# *Side Air Bags*

**January 2002**

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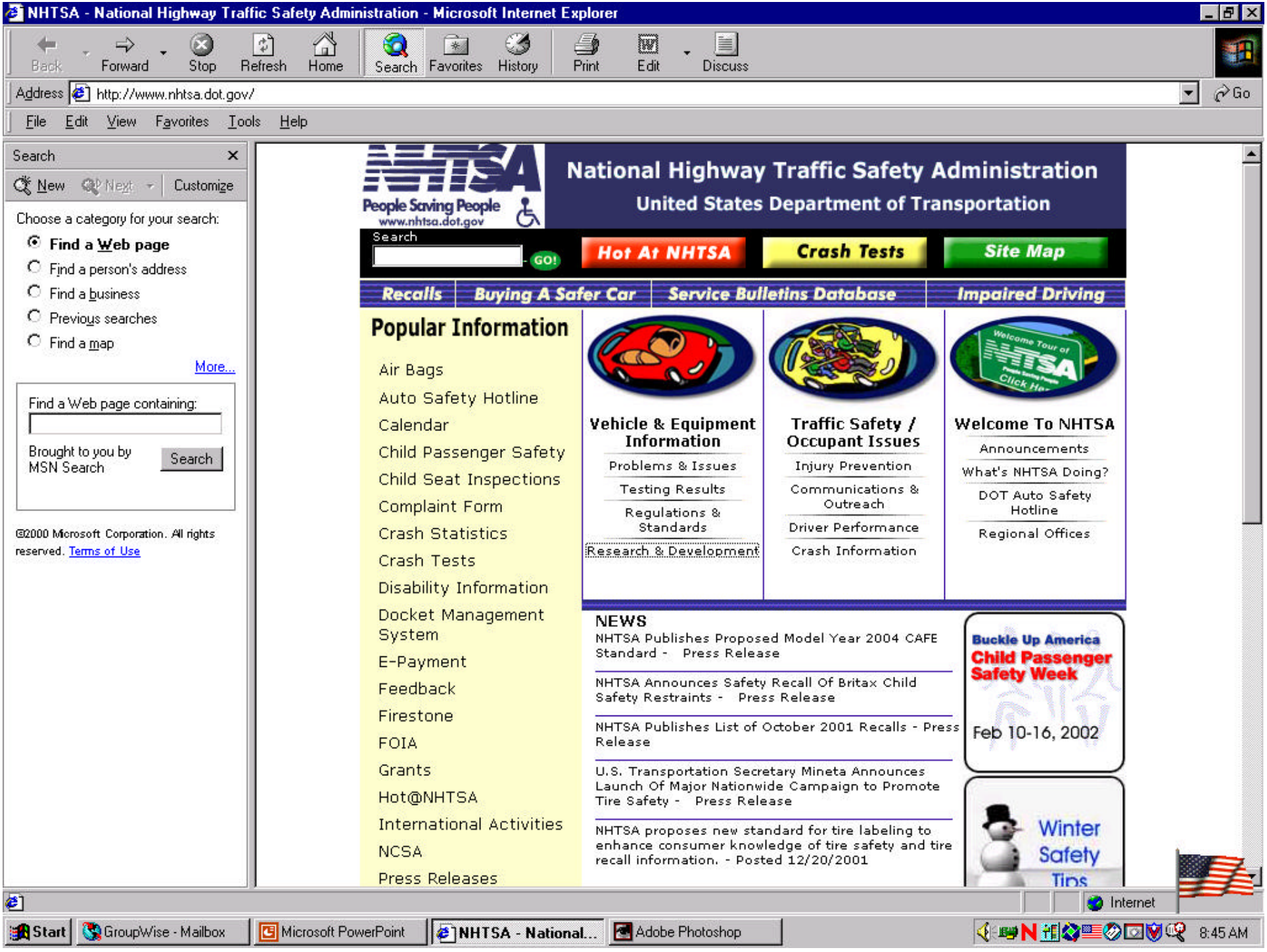
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Through extensive research, development, testing, crash investigation, and data collection and analysis activities, R&D provides the scientific strength needed to support the Agency's motor vehicle and traffic safety goals.
