

Severity Measurements for Rollover Crashes

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(2) The National Highway Traffic Safety Administration

Application of Rollover Crash Severity

Needed for benefits analysis –

- Injuries in real-world crashes vs. test condition

Test may depend on countermeasure

- Ejection prevention
- Intrusion control (Roof strength)
- Safety belt design

Requirements for a Crash Severity Metric

- Measurable from post-crash data
- Related to crash energy
- Injury rate increases with metric

Data Sources

- NASS/CDS 1995 -2001
- 5,227 Front Seat Occupants Age 12+
- 1,309 MAIS 3+ F Injuries
- Expanded to 125,768 MAIS 3+F Injuries

Rollover Injuries by Belt Use and Ejection

MAIS 3+F	No-Eject	Total Eject	Part-Eject
Belted	35.0%	0.4%	3.9%
Unbelted	22.8%	32.1%	4.9%

Three Populations with Most MAIS 3+F Injuries

- Belted –Not Ejected – 35.3%
 - Unbelted – Ejected – 32.5%
 - Unbelted – Not Ejected – 22.8%
-
- Investigate Each Population Separately

Belted Not Ejected

Examine Single Vehicle vs.
Multi-Vehicle Crashes

Exposure and Injuries of Belted Occupants Single and Multiple Crash Events

Belted	Single	Multi
Exposed	81%	19%
MAIS 3+ F	68%	32%
RISK MAIS 3+F/100	2.8	5.8

Multi-vehicle Crashes Involve Higher Risks
DELTA-V needs to be included in the crash severity metric

Belted Not Ejected

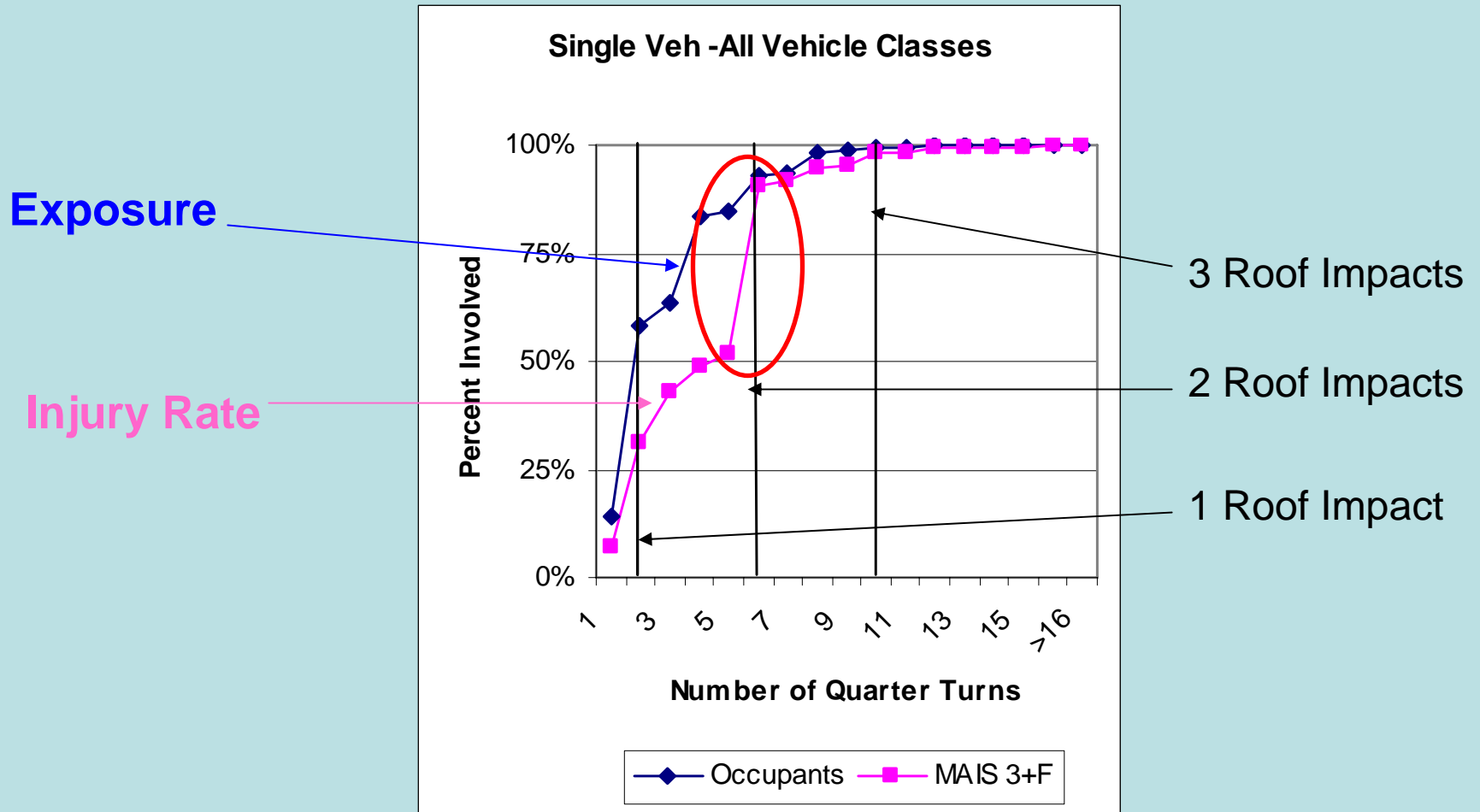
Examine Separately:

