

Research Programs in Crash-Induced Fire Safety

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February 2005

MVFRI

Presentation Outline

Who is MVFRI?

Selected Research Projects

- ≡ Analysis of field data - Frequency of fires
- ≡ Rollover Fire Occurrence and Fuel Containment
- ≡ Electrical conductivity of under-hood materials
- ≡ Other Research Projects

Conclusions

MVFRI - Charter

The Motor Vehicle Fire Research Institute (MVFRI) is an independent, nonprofit, organization specializing in automobile fire safety research.

MVFRI performs objective research to develop and implement successful technology to reduce the incidence of injuries and death resulting from post-collision fuel fed fires in existing and future designs of passenger vehicles.

Background of Research

From 1995-2000 GM funded \$10 million in fire research in a GM/DoT Settlement of an investigation of an alleged defect in C/K pickup trucks.

Beginning in 2001 GM began funding \$4.1 million in fire related research as result of a judicial settlement of the alleged defect.

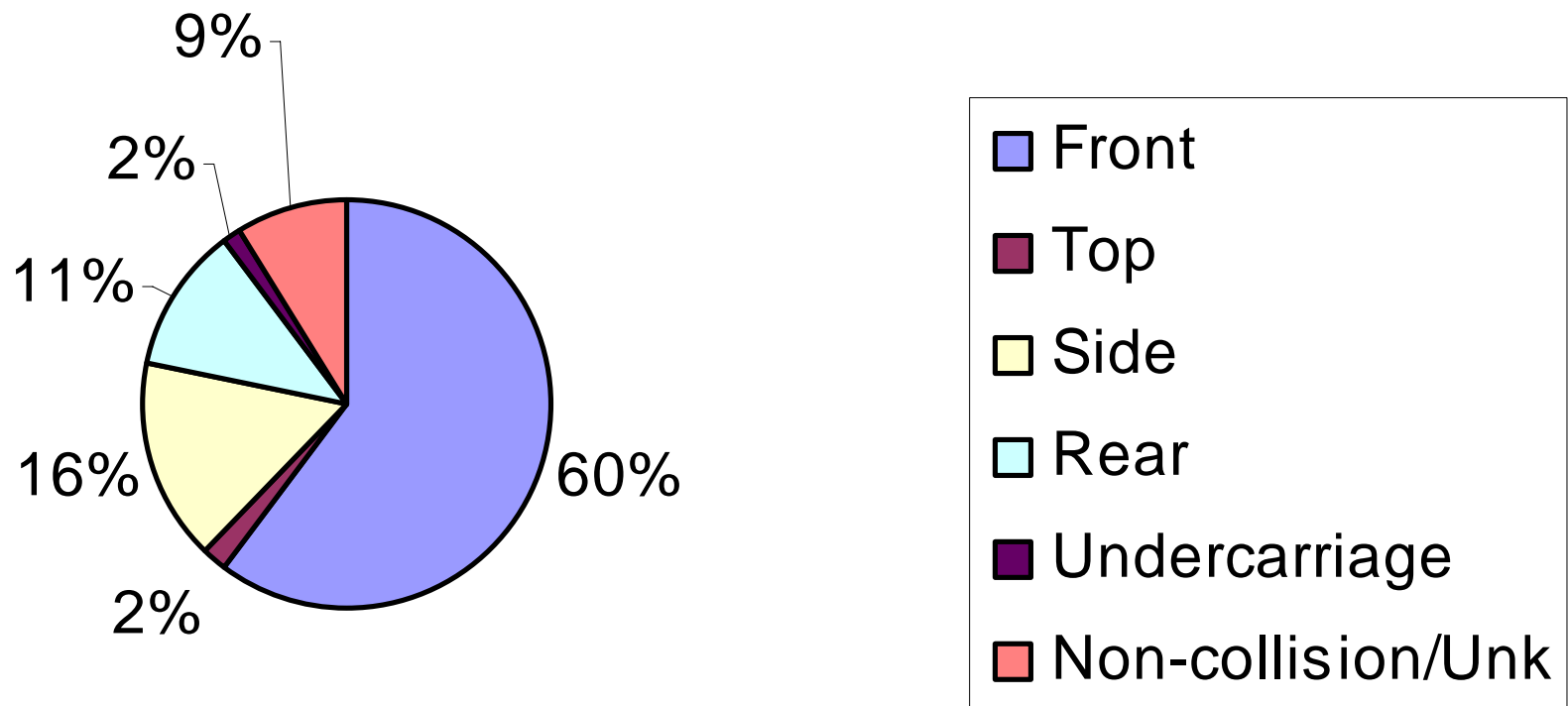
This research is being administered by MVFRI with K. Digges at trustee. Neither of the settlement parties specify the research to be done.

