Enhancing Motor Vehicle Safety:

Through Research, Regulations and Enforcement

The Children's Hospital of Philadelphia

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Outline

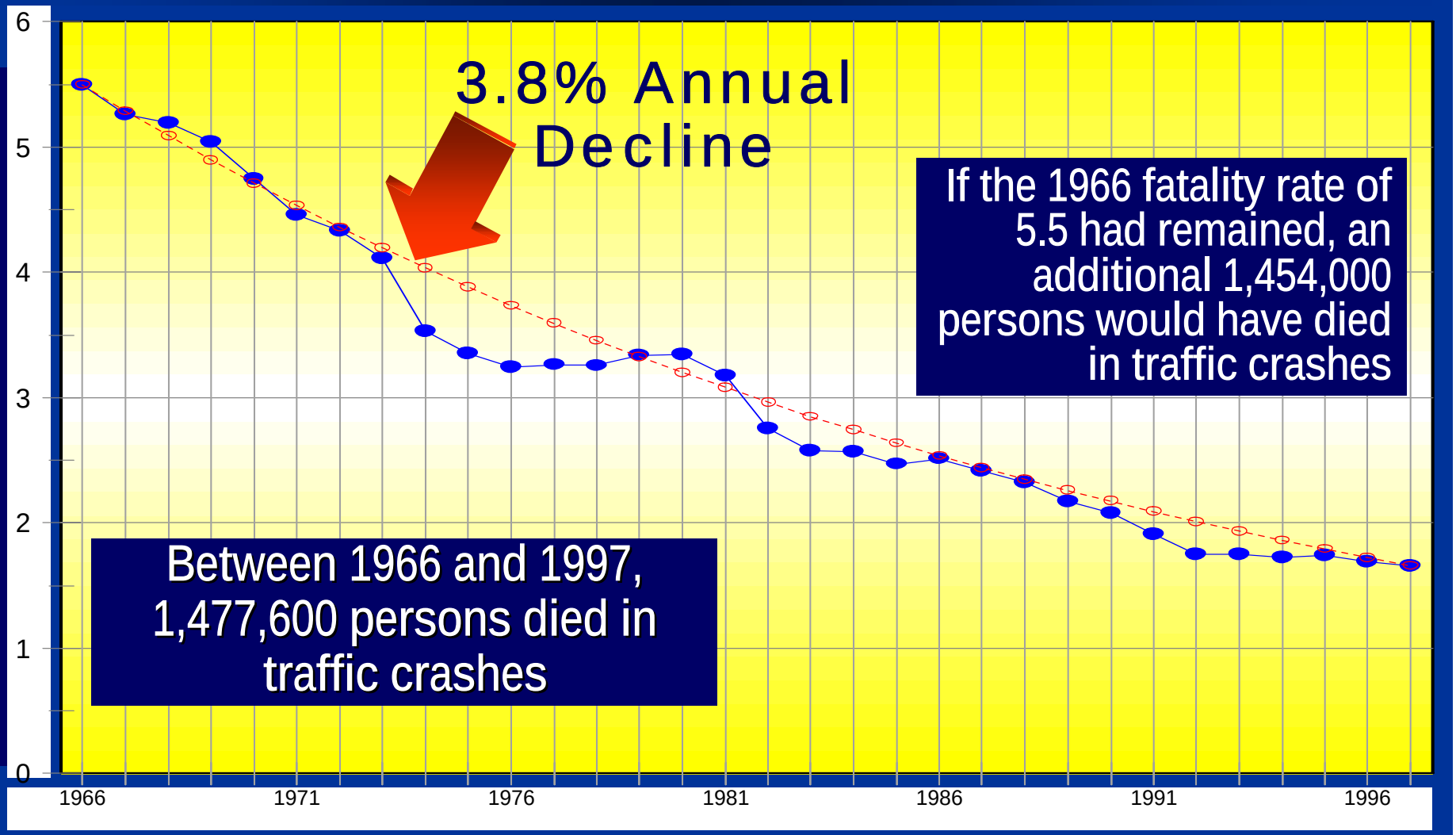
Introduction

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

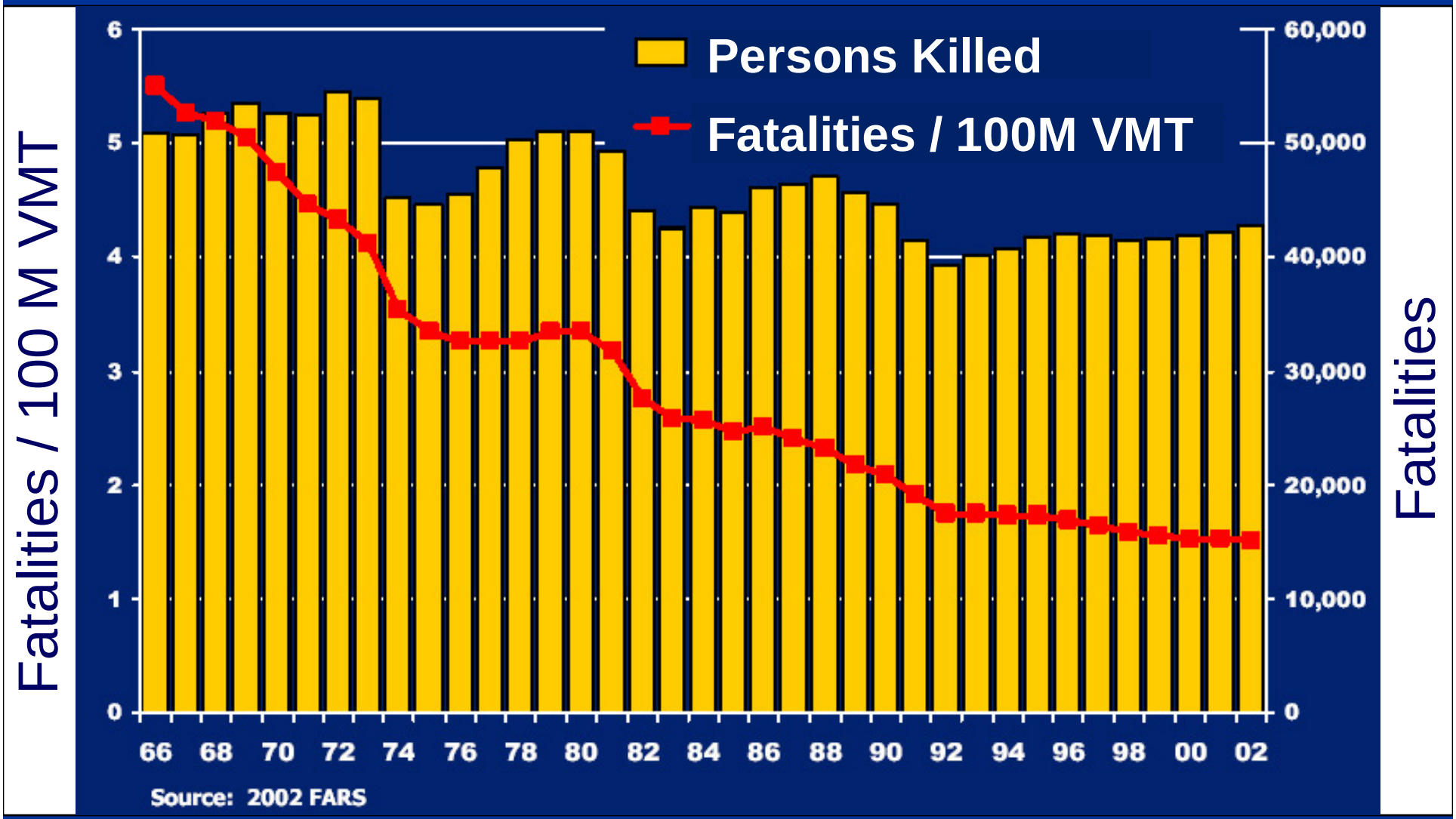
NHTSA Mission

- 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

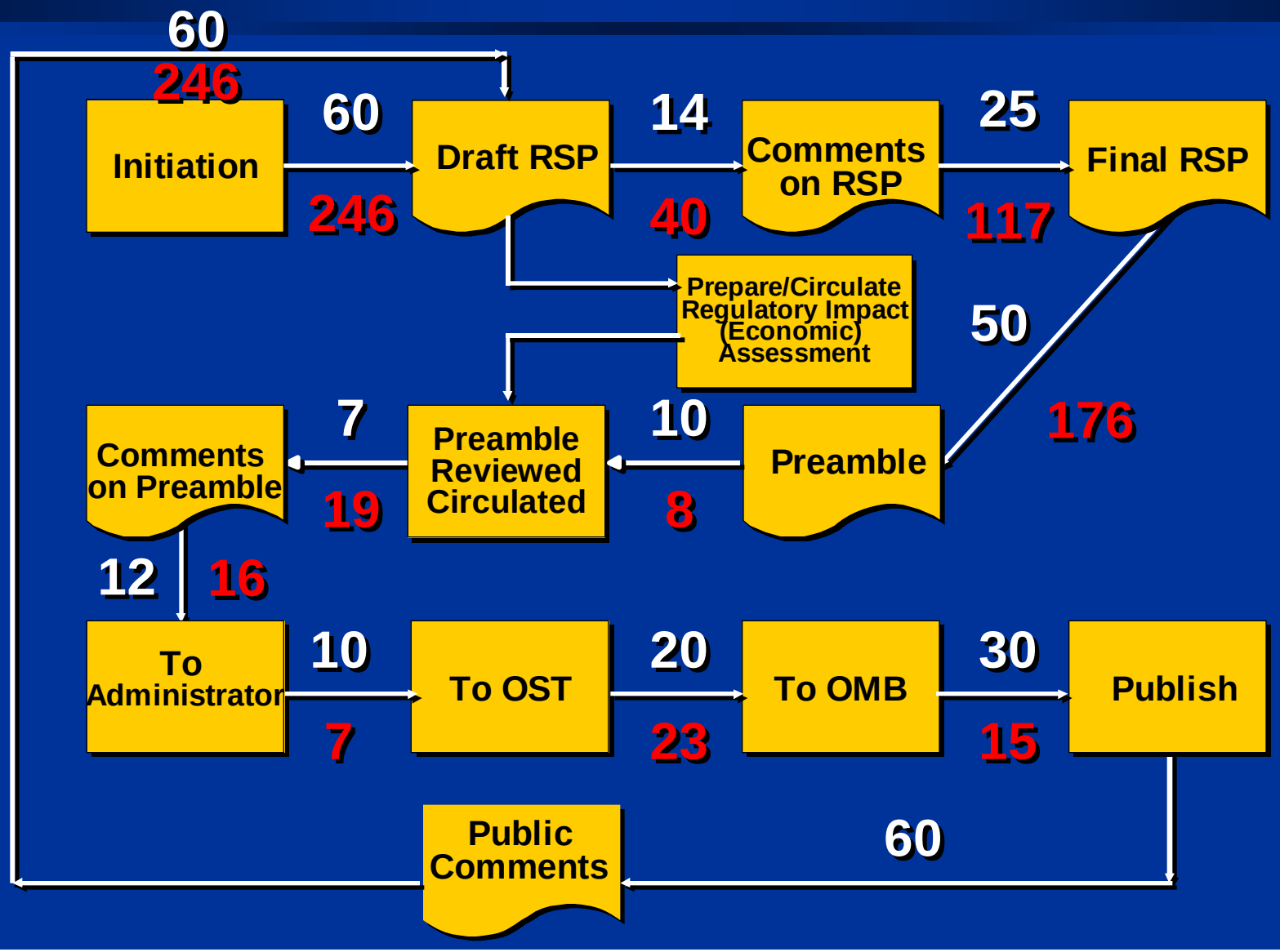


NHTSA Approach to Safety

- Engineering, Enforcement, Education
- Define Safety Need
- Science Based Regulations
- Performance based requirements
- Technically Feasible Solutions
- Establish 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

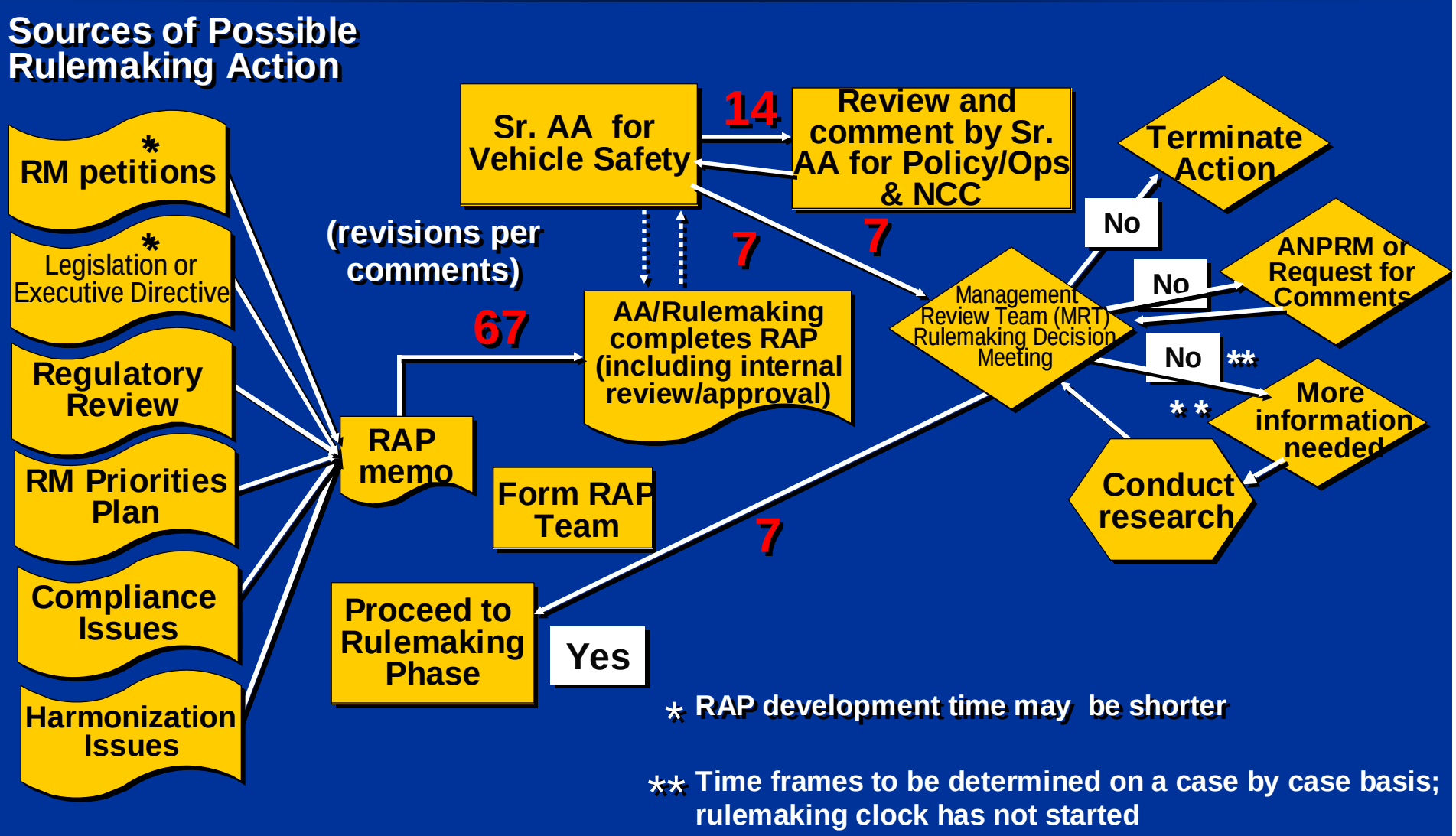
Pre-Rulemaking Phase

- 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

Pre-Rulemaking Phase (Continued)

- 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]

