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Local Fire Department Responses to Fires involving Automobiles, Buses, and Larger Trucks: 2006-2010 estimates

Marty Ahrens

National Fire Protection Association

ABSTRACT

Automobile fires account for the majority of vehicle fires and vehicle fire deaths. Fires involving larger trucks resulted in a disproportionate share of vehicle fire losses. Although bus fires are less common, they have a much higher rate of fire based on distance driven. Bus fires have the potential to endanger a larger number of passengers. Any efforts to evaluate the merits of proposed fire safety improvements require an understanding of how many fires and deaths are presently occurring and how many might be prevented with the proposed improvements. Data from the U.S. Fire Administration's National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA's) fire department survey were used to estimate the frequency and associated losses of such fires attended by local U.S. fire departments, and the major factors in these fires and losses. The risk of these fires and of automobile deaths overall and from fires resulting from collision or overturn per billion kilometers driven are also included. The majority of these vehicle fires resulted from mechanical or electrical problems, but three out of every five automobile fire deaths resulted from fires associated with collision or overturn.

INTRODUCTION

During 2006-2010, U.S. fire departments responded to an estimated average of 223,300 fires involving passenger and freight road vehicles. These fires caused an average of 329 civilian deaths, 1,221 civilian injuries, and more than $1 billion in direct property damage. Fires involving road vehicles (vehicles designed to carry passengers or freight on roads) accounted for 15% of reported fires, 10% of civilian fire deaths, 7% of civilian fire injuries, and 8% of the direct property damage. This analysis focuses on fires in three types of road vehicles: automobiles; buses, including school buses or trackless trolleys; and larger trucks. Because the leading causes of automobile fires differ from those of fires that result in death, automobile fire deaths were analyzed and shown separately.

Table 1 shows that an average of 152,300 automobile fires per year caused annual averages of 209 civilian deaths, 764 civilian injuries, and $536 million (US) in direct property damage, accounting for two-thirds (68%) of reported road vehicle fires, 63% of the associated deaths and injuries and 52% of the associated property damage. Overall, automobile fires accounted for 10% of all reported U.S. fires (excluding those handled by private, state or federal firefighting agencies) and 6% of the associated fire deaths. During this period, there were 1.4 fire deaths per 1,000 reported automobile fires. With almost 131 million automobiles registered in the U.S. during 2010 [1], these vehicles are essential to getting people where they need to go. In most years, more people are killed by automobile fires than by non-residential structure fires. [2]

Larger trucks, including: semi-trailers; general use trucks; garbage, waste or refuse trucks; and tank trucks; and excluding pick-up trucks and unclassified freight road vehicles, were involved in an average of 12,900 fires per year, resulting in annual averages of 36 deaths, 91 injuries, and $168 million in direct property loss annually, accounting for 6% of reported road vehicle fires, 11% of the associated deaths, 8% of the associated injuries and 16% of the road vehicle fire property damage. With a rate of 2.8 deaths per 1,000 reported fires, fires involving larger trucks cause a disproportionate share of the fires losses.

An average of 2,100 fires per year involving buses, school buses or trackless trolleys caused an average of 22 civilian injuries, and $29 million in direct property damage annually, accounting for 1% of reported road vehicle fires, 2% of the associated injuries and 3% of the associated property damage. Deaths averaged less than one per year. Buses transport school children, commuters, and travelers. Some buses transport people with disabilities. Although the fire and loss frequency is much lower, 190 bus fires occurred per billion kilometers travelled, three times the rate of 57 fires per billion kilometers travelled for automobiles.

While progress has been made, there is more to do. It is necessary to understand the causes and circumstances of these fires in order to develop sound strategies to prevent these fires and losses. These factors, as well as fire and loss rates based on distance travelled, fire department response times, and automobile fire and fire death trends are discussed. Data issues and limitations are also addressed.