Summary of FARS and NASS Findings

Analysis of Most Harmful Event in FARS

Most harmful event applies to the vehicle, not the people in the vehicle. Therefore, one can not assume that the most harmful event for a vehicle was the cause of any death or injury for any specific individual within the vehicle.

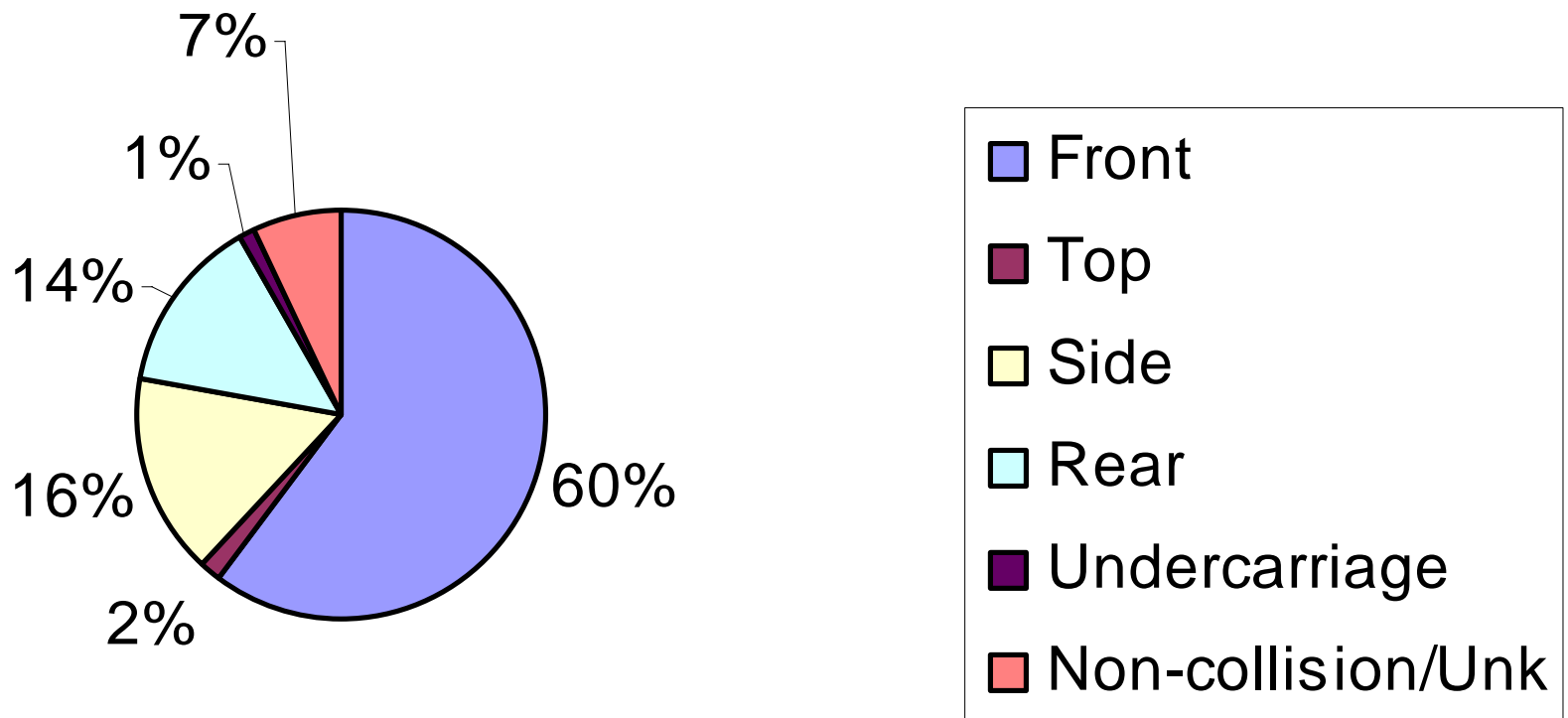
Damage Location for Fatal Fire Cases where Fire is Most Harmful Event



