Final Report:

A FURTHER ANALYSIS OF FIRE OCCURRENCE AND ROLLOVER RATES IN THE FATALITY ANALYSIS REPORTING SYSTEM (FARS)

Study Conducted for:
The Motor Vehicle Fire Research Institute

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BACKGROUND

The Fatality Analysis Reporting System (FARS) is one of the most important and frequently used data systems on traffic crash related deaths in the world. Initiated in 1975 by the National Highway Traffic Safety Administration (NHTSA), the FARS contains important information pertaining to fatal motor vehicle crashes that occur in the United States (US). FARS adheres to strict definitions of a fatal crash (e.g. death from the crash must occur within 30 days of the crash to be included in FARS; the crash must involve a motor vehicle in transport on a public roadway; etc.) and rules regarding coding of data. Therefore, FARS does not include information on certain fatal motor vehicle crashes that do not fit FARS definitions and rules. Based upon death certificate and other data sources, it has been estimated that motor vehicle related fatalities that occur on private property, result in a death more than 30 days after the crash, involve a death without a crash occurring (e.g. suffocation, fire) etc. (i.e. do not fit the FARS definition), may account for 1,000 to 2,000 more deaths annually than appear in FARS (National Safety Council, 1990, NHTSA 1996).

Up to 100 or more data elements are collected for each crash (depending upon the number of vehicles involved and the data availability), including information about the crash location and crash scene, key data on each of the vehicles involved in the fatal crash, and vital information on all the drivers, passengers and pedestrians/bicyclists involved in the crash. FARS has been used to identify vehicle safety issues, highway safety problems, examine trends, evaluate countermeasures, and provide key statistics on fatal crashes occurring in the Nation.

FARS data sources include police accident reports, driver licensing records, vehicle registration files, coroner's and medical examiner's reports, emergency medical services (EMS) log sheets, death certificates, hospital reports, and roadway inventories, as examples. FARS Analysts in each State gather data sources and code the information in an electronic FARS file. Some data elements are readily available to these FARS Analysts------other data are difficult to obtain.

Recently, NHTSA released reports generated by Integrated Project Teams (IPTs) on high priority initiatives to address: Safety Belt Use, Impaired Driving, Rollover Mitigation and Vehicle Compatibility (NHTSA 2003). An IPT report was also developed to address Data Improvement which includes FARS data (NHTSA 2004).

Every data element in FARS is important for analysis purposes and it is imperative that data are as complete and as accurate as possible for these analyses to be useful. This is especially true for the following key data elements which are used very frequently in safety investigations and analyses: (1) fire occurrence, (2) rollover occurrence and (3) both fire and rollover occurrence.

For example, FARS data are used to determine the incidence of vehicle fires in fatal crashes and whether the fire caused the death of any occupant. The relative frequency of fires by year/make/model of the vehicle where the fire occurred is used to determine if there is a potential safety problem. It is important for FARS Analysts to use every source of information available to assess whether a fire occurred and then to provide accurate information on the vehicle involved and the injuries sustained. For several reasons, there is good evidence that fire occurrence is underreported in FARS.

It is equally important to determine if a rollover occurred in the crash and to accurately record the vehicle identifying information and the injuries to occupants, including whether they were ejected or not from the vehicle. Vehicle rollovers cause an inordinate number of fatal injuries, so it is important to obtain accurate information concerning their occurrence. There is also some evidence from NASS/CDS data that fires occur at a higher rate in rollover crashes than in other crash modes (Digges, 2005). Consequently it is important that FARS accurately report rollovers and fires in rollovers

In most States, if a fire occurred in close proximity to the crash or if it caused the death of a victim, it should appear in the police report somewhere. However, in a review of NHTSA's Crash Forms Catalog in 2007, it was determined that only 9 States had a specific "box" with a fire notation for routine coding in their PAR (AR, KS, KY, MT, NC, OR, SD, TN, and WV). A full 36 States had the choice of "fire" for the most harmful event while 13 States had "fire" as a choice for their truck/bus fatal supplemental form. Five States made no mention of fire at all in the PAR (CA, DC, MD, VA and WY).

While quality control measures in FARS are state-of-the-art, human resources are limited and it is very difficult for Federal monitors to uncover all the reasons for incomplete or inaccurate data in these areas. There is an urgent need for a special quality control effort to improve reporting rates in these critical areas of FARS.

PREVIOUS RESEARCH

In a prior study (Fell, Tippetts and Bahouth, 2007, SAE), the 10 States with the lowest fire occurrence and rollover rates for 2000-2002 were examined further to investigate whether underreporting of fires and rollovers in those States may have been a factor in the low rate. NHTSA officials contacted the FARS Analysts in these low rate States to discuss potential issues that may result in inaccurate data or underreported occurrences, and the reasons for them. Classifications included issues such as:

- Data source problems (e.g. not able to obtain death certificate to verify a fire death)
- Legal barriers in obtaining the desired data (e.g. such as not having access to certain data due to pending litigation)
- Administrative problems or policy issues (privilege, confidentiality, etc.)

- Communication problems/issues (not contacting the right person)
- FARS definitions and data entry rules (e.g. interpretations from the FARS Coding Manual)
- Other

NHTSA officials also queried the FARS Analysts from the low rate States about the availability and use of such key records as:

- Death certificates
- Vehicle Identification Number (VIN)
- Vehicle Registration Files (especially for out-of-state vehicles)

Other issues were also discussed with the FARS Analysts from the low rate States:

- Definition of a motor vehicle crash death within 30 days of the crash
- Possible underreporting of vehicle fires, especially in rear-end collisions (and crashes involving police vehicles)
- Crashes involving stationary vehicles off the roadway, especially where the fire and the death occurs in the parked vehicle
- Various sources of information for vehicle fires or rollovers

NHTSA provided written responses to questions about fires and rollovers from FARS Analysts in the 14 States with very low rates. Below is a summary of the responses on key questions:

Fires

- ***Data Sources:*** Of the 10 States with very low reported fire rates, 4 States only used the police accident report (PAR) as their source of coding. Two States used the PAR and the death certificate (DC) for verification. Two States used the PAR and the emergency medical services (EMS) report as verification. One State used the PAR and the medical examiners (ME) report and the final State used the PAR, the DC and the ME reports as verification. Ideally, States should use some other source in addition to the PAR for fire occurrence coding.
- ***Death Certificates:*** Only 3 of the 10 States receive and use the death certificate for coding fire occurrence. Ideally, most States should have access to death certificates and should use them for fire occurrence coding.
- ***Barriers and Issues:*** No States reported any legal issues or barriers concerning reporting fire occurrence. One State of the 10 reported an administrative barrier (lack of cooperation from another state agency) while 2 States reported communication issues. Five States reported other reasons for not capturing a fire occurrence when one occurred (not reported in the PAR).

- ***FARS Definition Issues or Rules:*** None of the 10 States reported any FARS definition issues or rules that would affect their coding of a fire occurrence.
- ***News Services:*** Only one State reported that there was a news service available in the State where news articles about fires might be reported.

Rollovers

- ***Data Sources:*** Of the 10 States with very low reported rollover rates, 5 States only used the police accident report (PAR) as their source of coding. One State used the PAR and the death certificate (DC) for verification. One State used the PAR and the medical examiners (ME) report and one State used the PAR, the DC and the ME reports as verification. Two States used the PAR and one other source (supplemental report from police, news article) for verification. Ideally, States should use some other source in addition to the PAR for coding rollover occurrence.
- ***Death Certificates:*** Only 2 of the 10 States receive and use the death certificate for coding rollover occurrence. Ideally, most States should have access to death certificates and should use them for rollover occurrence coding.
- ***Barriers and Issues:*** One State reported a legal issue (cases involving police vehicles delayed) concerning reporting rollover occurrence. One State of the 10 reported an administrative barrier (lack of details from local police agencies) while no States reported communication issues. One State reported one other reason for not capturing a rollover occurrence when one occurred (not reported in the PAR in one of four sequences of events).
- ***FARS Definition Issues or Rules:*** None of the 10 States reported any FARS definition issues or rules that would affect their coding of a rollover occurrence.

General Coding Issues

- ***Availability of Various Data Sources***: Of the 14 States with either low fire or low rollover rates, many did not have access to key data sources:

  Death Certificates: Only 8 of the 14 States reported routine access to death certificates.
  Medical Examiner/Coroner Reports: Only 5 States had routine access.
  Vehicle Registration Files: All 14 States had access.
  Vehicle Identification Number: 13 States had access.
  Driver Records: 13 States had access.
  Highway Inventories: 12 States had access.
  Other Data Sources: Only 2 States reported the use of other data sources (police supplemental reports; news clips)

- ***Other Barriers and Issues***: Only one State of the 14 reported that the 30 day definition of a fatality in FARS may be an issue in coding fire or rollover

occurrence. Two States reported the involvement of police vehicles as a delay issue due to pending litigation. Two States reported the parked or stationary vehicle off the roadway as a possible issue in the coding. Finally, two States reported the lack of a distinct box in the PAR for fire or rollover occurrence as an issue in determining fire or rollover occurrence.

In summary, it appears that many FARS Analysts in these 14 States with low fire and rollover rates do not have routine access nor routinely use other data sources (other than the PAR) in coding fire or rollover occurrences. This lack of information could lead to an under reporting of both fires and rollovers. There is no reason to believe that the missing information would lead to over reporting in the states with higher fire and rollover rates. Consequently, national averages based on data that is under reported can be considered as underestimates.

Every effort should be made to obtain access to key data as an aid to reporting these important data elements in FARS. Death certificates, medical examiners or coroners reports, emergency medical service reports and even news clippings of the fatal crash would all help in the FARS coding.

Given this as a background, further analyses of the fire and rollover occurrences in FARS for the six year period from 2000-2005 were conducted.

