Side Impact Upgrade Research Update

Agency Briefing

April 2002

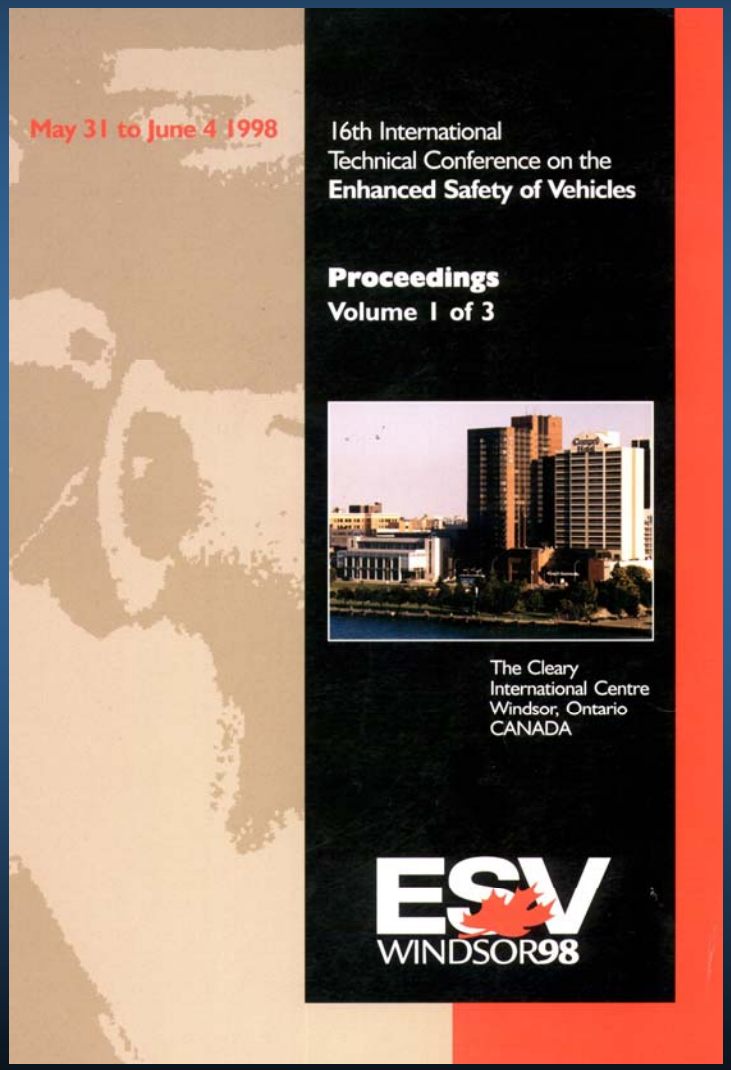
Research and Development

National Highway Traffic Safety Administration

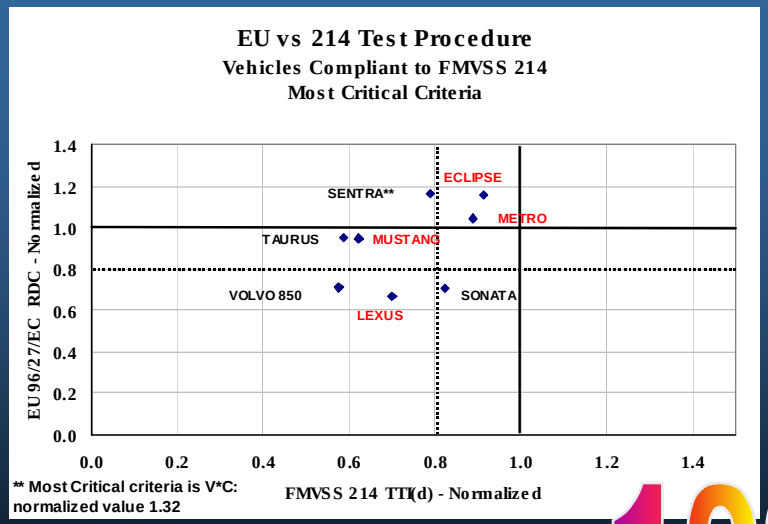
Briefing Outline

- **Background**
- **ES-2 research update**
  - Mechanical Performance
  - Crash Results
  - Biofidelity Assessment
  - Preliminary Injury Criteria
- **MDB Evaluation**
- **Conclusions and recommendations**

