

NHTSA Frontal Offset Research

Update on 40% Offset Deformable Barrier And Vehicle-to-Vehicle Tests

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Objectives

- **Reduce death and injury**
- **Reduce long term impairment, pain and suffering (especially lower extremities)**
- **Reduce costs of recovery and rehabilitation**
- **Ensure the test procedure does not induce disbenefits to the collision partner**

Risk of Injury to Different Body Regions

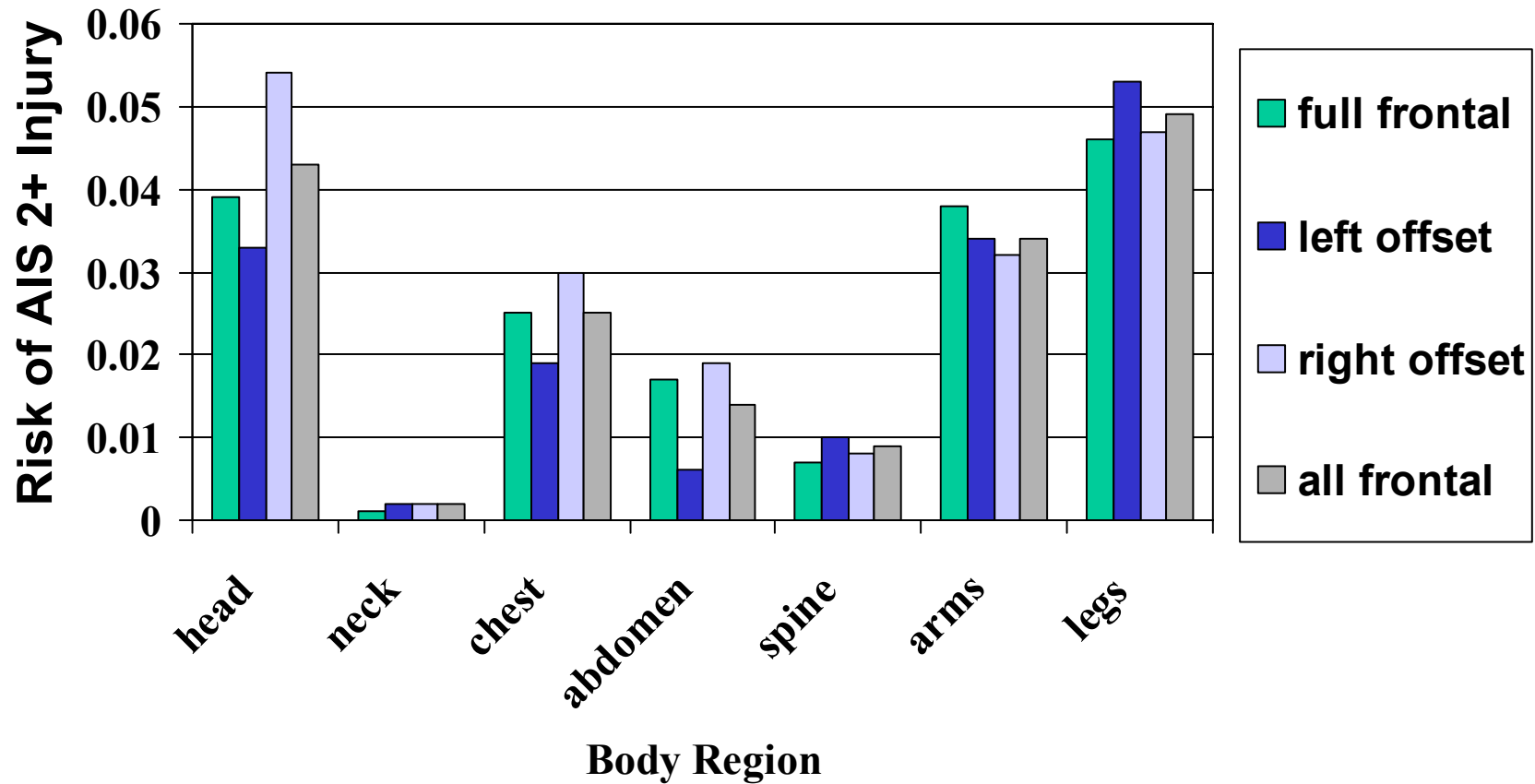


- **Maximum AIS₉₀ level injury to each body region**
- **For a specified crash mode, the risk of AIS 2+ injury to a specific body region is**

No. of occupants in specified crash mode with at least one AIS 2+ injury to specified body region

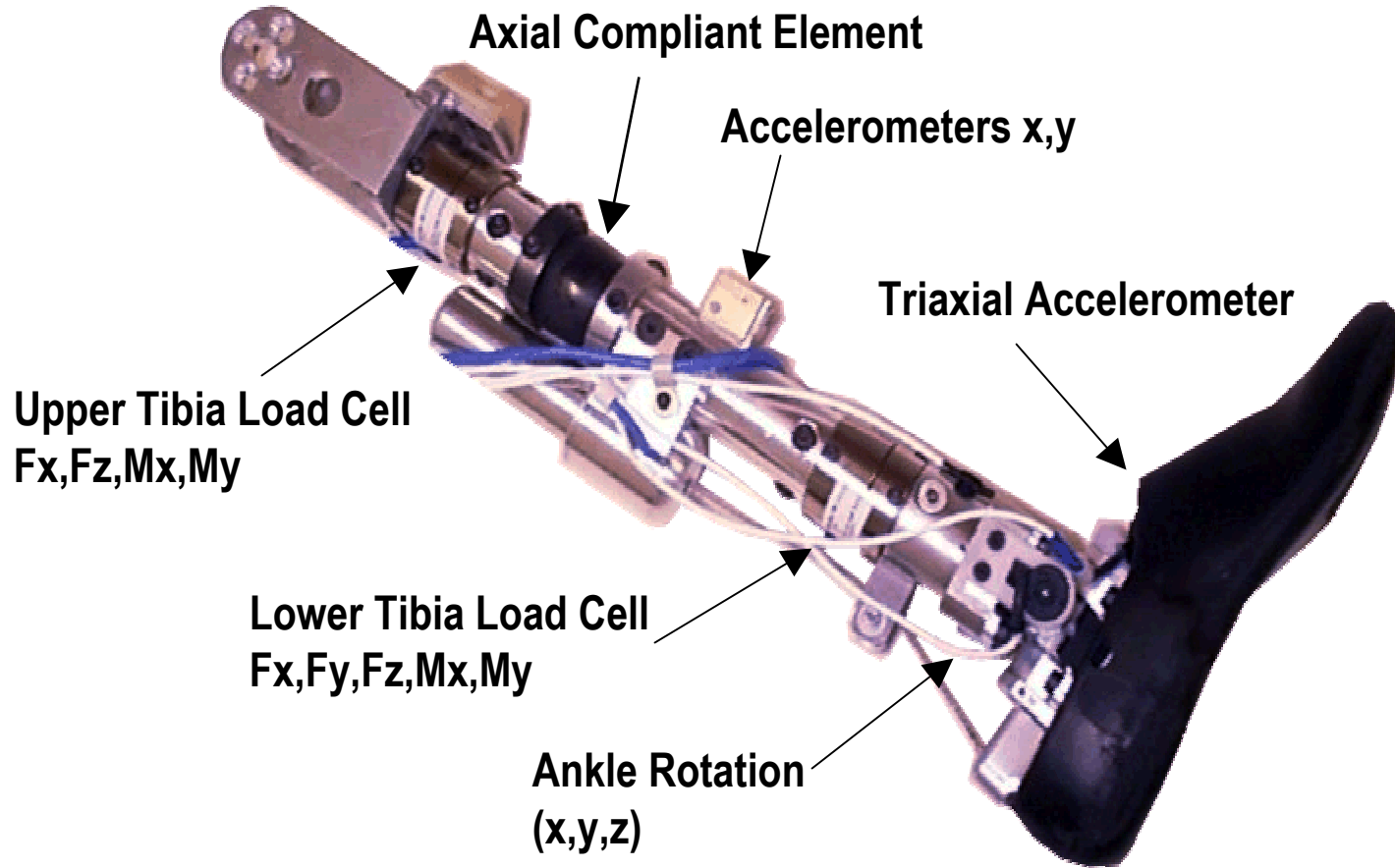
Total no. of occupants in specified crash mode