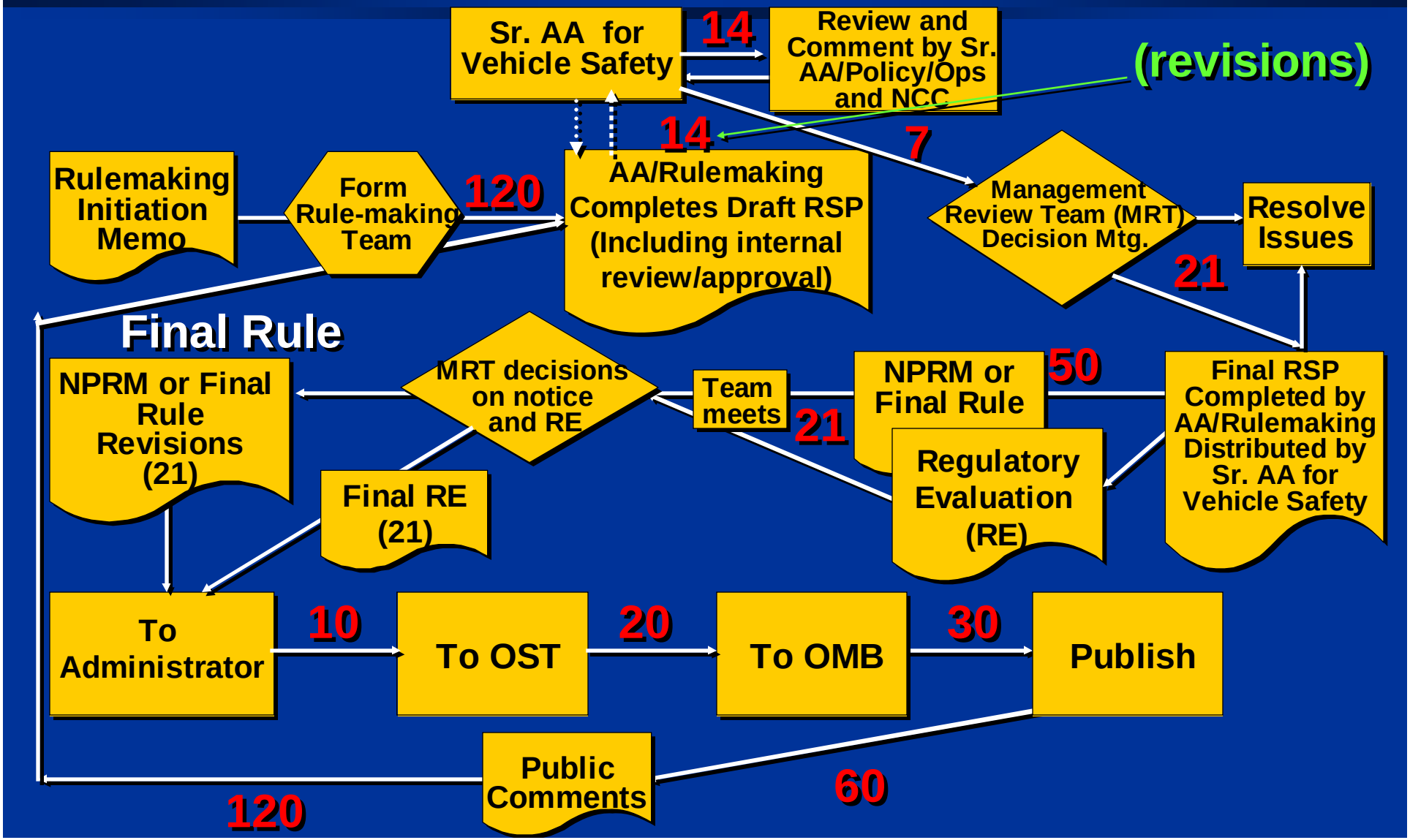


Rulemaking Phase

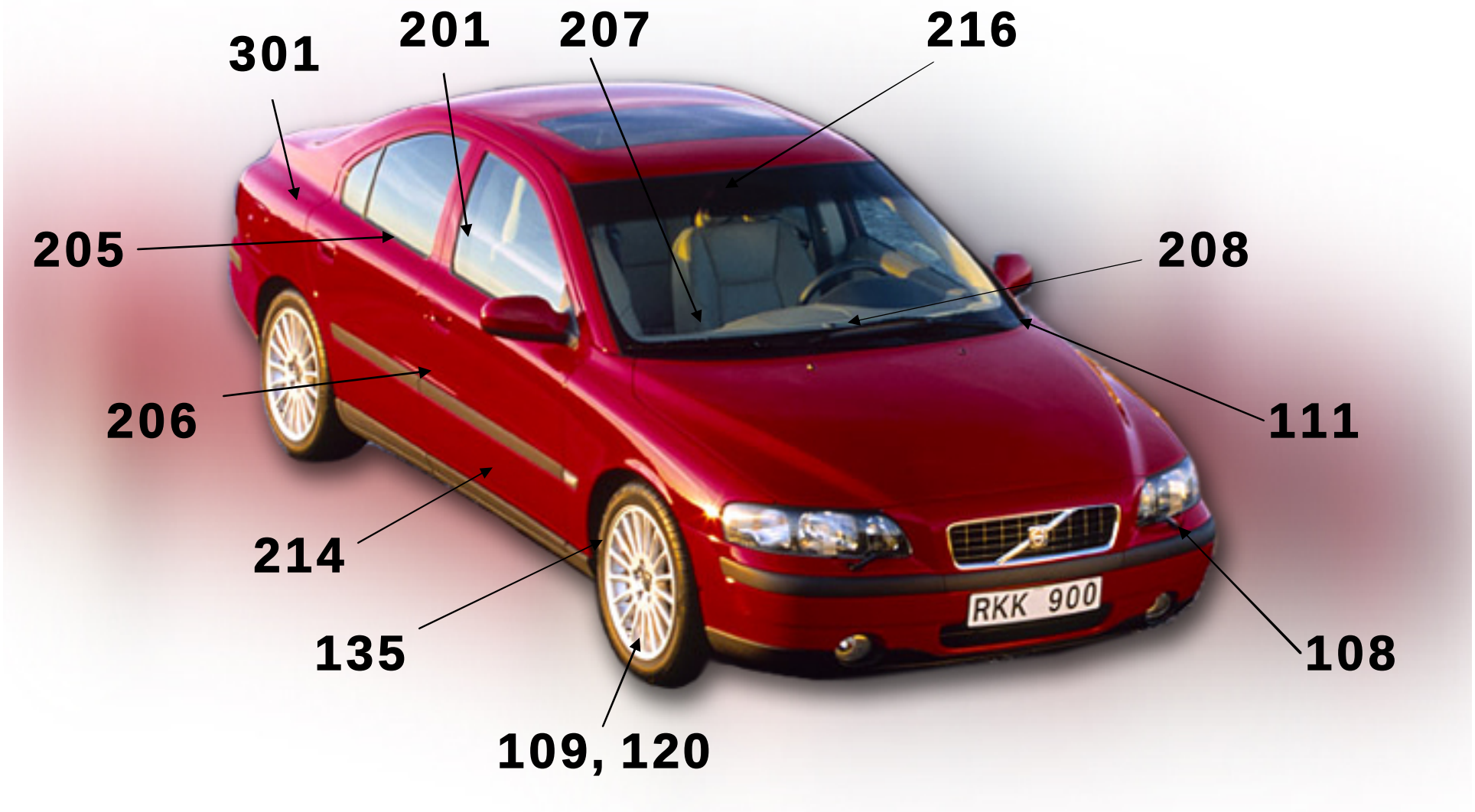
- Engage other offices early for development of documents
- Follow RSP templates; follow templates for Resolution documents
- Provide information needed by others, in a timely manner
- Adhere to time frames for review and comment
- FMVSS Management Review Team reaches consensus within time frames established.

Rulemaking Phase Flow Chart

[Average number of calendar days]



Federal Motor Vehicle Safety Standards



Enforcement Activities

- Compliance Testing
- Defect Investigations and Recall

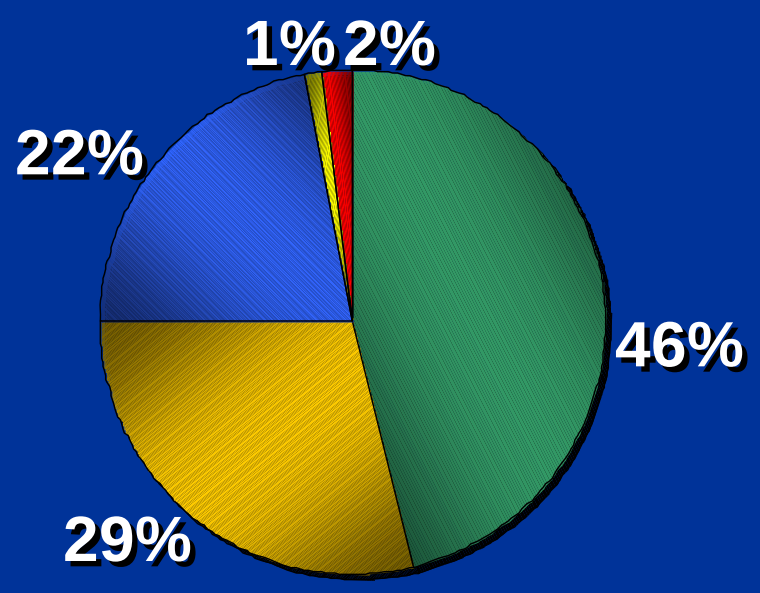
The Safety Problem

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

Vehicles and Fatalities by Collision Type 2002

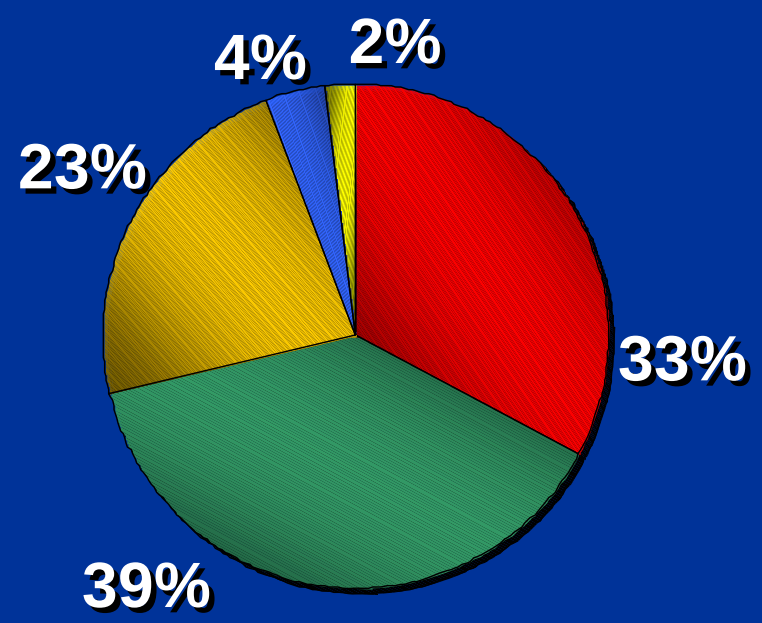
Passenger Vehicles in Crashes

Approx. 10.6 million vehicles involved



Passenger Vehicles Occupant Fatalities

32,335 total occupants killed



Rollover | Front | Side | Rear | Other

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

Side Crash Protection

Side Crash Safety

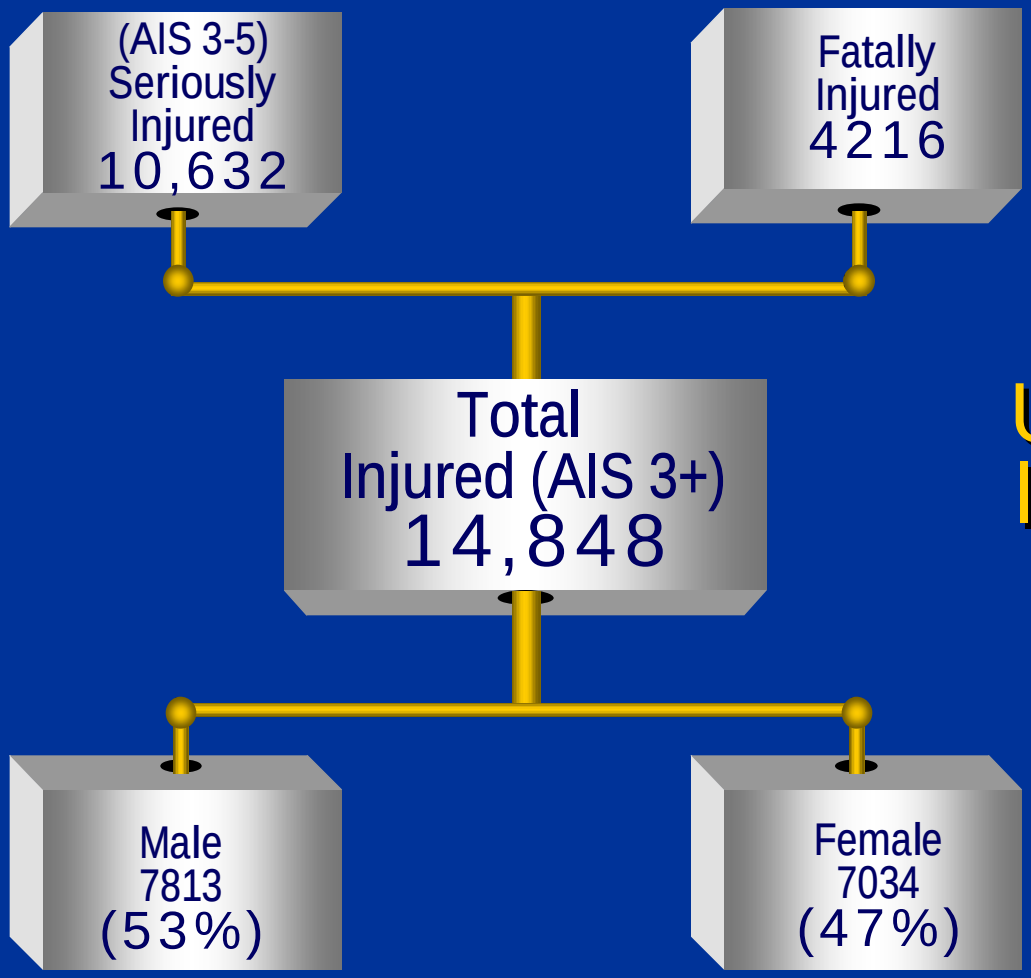
- Chest Protection
- Head Protection
- FMVSS No. 214- In-depth look at the Rule
- Further Improvements in Side Impacts
- Risks of Side Air Bags

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

Annual Estimate of Struck Side Occupants

(Non Rollover Towaway Side Crashes)

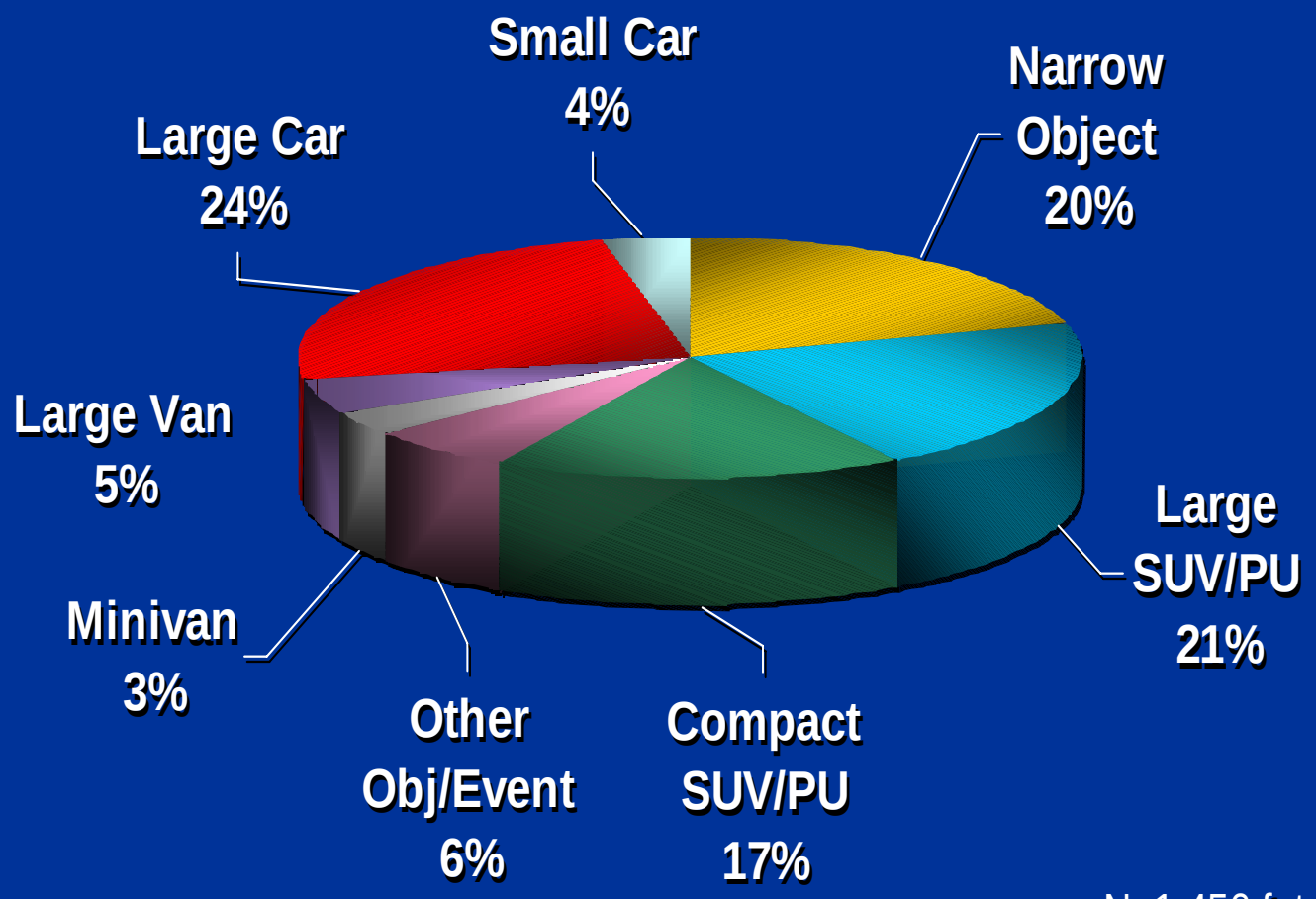
1991-2000 NASS Weighted Data / Occupant > = 56" in Height