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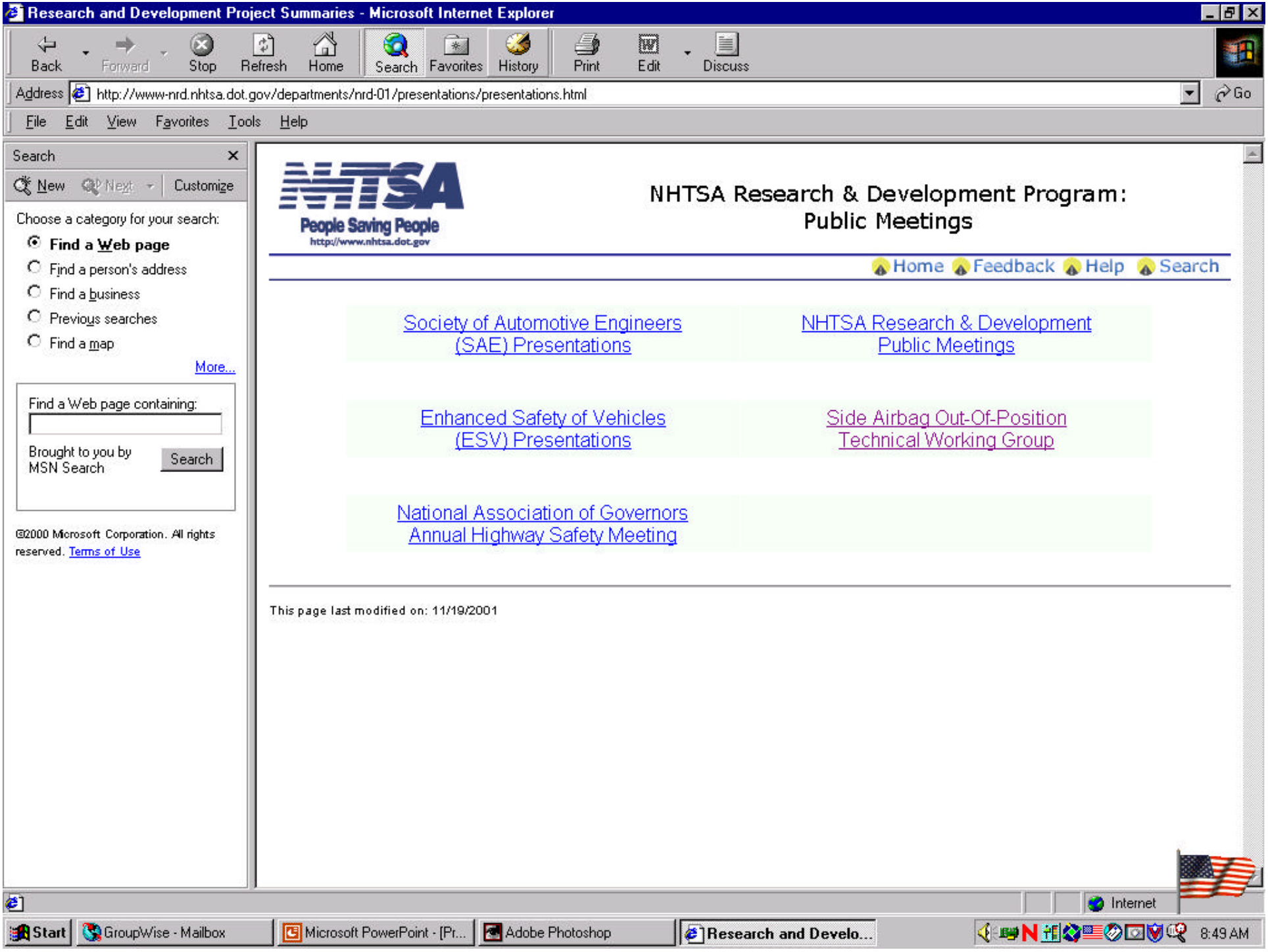
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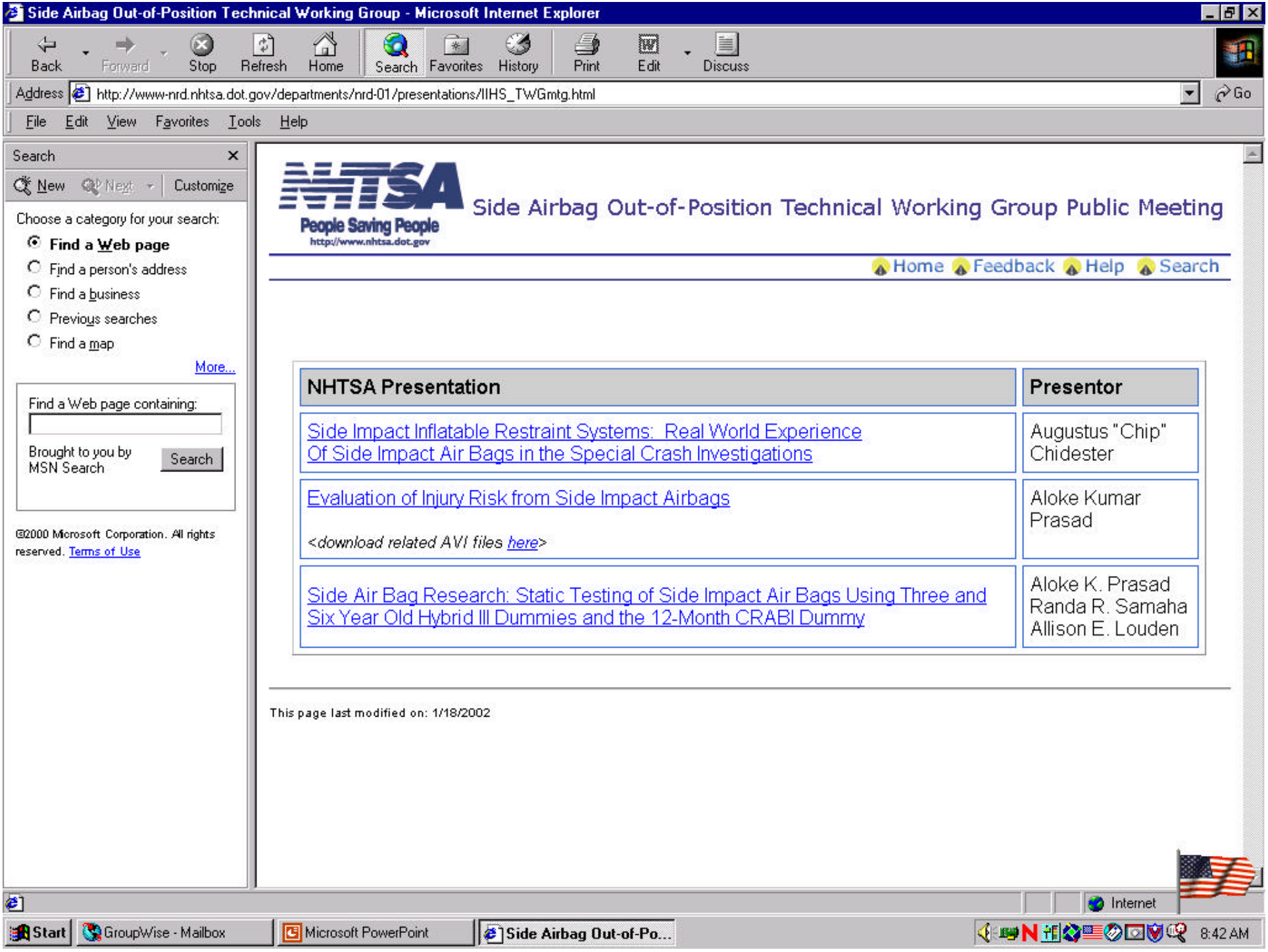
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Aloke Kumar Prasad
Side Air Bag Research: Static Testing of Side Impact Air Bags Using Three and Six Year Old Hybrid III Dummies and the 12-Month CRABI Dummy
Aloke K. Prasad
Randa R. Samaha
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# Outline