METHODS

Fire Occurrence and Rollover Occurrence reporting rates were generated for the combined years 2000-2005 on a State-by-State basis compared to the average rates for the group.. The rates in the Tables 1 through 18 to follow were calculated using the number of fire occurrences and rollover occurrences in FARS per total number of vehicles in fatal crashes for that State during that combined 6-year period (2000-2005). Although FARS contains a census of fatal crashes, vehicles where no fatality occurred yet are involved in the crash are included, as well. It should be noted that fires per fatal crash reported in these tables includes any vehicle coded in the FARS even if no fatality occurred in that vehicle. While the number of fire related fatalities is also of interest, the results can be skewed due to multiple occupants per vehicle where some vehicle types are more likely to be operated with more than just a driver. For this reason, the vehicles in FARS rather than the fatalities are examined.

Appendix Table A1 lists each state, fatality count and fatality rates for the 2000-2007 crash years. Within Table A1, fire rates and rollover rates are calculated in two ways. The first, labeled as 'Death in Vehicle' rates includes only vehicles where one or more person died in both the numerator and denominator of the rate calculation. The second rate, labeled as 'All FARS' vehicle rate includes any vehicle coded in FARS even if no fatality occurred in that vehicle. As expected, the rate of fire and the rate of rollover are

higher when only vehicles where one or more fatality occurred in that vehicle compared with rates using all vehicles in FARS. Table A1 also includes Annual Vehicle Miles Travelled (VMT) in millions of miles as estimated by FHWA in 2003. This data is presented by state and offers insight into varied exposure for drivers by state and could explain differences in fatal crash involvement. The most recent year of VMT data available was 2003 as shown in the table. Appendix Table A2 shows the number of fires, fire rate per FARS crash and fires as most harmful event by state.

RESULTS

Factors that Could Influence Fire Rates

It is clear from Figure 1 below that the reporting of fire occurrence in FARS is widely variable in the States. The rate per number of vehicles in fatal crashes for 2000-2005 ranges from 0.42% in Utah to 5.95% in Minnesota with the group average at 2.88%.

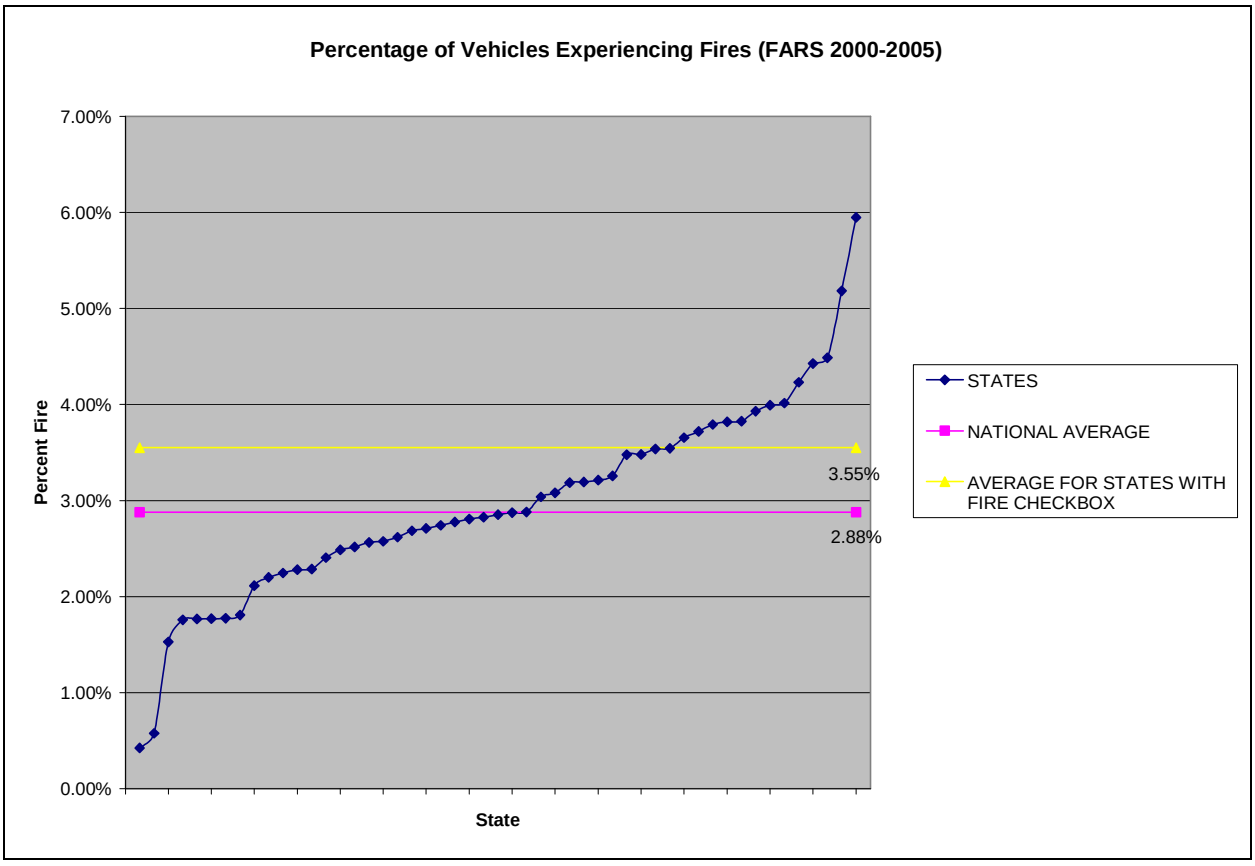

Figure 1. Fire Occurrence Rates by State in FARS (2000-2005)

The 10 States with the lowest rates of fire occurrence per vehicles involved in fatal crashes are shown in Table 1. The group average fire rate for rural crashes was 3.37% compared to 2.33% for urban crashes. Consequently, states with higher percentages of

urban fatal crashes would be expected to have lower fire rates. To provide information on whether the low rates are because of the urban/rural mix of the State, the lowest rates of fire occurrence by State by rural area are shown in Table 2 and by urban area in Table 3. Six of the 10 lowest rate States appear in both the rural (Table 2) and urban (Table 3) lowest rate States. None of these 10 States have a box to check if a fire occurs. Two of these states, VA and WY have no mention of fire on the PAR. This suggests that coding and data source issues exist in those two States, and that under reporting is present in at least four and possibly all of the others. Appendix Table A2 identifies those states where no check box exists on the PAR indicating Fire as the most harmful event.

Rates of Fire Occurrence, by State, 10 Lowest			
	State	Fires 2000-2005	Rate per Vehicles Inv.
1.	Utah	10	0.42%
2.	Mississippi	39	0.58%
3.	Florida	414	1.53%
4.	Virginia	134	1.76%
5.	South Carolina	147	1.77%
6.	Michigan	195	1.77%
7.	Dist of Columbia	8	1.77%
8.	Idaho	37	1.81%
9.	Colorado	118	2.11%
10.	New Hampshire	26	2.20%
	National	10096	2.88%

Table 1. Lowest Rates of Fire Occurrence in FARS

Rates of Rural Fire Occurrence, by State, 10 Lowest			
	State	Fires 2000-2005	Rate per Vehicles Inv.
1.	Dist of Columbia	0	0.00%
2.	Mississippi	34	0.57%
3.	Utah	10	0.57%
4.	Hawaii	6	1.39%
5.	Idaho	28	1.72%
6.	South Carolina	138	1.89%
7.	Florida	233	1.95%
8.	Michigan	113	1.97%
9.	Virginia	98	2.17%
10.	New Hampshire	20	2.36%
	National	6647	3.37%

Table 2. Lowest Rates of Fire Occurrence in FARS in Rural Areas of the State

Rates of Urban Fire Occurrence, by State, 10 Lowest			
	State	Fires 2000-2005	Rate per Vehicles Inv.
1.	Utah	0	0.00%
2.	Mississippi	4	0.52%
3.	Nebraska	3	0.60%
4.	South Carolina	9	0.88%
5.	Wyoming	2	1.07%
6.	Florida	170	1.16%
7.	Virginia	36	1.18%
8.	New Mexico	13	1.29%
9.	Michigan	76	1.49%
10.	Alabama	50	1.74%
	National	3315	2.23%

Table 3. Lowest Rates of Fire Occurrence in FARS in Urban Areas of the State

The 10 States with the highest fire occurrence rates in FARS are shown in Tables 4, 5 and 6. Table 4 shows the top 10 highest rate States overall with Tables 5 and 6 showing those top 10 rates for rural and urban areas of the State, respectively. Six of the nine states with a fire box on the PAR show up in Table 4 and/or Table 6 as high fire rate States. The average fire rate for these six States is 3.76. For all nine States with a fire check box, the average is 3.55. This result suggests that if properly reported in FARS, the National average for the fire rate might be around 3.55 rather than 2.88 as shown in Figure 1.