Risk of AIS 2+ Injuries



Lower Extremity Injuries

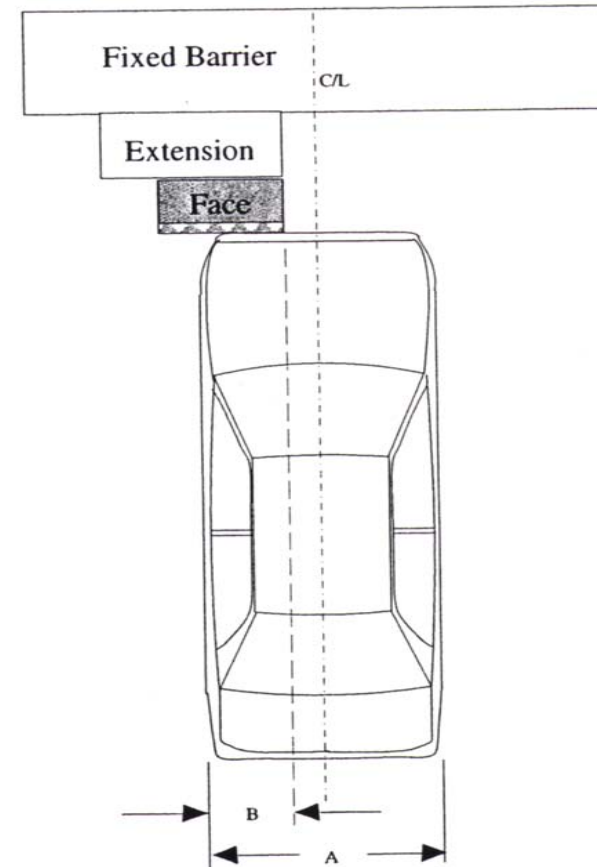
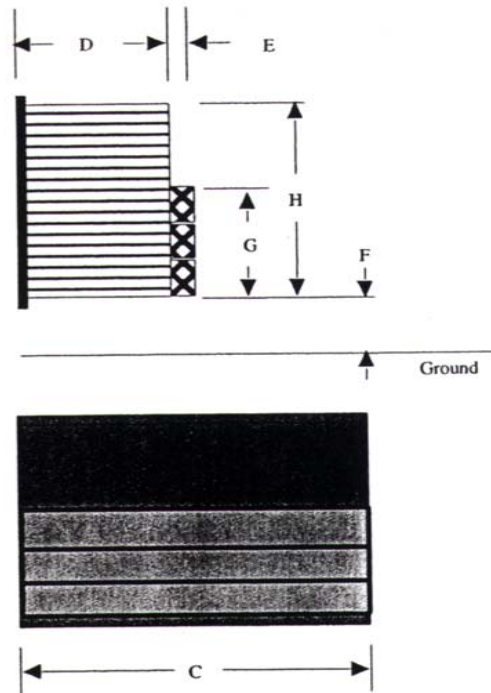
- **NHTSA estimates approximately 110,000 occupants sustain AIS 2 or 3 lower extremity injuries every year.**
- **Annual Cost estimated at \$9.2 billion.**
- **Lower Extremity Injuries**
 - Knee-thigh-hip complex
 - 55% of AIS 2+ injuries
 - 42% Associated functional Life-years Lost to Injury
 - Remaining Lower extremities
 - 45% of AIS 2+ injuries (74% foot and ankle)
 - 58% Associated functional Life-years Lost to Injury
- **FMVSS 208 designed to reduce fatalities and serious head, neck and torso injuries in frontal crashes**



Injury Criteria for Thor Lower Leg

Region	Thor-Lx/HIII Criteria and Limits	Thor-FLx/HIII Criteria and Limits
knee-thigh-hip	Femur Fz = 9040 N	Femur Fz = 6510 N
Knee ligament	Knee shear = 15 mm	Knee shear = 13 mm
Tibia Plateau	Upper tibia Fz = 5.6 kN	Upper tibia Fz = 4.0 kN
Leg Shaft	$RTI = F/12 + M/240 = 0.91$	$RTI = F/8.6 + M/146 = 0.91$
Calcaneus, pilon, midfoot	Lower tibia Fz = 5.2 kN	Lower tibia Fz = 3.8 kN
Ankle /malleolus	Dorsiflexion angle = 35 deg	Dorsiflexion angle = 35 deg
	Xversion angle = 35 deg	Xversion angle = 35 deg

40% Offset Deformable Barrier (ODB) Test Setup



2002 Dodge Neon with 5th HIII

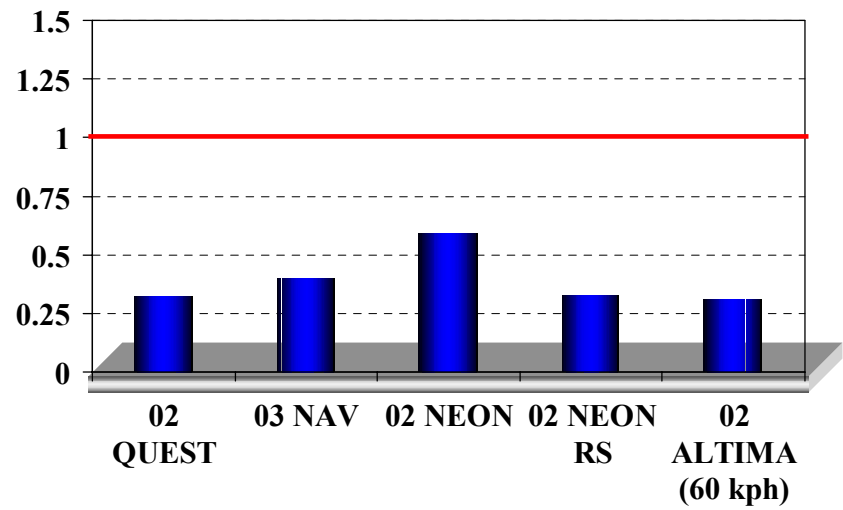


50th HIII with Thor-Lx/HIII Test Matrix

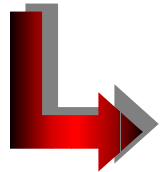
Make	Model	Year	Closing Speed (kph)	Abbreviation
Nissan	Quest	2002	56	02 Quest
Lincoln	Navigator	2003	56	03 Nav
Dodge	Neon	2002	56	02 Neon
Dodge*	Neon	2002	56	02 Neon RS
Nissan	Altima	2002	60	02 Altima (60kph)