FARS 1994-2003 – 4,322 Cases

Damage Location for Fatal Fire Cases Requiring Extraction

where Fire is the Most Harmful Event



FARS 1994-2003 – 1004 Cases

NASS/CDS 1994-2002 Data

513 crashes in which there was an occurrence of fire –
expanded to 66,243 (weighted) vehicle fire occurrences.

NASS/CDS Fire Data

The 513 crashes had 820 occupants where 350 sustained MAIS 3+ injuries and 188 were fatally injured. These expanded to 105,926 occupants 20,000 MAIS3+ and 10,348 fatalities

When the most severe injury was attributed to the fire (fire as the most harmful event), the corresponding numbers of MAIS 3+ injuries and fatalities were 100 and 83, respectively. These numbers expanded to 5,766 MAIS 3+ and 4,744 fatalities.

NASS Raw and Weighted Fire Data

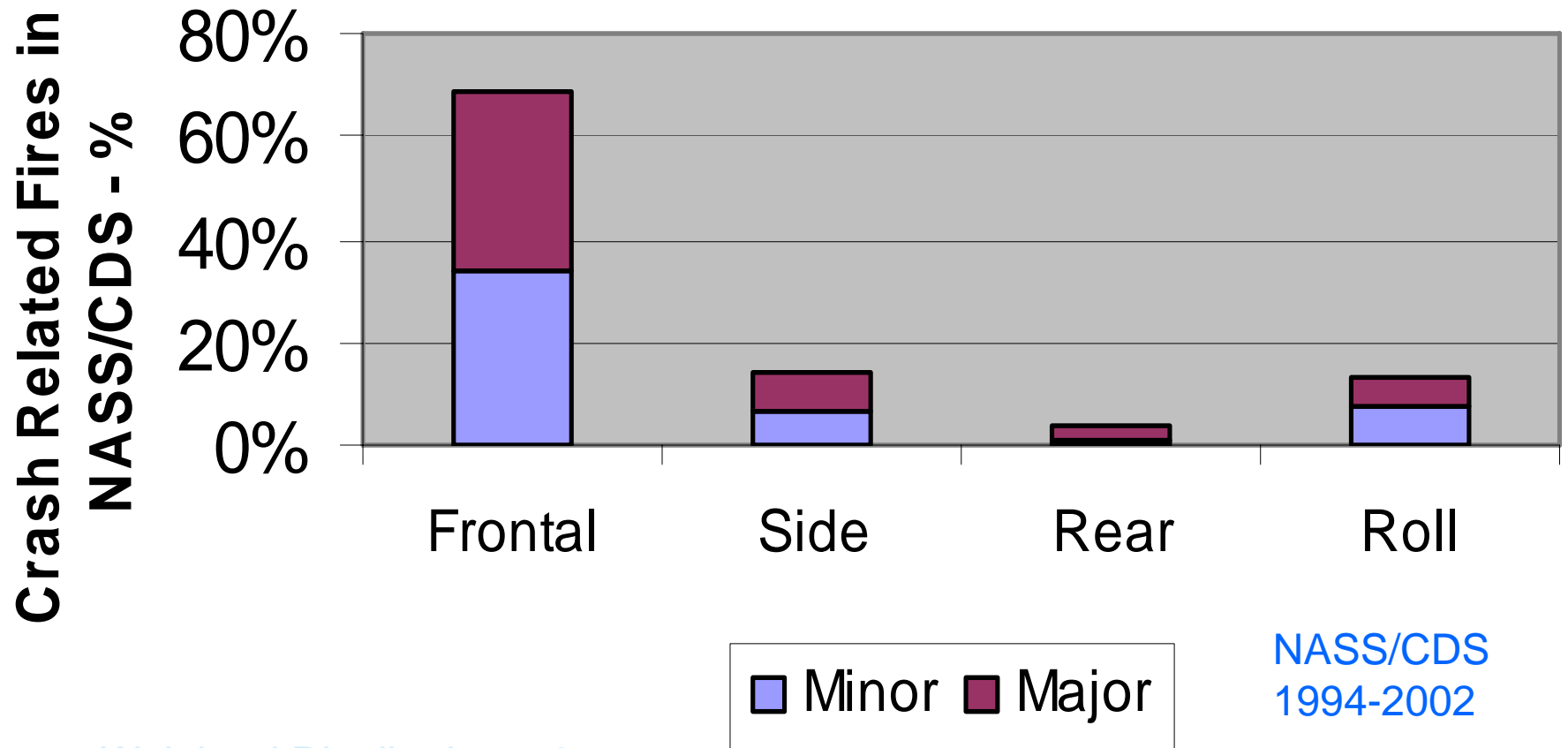
All Fires	Occupants	MAIS 3+	Fatals
Raw	820	350	188
Weighted	105,962	20,000	10,348
Fires as Most Harmful Event			
Raw		100	83
Weighted		5,766	4,744