Rates of Fire Occurrence, by State, 10 Highest			
	State	Fires 2000-2005	Rate per Vehicles Inv.
1.	Montana	67	3.82%
2.	Wisconsin	251	3.83%
3.	Illinois	462	3.93%
4.	Tennessee	405	3.99%
5.	North Dakota	31	4.02%
6.	Missouri	403	4.23%
7.	Kansas	169	4.43%
8.	Oklahoma	260	4.49%
9.	Arkansas	265	5.18%
10.	Minnesota	299	5.95%
	National	10096	2.88%

Table 4. States with the Highest Fire Occurrence Rates in FARS (in ascending order)

Rates of Rural Fire Occurrence, by State, 10 Highest			
	State	Fires 2000-2005	Rate per Vehicles Inv.
1.	Tennessee	228	4.38%
2.	Wisconsin	211	4.45%
3.	Arizona	178	4.57%
4.	Missouri	298	4.59%
5.	Oklahoma	194	4.86%
6.	Illinois	242	5.23%
7.	Kansas	152	5.26%
8.	Rhode Island	7	5.74%
9.	Arkansas	226	5.80%
10.	Minnesota	224	6.39%
	National	6647	3.37%

Table 5. States with the Highest Fire Occurrence Rates in their Rural Areas

Rates of Urban Fire Occurrence, by State, 10 Highest			
	State	Fires 2000-2005	Rate per Vehicles Inv.
1.	Illinois	220	3.09%
2.	Arkansas	39	3.21%
3.	Connecticut	63	3.21%
4.	Oregon	31	3.27%
5.	Missouri	105	3.47%
6.	Tennessee	129	3.56%
7.	Oklahoma	66	3.67%
8.	North Dakota	4	3.74%
9.	West Virginia	24	4.26%
10.	Minnesota	75	4.92%
	National	3315	2.23%

Table 6. States with the Highest Fire Occurrence Rates in their Urban Areas

Minnesota has the highest fire occurrence rates in the Nation in both their rural and urban areas. In fact, six of the 10 highest rate States appear in both the rural table (Table 5) and the urban table (Table 6).

Appendix Tables A3 through A3 examine the FARS data for different ages of vehicles – less than 5 years, less than ten years and ten years and older. The Tables show vehicle counts in FARS and fatality counts by crash direction, fire involvement and fire as most harmful event. The MHE is defined as the most severe injury-producing event for the vehicle. When a vehicle is involved in multiple harmful events, the event which produced the most severe injury or property damage is used. Any crash where one or more quarter turns occurred, regardless of the most harmful event is classified as a

rollover crash for this portion of the analysis. In general, analysis of this data showed that most passenger vehicles ten years and older have higher fire rates than newer vehicles. The results are presented later in this report.

Appendix Table A9 lists fire related fatality counts and rates by state and percentage of fatalities in vehicles older than 10 years for 2000-2005 crashes. The fire rates shown do not support the hypothesis that states with a higher fire rate also have a higher percentage of older vehicles in service.

Factors that Could Influence Rollover Rates

Similar analyses were performed on FARS data for rollover occurrence. The results are shown nationally in Figure 2. The rates vary from under 10% to 45%. The average for the group was 18.84%. Since the principal focus of this study was fire occurrence, the cause for the large difference in rollover rates was not studied in detail. However, the data showed that the rollover rate for FARS vehicles is much greater for rural areas compared to urban areas. Consequently, the breakout of rural vs. urban is presented for the ten states with the highest and lowers rollover rates.

The States with the 10 lowest and the 10 highest rates appear in Tables 7-12. Table 7 shows the rollover rates for the ten States with the lowest rollover rates. Tables 8 and 9 show the ten states with the lowest rollover rates in rural and urban areas, respectively. Tables 10, 11 and 12 show similar data for the ten states with the highest rollover rates.

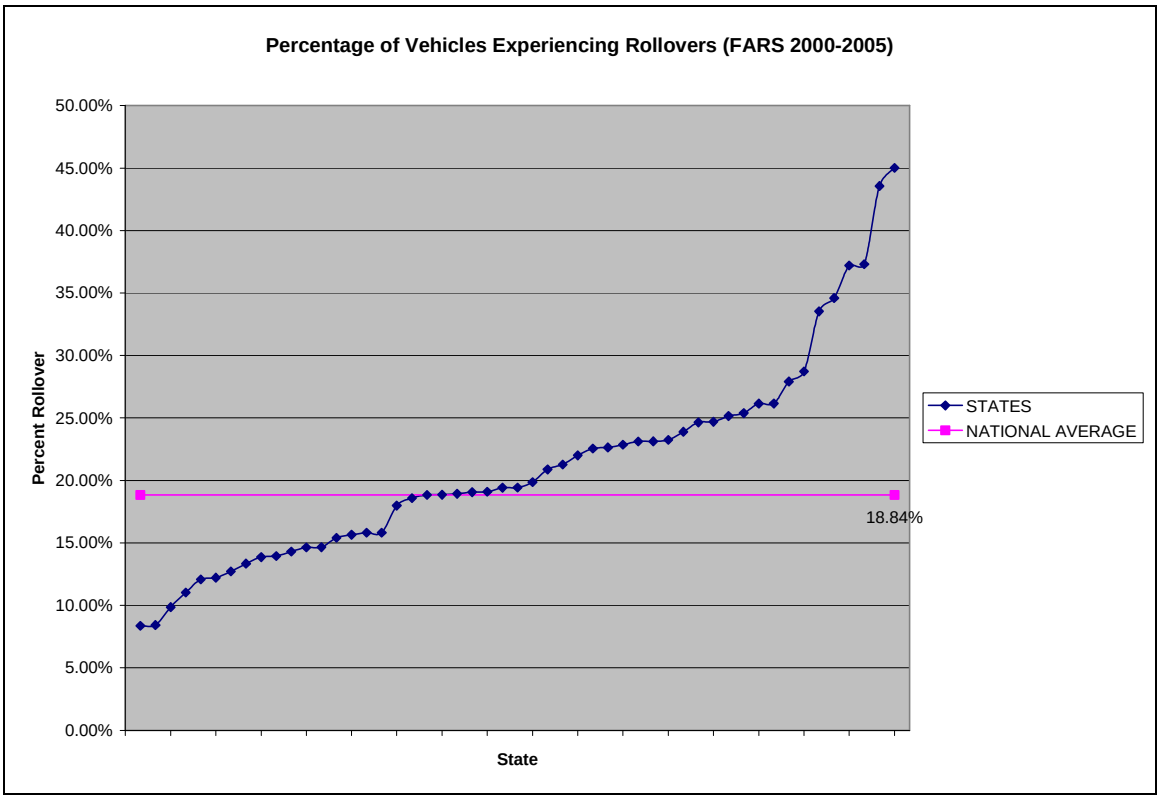

Figure 2. Percentage of Vehicles Experiencing Rollovers in FARS (2000-2005)

Rates of Rollover Occurrence, by State, 10 Lowest			
	State	Rollovers 2000-2005	Rate per Vehicles Inv.
1.	New Jersey	534	8.37%
2.	Dist of Columbia	38	8.43%
3.	Maryland	549	9.85%
4.	New York	1336	11.03%
5.	Mississippi	818	12.08%
6.	Michigan	1347	12.22%
7.	Hawaii	136	12.72%
8.	Massachusetts	493	13.34%
9.	Florida	3754	13.86%
10.	Indiana	1068	13.94%
	National	66102	18.84%

Table 7. States with Lowest Rollover Occurrence Rates in FARS (ascending order)

Rates of Rural Rollover Occurrence, by State, 10 Lowest			
	State	Rollovers 2000-2005	Rate per Vehicles Inv.
1.	New Jersey	140	10.61%
2.	Maryland	275	12.07%
3.	Mississippi	753	12.62%
4.	Massachusetts	93	15.10%
5.	Indiana	820	15.44%
6.	Michigan	898	15.69%
7.	New York	897	16.12%
8.	Connecticut	93	16.37%
9.	New Hampshire	147	17.38%
10.	Pennsylvania	1354	18.13%
	National	48604	24.66%

Table 8. States with Lowest Rollover Occurrence Rates in their Rural Areas

Rates of Urban Rollover Occurrence, by State, 10 Lowest			
	State	Rollovers 2000-2005	Rate per Vehicles Inv.
1.	New York	438	6.71%
2.	Oregon	68	7.17%
3.	Hawaii	48	7.75%
4.	Mississippi	60	7.76%
5.	New Jersey	394	7.79%
6.	Dist of Columbia	36	8.11%
7.	Maryland	263	8.34%
8.	Michigan	428	8.39%
9.	Delaware	44	8.59%
10.	Illinois	631	8.87%
	National	16713	11.26%

Table 9. States with Lowest Rollover Occurrence Rates in Urban Areas

Five States appeared as the 10 lowest rollover rate States in both rural areas (Table 8) of their State and urban areas (Table 9). Once again, this could indicate some data source issues in these States.

Rates of Rollover Occurrence, by State, 10 Highest			
	State	Rollovers 2000-2005	Rate per Vehicles Inv.
1.	Missouri	2491	26.15%
2.	Nebraska	589	26.15%
3.	Colorado	1559	27.91%
4.	Utah	679	28.72%
5.	South Dakota	451	33.53%
6.	New Mexico	1182	34.60%
7.	Idaho	761	37.19%
8.	North Dakota	288	37.31%
9.	Montana	764	43.56%
10.	Wyoming	537	45.01%
	National	66102	18.84%

Table 10. States with the Highest Rollover Occurrence Rates in FARS (ascending order)

Rates of Rural Rollover Occurrence, by State, 10 Highest			
	State	Rollovers 2000-2005	Rate per Vehicles Inv.
1.	Utah	594	34.02%
2.	South Dakota	430	36.20%
3.	Colorado	1189	39.70%
4.	Arizona	1582	40.63%
5.	North Dakota	276	41.50%
6.	New Mexico	1010	42.05%
7.	Idaho	690	42.31%
8.	Montana	738	46.18%
9.	Nevada	512	47.10%
10.	Wyoming	510	50.70%
	National	48604	24.66%

Table 11. States with Highest Rollover Rates in their Rural Areas

Rates of Urban Rollover Occurrence, by State, 10 Highest			
	State	Rollovers 2000-2005	Rate per Vehicles Inv.
1.	Wyoming	27	14.44%
2.	Rhode Island	85	14.68%
3.	Alabama	432	15.02%
4.	Arkansas	198	16.28%
5.	Montana	26	16.67%
6.	New Mexico	169	16.73%
7.	Idaho	71	17.11%
8.	Vermont	14	17.28%
9.	Missouri	524	17.32%
10.	Alaska	48	17.78%
	National	16713	11.26%

Table 12. States with Highest Rollover Rates in their Urban Areas

Three States, NM, ND and WY, had higher than average rollover rates in both their rural areas (Table 11) and their urban areas (Table 12). These States have low population densities where higher speed roadways may be more prevalent and vehicles with lower resistance to rollover could also be more common.