METHODOLOGY

This paper focuses on fires involving automobiles, buses, and larger trucks that were reported to local (municipal or county) fire departments in the U.S. Civilian deaths resulting from automobile fires are also discussed. National estimates of fires and associated losses were calculated using the detailed data and data classification system from the U.S. Fire

Administration's National Fire Incident Reporting System (NFIRS) [3] and the National Fire Protection Association's (NFPA's) fire department experience survey following the general procedures described by Hall and Harwood. [4] Fire departments throughout the U.S. use NFIRS to document their incidents. Typically, state fire authorities administer the NFIRS program for their state, providing training, support and quality control. States set their own reporting requirements, ranging from mandatory for all incidents, to mandatory for incidents meeting a loss threshold to completely voluntary. Participation in NFIRS is voluntary at the federal level. Note that fires that are reported to federal, state or private firefighting organizations are not captured in NFIRS. Fires that are handled without fire department assistance are also not captured.

Table 1. Road vehicle fires reported in the U.S., by vehicle type: 2006-2010 annual averages
(The underlined vehicle types are the focus of this paper.)

Vehicle type	**Fires**		**Civilian Deaths**		**Civilian Injuries**		**Direct Property Damage (in Millions US)**	
Passenger road vehicles	**202,800**	**(91%)**	**277**	**(84%)**	**1,077**	**(88%)**	**$776**	**(76%)**
Automobile, passenger car, ambulance, race car or taxi-cab	152,300	(68%)	209	(63%)	764	(63%)	$536	(52%)
Unclassified passenger road vehicle	41,200	(18%)	56	(17%)	173	(14%)	$144	(14%)
Motor home, camper mounted on pickup	2,700	(1%)	5	(2%)	60	(5%)	$45	(4%)
Bus, school bus or trackless trolley	2,100	(1%)	0	(0%)	22	(2%)	$29	(3%)
Motorcycle or trail bike	1,600	(1%)	3	(1%)	19	(2%)	$5	(0%)
Off-road recreational vehicle	1,300	(1%)	1	(0%)	10	(1%)	$4	(0%)
Towable travel trailer	1,300	(1%)	3	(1%)	23	(2%)	$11	(1%)
Collapsible camper trailer	200	(0%)	0	(0%)	4	(0%)	$1	(0%)
Portable building or manufactured home	200	(0%)	0	(0%)	2	(0%)	$2	(0%)
Freight road vehicles	**20,500**	**(9%)**	**52**	**(16%)**	**144**	**(12%)**	**$250**	**(24%)**
Larger trucks	*12,900*	*(6%)*	*36*	*(11%)*	*91*	*(8%)*	*$168*	*(16%)*
Semi-trailer, with or without tractor	5,900	(3%)	23	(7%)	38	(3%)	$92	(9%)
General use truck	4,600	(2%)	7	(2%)	32	(3%)	$39	(4%)
Garbage, waste or refuse truck	1,700	(1%)	0	(0%)	9	(1%)	$18	(2%)
Tank truck for flammable or combustible liquid	400	(0%)	4	(1%)	10	(1%)	$13	(1%)
Tank truck for nonflammable cargo	300	(0%)	2	(1%)	1	(0%)	$4	(0%)
Tank truck for compressed or LP-gas	100	(0%)	0	(0%)	1	(0%)	$1	(0%)
Other freight road vehicles	*7,600*	*(4%)*	*16*	*(5%)*	*52*	*(4%)*	*$82*	*(7%)*
Unclassified freight road vehicle	4,600	(2%)	10	(3%)	30	(2%)	$68	(7%)
Pickup truck or hauling rig	3,000	(1%)	6	(2%)	23	(2%)	$14	(1%)
Total	**223,300**	**(100%)**	**329**	**(100%)**	**1,221**	**(100%)**	**$1,025**	**(100%)**

Source: NFIRS and NFPA survey.

NFPA's annual fire department experience survey collects summary data from a sample of local fire departments. Because a statistical sample is used, estimates of the national frequency of different types of fires and losses can be developed. These estimates are then divided by the total fires and losses in NFIRS to obtain a multiplier that is applied to NFIRS to compensate for fires that were reported to local fire departments but not captured in NFIRS.

