Joint Australian and Canadian Pole Side Impact Research

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Program Overview

- Paired comparisons of 29 km/h perpendicular and 32 km/h oblique pole side impact tests with WorldSID 50th percentile adult male ATDs.

- Canadian market vehicles including Chevrolet Cruze, Suzuki Kizashi, Mitsubishi RVR (ASX), Mazda 2, Ford Fiesta, Dodge Journey and Nissan Juke. All have separate head curtain and seat mounted thorax side airbags.

- Australian market vehicle, Ford Falcon* added to plots for comparison. Seat mounted head/thorax combination side airbag.

*NB: Perpendicular test was conducted at 32 km/h for this vehicle model.
Head Injury Risk

HIC36 results suggest probability of AIS 3+ head injury from head to airbag/pole interaction is less than 20% in all vehicles.

For majority of vehicle models 32 km/h oblique pole tests produced HIC36 results greater than or equal to 29 km/h perpendicular pole tests.

Technically feasible to achieve/ensure less than 30% AIS 3+ head injury risk.

Occupant-to-occupant head collisions (HIC36 > 2000) occurred in every test.

Head injury risk has been determined using the Prasad/Mertz AIS 3+ skull fracture probability risk function published in FMVSS 214 Final Regulatory Impact Analysis (August 2007).
Shoulder Injury Risk

Maximum Shoulder Force

50% AIS 2+ Shoulder Injury Risk (relative to $F_Y$) 95% AIS 2+ Shoulder Injury Risk (estimate)

- For all vehicle models except Ford Fiesta (NB(?): shoulder rib broke in oblique test of Ford Fiesta), 32 km/h oblique pole impact produced shoulder forces greater than or at least equal to 29 km/h perpendicular pole impact.

- Peak lateral ($F_Y$) shoulder force was very similar to peak resultant ($F_R$) shoulder force in every test.

- May be feasibility issues associated with applying a 50% AIS 2+ shoulder force limit – most current model vehicles would probably fail such a limit if applied to a 32 km/h oblique pole test. **Benefit?**

- Shoulder RibEye drop outs consistently occur for theoretical IRTRACC deflections around 60 mm – theoretical shoulder rib IRTRACC deflection was unable to be calculated from most vehicle-to-pole tests.

Shoulder injury risk has been determined from the AIS 2+ (survival method) shoulder injury risk curve published by Petitjean et al., Stapp 2009.
Thorax Injury Risk

Maximum Thorax or Abdomen Rib Theoretical IRTRACC Deflection

- For all vehicle models, 32 km/h oblique pole tests produced maximum thorax or abdomen rib deflections greater than or at least equal to 29 km/h perpendicular pole tests.
- Three vehicles exceeded (marginally) 50% AIS 3+ thorax injury risk in oblique pole test.
- Five vehicles had less than 30% AIS 3+ thorax injury risk in oblique and perpendicular pole tests.
- Ford Fiesta theoretical IRTRACC deflections unable to be determined (?) in perpendicular pole test due to dropouts caused by large forward movement of RibEye LEDs relative to sensor.

Thorax injury risk has been determined from the AIS 3+ (survival method) thorax injury risk values (adjusted to 45 year old) published by Petitjean et al., Stapp 2009.
Thorax Injury Risk

Maximum Thorax or Abdomen Rib Viscous Criterion (VC)

- 32 km/h oblique pole tests produced maximum thorax or abdomen rib viscous criterion responses either greater than or at least similar to 29 km/h perpendicular pole tests.
- Two vehicles exceeded 50% AIS 3+ thorax injury risk in oblique pole test.
- Four vehicles had less than 30% AIS 3+ thorax injury risk in oblique and perpendicular pole tests.
- Ford Fiesta viscous criterion response values (?) unable to be reliably determined due to RibEye dropouts.

Thorax injury risk has been determined from the AIS 3+ (survival method) thorax injury risk values (adjusted to 45 year old) published by Petitjean et al., Stapp 2009.
Suzuki Kizashi

X-Y Response (0-100ms): Thorax Rib 2

Diagram showing X-Y response measurements with specific locations such as 25 mm, 55 mm, IRTRAACC Deflection, Oblique, and Perpendicular.
Suzuki Kizashi

Thorax Rib 2 (Oblique Impact)

Graph showing displacement over time for Y Displacement (middle LED) and Theoretical IRTRACC Deflection.
X-Y Response (0-100ms): Thorax Rib 1
Mitsubishi RVR

Thorax Rib 1 (Oblique Impact)
Mazda 2

X-Y Response (0-100ms): Thorax Rib 1
Dodge Journey

X-Y Response (0-100ms): Thorax Rib 3

- X
- 55 mm
- 25 mm

IRTRAQ Deflection

Oblique
Perpendicular

Rearward
Forward
Dodge Journey

Thorax Rib 3 (Oblique Impact)

Displacement / Deflection [mm]

Time [s]

Y Displacement  IRTRACC Deflection
Ford Falcon

X-Y Response (0-100ms): Abdominal Rib 1
Ford Falcon

Abdominal Rib 1 (Oblique Impact)

Graph showing displacement vs. time for Y Displacement and IRTRACC Deflection.
Abdomen Injury Risk

3ms Lower (T12) Spine Acceleration

50% AIS 3+ Abdominal Injury Risk  25% AIS 3+ Abdominal Injury Risk

- 3ms lower spine acceleration responses suggest less than 25% AIS 3+ abdominal injury risk in all but one test.
- For a majority of vehicle models, 32 km/h oblique pole tests produce higher 3ms T12 acceleration than 29 km/h perpendicular pole tests.

Abdomen injury risk has been determined from the AIS 3+ (survival method) abdomen injury risk values (adjusted to 45 year old) published by Petitjean et al., Stapp 2009.
Pelvis Injury Risk

Peak Pubic Symphysis Force

- 32 km/h oblique pole tests produced higher pubic symphysis forces than 29 km/h perpendicular pole tests.
- Pubic symphysis force responses suggest much less than 5% probability of AIS 3+ pelvis injury for each vehicle model/test.

Pelvis injury risk has been determined from the AIS 3+ (survival method) pelvis injury risk values (adjusted to 45 year old) published by Petitjean et al., Stapp 2009.
Summary

• Likely that many current model vehicles would fail shoulder force/deflection thresholds based on 50% AIS 2+ shoulder injury risk.

• Consistently more forward movement of ribs in perpendicular pole tests than oblique pole tests.

• Current injury risk curves were developed for lateral rib deflection (i.e. are not suited to rib deflection responses with large forward movement and may underestimate injury risk in such cases).

• WorldSID 50\textsuperscript{th} male typically predicted lower injury risks for abdomen and pelvis when compared to head or thorax.

• Highest AIS 3+ injury risks typically occurred for WorldSID 50\textsuperscript{th} male thorax.

• Majority of WorldSID 50\textsuperscript{th} male injury responses were higher for 32 km/h oblique pole tests than 29 km/h perpendicular pole tests.
Thank you