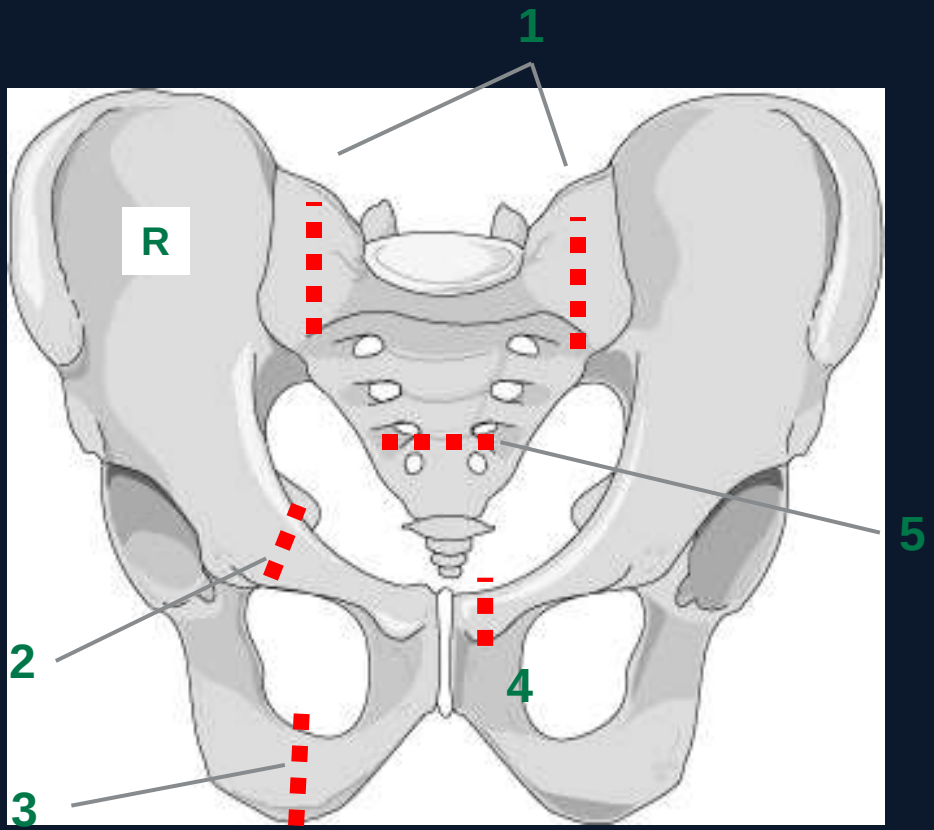

Pelvis Injuries

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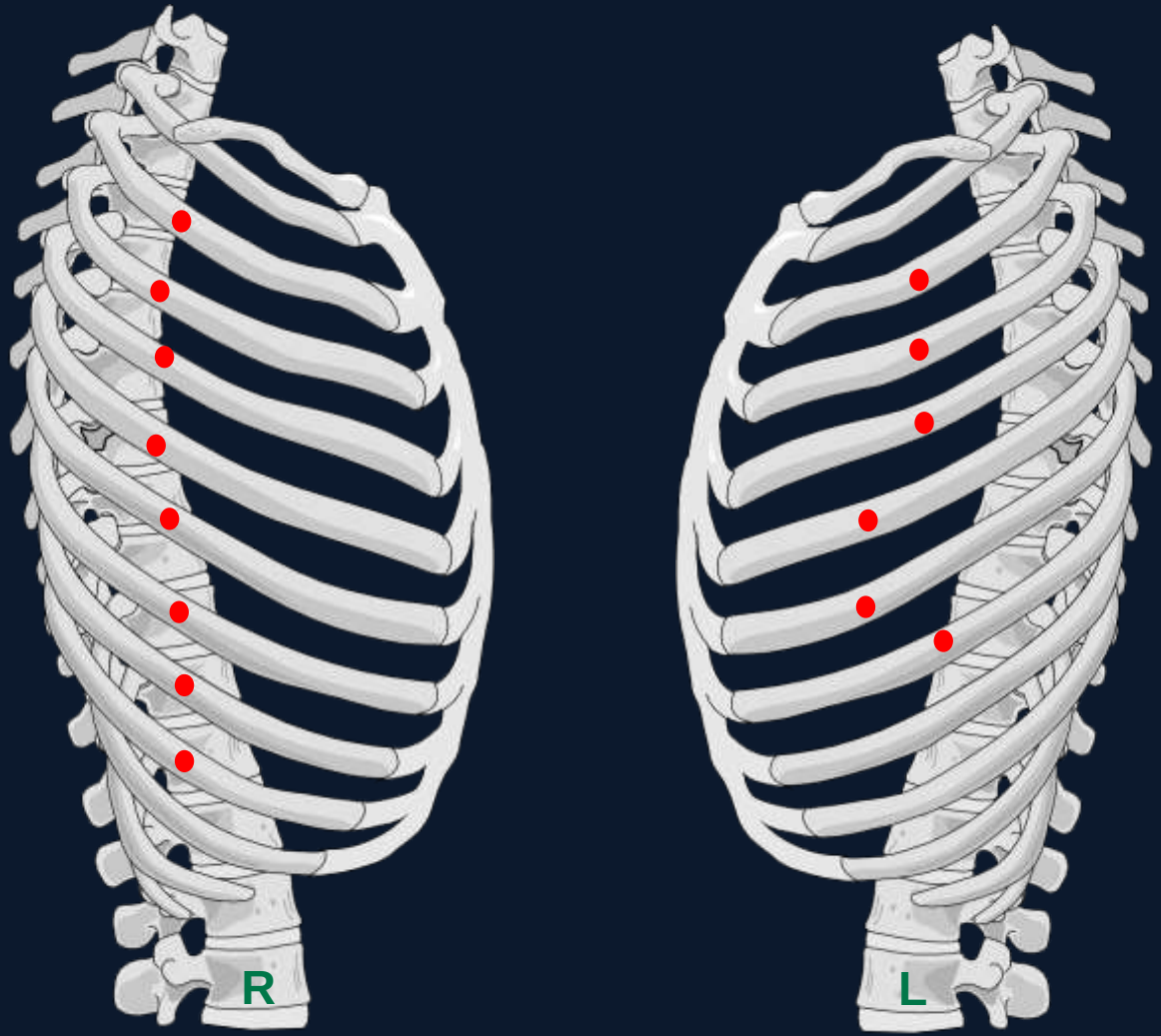

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MODELLING OF DIRECT HEAD IMPACT INJURY MECHANISMS
APPLIED TO TRANSPORT AIRCRAFT: ARE LONG PITCH SEATS SAFE?

T.H. Barth, AmSafe Aviation
S.M.R. Hashemi, CIC
A.C. Walton, CIC

D **Right** tibial shaft fracture

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Condition 1

Condition 2

Condition 3

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Matched-Paired Tests

Conducted 100% Pulse PMHS for Conditions 1, 2, and 3

Conducted 100, 75, 60, and 50% Pulse ATD for Conditions 1, 2, and 3.