Query Criteria

In this analysis, road vehicle fires were identified by using the entire range of NFIRS vehicle fire incident types (NFIRS incident type codes 130-139) and all passenger and freight road vehicle mobile property types (NFIRS mobile property type codes 10-29). The mobile property type codes shown below were used to identify the three specific categories of vehicles analyzed in this study:

11. Automobile, passenger car, ambulance, race car or taxi-cab;
12. Bus or school bus, including trackless trolleys,

And several types of trucks grouped together in a category called "larger trucks:"

21. General use truck, dump truck or fire apparatus,
23. Semi-trailer designed for freight, with or without a trailer;
24. Tank truck for non-flammable cargo;
25. Tank truck for flammable or combustible liquids or chemical cargo;
26. Tank truck for compressed gas or LP-gas
27 Garbage, waste or refuse truck, including recyclable material collection trucks and excluding roll-on type trash containers.

Table 1 also shows estimated annual averages of reported vehicle fires and associated losses for all types of road vehicles, including both passenger and freight road vehicles. Unclassified freight road vehicles and pick-up trucks or hauling rigs (shown under the heading of "other freight road vehicles") were excluded from the larger truck category and this study. The three types of vehicles or vehicle groups (larger trucks) analyzed in this paper are underlined. Note that fires were rounded to the nearest hundred, civilian deaths and injuries were rounded to the nearest one, and direct property damage was rounded to the nearest million dollars. Percentages were calculated on unrounded values.

Only data originally collected in Version 5.0 of NFIRS were analyzed. Fires in which mutual aid was given were excluded. Vehicle fires inside structures that involved the structure are considered structure fires and not included here. Only casualties caused by the fire are considered fire casualties. Trauma-only casualties should, by NFIRS and NFPA definition, be excluded. Over the five-year period of 2006-2010, *raw* NFIRS data contained a *total* of 446,926 automobile fires that meet these criteria, with 884 civilian deaths, 1,754 civilian injuries, and $1,371,288,438 in direct property damage. It also contained totals of 6,270 bus or school bus fires with one civilian death, 56 civilian injuries, and $73,823,166 in direct property damage; and 37,721 larger truck fires, with 151 civilian deaths, 211 civilian injuries, and $434,181,653 in direct property damage.

Handling Unknown or Missing Data in NFIRS

For NFIRS fields other than incident type and property use, unknown or missing data were allocated proportionally. A proportional share of vehicle fires in which the mobile property involved in ignition as coded as none were treated as unknown and included in the estimates. "None" was also treated as unknown in the factor contributing to ignition field. This basic approach, also described in Hall and Harwood [4] assumes that if the unknown or missing data were known, the patterns would resemble the known data. It is essentially the same as calculating the percentage of fires with known data and applying that percentage to the total. The percentages of unknown or missing data can vary over time, between jurisdictions, and across data elements, loss measures, and type of fire, vehicle, etc. This approach makes it easier to do comparisons and trend analysis. While not a perfect solution, the alternative approach of excluding fires with unknown or missing data is worse. Large numbers of fires would be excluded from the discussion. Different totals would be obtained for different data elements, making it hard to get a handle on the importance of different issues.

The percentages of missing or unknown data for different data elements are shown in the discussion of data limitations.

Distance Data

Data from the U.S. National Highway Traffic Safety Administration (NHTSA) were used to calculate event rates based on kilometers driven. [5] Because the data on kilometers (converted from miles) driven were not shown separately for automobiles, annual averages for 2006-2008 rather than more current data were used in calculations involving distance travelled. Risk relative to exposure is useful for setting priorities and tracking progress.