* Vehicle impacted on the right side

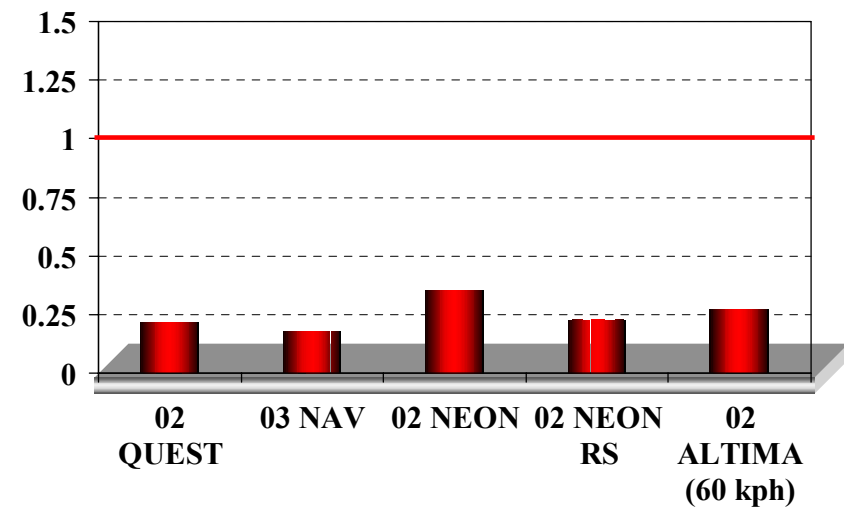
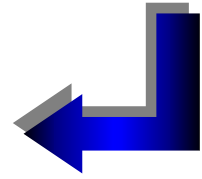
50th HIII Lower Leg Responses with Thor-Lx/HIIIr



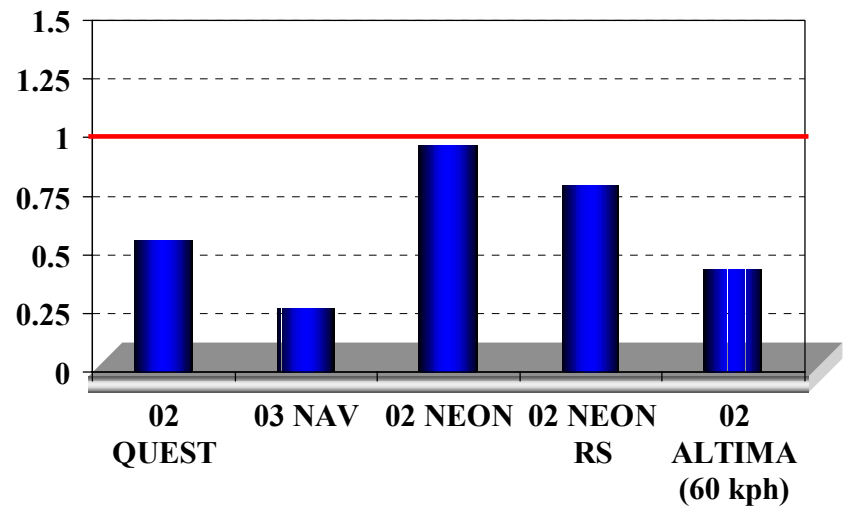
Normalized Knee Displacement



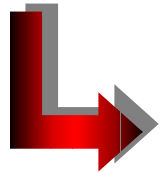
Normalized Femur Load



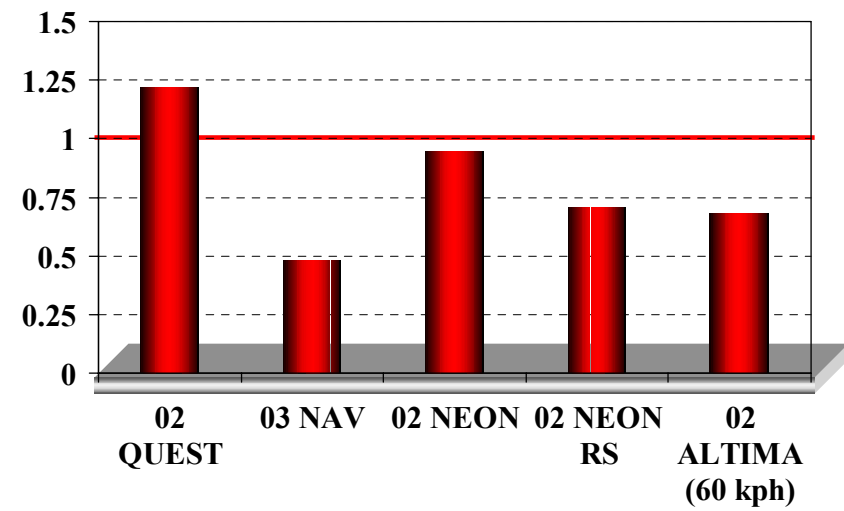
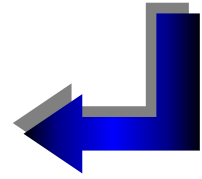
50th HIII Lower Leg Responses with Thor-Lx/HIIIr (continued)



