COMPARISON OF STANDARD AND Y-BELT AIRCRAFT PASSENGER RESTRAINTS IN FRONTAL IMPACTS WITH PMHS AND ATD

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**Front Row Occupants**

- Motivation: Severe injury in oblique tests with PMHS → Flailing
- “Front Row” Occupants → Increased seat pitch → Flail
- Will similar injuries be produced in frontal impacts?
- Standard belt/Y-Belt
WHAT IS A Y-BELT?

Reduce dummy head excursion → Alter pelvis kinematics
CAMI SLED TESTS

Move occupant close to wall → increase seating density
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)
AIRCRAFT V. MOTOR VEHICLE
SLED BUCK – AIRCRAFT INTERIOR

Cushion

Open back

Triaxial loadcells
PMHS Instrumentation

Spine

- Head NAP
- T1 6 DOF
- T6 6 DOF
- T12 6 DOF
- Sacrum 6 DOF

Left
PMHS Instrumentation
CFR Part 25.562, Emergency landing dynamic condition for horizontal impacts

**DeltaV = 30 mph**

Test Requirements:
- Peak G's = 16 g's
- Test Vel = 44 ft/s
- Rise Time = 90 ms

Sled X Evaluation - A16017

- **T1 = 14**
- **T1 + 1.33(T3-T1) = 134**
- **T4 = 164**
- **T1 + 2.3(Treq) = 221**

Achieved G Peak = -16.32 g's (Pass)
- Rise Time = 80 ms (Pass)
- Vel over T1 to T3 = 26.02 ft/s (Pass)
- Vel over T1 to T4 = 45.06 ft/s (Pass)
- Sled pulse does not drop below 2G offset line (Pass)
- Impact Velocity = ft/s (For Ref)
**ONBOARD LATERAL: 0 msec**

- Standard Belt
- Y-Belt
Onboard Lateral: 50 msec
Onboard Lateral: 100 msec
Onboard Lateral: 125 msec
ONBOARD LATERAL: 150 msec
Onboard Lateral: 175 msec
Onboard Lateral: 275 msec
Injuries – Standard Belt

1. Transection of vertebral column and Spinal Cord T4-T5
2. Multiple Bilateral Rib Fractures
3. Flail Chest
4. Bilateral Proximal femoral shaft fractures
Transection of vertebral column and Spinal Cord at T4-T5. Also demonstrated are multiple bilateral rib fractures resulting in Flail Chest condition.
T4-5 Transection of Vertebral Column/SC
PROXIMAL FEMUR FRACTURES
PROXIMAL FEMUR FRACTURES
LEFT RIB FRACTURES
RIGHT RIB FRACTURES
POSTERIOR RIB FRACTURES
Injuries – Y-Belt

Summary

- Transection of vertebral column L5-S1
- Multiple Left Rib Fractures
- Flail Chest
L5-S1 Transection of Vertebral Column

T10  
T11  
T12  
L1   
L2   
L3   
L4   
L5

T10  
T11  
T12  
L1   
L2   
L3   
L4   
L5
L5-S1 Transection of Vertebral Column

L5 Vertebral Body

Sacrum
Left Rib 2 Fx
Left Rib 3 Fx(s)
Left Rib 4 Fx(s)
Left Rib 5 Fx
Kinematics
BELT LOADS
Y-Belt Load
MATCHED-PAIRED TESTS

FAA-Hybrid III
Fixed (standard) Pelvis
Pedestrian Pelvis
Lumbar Load cell
Thoracic Load cell
HEAD KINEMATICS - ATD
Pelvis Kinematics - ATD

[Graph showing ATD Pelvis with Y-Belt and Standard lines]
Peak Forward Translation

Graph showing the peak forward translation for Head and Pelvis under different conditions:

- Lap Belt
- Y-Belt

Data categories include:
- PMHS
- ATD-Fixed
- ATD-Pedestrian

Forward displacement measured in millimeters [mm].
ATD Lumbar Force

5.2 kN Tension Limit Oblique Seats
2 PMHS Tests → Standard and Y-Belt
Severe spine injuries
Matched ATD Tests → Fixed/Pedestrian Pelvis
Head kinematics
  - Standard Belt PMHS > ATD : Pedestrian & Fixed similar
  - Y-Belt PMHS and ATD similar : Pedestrian < Fixed
ATD lumbar tension forces similar
Results may require updates to future certification projects
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Thanks