CAUSES AND CIRCUMSTANCES OF AUTOMOBILE, BUS, AND LARGER TRUCK FIRES

A number of factors influence the outcome of a fire. The location of the fire can affect the likelihood of prompt discovery, fire department notification and timely fire department response. Some types of fires have a higher risk of death than others. The area of the vehicle where the fire originates also matters.

Where Do Automobile Fires Occur?

Roughly three-quarters of these vehicle fires and automobile fire deaths occurred on highways, streets or parking areas. Figure 1 shows that only 17% of the automobile fires and 20% of the bus fires occurred on highways or divided highways. However, two out of five (41%) automobile fires deaths and fires involving larger trucks (39%) occurred on these properties. Four percent of bus fires occurred on educational properties making buses the only type of vehicle with at least 1% of the fires at these sites.

What Are the Leading Causes of Automobile, Larger Truck and Bus Fires?

Table 2 and Figure 2 show the major causes of these vehicle fires. These causes were pulled from three NFIRS fields: cause of ignition, factors contributing to ignition, and heat source. The major casual factors describe specific scenarios. Because the field for factor contributing to ignition allows multiple entries and calculations were done separately for each field, double-counting is possible. Less common fire causes are not shown.

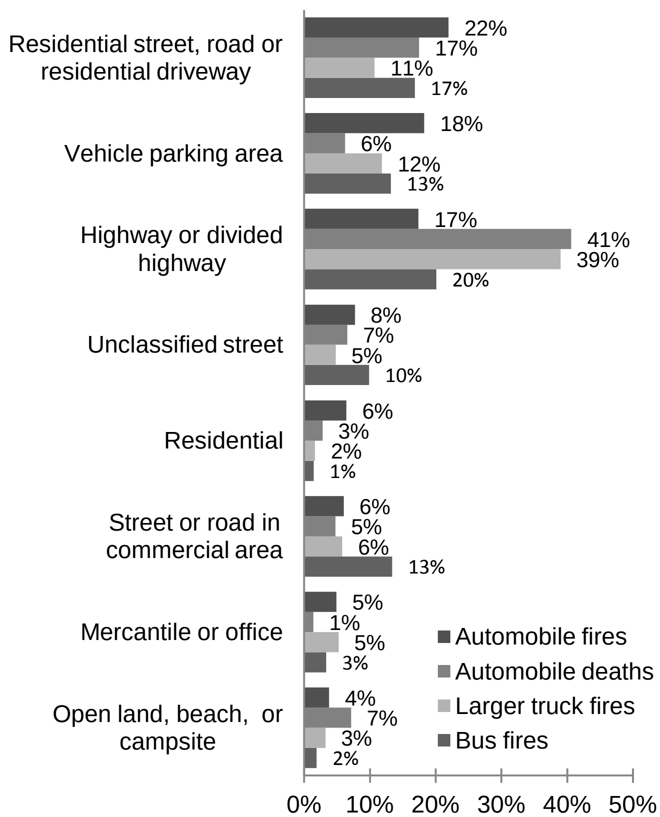

Figure 1. Vehicle fires, by leading location where fire occurred: 2006-2010

A mechanical failure or malfunction was the leading factor in fires in all three types of vehicles, playing a role in 45-60% of the fires. However, Table 2 shows that only 11% of the automobile fire deaths resulted from fires involving such failures or malfunctions. Mechanical failures may be due to leaks or breaks, worn out parts, backfires, or similar issues. Electrical failures or malfunctions were factors in one-quarter (23%) of the automobile and bus fires, but only 1% of the automobile fire deaths.

While collisions or overturns were factors in only 4% of the automobile fires, 3% of the larger truck fires and 0% of the bus fires, these incidents caused three of every five (60%) automobile fire deaths. More than half (57%) of the automobile collision fire deaths resulted from fires on highways or divided highways, suggesting that these situations are more likely to occur where travel speeds are higher.

