

Enhancing Motor Vehicle Safety:

Through Research, Regulations and Enforcement

The Children's Hospital of Philadelphia

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Outline

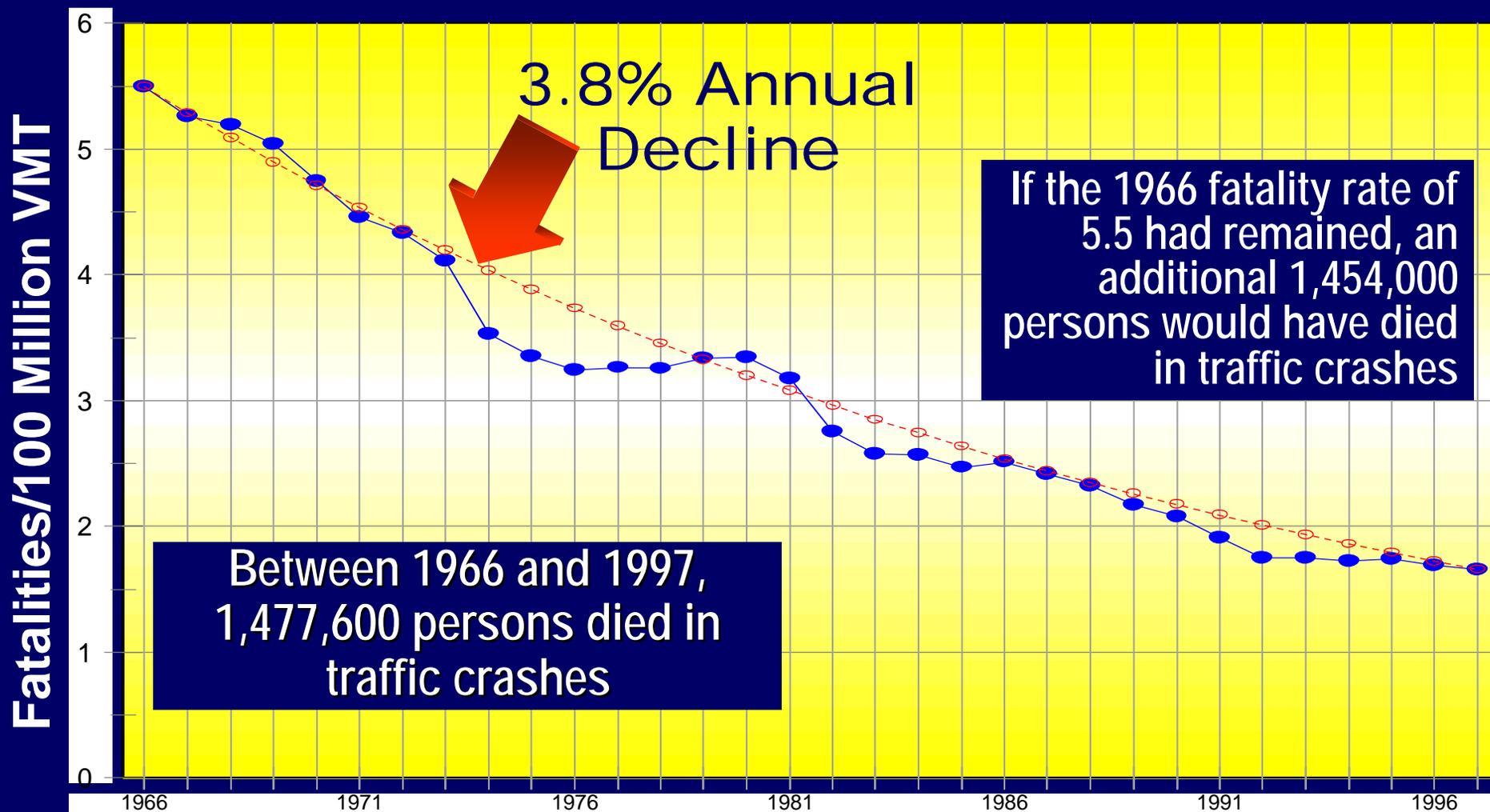
Introduction

- **NHTSA's Mission**
- **The History of Traffic Safety**
- **Early Achievements**
- **NHTSA Approach to Safety**
- **The Regulatory Process**
- **Safety Research**
- **The Road Ahead for Safety**

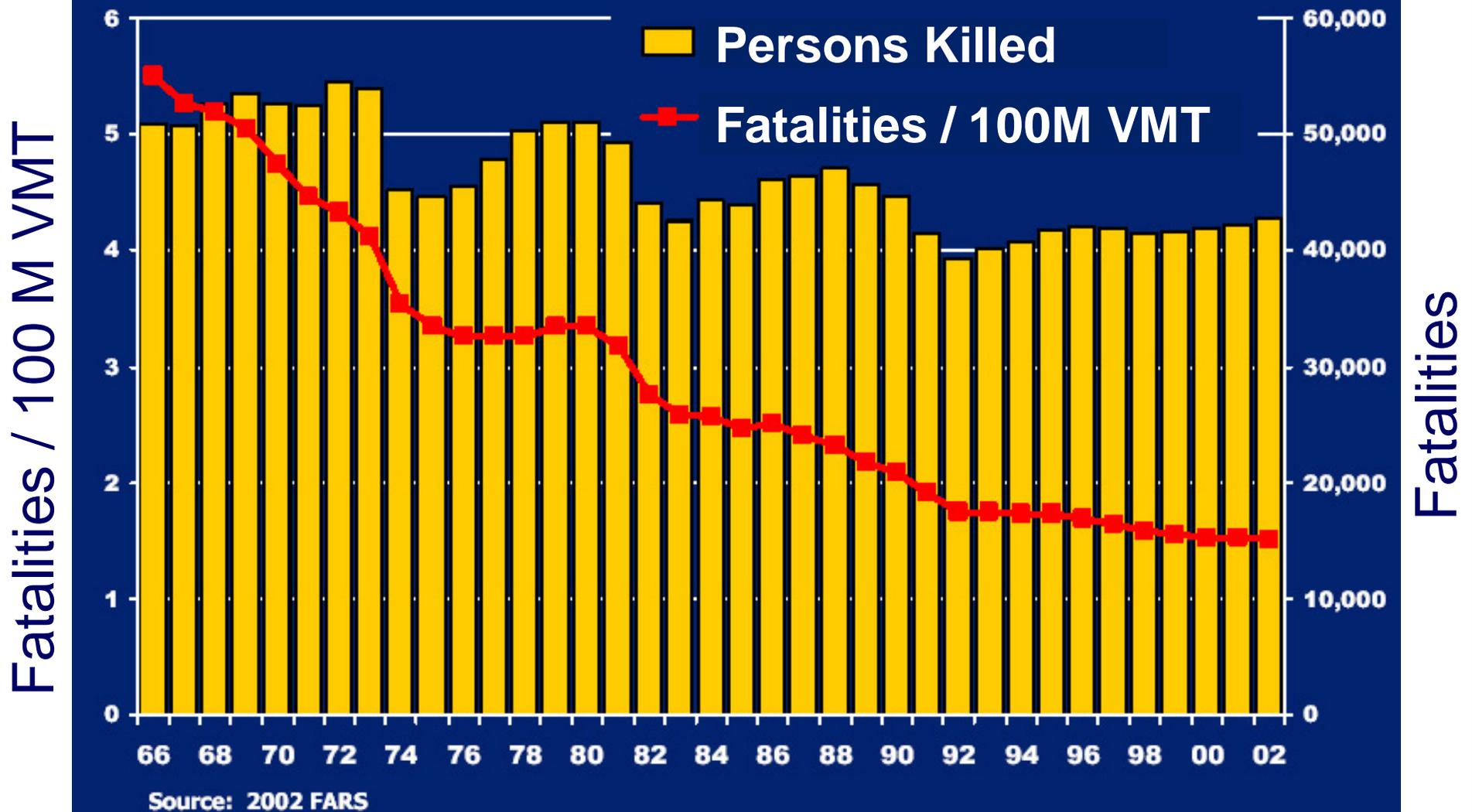
NHTSA Mission

- **To Reduce Motor Vehicle Fatalities and Injuries and the Costs Associated With Crashes**
- **Carrying Out Needed Research, Implementing Education and Enforcement Programs**
- **Responsible for Issuing Safety Standards**

U. S. Fatality Rate



Person Killed and Fatalities per 100M VMT

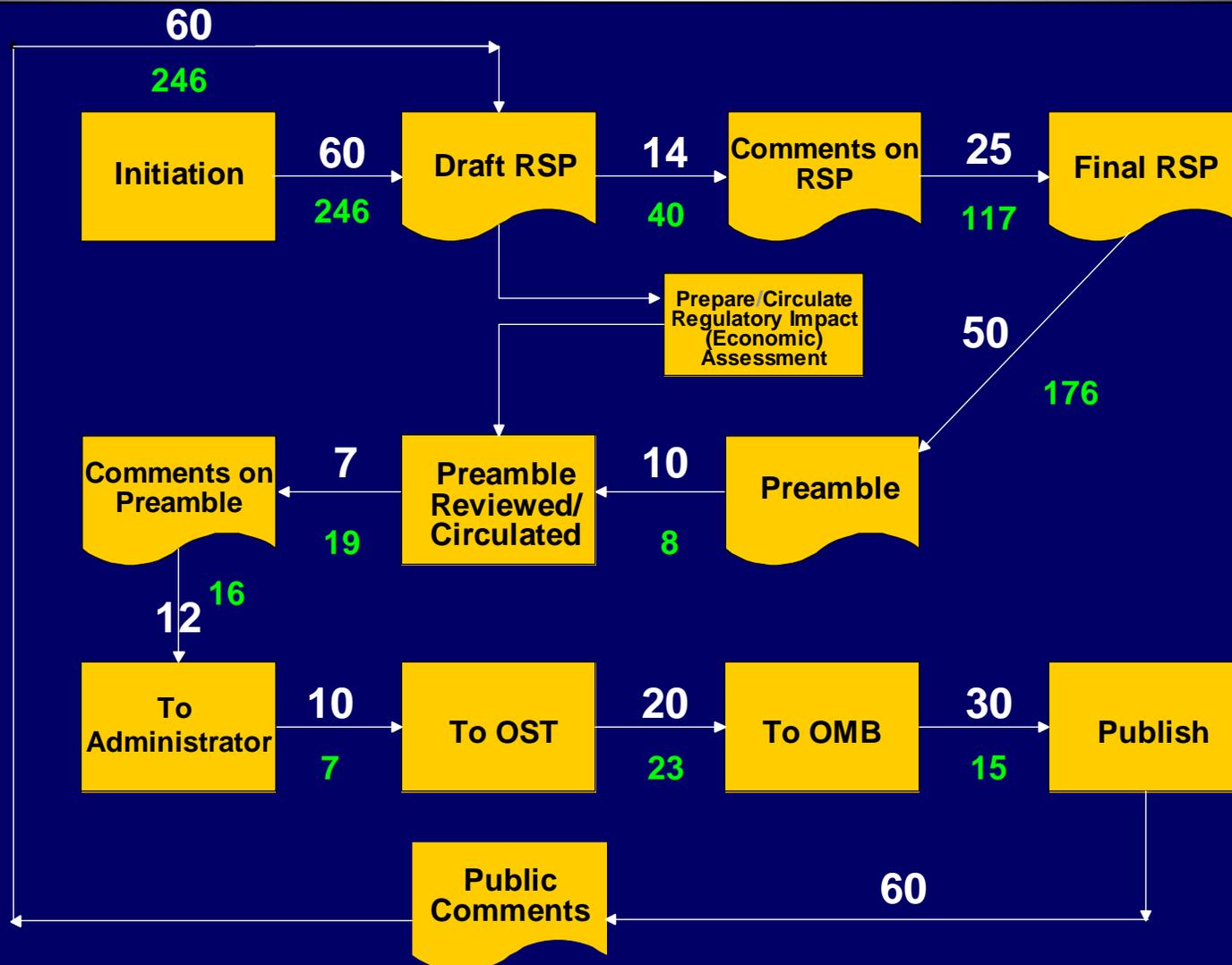


NHTSA Approach to Safety

- **Engineering, Enforcement, Education**
- **Defined Safety Need**
- **Science Based Regulations**
- **Performance based requirements**
- **Technically Feasible Solutions**
- **Established Cost Effectiveness**
- **Aggressive Enforcement**

Rulemaking Process:

GOAL (17.9 months) and Actual (45.8 months)
[as of 9/30/01]



Factors Affecting Process

- **Priorities not identified by top management or priorities change**
- **Rulemaking initiation and RSP development:**
 - **Key technical and policy issues not resolved early**
 - **Delays due to identification of needs and completion of research**
 - **Lack of uniformity in RSPs**

Sources for Initiating Rulemaking

- **Petitions**
- **Legislation**
- **(New) Multi-Year Rulemaking Priorities Plan**
– sets agency rulemaking priorities for 5 years
- **(New) Regulatory Review Plan** – looks at all FMVSS over a 7 year cycle to determine need for update/upgrade
- **Compliance issues** – standard difficult to enforce due to problems in test procedures

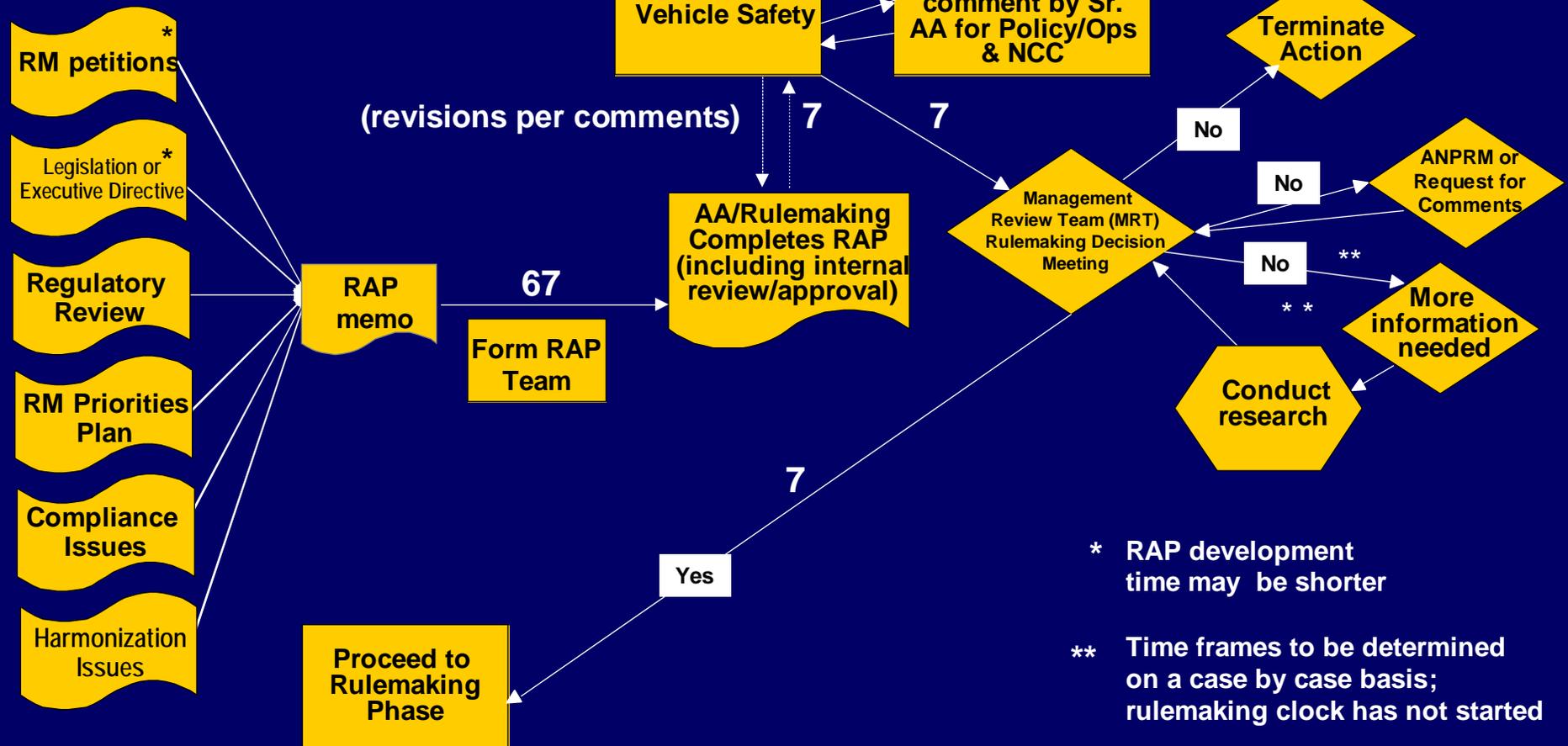
Pre-Rulemaking Phase

- **Rulemaking and Research Action Plan (RAP):**
 - **Identification of problem and possible benefits**
 - **Key policy and technical issues**
 - **Research status**
 - **Technological developments**
- **Two month development of RAP**
- **NVS involves other offices in development**
- **FMVSS Management Review Team meets for decision:**
 - **Whether to proceed with rulemaking**
 - **Conduct additional research**
 - **Makes decisions on key policy and technical issues**
- **Decision to initiate rulemaking**