Figure 3 shows the national rates of rollover crashes that also experienced fires. That rate varies from under .20% in a couple of States to almost 1.60% in some States.

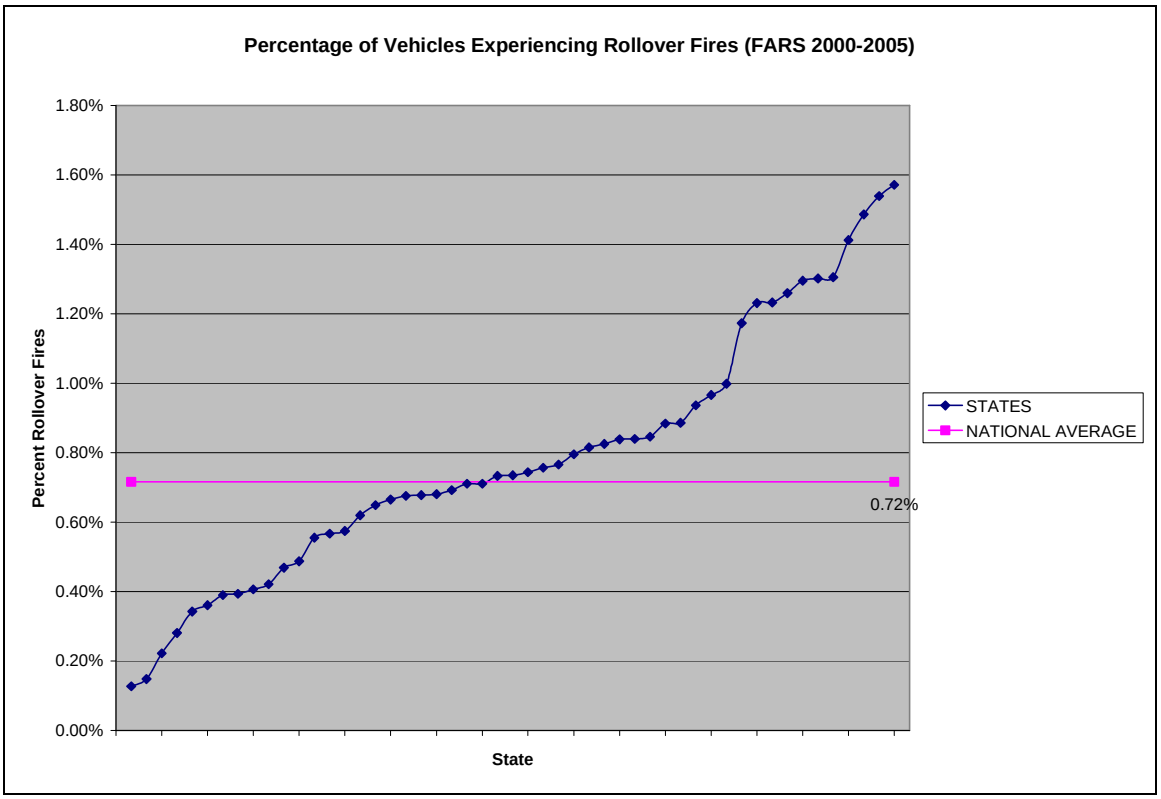

Figure 3. Percent of Vehicles in Rollover Crashes with a Fire Occurrence

Tables for rates of rollover crashes that also resulted in fires were also constructed. Tables 13-18 show the States with the 10 lowest rates (Table 13), the 10 States with the lowest rural rates (Table 14), the 10 States with the lowest urban rates (Table 15), followed by the 10 States with the highest rates (Table 16), the 10 States with the highest rural rates (Table 17) and the 10 States with the highest urban rates (Table 18).

There were 4 States with the 10 lowest rates in both their rural areas and urban areas, but the numbers are very small here. There was only one State that had high rates of rollover crashes with a fire for both their rural and urban areas (MO).

Rates of Rollover Fire Occurrence, by State, 10 Lowest			
	State	Rollover Fires 2000-2005	Rate per Vehicles Inv.
1.	Utah	3	0.13%
2.	Mississippi	10	0.15%
3.	Dist of Columbia	1	0.22%
4.	Hawaii	3	0.28%
5.	Delaware	4	0.34%
6.	New Jersey	23	0.36%
7.	Michigan	43	0.39%
8.	Virginia	30	0.39%
9.	Florida	110	0.41%
10.	New York	51	0.42%
	National	2513	0.72%

Table 13. States with Lowest Rates of Rollover Crashes with a Fire

Rates of Rural Rollover Fire Occurrence, by State, 10 Lowest			
	State	Rollover Fires 2000-2005	Rate per Vehicles Inv.
1.	Dist of Columbia	0	0.00%
2.	Hawaii	0	0.00%
3.	Mississippi	8	0.13%
4.	Utah	3	0.17%
5.	Connecticut	1	0.18%
6.	Virginia	21	0.46%
7.	Delaware	3	0.48%
8.	Maryland	11	0.48%
9.	Massachusetts	3	0.49%
10.	Michigan	28	0.49%
	National	1800	0.91%

Table 14. States with Lowest Rates of Rollover Crashes with Fires in their Rural Areas

Rates of Urban Rollover Fire Occurrence, by State, 10 Lowest			
	State	Rollover Fires 2000-2005	Rate per Vehicles Inv.
1.	Utah	0	0.00%
2.	Wyoming	0	0.00%
3.	Alaska	0	0.00%
4.	Mississippi	1	0.13%
5.	West Virginia	1	0.18%
6.	Delaware	1	0.20%
7.	South Carolina	2	0.20%
8.	New Mexico	2	0.20%
9.	Nebraska	1	0.20%
10.	Dist of Columbia	1	0.23%
	National	681	0.46%

Table 15. States with Lowest Rates of Rollover Crashes with Fires in their Urban Areas

Rates of Rollover Fire Occurrence, by State, 10 Highest			
	State	Rollover Fires 2000-2005	Rate per Vehicles Inv.
1.	Kansas	47	1.23%
2.	Vermont	8	1.23%
3.	Oklahoma	73	1.26%
4.	North Dakota	10	1.30%
5.	Missouri	124	1.30%
6.	Maine	20	1.31%
7.	South Dakota	19	1.41%
8.	Arkansas	76	1.49%
9.	Montana	27	1.54%
10.	Minnesota	79	1.57%
	National	2513	0.72%

Table 16. States with Highest Rates of Rollover Crashes with Fires

Rates of Rural Rollover Fire Occurrence, by State, 10 Highest			
	State	Rollover Fires 2000-2005	Rate per Vehicles Inv.
1.	Illinois	62	1.34%
2.	Missouri	87	1.34%
3.	Oklahoma	55	1.38%
4.	Kansas	43	1.49%
5.	South Dakota	18	1.52%
6.	Tennessee	82	1.58%
7.	Montana	26	1.63%
8.	Arkansas	67	1.72%
9.	Nevada	19	1.75%
10.	Minnesota	67	1.91%
	National	1800	0.91%

Table 17. States with Highest Rates of Rollover Fires in their Rural Areas

Rates of Urban Rollover Fire Occurrence, by State, 10 Highest			
	State	Rollover Fires 2000-2005	Rate per Vehicles Inv.
1.	Minnesota	12	0.79%
2.	Indiana	16	0.82%
3.	Connecticut	17	0.87%
4.	Oklahoma	18	1.00%
5.	Rhode Island	6	1.04%
6.	Idaho	5	1.20%
7.	Missouri	37	1.22%
8.	Vermont	1	1.23%
9.	Maine	2	1.71%
10.	North Dakota	2	1.87%
	National	681	0.46%

Table 18. States with Highest Rates of Rollover Fires in their Urban Areas

Factors that Could Influence Extrication

Figure 4 shows the high variability in extrication required for drivers (entrapment) by state. While the national average is 12% of fatal crashes result in driver entrapment, values range from 0.05% to 32% by state. This variability could result from varied definitions of entrapment, varied requirements by state for reporting this data or errors in reporting. As described in the 2007 FARS Coding and Validation Manual, extrication refers to the use of equipment or other force to remove persons from the vehicles requiring more than just lifting or carrying person out of wreckage. If the police officer uses the word "extricated" to indicate occupant removal, then this is sufficient information for FARS investigators to indicate extrication required even if no mention of equipment is made.

