

Fire Occurrence in Frontal Crashes Based on NASS/CDS

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Earlier Test Data

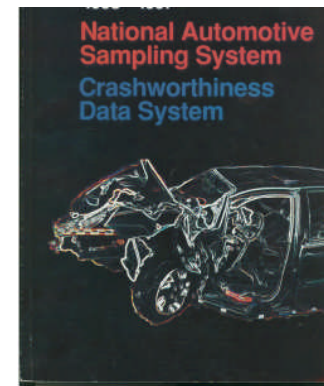
- GM Crash Test - SAE paper 2005-01-1788
 - Leakage from damaged power-steering system was fire origin in two crash tests
- GM Crash and Burn tests – GM/Dot Settlement
 - Crash tests - Fire initiated by electrical fault
 - Burn tests – For fire origin in engine compartment, tenability time for occupants ~ 10 to 28 minutes

Data Sources

The Fatality Analysis Reporting System (FARS) years 1979 to 2005



The National Automotive Sampling System - Crashworthiness Data System (NASS/CDS) 1997-2005



Definitions

FARS Fires – Any vehicle in the FARS file where there was both a fatality and a fire.

FARS MHV (Most Harmful Event) Fires – The FARS cases where fire was the most harmful event that occurred to the vehicle. The MHV does not necessarily apply to the people in the vehicle. Therefore, one can not assume that the most harmful event for a vehicle was the cause of the death or injury for any specific individual within the vehicle.

NASS Major Fire – Any NASS case where fire enters the occupant compartment

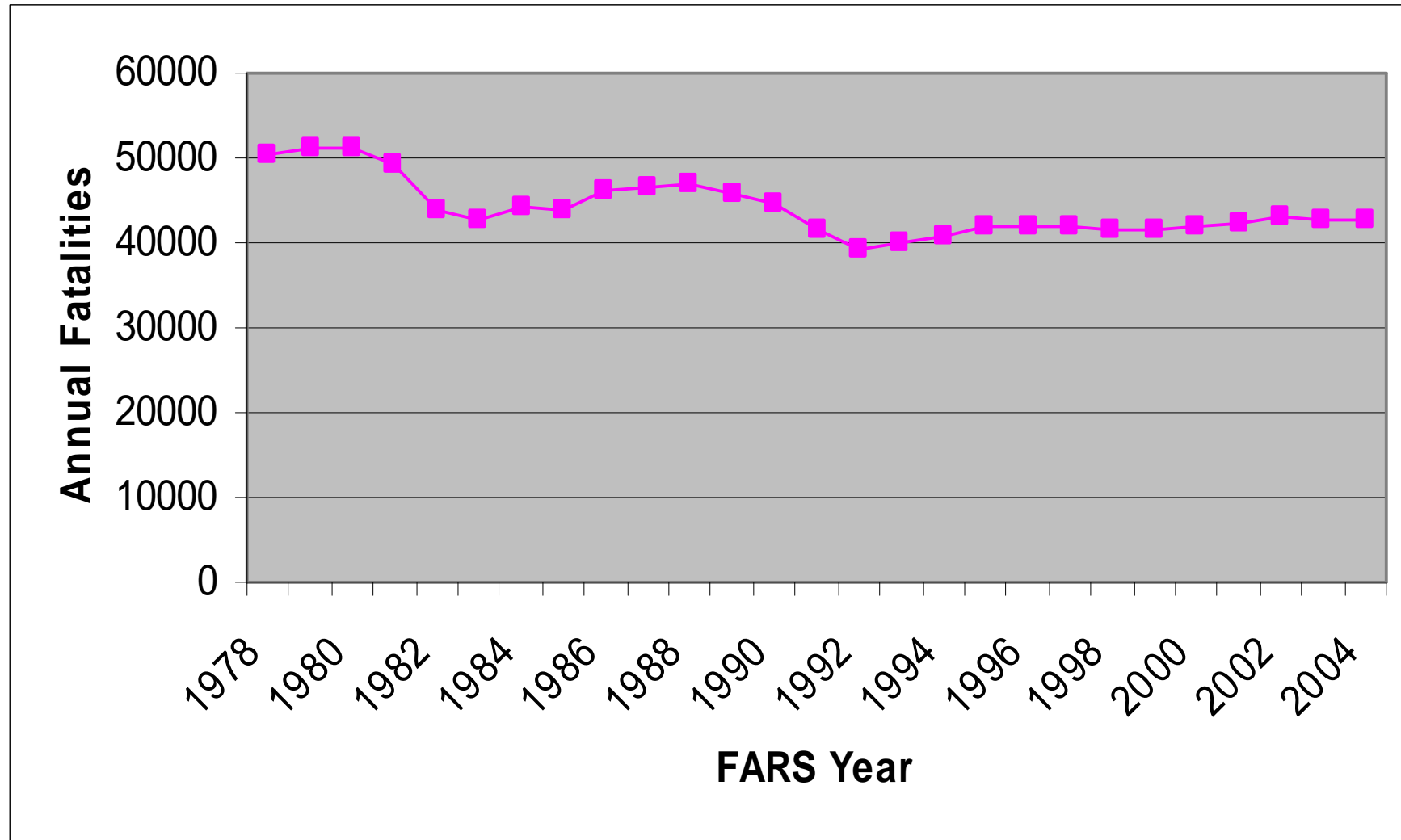
NASS Major Fire with a Fatality – Any NASS case in which there is a major fire and a fatality. The fatality could have been due to crash forces or to the fire or to both.

Presentation Outline – Fires in Frontal Crashes

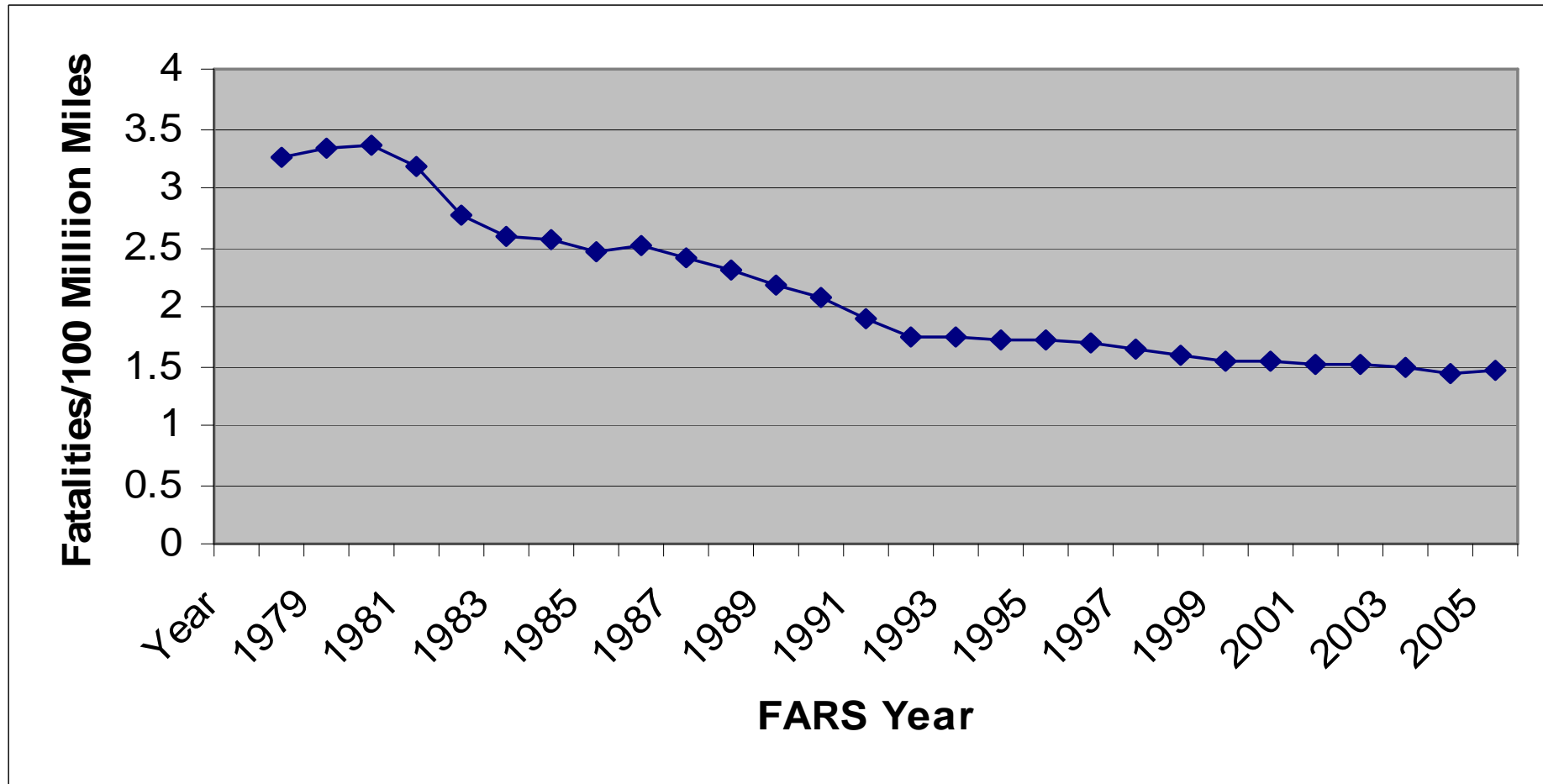
- Overview of Fires in FARS
 - Frontal crashes relative to other crash modes
- NASS/CDS Data on Frontal Crashes with Major Fires and Fires with Fatalities
- Examination of Eight Cases in NASS where Fire may have contributed to the Fatality
- Conclusions