Historical Perspective



- 1st phase of NHTSA harmonization: Determine relative performance under FMVSS 214 and EU 96/27/EC
- Eight US production FMVSS 214 compliant vehicles were tested to the EU 96/27/EC requirements



1998

1999 Report to Congress "Status of NHTSA Plan for Side Impact Regulation Harmonization and Upgrade"

NHTSA
People Saving People
http://www.nhtsa.dot.gov

FY 97 98 99 00 01 02 03 04-05-06-07

Phase I

- OOPS Testing
- Updated Def. Safety Problem

- Eurosid 2 Evaluation
- Injury Criteria - 50thM

Phase II

- OOP Test Procedure
- Pole Test Procedure
- Representative MDB
- Family of Dummies/Injury Criteria

Phase III

- Updated Definition of Safety Problem
- Worldwide Harmonized Dummy
- Supplemental Injury Criteria-Family of Dummies

R&D Recommendations (Agency briefing 5/01)

- **Incorporate ES-2 in <u>current</u> FMVSS 214, assuming . . .**
  - No head/neck injury regulation
  - Regulate* abdominal load in ES-2
  - No rib binding in planned VRTC component tests
  - Acceptable** ES-2 performance in 8 planned 214/NCAP research tests

* ES-2 detects abdominal injuries that SID misses

** Good mechanical performance of ribs & back plate

R&D Recommendations (Agency briefing 5/01)

- **Incorporate ES-2 in the optional FMVSS 201 pole test assuming:**
  - Acceptable ES-2 head and neck biofidelity test results, and
  - ES-2 performs adequately* in FMVSS 201 pole tests