- **Background**
  - Definition, Types, and Trends
- **NHTSA Evaluation Plan**
  - 13 Vehicles
  - Variations of TWG Procedures
  - Real World Effectiveness
  - Real World Risk
- **Status of Research**

# Background

## All Side Air Bags Not the Same …

- **Thorax Bags**
  - Seat Mounted
  - Door Mounted
- **Combination Bags for Head / Chest**
  - Seat Mounted
- **Head Bags**
  - Roof Rail Mounted

## Audi A6 seat mounted (thorax)

## Volvo S80 seat mounted (thorax)

## Cougar seat mounted (head & thorax)

## Saab 9-5 seat mounted (head & thorax)

## BMW Roof rail mounted (head)

## Mercedes roof rail mounted (head)

## Mercedes door mounted (thorax)

# NHTSA's R&D Approach

- Monitor Real World Risks Through SCI
- Conduct Static Tests to Evaluate Risks
- Conduct Dynamic Tests to Assess Benefits and Risks
- Enhanced Biofidelic Dummies

# Why Side Air Bags?

Not required in FMVSS 214…

- **Safer Vehicles**
  - Offer Better Protection in Aggressive Vehicle and Narrow Object Crashes
  - Better Side Impact NCAP Scores
  - Rollover Protection (Ejection Mitigation)

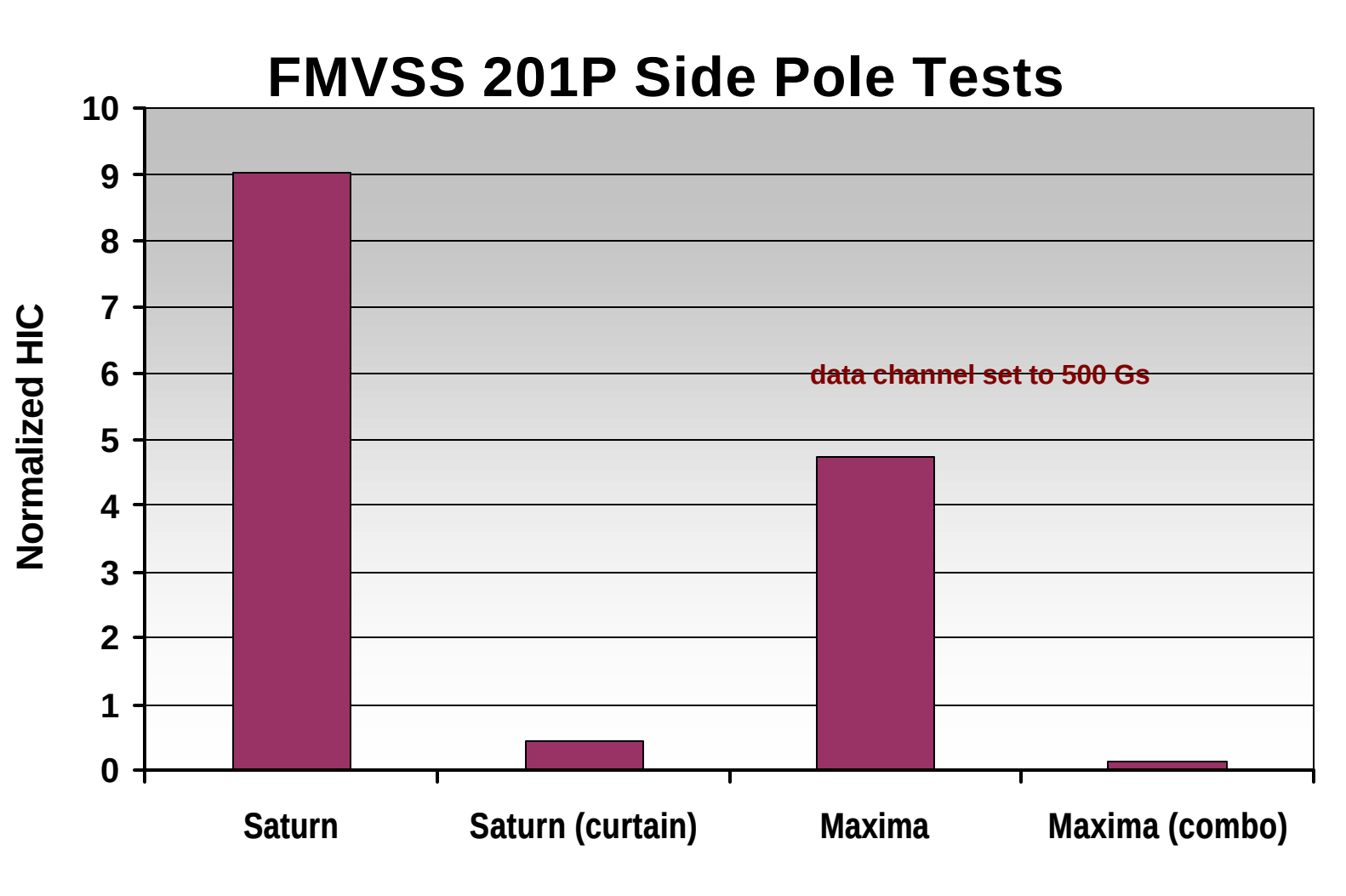
# Address Increased Risk of Head Injuries From Crashes Involving LTVs and Narrow Object