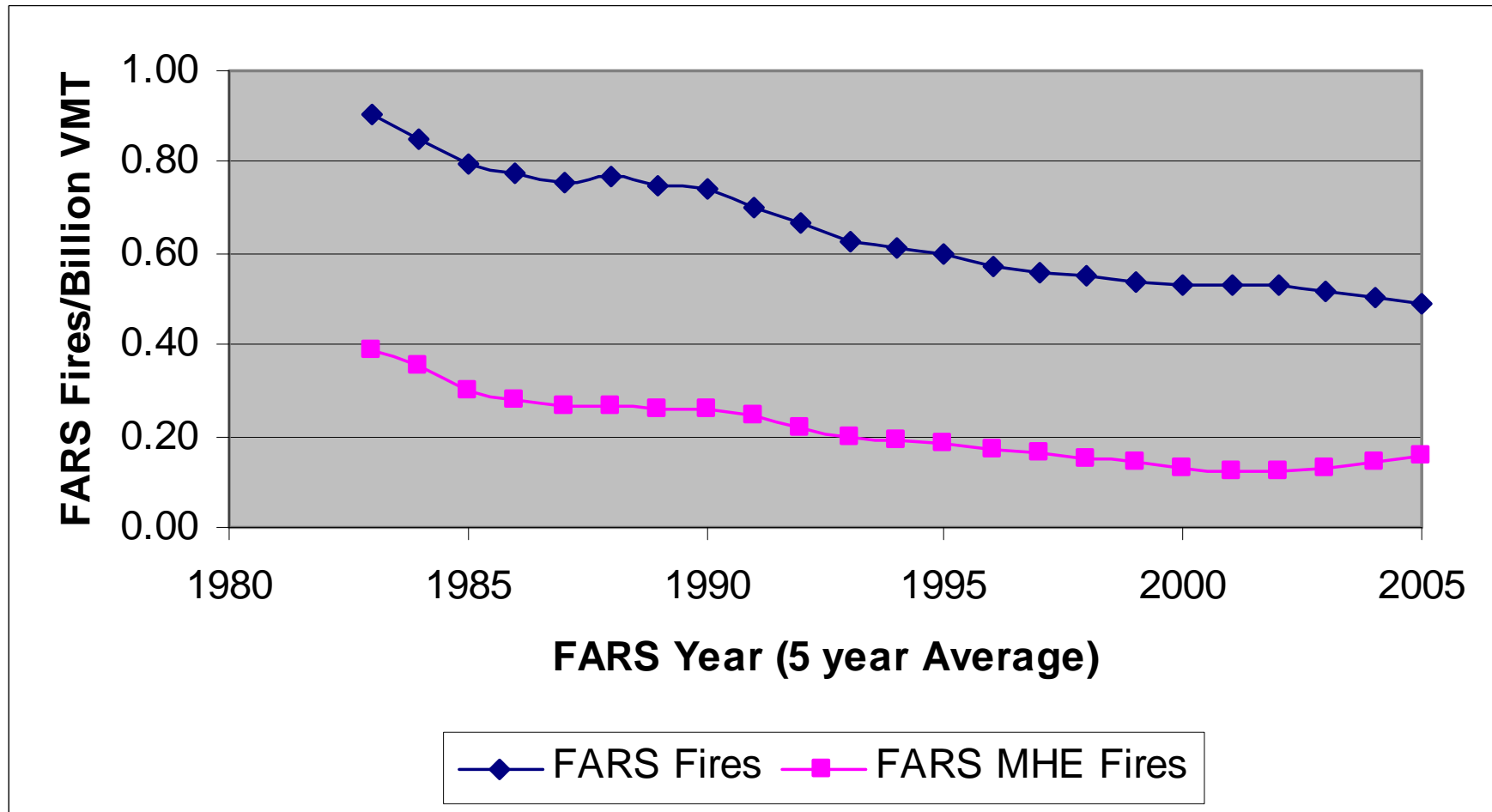
Annual US Motor Vehicle Fatalities (FARS)