Ten percent of automobile fires were intentional; these incidents caused 11% of the automobile fire deaths. Only 3% of the larger truck and bus fires were intentionally set. Because intentional firesetting deliberately overrides any fire prevention, intentional fires are excluded from the remainder of the analysis of causal factors. Because the NFIRS field "cause of ignition," includes unintentional, equipment or heat source failure, and act of nature as separate code choices, the term "non-intentional" will be used to describe all fires that were not intentionally set. During 2006-2010, fire departments responded to an estimated annual average of 136,400 non-intentional automobile fires, resulting in an average of 186 civilian deaths, 720 civilian injuries, and $424 million (US) in direct property damage per year. They also responded to 12,500 non-intentional larger truck fires and 2,100 non-intentional bus fires.

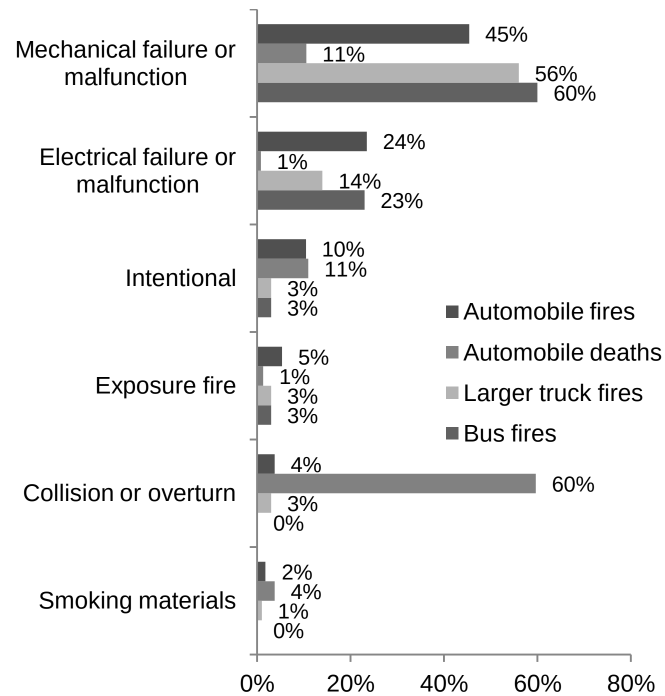

Figure 2. Vehicle fires, by major causal factors: 2006-2010

How Is the Area of Fire Origin Related to the Cause of Non-Intentional Vehicle Fires?

Table 3 and Figure 3 show that two-thirds (69%) of the non-intentional automobile fires, more than half (56%) of the non-intentional fires involving larger trucks and almost three-quarters (71%) of such bus fires began in the engine, running gear area or wheel area. Two of every five (39%) automobile fire deaths resulted from fires originating in these areas. Because of its dominant share, the leading factors for this group of areas resemble that of overall vehicle fires.

Figure 4 shows the leading causal factors for non-intentional vehicle fires that started in the engine area, running gear or wheel area for the different types of vehicles and for automobile fire deaths. Comparable data for fires starting: in the passenger area are shown in Figure 5, on the vehicle exterior are shown in Figure 6, and in or along the vehicle fuel tank or fuel line are shown in Figure 7. Due to the small number of bus fires originating in that area, buses were excluded from Figure 7. Circumstances of fires originating in the cargo area are often influenced as heavily by the nature of the cargo as by the design and consequently are not discussed here.

Table 2. Automobile fires, by major causal factors: 2006-2010 annual averages

Causal Factor	Automobile Fires		Automobile Civilian Deaths		Larger Truck Fires		Bus Fires	
Mechanical failure or malfunction	69,100	(45%)	22	(11%)	7,300	(56%)	1,300	(60%)
Electrical failure or malfunction	35,800	(24%)	2	(1%)	1,900	(14%)	500	(23%)
Intentional	15,900	(10%)	23	(11%)	400	(3%)	100	(3%)
Exposure fire	8,200	(5%)	3	(1%)	400	(3%)	100	(3%)
Collision or overturn	5,700	(4%)	125	(60%)	400	(3%)	0	(0%)
Smoking materials	2,700	(2%)	8	(4%)	200	(1%)	0	(0%)