Pre-Rulemaking Phase Flow Chart

[Average number of calendar days]

Sources of Possible Rulemaking Action

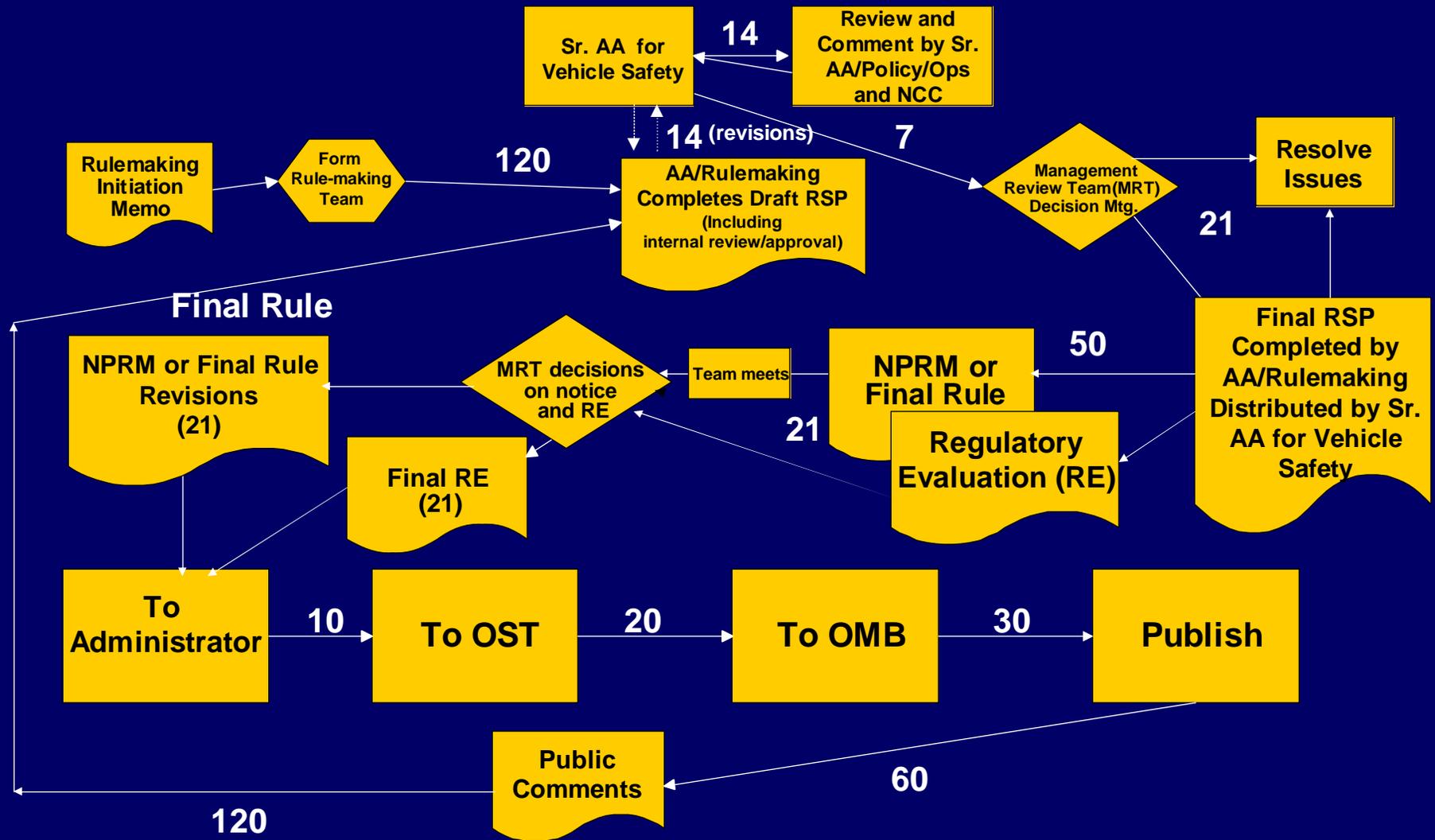


Rulemaking Phase

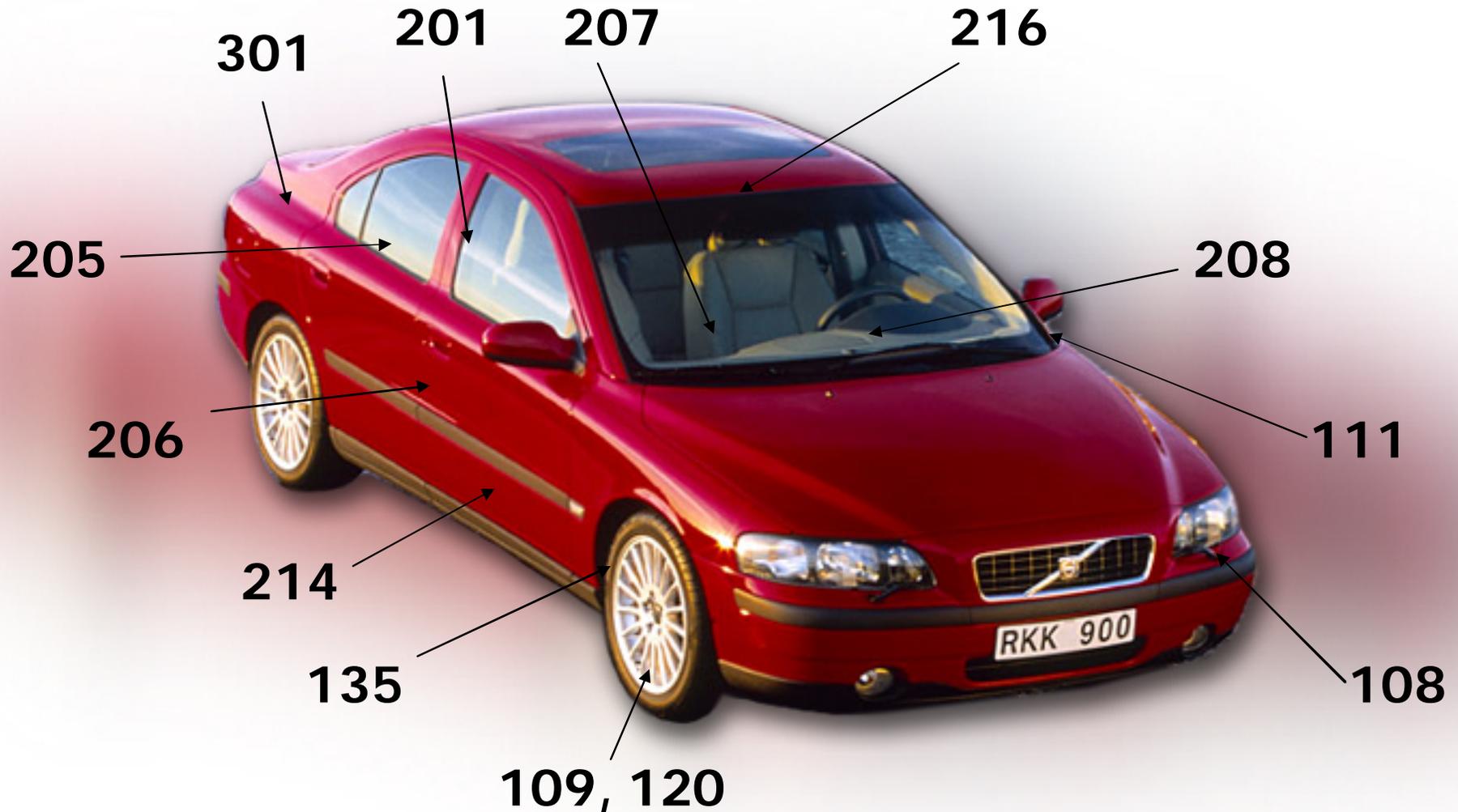
- **Engage other offices early for development of documents**
- **Follow RSP templates; follow templates for Resolution documents**
- **Provide information needed by others, in a timely manner**
- **Adhere to time frames for review and comment**
- **FMVSS Management Review Team reaches consensus within time frames established.**

Rulemaking Phase Flow Chart

[Average number of calendar days]



Federal Motor Vehicle Safety Standards



Enforcement Activities

- **Compliance Testing**
- **Defect Investigations and Recall**

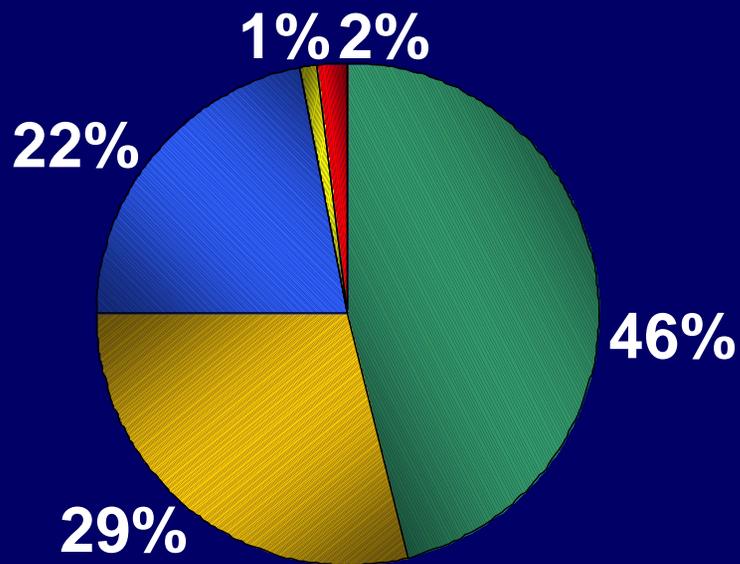
The Safety Problem

- **Major Crash Types**
- **Fatalities and Injuries**
 - Front
 - Side
 - Rear
 - Rollover
 - Compatibility

Vehicles and Fatalities by Collision Type 2002

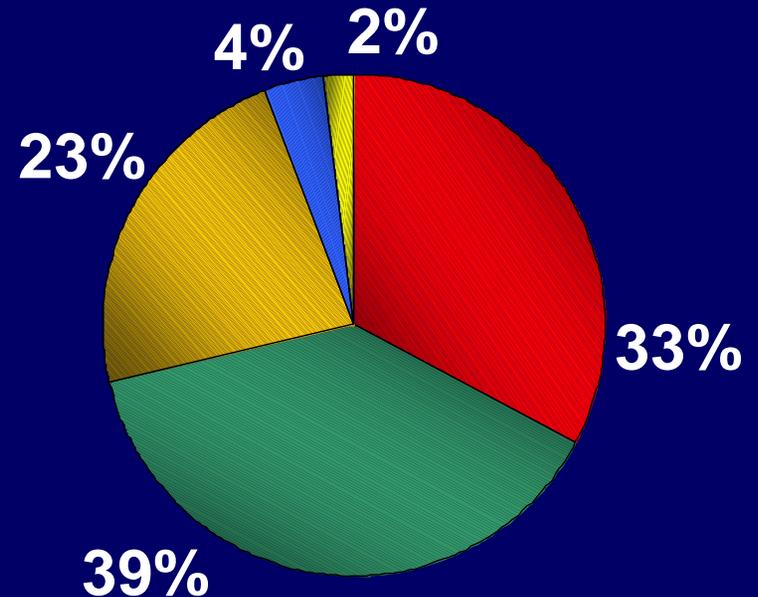
Passenger Vehicles in Crashes

Approx. 10.6 million vehicles involved



Passenger Vehicles Occupant Fatalities

32,335 total occupants killed



Rollover **Front** **Side** **Rear** **Other**

Side Crash Protection



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



HIC=9,000, 2001 Saturn L200 no curtain

Side Crash Safety

- **Side Impact Protection**
- **Chest Protection**
- **Head Protection**
- **FMVSS No. 214- In-depth look at the Rule**
- **Further Improvements in Side Impacts**
- **Risks of Side Air Bags**

Frontal Air Bag Development / Performance –1967 to 1981

- **Efforts predominantly experimental rather than analytical**
- **Sled testing followed by a few vehicle to rigid barrier crashes**
- **Experimental focus due to lack of viable vehicle/occupant restraint models**
- **No significant crash sensor work**
- **Air bag actuation by delayed-action strip switches or by production sensors taken from early air bag-equipped vehicles**

Air Bag Development / Performance –1982 to Present

- **Real-world crash investigations monitored the field performance of production air bag systems**
- **Vehicle crash testing in early 1980's evaluated retrofit air bag systems**
- **Computer models used to investigate performance of air bag systems**
- **Vehicle crash tests during 1990's mainly concerned with aggressiveness of air bag deployment**
- **Interaction of air bags with restraint systems for children**
- **Out-of-position occupant tests**
- **Vehicle crash tests to assess efficacy of 'depowered' air bags**