From ATD data targeted 60% Pulse for no injury PMHS

Conducted 60% Pulse PMHS for Conditions 1 and 2

No Injury

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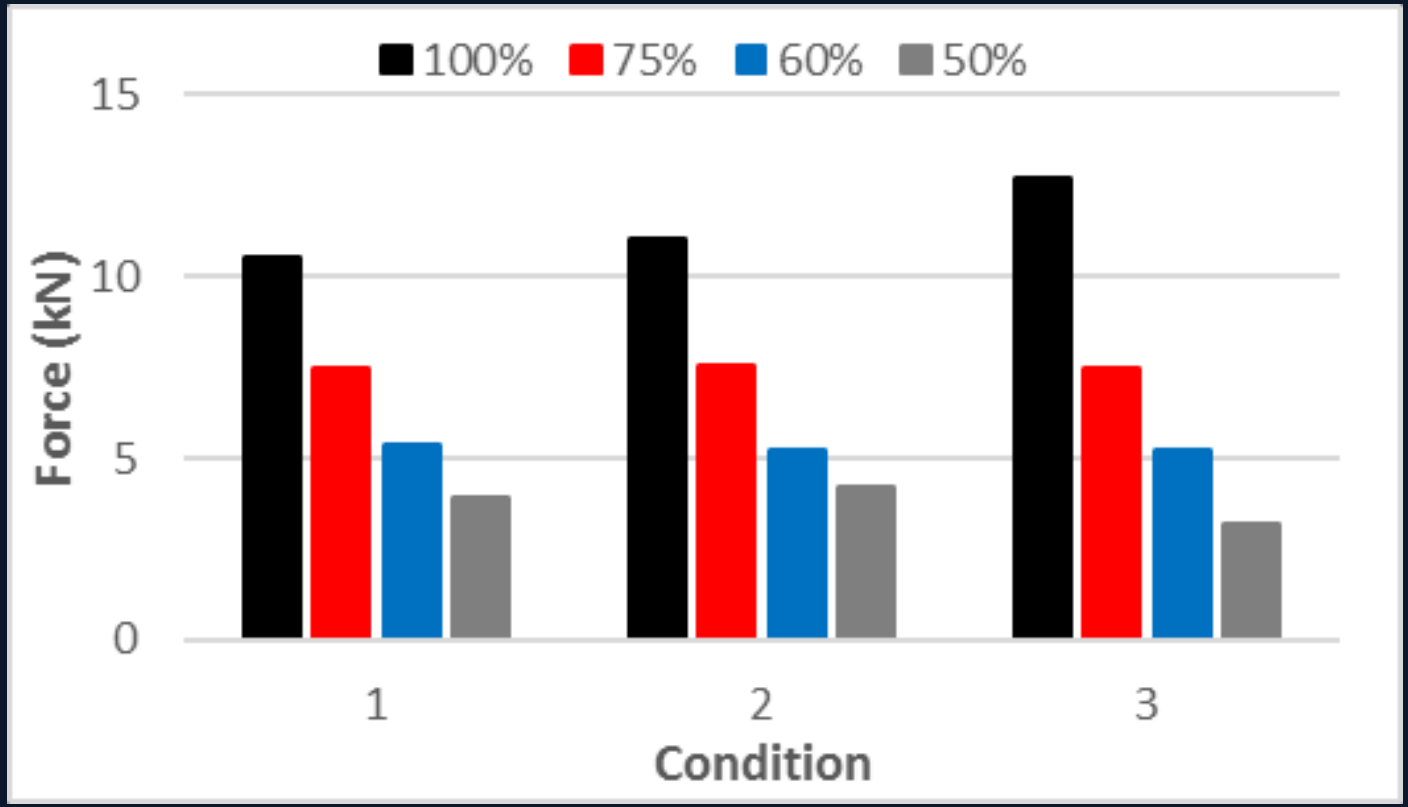