Source: NFIRS and NFPA survey

Table 3. Non-intentional automobile fires, by area of origin: 2006-2010 annual averages

Area of Origin	Automobile Fires		Automobile Civilian Deaths		Larger Truck Fires		Bus Fires	
Vehicle engine area, running gear or wheel area	93,600	(69%)	72	(39%)	7,000	(56%)	1,500	(71%)
Passenger area of vehicle	16,600	(12%)	31	(16%)	900	(7%)	200	(9%)
Unclassified vehicle area	9,100	(7%)	39	(21%)	1,000	(8%)	200	(8%)
Cargo or trunk area of vehicle	4,100	(3%)	3	(2%)	1,600	(13%)	0	(1%)
Exterior surface of vehicle	3,500	(3%)	3	(2%)	900	(7%)	100	(3%)
Unclassified area of origin	2,600	(2%)	3	(1%)	200	(2%)	100	(3%)
Vehicle fuel tank or fuel line	2,100	(2%)	29	(15%)	200	(1%)	0	(1%)
Other known area	4,600	(3%)	7	(4%)	700	(6%)	100	(4%)
Total	136,400	(100%)	186	(100%)	12,500	(100%)	2,100	(100%)

Source: NFIRS and NFPA survey.

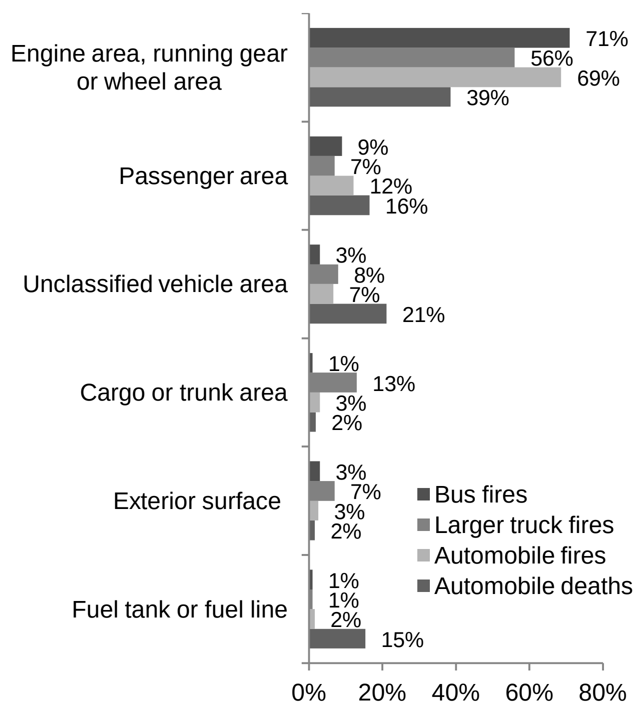

Figure 3. Non-intentional vehicle fires by leading areas of origin: 2006-2010

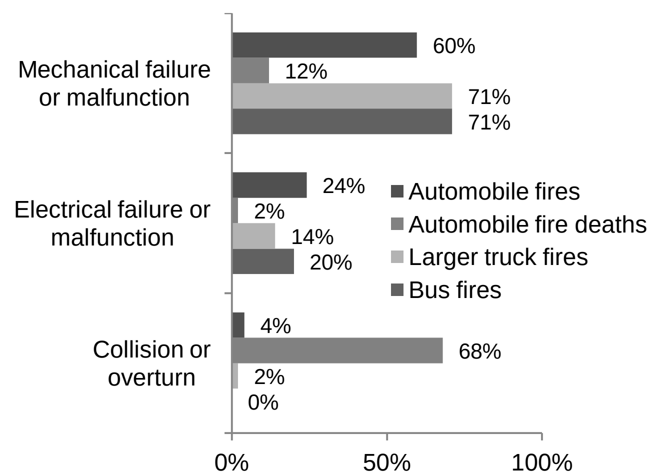

Figure 4. Non-intentional vehicle fires that began in the engine, running gear or wheel area by leading major causal factor: 2006-2010