Unknown less than (.01%)

Current Safety Problem Fatalities

Near Side Belted Fatalities by Crash Partner

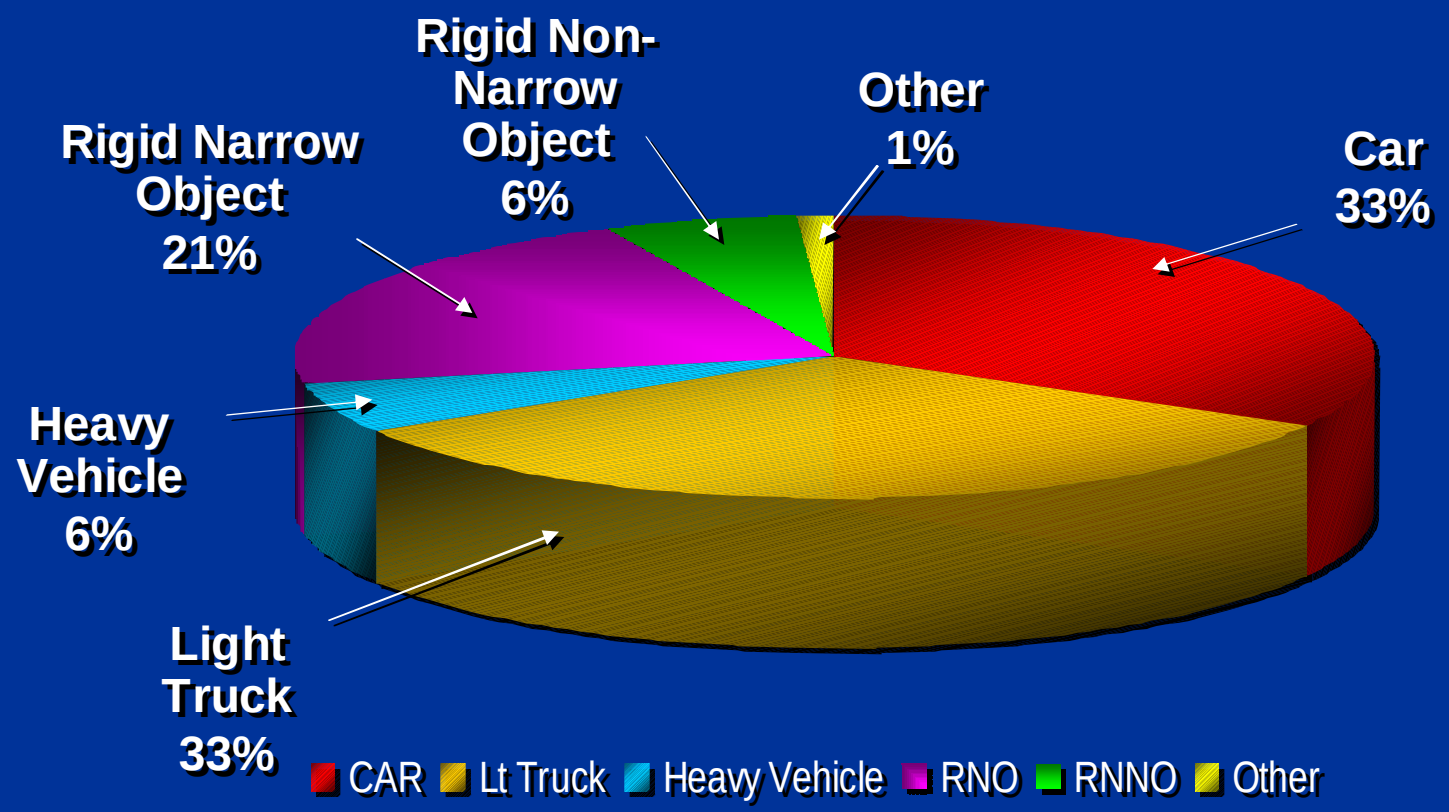


1999 FARS Side Crashes – Model Year 1995+ (light vehicles ≤10,000lbs, no rollover)

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 ≤10,000lbs, no rollover)

3,272 Occupants (total)/year

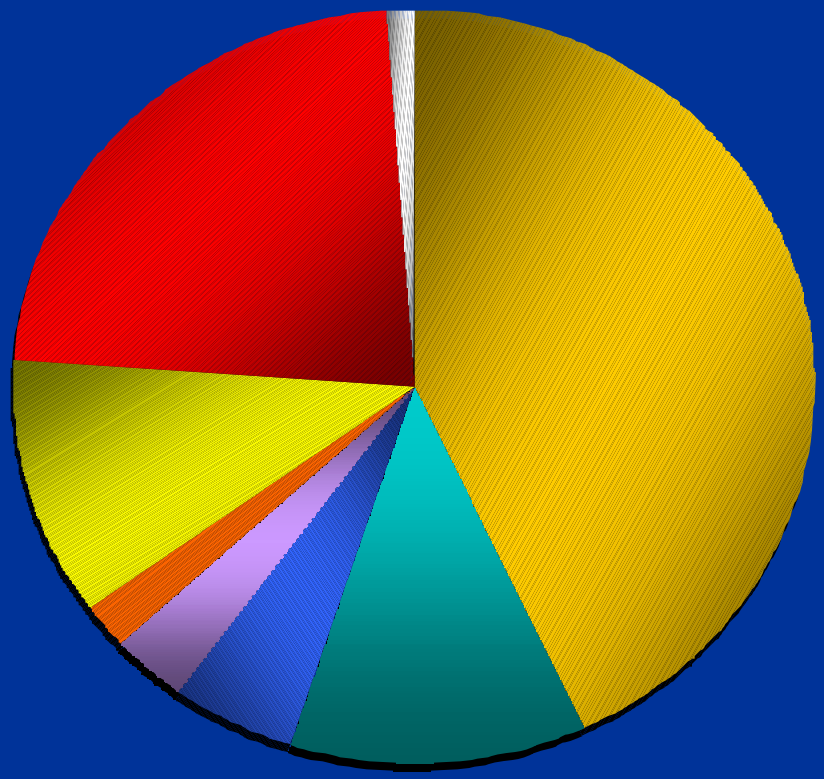
Annual Estimate of Struck Side Occupants

(Non Rollover Towaway Side Crashes)

1991-2000 NASS Weighted Data / Occupant > = 56” in Height

1%	Head/Abdomen/ Chest
2%	Chest/Abdomen
3%	Head/Chest
5%	Unknown
11%	Abdomen
12%	Other
23%	Head
43%	Chest

Distribution of Body Regions Injured Male Occupants



Analyses of Side Crash Safety Problem

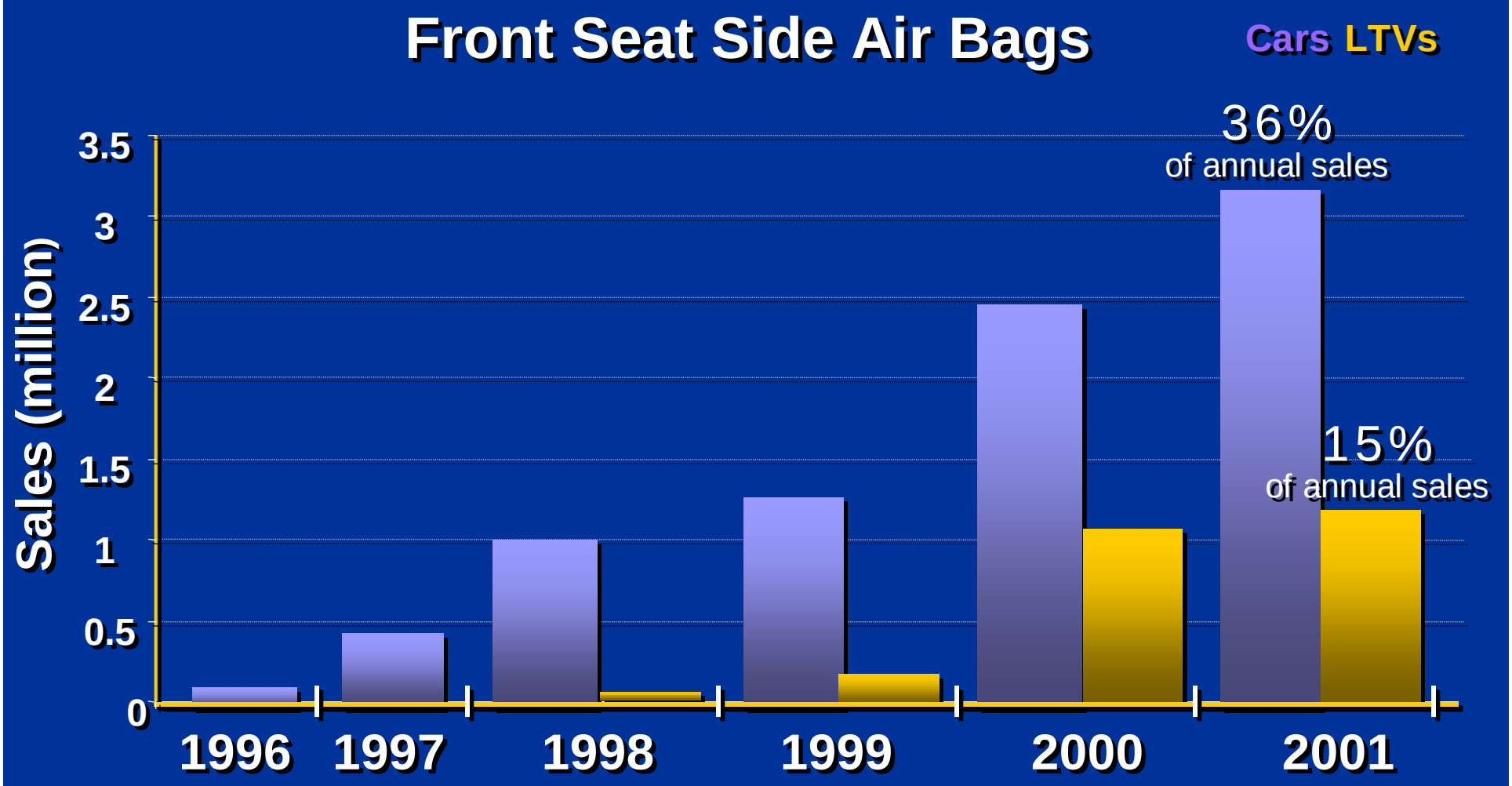
- Predominant problem is still with 50th percentile occupants followed by other sizes
- Head/neck, chest, abdomen & pelvis get injured
- Narrow objects and LTV's involved in large numbers
- Needs further improvement for chest