NASS Fires

Major – A fire that spreads to the occupant compartment ~4,500 per year

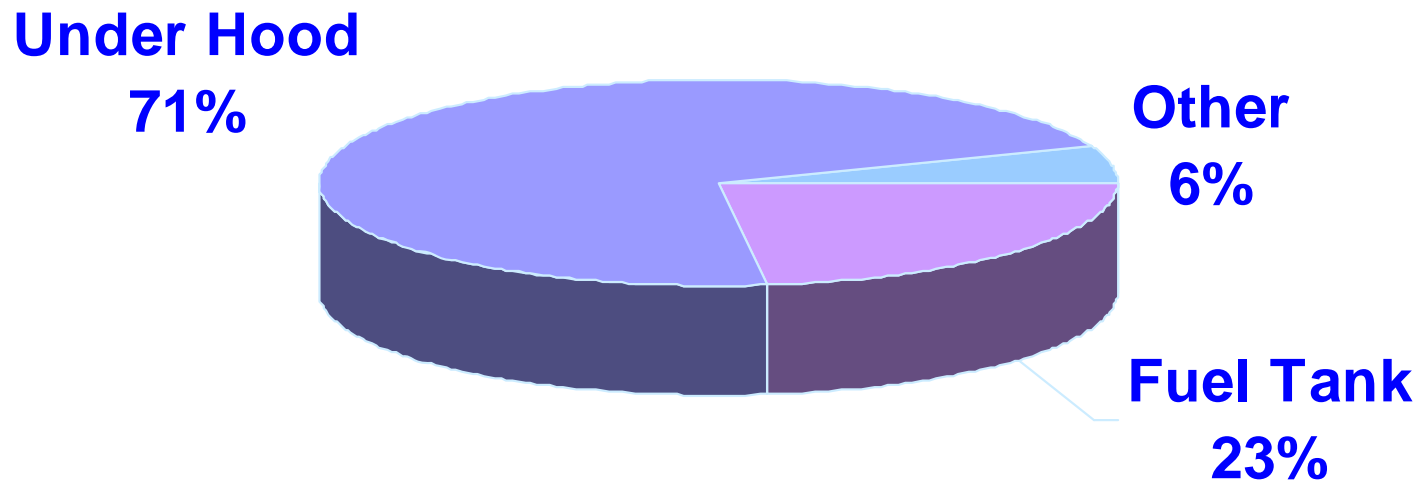
Minor – A fire that does not spread to the occupant compartment from outside or, if initiated within the occupant compartment does not spread ~ 4,245 per year