(1) Single Vehicle

(2) Multi-Impact Crashes

(Planar Impacts prior to Rollover)

Belted – Non Ejected Single Vehicle Front Seat Occupants 12+ and MAIS 3+ Injuries by Nr Quarter Turns



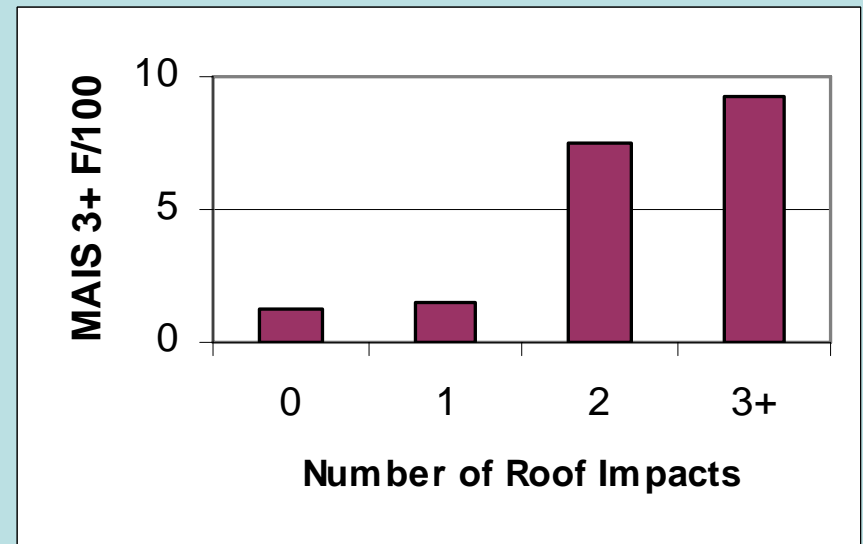
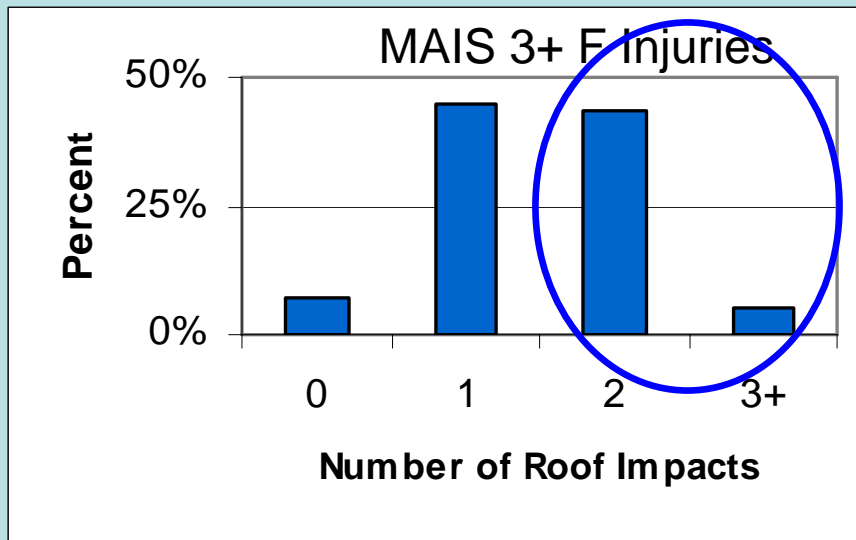
2nd roof impact increases injury rate