Side Air Bag Types

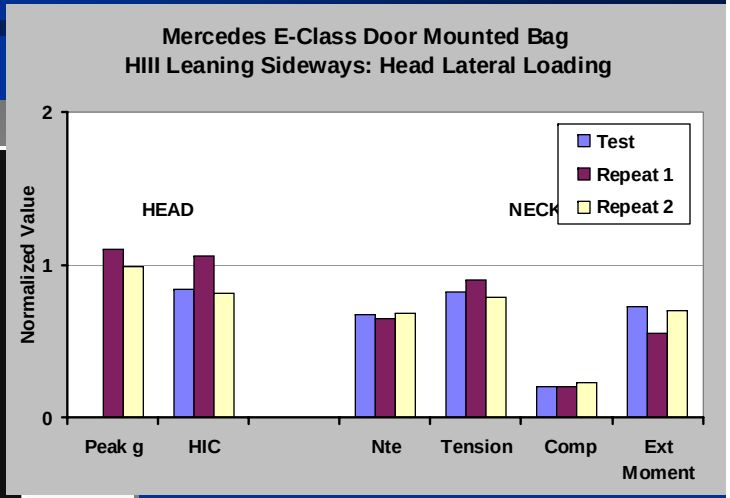
All Side Air Bags Not the Same …

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

Fleet Penetration of SABs



Early Assessment of Side Air Bag Risks

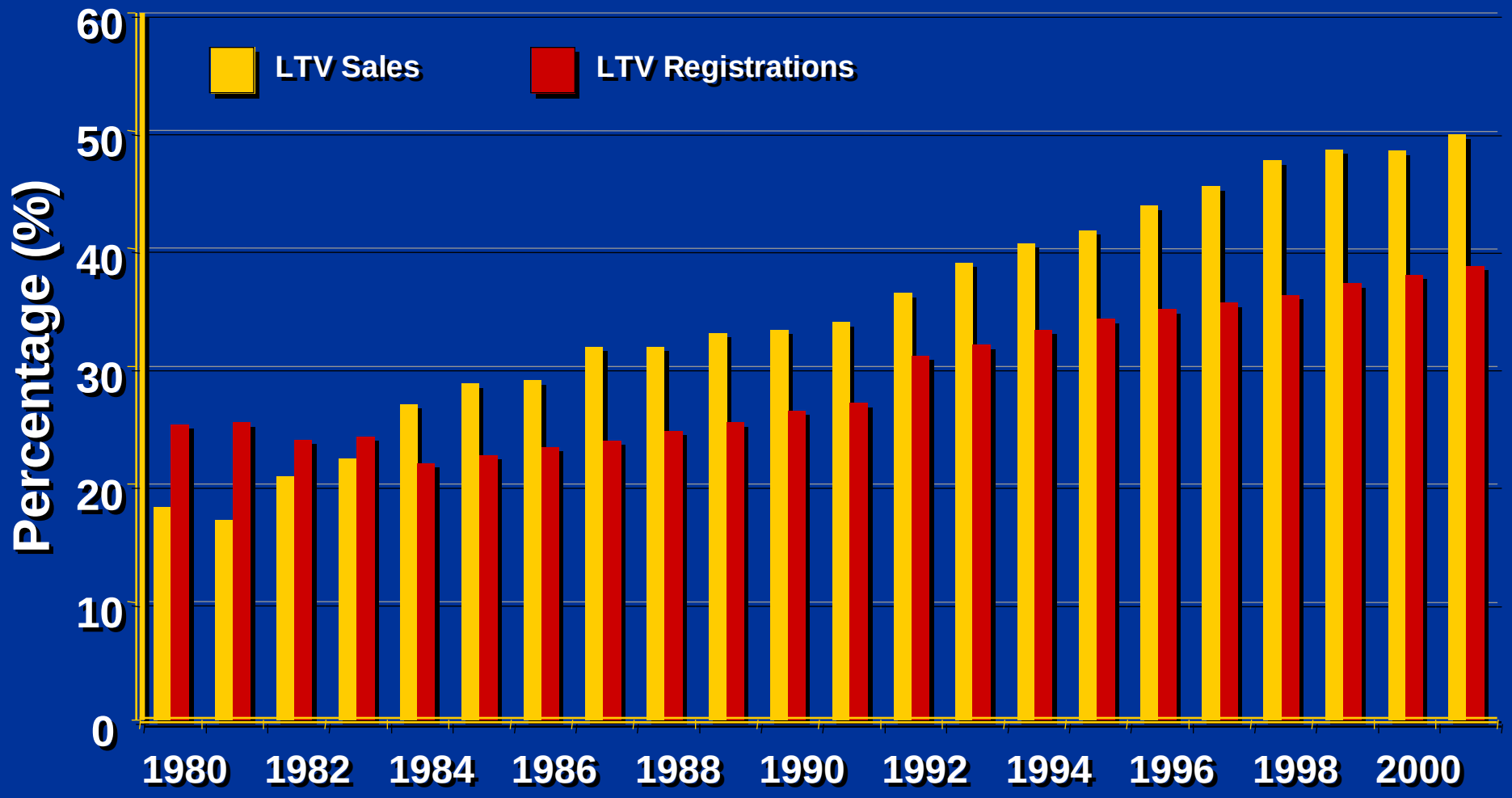


Vehicle Compatibility

Vehicle Compatibility

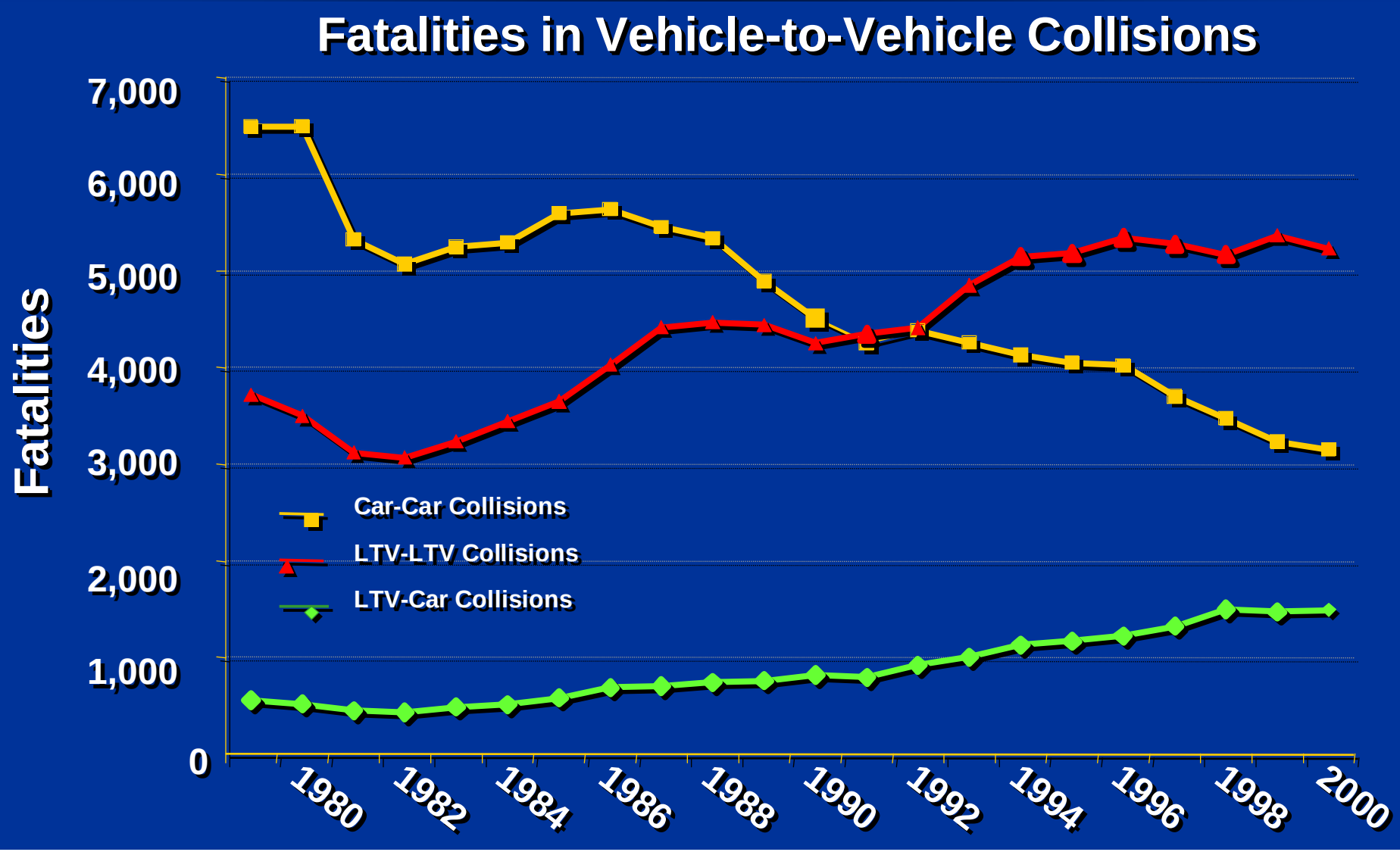
Compatibility Problem

US LTV sales have leveled off at just under 50 %

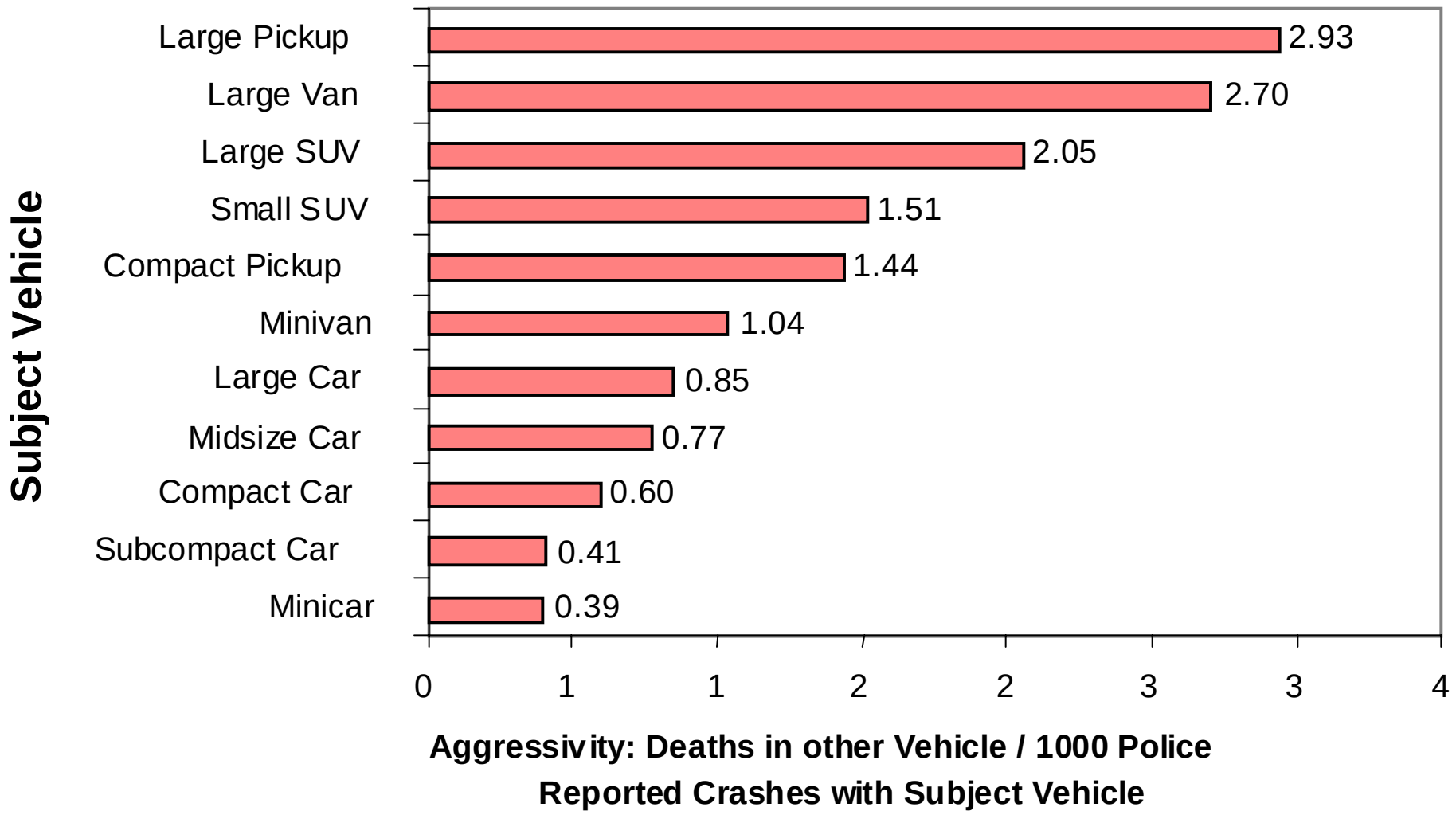


Compatibility Problem

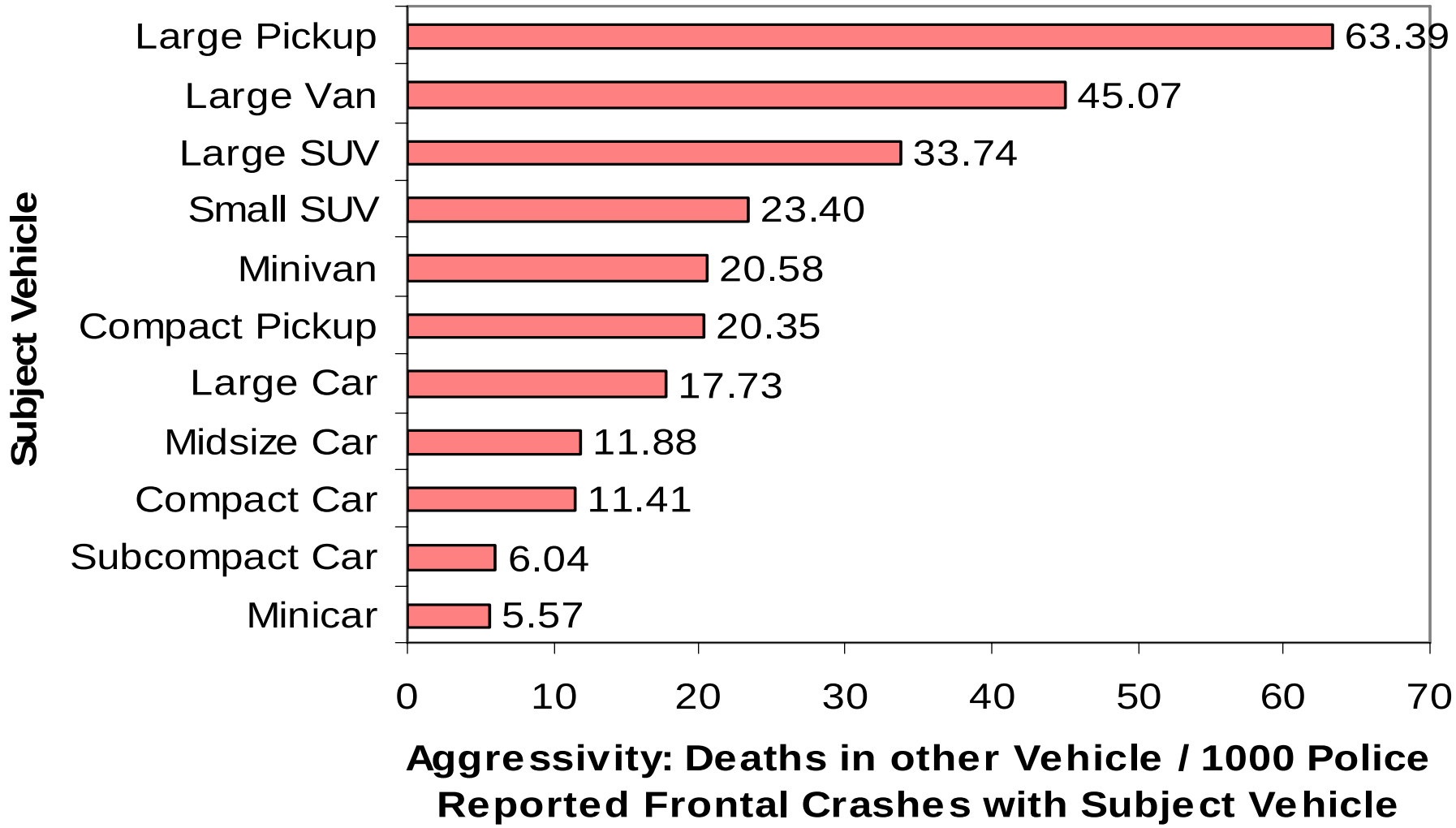
Car – LTV fatalities appear to have leveled off just above 6,000 annually



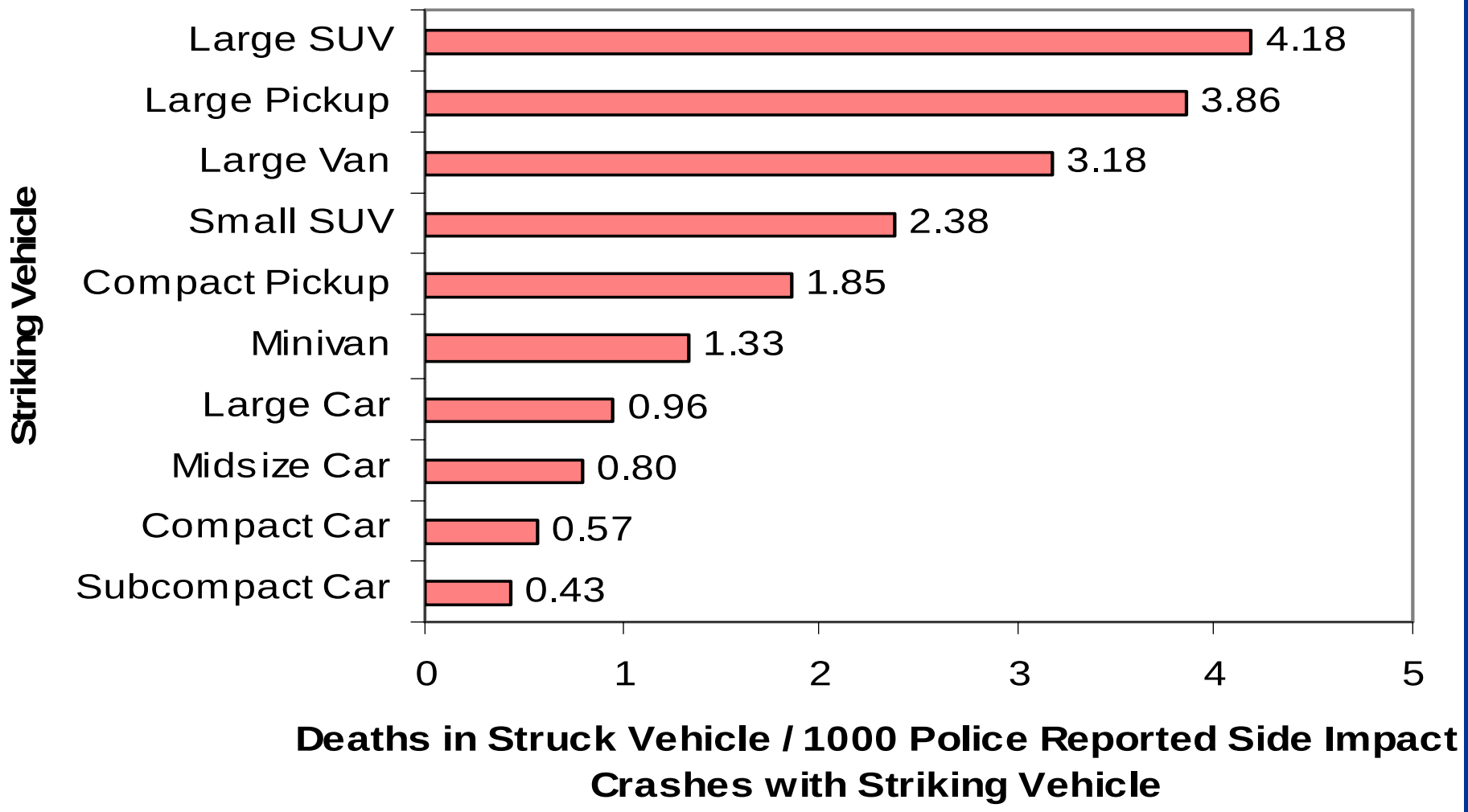
Aggressivity Metrics for Vehicle-to-Vehicle Crashes