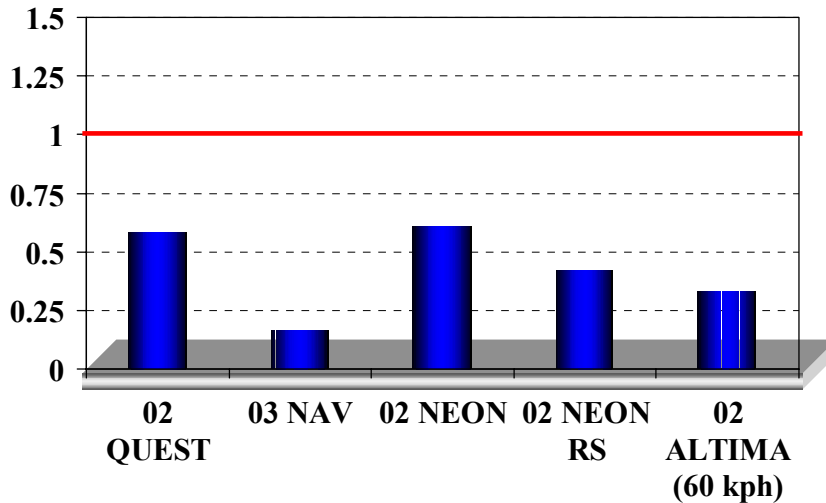
Max Lower Tibia Index



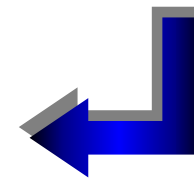
Max Upper Tibia Index



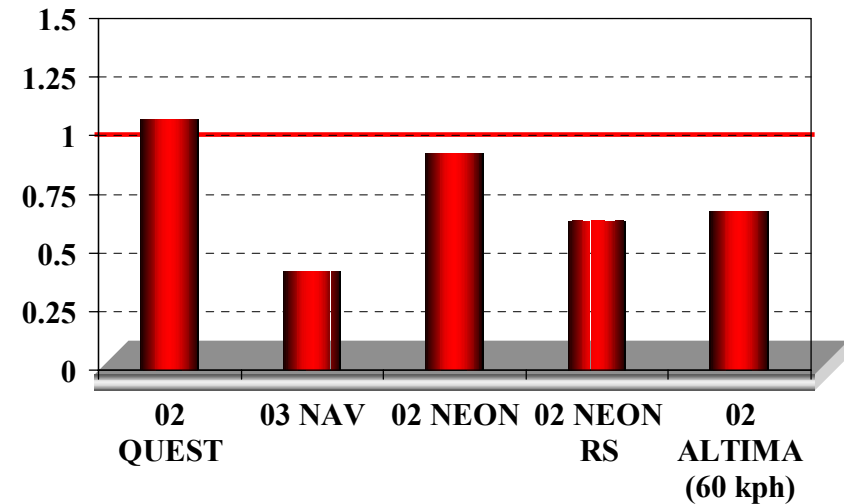
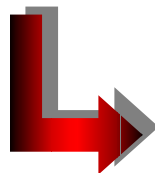
50th HIII Lower Leg Responses with Thor-Lx/HIIIr (continued)



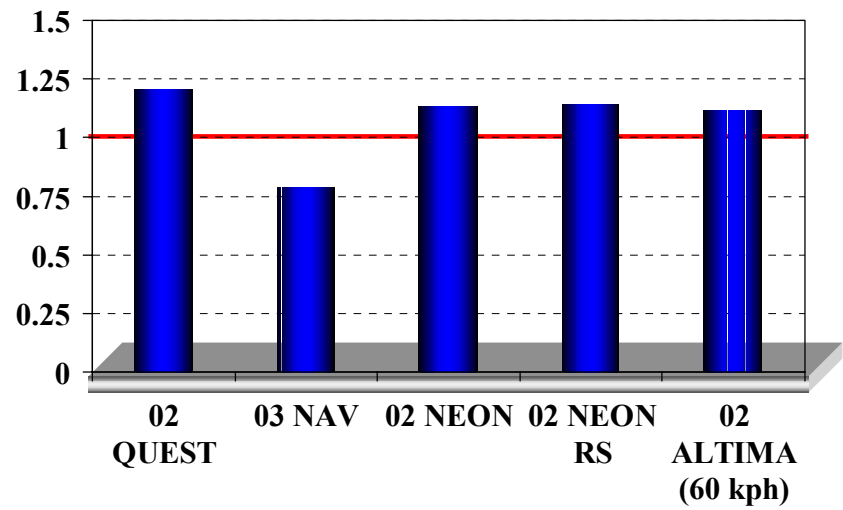
**Normalized Max Upper
Tibia Axial Force**



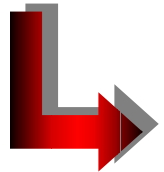
**Normalized Max Lower
Tibia Axial Force**



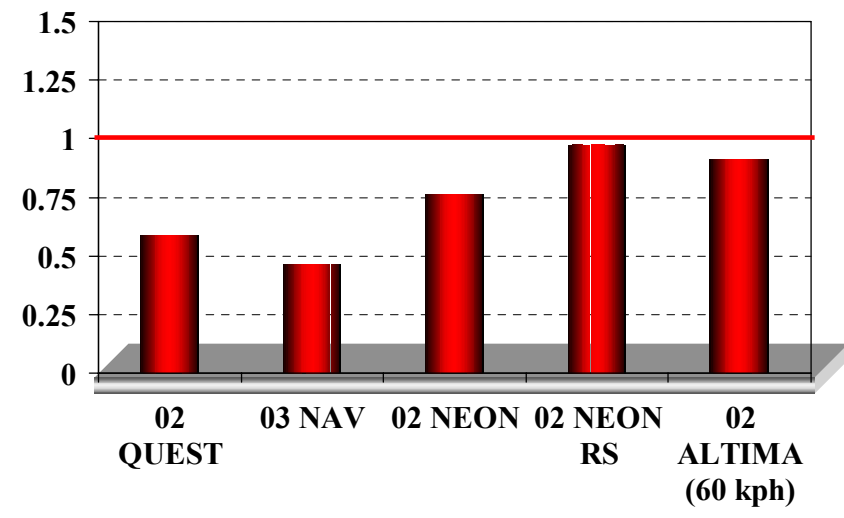
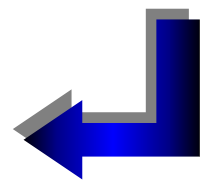
50th HIII Lower Leg Responses with Thor-Lx/HIIIr (continued)



Normalized Max Inversion / Eversion



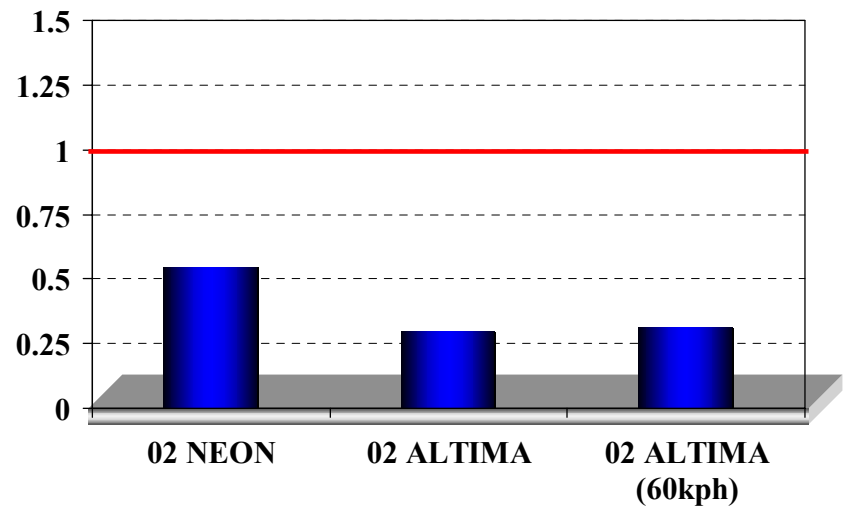
Normalized Max Dorsiflexion



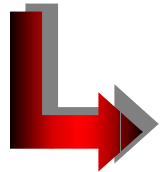
5th HIII with Thor-FLx/HIII Test Matrix

Make	Model	Year	Closing Speed (kph)	Abbreviation
Dodge	Neon	2002	56	02 Neon
Nissan	Altima	2002	56	02 Altima
Nissan	Altima	2002	60	02 Altima (60kph)