Collisions or overturns ranked first among the causal factors for automobile fire deaths resulting from fires starting in all four areas. Deaths resulting from fires originating on the exterior are not shown because of their small numbers. Mechanical failures or malfunctions are by far the most common factor in non-fatal fires when the fire originated in the engine, running gear or wheel area of all three types of vehicles. Mechanical failures or malfunctions were the leading factor in fires involving larger trucks or buses that began on the vehicle's exterior. Automobile fires that began on the exterior were more likely to have resulted from exposure to another hostile fire.

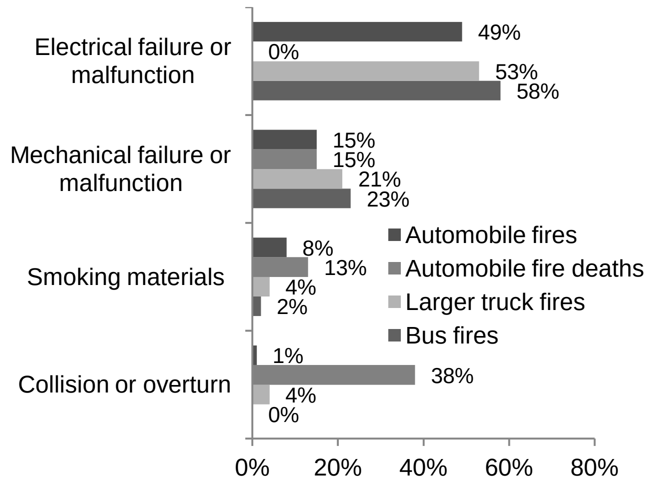

Figure 5. Non-intentional vehicle fires that began in the passenger area by leading major causal factor: 2006-2010

Electrical failures or malfunctions were the leading factor in fires that originated in the passenger area in all three categories of vehicles. Automobile passenger area fires were more likely to have been started by smoking materials than were passenger area fires in larger trucks or buses.

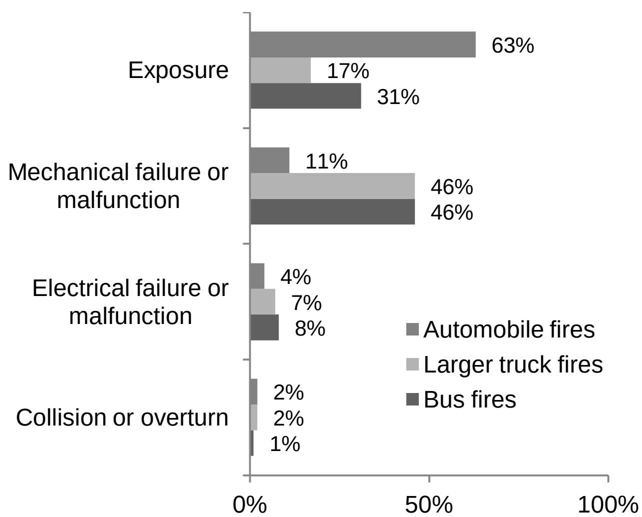

Figure 6. Non-intentional vehicle fires that began on the exterior area by leading major causal factor: 2006-2010

It is worth noting that only 2% of automobile fires originated in the fuel tank or fuel line, but these fires caused 15% of the associated deaths. Mechanical failures or malfunctions were factors in half (52% of these fires) and one in five (19%) of these deaths. Leaks or breaks dominated the mechanical failure or malfunction category, accounting for one-third (32%) of the fires originating in the fuel tank or fuel line.