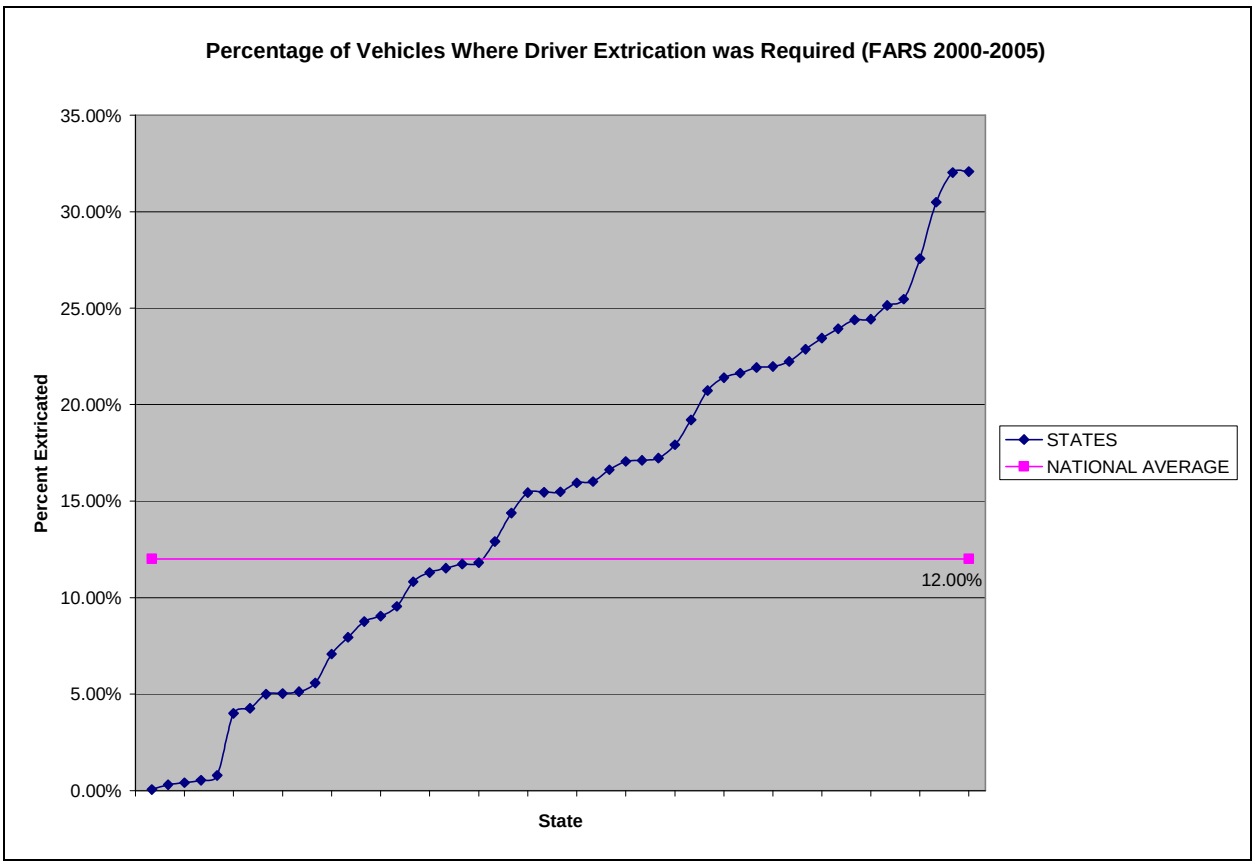

Figure 4. Percent of Vehicles In All FARS Crashes Where Driver Extrication Was Required

Appendix Table A10 shows the annual entrapment fatalities in FARS Tables 10 and 11 show the entrapments with fire involvement and fire as MHE. Table A13 lists the count of entrapments by State for the 2000-2007 crash years. Obviously, many of the larger States show the high numbers, but not always. When analyzed by state, some indications of coding issues with this variable become evident. For example, Virginia only indicated that 7 vehicles experienced entrapments from 2000-2007 FARS while 4,562 vehicles did not, a rate of less than .09%. West Virginia, on the other hand, indicated that 999 vehicles experienced entrapment while 1,067 vehicles did not-------a rate of 34%. Clearly, the coding of entrapment needs to be thoroughly reviewed in FARS for quality and data sources before valid data analyses can be conducted.

ANALYSIS OF FARS TRENDS- FIRES AND ROLLOVERS

The first section of this report and earlier analyses examined the extent to which fires and rollover information could be improperly coded or missed by FARS analysts (Fell 2006). For this reason, fire rates were calculated including any vehicle coded in the FARS system regardless of the presence of fatal occupants and the number who died. Additional FARS analyses were performed to provide a historical perspective on fatalities during fire and rollovers crashes on a national level. For reference, the Appendix contains the data by year and the tables to follow present findings in 3 year intervals. Results below are summarized in two ways including 1) occupant fatality counts and 2) number of vehicles involved and coded in the FARS regardless of the number of fatalities within the vehicle. While the number of fatalities that result from a set of crashes is of most interest, results can be skewed due to multiple occupants per vehicle where some vehicle types are more likely to be operated with more than just a driver. For this reason, a second table containing the number of vehicles involved and coded in FARS is also presented for each case below.

All						
Crash Year	Frontal	Side	Rear	Rollover	Other	Total
1978-1980	44,304	23,638	2,472	16,351	4,413	91,178
1981-1983	39,511	20,757	2,475	12,239	6,872	81,854
1984-1986	40,200	22,807	2,877	11,061	4,908	81,853
1987-1989	44,432	25,447	3,427	12,385	4,385	90,076
1990-1992	42,113	24,221	2,891	9,654	3,867	82,746
1993-1995	42,846	24,338	3,085	9,042	3,542	82,853
1996-1998	44,193	25,569	3,502	9,520	3,585	86,369
1999-2001	42,841	25,352	3,917	10,549	3,636	86,295
2002-2004	42,957	25,758	3,861	10,202	3,377	86,155
2005-2007	41,143	23,197	3,549	9,895	4,035	81,819
Fire Involved						
1978-1980	1,682	664	327	454	179	3,306
1981-1983	1,714	571	281	327	282	3,175
1984-1986	1,747	655	278	275	207	3,162
1987-1989	2,019	691	303	264	227	3,504
1990-1992	2,101	655	220	176	147	3,299
1993-1995	2,116	646	221	142	157	3,282
1996-1998	2,113	609	224	161	147	3,254
1999-2001	2,233	617	288	206	152	3,496
2002-2004	2,171	641	240	195	156	3,403
2005-2007	2,206	615	243	218	180	3,462
Fire Coded as Most Harmful Event						
1978-1980	470	190	113	148	67	988
1981-1983	667	196	163	145	99	1,270
1984-1986	599	174	110	102	78	1,063
1987-1989	672	197	124	90	112	1,195
1990-1992	616	165	115	48	68	1,012
1993-1995	547	160	107	45	76	935
1996-1998	497	142	82	26	63	810
1999-2001	475	112	110	27	47	771
2002-2004	652	177	100	51	57	1,037
2005-2007	813	211	127	67	82	1,300

Table 19. Fatality Counts in All Passenger Vehicles by Crash Mode (FARS 1978-2007, 'Other' category includes unknown, undercarriage, top damage and non-collision including immersion, fall or thrown from vehicle, non-collision fire/explosion, gas inhalation events)

Crash mode was defined using the principal impact point which is the damage area on the vehicle that produced the most severe instance of injury or property damage. Using this definition, it is possible that a rollover crash where one or more quarter turns occurs about the vehicle lateral or longitudinal axis may be classified as a planar event (i.e. a frontal, side, rear crash) if other more severe impacts occur as determined by the FARS investigator. Later in this report, an alternate approach is used to calculate fire rates where rollover crashes are defined as an event where one or more vehicle quarter turns occurs regardless of the principle impact point or most harmful event coded. The 'Other' category includes unknown, undercarriage, non-collision (i.e. immersion, fall or

thrown from vehicle, non-collision fire/explosion, gas inhalation, etc.) and top damage related events.
As defined in the 2008 FARS Analytical Reference Guide, Most Harmful Event applies to the vehicle. Since the most harmful event describes a vehicle, not a person, one cannot assume that the most harmful event for a vehicle was the cause of any death or injury for any specific individual within the vehicle.

Table 19 is broken into three sections. The first (labeled All) lists the number of vehicles where one or more fatalities occurred in each 3 year segment. The second section lists the vehicle count where a fire occurred as a result of the crash when a fatality occurred in that vehicle. The third section shows the vehicle count where the fire was coded as the most harmful event by the FARS investigator and a fatality occurred in the vehicle.

All						
Crash Year	Frontal	Side	Rear	Rollover	Other	
1978-1980	94,720	32,067	6,627	16,771	6,539	156,724
1981-1983	83,288	27,751	6,452	12,411	11,360	141,262
1984-1986	85,510	30,488	7,279	11,181	8,426	142,884
1987-1989	93,666	33,352	7,755	12,534	7,160	154,467
1990-1992	86,690	31,042	6,728	9,717	6,116	140,293
1993-1995	88,568	30,465	6,993	9,101	5,591	140,718
1996-1998	91,272	31,785	7,749	9,580	5,677	146,063
1999-2001	88,380	31,544	8,386	10,653	5,740	144,703
2002-2004	88,864	32,619	8,537	10,334	5,393	145,747
2005-2007	83,559	30,244	8,460	10,053	6,330	138,646
Fire Involved						
1978-1980	2,067	737	380	470	188	3,842
1981-1983	2,074	631	343	331	310	3,689
1984-1986	2,086	725	353	280	229	3,673
1987-1989	2,469	760	380	267	249	4,125
1990-1992	2,477	719	283	178	156	3,813
1993-1995	2,516	697	261	143	172	3,789
1996-1998	2,486	652	282	161	156	3,737
1999-2001	2,675	652	345	209	165	4,046
2002-2004	2,624	678	289	198	183	3,972
2005-2007	2,595	658	277	222	197	3,949
Fire Coded as Most Harmful Event						
1978-1980	507	195	121	150	68	1,041
1981-1983	702	210	175	147	103	1,337
1984-1986	632	181	123	103	80	1,119
1987-1989	709	203	133	91	120	1,256
1990-1992	650	171	132	48	71	1,072
1993-1995	582	166	117	46	82	993
1996-1998	524	150	92	26	64	856
1999-2001	496	115	119	27	54	811
2002-2004	715	181	114	52	60	1,122
2005-2007	889	222	140	68	88	1,407

Table 20. Passenger Vehicle Counts by Crash Mode (FARS 1978-2007)

Similarly, Table 20 shows the number of *vehicles* involved in fatal crashes by primary impact type. This includes any vehicle coded in the FARS with one or more fatalities and each vehicle is counted only once regardless of the number of fatalities that occurred in that vehicle. When compared, Table 19 and Table 20 show similar trends over time with respect to crash mode.