HIC=9,000, 2001 Saturn L200 no curtain

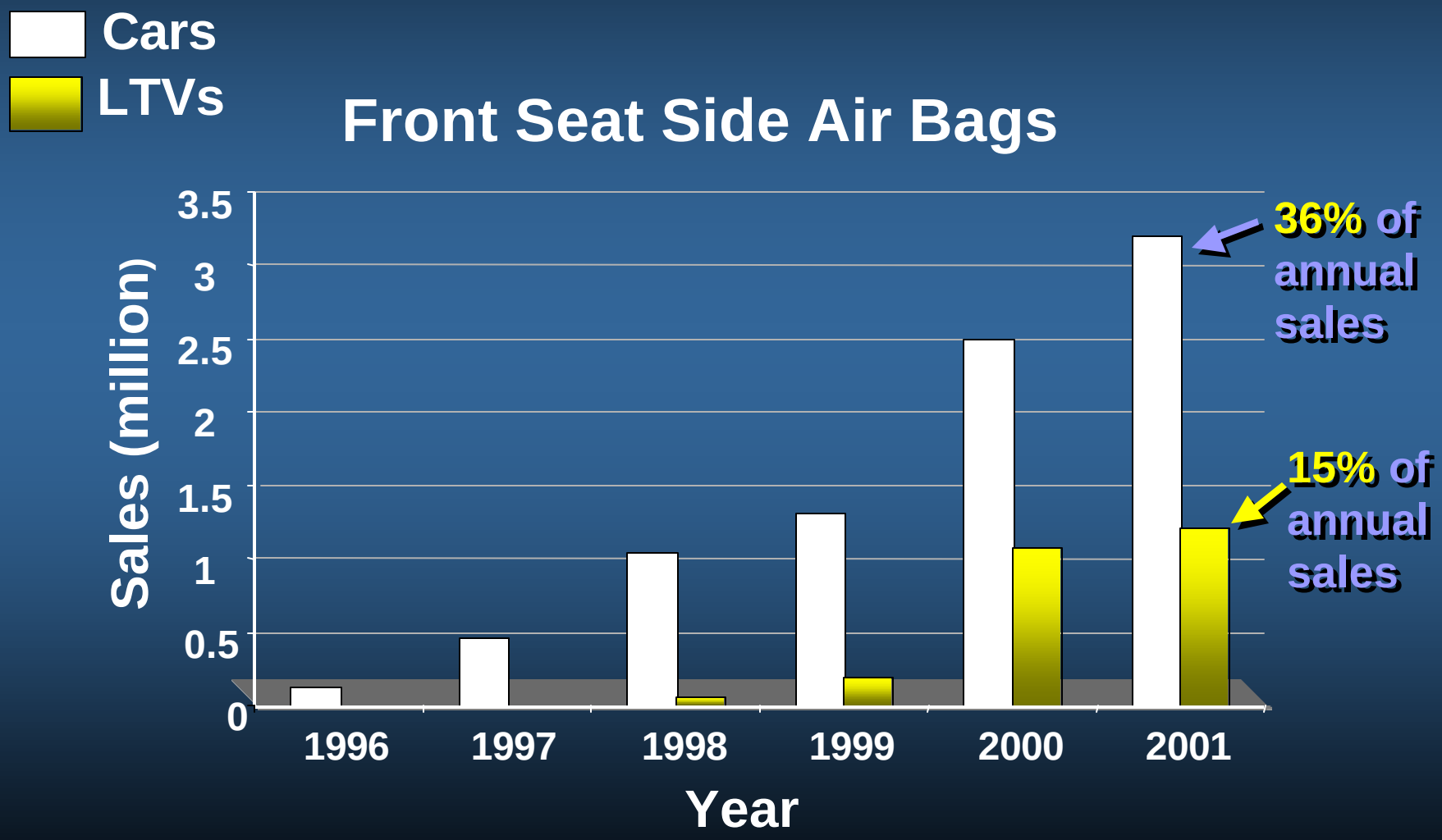
# Address Increased Risk of Head Injuries From Crashes Involving LTVs and Narrow Object

HIC=435, 2001 Saturn L200 with curtain

# Address Increased Risk of Head Injuries From Crashes Involving LTVs and Narrow Object



# Fleet Penetration of SABs



# Special Crash Investigation Case Selection Criteria

- High injury outcome with deployment of a side air bag
- Allegations of a fatal or seriously injured occupant attributed to the deployment of a side air bag
- Deployment of a side air bag into a position occupied by a child.
- Deployment of a head occupant protection system into an occupied position.

