5th vs 50th

Results of 56 KMPH Crash Tests

National Highway Traffic Safety Administration

NHTSA Public Meeting
Baltimore, MD.
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Outline

- Motivation
- Test Set Up
- Injury Test Results
  - Driver Dummy
- Discussion
- Conclusion
Motivation

- Previous testing at speed of 48 KMPH (30 MPH) with the 5th percentile showed that the 5th had greater loads than the 50th.
- Performance data on the 5th percentile in a 56 KMPH (35 MPH) full frontal barrier crash was lacking.
- Congress provided funds for NHTSA to investigate
1998 – NHTSA and Transport Canada tested the 5th percentile dummy and the 50th percentile dummy in paired 48 KMPH (30 MPH) belted full-frontal crash tests.

- 5th percentile dummy experienced increased injury measures to the neck and tibia compared to the 50th percentile dummy.

## Vehicle Matrix

<table>
<thead>
<tr>
<th>Vehicle Size</th>
<th>Model</th>
<th>Driver and Passenger</th>
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<th></th>
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<tr>
<td></td>
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<td>Air Bag Inflator Type</td>
<td>Load Limiter</td>
<td>Pretensioner</td>
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<td>Light</td>
<td>Civic 4 dr</td>
<td>Dual Stage</td>
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<td>✓</td>
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<td>Sentra</td>
<td>Single Stage</td>
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<tr>
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<td>Echo</td>
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<tr>
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<td>Accord</td>
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Test Procedure

- Frontal NCAP laboratory procedure
  - Vehicle weight--modified
  - Seating procedure--modified
  - Dummy paint locations--modified
  - Calibration
Figure 1: 50th % Driver Vs. 5th % Driver Normalized HIC 15

Normalized HIC 15

50th %

5th %

Vehicles

DODGE
FORD
DODGE
FORD
CHEVROLET
HONDA
HONDA
NISSAN
NISSAN
TOYOTA
NISSAN
GRAND CARAVAN
WINDSTAR
DURANGO
ESCORT
IMPALA
ACCORD
CIVIC
SENTRA
ECHO
MAXIMA
Figure 3: 50th % Driver Vs. 5th % Driver Normalized Neck Tension

Normalized Neck Tension

Vehicles

DODGE FOR D  DODGE CHEVROLET HONDA NISSAN TOYOTA
GRAND CARAVAN WINDSTAR DURANGO ESCAPE IMPALA ACCORD CIVIC SENTRA ECHO MAXIMA
Neither 50th nor 5th percentile driver and passenger dummies exceeded the peak neck compression values for each respective dummy. All were well below the IARV by more than 20%.
Figure 4: 50th % Driver Vs. 5th % Driver Normalized Chest Acceleration
Figure 5: 50th % Driver Vs. 5th % Driver Normalized Chest Displacement

- DODGE
- FORD
- DODGE
- FORD
- CHEVROLET
- HONDA
- HONDA
- NISSAN
- TOYOTA
- NISSAN

Vehicles

Normalized Chest Displacement
Figure 6: 50th % Driver Vs. 5th % Driver Normalized Left Femur Compression and Right Femur Compression
Figure 7: 5th % Driver Tibia in Passenger Cars and LTV's

Normalized Tibia

DODGE, FORD, DODGE, FORD, CHEVROLET, HONDA, HONDA, NISSAN, TOYOTA, NISSAN

Left Upper Tibia, Right Upper Tibia, Left Lower Tibia, Right Lower Tibia

Vehicles

GRAND CARAVAN, WINDSTAR DURANGO, ESCAPE, IMPALA, ACCORD, CIVIC, SENTRA, ECHO, MAXIMA

Tibia Index Cont....
Figure 8: 50th % Driver Tibia in Passenger Cars and LTV's

Normalized Tibia

Vehicles

- Dodge
- Ford
- Chevrolet
- Honda
- Nissan
- Toyota
- Grand Caravan
- Windstar
- Escape
- Impala
- Civic
- Sentra
- Echo

Legend:
- Left Upper Tibia
- Right Upper Tibia
- Left Lower Tibia
- Right Lower Tibia

Tibia Index Cont....
Test Results – Tibia Index

- 5th percentile driver dummy - all but 3 vehicles exceeded one of the four indices for the tibia
- 50th percentile driver dummy - only 4 vehicles exceeded one of these indices
- 5th percentile passenger dummy - all but 2 vehicles exceeded one of the four indices for the tibia
- 50th percentile passenger dummy - only 3 vehicles exceeded one of the tibia indices.
The Need For Different Dummies
It appears that most vehicles would achieve dummy injury values below the IARV.

In some instances, vehicles exceeded injury criteria for the 5th percentile dummy, but did not exceed injury criteria for the 50th percentile dummy. Two main players

- Vehicle structure
- Occupant restraint systems (seat belt, pretensioners, and air bags)
Windstar and Grand Caravan Film
Vehicle pulses were analyzed

3 factors associated with crash management:
- Dynamic crush
- Maximum acceleration of the occupant compartment
- Time period of the acceleration pulse

Vehicle pulses for both vehicles show:
- The Grand Caravan and the Windstar have roughly the same peak G
- The Windstar peaks later in time than the Grand Caravan
Discussion Cont.….  

Peak G
Discussion Cont.

Force vs Deflection

![Graph showing force vs deflection for Windstar and Grand Caravan with millimeters and Newtons (e5) axes. The graph compares the deflection of the two vehicles under different forces. The Windstar curve is consistently lower than the Grand Caravan curve, indicating less deflection.]
Overall lengths of the 2 vehicles are almost the same.

Bumper to firewall distance:
- Windstar – 1201 mm
- Grand Caravan – 725 mm

So, for about the same mass and overall length of vehicle, the Windstar has more bumper to firewall distance to absorb the crash energy than does the Grand Caravan. Then, less force is transmitted to the occupant, reducing the chance for injury.
Discussion Cont…

Head Resultant
Discussion Cont....

Chest Resultant
Discussion Cont....

Neck Force Z
Driver shoulder belt load data for the Toyota Echo (for both the 5th and 50th percentile dummies) was analyzed to see the effect pretensioners and load limiting seat belts had on occupant performance.
Load limiters and their ability to function may be a key factor in reducing occupant loads.
Conclusion

- 2001 – NHTSA conducted 10 belted 56 KMPH (35 MPH) frontal vehicle crash tests using the 5th percentile dummy.
  - 5th percentile dummy is robust and very durable
  - 5th percentile dummy incurred greater injury than the 50th percentile dummy, particularly for the neck and lower extremities in some vehicles tested
  - Need for dummies of different stature to ensure equal protection for all occupants
Additional Information

- **Docket** [http://dms.dot.gov](http://dms.dot.gov)
  - For 5\textsuperscript{th} Percentiles 10687
  - For NCAP Frontals 4962

- **Films at NCAC** 703-726-8236
Thank you for your attention!!