Lumbar Spine ATD Tension Force



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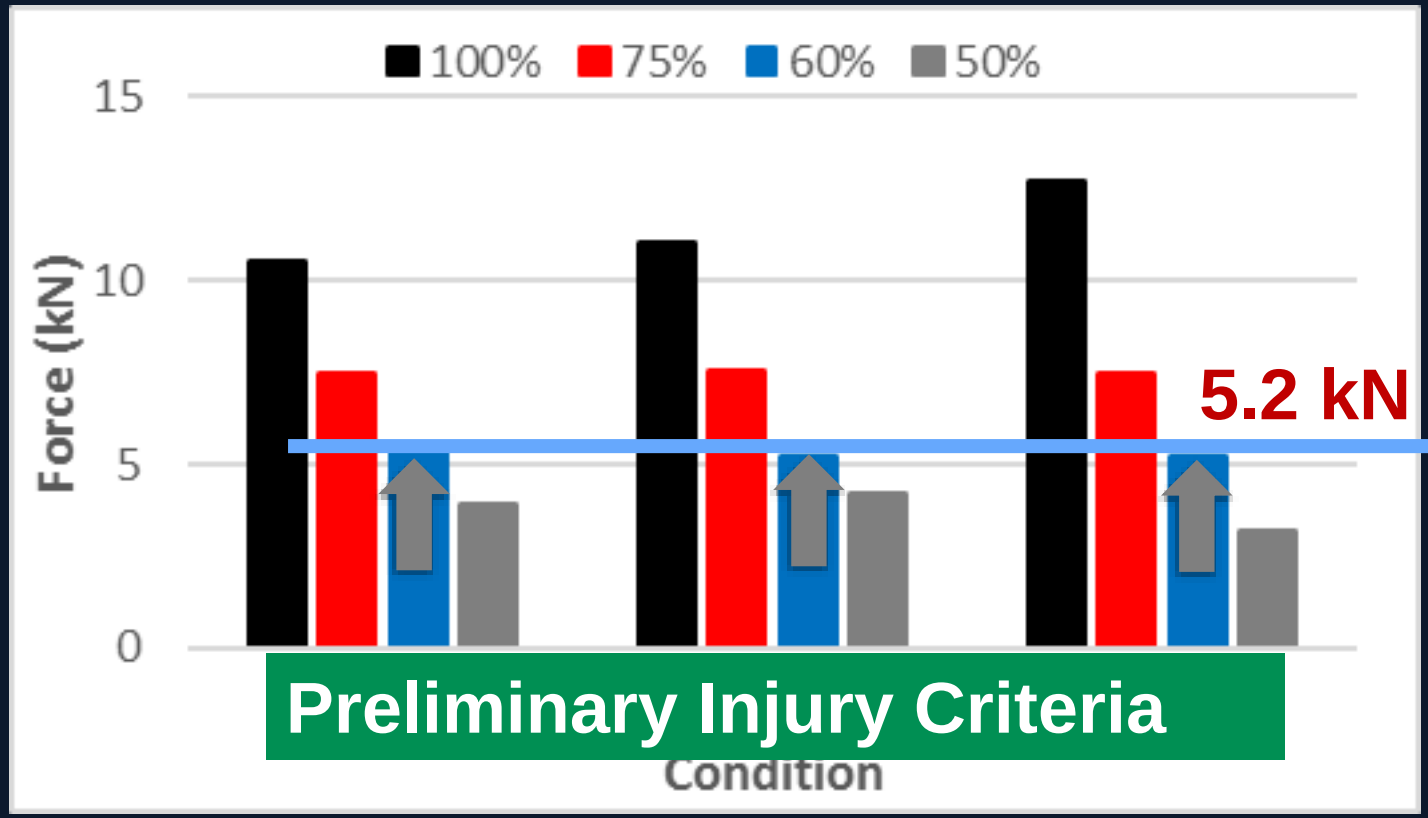
Lumbar Spine ATD Tension Force