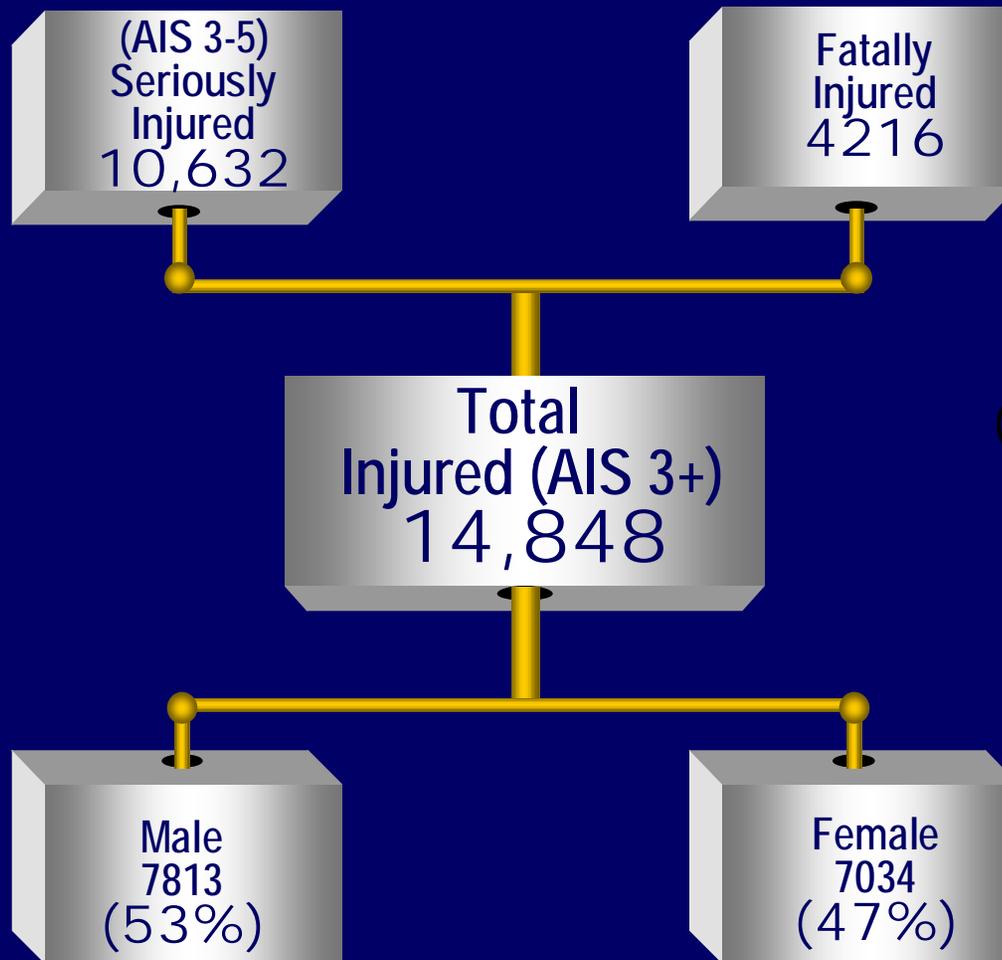
Air Bag Development and Performance Regulatory Effort

- **Air bag regulatory effort began with Advanced Notice of Proposed Rulemaking in 1969**
- **Latest modification to FMVSS 208 issued in May 2000**
- **During the 1990's, a new round of regulatory activity began in response to injuries and fatalities in air bag deployment**
- **Initial efforts consisted of temporizing measures to make air bags less aggressive**
- **A more long-term and more complicated rule to minimize the probability of air bag caused injuries was established**

Annual Estimate of Struck Side Occupants

(Non Rollover Towaway Side Crashes)

1991-2000 NASS Weighted Data / Occupant \geq 56" in Height



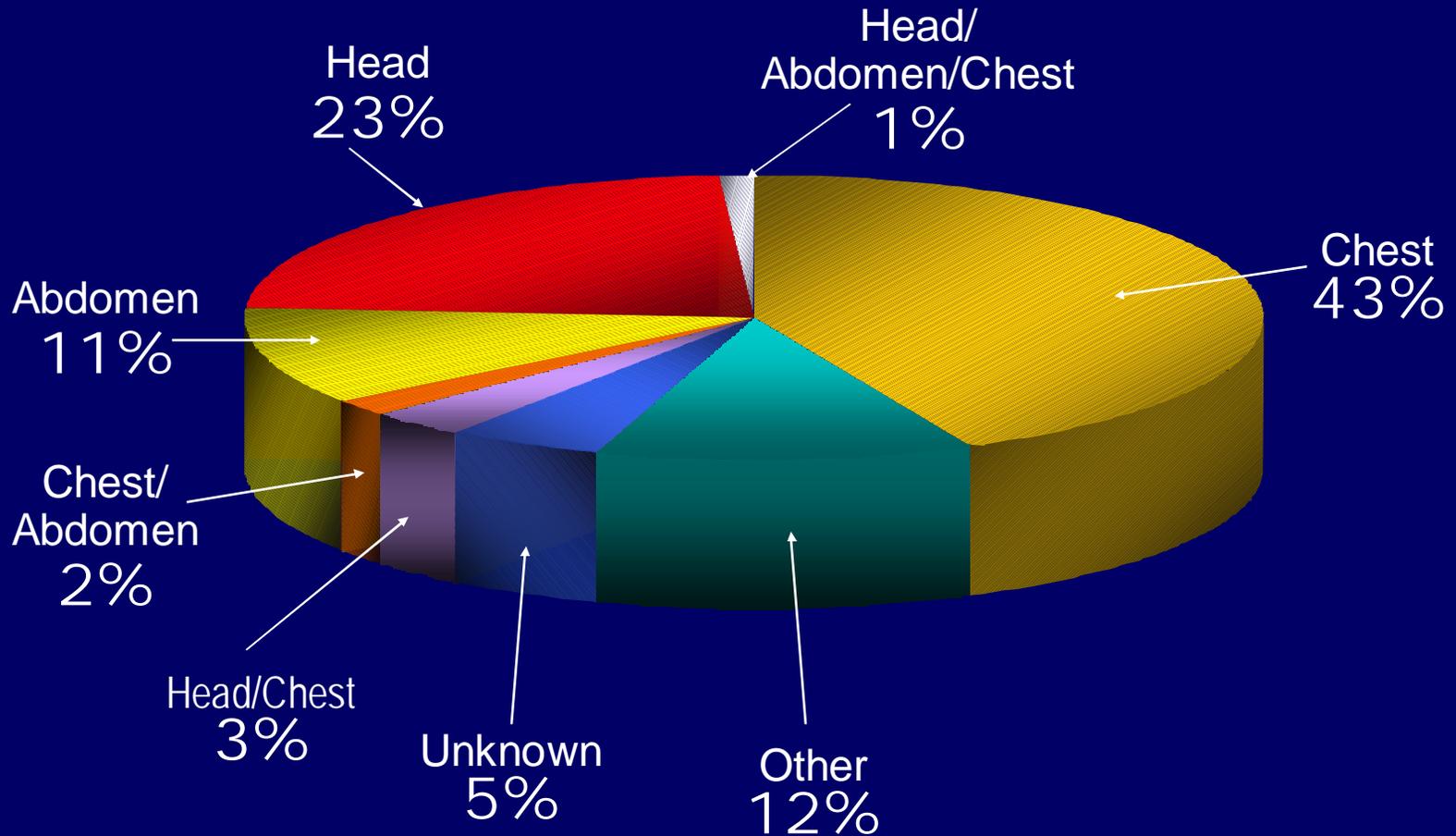
(Unknown
less than
(.01%))

Annual Estimate of Struck Side Occupants

(Non Rollover Towaway Side Crashes)

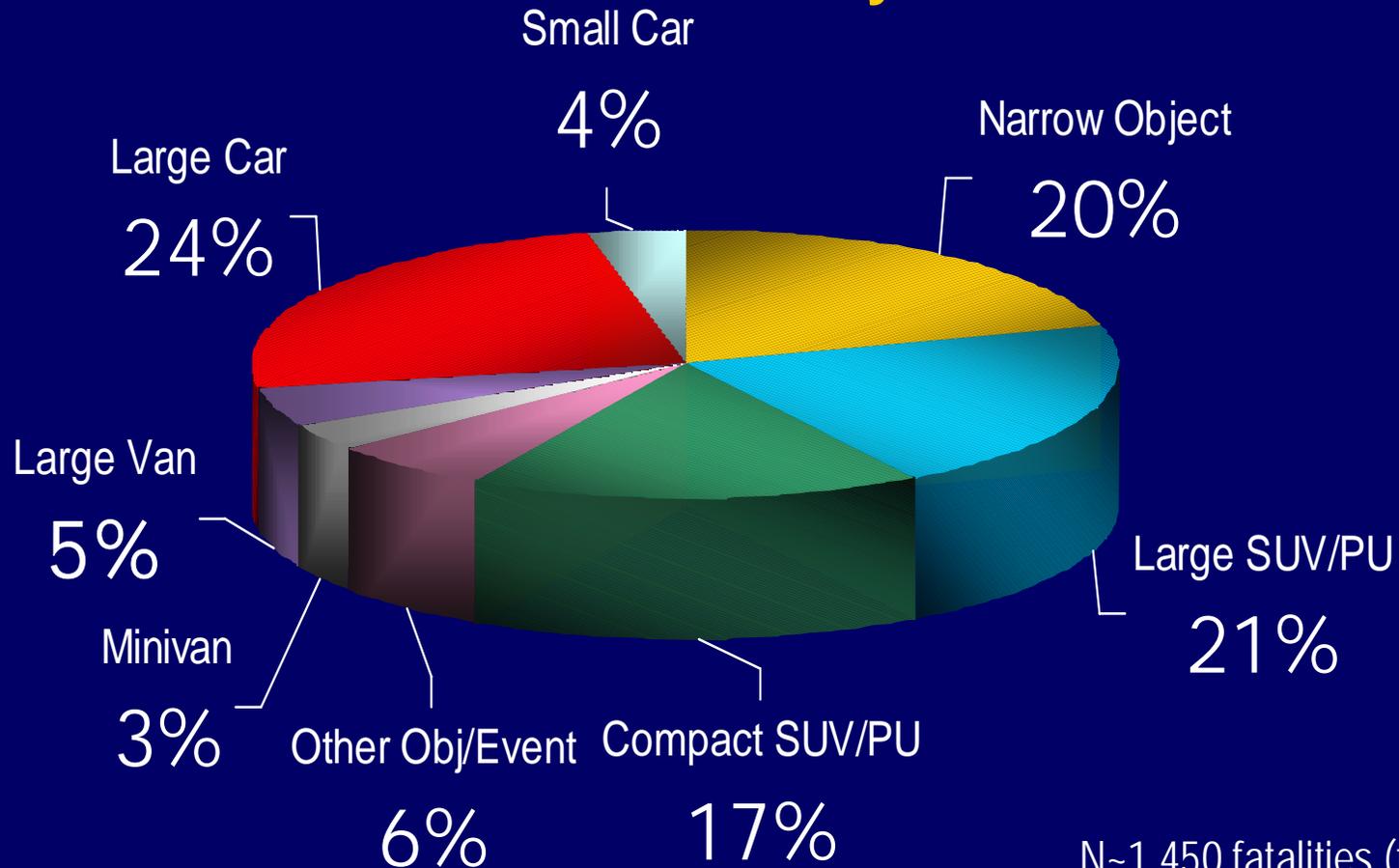
1991-2000 NASS Weighted Data / Occupant > 140 CM

Distribution of Body Regions Injured Male Occupants



Current Safety Problem Fatalities

Near Side Belted Fatalities by Crash Partner

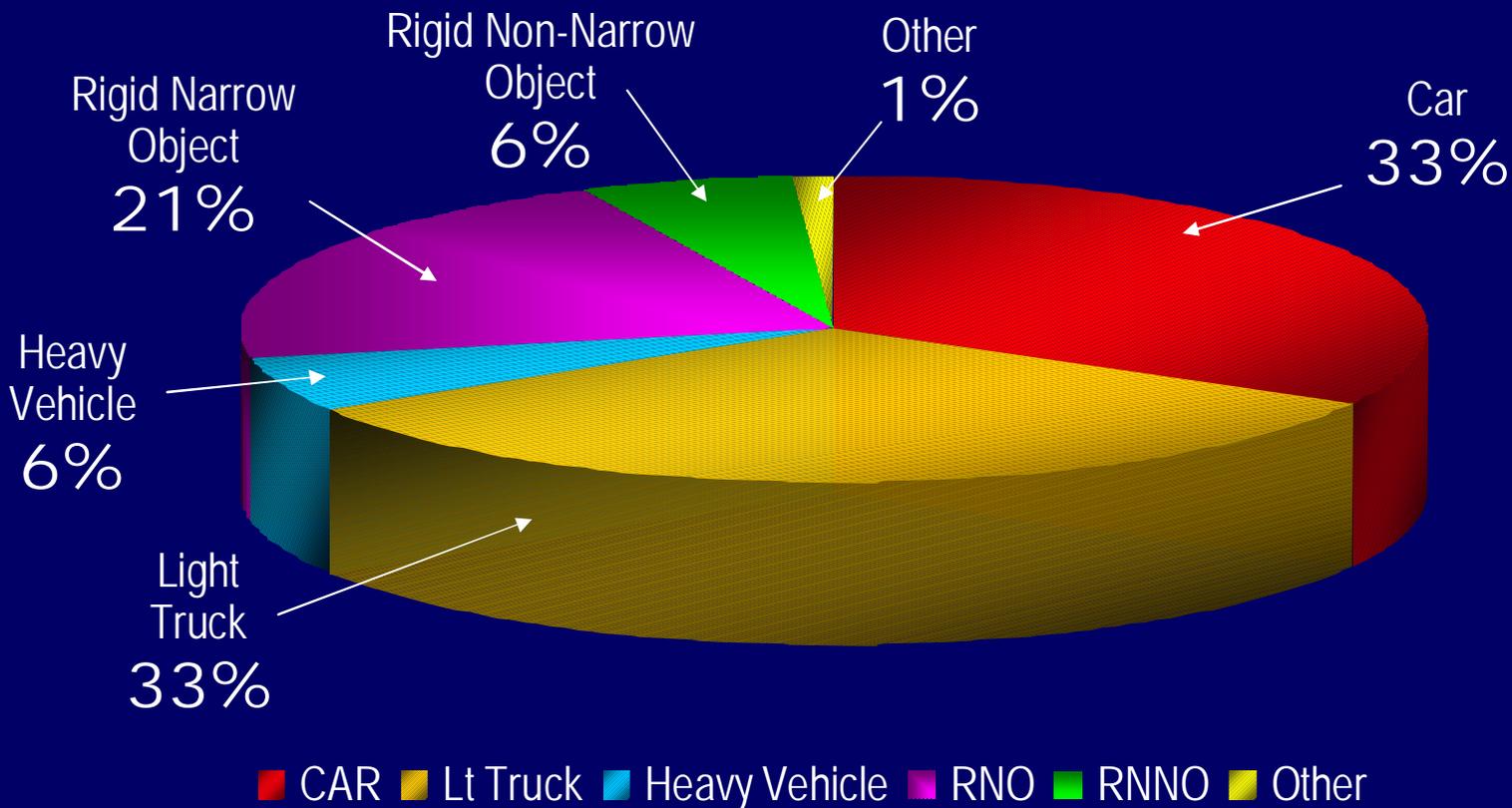


1999 FARS Side Crashes – Model Year 1995+ (light vehicles ≤10,000lbs, no rollover)

N~1,450 fatalities (total)/year
N~805 fatalities (belted)/year

Current Safety Problem Injuries

Occupants with AIS 3+ Injuries - Belted & Unbelted



NASS '95-'99 Weighted...Model Year 1995+ (light vehicles \leq 10,000lbs, no rollover)