Belted – Not Ejected Occupants

Single Vehicle

Weighted Data NASS 1995-2001

Injury Risk



- **48% MAIS 3+F in rollovers with more than 1 roof impact**

Number of roof impacts is a good severity measure for belted occupants
(Not-ejected in Single-vehicle Crashes)

Belted Not Ejected Occupants

Examine Separately:

(1) Single Vehicle

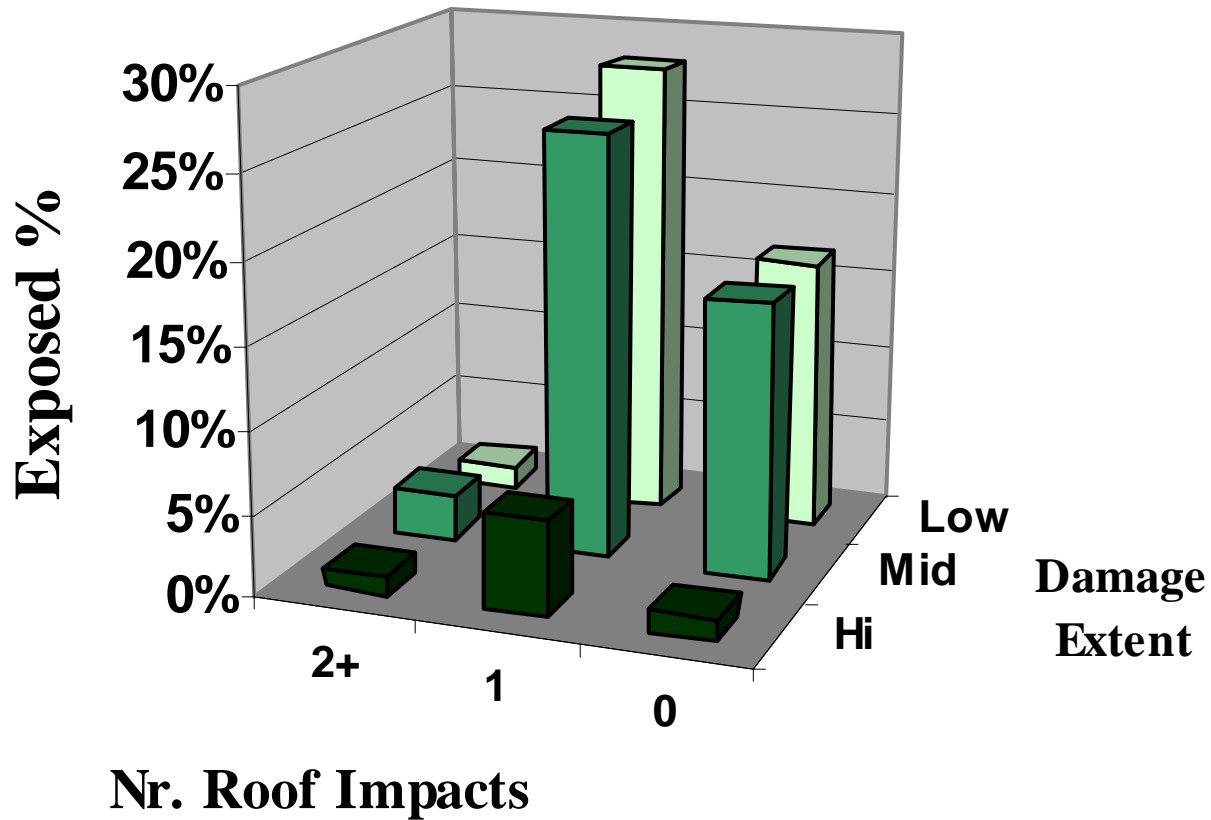
(2) Multi-Impact Crashes

(Planar Impacts prior to Rollover)