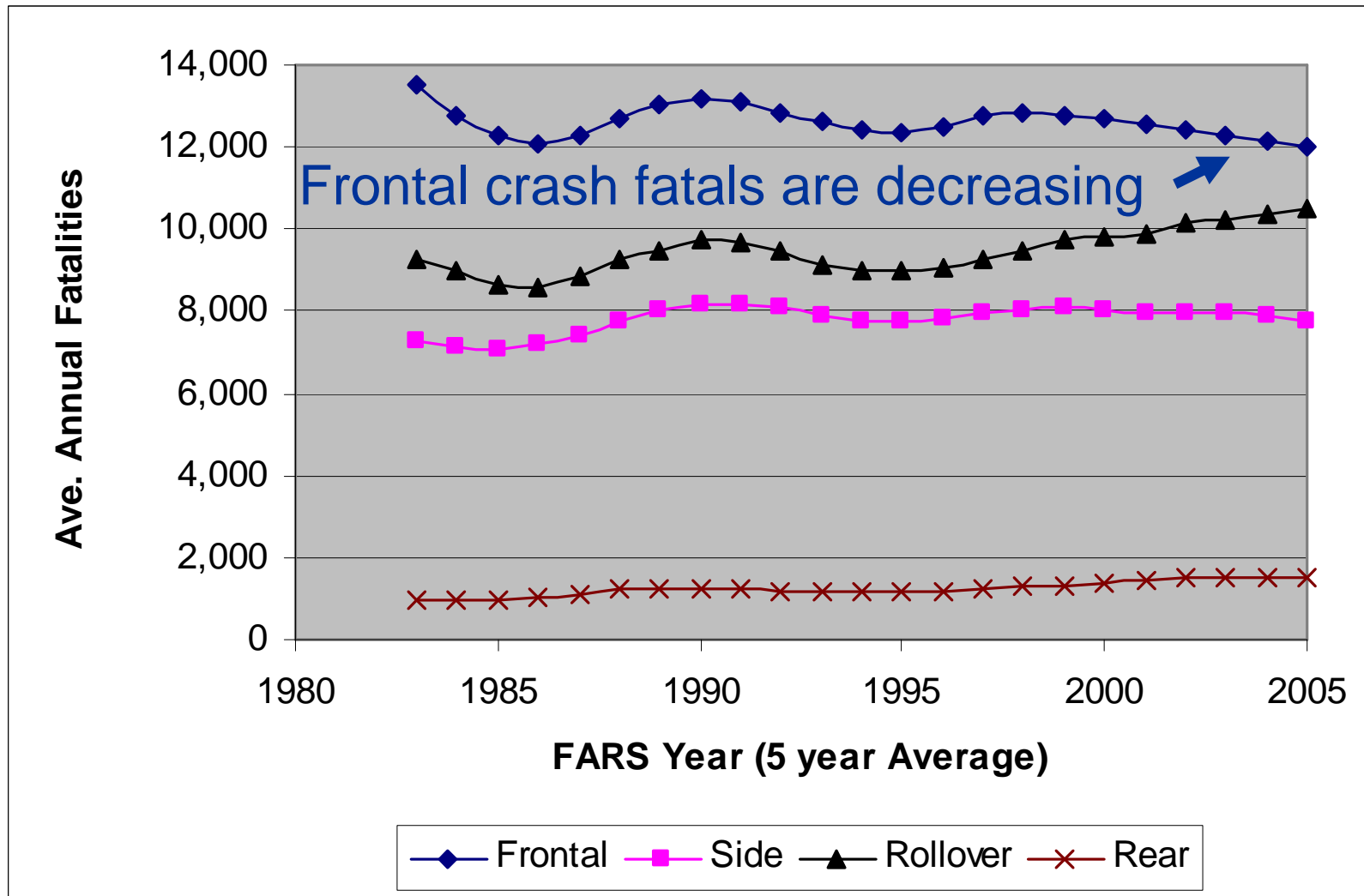
US Motor Vehicle Fatality Rate



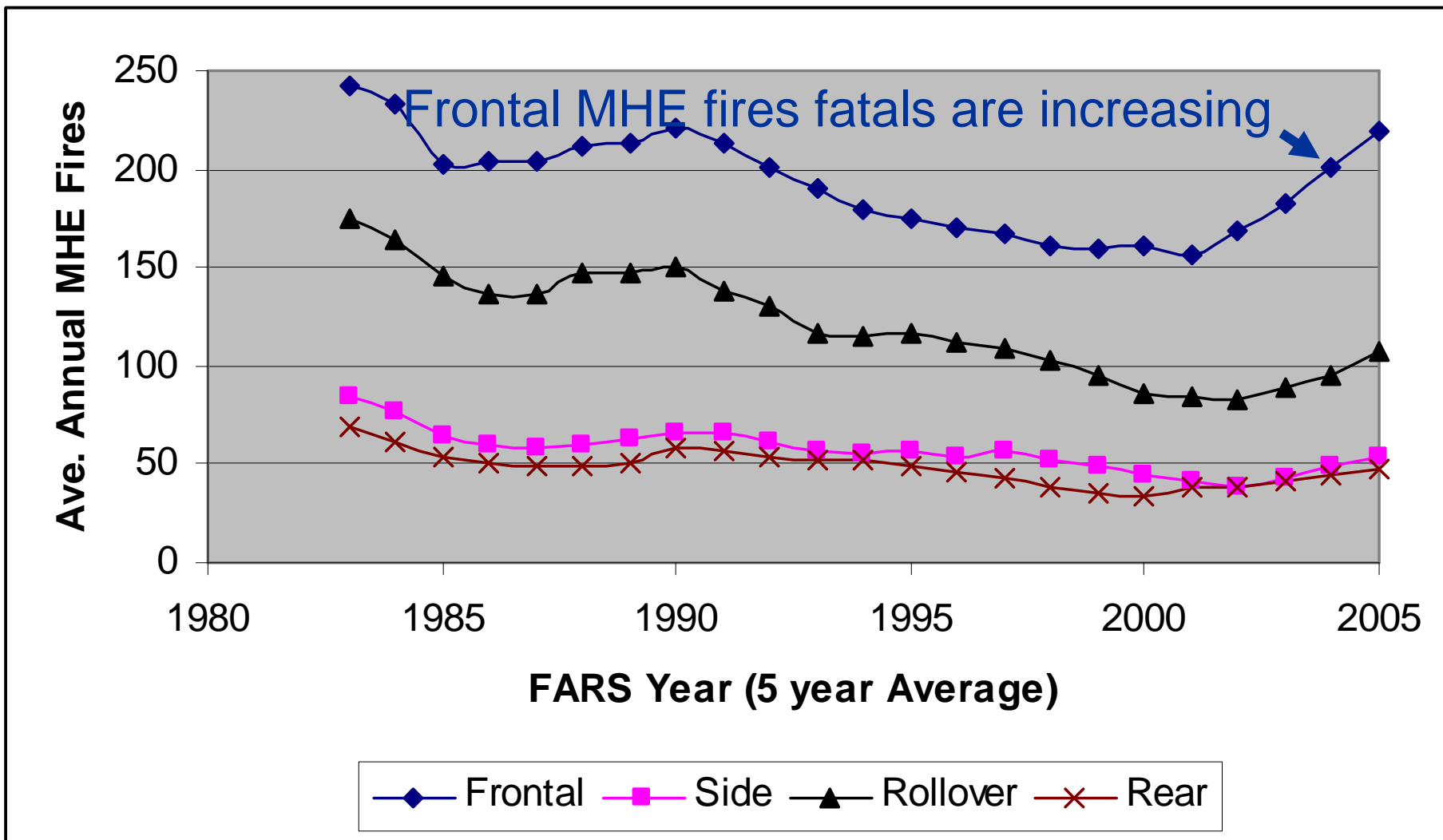
Annual Fire Rates in FARS



US Passenger Vehicle Fatalities (FARS - 5 Year Moving Average)

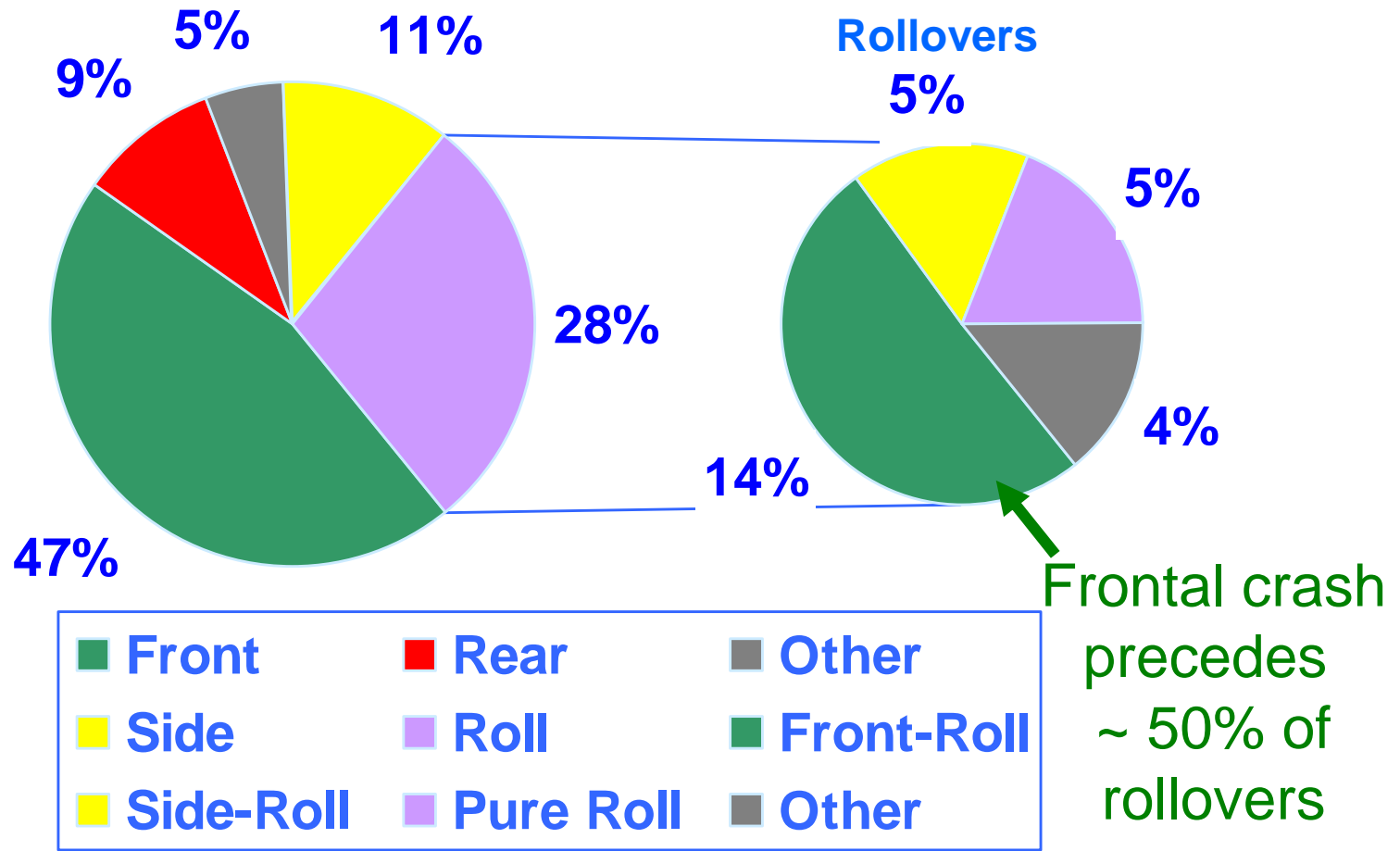


Most Harmful Event Fires by Crash Mode (FARS - 5 Year Moving Average)