# SCI NHTSA Notifications

- Special Crash Investigations (SCI) Program
  - 3 teams, Headquarters
- Fatality Analysis Reporting System (FARS) -
  - 50 States, Guam & Puerto Rico
- National Automotive Sampling System (NASS)
  - 62 Sites, 24 CDS, 36 GES & 2 ZCs
- Crash Injury Research and Engr. Network (CIREN)
  - 8 Trauma Centers
- Office of State and Community Services
  - 10 Regional Offices
- Office of Traffic Safety Programs
  - Extensive Law Enforcement Network
- Office of Defects Investigations
  - Consumer Notifications Through the Auto Safety Hotline
- Office of Public & Consumer Affairs
  - Media

# 55 Side Air Bag Cases (10/1/01)

- **Side Impact Conditions - 43**
  - Drivers 31
  - Passenger 12
- **Other conditions where Side airbag Deployed - 7**
- **Rollover - 5**

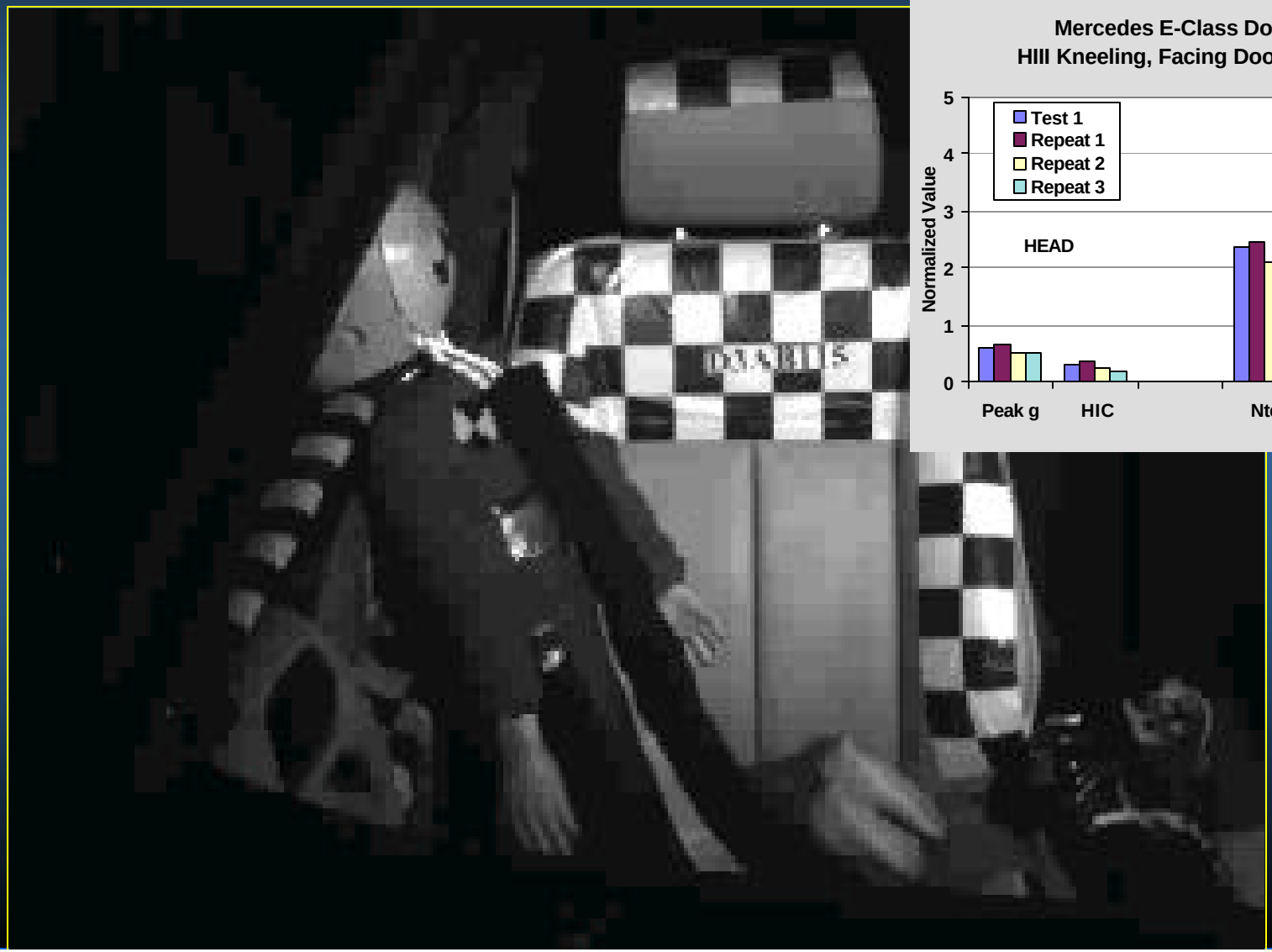
# Real World Experience

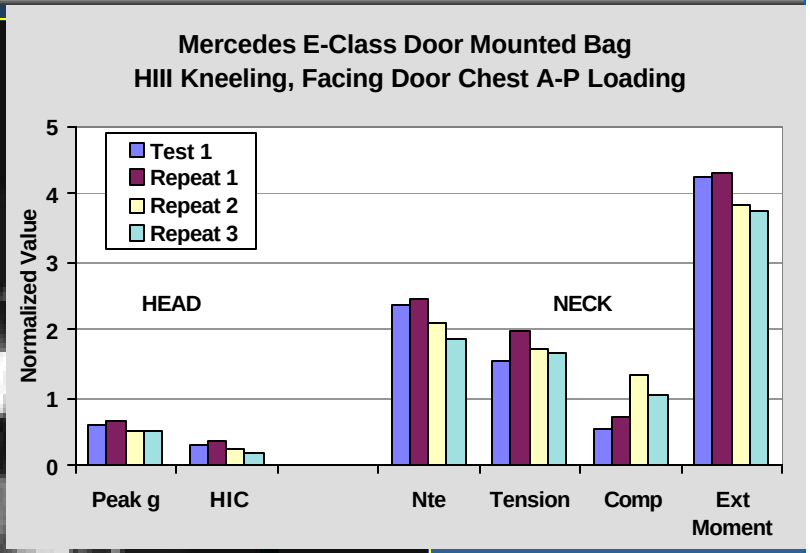
- 55 special crash investigations with SABs
- Several anecdotal cases of side air bags saving lives and preventing injuries

# Real World Experience

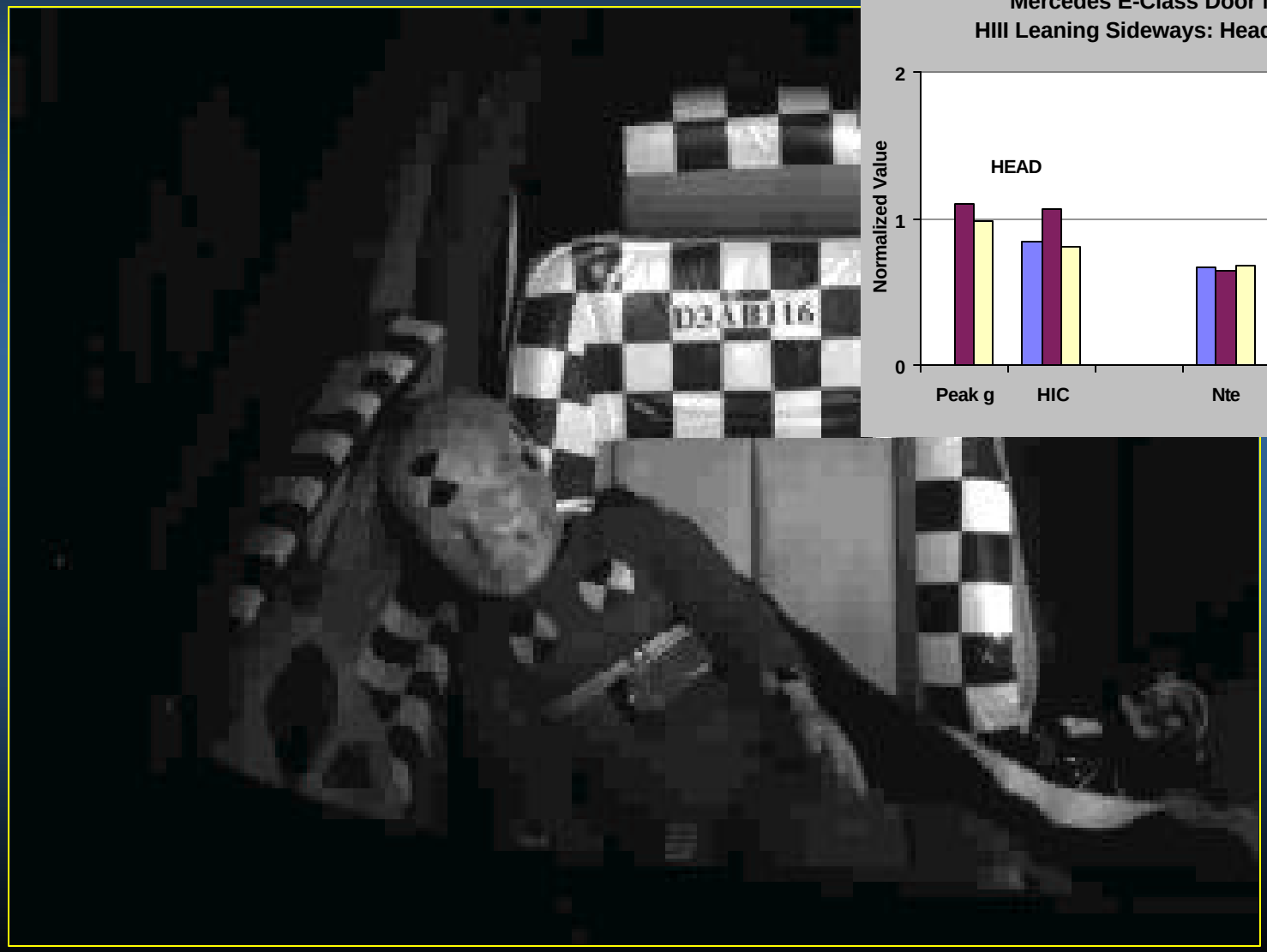
- No fatalities attributed to side bag deployment
- One seriously injured 76 y/o male (AIS 3 rib fractures due to cover flap, Deville no longer in production with door mounted SAB)
- The two cases with kids: the SAB provided protection (AIS 1 injuries)
- The head side air bag has been successful in reducing head injury
- Passenger compartment intrusion is the primary contributor to the fatal injury mechanism