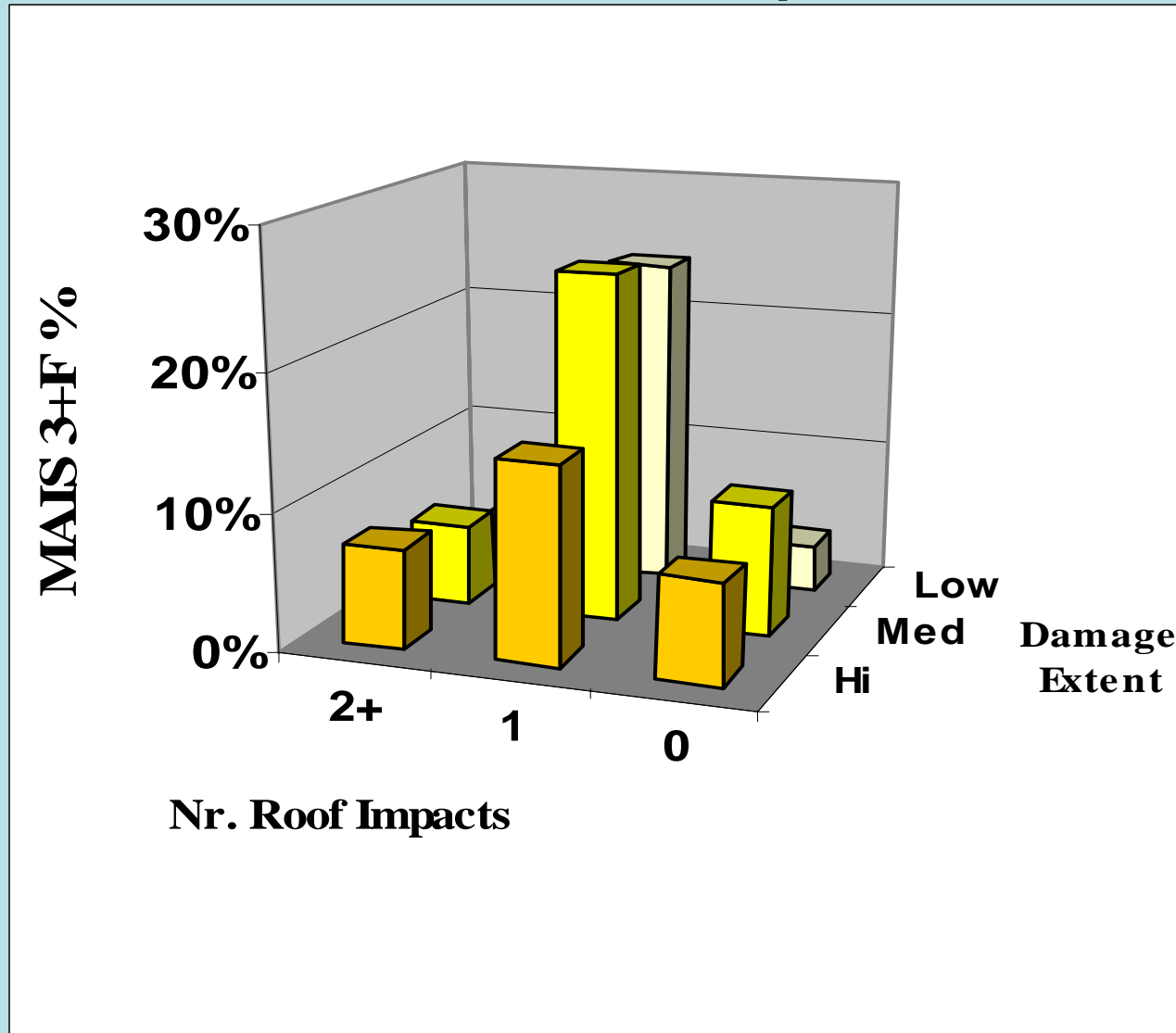
Rollovers in Multi-impact Crashes— Belted Occupants

- NASS records estimated delta-V for planar crashes
- Combine measured and estimated delta-V
- Measured and estimated delta-V combination:
 - Low - <24 Kph
 - Med - >24 and <55 Kph
 - Hi - >55 Kph
- Compare delta-V levels by number of roof impacts
 - MAIS 3+F Injuries
 - Injury Risk