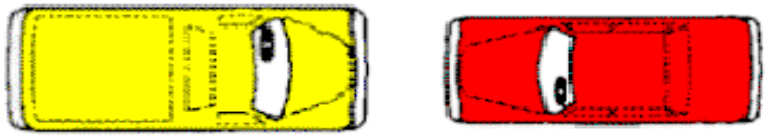
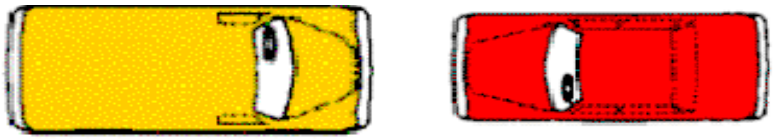
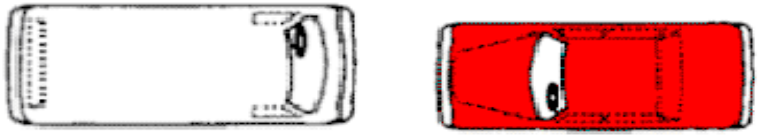
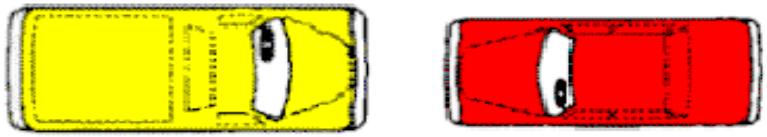
Aggressivity Metrics for Front-Front Crashes



Aggressivity Metrics for Side Impact Crashes



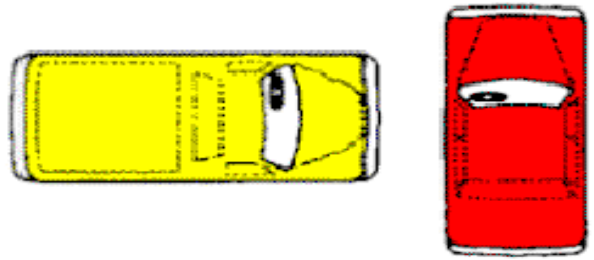
Driver Fatality Ratios for Frontal-Frontal LTV-to-Car Crashes

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 >= 1990

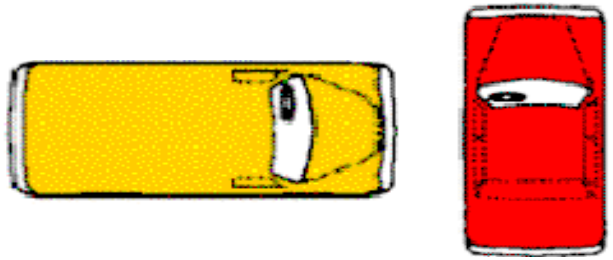
Driver Fatality Ratios for Side Impact Crashes into Passenger Cars

Large Pickup



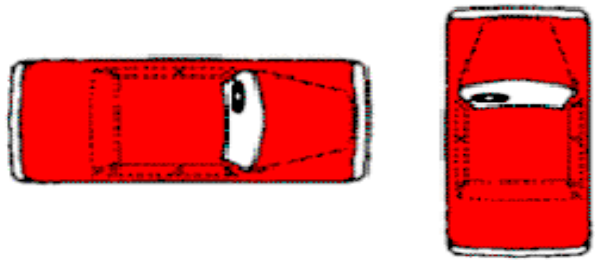
1:39.1

Sport Utility Vehicle (all)



1:22.1

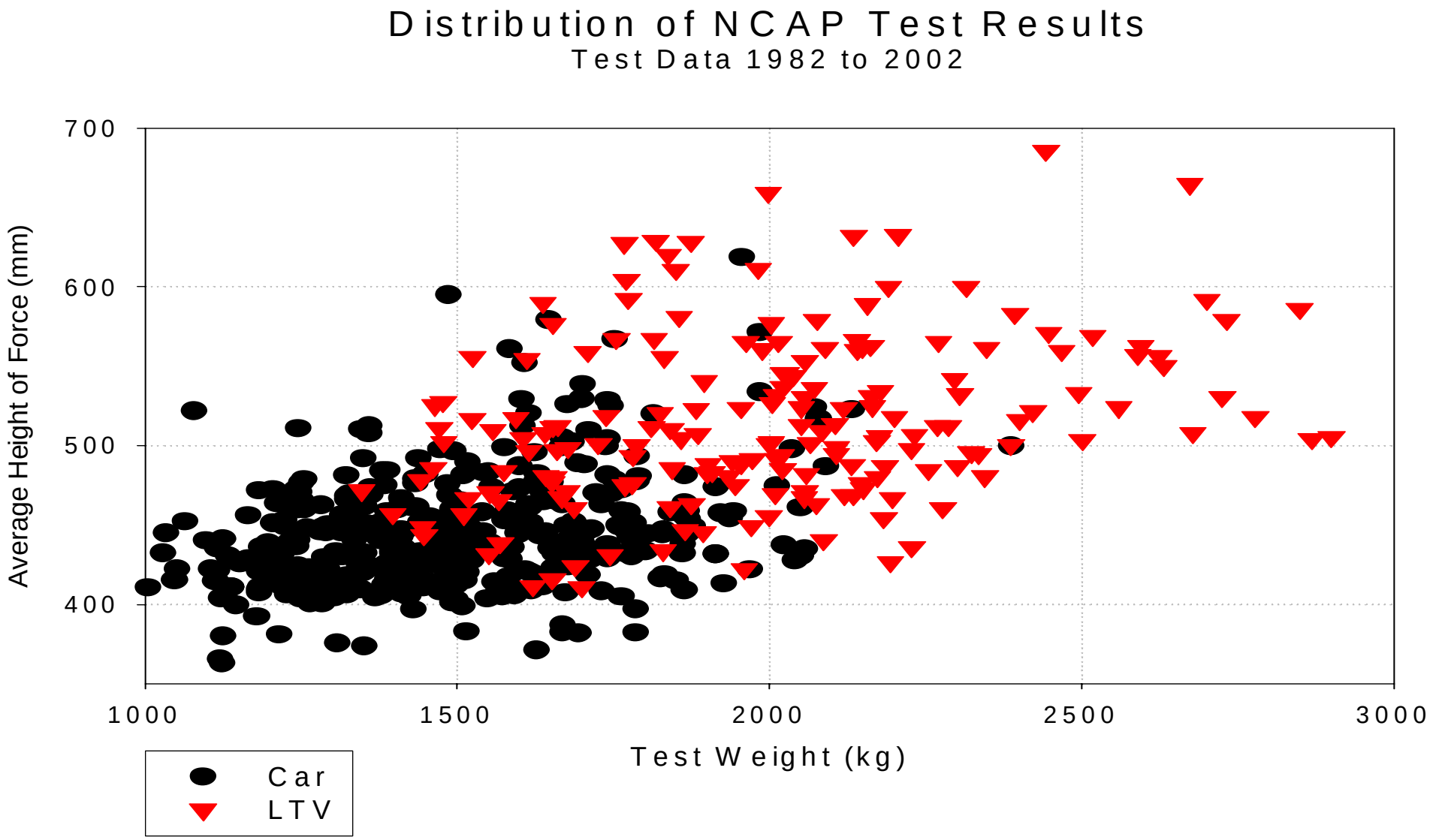
Passenger Car



1:8.2

1995-2001 FARS, Driver Fatality Ratios Both Vehicles MY >= 1990

Average Height of Force for 1982-2002 NCAP Tests

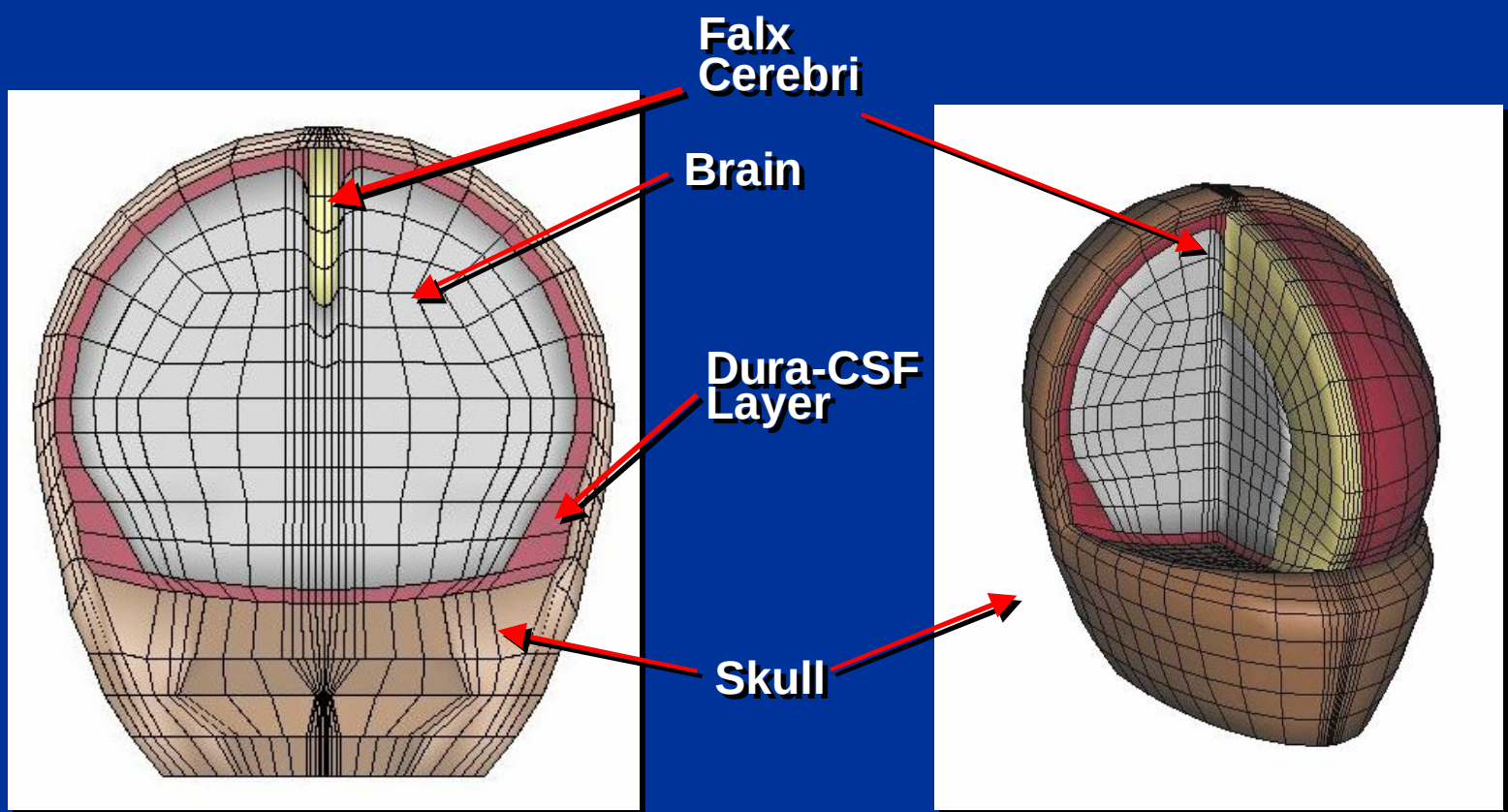


Biomechanics Research

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

Head Injury Research

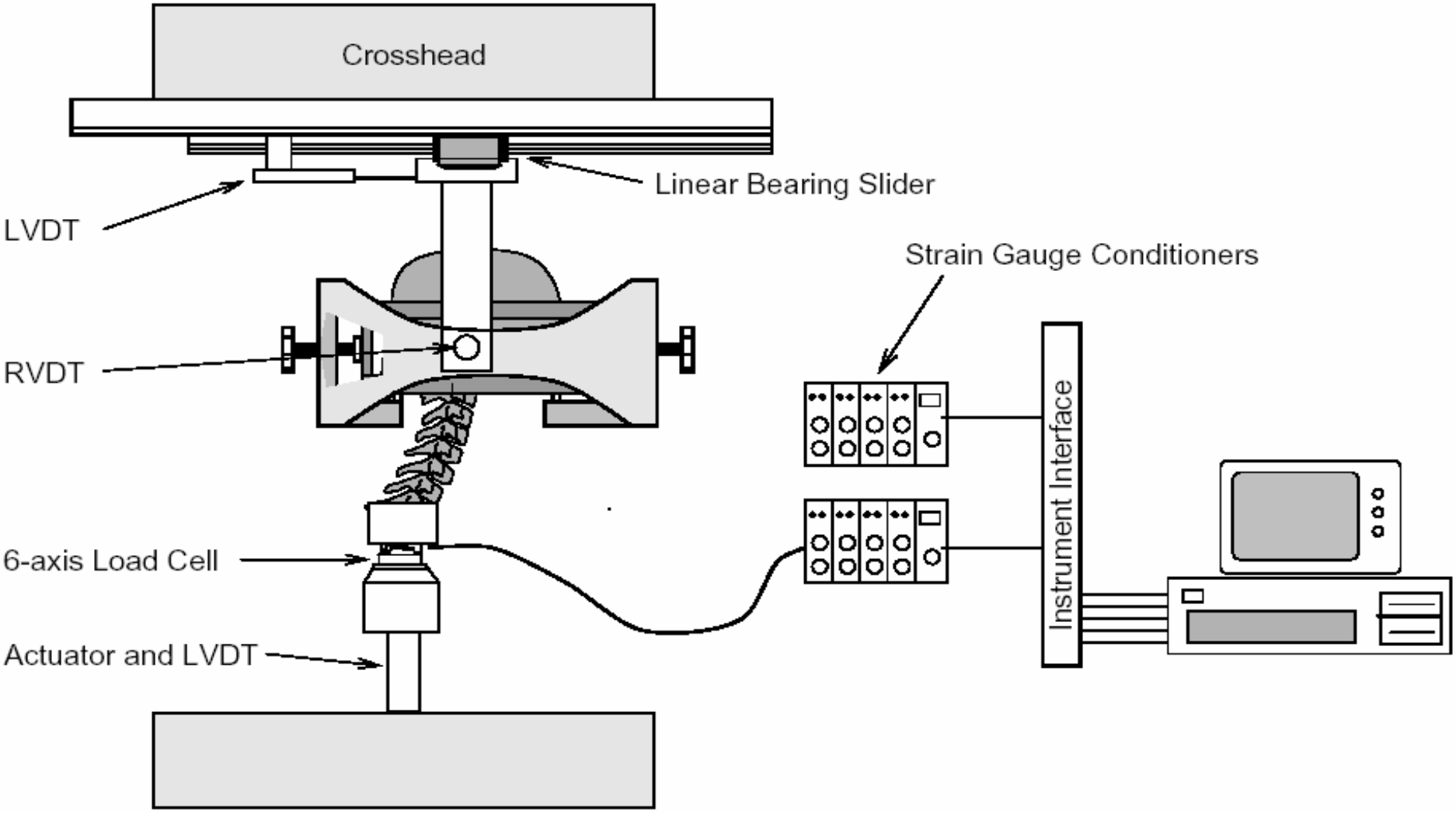
SIMon Finite Element Human Head Model



~ 3900 deformable solid elements (brain, falx, and dura-CSF layer)

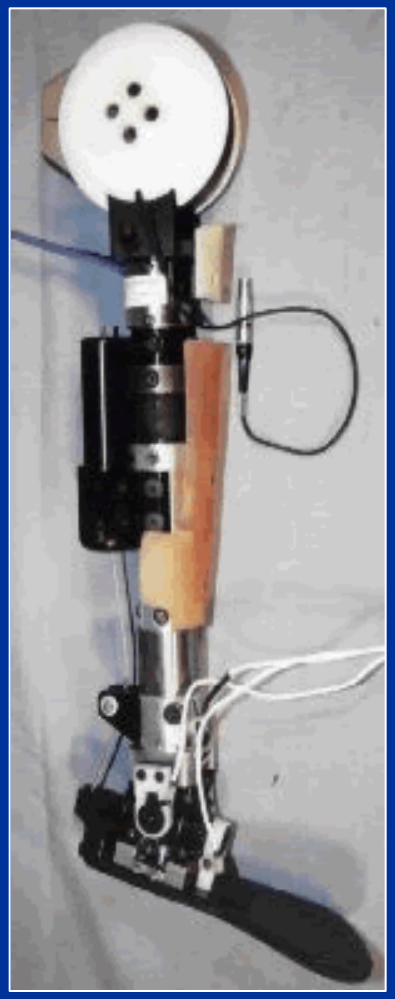
76 beam elements to simulate the parasagittal bridging veins (not shown)