3,272 Occupants
(total)/year

Analyses of Side Crash Safety Problem

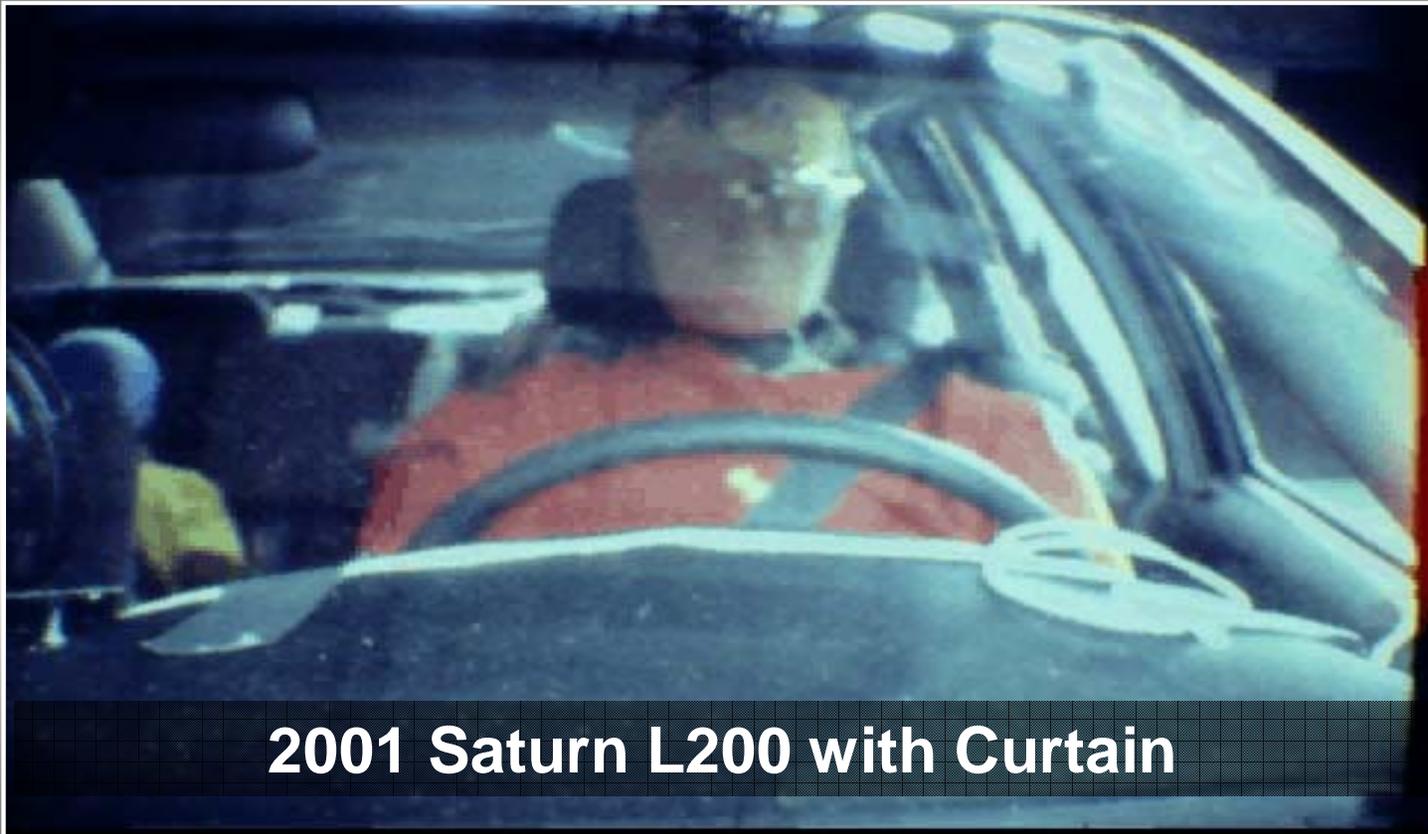
- Predominant problem is still with 50th percentile occupants followed by other sizes**
- Head/neck, chest, abdomen & pelvis get injured**
- Narrow objects and LTV's involved in large numbers**
- Needs further improvement for chest**

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

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

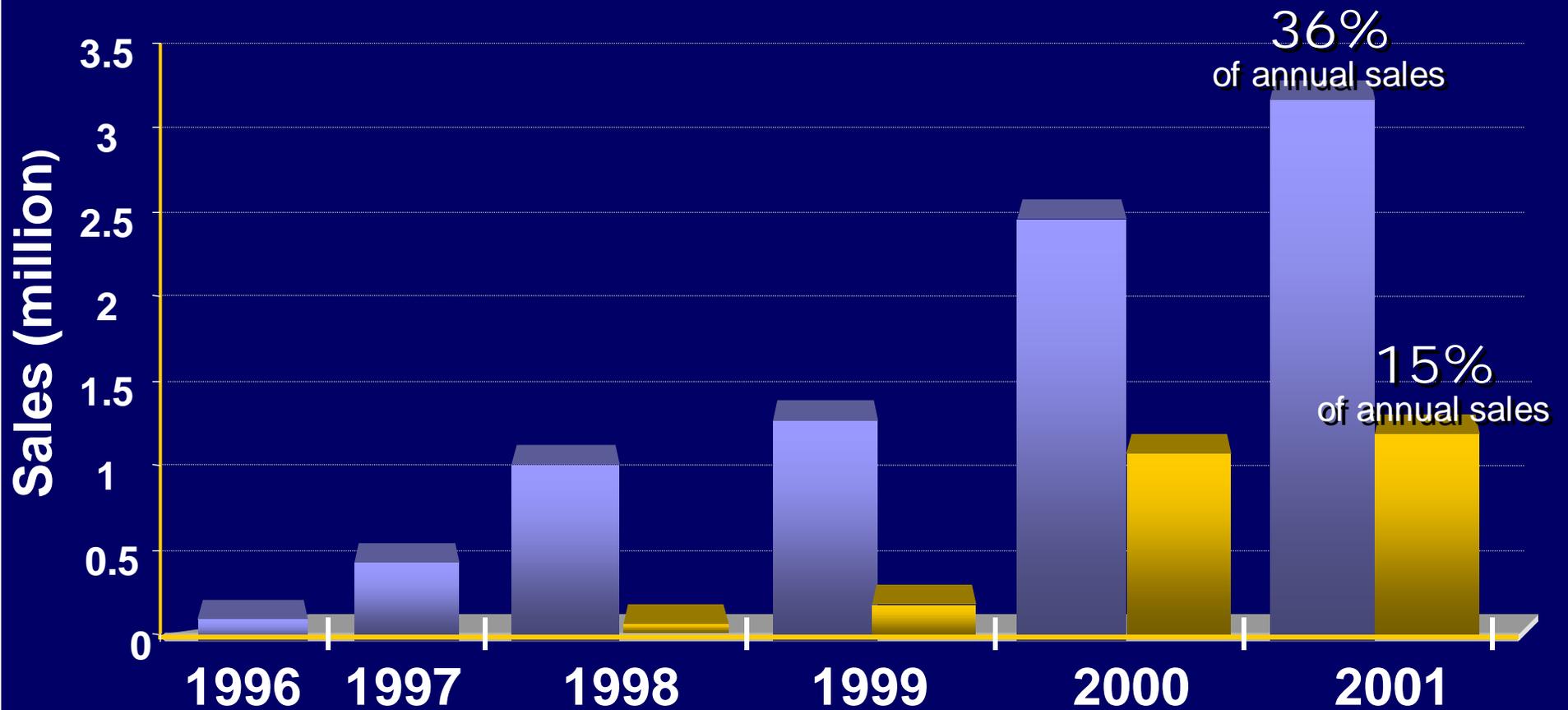


2001 Saturn L200 with Curtain

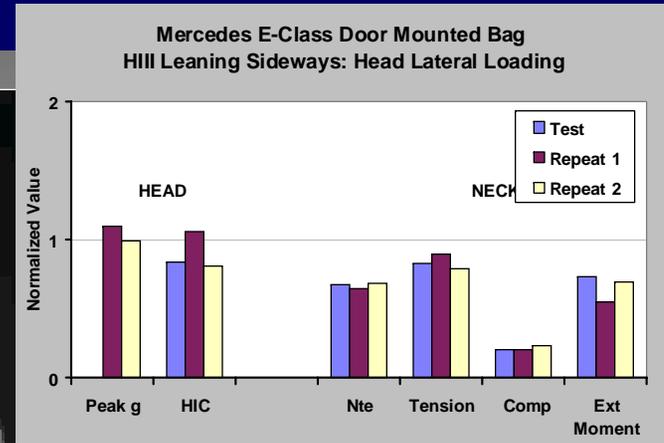
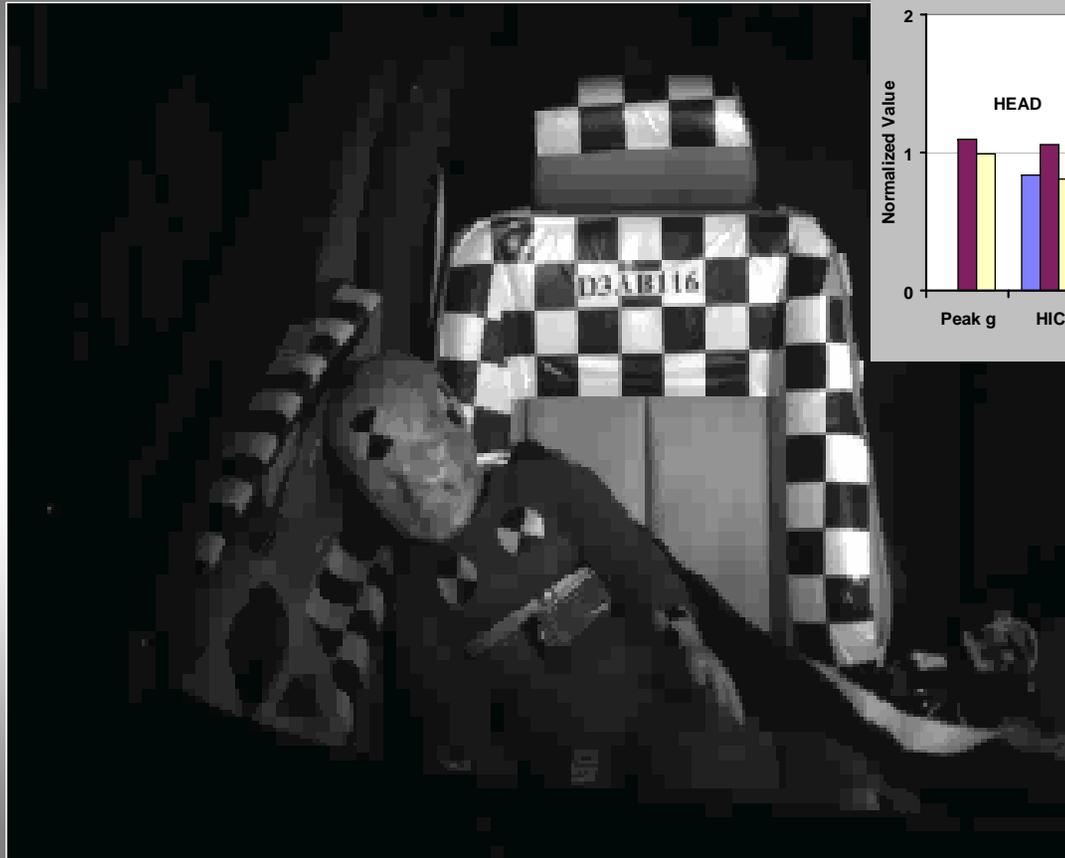
Fleet Penetration of SABs

Front Seat Side Air Bags

Cars LTVs



Early Assessment of Side Air Bag Risks



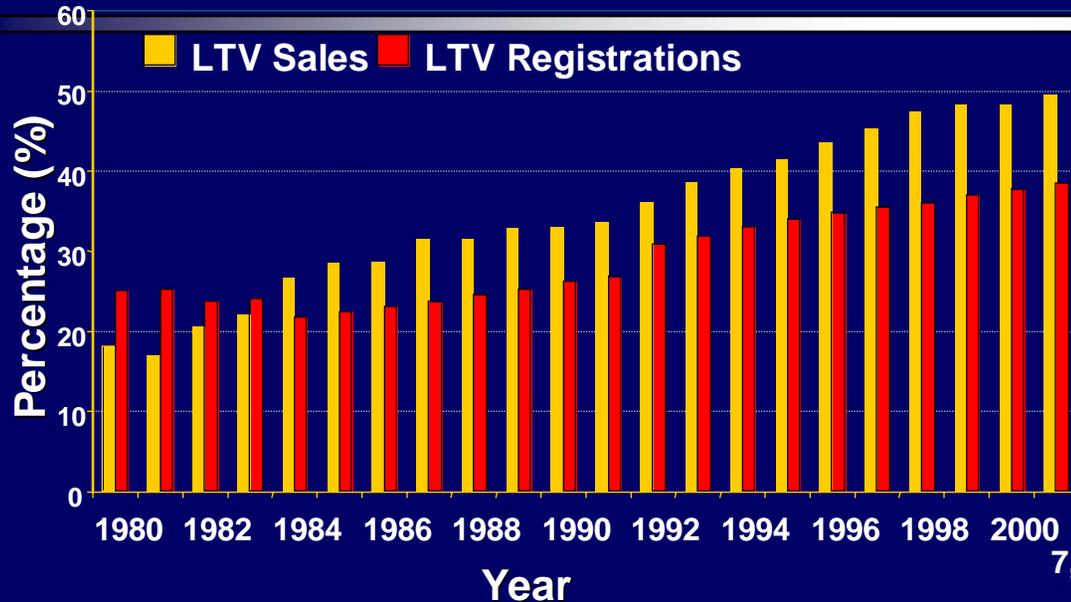


Vehicle Compatibility



Compatibility Problem

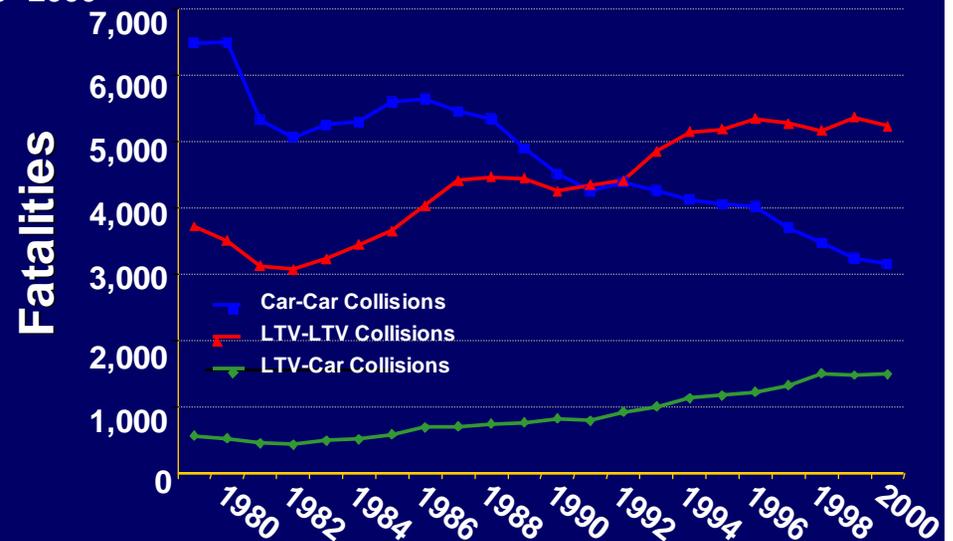
U.S. Sales and Registrations of Light Trucks and Vans