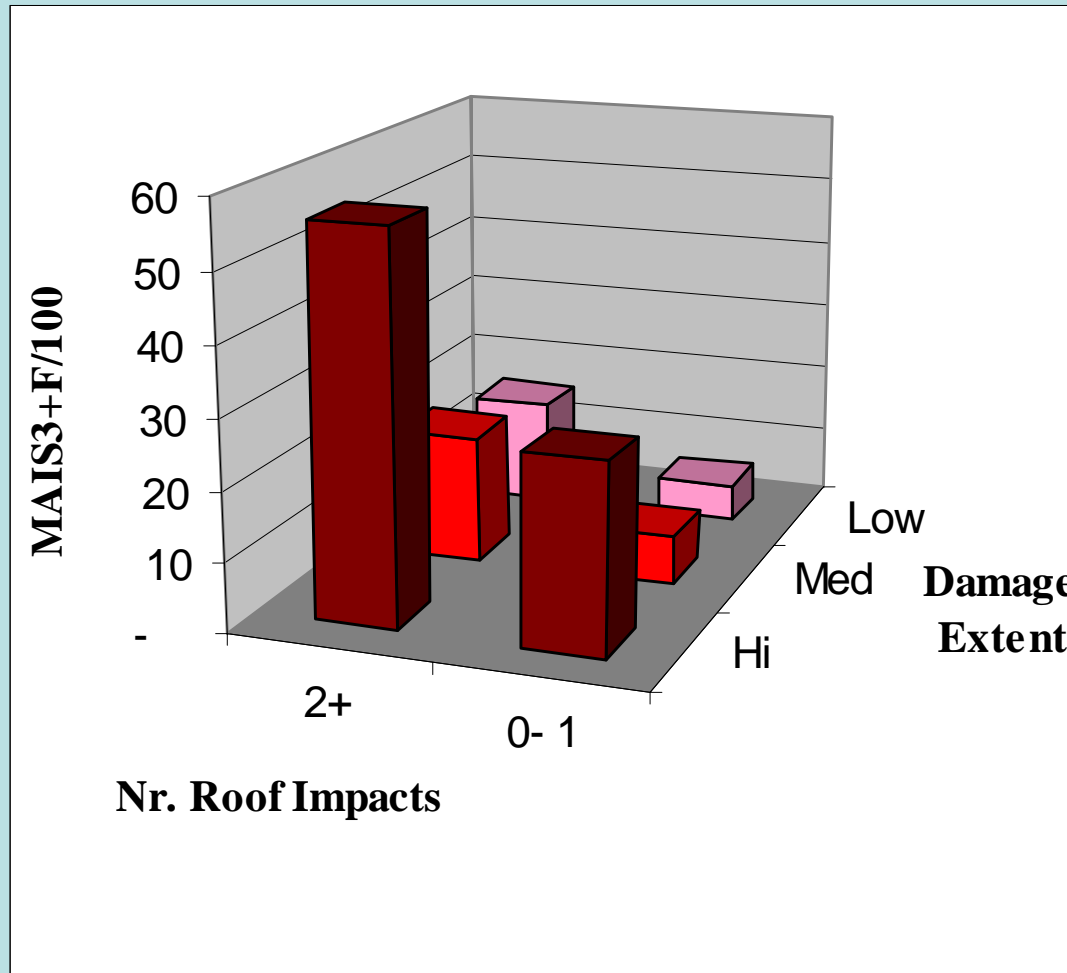
Crash Severity of Multi-impact Rollovers – Belted Occupants



MAIS 3+F in Multi-impact Rollovers – Belted Occupants



Injury Rates in Multi-impact Rollovers – Belted Occupants



General increase in risk with damage extent and roof impacts

Unbelted with and without Ejection

Examine Separately:

- (1) Single Vehicle
- (2) Multi-Impact Crashes
(Planar Impacts prior to Rollover)