Neck Injury Research Neck Tension Test Apparatus



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

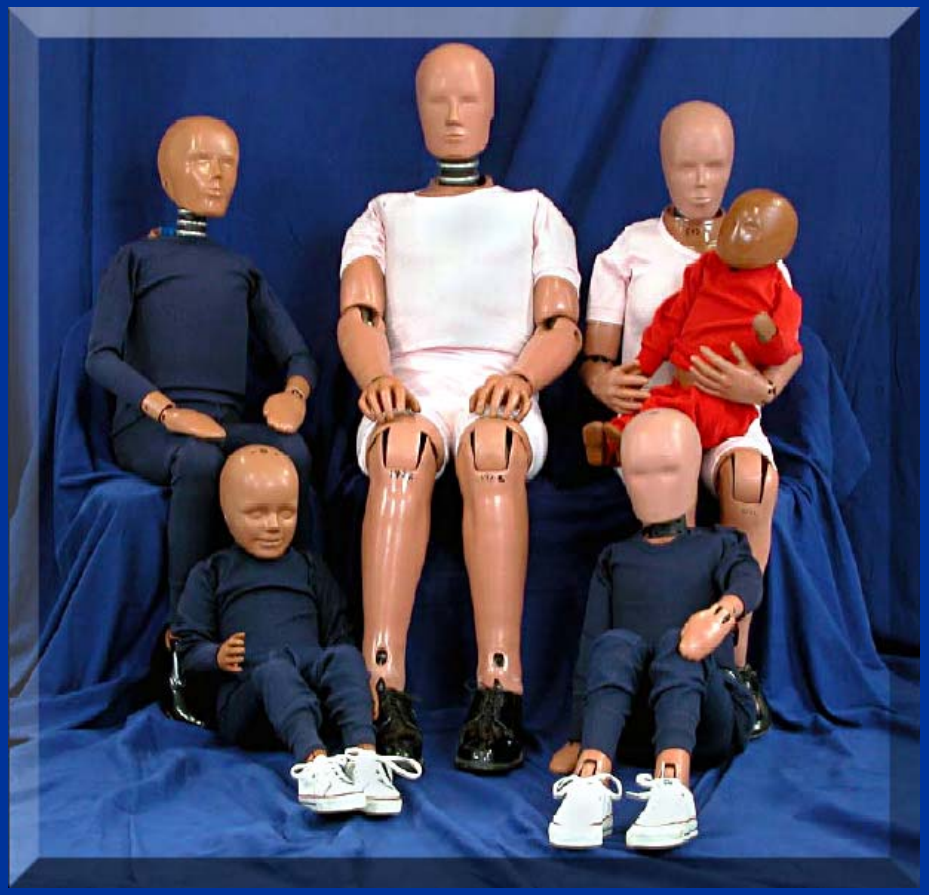
- Can retrofit to Hybrid III at knee for near-term Agency use
- Monitors tibia forces and foot/ankle injury potential due to local structural deformation
- In use by Ford, Honda, etc.
- Thor-Lx ANPRM issued 2002; received substantial industry support
- Thor-Lx NPRM was prepared Jan 2003; action on hold



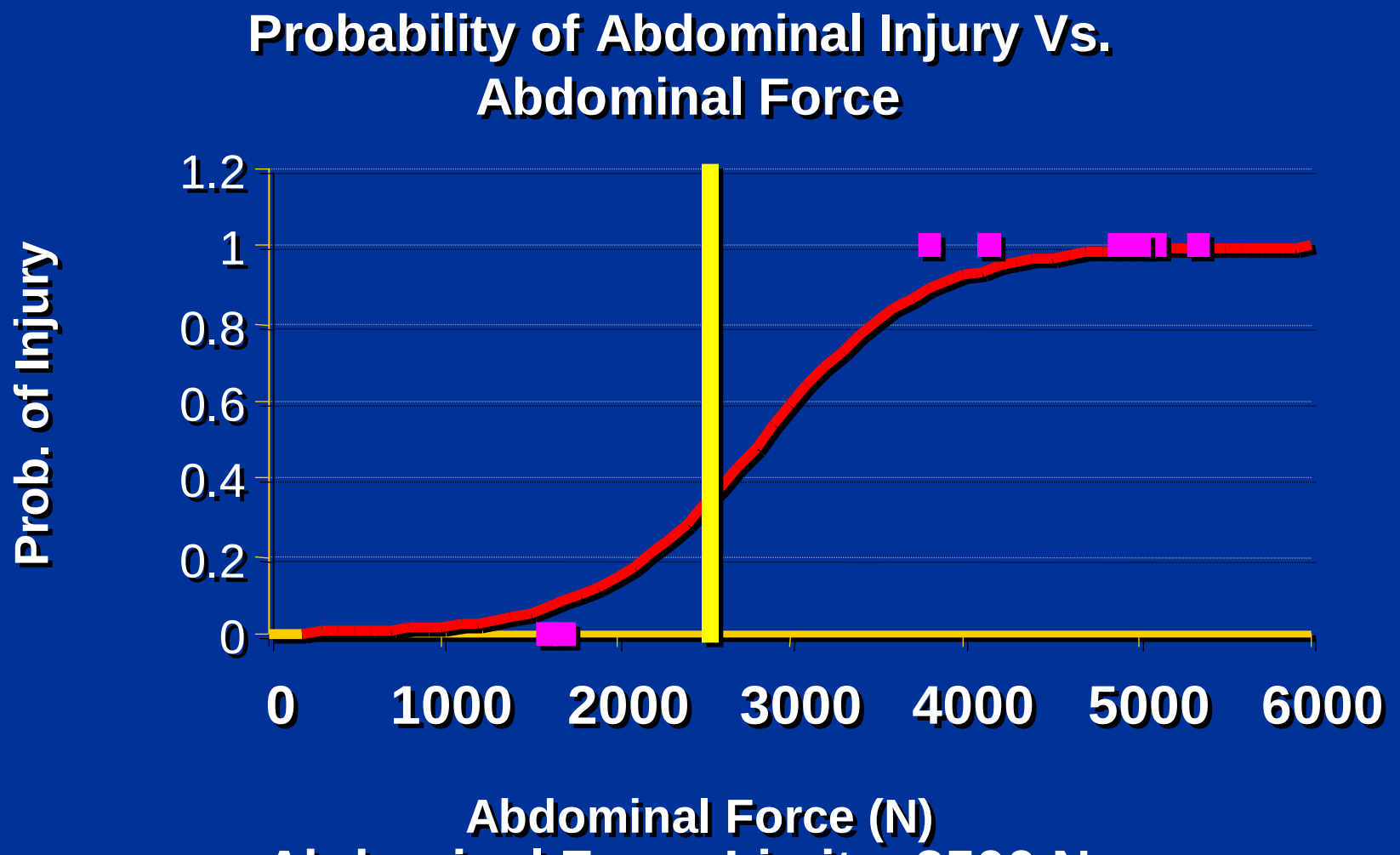
THOR Advanced Frontal ATD (Released to Public Domain)

- 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



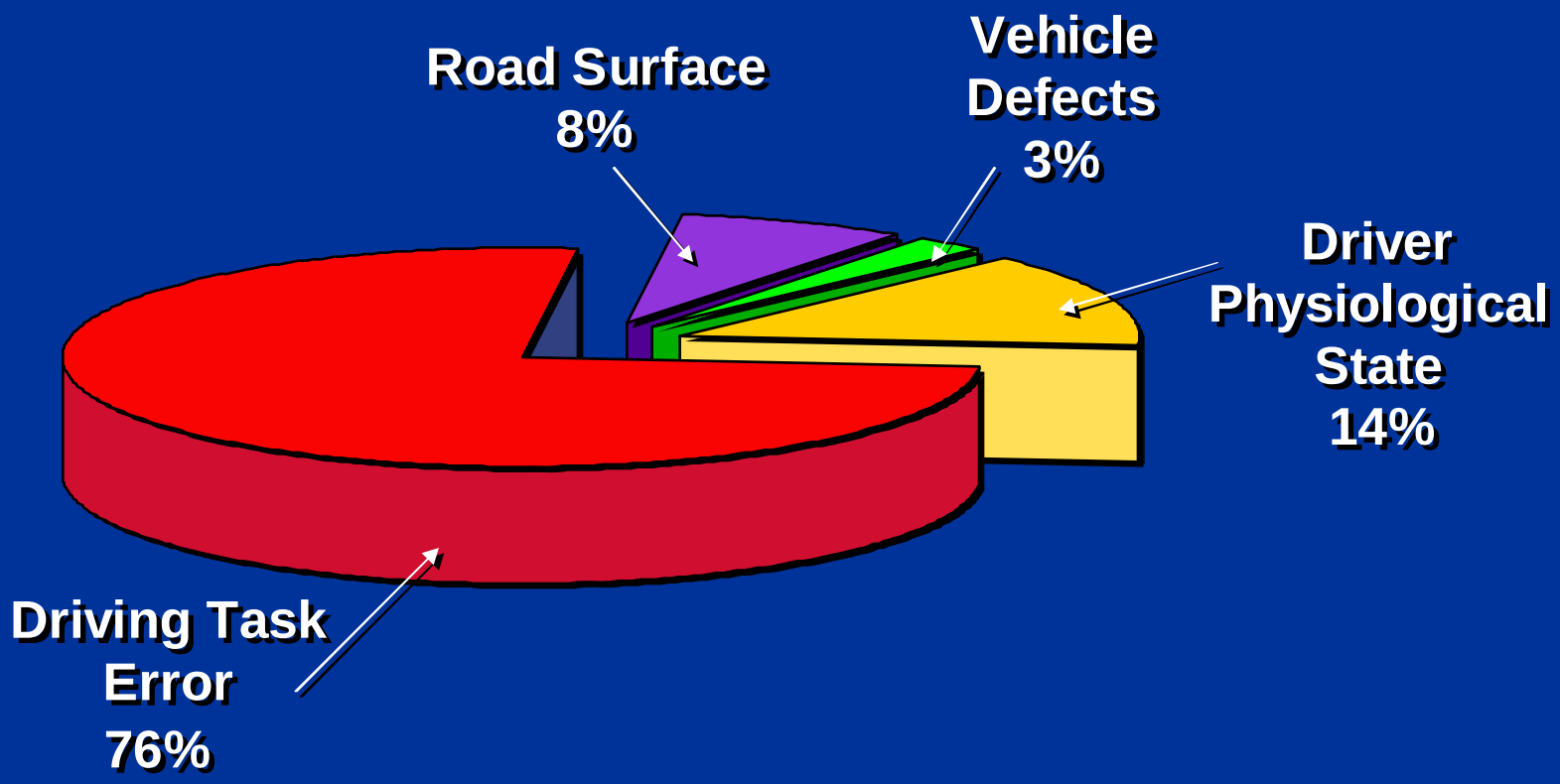
Sample Injury Curve



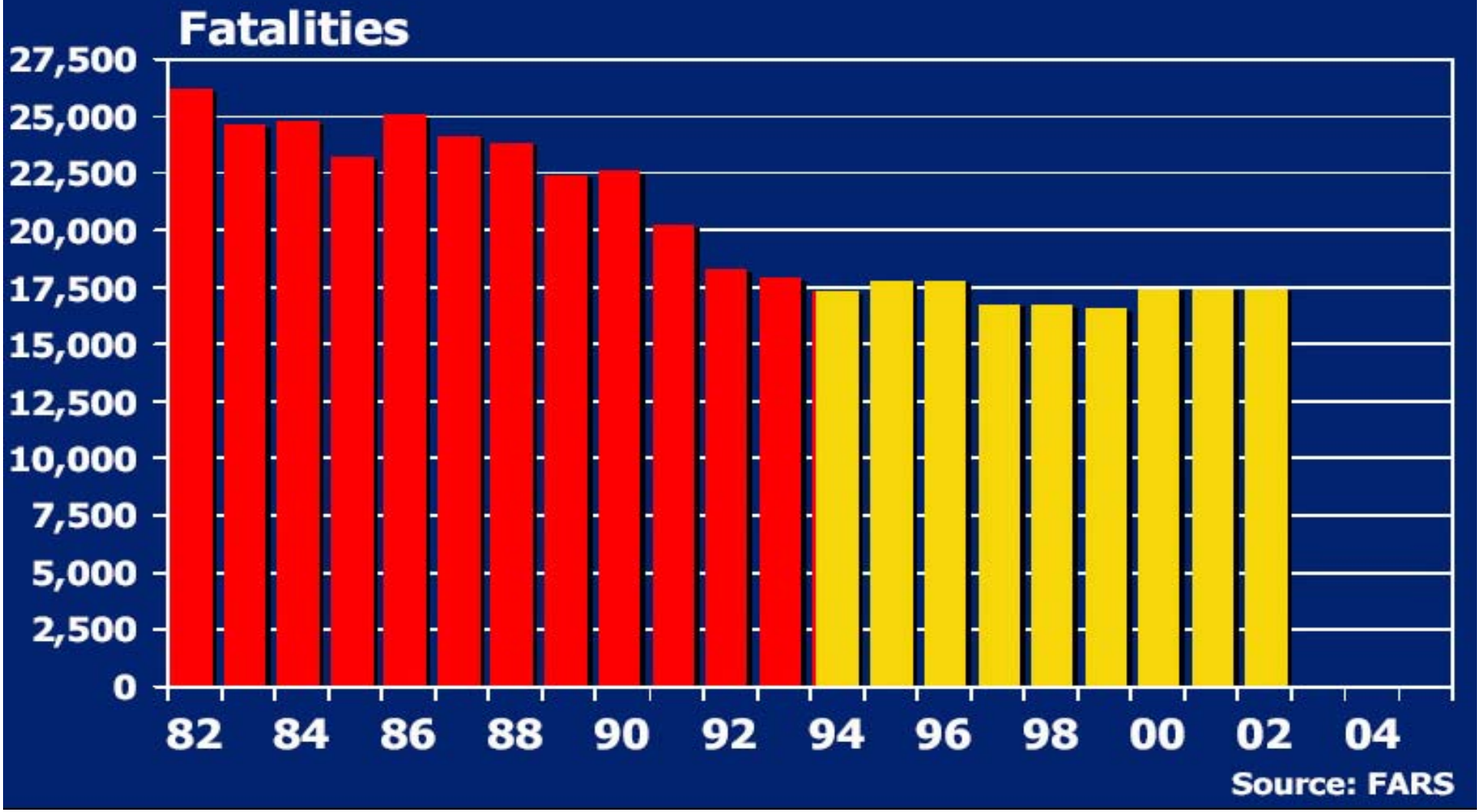
Abdominal Force Limit = 2500 N

The Safety Problem

Causal Factor Distribution



Number of Alcohol-Related Fatalities



Safety Research in Crash Prevention

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

Rollover Research

Technical Highlight:
Programmable Steering Machine

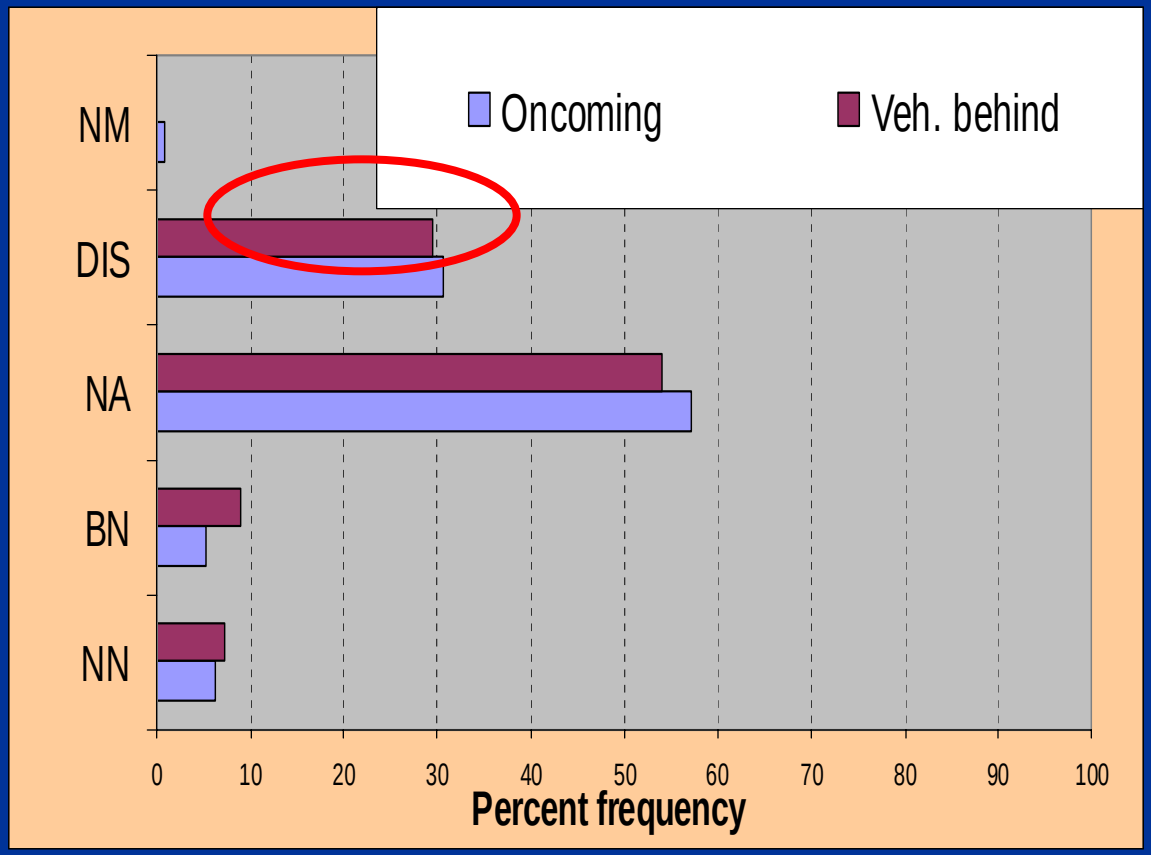
- **Provides accurate and repeatable inputs**
  - Important for NCAP testing
- **Able to receive outputs from other sensors**
  - Roll Velocity
  - Vehicle Speed

