

# *Evaluation of Injury Risk from Side Impact Airbags*

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# *Introduction*

- ❧ Several types of side impact air bag (SAB) systems
  - Thorax
  - Head and thorax
  - Head
  
- ❧ Different designs
  - Seat mounted
  - Door mounted
  - Window curtain
  - Inflatable tubular

# Background



- ❧ Fall 1998 – NHTSA study at Medical College of Wisconsin (MCW) – Paper 99SC03, 43<sup>rd</sup> Stapp Conf. 1999
- ❧ 1998 – Transport Canada study – Paper 2000-01-ST-02, 44<sup>th</sup> Stapp Conf., 2000
- ❧ April 1999 – NHTSA Public Meeting
- ❧ May 1999 – Letter from Dr. Martinez to Alliance, AIAM
- ❧ Summer 1999 – Research initiated at VRTC/NHTSA
- ❧ Aug 2000 – Technical Working Group (TWG – Alliance, AIAM, AORC, IIHS) recommendations – ISO WG3
- ❧ June 2001 – Evaluation of Injury Risk from Side Impact Air Bags - Prasad, A. K., Samaha, R. R., and Loudon, A. E., 17th ESV Conf., Paper No. 331.

# Test Conditions Vehicle Selection



Seat Mounted		Door Mounted	Roof Mounted
Thorax	Head/Thorax		
99 Geo Prizm	99 Ford Windstar	99 Cadillac Deville	99 Volvo S80
99 VW Jetta	99 Mercury Cougar	00 Mercedes S430 (F+R)	00 Mercedes S430
00 Audi A6 (F+R)	00 Nissan Maxima	00 BMW 528i (F+R)	00 BMW 528i
99 Volvo S80	99 Saab 95		00 Audi A6
00 Cadillac Deville (R)			01 Saturn L200

(F+R) = Front and rear seat air bags

(R) = Rear seat air bags

# *Test Conditions*

## *Test Positions*



- ❧ TWG recommended positions – Baseline
- ❧ Study high speed videos of “blank deployments”
- ❧ Develop additional test positions, variations of TWG positions, MCW positions
- ❧ Goal – most severe loads for dummies of various sizes

# *Test Conditions Dummies Used*



- ✘ Hybrid III 3 year old
- ✘ Hybrid III 6 year old
- ✘ SID-IIs
- ✘ 12 month CRABI\*\*
- ✘ 95% Adult Male\*\*
- ✘ All were instrumented according to TWG recommendations

-\*\*Not included in TWG procedures

# *Test Conditions Injury Criteria*



- ❏ Interim values used – TWG recommendations
- ❏ Evaluation of injury criteria and IARV -pending
- ❏ 3 YO chest deflection, 6 YO HIC - FMVSS 208  
Interim Final Rule
  - 3YO Chest: 34g (FMVSS 208) 36g (TWG)
  - 6YO HIC: 700 (FMVSS 208) 723 (TWG)

# *Status of Research*



- ❏ 3 YO, 6YO, 12 month CRABI seat and door mounted SAB – completed
- ❏ Roof mounted bags including SID IIs & 95<sup>th</sup>% Adult Male – completed
- ❏ Seat and Door Mounted bags with SID IIs – ongoing

# Selecting Dummy Positions



- ❏ Use “blank deployments” to see the deployment envelope of selected airbags
- ❏ Use TWG recommended positions
- ❏ Make modifications to get “worst case” for the vehicles, if needed
- ❏ With 20 different airbag setups, 3 YO, 6YO, CRABI, SID-IIs get ~300 test combinations plus repeatability

# NHTSA Modifications (3YO) Seat Mounted Bags

## ❏ TWG 3.3.2.1

- NHTSA Seat-02-3
- NHTSA Seat-03-3
- NHTSA Seat-07-3
- NHTSA Seat-08-3
- NHTSA Seat-09-3
- NHTSA Seat-10-3