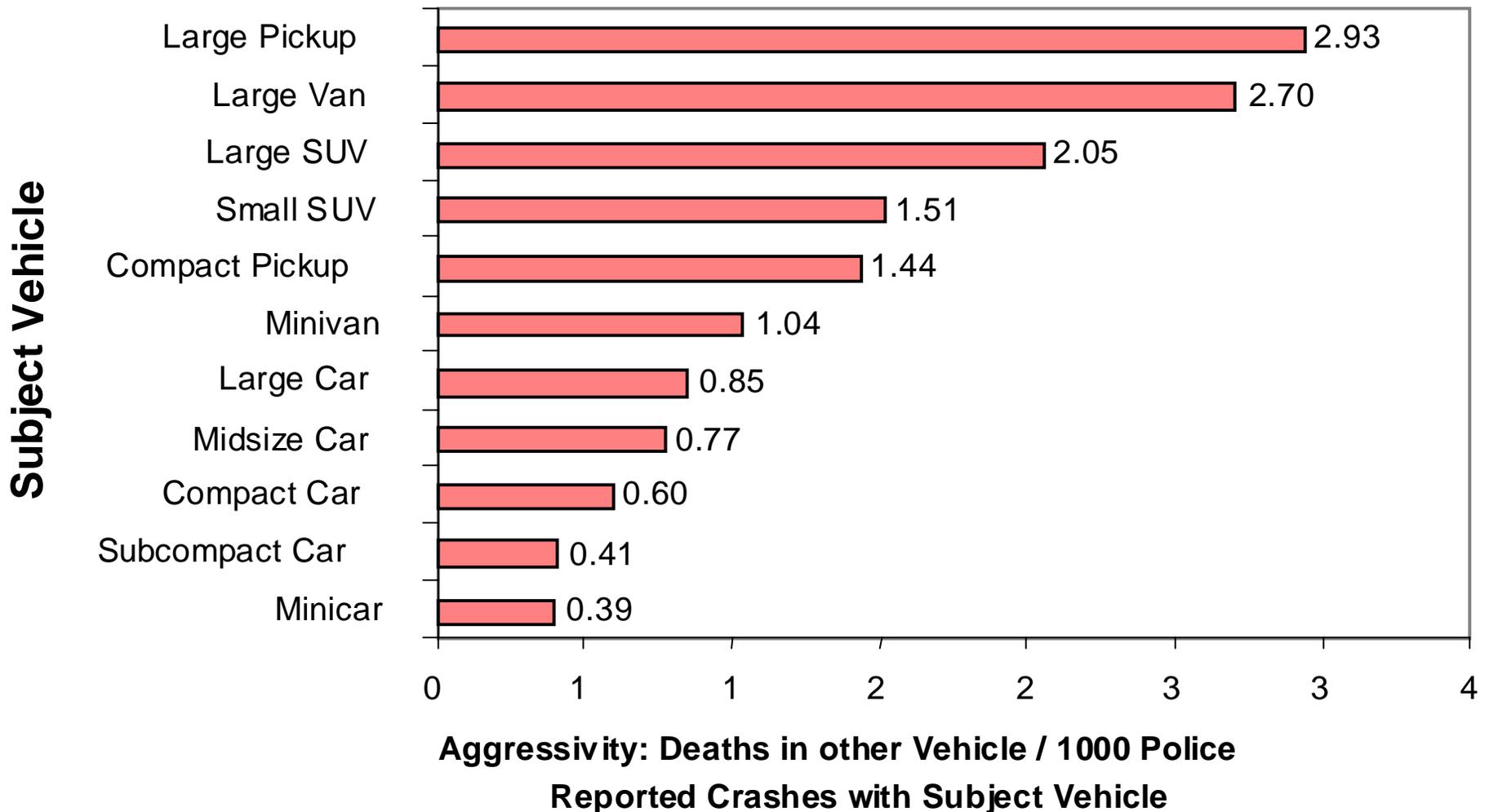
US LTV sales have leveled off at just under 50%

Car – LTV fatalities appear to have leveled off just above 6,000 annually

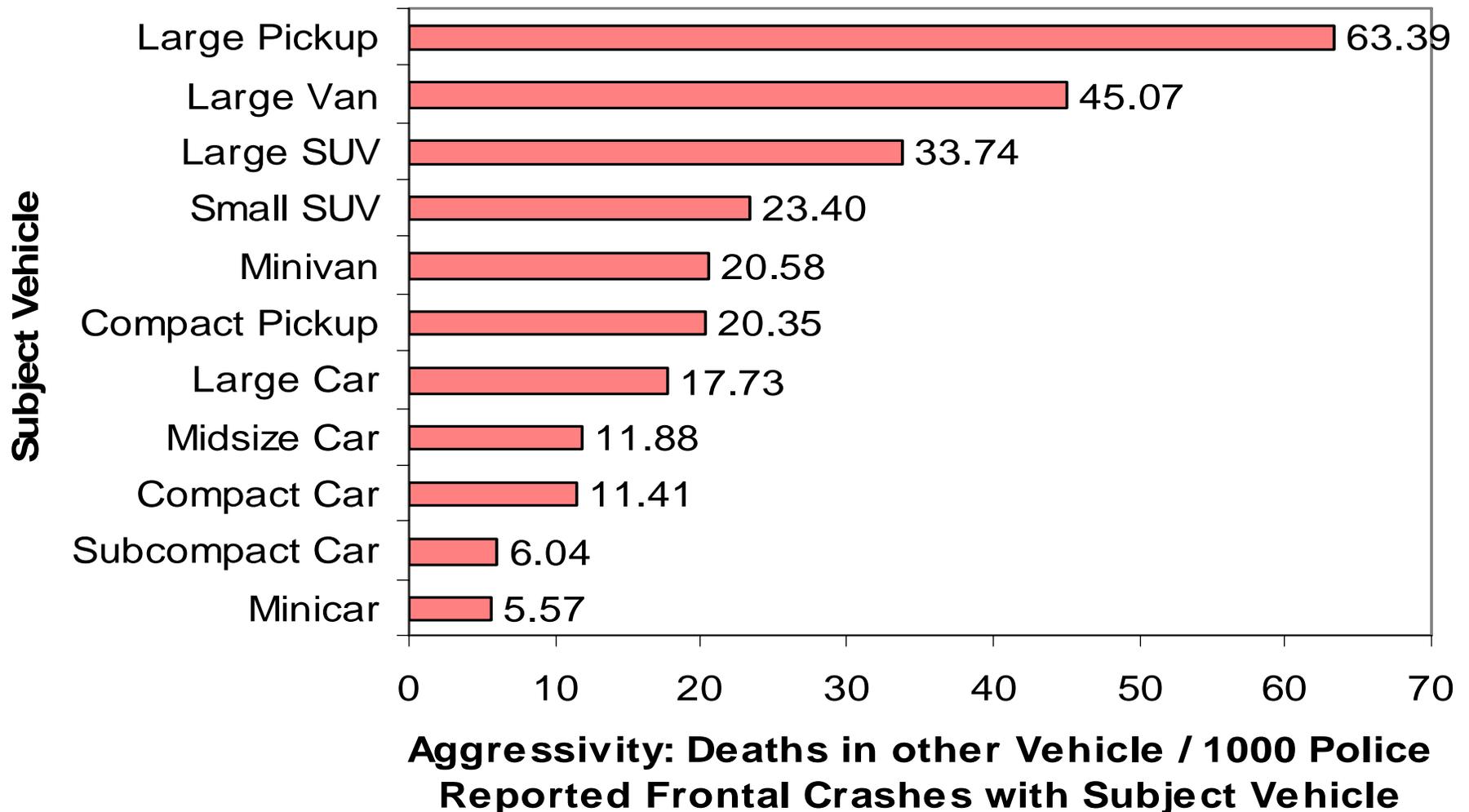
Fatalities in Vehicle-to-Vehicle Collisions



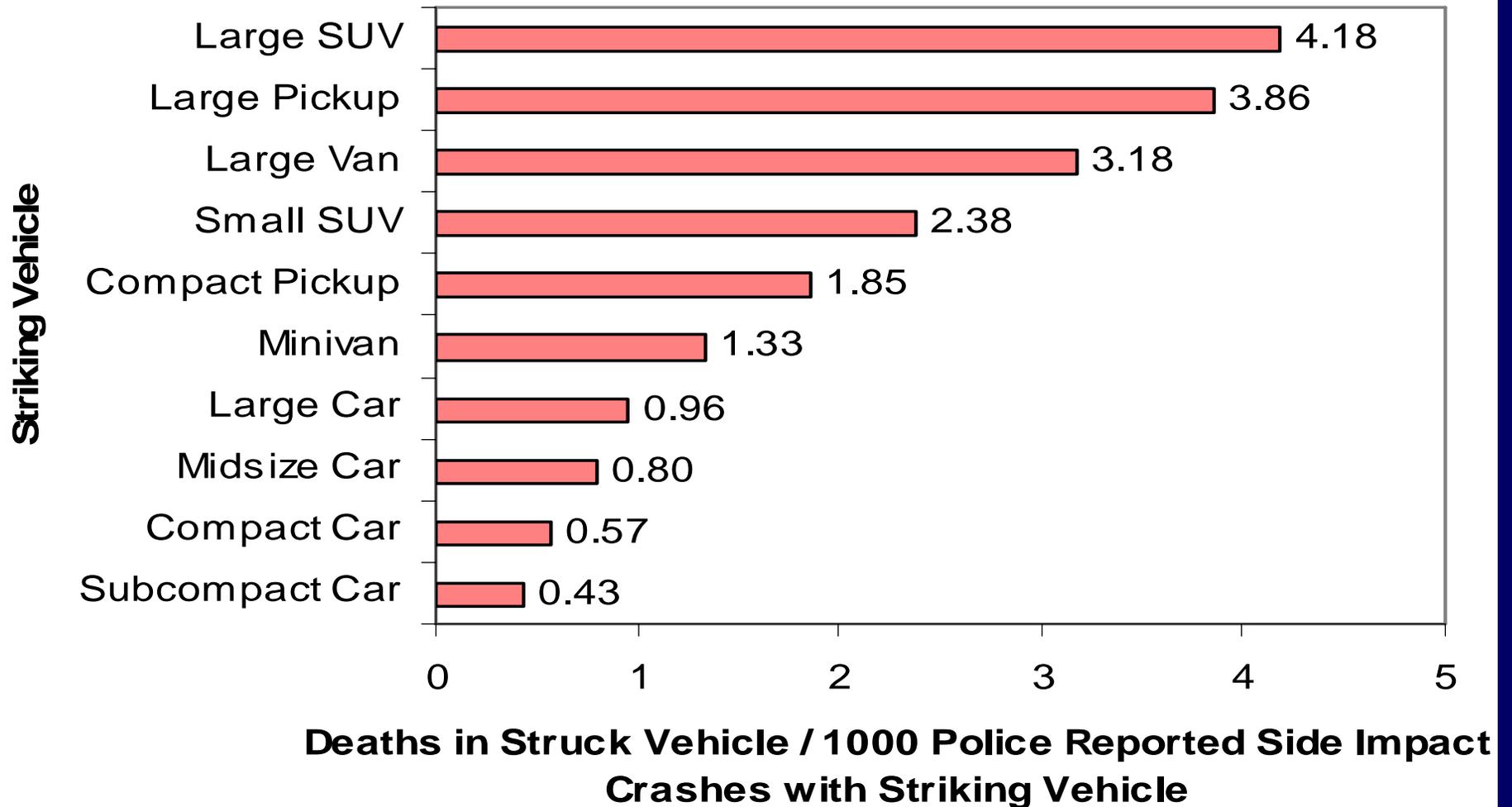
Aggressivity Metrics for Vehicle-to-Vehicle Crashes



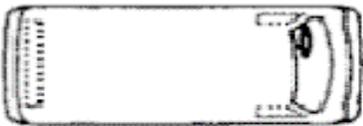
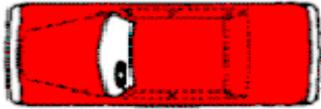
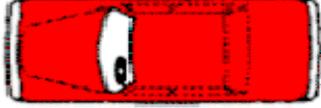
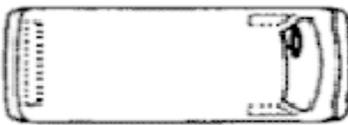
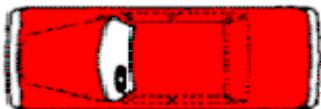
Aggressivity Metrics for Front-Front Crashes



Aggressivity Metrics for Side Impact Crashes



Driver Fatality Ratios for Frontal-Frontal LTV-to-Car Crashes

Large Van			1:8.5
Large Pickup			1:7.9
Sport Utility Vehicle (all)			1:4.5
Minivan			1:3.6
Compact Pickup			1:2.1

1995-2001 FARS, Driver Fatality Ratios Both Vehicles MY \geq 1990

Driver Fatality Ratios for Side Impact Crashes into Passenger Cars

Large
Pickup



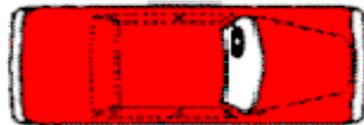
1:39.1

Sport Utility
Vehicle (all)