All						
Crash Year	Frontal	Side	Rear	Rollover	Other	Total
1978-1980	8,135	3,444	370	1,749	713	14,411
1981-1983	5,781	2,963	267	976	1,684	11,671
1984-1986	5,778	3,187	303	653	1,183	11,104
1987-1989	7,276	3,886	475	865	688	13,190
1990-1992	7,098	3,940	375	675	462	12,550
1993-1995	7,936	4,364	475	710	557	14,042
1996-1998	9,640	5,298	592	909	597	17,036
1999-2001	11,086	6,711	803	1,182	720	20,502
2002-2004	11,649	7,395	869	1,348	668	21,929
2005-2007	10,728	6,736	745	1,345	753	20,307
Fire Involved						
1978-1980	548	222	126	117	55	1,068
1981-1983	421	151	62	65	98	797
1984-1986	359	161	66	34	70	690
1987-1989	480	134	85	42	64	805
1990-1992	473	149	56	18	26	722
1993-1995	520	143	67	17	36	783
1996-1998	638	150	81	18	37	924
1999-2001	807	205	115	50	46	1,223
2002-2004	793	229	114	38	57	1,231
2005-2007	816	193	101	48	48	1,206
Fire Coded as Most Harmful Event						
1978-1980	150	88	57	42	19	356
1981-1983	141	51	47	40	28	307
1984-1986	92	26	26	20	10	174
1987-1989	138	37	22	18	24	239
1990-1992	109	40	35	7	9	200
1993-1995	131	37	43	6	17	234
1996-1998	118	32	24	7	14	195
1999-2001	177	41	52	15	18	303
2002-2004	237	72	48	10	10	377
2005-2007	288	64	49	17	22	440

Table 21. Entrapment- Fatality counts where one or more occupants was entrapped by Crash Mode (FARS 1978-2007, passenger vehicles only)

Table 21 shows the count of vehicles where one or more occupants were entrapped following a crash. This includes those requiring extrication and those pinned in the vehicle. As defined in the 2007 FARS Coding and Validation Manual, extrication refers to the use of equipment or other force to remove persons from the vehicles; i.e., more than just lifting or carrying person out of wreckage. Occupants who were pinned or

wedged in the vehicle are also coded and included in the "Entrapment" category in Table 21. It is possible that a pinned occupant may have been removed with force, but FARS does not make it clear whether equipment was used or not. Both extricated and pinned occupants would benefit from increased time before fire penetration occurs and are therefore grouped together within the "Entrapment" category

A comparison of data in Tables 19 and 21 indicates that fatal occupant entrapment was coded for 34% of the fatalities where fire was the MHE for 2005-2007 data years. The highest rates of entrapment were in frontal and rear crash modes. In terms of survivability, increased fire penetration times might prevent some of these fatalities as the time required for rescue to identify a crash, travel to the crash scene and extricate severely injured occupants could be quite lengthy in some cases. Appendix Tables A10-A12 list the number of entrapped fatal crash victims by year, crash mode and the occurrence of a vehicle fire. Appendix Tables A11 and A12 separate fatality counts for crashes where fire occurred and fire was coded as the most harmful event.

All						
Crash Year	Frontal	Side	Rear	Rollover	Other	Total
1978-1980	7,724	2,655	253	1,419	476	12,527
1981-1983	5,540	2,344	205	794	1,481	10,364
1984-1986	5,598	2,507	230	543	1,012	9,890
1987-1989	7,152	3,054	363	706	517	11,792
1990-1992	7,170	3,090	283	569	376	11,488
1993-1995	8,160	3,461	344	600	406	12,971
1996-1998	9,769	4,122	445	792	441	15,569
1999-2001	11,382	5,379	646	1,018	543	18,968
2002-2004	12,130	5,994	694	1,168	522	20,508
2005-2007	11,371	5,516	618	1,203	624	19,332
Fire Involved						
1978-1980	429	154	61	83	31	758
1981-1983	353	111	40	43	69	616
1984-1986	285	114	38	29	49	515
1987-1989	393	98	58	29	38	616
1990-1992	389	108	34	15	21	567
1993-1995	429	105	34	14	23	605
1996-1998	535	106	44	16	21	722
1999-2001	663	142	73	37	31	946
2002-2004	650	176	73	31	41	971
2005-2007	692	153	72	33	34	984
Fire Coded as Most Harmful Event						
1978-1980	109	55	25	29	14	232
1981-1983	104	38	28	23	15	208
1984-1986	76	19	16	17	7	135
1987-1989	98	23	17	13	8	159
1990-1992	83	31	19	5	10	148
1993-1995	104	25	19	4	9	161
1996-1998	85	23	13	6	5	132
1999-2001	129	30	30	10	13	212
2002-2004	175	52	30	9	6	272
2005-2007	232	51	36	11	14	344

Table 22. Entrapment-Vehicle counts where the driver was entrapped by Crash Mode (FARS 1978-2007, Passenger vehicles only)

Table 22 shows the vehicle level count of entrapment per 3 year interval where entrapment occurred in fatal crashes.

Vehicle Type and Age

Fatal crash data from FARS 2000-2007 were analyzed to identify differences in fire rate by vehicle body type. Fatal crash rates were calculated by dividing the number of vehicles where a fire occurred and one or more occupants died by the total number of vehicles involved in crashes where one or more occupants died. Seven primary vehicle body type categories were analyzed as shown in Table 23 below. Overall, the large truck and bus category showed the highest rate of fire occurrence (22.43 fires per 100

fatal crashes). It was noted earlier that PAR's in 9 States have a box to designate fires. An additional 13 have a supplemental form for trucks that includes a fire designation. Table 23 shows that the frequency of large truck crash occurrence (fire and non-fire involved) is substantially smaller when compared with passenger vehicles. Among passenger vehicles, Pickups have the highest fire rate during fatal crashes (5.04) followed by SUVs (4.60), Passenger Cars (3.94) and Minivans (3.52). Table 23 indicates that SUV's, Pickups, Big Vans and Large Trucks/Buses have higher than average fire rates while Passenger cars, Minivans and Motorcycles involved in fatal crashes have lower than average fire rates when compared to the total vehicle population.

Vehicle Type	Fatal Crashes with Fires (2000-2007)	Fatal Crashes without Fires (2000-2007)	Rate Per 100 Veh. Inv.
All Passenger Vehicles	9,001	212,847	4.23
All Vehicles	10,897	256,202	4.25
Large Trucks & Buses	1,094	4,878	22.43
Big Van	195	3,328	5.86
Pickup	2,134	42,357	5.04
SUV	1,361	29,587	4.60
Passenger Car	5,164	131,193	3.94
Minivan	342	9,710	3.52
Other	109	4,953	2.20
Motorcycles	498	30,196	1.65

Table 23. Frequency of fire occurrence by vehicle type (FARS 2000-2007)

Table 24 shows the fatality frequency by body type where fire was coded as the most harmful event. As described earlier, the MHE is not necessarily the cause of death however it is the event which caused the most vehicle related damage and in most cases we could infer a strong relationship with occupant fatality.

Vehicle Type	Fatal Crashes with Fire as MHE (2000-2007)	Fatal Crashes without MHE Fires (2000-2007)	Rate Per 100 Veh. Inv.
All Passenger Vehicles	2,824	219,024	1.29
All Vehicles	3,491	263,608	1.32
Large Trucks & Buses	512	5,460	9.38
Big Van	73	3,450	2.12
Pickup	703	43,788	1.61
SUV	444	30,504	1.46
Passenger Car	1,580	134,777	1.17
Minivan	97	9,955	0.97
Other	38	5,024	0.76
Motorcycles	44	30,650	0.14

Table 24. Frequency of fire as most harmful event (MHE) occurrence by vehicle type (FARS 2000-2007)

In an effort to understand the impact of vehicle age on fire occurrence during fatal crashes, vehicles were classified according to their age at the time of the crash. Overall, Table 25 indicates that the rate of fire occurrence for vehicles over the age of 10 years is 7.5% higher compared to those less than 5 years old. It should be noted that the fire rate increase with age for Pickups (15%) and SUVs (38%) is larger than the corresponding increase for passenger cars (4%). The cause of this difference is unclear.

Appendix Tables A3-A8 contain a breakdown by year of fatalities and vehicles involved by vehicle age and crash mode.

Vehicle Type	Fires in Vehicles Lt. 5 Yrs	Rate Per 100 Veh. Inv.	Fires in Vehicles Lt. 10 Yrs	Rate Per 100 Veh. Inv.	Fires in Vehicles Gt. 10 Yrs.	Rate Per 100 Veh. Inv.
All Passenger Vehicles	3,066	4.13	5,230	4.04	3,771	4.52
All Vehicles	4,168	4.15	6,704	4.13	4,193	4.46
Large Trucks & Buses	665	27.45	908	25.72	186	13.80
Big Van	64	5.87	107	6.00	88	5.70
Pickup	765	4.81	1,205	4.71	929	5.53
SUV	554	4.17	919	4.19	442	5.76
Passenger Car	1,645	3.94	2,896	3.82	2,268	4.09
Minivan	102	3.10	210	3.35	132	3.83
Other	62	1.66	73	1.77	36	4.29
Motorcycles	311	1.64	386	1.66	112	1.61

Table 25. Frequency of fire by vehicle type and vehicle age (FARS 2000-2007)

Fire involved crashes where one or more fatalities occurred in the vehicle were further subdivided by crash mode for each vehicle type. Table 26 lists the fire frequency (count) and fire rate for the FARS 2000-2007 fatality data. Crashes are coded as Rollovers when the rollover is the most severe crash event. Fire rate is calculated as the

number of fatal involved vehicles where a fire occurred per 100 vehicles with one or more fatal occupants. These rates are calculated for each cell of the resulting vehicle type versus crash mode table. As shown in Table 19 and Table 20, fires most frequently occur following a frontal crash, however, when fire rate is considered (see Table 26) in vehicles with one or more deaths, rear crashes show much higher values.