* i.e., demonstrates ability to detect usefulness of head protection

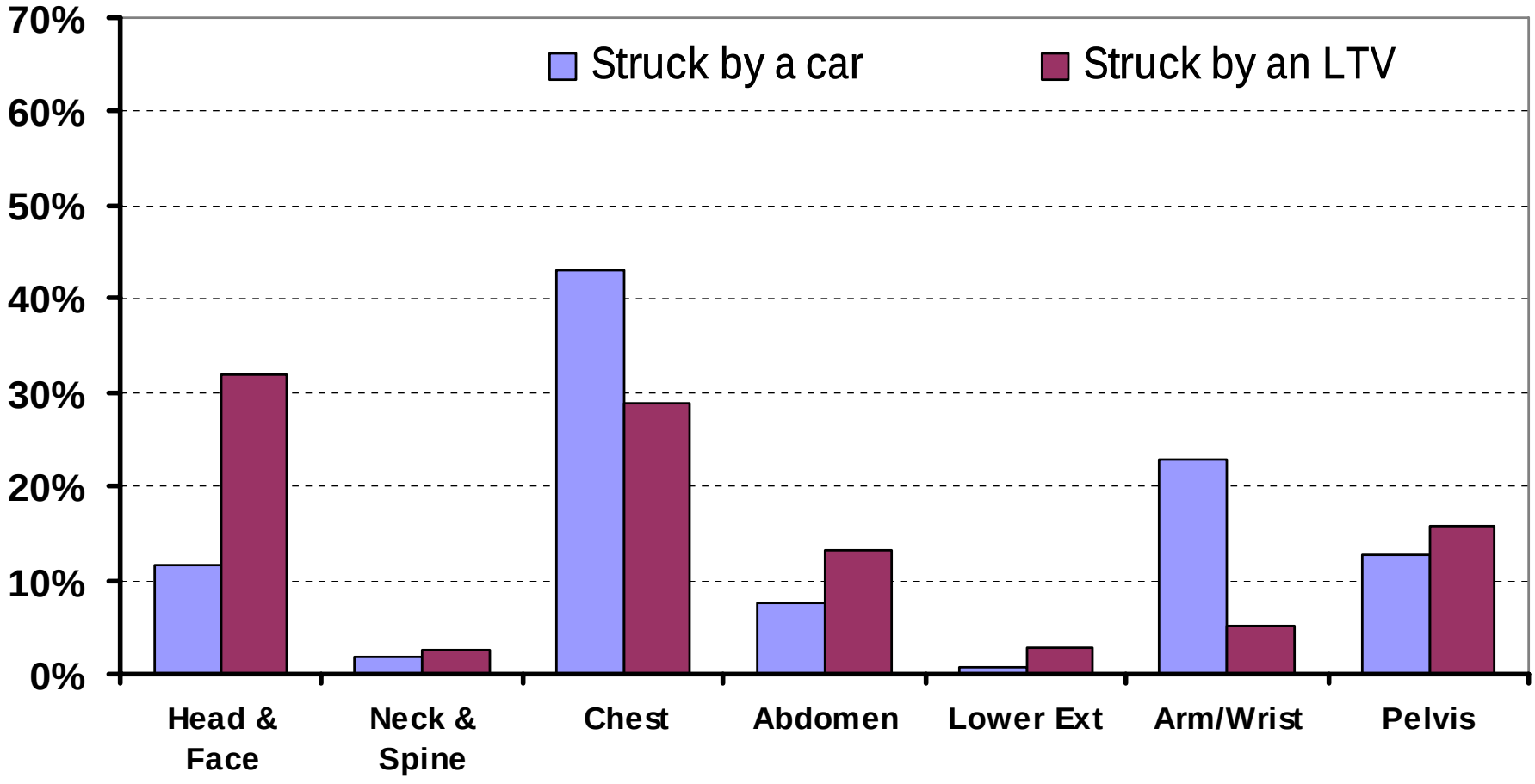
ES-2 Status in Europe

- In September 2001, the EEVC Steering Committee formally accepted ES-2 and letters of recommendation were sent out to ECE, EU, NHTSA, Transport Canada, JMOT, and the Australian DOTRS.
- In May 2002, the Netherlands is expected to propose to the ECE to incorporate the ES-2 with its current injury criteria in ECE 95

Vehicle to Vehicle -AIS 3+ Injury

Near Side Belted Occupant by Body Region

Model Year 95-2000 (Weighted NASS/CDS 95-99)