1:22.1

Passenger
Car

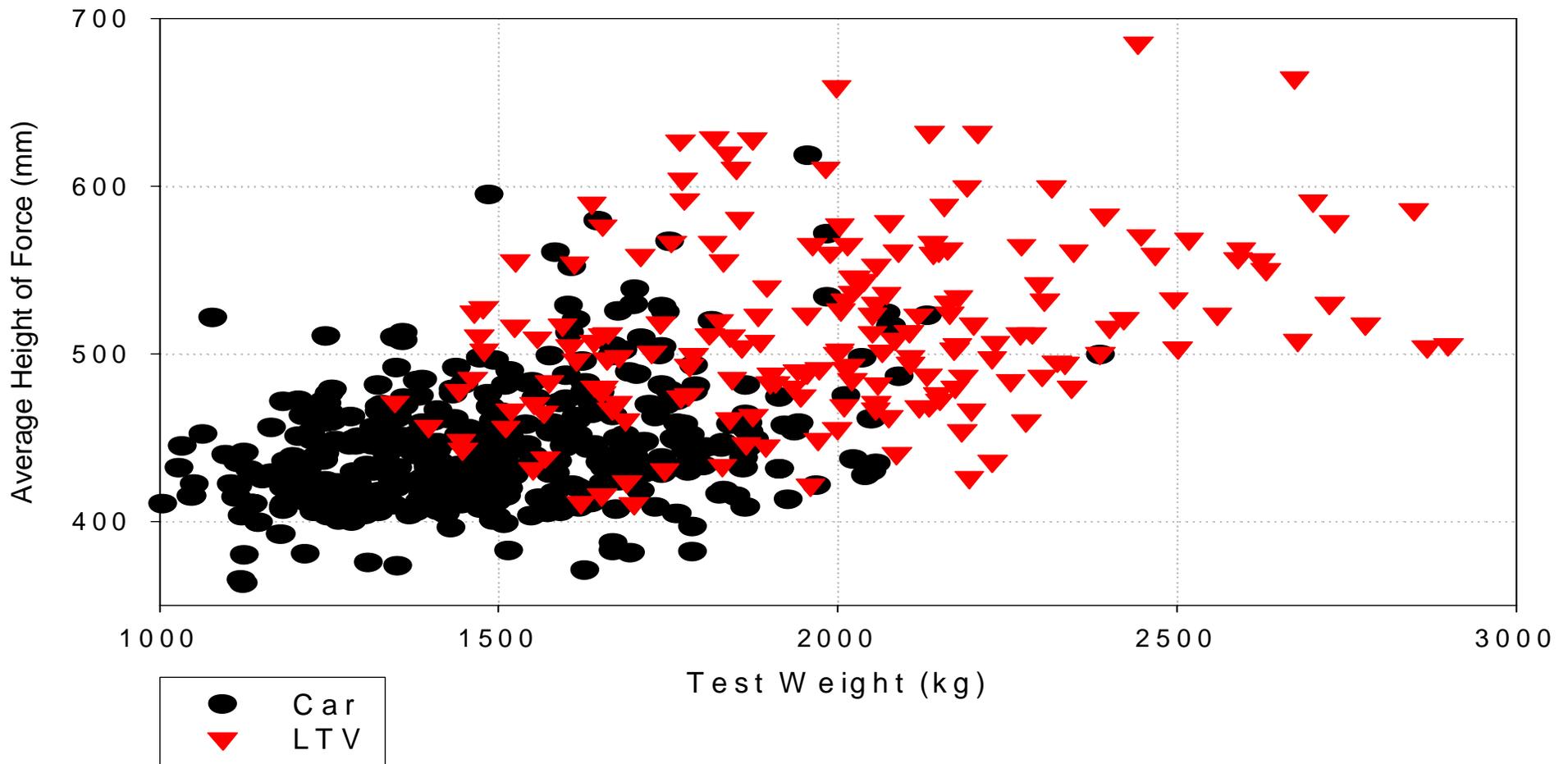


1:8.2

1995-2001 FARS, Driver Fatality Ratios Both Vehicles MY \geq 1990

Average Height of Force for 1982-2002 NCAP Tests

Distribution of NCAP Test Results
Test Data 1982 to 2002

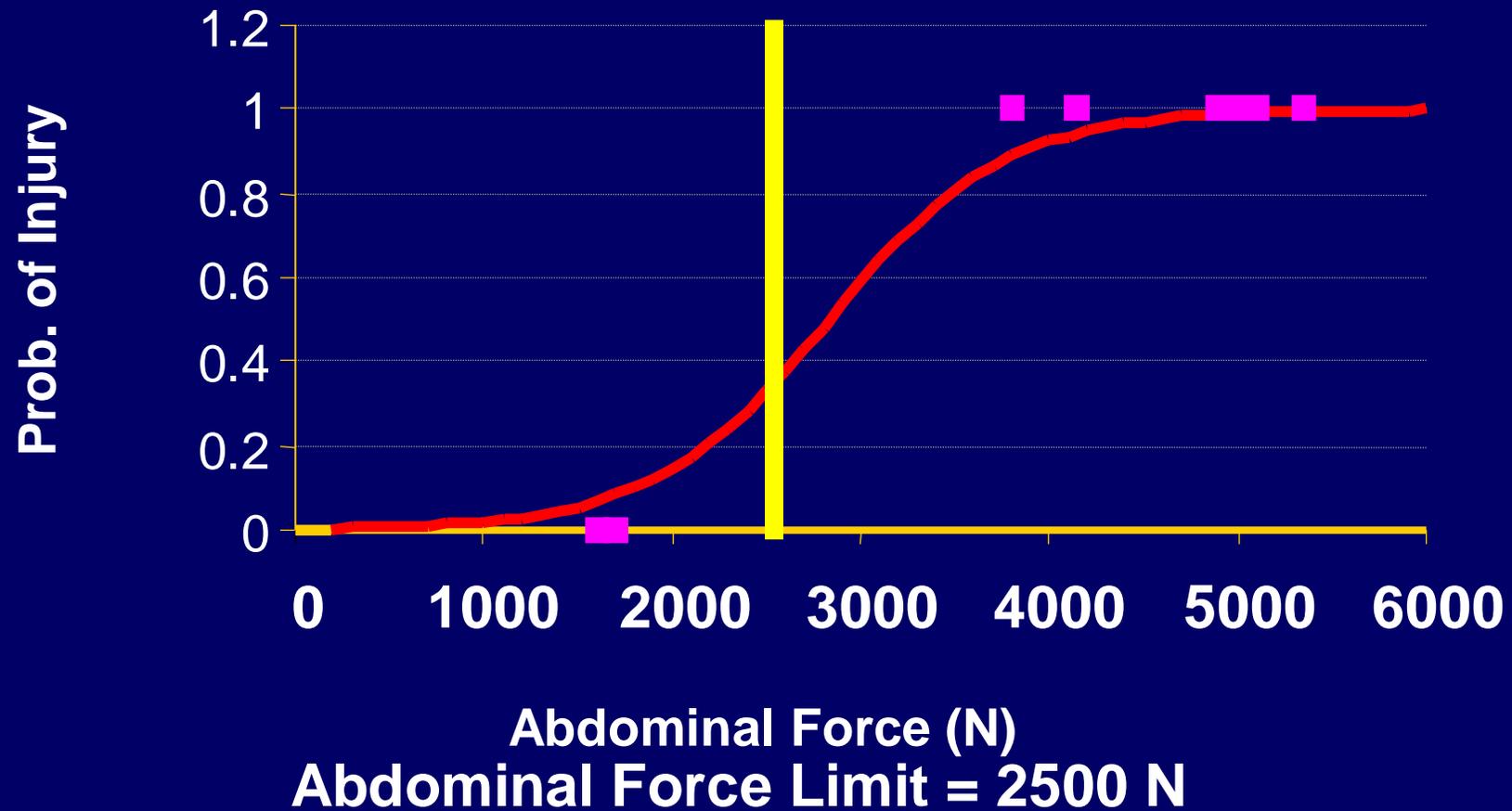


Biomechanics Research

- **Impact Injury Research**
- **Injury Criteria Development**
- **Dummy Development**
- **Federalization of Dummies**

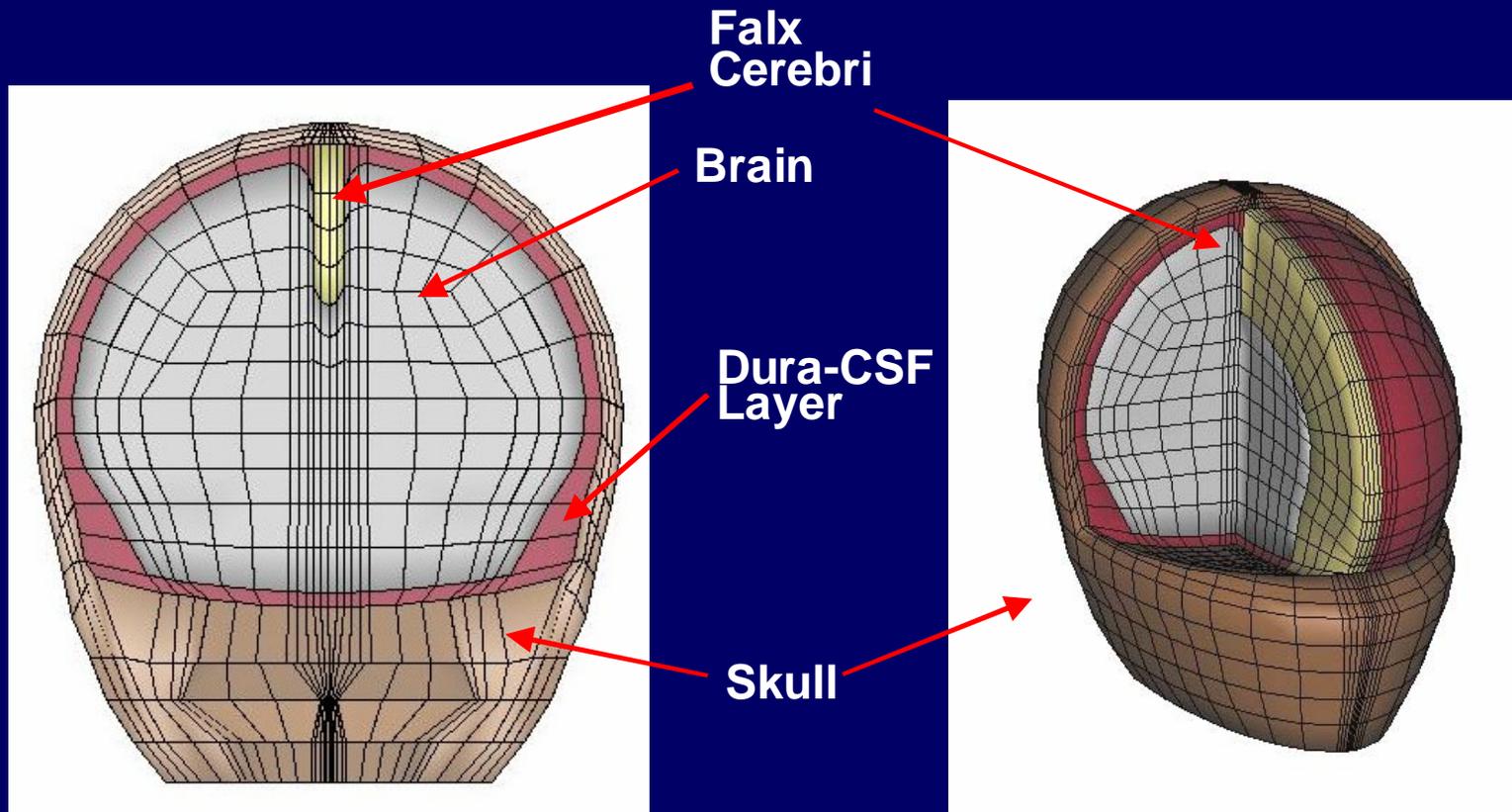
Sample Injury Curve

Probability of Abdominal Injury Vs.
Abdominal Force



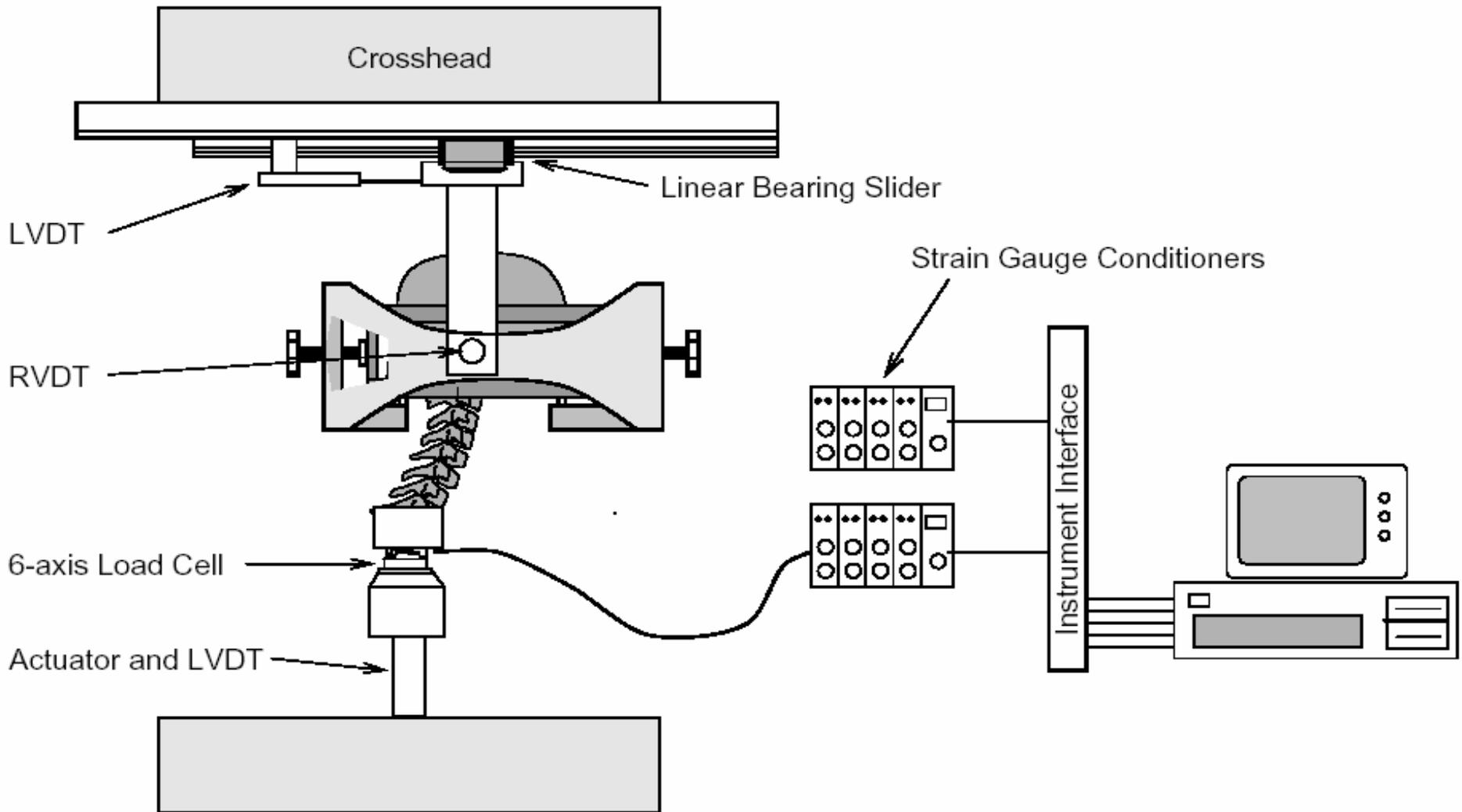
Head Injury Research

SIMon Finite Element Human Head Model



~ 3900 deformable solid elements (brain, falx, and dura-CSF layer)
76 beam elements to simulate the parasagittal bridging veins (not shown)

Neck Injury Research Neck Tension Test Apparatus



Thor-Lx: 50th Male Leg (Released to Public Domain)

- Can retrofit to Hybrid III at knee for near-term Agency use
- Monitors tibia forces and foot/ankle injury potential due to local structural deformation
- In use by Ford, Honda, etc.
- Thor-Lx ANPRM issued 2002; received substantial industry support
- Thor-Lx NPRM was prepared Jan 2003; action on hold



THOR Advanced Frontal ATD (Released to Public Domain)

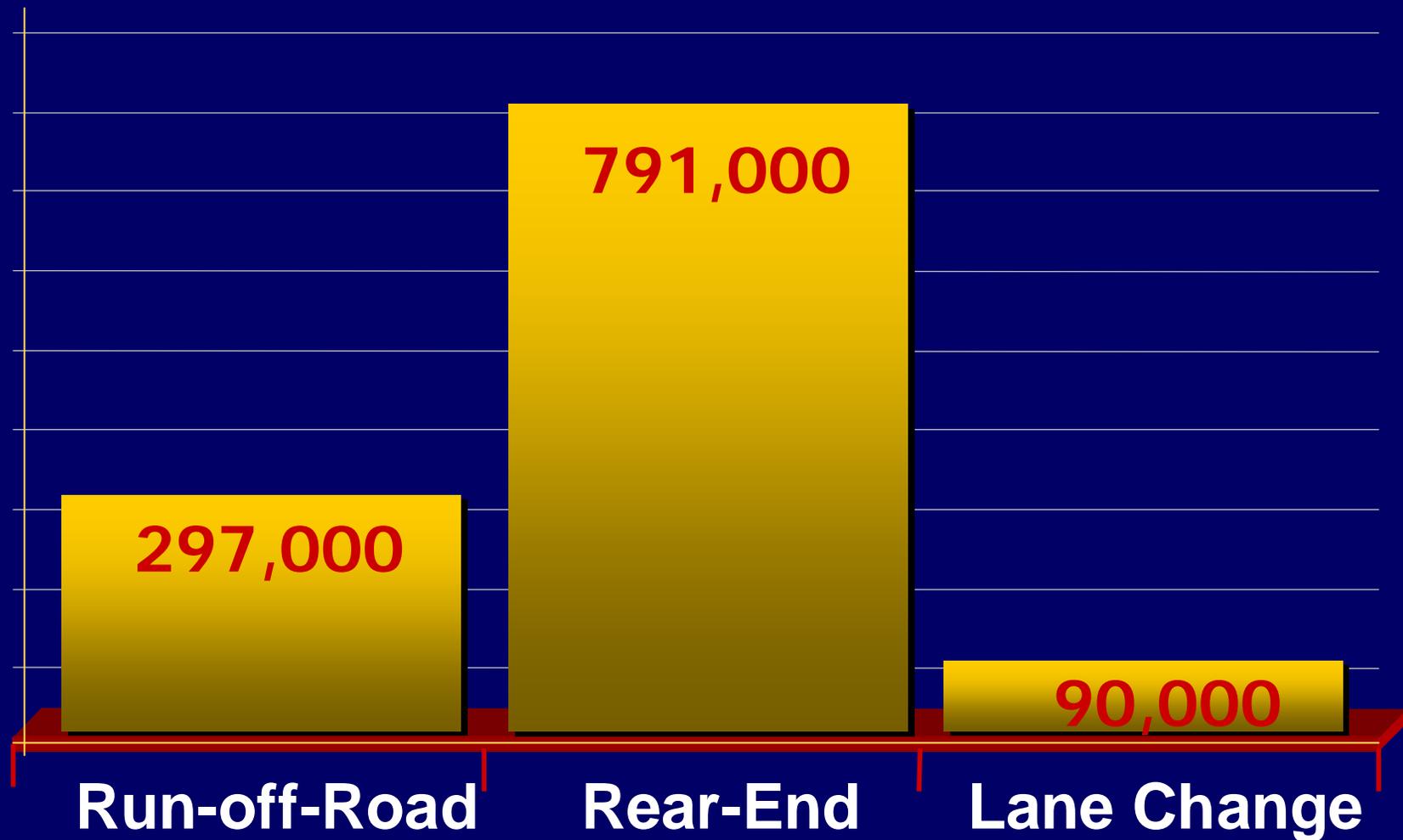


- **NTBRC- developed next-generation frontal dummy; Hybrid III dates to 1977**
- **Significantly improved regional biofidelity and injury assessment capabilities**
- **Potential application to FMVSS 201, 202, 207, 208, 210, 213, 214, & 218**
- **Thor head/ neck and leg components offer near-term benefits for regulatory use**