Vehicle Type Fire Frequency *Fire Rate*	Frontal	Side	Rear	Rollover	Other	All Modes Combined
Passenger Vehicles	5,745	1,624	667	538	427	
	5.18	*2.49*	*6.72*	*2.03*	*4.49*	*4.06*
All Vehicles	7,102	1,841	722	654	578	
	5.13	*2.57*	*6.24*	*2.27*	*3.48*	*4.08*
Motorcycles	387	50	10	.	51	
	1.96	*1.16*	*1.04*	*0.00*	*0.98*	*1.65*
Passenger Cars	3,231	994	462	230	247	
	5.00	*2.14*	*7.50*	*2.46*	*5.38*	*3.94*
Pickups	1,440	379	89	131	95	
	6.38	*4.42*	*6.35*	*1.78*	*3.88*	*5.04*
SUVs	843	200	97	154	67	
	6.67	*3.37*	*8.06*	*1.89*	*3.99*	4.60
Minivans	231	51	19	23	18	
	4.44	*2.00*	*3.87*	*2.11*	*4.86*	*3.52*
Big Vans	138	23	13	9	12	
	7.19	*3.89*	*8.39*	*1.84*	*6.90*	*5.86*
Other	60	11	9	9	20	
	2.97	*1.59*	*2.60*	*1.25*	*1.71*	2.20
Large Trucks & Buses	772	133	23	98	68	
	28.18	*20.62*	*16.79*	*10.07*	*17.75*	*22.43*

Table 26. Fire rates by vehicle type and crash mode where one or more fatalities occurred in that vehicle (FARS 2000-2007)

It should be noted that, due to the large amount of crush space in the rear of vehicles and inherent protection for occupants provided by the vehicle seat, rear impact crashes resulting in death tend to be very high energy events with significant vehicle damage and a higher risk of fire. In the absence of other impact events, rollover crashes where the rollover was coded as the most harmful event (MHE) results in fire less often than other crash modes (2.03% for passenger vehicles and 2.27% for all vehicles. However, as noted in the earlier sections, there is considerable evidence of under reporting of both rollover crashes and crashes with fires in FARS.

Table 27 shows crash counts and fire rates by crash mode for any vehicle included in FARS. This data differs significantly from that shown in Table 26 where only vehicles where one or more deaths occurred in the vehicles were included in the analysis. Overall, the rate of fire occurrence in all passenger vehicles in FARS is 2.79 per 100 crashes. Considering vehicles where one or more fatalities occurred in that vehicle, the fire rate for passenger vehicles was 4.06 per 100 (see Table 26). Presumably, those vehicles where one or more fatalities occurred were more heavily damaged and therefore fires resulted more often due to engine compartment, electrical component or fuel system damage.

Vehicle Type Fire Frequency *Fire Rate*	Frontal	Side	Rear	Rollover	Other	All Modes Combined
Passenger Vehicles	6,842	1,724	784	552	473	
	3.04	*2.09*	*3.55*	*2.06*	*3.17*	*2.79*
All Vehicles	9,128	2,075	960	675	678	
	3.23	*2.16*	*3.06*	*2.31*	*2.65*	*2.91*
Motorcycles	403	52	13	.	55	
	8.05	*4.08*	*81.25*		*96.57*	*1.61*
Passenger Cars	3,702	1,032	519	234	266	
	3.07	*1.83*	*4.12*	*2.41*	*3.39*	*2.78*
Pickups	1,798	421	111	137	107	
	3.14	*3.12*	*2.40*	*1.80*	*2.83*	*2.97*
SUVs	1,066	216	125	157	79	
	3.08	*2.41*	*3.58*	*1.86*	*3.05*	*2.83*
Minivans	276	55	29	24	21	
	2.16	*1.45*	*2.13*	*2.11*	*2.87*	*2.04*
Big Vans	164	26	23	10	16	
	2.47	*2.16*	*3.60*	*1.95*	*4.10*	*2.55*
Other	86	11	13	10	20	
	1.60	*0.96*	*1.26*	*1.36*	*0.75*	*1.28*
Large Trucks & Buses	1,633	262	127	103	114	
	6.61	*4.13*	*1.97*	*9.05*	*5.64*	*5.51*

Table 27. Fire rates by vehicle type and crash mode for all FARS vehicles (FARS 2000-2007)

Table 28 and Table 29 below explore rollover crashes further to identify their impact on fire rate. Comparing Table 27 and Table 29 , the overall fire rate for passenger vehicles when rollovers occur increases from 2.79 to 3.36 per 100 vehicles in FARS. This is a 20% overall increase fire risk during rollovers compared to all crashes. It should be noted that the observation that fire rates increase when rollovers occur is supported by

earlier findings of the research team (Fell 2006) and other research studies (Tessmer 1994, Digges 2005).

Vehicle Type Fire Frequency *Fire Rate*	Frontal	Side	Rear	Rollover	Other	All Modes Combined
Passenger Vehicles	1,259	412	113	538	168	
	4.66	*3.29*	*3.71*	*2.03*	*3.35*	*3.36*
All Vehicles	1,557	491	132	654	208	
	5.31	*3.66*	*3.96*	*2.27*	*3.86*	*3.79*
Motorcycles	0	0	0	0	0	
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Passenger Cars	607	195	52	230	79	
	4.92	*3.39*	*4.19*	*2.46*	*3.58*	*3.63*
Pickups	353	110	27	131	51	
	5.06	*3.65*	*3.57*	*1.78*	*3.96*	*3.35*
SUVs	242	80	29	154	32	
	4.52	*2.95*	*3.88*	*1.89*	*2.74*	2.88
Minivans	57	27	5	23	6	
	5.38	*4.21*	*2.65*	*2.11*	*3.28*	*4.09*
Big Vans	39	10	3	9	3	
	8.04	*4.33*	*3.75*	*1.84*	*4.84*	*1.76*
Other	9	5	3	9	2	
	1.71	*2.82*	*2.63*	*1.25*	*1.69*	2.10
Large Trucks & Buses	250	64	13	98	35	
	24.58	*16.54*	*17.11*	*10.07*	*21.47*	*3.83*

Table 28. Fire rates where rollover occurred by vehicle type and principle crash mode where one or more fatalities occurred in that vehicle (FARS 2000-2007)

Vehicle Type Fire Frequency *Fire Rate*	Frontal	Side	Rear	Rollover	Other	All Modes Combined
Passenger Vehicles	1,400	431	125	552	174	
	4.52	*3.22*	*3.66*	*2.06*	*3.35*	*3.36*
All Vehicles	1,806	529	148	675	220	
	5.16	*3.58*	*3.84*	*2.31*	*3.89*	*3.81*
Motorcycles	0	0	0	0	0	
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Passenger Cars	637	195	56	234	81	
	4.63	*3.17*	*4.00*	*2.41*	*3.45*	*3.61*
Pickups	411	125	29	137	53	
	4.54	*3.62*	*3.21*	*1.80*	*3.80*	*3.37*
SUVs	288	84	34	157	34	
	4.19	*2.74*	*3.78*	*1.86*	*2.71*	*2.91*
Minivans	64	27	6	24	6	
	4.98	*3.79*	*2.80*	*2.11*	*3.05*	*3.58*
Big Vans	44	10	4	10	3	
	5.71	*3.47*	*4.26*	*1.95*	*4.29*	*4.09*
Other	11	5	3	10	3	
	1.86	*2.45*	*2.14*	*1.36*	*2.38*	*1.78*
Large Trucks & Buses	351	83	16	103	39	
	13.01	*9.10*	*7.84*	*9.05*	*14.39*	*11.33*

Table 29. Fire rates where rollover occurred by vehicle type and principle crash mode for all FARS vehicles (FARS 2000-2007)

Appendix Tables A15 and A16 list the number of fatalities and fatal crash involved vehicles respectively by year where a rollover took place.

All						
Crash Year	Frontal	Side	Rear	Pure Rollover	Other	Total
1978-1980	4,995	3,473	394	16,351	1,012	26,225
1981-1983	6,739	2,942	590	12,239	1,459	23,969
1984-1986	7,568	3,373	730	11,061	1,122	23,854
1987-1989	8,551	3,758	877	12,385	1,488	27,059
1990-1992	8,945	3,830	865	9,654	1,666	24,960
1993-1995	8,955	4,006	895	9,042	1,601	24,499
1996-1998	9,312	4,443	1,032	9,520	1,820	26,127
1999-2001	9,556	4,348	1,165	10,549	1,809	27,427
2002-2004	10,514	4,929	1,190	10,238	1,774	28,645
2005-2007	10,596	4,990	1,150	9,895	2,188	28,819
Fire Involved						
1978-1980	267	164	33	454	41	959
1981-1983	387	110	36	327	50	910
1984-1986	373	131	38	275	44	861
1987-1989	432	126	48	264	69	939
1990-1992	486	124	32	176	47	865
1993-1995	461	121	31	142	61	816
1996-1998	443	131	38	161	47	820
1999-2001	479	141	39	206	67	932
2002-2004	499	165	43	195	61	963
2005-2007	494	158	46	218	65	981
Fire Coded as Most Harmful Event						
1978-1980	73	50	11	148	10	292
1981-1983	149	39	19	145	17	369
1984-1986	141	48	13	102	14	318
1987-1989	153	46	18	90	39	346
1990-1992	151	38	14	48	17	268
1993-1995	141	32	14	45	27	259
1996-1998	107	37	13	26	12	195
1999-2001	100	26	9	27	14	176
2002-2004	134	45	17	51	14	261
2005-2007	184	55	19	67	16	341