❏ Gets head closer to the airbag

❏ Places head at different locations along the seatback



# NHTSA Modifications (3YO) Seat Mounted Bags

## ✎ TWG 3.3.2.2

### - NHTSA Seat-01-3

📄 Allows dummy closer to the edge of the seat



## ✎ TWG 3.3.2.2

### - NHTSA Seat-04-3

📄 Gets head closer to the seatback

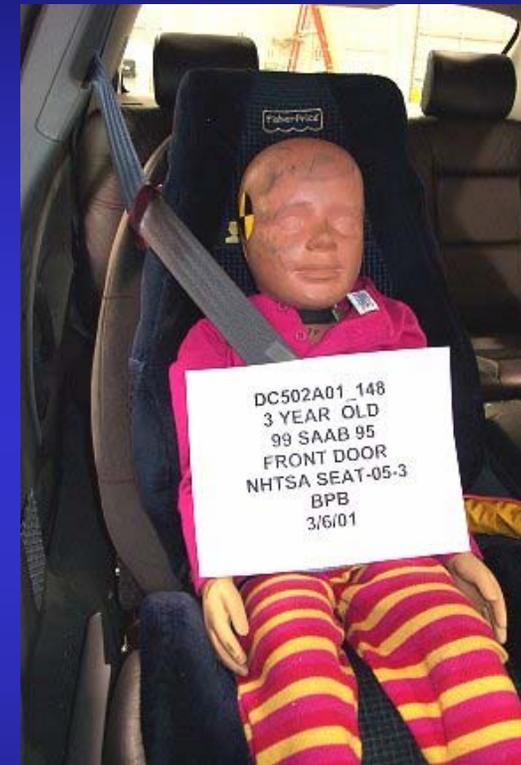


# NHTSA Modifications (3YO) Seat Mounted Bags

Booster Seats not addressed by TWG

- NHTSA Seat-05-3
- NHTSA Seat-06-3

❧ Restrained dummy



# NHTSA Modifications (3YO) Door Mounted Bags

## ❏ TWG 3.3.3.1

- NHTSA Door-01-3
- NHTSA Door-02-3

📌 Allows the chest to be closer to the airbag

## ❏ TWG 3.3.3.2

- NHTSA Door-03-3

📌 Places neck at higher location on the airbag



# NHTSA Modifications (3YO) Door Mounted Bags

- ❧ Leaning Sideways for Door Mounted Bags  
Not addressed by TWG
  - NHTSA Door-04-3
  - NHTSA Door-05-3
  - NHTSA Door-06-3



# NHTSA Modifications (3YO) Door Mounted Bags

- ❏ Booster Seats Not addressed by TWG
  - NHTSA Door-07-3
  - NHTSA Door-08-3
- ❏ Restrained dummy



# NHTSA Modifications (6YO) Seat Mounted Bags

## ❏ TWG 3.3.2.5

- NHTSA Seat-01-6
- NHTSA Seat-02-6
- NHTSA Seat-03-6
- NHTSA Seat-04-6
- NHTSA Seat-05-6

❏ Gets head closer to the airbag

❏ Places head at different locations on the seatback



# NHTSA Modifications (6 YO) Door Mounted Bags

❧ TWG has no positions for 6 YO for door mounted systems

❧ Back at Door

- NHTSA Door-01-6

  - ☑ Places neck against the airbag

❧ Leaning Sideways for Door Mounted Bags  
NHTSA Door-02-6

- NHTSA Door-03-6

- NHTSA Door-04-6

- NHTSA Door-05-6



# NHTSA Modifications (6YO) Roof Mounted Bags

## ✎ TWG 3.3.4.1

### - NHTSA Head-01-6

📄 Places head next to opening of the airbag



# Dummy Seating for 12 month CRABI

- ❏ Infants not addressed by TWG
- ❏ Seat & Door Mounted Side Airbag
  - NHTSA Seat-01-12 – FWD Facing CRS with Flip over tray
  - NHTSA Seat-02-12 – Rear Facing CRS
- ❏ CRABI dummies properly restrained



# Dummy Seating for 95<sup>th</sup> % Adult Male

- ❧ TWG did not address large occupants
- ❧ Roof Mounted Airbags
  - NHTSA Head-01-95 – Leaning sideways with center of head at airbag opening



# Observations

- 3 & 6 YO - high loads possible in most SAB systems, especially from door mounted bags and seat mounted head-thorax combination bags.