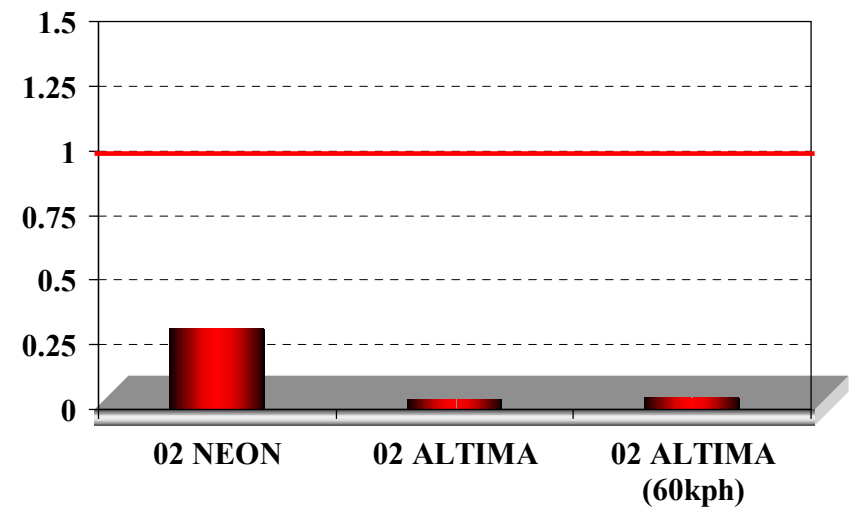
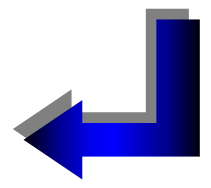
5th HIII Lower Leg Responses with Thor-Lx/HIIIr



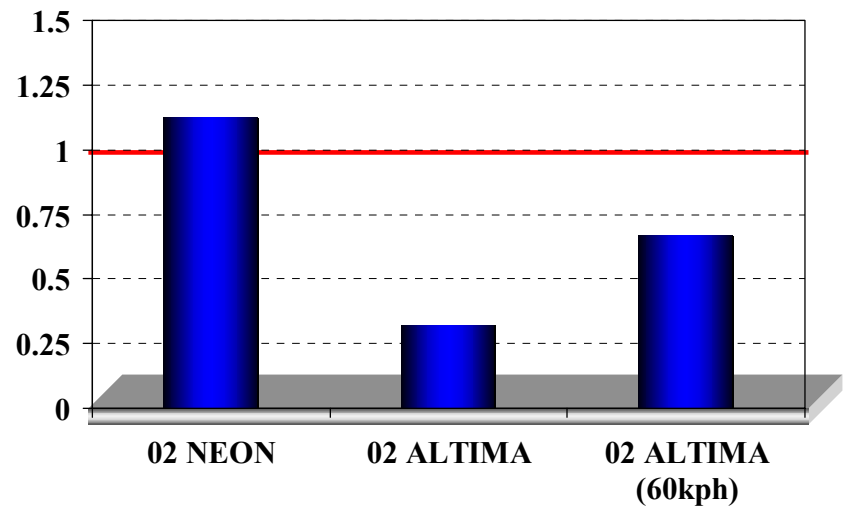
Normalized Knee Displacement



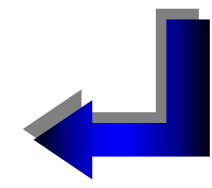
Normalized Femur Load



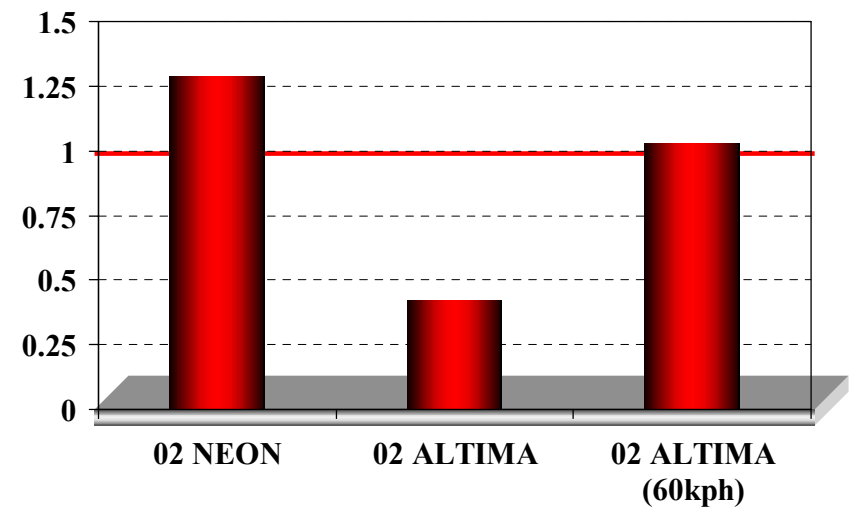
5th HIII Lower Leg Responses with Thor-Lx/HIIIr (continued)



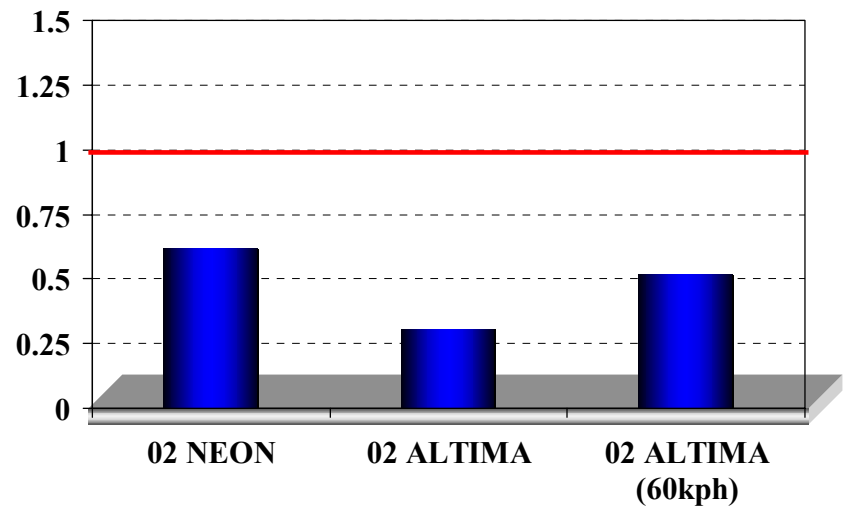
Max Upper Tibia Index



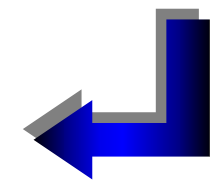
Max Lower Tibia Index



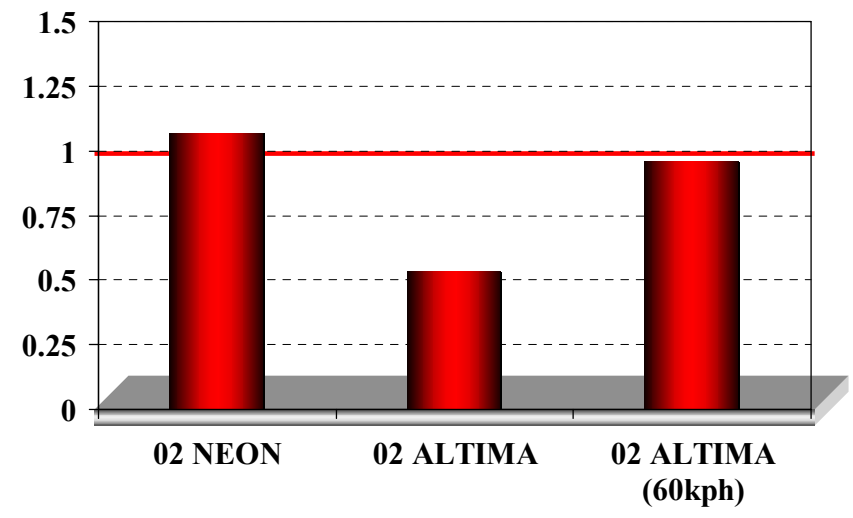
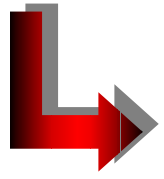
5th HIII Lower Leg Responses with Thor-Lx/HIIIr (continued)