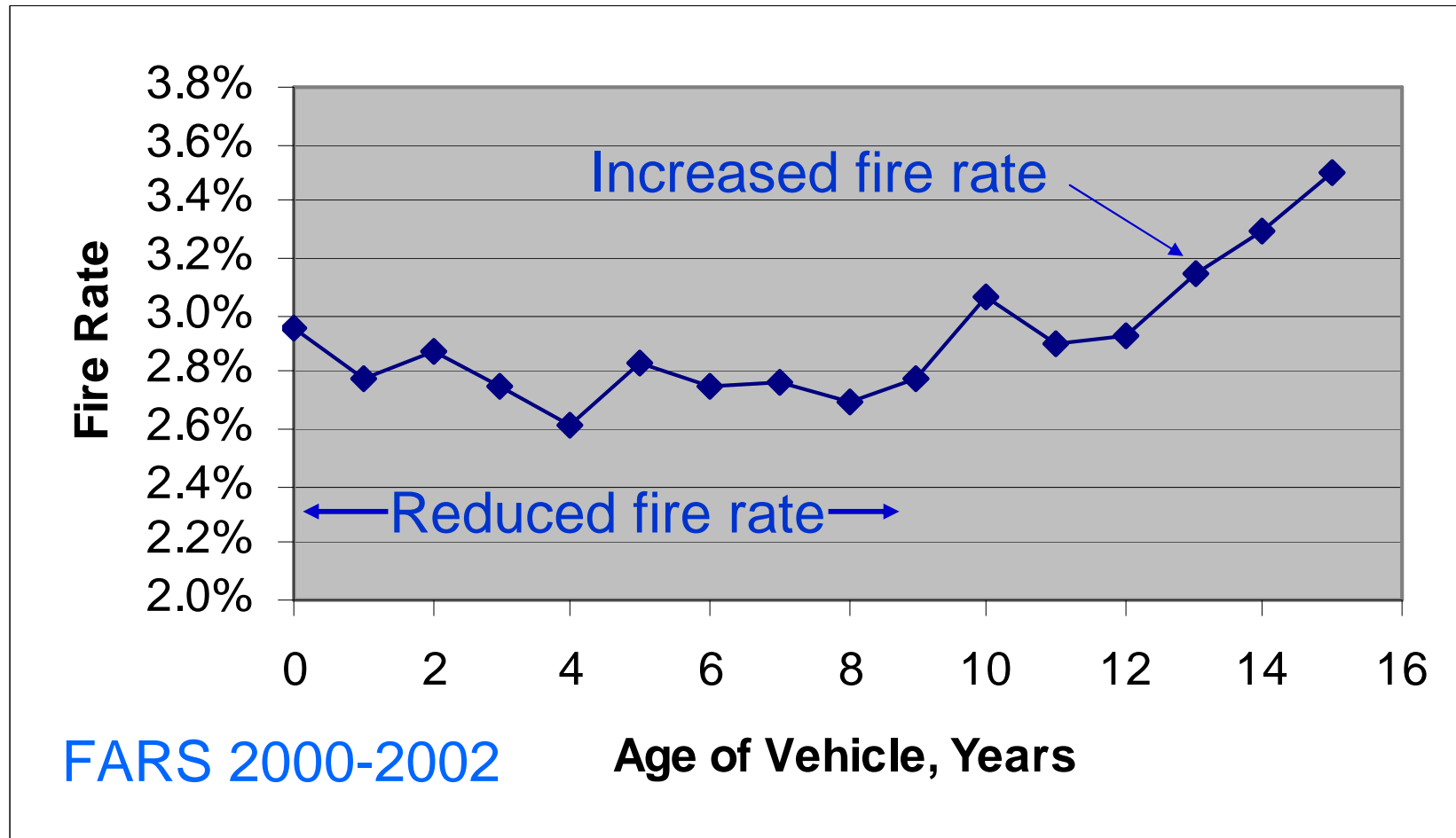


Distribution of Fatalities with Fire MHV by Crash Direction

FARS 2001-2005



Fire Rate (Fires per Crash Involved Vehicle in FARS) vs. Age of Vehicle



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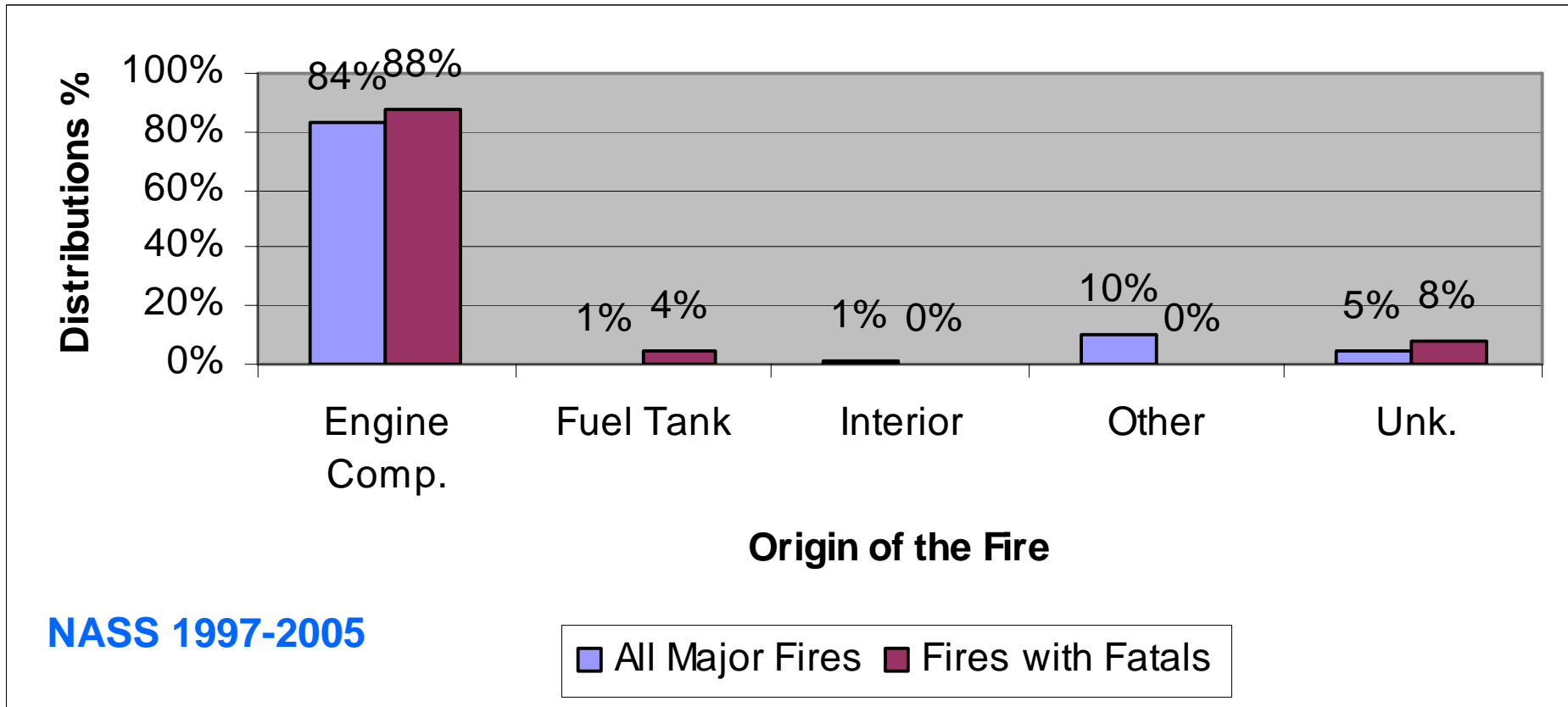


NASS/CDS Data on Frontal Crashes with Major Fires and Fires with Fatalities

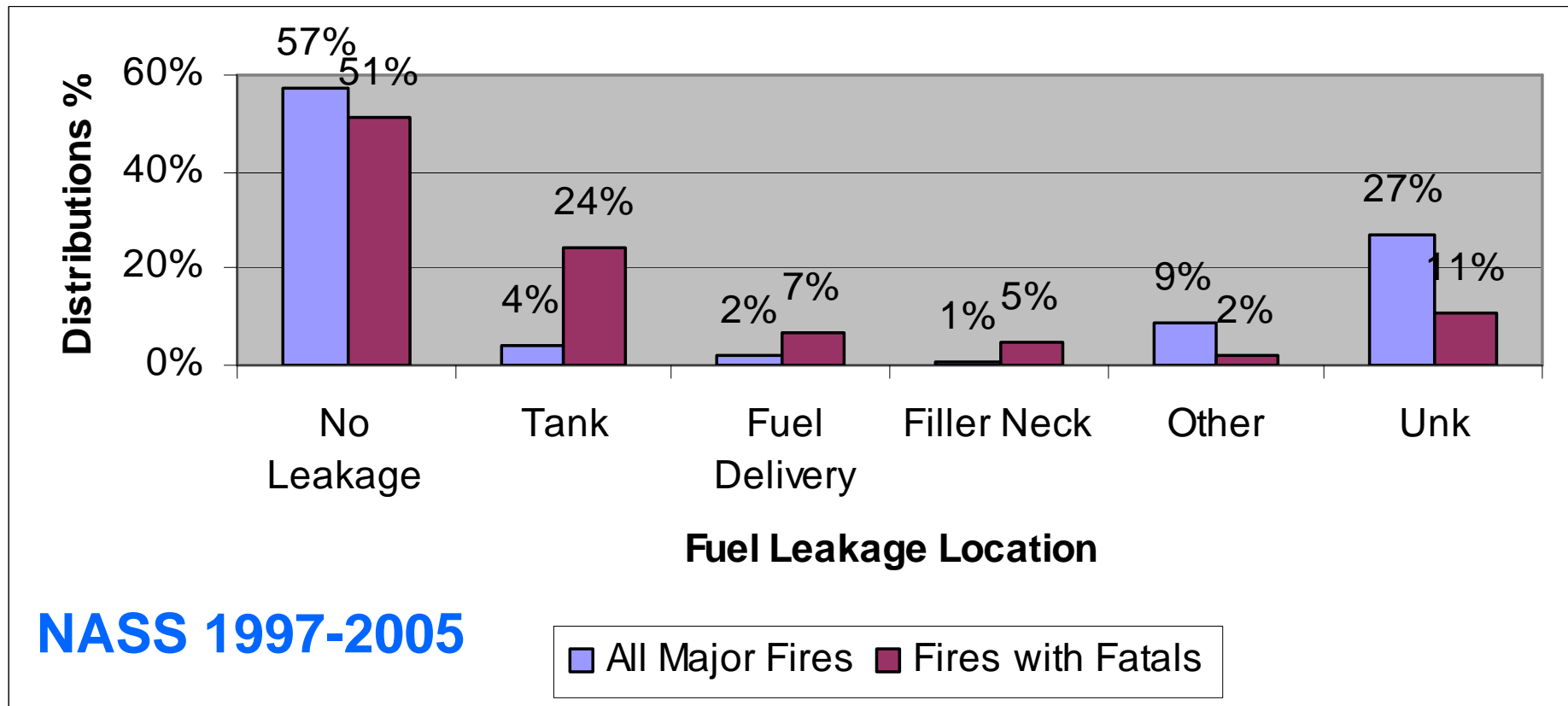
The National Automotive Sampling System/Crashworthiness Data System (NASS/CDS) 1997-2005 –