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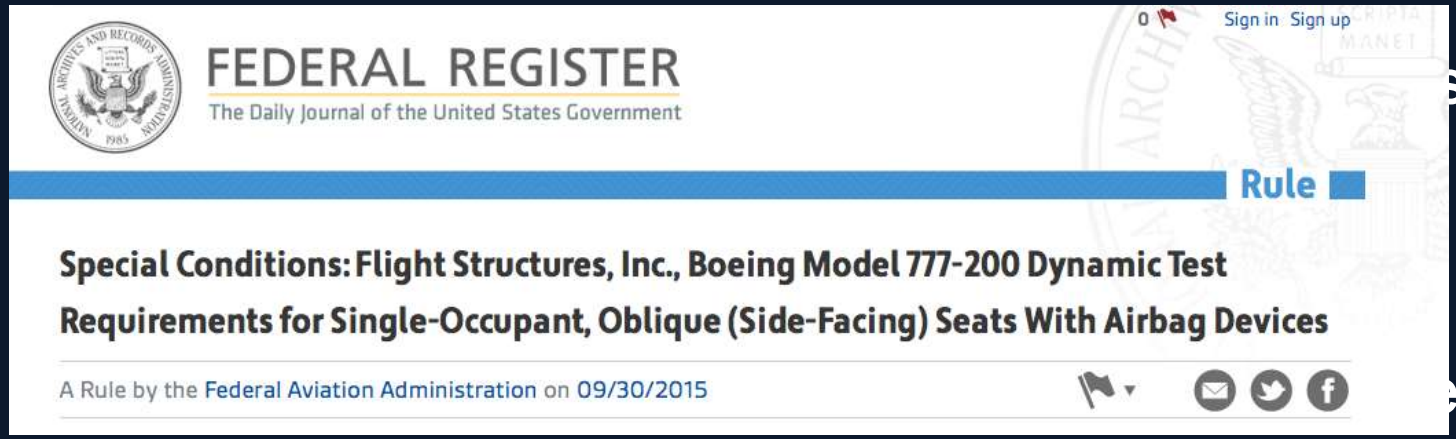
SUMMARY



FEDERAL REGISTER

The Daily Journal of the United States Government

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Rule

Special Conditions: Flight Structures, Inc., Boeing Model 777-200 Dynamic Test Requirements for Single-Occupant, Oblique (Side-Facing) Seats With Airbag Devices

A Rule by the Federal Aviation Administration on 09/30/2015

FAA res Seats

4. Spine and Torso Injury Criteria

a. The shoulders must remain aligned with the hips throughout the impact sequence, or support for the upper torso must be provided to prevent forward or lateral flailing beyond 45 degrees from the vertical during significant spinal loading. Alternatively, the lumbar spine tension (F_z) cannot exceed 1200 lb ≈5.2 kN

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Thanks

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