Example:
Fishhook Maneuver Effectiveness

National Survey of Headlamp Glare Discomfort

Glare has been:

- Cause of crash, Near Miss
- Disturbing
- Noticeable but Acceptable
- Barely Noticeable
- Not Noticeable

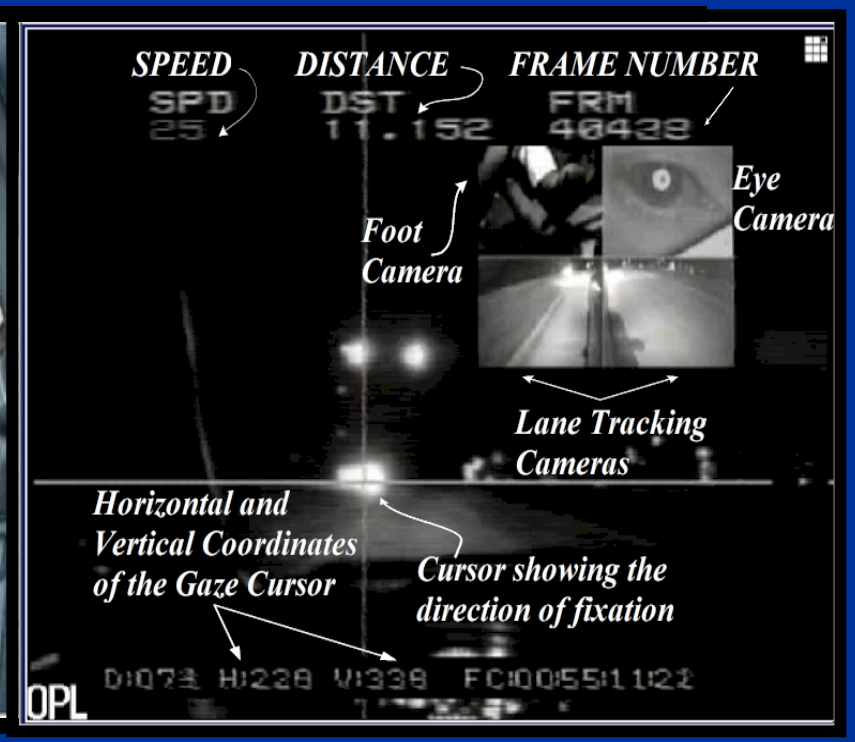


From Bureau of Transportation Statistics, 2002

(sample size~4321)

NHTSA Glare Research
(at U Iowa, completion Winter, 2004)

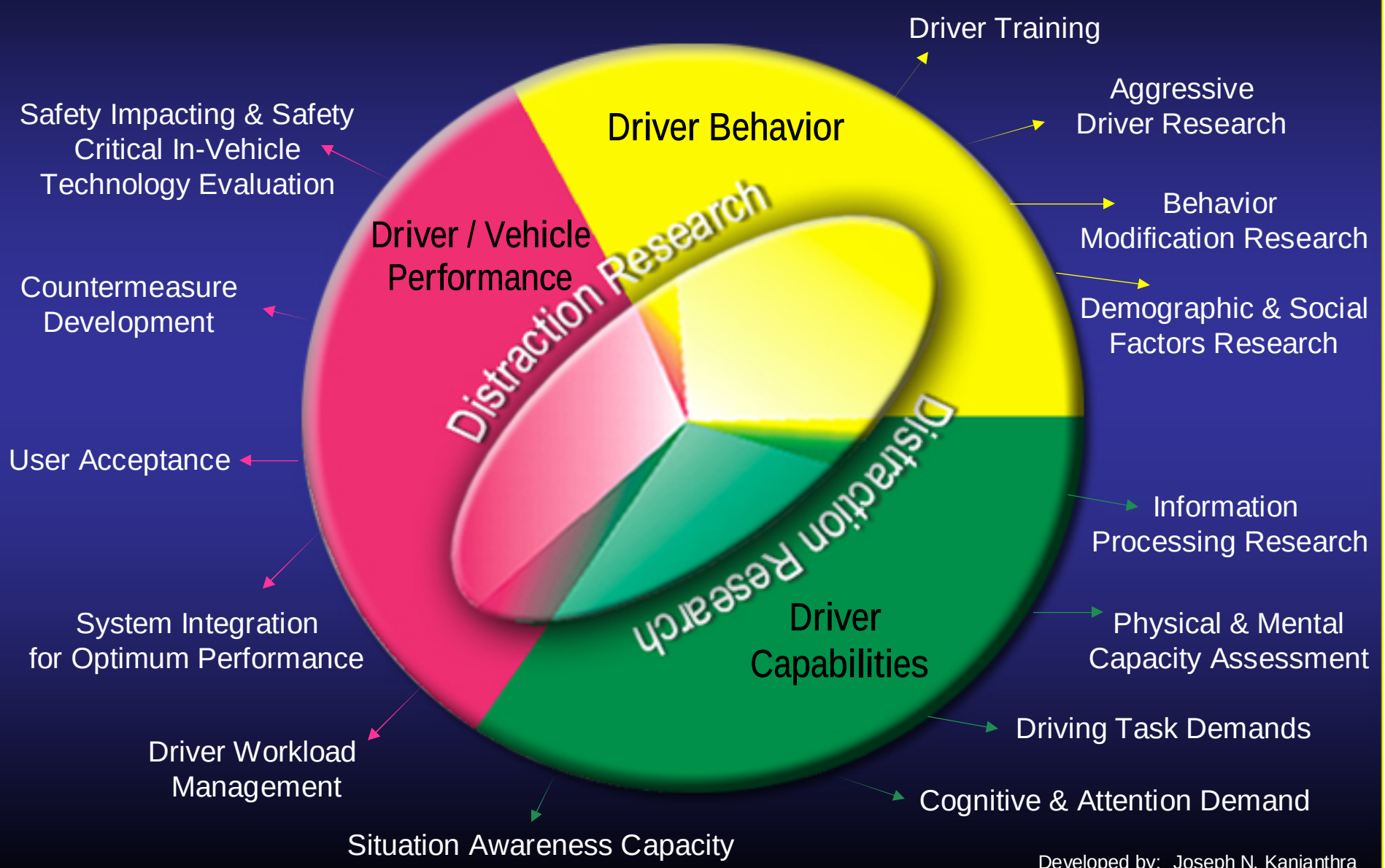
Do drivers take longer or more frequent glances at bluish headlamps?



Preliminary Findings

	Disability Glare	Discomfort Glare
Illuminance	Significant	Significant
Spectrum	Not Significant	HID Significant
Size	Not Significant	Not significant But trend

Driver Vehicle Safety Research



Developed by: Joseph N. Kanianthra

Road Ahead for Safety

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

Solving Problems

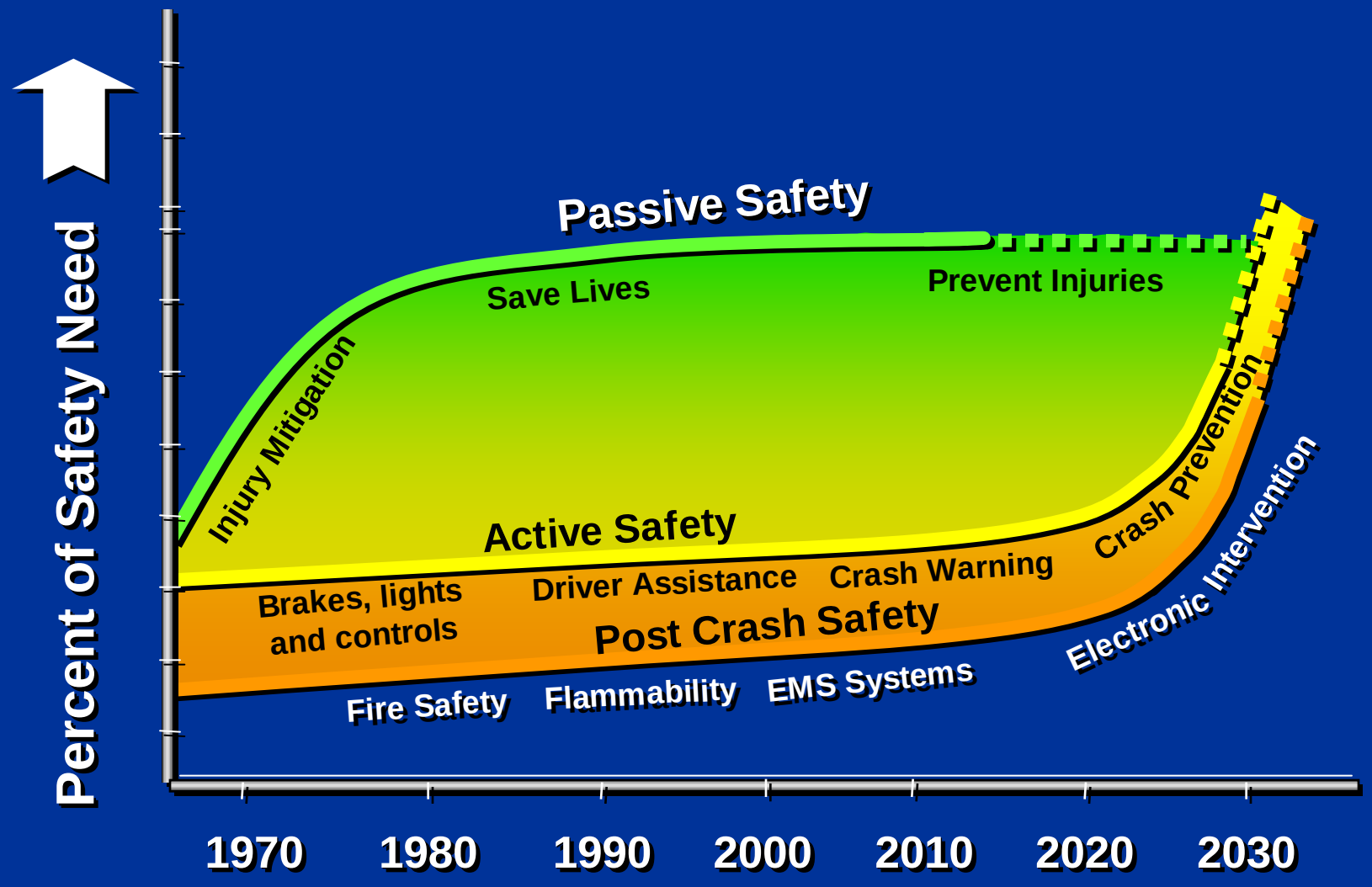
Human **Vehicle** **Environment**

Pre-Event

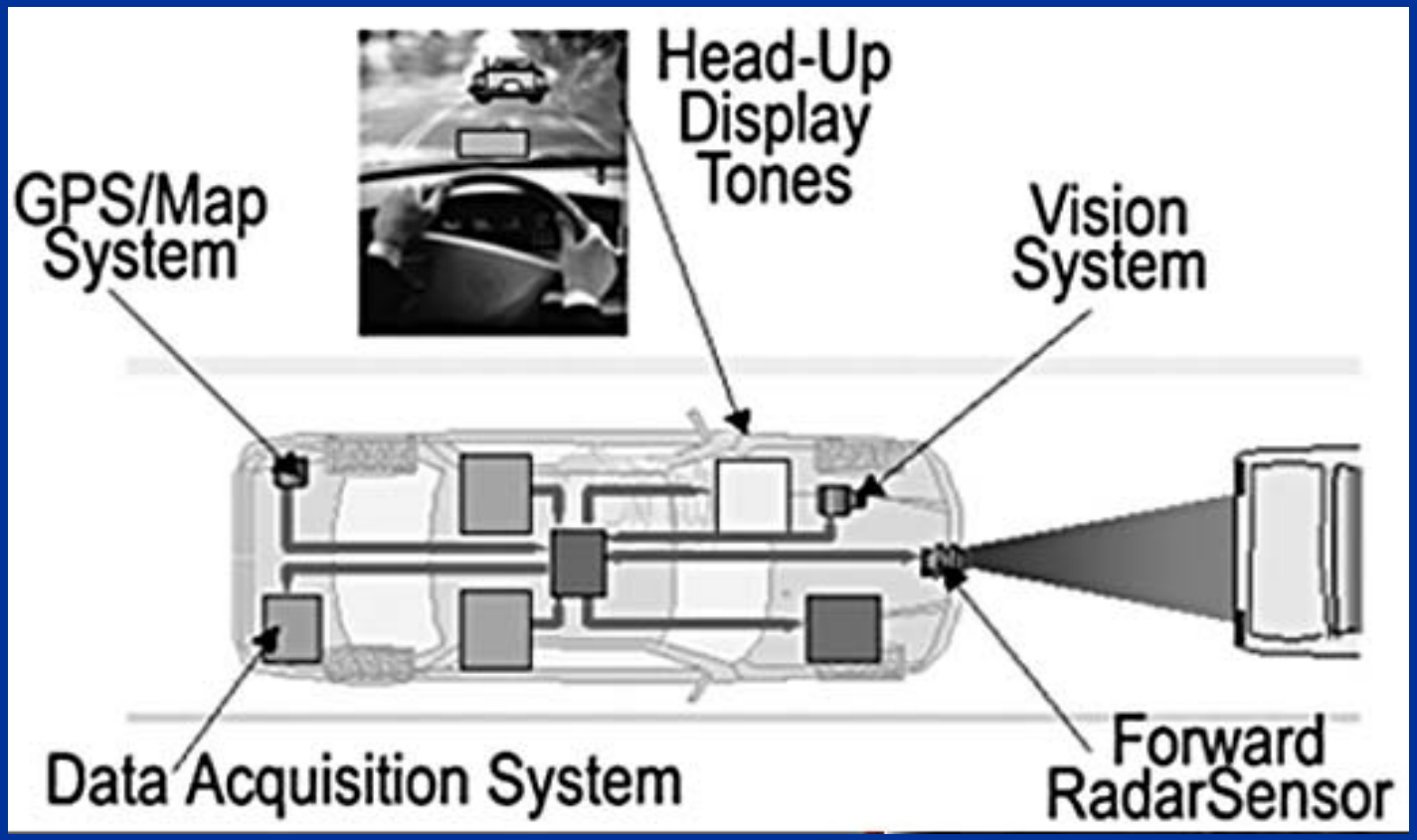
Event

Post-Event

The Safety Need



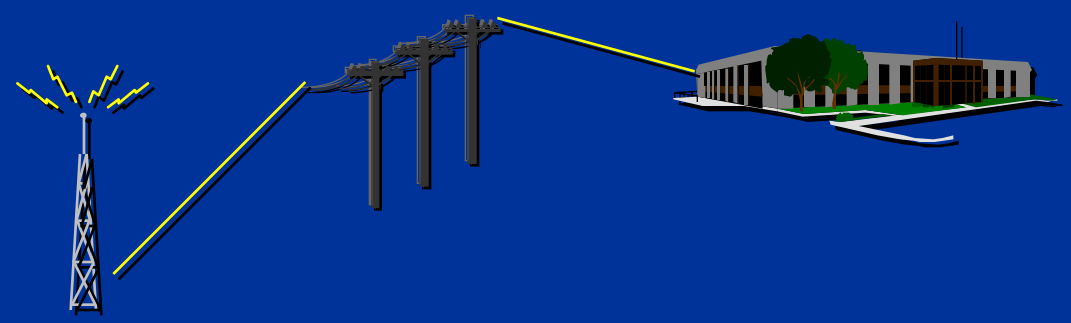
IVI


Head-Up
Display
Tones
GPS/Map
System
Vision
System
Data Acquisition System
Forward
RadarSensor