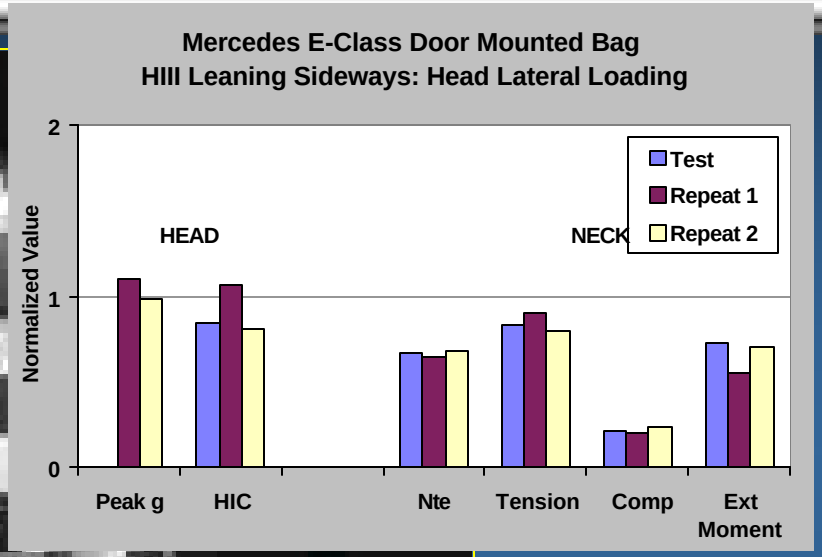
# Early Assessment of Side Air Bag Risks





# Early Assessment of Side Air Bag Risks





# NHTSA / Transport Canada / in TWG

- **NHTSA**
  - Participated as observer
- **Transport Canada**
  - Participated as member
  - Developed test procedures
  - Conducted tests

# Industry's Technical Working Group Approach

- Use ISO Developed Procedures as Starting Point
- Modify ISO Procedures for Static Testing
- Use Available Frontal Child Dummies
- Use Injury Criteria Based on Expert Judgement

# TWG Activities

- Identified Population at Risk
- Selected Available Test Dummies
- Established Dummy Injury Measures and Thresholds
- Set Associated Injury Risks for Children
  5% for AIS 3 & 4
- Drafted Test Procedures
- Held Public Meetings

# TWG Injury Assessment

- For 3 YO, 6 YO: Head, Neck, Chest
- For 5$^{th}$ %tile: Head, Neck, Chest, abdomen, pelvis, and arm
- Includes both injury criteria and injury research values
- Limits based on industry biomechanical expertise
- Minimizes risks for children

# Child Injury Criteria

- **Head - HIC ( 15 Msec)**
- **Neck – $N_{ij}$, Force and Moment Components**
  - Both upper and lower neck instrumentation
- **Chest – Acceleration and Deflection**
  - Chest deflection rates calculated

# SAB OOP
# Test Positions – Examples for 3 and 6 year old HIII dummies

## 3 yr Hybrid III

# SAB OOP
# Test Positions – Examples for 3 and 6 year old HIII dummies

## 6 yr Hybrid III

# 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

# NHTSA Test Conditions & 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 with head, neck (upper and lower) and chest instrumentation

**Not included in TWG procedures

# Status of Research

- 3 YO, 6YO, 12 month CRABI seat and door mounted SAB – completed
- Roof mounted bags including SID IIs & 95$^{th}$% Adult Male – completed
- Seat and Door Mounted bags  with SID IIs – ongoing

# NHTSA Dummy Positions

- Use “blank deployments” to see the deployment
- 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 planned test combinations plus repeatability (200+ completed)

# NHTSA Positions and Dummies

- Gets Head / Neck Closer to the Airbag
- Places Head / Neck at Different Locations Along the Seatback
- 12 – 18 Different Positions Were Added
- Three Different Child Dummies and a 5$^{th}$ Percentile Dummy Used in Testing

# Dummy Implications

- **The more Biofidelic Hybrid III 3YO neck can be used for:**
  - **Child Restraint Evaluation in lateral impact**
  - **Side Airbags OOPs evaluation**

  **lateral internal moments and external forces than the standard Hybrid III 3yo**

# Sled Test Kinematics

All frames at maximum head excursion.