- Vehicles less than 10 years old
- 87 vehicles with frontal impact and major fires
- When weighted expands to 10,337 vehicles
- Standard error \sim 23% for this size NASS population

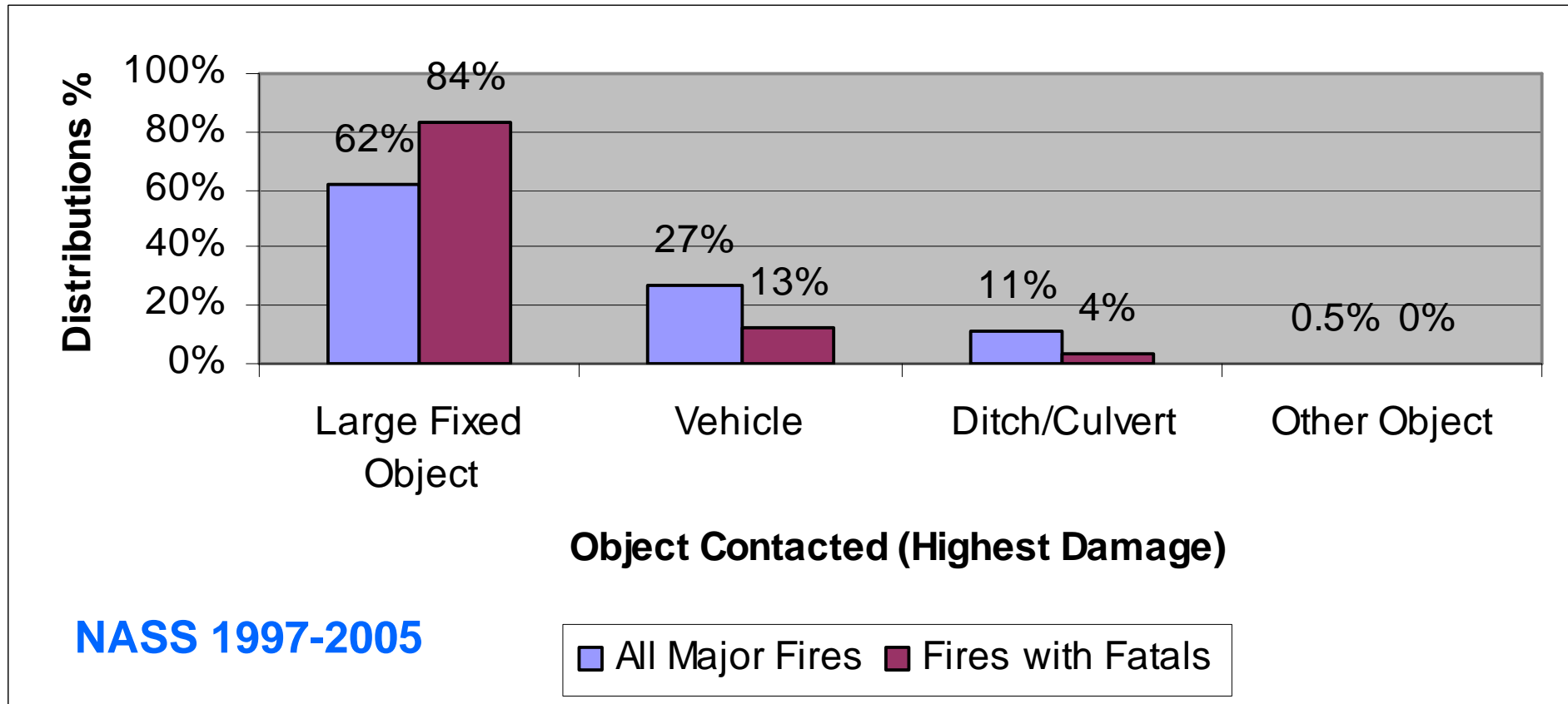
Distribution of Major Fires and Fires with Fatalities; Vehicles <10 Years Old - Fire Origin



Distribution of Major Fires and Fires with Fatalities; Vehicles <10 Years Old - Fuel Leakage Location



Distribution of Major Fires and Fires with Fatalities; Vehicles <10 Years Old -Object Contacted