Family of Dummies



Estimated Benefits Crashes Prevented



Enhancing Safety

Conclusions

- **Advanced Technologies is the Answer**
- **Treat Vehicle/Driver/Environment as Total System**
 - Need Constant Communications Among All Components
- **Society Must Accept Some Control by Vehicle**
- **Proper Testing and Evaluation Procedures Needed**
- **Facilitate Deployment Through a Variety of Methods**
 - Establish Regulations and Test Requirements
 - Demonstrate Feasibility
 - Pursue Collaborative Research
 - Seek Novel Methods of Standards Development
 - Disseminate Consumer Information on Total Safety
 - Evaluate Consumer Acceptance

Rulemaking

- Rules based on Identified Needs
- Proposed and Final Rules
 - Comments Process
 - Petitions for Reconsideration
- Regulatory Evaluation
- DOT & OMB Review

Analysis of the Problem

- **Police Reported Crashes**
- **Causal Factors**
- **Aggressiveness metric**
- **Fatality Risks in Incompatible Vehicle Crashes**
- **Alcohol Related Crashes**
- **Seat belt use and Safety**

Safety Research

- **Crash Avoidance Research**
- **Lighting, Brakes, Handling & Stability**
- **Intelligent Technologies**
- **Tire Research**
- **Human Factors Research**

Rollover Research



Technical Highlight:

Programmable Steering Machine

- Provides accurate and repeatable inputs
 - Important for NCAP testing
- Able to receive outputs from other sensors
 - Roll Velocity
 - Vehicle Speed

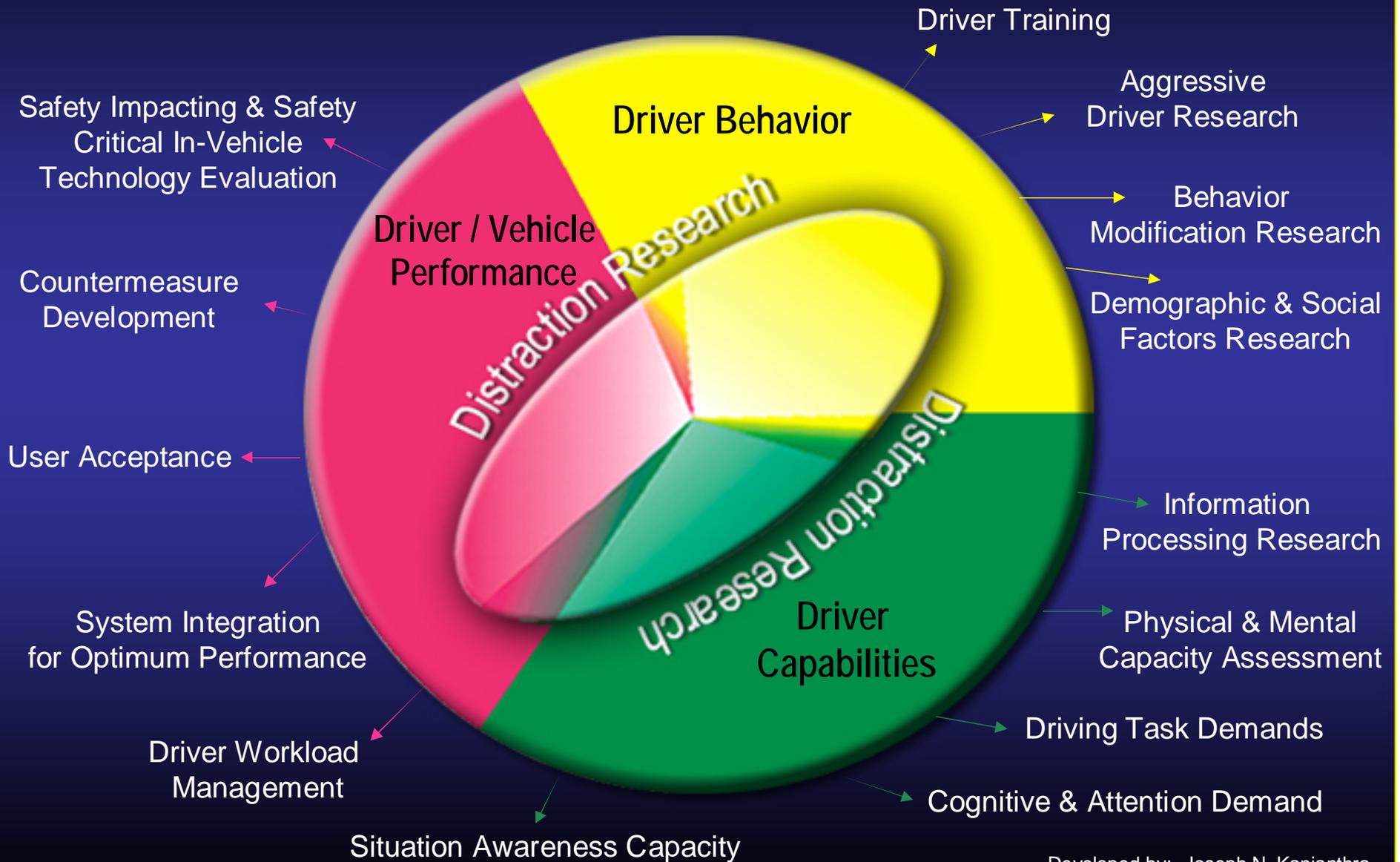


Example:

Fishhook Maneuver Effectiveness



Driver Vehicle Safety Research



Solving Problems

Human

Vehicle

Environment

Pre-Event



Event



Post-Event



Road Ahead for Safety

- **The Safety Need**
- **The New Paradigm**
- **Passive and Active Safety**
- **Near-term Technologies**
- **Advanced Technologies**
- **Available Strategies**
 - Demonstrate Feasibility
 - Collaborative Research
 - Consumer Information
 - Market Pull

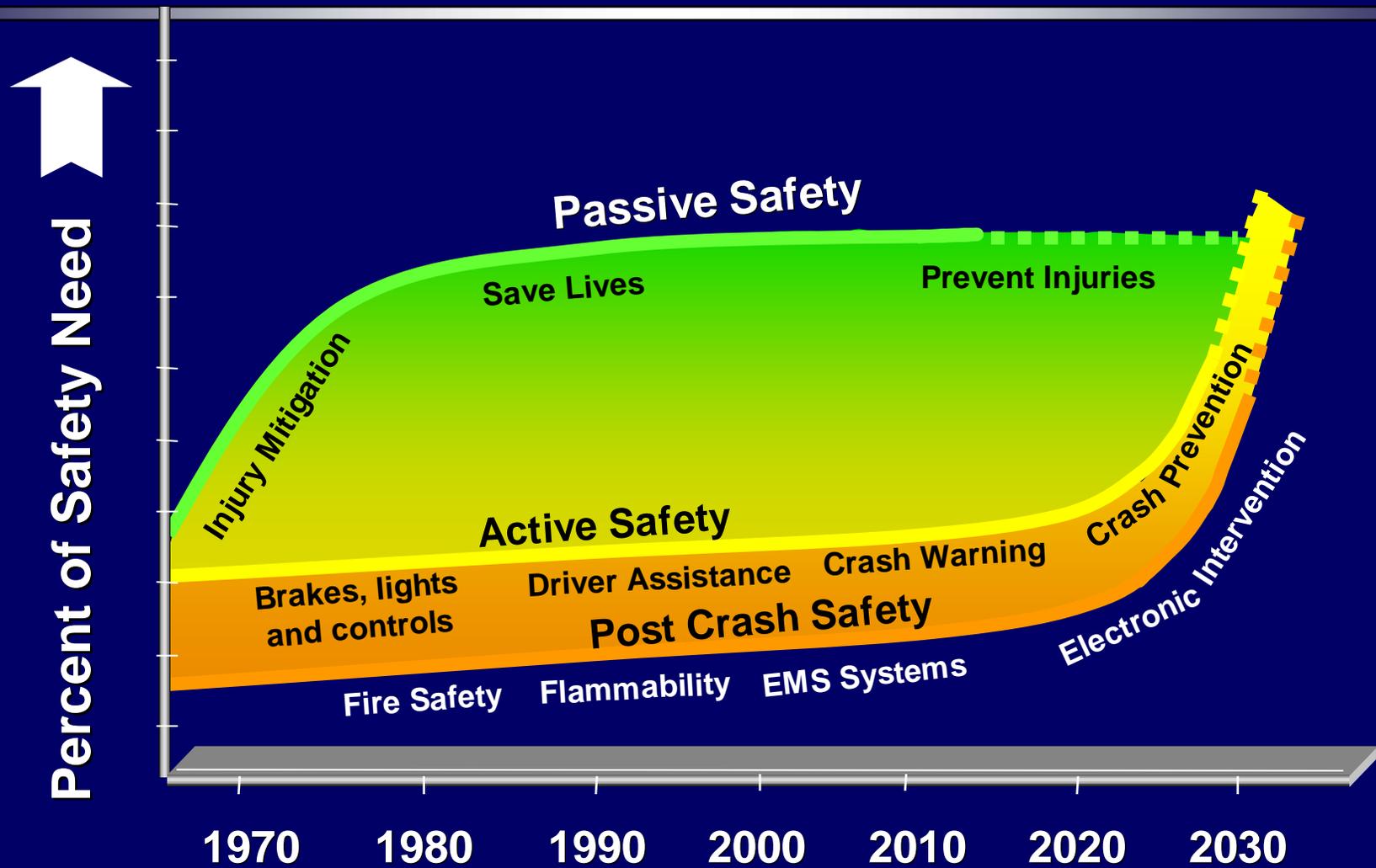
Special Crash Investigation Case Selection Criteria

- **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.**

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

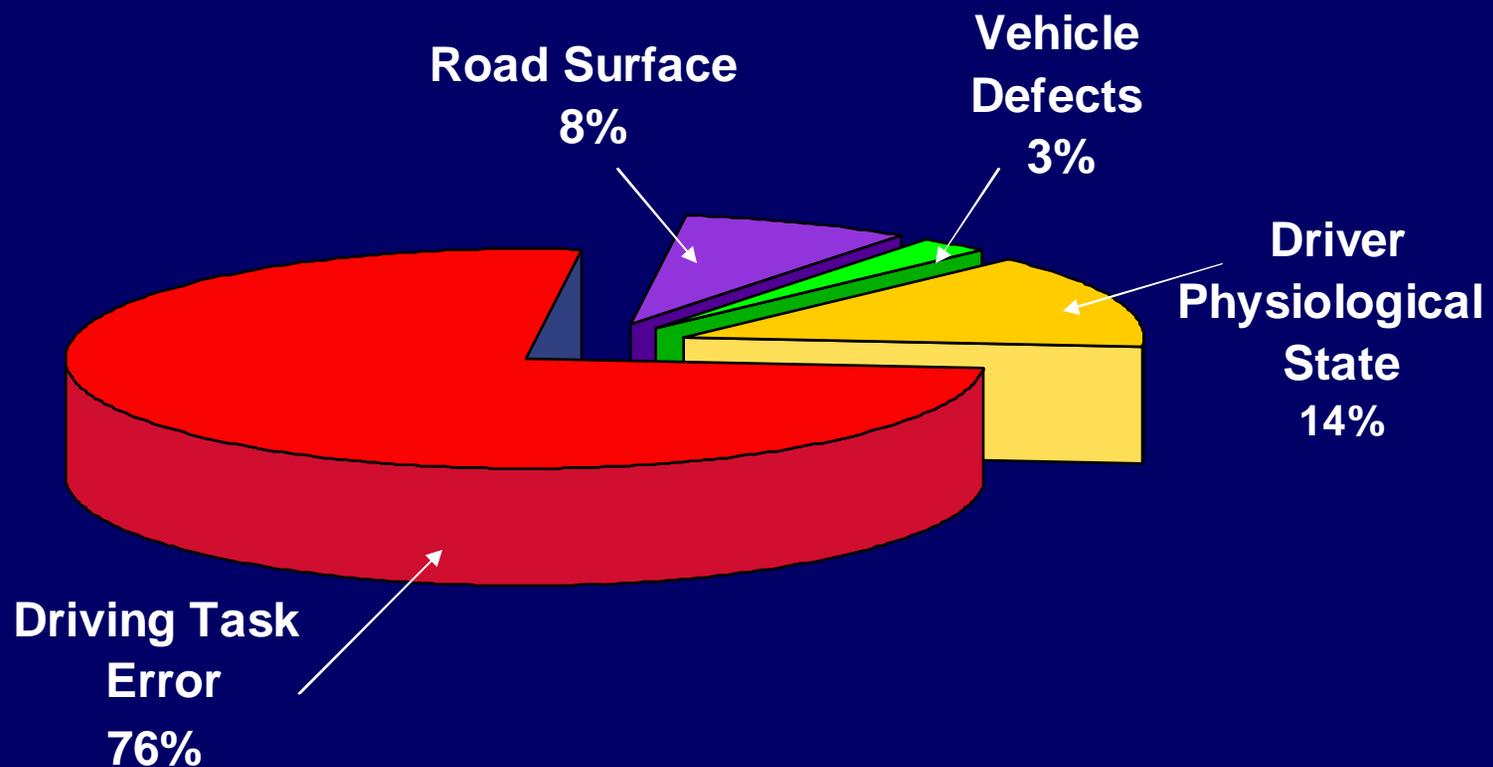
- **Side Impact Conditions - 43**
 - Drivers 31
 - Passenger 12
- **Other conditions where Side airbag Deployed - 7**
- **Rollover - 5**