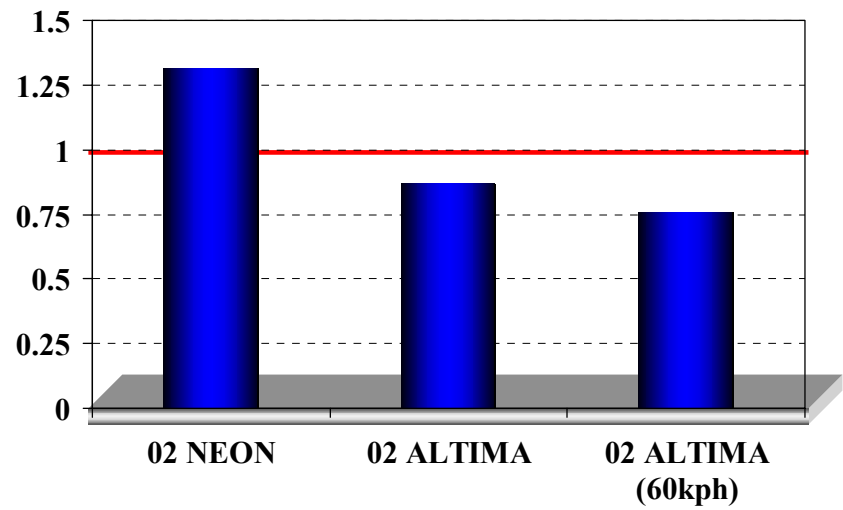
Normalized Max Upper Tibia Axial Force



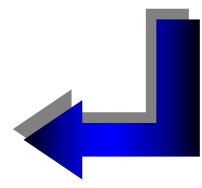
Normalized Max Lower Tibia Axial Force



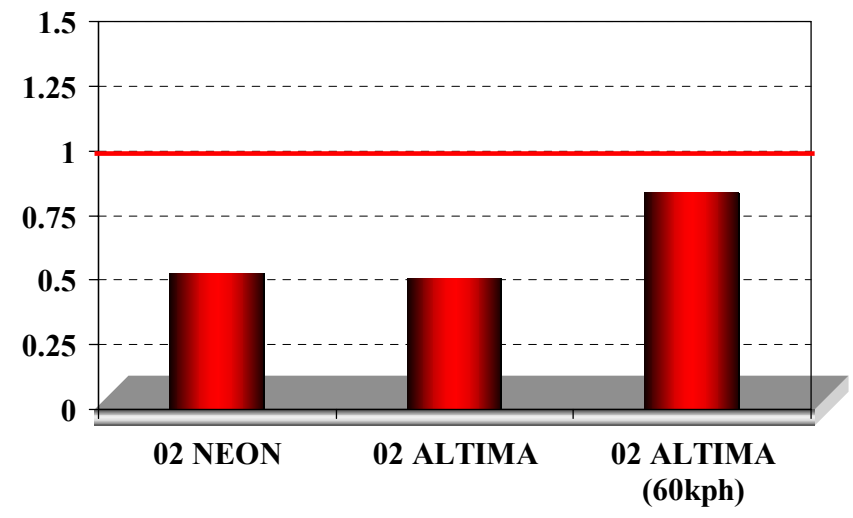
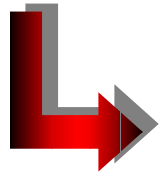
5th HIII Lower Leg Responses with Thor-Lx/HIIIr (continued)



**Normalized Max
Dorsiflexion**



**Normalized Max
Inversion / Eversion**



ODB Conclusions

- **Injury assessment with 50th HIII Thor-Lx/HIIIr is in accordance with injury distribution seen in real world crashes**
- **Previous results can be found at <http://www-nrd.nhtsa.dot.gov/departments/nrd-01/presentations/SAE.html>**

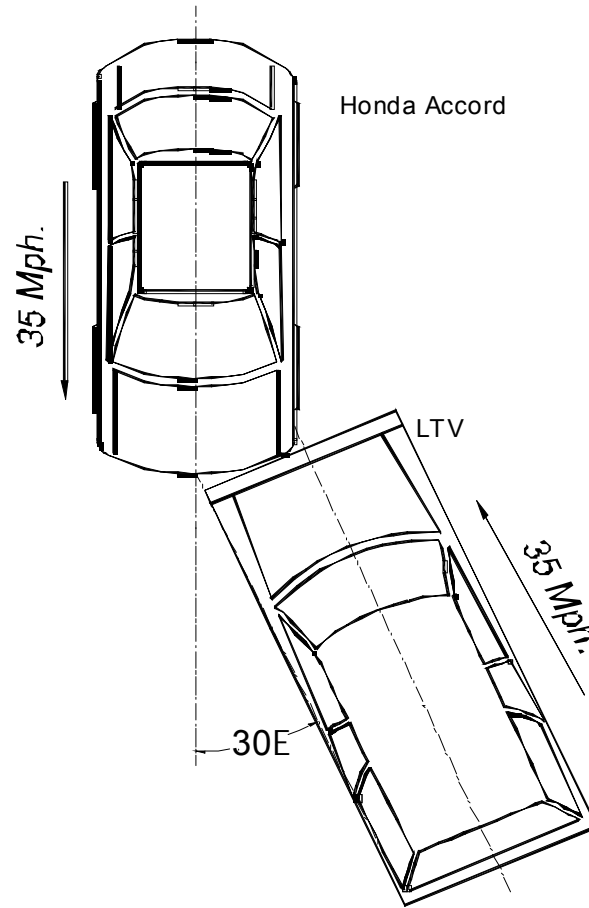
Vehicle-to-Accord tests

Objective

- **To determine the disbenefits, if any, from requiring the 40% Offset Deformable Barrier crash tests to evaluate high speed frontal offset crashes**

Vehicle-to-Accord Test Configuration

Light Vehicle Aggressivity Front, Offset, Oblique



Test Matrix

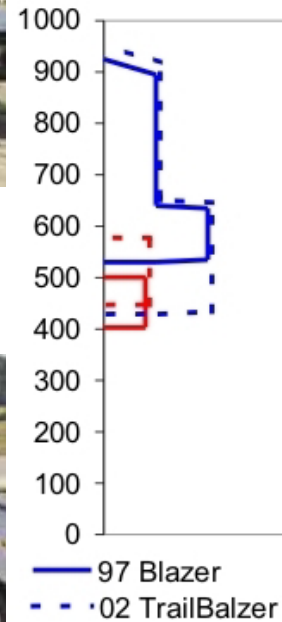
	“Before”	“After”
Large Car	Cadillac Seville (3,885 lbs.) IIHS Rating: Poor	Cadillac Seville (4,008 lbs.) IIHS Rating: Good
Large Car	Toyota Avalon (3,225 lbs.) IIHS Rating: Marginal	Toyota Avalon (3,468 lbs.) IIHS Rating: Good
Pickup	Dodge Ram 1500 (4,930 lbs.) IIHS Rating: Poor	Dodge Ram 1500 (4,969 lbs.) IIHS Rating: Good
SUV	Chevrolet Blazer IIHS Rating: Poor	Chevrolet TrailBlazer IIHS Rating: Marginal
SUV	Mitsubishi Montero Sport IIHS Rating: Poor	Mitsubishi Montero Sport IIHS Rating: Good
Minivan	Toyota Previa (3,810 lbs.) IIHS Rating: Poor	Toyota Sienna (3,937 lbs.) IIHS Rating: Good