CDC -Extent of Deformation

Extent of Damage - Frontal Crash Direction

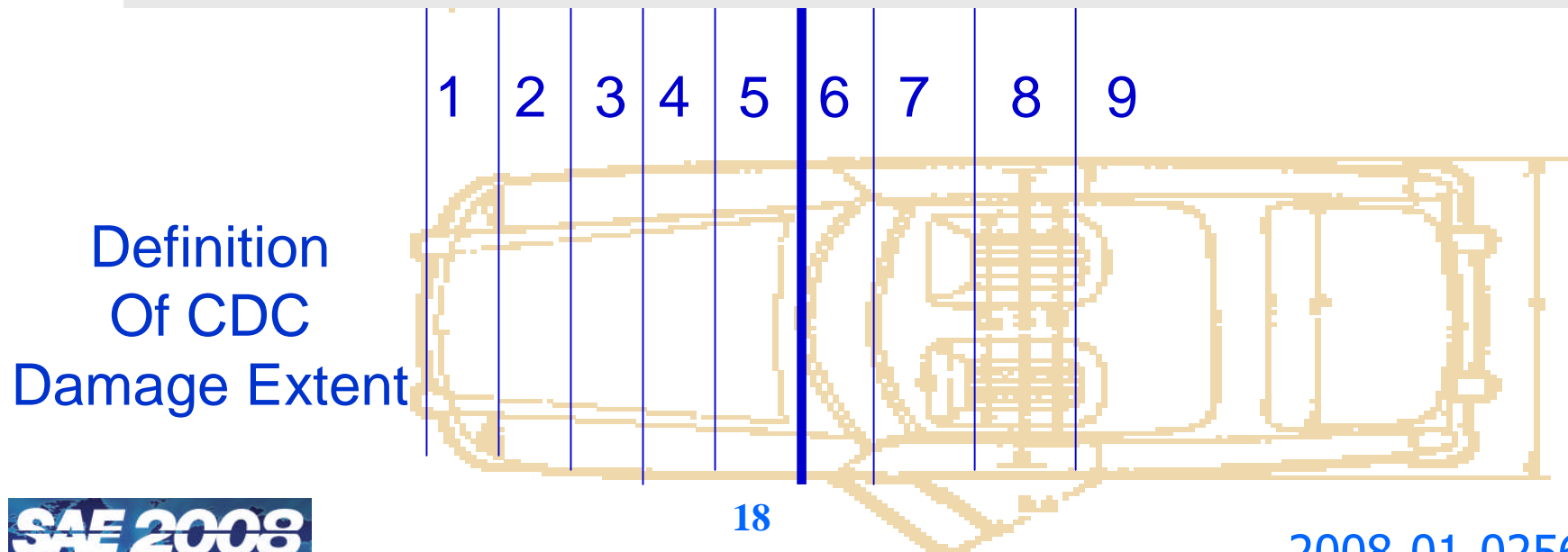
Range 1 to 9

1 to 5 - Equally Divided to Firewall

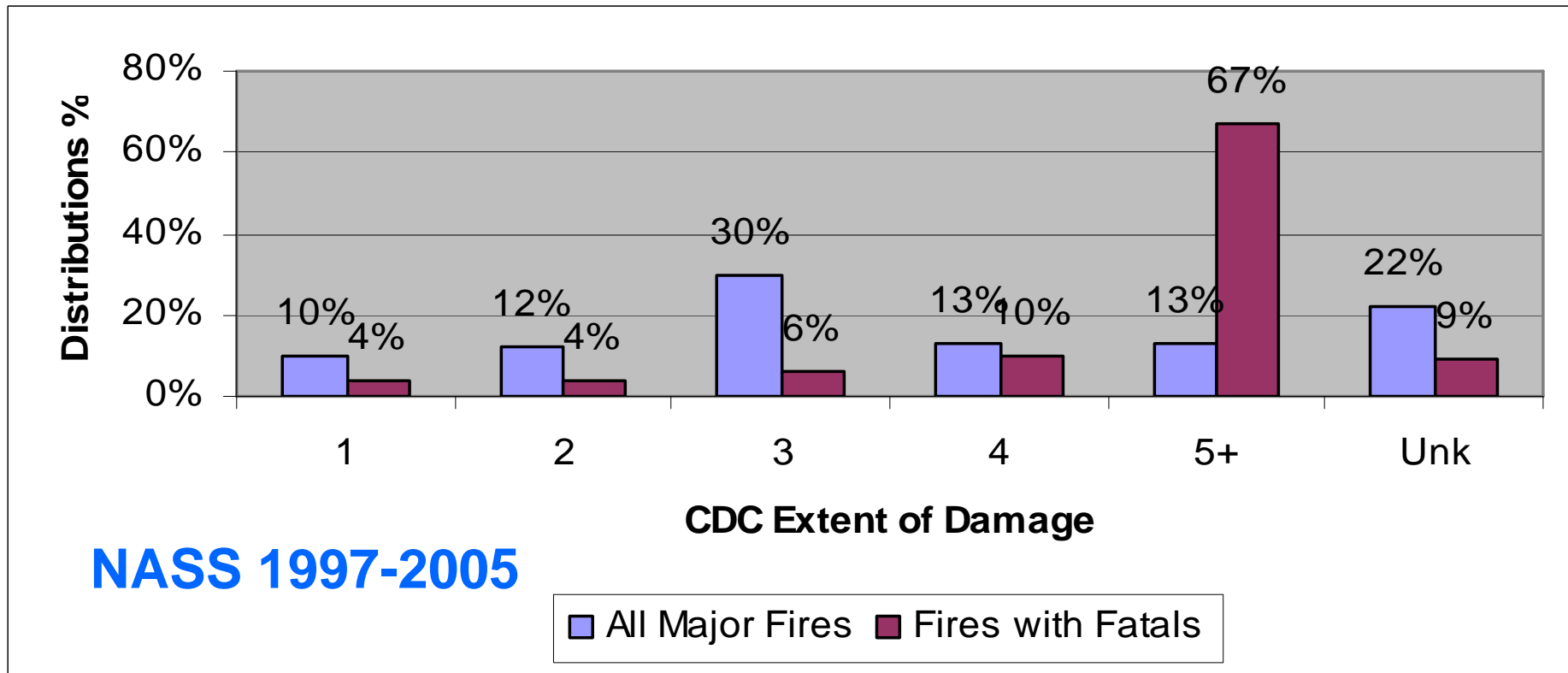
6 – Front to Rear of Windshield

7 & 8 – Equally Spaced; Rear of Windshield to B-Pillar

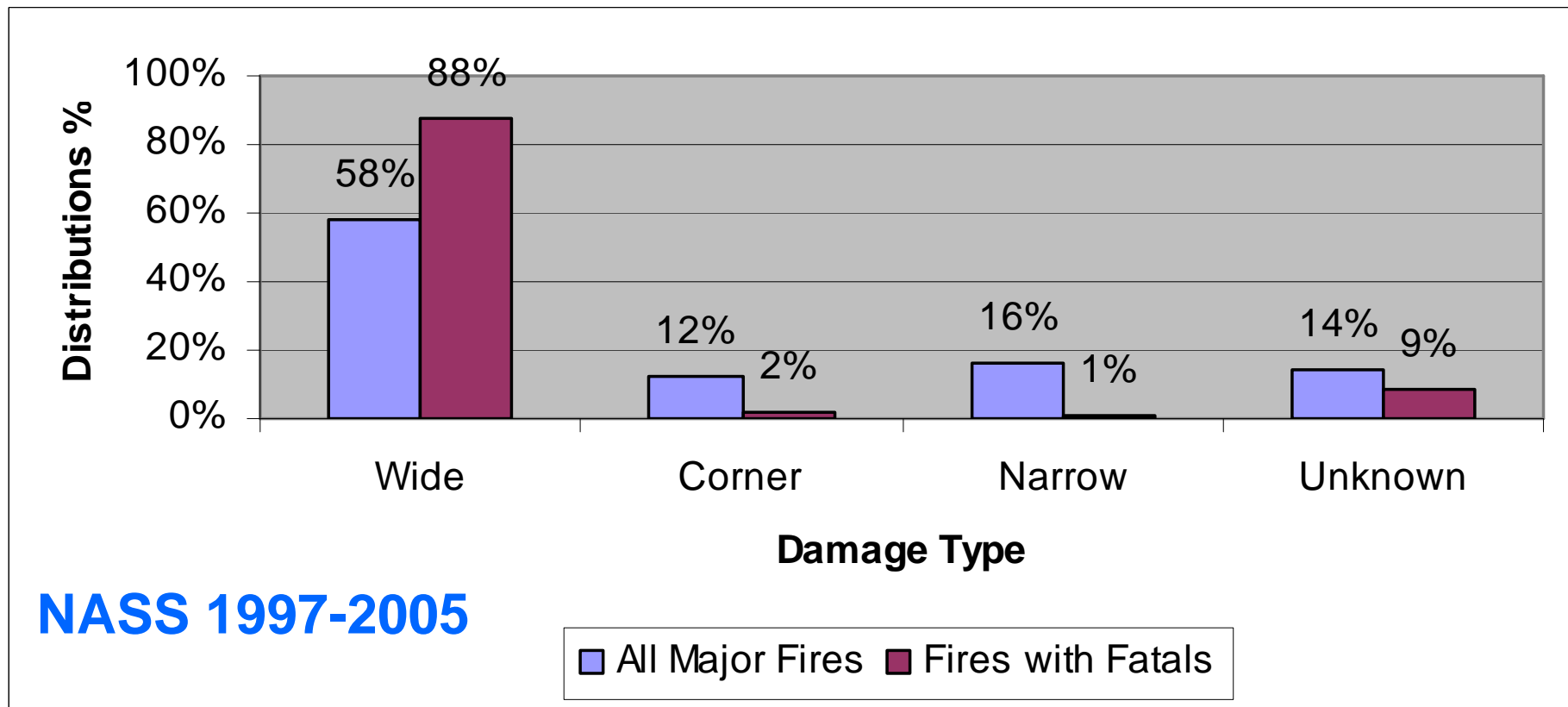
9 – Beyond B-Pillar



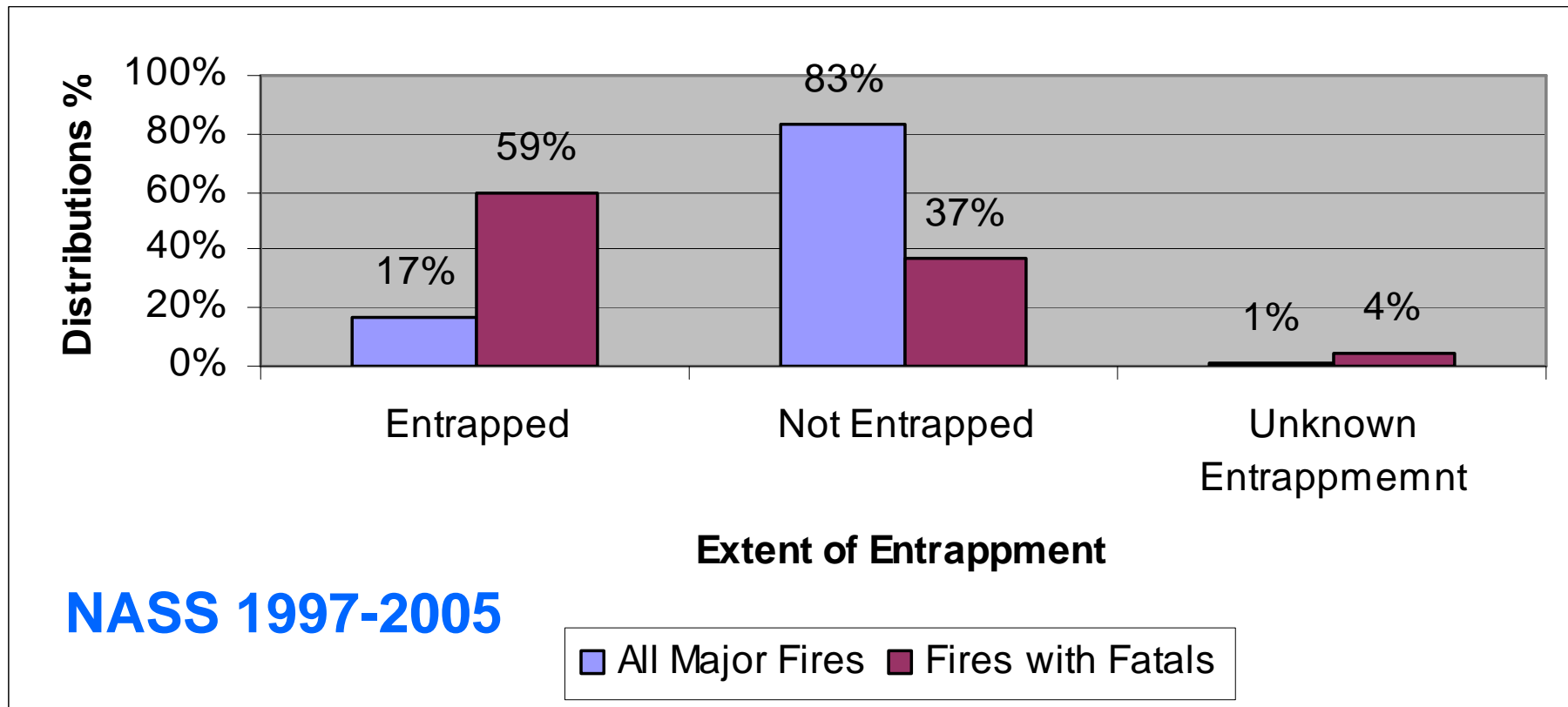
Distribution of Major Fires and Fires with Fatalities; Vehicles <10 Years Old -Extent of Damage