The Safety Need

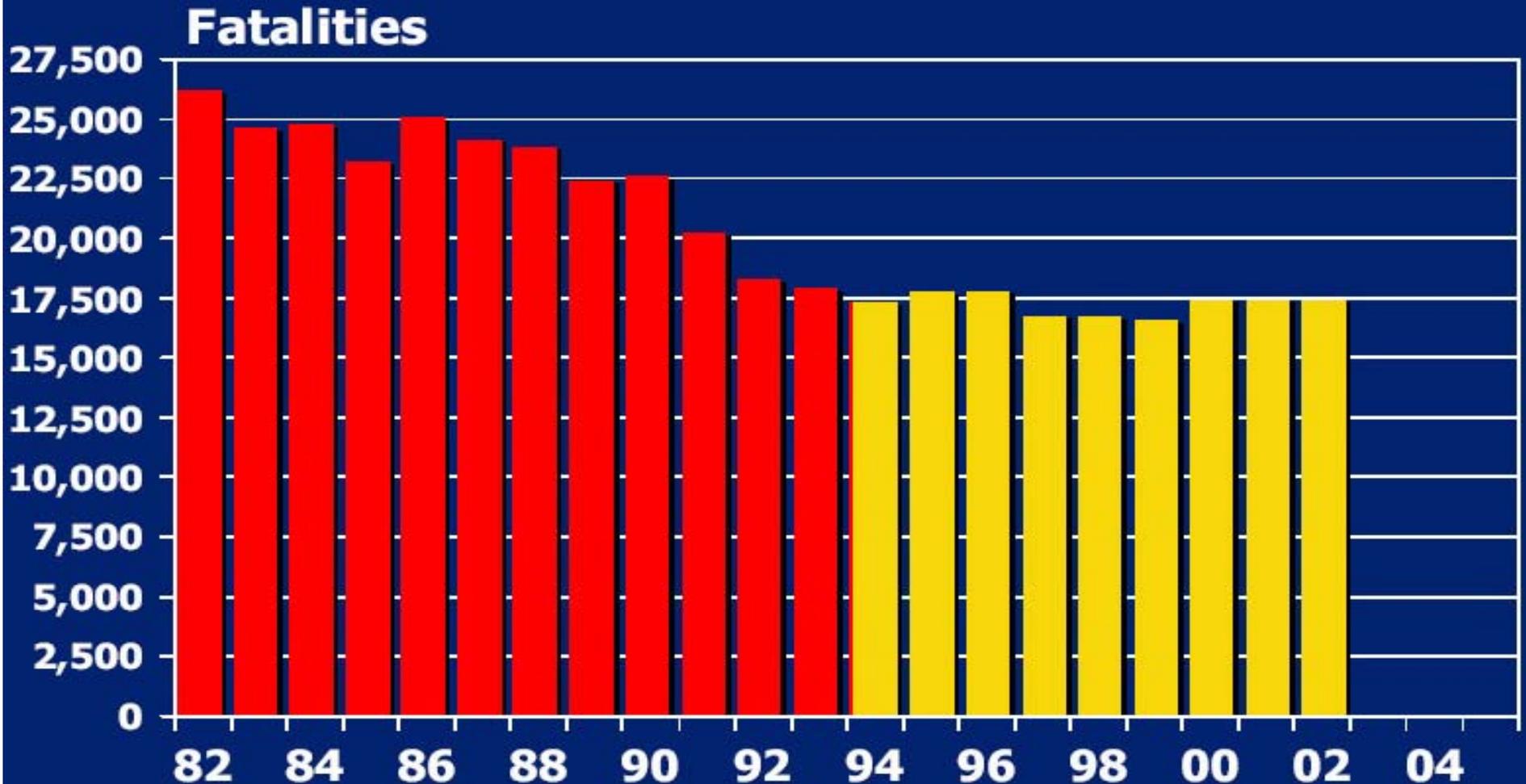


The Safety Problem

Causal Factor Distribution

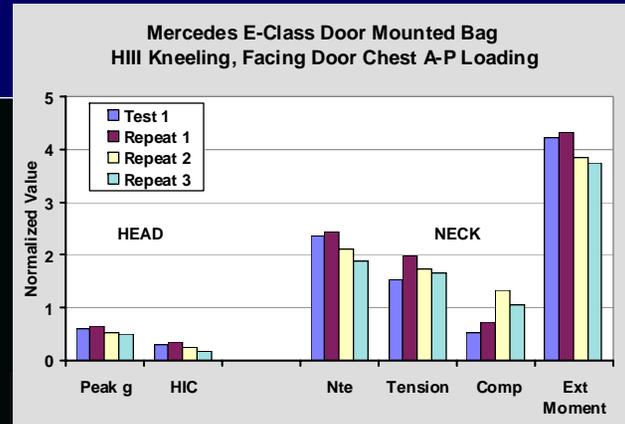
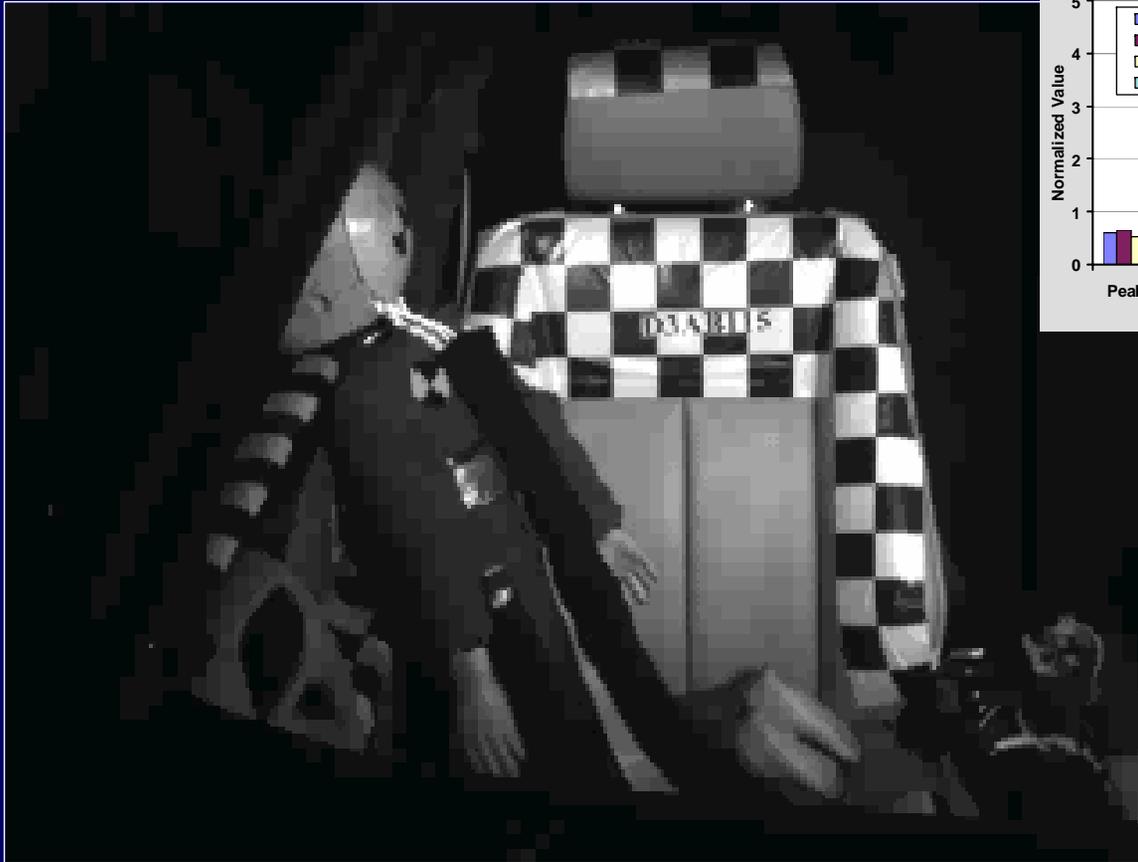


Number of Alcohol-Related Fatalities



Source: FARS

Early Assessment of Side Air Bag Risks



Overview

- **Background**
- **Why ACN?**
- **Field Operational Test and Data Collection**
- **System Performance**
- **Institutional and Operational Issues**
- **Benefits Estimate**
- **Conclusions**

30% of Deaths

Occur Within Minutes of Crash



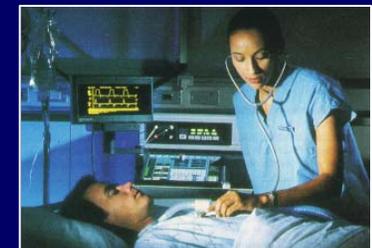
50% of Deaths

Occur Prior to Arrival at Hospital



70% of Deaths

Occur Within 2 Hours of Crash



Why ACN?

- **1999 FARS data – 41,611 fatalities**
 - Nearly 20,000 die without receiving hospital care
- **1999 NASS data – 3,236,000 injured persons**
- **Annual costs of crash injuries – over \$ 100 billion**
- **Uncertainty of crash location delays EMS delivery**

Field Operation Test & Data Collection

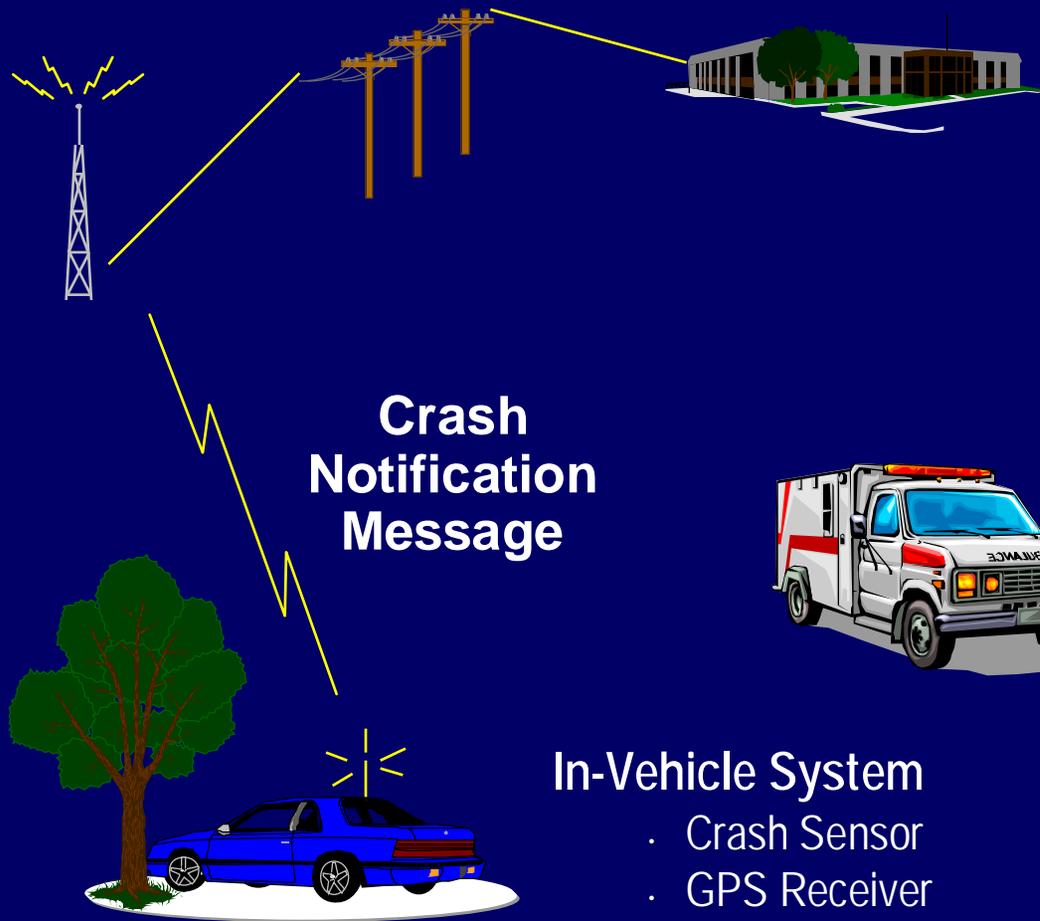
- **Data collection efforts**
 - Baseline EMS response times
 - ACN Response time
- **Crash severity estimates**
 - Allows decision whether EMS response is required
 - Allows delivery of appropriate response
- **Injury probability estimation**



Automatic Collision Notification

- **What is ACN**
 - An in-vehicle system
 - Uses crash sensors, GPS receivers and communication devices
- **Goal of ACN**
 - Reduce response time for EMS delivery
 - Provide necessary information for improvement in service quality
- **System Capabilities Essential**
 - Determine crash has occurred
 - Notify vehicle and crash location
 - Provide vital information about the crash
 - Establish communication link between vehicle and PSAP
 - Do all of the above automatically

Example ACN System



**Crash
Notification
Message**

In-Vehicle System

- Crash Sensor
- GPS Receiver
- Cellular Phone

Emergency Services Dispatch

- Data Message Reception
- Graphic Display of Crash
- Location & Information
- Voice Contact w/Vehicle

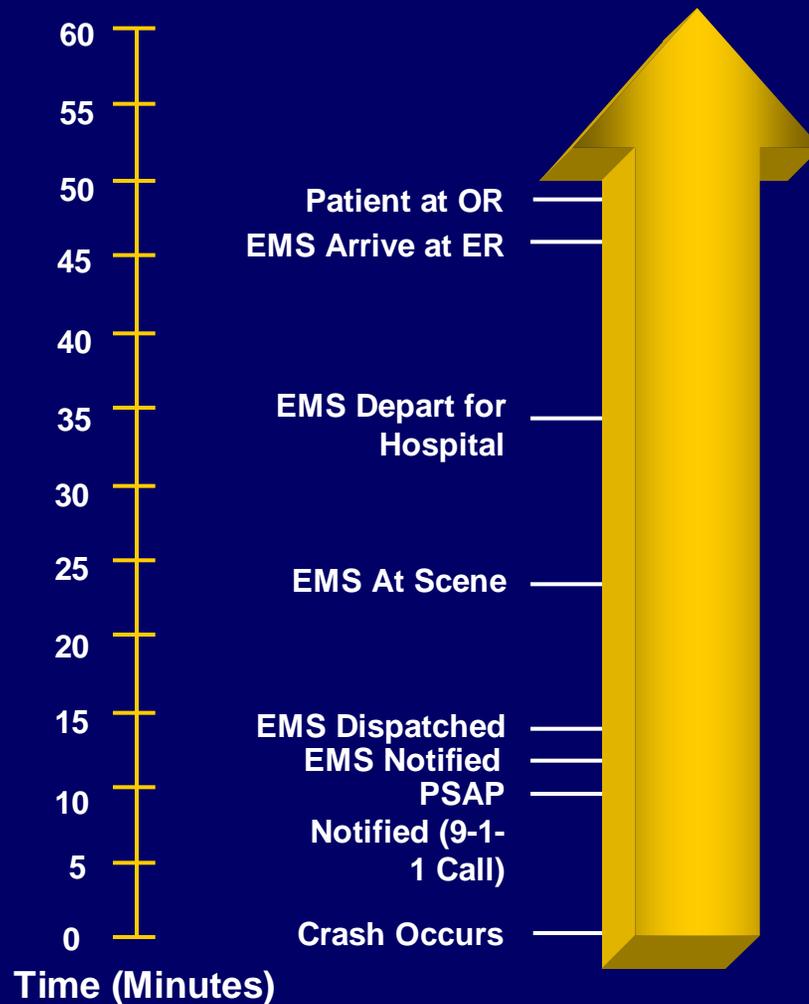


EMS Notification

- Location
- Crash Severity
- Probability of Serious Injury



Typical EMS Response Time Line



DEFINITIONS

- PSAP Notification - Time Appropriate PSAP Notified by 9-1-1 Call
- EMS Notification - Time Appropriate EMS Provider Notified by PSAP
- EMS Dispatch - Time EMS Unit is Dispatched to Crash

ACN 9-1-1 Dispatcher Screen

NHTSA/Calspan Automated Collision Notification System

File View Agencies Locate Incident Help

728

Crash Information

Time of Crash
 Crash Date: 1/31/99
 Crash Time: 4:40:00 PM
 Elapsed Time: 0 days 00:03:53

Impact Details:

Lat/Long: N 42 52' 3.97"/W 78 44' 32.93"
 Position Error: 2.67 m

Final Resting Position:
 Upright

Change in Velocity = 16 mph

728: Erie FIRE DISTRICT: Southline

Communications

Vehicle	Fax	Voice	Call status	Hold	Prerec
Dispatcher					
Cheektowaga Police					
Cheektowaga Fire					
ECMC					
Manual Dial:					
Manual Dial:					

Vehicle Information - 7164401094

Vehicle	Owner	Likely Occupants
Make:		
Model:		
Color:		
Year:		
Plate:		

Incident: 728

Sunday January 31 1999, 4:43:53 PM

Benefit Estimate

(Based on Annual Light vehicle fatalities of 32,000)
Safety Benefits