Distribution of Crash Related Fires in NASS/CDS by Crash Direction



Weighted Distribution - 9 years

NASS Major Fires by Fire Origin



Engine compartment fires are most frequent

Fires in NASS/CDS 1997/2002

All Crash Directions

Fire Location	Fire Severity		Total
	Minor	Major	
Fuel Tank	1%	12%	12%
Under Hood	40%	37%	77%
Cargo/Trunk	1%	1%	2%
Dashboard	4%	0.4%	4%
Other	1%	2%	3%
Total	47%	53%	100%

Fuel Leakage in NASS/CDS

Leak Location	Minor	Major
No Fuel Leakage	97.60%	58.60%
Tank	0.90%	7.30%
Filler Neck	0.50%	24.50%
Cap	0.10%	0.30%
Line/Pump/Filter	0.70%	1.30%
Other	0.20%	8.00%
Total Vehicles	35,731	25,039

Entrapment Mode – NASS/CDS

Entrapment Mode	Fire Severity		Total
	Minor	Major	
Not Entrapped	28%	72%	94%
Mechanically Restrained	13%	87%	4.9%
Vehicle Jammed	36%	64%	1.3%

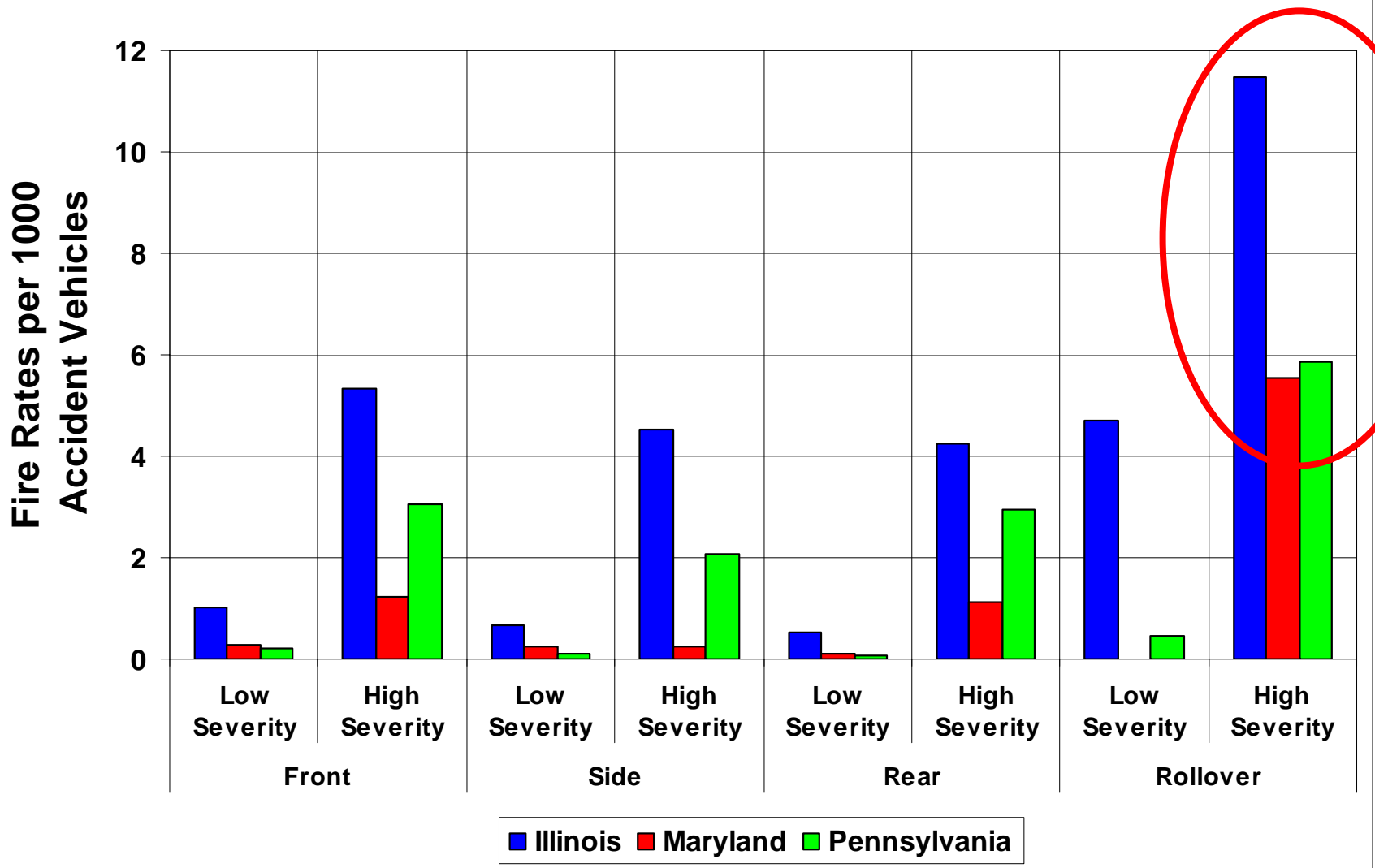
Rollovers and Fires

State Data

FARS

NASS/CDS

Passenger Car Fire Rates by Damage Area and Severity



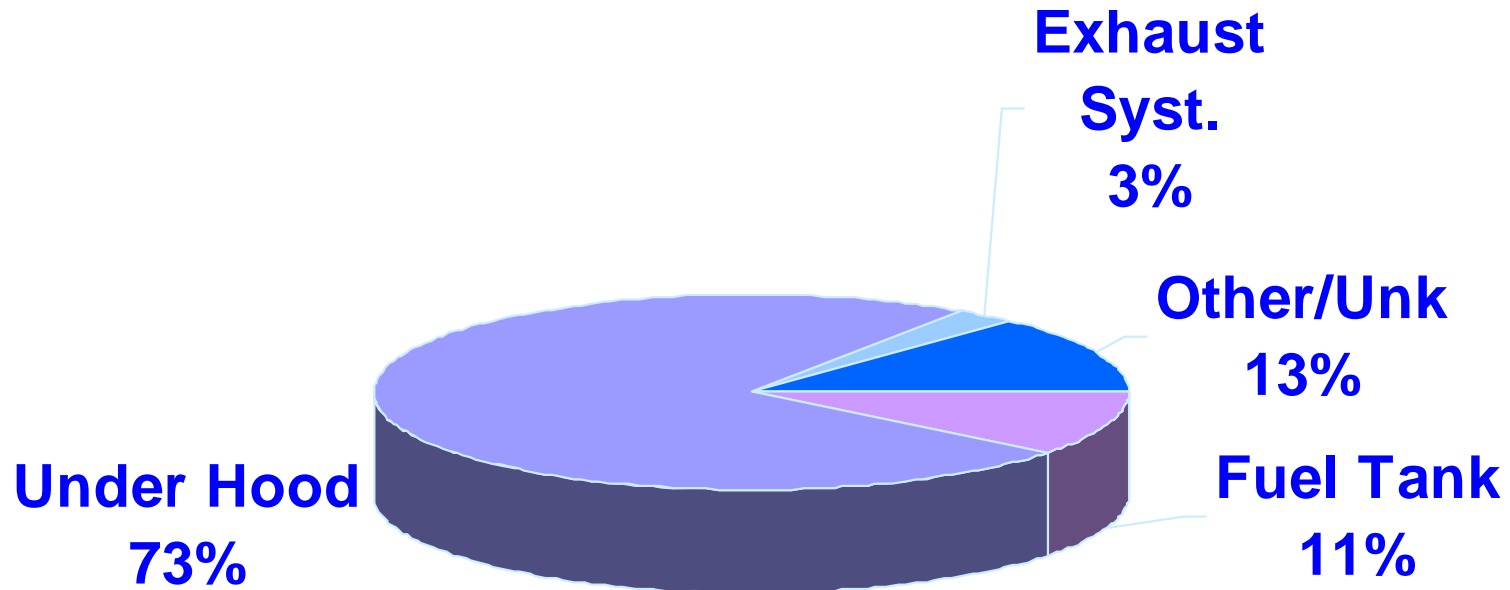
Fires in Rollovers from FARS 2000-2002

Average numbers for three years

	All FARS	Roll no fire	Fire no roll	Fire+Roll
Numbers	58,113	10,777	1,268	443
% of FARS			2.18%	0.76%
% rolls w fires				3.95%

Rollovers have 1.7 times increased fire risk vs. other crash modes

NASS Major Rollover Fires by Fire Origin



Engine compartment fires are most frequent