HIII Standard Head/Neck

FTSS HIII-3CS Head/Neck

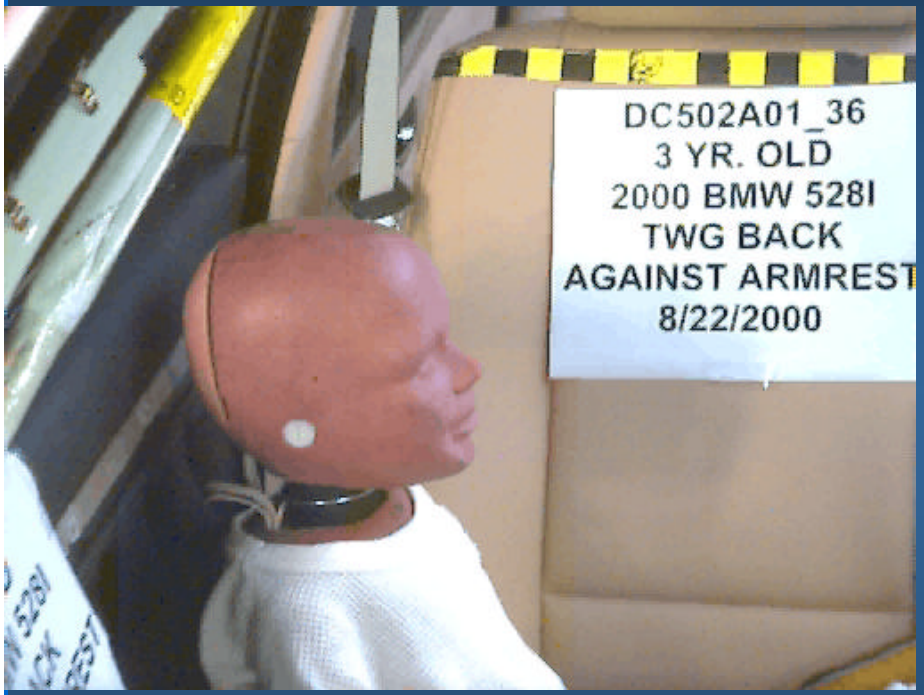
Denton HIII-3CS Head/Neck

# Comparison of TWG & NHTSA OOP Test Position

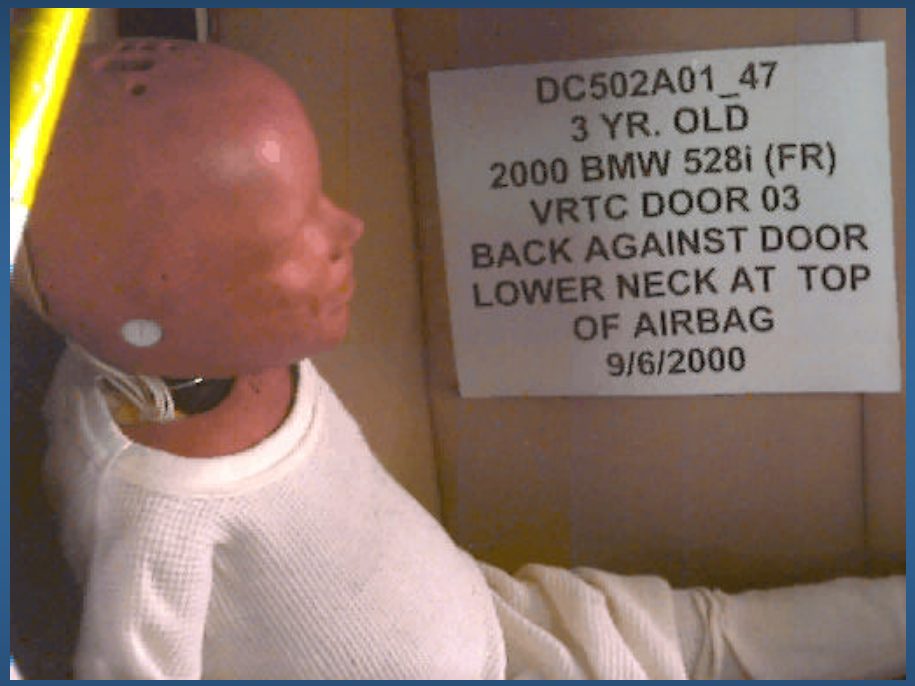
TWG - 3 yr old leaning sideways on a foam booster block

NHTSA variation - gets head closer to seat back & places head at different location along the seatback (resulted in high upper neck twist)

# Comparison of TWG & NHTSA OOP Test Position




TWG Back Against Armrest




NHTSA variation - Back Against Door Lower Neck At Top of Airbag

# Rear Door Side Air Bags OOP Testing

NHTSA variation 3yo – high HIC

NHTSA variation 3yo– high $N_{ij}$, bending

# Observations

- 3 & 6 YO - high loads possible in some SAB systems, especially from door mounted bags and seat mounted head-thorax combination bags.
- The TWG 3.3.2.2 (peek-a-boo) - good procedure for measuring injuries to the chest of 3 YO.
- 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.

# 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.)

- The dummy responses were low in the tests conducted with a properly restrained 12 month CRABI
- The dummy responses were low for all roof mounted airbags

# General Comments on TWG Procedures

- IIHS Did a Good Job in Developing Consensus
- The TWG Procedures Are Quite Comprehensive and Are Successful at Discriminating Aggressive SABs
- The TWG Addressed Dummy Sizes, Positions, and Expanded Traditional Injury Assessment
- Generic Worse Case Position Will Not Always Be Absolute Worst Case