Table 30. Rollover Crashes (as MHE), Fatality Counts for Passenger Vehicles by Crash Mode

All						
Crash Year	Frontal	Side	Rear	Pure Rollover	Other	Total
1978-1980	5,621	3,741	473	16,771	1,035	27,641
1981-1983	7,523	3,149	656	12,411	1,542	25,281
1984-1986	8,426	3,618	816	11,181	1,170	25,211
1987-1989	9,647	4,038	976	12,534	1,535	28,730
1990-1992	10,121	4,085	948	9,717	1,707	26,578
1993-1995	10,235	4,265	993	9,101	1,657	26,251
1996-1998	10,727	4,743	1,151	9,580	1,868	28,069
1999-2001	10,956	4,599	1,309	10,653	1,883	29,400
2002-2004	12,179	5,258	1,337	10,334	1,816	30,924
2005-2007	12,127	5,353	1,282	10,053	2,263	31,078
Fire Involved						
1978-1980	298	174	35	470	41	1,018
1981-1983	422	117	38	331	53	961
1984-1986	402	137	39	280	48	906
1987-1989	463	137	52	267	72	991
1990-1992	525	133	34	178	48	918
1993-1995	503	129	32	143	64	871
1996-1998	494	138	43	161	49	885
1999-2001	529	146	44	209	70	998
2002-2004	567	170	51	198	62	1,048
2005-2007	535	167	48	222	67	1,039
Fire Coded as Most Harmful Event						
1978-1980	75	50	11	150	10	296
1981-1983	152	41	20	147	17	377
1984-1986	145	48	13	103	14	323
1987-1989	158	46	18	91	40	353
1990-1992	154	40	14	48	17	273
1993-1995	143	32	15	46	27	263
1996-1998	109	37	13	26	12	197
1999-2001	103	26	9	27	15	180
2002-2004	137	46	17	52	14	266
2005-2007	187	58	20	68	16	349

Table 31. Rollover Crashes (as MHE), Vehicle Counts for Passenger Vehicles by Crash Mode

Damage Severity

When damage severity is considered, it is clear that the majority of fires occur when vehicles sustain severe/disabling damage (see Table 32, Table 33 & Table 34). Within FARS, damage severity is coded based on tow status and police officer report. If the police report indicates that the vehicle was 'totaled' and the vehicle was towed away, this is considered 'Disabling' damage." If the report indicates that the vehicle was 'totaled,' but the vehicle was driven away, this is 'Functional.'

All						
Crash Year	Frontal	Side	Rear	Rollover	Other	Total
1978-1980	260	121	32	88	60	561
1981-1983	331	143	39	123	78	714
1984-1986	259	128	37	101	64	589
1987-1989	267	128	52	105	83	635
1990-1992	286	109	46	89	83	613
1993-1995	266	89	34	70	59	518
1996-1998	261	102	28	55	58	504
1999-2001	224	86	35	57	67	469
2002-2004	242	92	46	48	48	476
2005-2007	228	61	34	38	33	394
Fire Involved						
1978-1980	6	1	.	1	2	10
1981-1983	6	6	1	4	.	17
1984-1986	5	1	.	2	1	9
1987-1989	1	5	.	3	1	10
1990-1992	9	-	1	1	3	14
1993-1995	4	1	.	.	1	6
1996-1998	6	-	.	.	.	6
1999-2001	7	1	2	.	.	10
2002-2004	4	1	.	.	.	5
2005-2007	5	1	.	.	1	7
Fire Coded as Most Harmful Event						
1978-1980	2	-	.	.	1	3
1981-1983	5	3	.	3	.	11
1984-1986	.	-	.	1	.	1
1987-1989	1	2	.	1	.	4
1990-1992	4	-	.	.	2	6
1993-1995	1	-	.	.	.	1
1996-1998	3	-	.	.	.	3
1999-2001	1	-	1	.	.	2
2002-2004	1	-	.	.	.	1
2005-2007	5	-	.	.	1	6

Table 32. Crashes with Minor Damage, Fatality Counts for Passenger Vehicles by Crash Mode

All						
Crash Year	Frontal	Side	Rear	Rollover	Other	Total
1978-1980	2,092	1,318	151	944	156	4,661
1981-1983	2,206	1,302	164	989	208	4,869
1984-1986	2,102	1,286	194	1,089	164	4,835
1987-1989	2,395	1,456	237	1,190	233	5,511
1990-1992	2,976	1,593	260	891	261	5,981
1993-1995	2,973	1,517	283	786	250	5,809
1996-1998	3,127	1,756	259	849	316	6,307
1999-2001	2,592	1,472	275	734	272	5,345
2002-2004	2,461	1,482	284	635	196	5,058
2005-2007	2,191	1,202	224	549	209	4,375
Fire Involved						
1978-1980	32	14	7	8	2	63
1981-1983	52	21	14	16	1	104
1984-1986	47	22	14	18	.	101
1987-1989	67	27	13	13	9	129
1990-1992	114	27	11	12	7	171
1993-1995	103	29	9	6	3	150
1996-1998	75	23	6	6	11	121
1999-2001	51	16	6	6	6	85
2002-2004	53	9	6	4	1	73
2005-2007	36	15	4	7	1	63
Fire Coded as Most Harmful Event						
1978-1980	12	7	4	3	.	26
1981-1983	27	8	13	9	.	57
1984-1986	20	4	6	3	.	33
1987-1989	31	15	5	6	9	66
1990-1992	46	9	6	5	4	70
1993-1995	31	3	5	2	1	42
1996-1998	14	9	4	.	3	30
1999-2001	14	4	4	.	1	23
2002-2004	25	5	3	1	.	34
2005-2007	14	6	1	.	1	22

Table 33. Crashes with Moderate/Functional Damage, Fatality Counts for Passenger Vehicles by Crash Mode

All						
Crash Year	Frontal	Side	Rear	Rollover	Other	Total
1978-1980	41,725	22,028	2,264	15,226	3,065	84,308
1981-1983	36,746	19,204	2,250	11,019	5,629	74,848
1984-1986	37,544	21,236	2,621	9,773	3,819	74,993
1987-1989	40,739	23,377	3,058	10,834	3,223	81,231
1990-1992	38,131	22,179	2,517	8,489	2,819	74,135
1993-1995	39,444	22,610	2,735	8,092	2,550	75,431
1996-1998	40,621	23,593	3,175	8,530	2,631	78,550
1999-2001	39,820	23,681	3,578	9,669	2,711	79,459
2002-2004	40,440	24,255	3,537	9,494	2,602	80,328
2005-2007	38,585	21,872	3,281	9,266	3,327	76,331
Fire Involved						
1978-1980	1,642	645	319	442	170	3,218
1981-1983	1,652	543	266	302	279	3,042
1984-1986	1,689	630	263	255	203	3,040
1987-1989	1,896	641	286	242	208	3,273
1990-1992	1,931	611	204	161	137	3,044
1993-1995	2,006	615	212	133	150	3,116
1996-1998	2,027	583	216	154	132	3,112
1999-2001	2,167	600	279	199	144	3,389
2002-2004	2,126	629	234	191	152	3,332
2005-2007	2,159	597	239	210	175	3,380
Fire Coded as Most Harmful Event						
1978-1980	456	183	109	143	62	953
1981-1983	634	185	150	130	99	1,198
1984-1986	579	170	103	98	77	1,027
1987-1989	640	180	119	83	99	1,121
1990-1992	566	156	108	42	62	934
1993-1995	515	157	102	43	74	891
1996-1998	479	133	78	25	57	772
1999-2001	458	108	105	27	45	743
2002-2004	636	173	99	50	56	1,014
2005-2007	791	204	126	66	80	1,267

Table 34. Crashes with Severe/Disabling Damage, Fatality Counts for Passenger Vehicles by Crash Mode

CONCLUSIONS

In summary, this study presents descriptive statistics documenting the rate that states report fatal fire involved and rollover involved crashes per fatal crash occurrence. Based on interview findings, it appears that many FARS Analysts in the 14 States with low fire and rollover rates do not have routine access nor routinely use other data sources (other than the PAR) in coding fire or rollover occurrences. These states include Utah, Mississippi, Florida, Michigan, South Carolina, Dist of Columbia, Idaho, Virginia, New York, Nebraska, New Jersey, Colorado, Alabama and Nevada. Since these states include both predominantly rural and urban classes, it is unlikely that level of urbanization, which does affect fire and rollover crash rates, introduces any significant bias in reporting rates.

Five states made no mention of fire on their PAR. Only 9 states had a specific box for routine coding in their PAR. The fire rate for these 9 states ranged from 2.45 in North Carolina to 3.42 in Alaska. The average fire rate for these states was 3.55. This compared to an average of 2.88 for the entire group of 50 States and DC. Lack of data on the PAR requires additional resources to identify FARS cases with fires.

Figures 1 through 4 show the very large variations FARS rate data by State for fires, rollovers, rollovers with fires and extractions. These variations lead to questions regarding the validity of the data in predicting actual magnitude of these events.

Every effort should be made to obtain access to key data as an aid to reporting these important data elements in FARS. Death certificates, medical examiners or coroners reports, emergency medical service reports and even news clippings of the fatal crash would all help in the FARS coding. This study investigates a few critical data elements coded within FARS that many analysts use for safety evaluations including the occurrence of fire, rollover and occupant entrapment. Additional training should be conducted to alert FARS analysts and NHTSA staff of these deficiencies and to implement best practices to see that the information is adequately recognized and coded in the future. Further, follow- up analyses like the one presented in this report should be conducted regularly to insure that FARS analysts make changes and continue to maintain high standards for data collection.

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