Blazer Pre-Test Pictures



1997 Blazer (IIHS rated “poor”)
(4686 lbs, Width=1700 mm)

1997 Accord



2002 TrailBlazer (IIHS rated “marginal”)
(5181 lbs, Width=1847 mm)

1997 Accord

Post-test Pictures (Accord)

1997
Blazer
Test



2002
TrailBlazer
Test



Montero Pre-Test Pictures



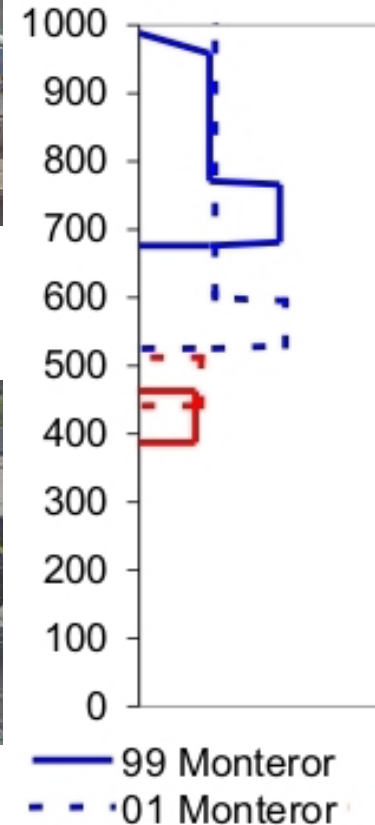
1999 Montero Sport (IIHS rated “poor”)
(4646 lbs, Width=1705 mm)

1997 Accord



2001 Montero Sport (IIHS rated “good”)
(4715 lbs, Width=1750mm)

1997 Accord



Post-test Pictures (Accord)