DC502A01\_181

3-year old

'00 BMW 528i

Front Door

TWG 3.3.3.3

Head on Armrest

05/01/01

3yodoorA01\_181.avi

DC502B01\_157

6-year old

'00 Nissan Maxima

Front Door

NHTSA Seat -04-6

MCW

03/14/01

seathtb01\_157.avi

**15ms HIC: 1.33**

**NIJ: 1.70**

**-FZ(Comp.): 1.40**

**NIJ: 0.90**

**+FZ(Tension): 1.56**

# Observations (Cont.)



- ⌘ The TWG 3.3.2.2 (peek-a-boo) - good procedure for measuring injuries to the chest of 3 YO.

DC502A01\_77  
3 YEAR OLD  
1999 MERCURY  
COUGER  
(FR SEAT)  
TWG PEEK-A-BOO  
10/25/2000

3yoseatpeakA01\_77.avi

DC502A01\_87  
3-year old  
'00 Audi A6  
Front Seat  
TWG Peek-a-boo  
11/30/00

DC502A01\_87.avi

**Chest Def.: 1.25 Def. Rate: 1.93**

**Chest Def.: 1.15 Def. Rate: 2.21**

# Observations (Cont.)

- ❧ TWG 3.3.2.1 (leaning sideways on a booster) - good for measuring the loads on the head-neck region of the 3 YO. In certain vehicles, the TWG position results in the head being away from the seat back.



99 Saab 95



99 Ford Windstar



99 Mercury Cougar

## *Observations (Cont.)*

- ❏ Seat mounted air bags are located at different heights along the seat back. Additional positions place the head of the 3 year old at a range of locations along the seat back - helps in finding a test condition which produces more severe loads.



# Observations (Cont.)

❖ Suggest adding procedures that places the head CG closer to the airbag.

📄 NHTSA Seat-02-3

📄 NHTSA Seat-07-3



## *Observations (Cont.)*

- ❧ A “leaning sideways” type position is not included in TWG procedures for door mounted systems for 3 and 6 year old occupants
- ❧ Suggest adding leaning sideways positions for the Hybrid III 3YO for Door Mounted Systems
  - 📄 NHTSA Door-04-3
  - 📄 NHTSA Door-06-3



# Observations (Cont.)

❏ Suggest adding leaning sideways positions for the Hybrid III 6YO for Door Mounted Systems

❏ NHTSA Seat-04-6

❏ NHTSA Seat-05-6



## *Observations (Cont.)*

- ❏ Suggest adding back against door position for the Hybrid III 6 year old for Door Mounted Systems

📄 NHTSA Door-01-6



# *Observations (Cont.)*

## ❏ SID-IIs dummy durability issues

- Broke the shoulder potentiometer and bent the shoulder rib in a TWG procedure – door mounted (TWG 3.3.3.5)
- High Injury in the rib deflection

**Max Rib Def.: 1.27**

**Def. Rate: 1.35**

**DC502F01\_218**

**SID IIs**

**'00 BMW 528i**

**Right Front**

**Side Airbag**

**TWG 3.3.3.5**

**9/27/01**

door218.avi

## *Observations (Cont.)*

- ❧ The dummy responses were low in the tests conducted with a properly restrained 12 month CRABI and 95<sup>th</sup> male dummy
- ❧ The dummy responses were low for all roof mounted airbags

# Conclusions

- ❧ Seat Mounted Side Airbags for 3YO
  - 40% of the airbags exceeded IARV in least one of the TWG or NHTSA procedures
- ❧ Door Mounted Side Airbags for 3YO
  - Of the 3 vehicles, each exceeded IARV in at least one TWG or NHTSA procedure
- ❧ Tests with in-position, properly restrained occupants did not produce high loads
- ❧ Considerable efforts were spent in locating the correct replacement parts for the side air bag systems (module, mounting hardware, etc.)

## *Conclusions (Cont.)*

- ❧ TWG procedures are generally capable of discriminating air bag systems over a wide variety of systems.
- ❧ Certain TWG positions may not be attainable in some vehicles.
- ❧ Certain TWG positions not expected to produce any significant loads on the dummies
- ❧ Several vehicles exceeded IARV in NHTSA procedures but didn't in the TWG indicating a need for more severe test conditions.