Distribution of Major Fires and Fires with Fatalities; Vehicles <10 Years Old - Damage Type



Distribution of Major Fires and Fires with Fatalities; Vehicles <10 Years Old - Extent of Entrapment



Pre-crash Factors – All Major Fires

73% were single vehicle crashes

63% involved run-off-the-road

25% involved braking and steering pre-crash maneuvers



Other Statistics - Fatalities

66% were in multi-impact crashes

30% involved a large fixed object as the second object impacted

25% involved secondary damage from ditches or culverts



General Observations from NASS – Frontal Crashes with Major Fires

- Under-hood is predominate fire origin
- Fuel leakage generally not present
- Fuel leakage more prevalent in fires with fatalities; tank most frequently the origin; undercarriage damage often suspected
- Prevalent crash mode – large fixed objects
- Prevalent damage – wide
- Most fatalities associated with CDC Extent 5+
- Entrapment frequent among fatalities

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Examination of Eight Cases in NASS where Fire may have contributed to the Fatality

Of 86 major fires, 27 vehicles had occupants
with fatal injuries

8 vehicles had occupants with burns coded as
the most severe injury

- Eight cases are insufficient to extrapolate results to the entire population of crashes
- They provide useful insights into fire causation

Summary of 8 NASS Cases with Fatalities and Burns as the Most Serious Injury

Case	Origin of Fire	Leakage Location	CDC Damage Extent	CDC Damage Width	Entrapped?	Object Contacted	2nd Object Contacted
1	Eng. Comp	See Note	4	Wide	Door Jam	Large Tree	
2	Eng. Comp	None	4	Wide	Door Jam	Large Tree	
3	Eng. Comp	None	7	Corner	Entrapped	Large Tree	
4	Eng. Comp	Tank	5	Wide	Entrapped	Ditch/Culvert	Large Tree
5	Fuel Tank	Tank	3	Wide	Door Jam	Barrier	Top of Barrier
6	Eng. Comp	None	2	Wide	None	Vehicle Side	Sideslap
7	Unknown	Unk.	3	Wide	Door Jam	Vehicle Side	
8	Eng. Comp	Unk.	Unk	Unk.	Unknown	Vehicle Rear	Barrier

Note: Leakage Location - Line/Pump/Filter

Cases 1 thru 4: Lane departure with severe frontal damage from impact with tree

Case 4: Culvert may have damaged fuel tank

Case 5: Hardware on top of barrier may have damaged fuel tank

Case 6: Frontal under-ride with a tractor/trailer

Cases 7 and 8: Fire probably originated in other vehicle

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3	Eng. Comp	None	7	Corner	Entrapped	Large Tree	
4	Eng. Comp	Tank	5	Wide	Entrapped	Ditch/Culvert	Large Tree
5	Fuel Tank	Tank	3	Wide	Door Jam	Barrier	Top of Barrier
6	Eng. Comp	None	2	Wide	None	Vehicle Side	Sideslap
7	Unknown	Unk.	3	Wide	Door Jam	Vehicle Side	
8	Eng. Comp	Unk.	Unk	Unk.	Unknown	Vehicle Rear	Barrier

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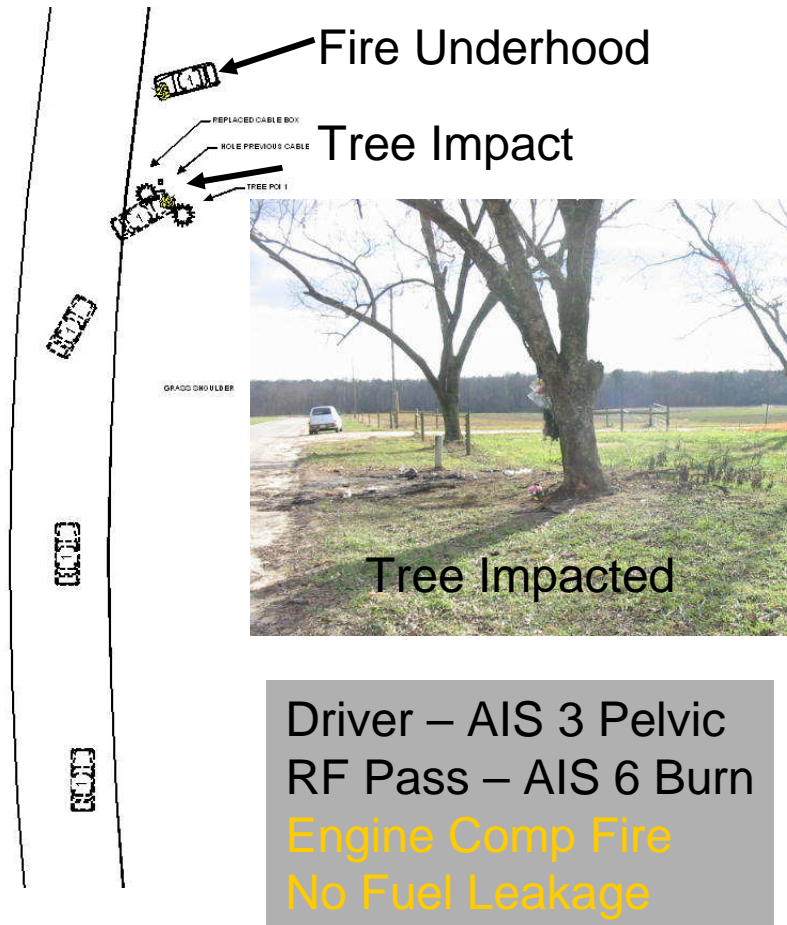
Case 4: Culvert may have damaged fuel tank

Case 5: Top of barrier may have damaged fuel tank

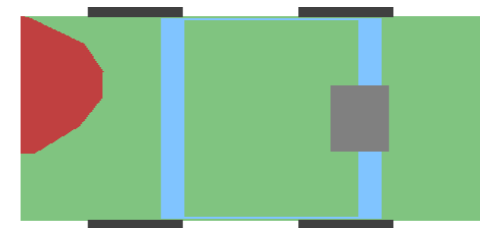
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Underhood Vehicle Fire – Run-off-road – Tree Impacted