Fuel Leakage Location for Underhood Rollover Fires in NASS/CDS

<u>Leakage Location</u>	<u>Major</u>	<u>Minor</u>	<u>All</u>
Cap/Filler Tube	2	1	3
Fuel Lines	1	0	1
Tank	1	0	1
No Fuel Leak	11	25	36
Other	1	0	1
Unknown	4	2	6
Total	20	28	48

Evaluation of Existing Fuel Containment Technology in Present Day Vehicles

20 fuel systems evaluated by simulating a rollover with leak measurements at 7 roll increments

None leaked with all lines in-tact

4 did not leak in any orientation when each of the lines was severed and the system was rolled

6 leaked at all orientations when lines were severed

Testing of Electrical Conductivity of Underhood Fluids

Objective –

Determine if fluids normally in the engine compartment could increase the risk of arcing if they contaminate electrical insulators and connectors.

This is called carbon-tracking.

It would be more prevalent in 42 volt systems

Testing of Electrical Conductivity of Underhood Fluids

Quaker State SAE 5W30

Motor Oil Mobil 1 SAE 5W30

Synthetic Motor Oil; Valvoline SynPower

Power Steering Fluid Quaker State Dextron III/Mercon

Automatic Transmission Fluid Prestone DOT3

Brake Fluid Prestone

Ethylene Glycol 100% Anti-freeze Sierra

Propylene Glycol 100% Anti-freeze All Weather

Windshield Washing Fluid Regular

Unleaded Gasoline

Diesel Fuel

Prestone Anti-freeze Mixture

Ethylene Glycol 50% / 50% H₂O Sierra Anti-freeze Mixture

Propylene Glycol 100%/50% H₂O

Testing of Electrical Conductivity of Underhood Fluids

Results – The tested fluids all have high resistivity and should not cause carbon-tracking

Underhood Fire Suppression

UMd report on Nitrogen based foam system completed

Successfully demonstrated the ability to control an 80 Kw underhood fire

Tested on 4 wheels and on roof (rollover)

Conclusions

Frontal crashes account for the largest percentage of fires; Rollover is second

In FARS, rollovers are 1.7 times more likely to have a fire than other crash modes

The engine compartment is the most prevalent origin of fires in frontal crashes and rollovers

Technologies exist to prevent fuel leakage in rollovers, even with lines severed

Under-hood fluids should not cause electrical arcing

An under-hood fire suppression system has been demonstrated

Acknowledgment

Funds for this project were provided by General Motors under the settlement agreement:

Judicial District Court "Agreement of Settlement, White, Monson and Cashiola vs General Motors", Number 42,865, DIV."D", 18th Judicial District Court, Parish of Iberville, Louisiana, June 27, 1996.

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The End

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