Research to Support a Far-side NCAP Test

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George Washington University
NHTSA Meeting June 9, 2015
Outline

• Far-side Crash Tests Conducted by GWU
• Application of the Far-side International Collaborative Research a Far-side NCAP and Safety Standard – Dummy Suitability
• Injury Criteria for Far-side Evaluations
• Conclusions
Far-side Tests Conducted at FOIL by GWU
Two Far-side Tests at FOIL – 1996 Explorer into Ford Taurus -62 kph (38.5mph)

Test 10010 60° B-pillar Impact

Test 10016 60° A-pillar Impact
Far-side Tests at FOIL – 1996 Explorer into Ford Taurus -62 kph (38.5 mph) - Videos

Test 10010 60° B-pillar Impact, 1997 Taurus

Test 10016 60° A-pillar Impact, 2002 Taurus
Vehicle Rotation – Yaw vs Time

B-pillar Impact

A-pillar Impact

Time, sec.
B-pillar Far-side Test at FOIL – 1996 Explorer
into 1997 Taurus -62 kph (38.5 mph)

Test 10010 60° B-pillar Impact Test

Occupant Modeling by Sean Haight
B-pillar Far-side Test at FOIL – 1996 Explorer into 1997 Taurus -62 kph (38.5 mph)

Test 10010 60° B-pillar Impact

Occupant Motion Simulation Test 10010 19 kph
B-pillar Far-side Test at FOIL – 1996 Explorer into 1987 Taurus -62 kph (38.5mph)

Test 10010 60° B-pillar Impact

Max G = 11 @ 52 ms; Crash pulse 115 ms
DeltaV 19 kph
A-pillar Far-side Test at FOIL – 1996 Explorer into 2002 Taurus -62 kph (38.5mph)

Test 10016 60° A-pillar Impact

Occupant Modeling by Sean Haight
A-pillar Far-side Test at FOIL – 1996 Explorer into 2002 Taurus -62 kph (38.5 mph)

Test 10016 60° A-pillar Impact

Occupant Motion Simulation Test 10016
A-pillar Far-side Test at FOIL – 1996 Explorer into 2002 Taurus -62 kph (38.5mph)

Test 10016 60° A-pillar Impact

Max G = 21 @ 52 ms; Crash pulse 80 ms
DeltaV 30 kph
Occupant Simulations Showing Upper Body Excursion and Unfavorable Belt Loading

Simulation - Test 10010 60° B-pillar Impact  200 ms

Simulation Test 10016 60° A-pillar Impact  200 ms
Observations

• Restraint loading unfavorable when shoulder belt releases upper body
• Large upper body excursion possible before contact with far-side
• Chest/back contact with seatback and console can occur with lower excursion
• Vehicle crash pulse and rotation vary with crash impact location
• Delta-V and crash severity vary with crash impact location
• Occupant kinematics and belt loading vary with impact location
• Sled tests may be suitable to evaluate far-side safety – variations in crash direction desirable to evaluate restraint systems
Far-side International Collaborative Research Project - Participants

- Monash University - B. Fildes (co-chair), C. Douglas, M. Fitzharris, A. Linder and T. Gibson
- Medical College of Wisconsin - F. Pintar, N. Yoganandan, K. Brazel, G. Stinson, M. Steinman and T. Generelli;
- Va. Tech/Wake Forest - S. Duma, C. Gabler, S. Gayzik, and J. Stitzel;
- University of Miami School of Medicine - J. Augenstein;
- Wayne State University – K. Yang;
- Autoliv; O. Bostrom, O. Ortenwall;
- GM Holden - L. Sparke and S. Smith; General Motors – R. Lange;
- Ford – S. Rouhana;
- MoT, Australia - C. Newland.
Final Report on Collaborative Far-side Research Project

• Results include:
  • THOR or WorldSID adequately mimic cadaver response in far-side crashes of 10 and 30 KPH
  • Chest/abdominal injury criteria is available for WorldSID
  • Suitable computer models and sled test conditions are available
Results of Cadaver and Dummy Far-side Tests

Either WorldSID or THOR dummy would be suitable for Far-side safety evaluation
What Injury Criteria to Use for a Far-side Test?

• Head Excursion - to be discussed here
• Chest deflection/V*C on WorldSID
• Abdominal deflection on WorldSID
• Neck Tension on WorldSID
• Carotid Artery Extension (Using FEM Model)  See 2009 Final Report
Cumulative Exposure, 3+ Injuries and Harm vs. Lateral Delta V (Gabler SAE 2005)
Example of Injury Rate from NASS Data

MAIS 3+ Rate Belted Occupants with Intrusion in Far-side Crashes
Far-side Tests of Dummies and Cadavers – Lateral Head Excursion in 3-point Belts

10 kph Lateral DeltaV

30 kph Lateral DeltaV
Example of Head Excursion vs Delta V based on Test Data
Injury Rate and Head Excursion vs Delta V

![Graphs showing the relationship between injury rate, head excursion, and delta V.](image)
Head Excursion Rating System (example)
Far-side Tests by Kent (ESV 2013)

Reduced Head Excursion may increase Chest, C-spine and T-spine Injuries
Need to control Chest/Abdominal Loads
Chest Injury Criteria for WorldSID – Deflection and V*C
Abdominal Deflection and Neck Tension Injury Criteria for WorldSID
Issue: What to do next to improve safety?

One of TR’s Mottos:

“Do what you can, with what you’ve got, where you are”

Theodore Roosevelt
NCAP for Far-side and Rollover

- Front, 47%
- Near-side, 18%
- Far-side, 9%
- Roll, 24%
- Rear, 2%
- No NCAP

Recent Model Years 2000-2009

Full Barrier and Offset NCAPs

Multiple Tests – Reg. and NCAP
Conclusions

• Far-side safety countermeasures present an untapped area for injury reduction
• The growing aging population are more likely to be cause increased exposure due to their vulnerability in making left hand turns
• Dummies (THOR and WorldSID) and criteria (WorldSID criteria + head excursion) are available to permit far-side NCAP testing
• Use of head excursion criteria would permit sled-test compliance since head impact is not a compliance criteria
• Testing for several far-side impact scenarios would be possible at low cost