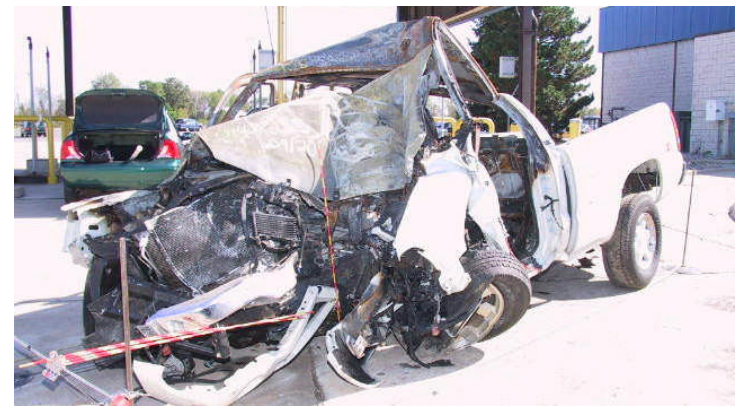
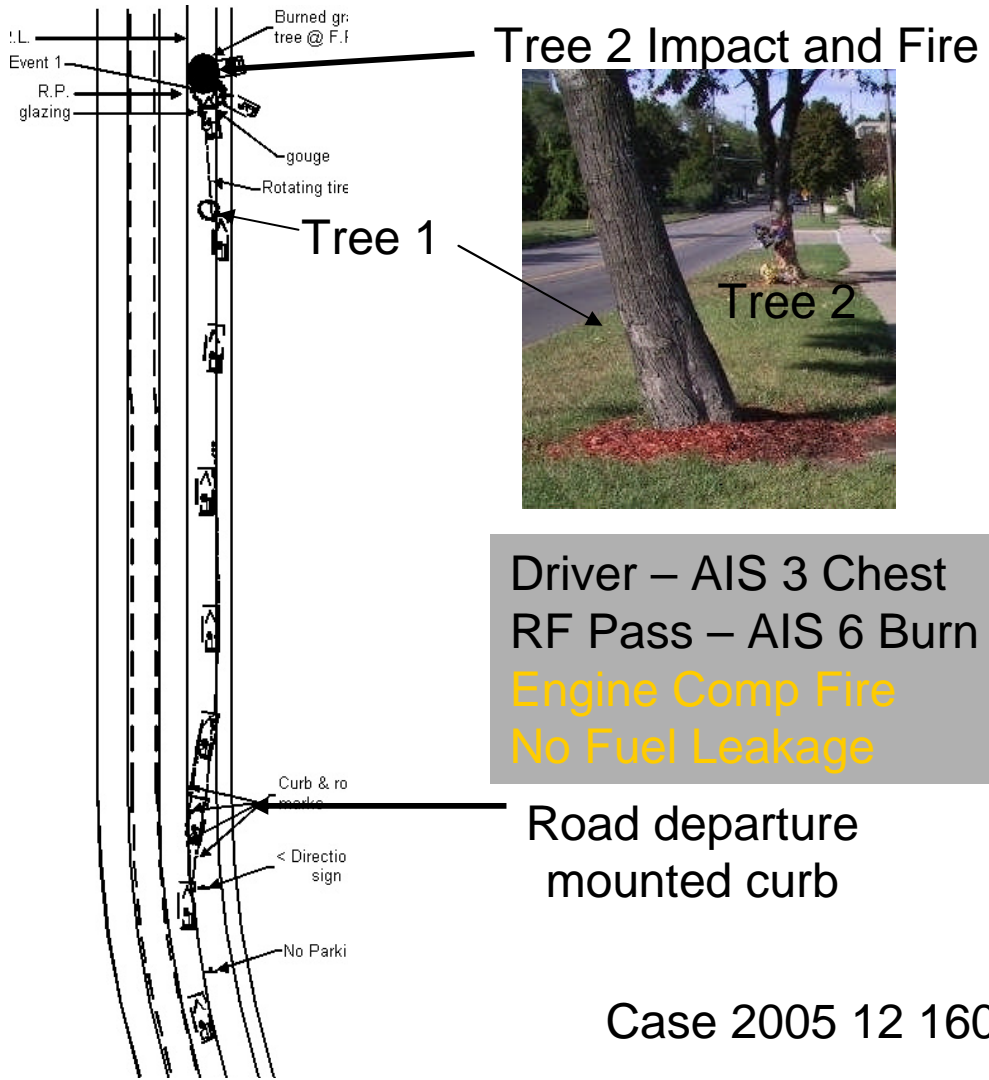
Vehicle Damage



Damage Profile CDC- 4
Jammed Door

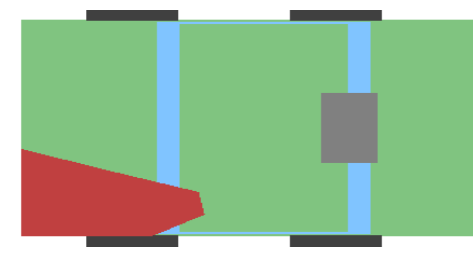
Case 2004 43 343

Underhood Vehicle Fire – Run-off-road – Tree Impacted



Driver – AIS 3 Chest
RF Pass – AIS 6 Burn
Engine Comp Fire
No Fuel Leakage

Vehicle Damage

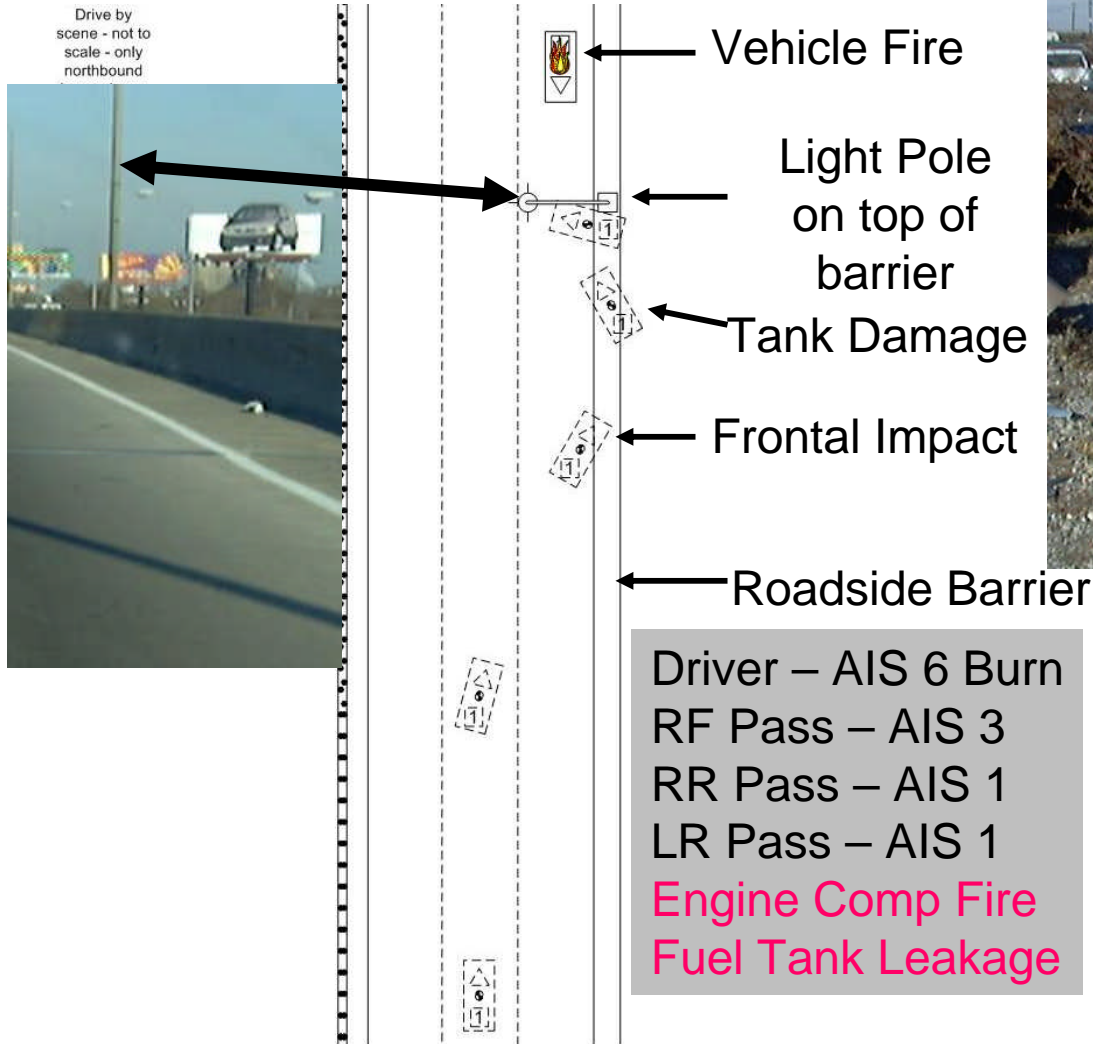


Road departure
mounted curb

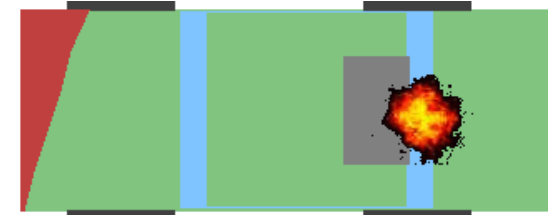
Damage Profile CDC – 7
Entrapped

Case 2005 12 160

Fuel Tank Fire Origin



Vehicle Damage



Damage Profile CDC -3
 Jammed Door

Observations – 8 Fatal Cases in NASS

- Most prevalent crash - lane departure and severe impact with fixed object
- Fire origin in other vehicle (from rear or side impacts) may contribute to frontal impact fire fatalities
- Undercarriage impacts prior to frontal impact may contribute to fuel leakage
- Entrapment was prevalent in these cases

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Conclusions

- Frontal crashes are ~50% of NASS major fires and FARS crashes with fire as MHE
- The numbers, while small, have been increasing (FARS)
- The engine compartment is the most frequent fire origin (NASS)
- Run-off-the-road impacts with fixed objects most frequent mode
- Multi-impacts with possible undercarriage damage also frequent
- Entrapment frequent in fatal cases

Possible Countermeasures

Electronic Stability Control and Lane Departure Control

Countermeasures to enhance egress in severe frontal crashes

Fuel tank protection from undercarriage impacts

Technology to prevent electrical faults and fluid leakage from frontal damage

Underhood fire suppression systems

Questions??