Exposure and Injuries of **Unbelted** Occupants Single and Multiple Crash Events

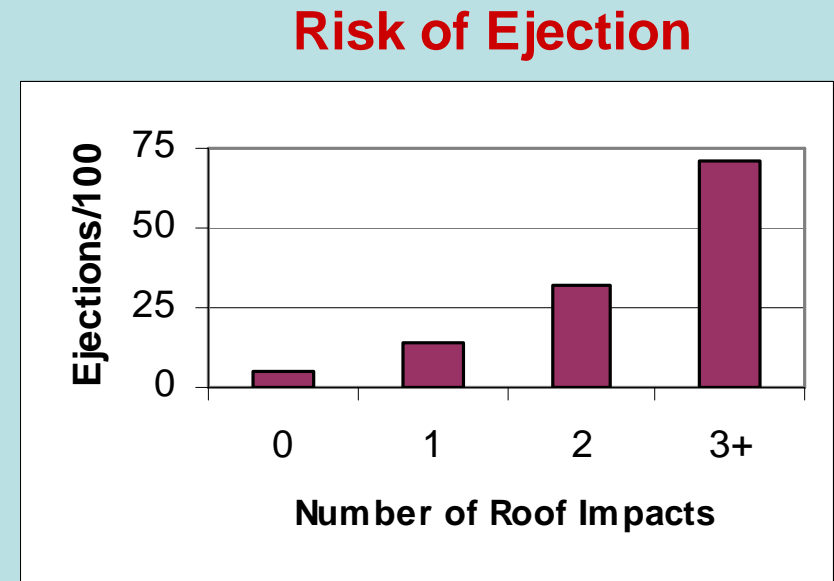
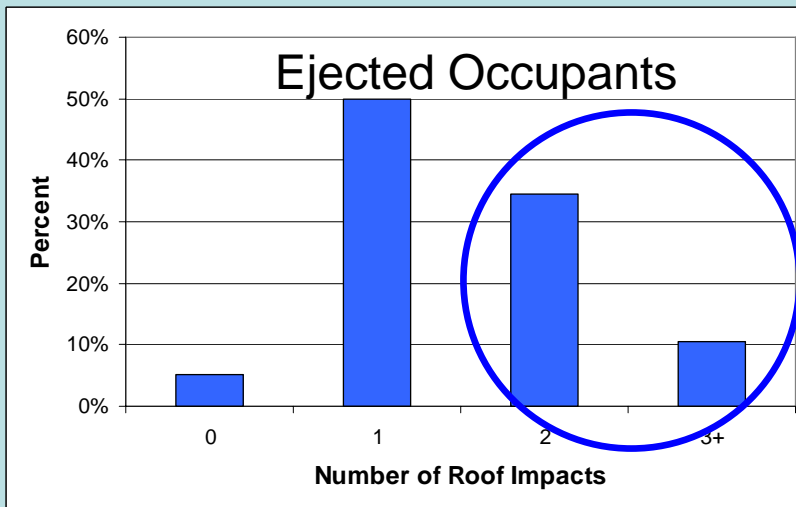
	Unbelted	Single	Multi
Exposed		80%	20%
MAIS 3+ F		78%	22%
RISK		15.1	18.5
MAIS 3+F/100			

Multi-vehicle Crashes Involve Slightly Higher Risks
DELTA-V may be included in the crash severity metric
(primarily for High Severity Planar Crashes)

Unbelted Occupants with Ejection

Single Vehicle Rollovers

Unbelted – Ejected Single Vehicle



- 44% of Ejected Occupants involve 2+ roof contacts
- Number of roof impacts is a good severity measure.

Conclusions - Unbelted Ejected Occupants

- Unbelted ejections account for 32.5% of all MAIS 3+F Injuries in rollovers
- Nr. of Roof Contacts is a good severity measure for Unbelted-ejected occupants.
- The relationship between number of roof contacts and injury risk was found to be statistically significant.
- The relationship between the number of wheel contacts and injury risk was not found to be statistically significant

Conclusions- Belted-not ejected Occupants

- Belted not-ejected occupants account for 35.3% of MAIS 3+F injuries in rollovers
- For belted occupants, 68% of the MAIS 3+F injuries are in single vehicle rollovers and 7.3% involve partial ejections.
- For not-ejected belted occupants in single vehicle collisions, the number of roof impacts is a good severity measure

Conclusions- Belted-not ejected Occupants in Multi-impact Rollovers

- For pre-roll multi-vehicle collisions the injury severity metric needs to combine pre-rollover extent of damage + rollover severity measure (Nr of roof contacts)
- For pre-roll fixed object collisions the injury severity metric needs to combine pre-rollover extent of damage + rollover severity measure (Nr of roof contacts)

The End

Questions?