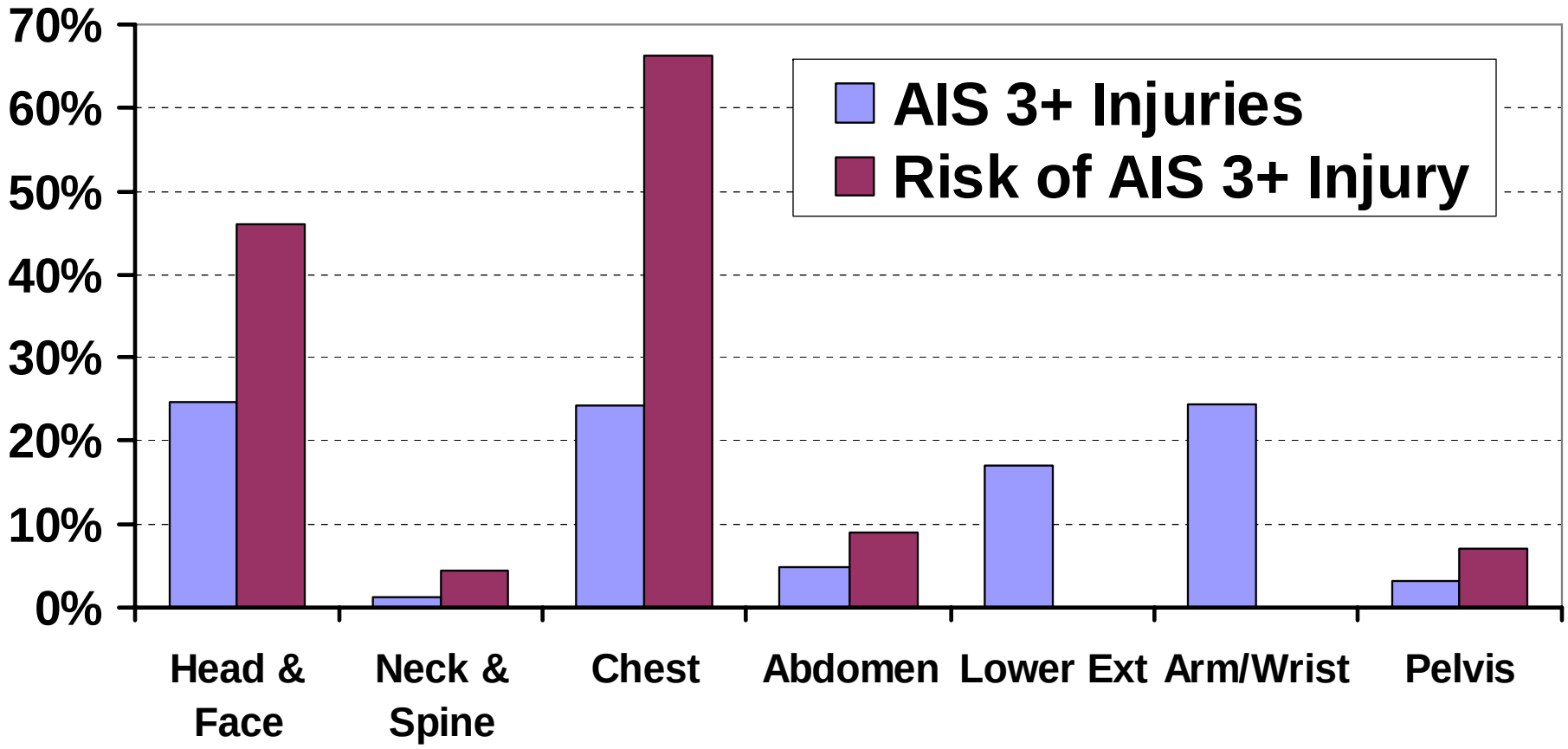
N_{PC}= 81 , weighted= 5,653

N_{LT}= 191, weighted= 9,918

Narrow Object Impacts

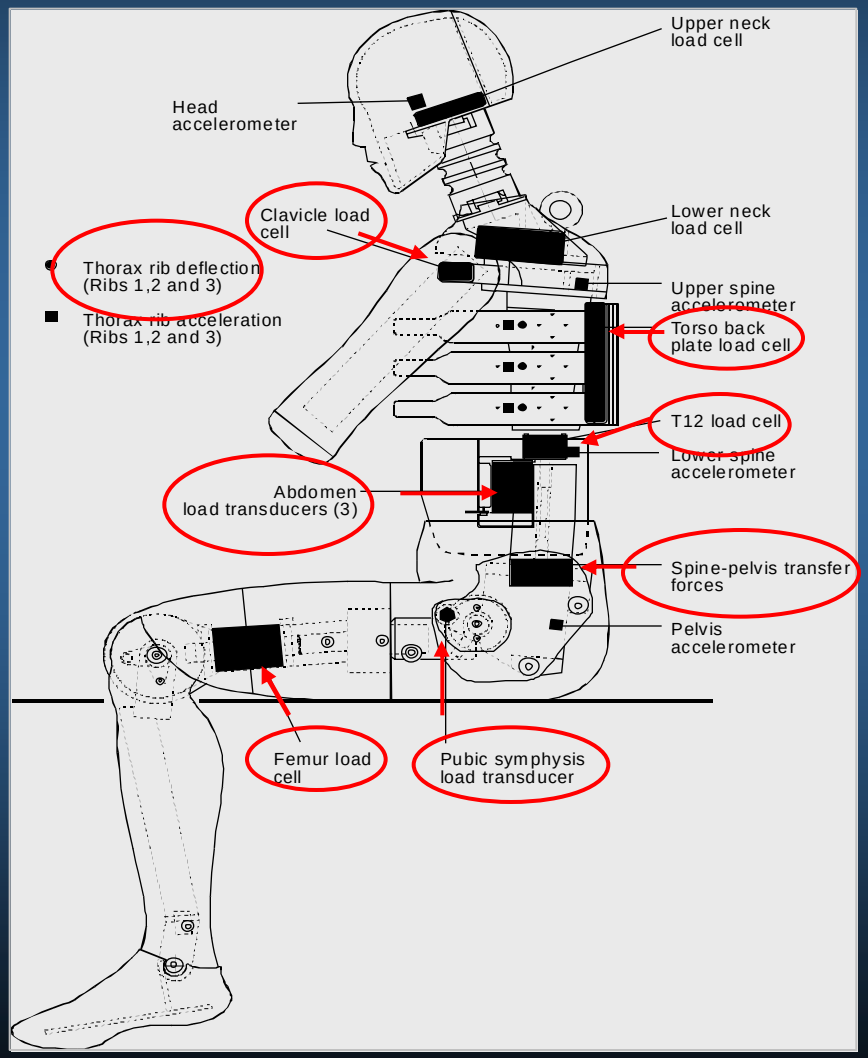
Near Side Belted Occupants by Body Region