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

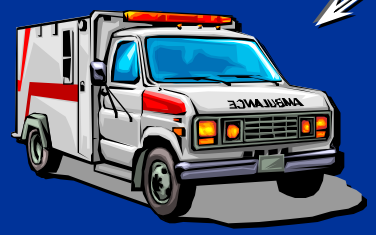
Example ACN System



Emergency Services Dispatch

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

Crash Notification Message



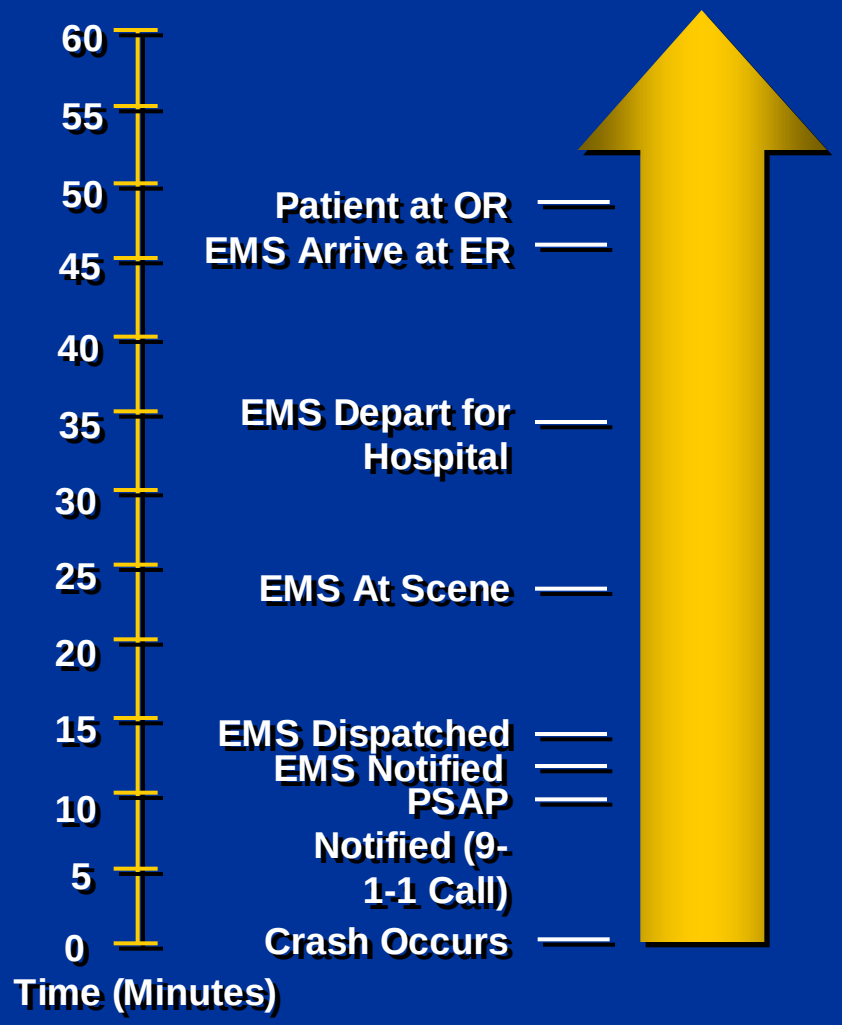
EMS Notification

- Location
- Crash Severity
- Probability of Serious Injury

In-Vehicle System

- Crash Sensor
- GPS Receiver
- Cellular Phone

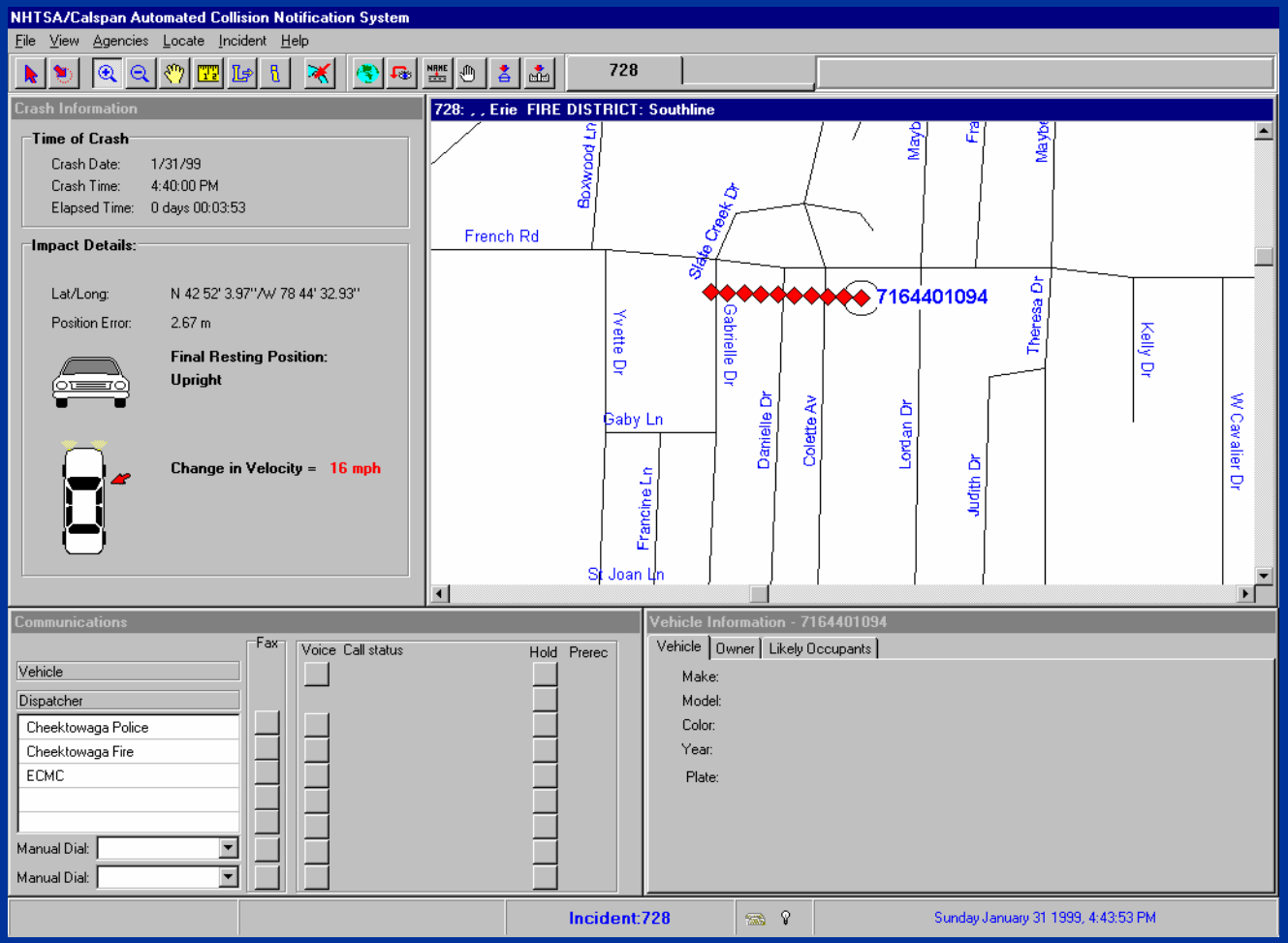
Typical EMS Response Time Line



DEFINITIONS

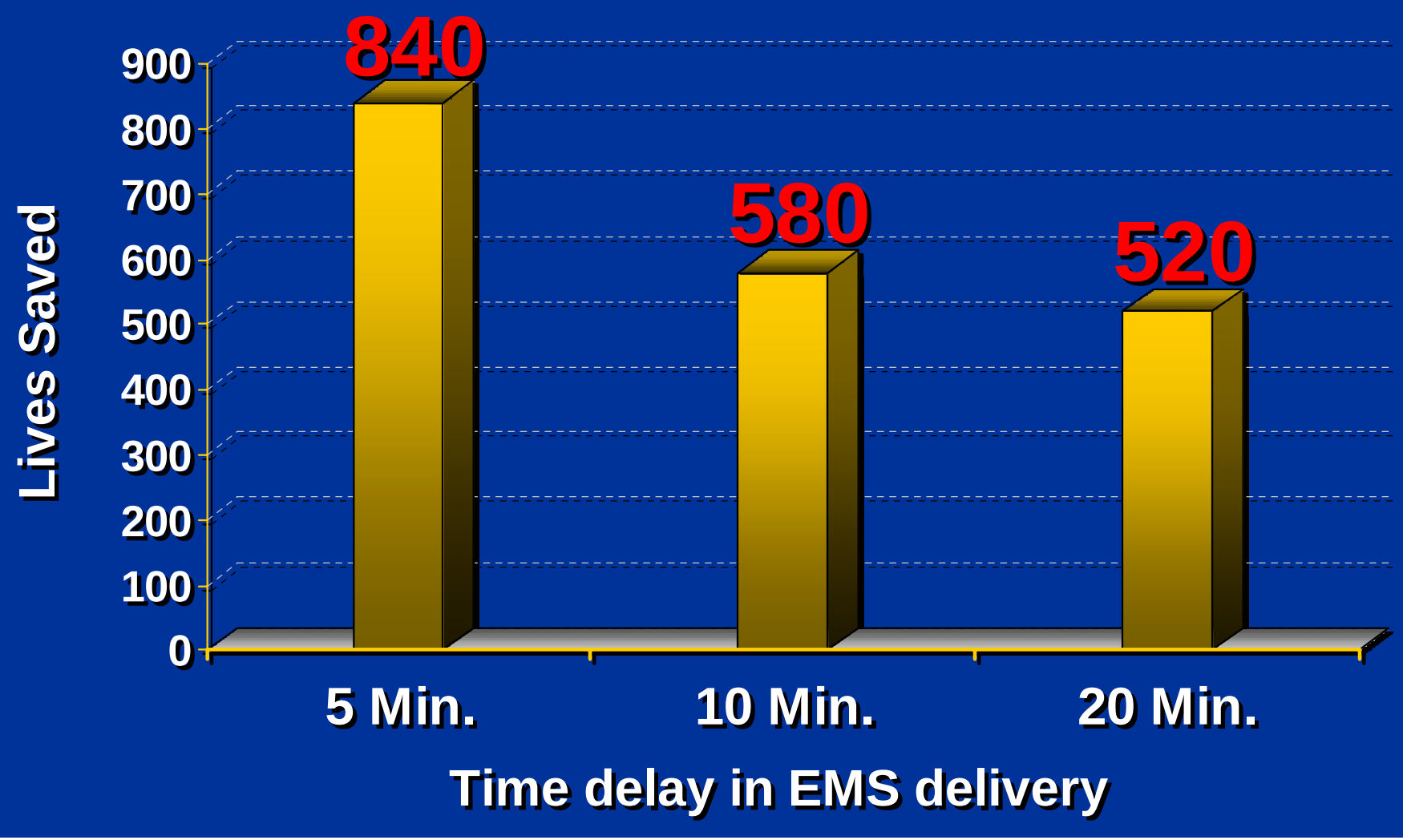
- PSAP Notification - Time Appropriate PSAP Notified by 9-1-1 Call
- EMS Notification - Time Appropriate EMS Provider Notified by PSAP
- EMS Dispatch - Time EMS Unit is Dispatched to Crash

ACN 9-1-1 Dispatcher Screen

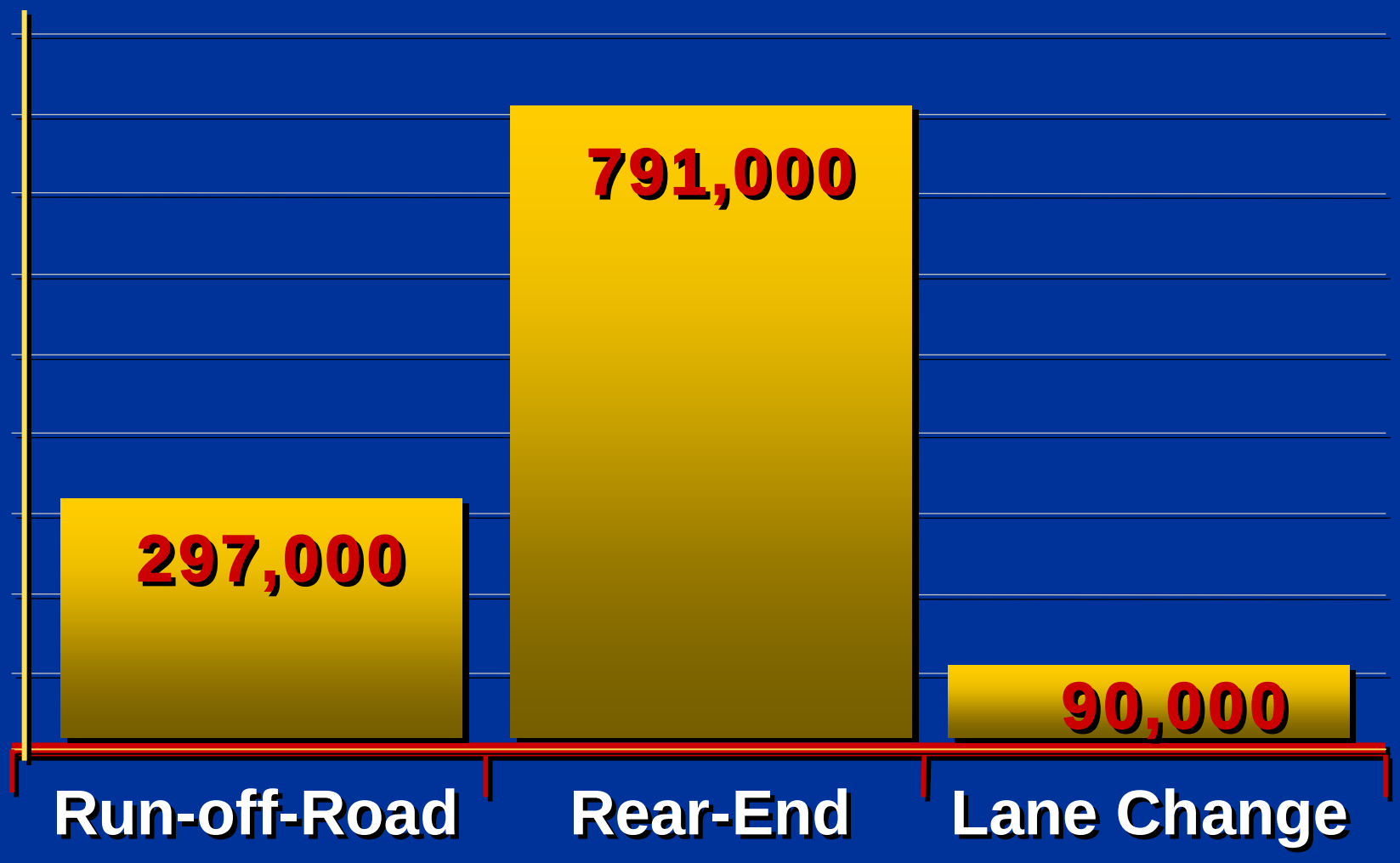


ACN Benefit Estimate

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



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