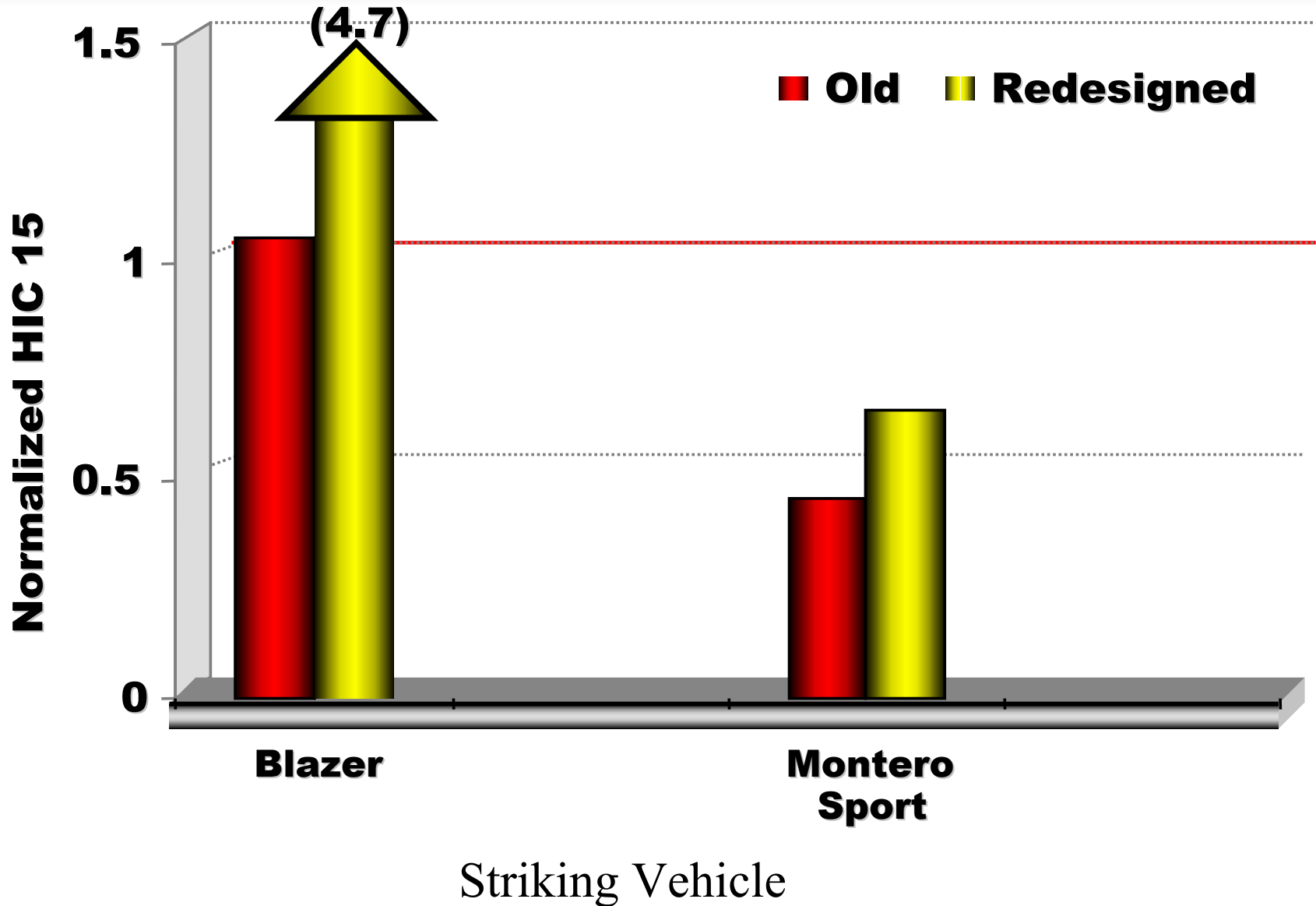
1999 Montero
Sport Test



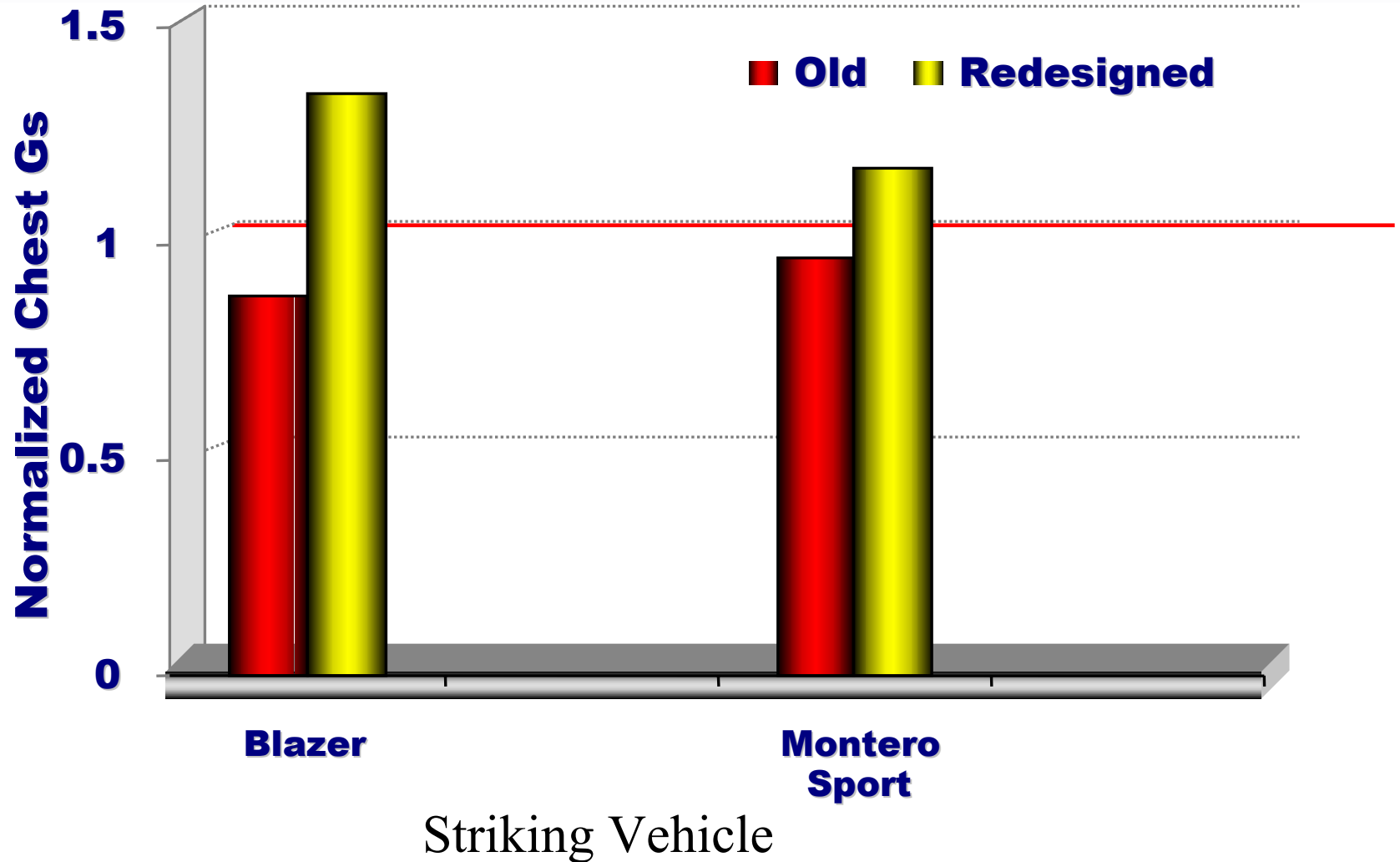
2001 Montero
Sport Test



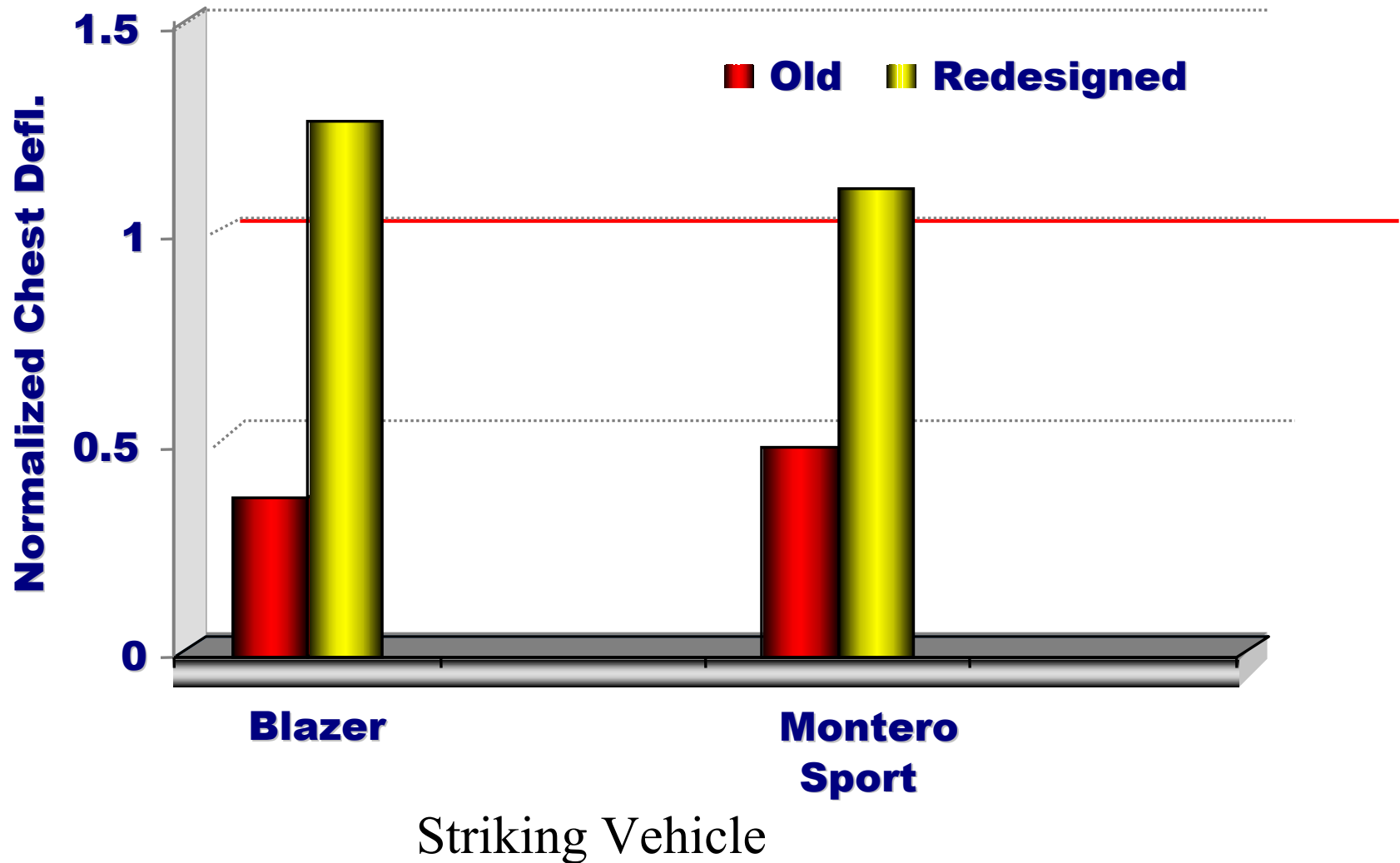
Normalized HIC 15 for Accord Driver



Normalized chest Gs for Accord Driver



Normalized Chest Displacement for Accord Driver



Vehicle-to-Accord Findings to Date

- **Both vehicles showed increased risk in both the head and chest injuries**
- **Not able to assess the contribution of stiffness, mass and geometry has toward the increase in injury measures**
- **Need to complete fleet study to determine if the same trend applies for all types of vehicles**