Model Year 95-2000 (Weighted NASS/CDS 95-99)



N_{NO}= 118, weighted=5,722

Dummy Instrumentation & Injury Criteria



Current Dummy Injury Criteria	
ES-2	SID
HIC-1000	
Rib Deflection- 42 mm	TTI- 85 or 90 G
V*C- 1ms	
Abdominal Load- 2.5 kN	
Pubic Symphysis Load- 6 kN	Pelvic Accel- 130 G

- R&D is developing new side crash injury criteria

ES-2 R&D Testing Update

- **Crash tests* (23 completed)**
  - High severity/upgrade 214 MDB tests
  - 201P pole side impact
  - NCAP side impact
- **Mechanical performance component tests**
  - Pendulum and rib drop tests
  - Seat back pressure maps
- **Biofidelity tests (total of 19 sled & 10 impactor)**
  - Head/neck/shoulder sled tests
  - Shoulder/thorax/pelvis impactor tests
  - Additional abdominal offset sled tests

* Since ESV 6/01

ES-2 Durability

ES-2 Research Findings

- **After 23 full scale crash tests, 6 sled tests*, and many component tests, ES-2 has demonstrated excellent durability**
- **At this time, we will be acquiring the following new parts:**
  - Shoulder foams
  - Pelvis foam plugs
  - A spare set of ribs

*** First 13 sled tests were performed with an ES-2 prototype**

ES-2 and Flat-Top

- There are a number of causes of rib deflection flat-top*

Unacceptable	Acceptable
▪ Rib binding ▪ Shoulder binding ▪ Load sharing with back-plate	▪ Load sharing with other body regions ▪ Attenuation of input load ▪ Maximum range

* Maltese et al 1999

Rib Deflection "Flat -Top" Not an Issue

ES-2 Research Findings

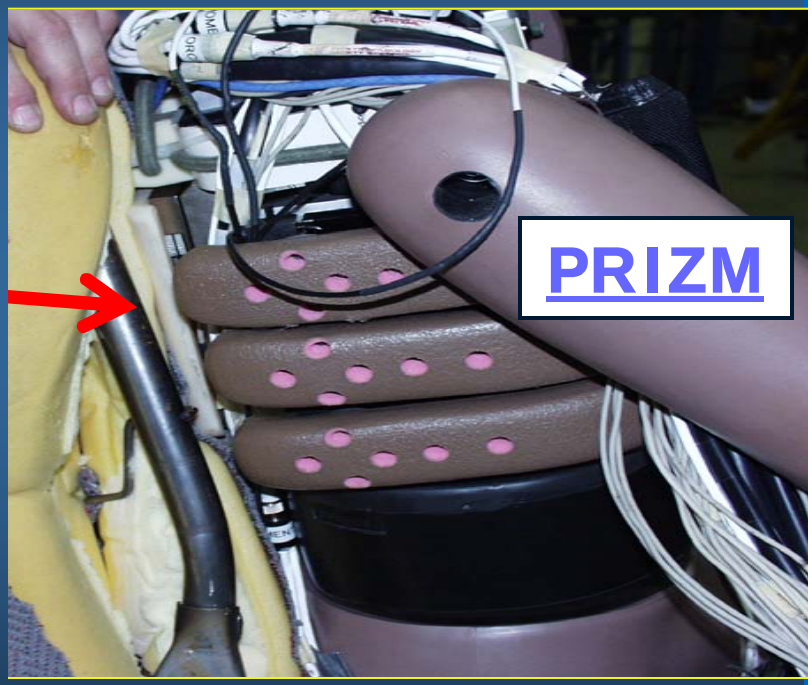
- Of 23 crash tests, corresponding to the measurement of 102 rib deflections considering front and rear dummies, there were three instances of "flat top" observed
  - Two instances are attributed to load sharing with other body regions (IIHS MDB/Prizm and pole/Cougar driver)
  - One instance attributed to response reaching maximum deflection (IIHS MDB/Cadillac at NCAP speed)
- No "flat top" observed in the oblique pendulum and rib drop tests
- Of 19 sled tests, corresponding to the measurement of 57 rib deflections, there was one of "flat top" response resulting from deflection at the maximum range

Details

Deficiencies Noted in ES-2

ES-2 Research Findings

- **Potential back plate interaction with seat**
  - Manufacturers can take advantage of this by designing seats to “grab” the back plate and offload the thorax
  - High and early back plate loads may affect injury criteria
- **Double peak in pubic symphysis load**
  - Magnitudes are small
  - All values are well below the threshold



Details - back plate

Details PSPF

FMVSS 201P ES-2 Tests

201P – Side Impact Pole Tests		
VEHICLE	BAG	DUMMY
Dummy Evaluation Tests		
2001 Saturn	none	SIDH3/ES-2
2001 Saturn	curtain only	SIDH3/ES-2
1999 Maxima	none	SIDH3/ES-2
1999 Maxima	head/thorax combo	ES-2
Fleet Performance Tests		
1999 Volvo S80	curtain plus thorax	SIDH3*/ES-2
1999 Cougar	head/thorax combo	ES-2
2000 Saab	head/thorax combo	ES-2
1999 Windstar	head/thorax combo	ES-2
2002 Explorer	curtain only	SIDH3*/ES-2

*Tests run by NSA

Pole Tests Performance

ES-2 Research Findings

- **ES-2 demonstrated ability to detect usefulness of head protection**
  - Head/neck/shoulder kinematics comparable to SIDH3
  - Head loading levels and timing similar to SIDH3
- **Existing ES-2 rib deflection criterion indicate higher level of thoracic injury than the measured SIDH3 TTI(D) in the same vehicles**

Head

Chest

FMVSS 214 ES-2 Tests

FMVSS 214 MDB Upgrade - High Severity/Barrier Development Tests				
VEHICLE	BAG	IMPACTOR	DUMMY	TEST CONDITION
1999 Prizm	none	IIHS MDB/F150	ES-2	214 speed/angle
1999 Cadillac Deville	none	IIHS MDB/F150	ES-2	214 speed/angle
1999 Maxima	none	IIHS MDB	ES-2	214 speed/angle
1999 Cadillac Deville	none	IIHS MDB/F150	ES-2	Side NCAP

Side NCAP- 2002 Fleet Performance Tests			
VEHICLE	SIZE/CLASS	BAG	DUMMY
2001 Focus	compact PC	none	SID*/ES-2
2003 Corolla**	light PC	thorax	SID*/ES-2
2002 Impala	medium PC	head/thorax combo	SID*/ES-2
2001 LeSabre	heavy PC	none	SID*/ES-2
2002 Escape	SUV	none	SID*/ES-2
2002 Odyssey	van	thorax	SID*/ES-2
2002 Tundra**	pickup	none	SID*/ES-2

*Tests run by NSA & NCAP

** NSA SID test planned

Side NCAP Fleet Tests Performance

VEHICLE	SIZE/CLASS
2001 Focus	compact PC
2003 Corolla	light PC
2002 Impala	medium PC
2001 LeSabre	heavy PC
2002 Escape	SUV
2002 Odyssey	van
2002 Tundra*	pickup

Exceeded one or more ES-2 injury criteria limits

All the vehicles passed the SID injury criteria

* NSA SID test planned

- ES-2 rib deflection maximum range reached only in one rib measurement for the LeSabre driver where both the door and hinge at A-pillar collapsed

Responses

Upgrade FMVSS 214 MDB/High Severity Tests Performance

ES-2 Research Findings

- **ES-2 demonstrated excellent durability**
- **Rib deflections reached maximum range**
- **ES-2 abdominal loads demonstrated ability to detect intruding armrest in IIHS MDB to Cadillac test**

Responses

Findings

- **Rib Binding is gone**
- **Dummy is durable**
- **Back plate is a potential issue:**
  - Possible solutions
    - placing a limit on back plate loads and/or impulse contribution
    - frangible back plate bolt
    - use of protective shield
- **Added measurement capabilities have potential for better assessment of thoracic and abdominal injuries**
- **Head injury an important aspect of SI**

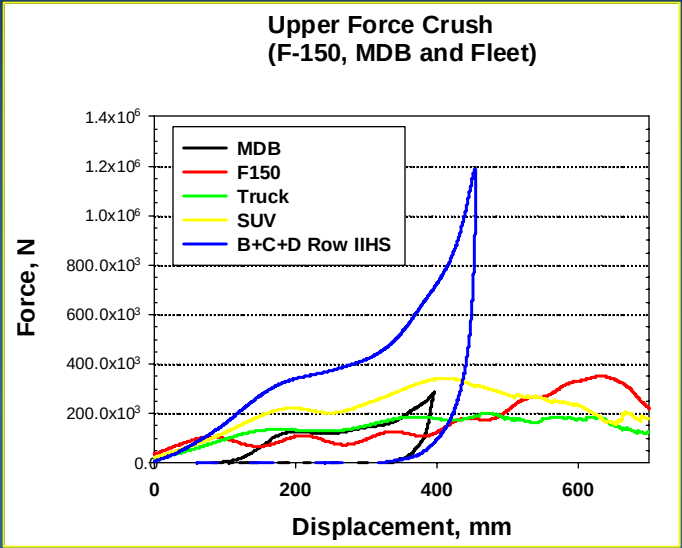
MDB Research Update

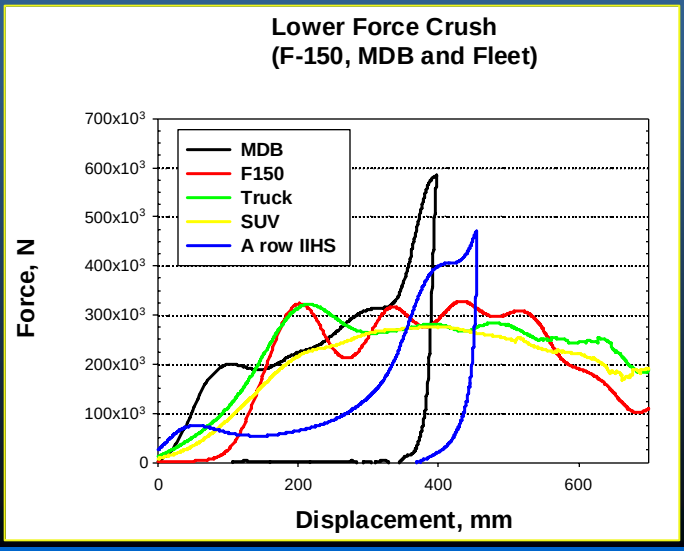
FMVSS 214 Upgrade - High Severity/Barrier Development Tests				
VEHICLE	BAG	IMPACTOR	DUMMY	TEST CONDITION
1999 Prizm	none	IIHS MDB/F150	ES-2	214 speed/angle
1999 Cadillac Deville	none	IIHS MDB/F150	ES-2	214 speed/angle
1999 Maxima	none	IIHS MDB	ES-2	214 speed/angle
1999 Cadillac Deville	none	IIHS MDB/F150	ES-2	Side NCAP

- Crash tests with IIHS MDB and F150 at FMVSS 214 and side NCAP speeds
- Load path analysis of striking vehicle from frontal NCAP load wall tests

Research Findings: Upgrade MDB

- Based on frontal NCAP load wall tests, the IIHS stiffness distribution is not representative of pickups or SUVs. It has a high average height of force
- The F150 is a soft pickup relative to its class





Upper Force

Lower Force

Research Findings: MDB Test Results

- **Dummy responses indicate that the IIHS MDB is stiffer than the F150**
  - Head, abdomen and pelvic dummy responses were higher for the IIHS MDB tests
  - Chest dummy responses were similar for both the IIHS MDB and F150 tests
- **Door contact velocities for the IIHS MDB were over 25 mph compared with about 18 mph for the FMVSS 214 MDB**
- **IIHS MDB and F150 tests resulted in similar exterior crush profiles for the vehicles tested**

Responses

Profiles

- **Questions???**