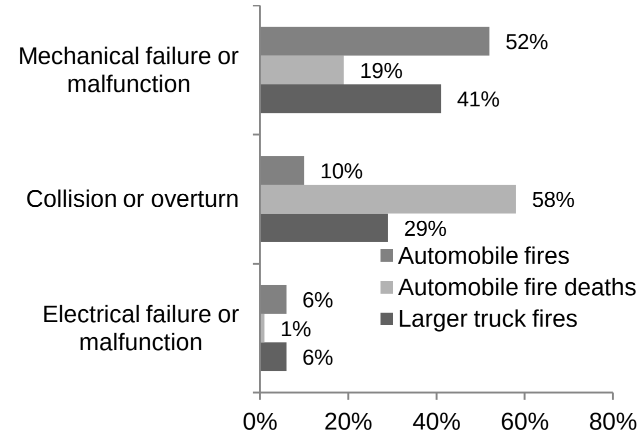

Figure 7. Non-intentional vehicle fires that began in the fuel tank or fuel line area by leading major causal factor: 2006-2010

Figures 8, 9, and 10 show the leading items first ignited in the engine, running gear or wheel area; in the passenger area; and on or along the vehicle's exterior; respectively. Because flammable or combustible liquids or gases so dominate fuel tank or fuel line fires, that data is not shown.

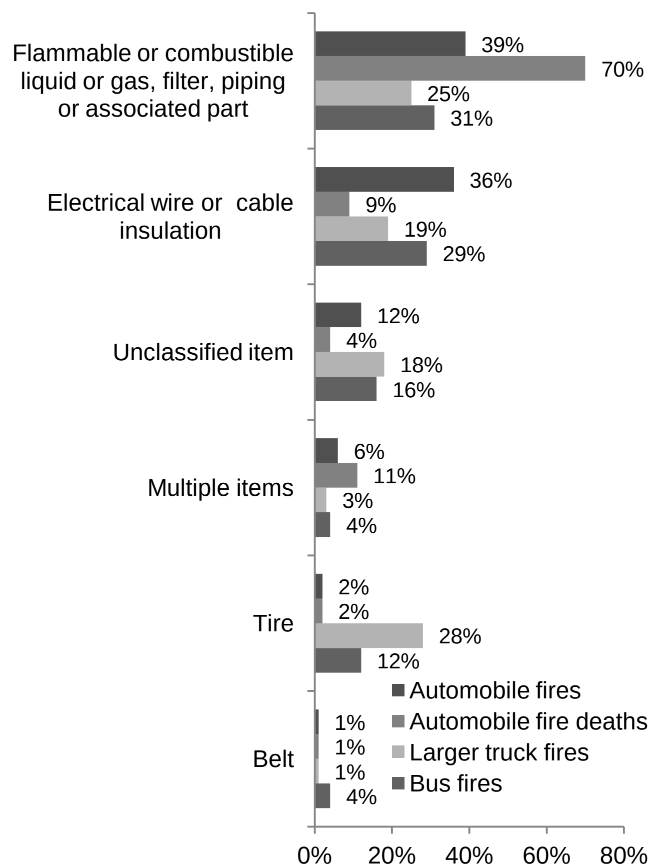

Figure 8. Non-intentional vehicle fires that began in the engine, running gear or wheel area by leading items first ignited: 2006-2010

The most common item first ignited in automobile fire deaths was some type of flammable or combustible liquid or gas, filter, piping, or associated part, regardless of the area of origin. Not surprisingly, this was also the most common item first ignited in fires beginning in the engine, running gear or wheel area for automobiles and buses. However, for fires involving larger trucks that started in the engine, running gear or wheel area, tires were the leading item first ignited; flammable or combustible liquids, gases, filters, piping or associated parts, ranked second.

Electrical wire or cable insulation ranked second among the leading items for automobile and bus fires starting in the engine, running gear or wheel area. It was the leading item first ignited for all three types of vehicles when the fire originated in passenger area. Upholstered furniture or vehicle seats ranked second in passenger area fires, again for all three types of vehicles. However, the share of upholstered furniture or vehicle seats was nearly twice as high among automobile passenger area fires (27%) compared to larger truck fires (15%) and bus fires (14%).

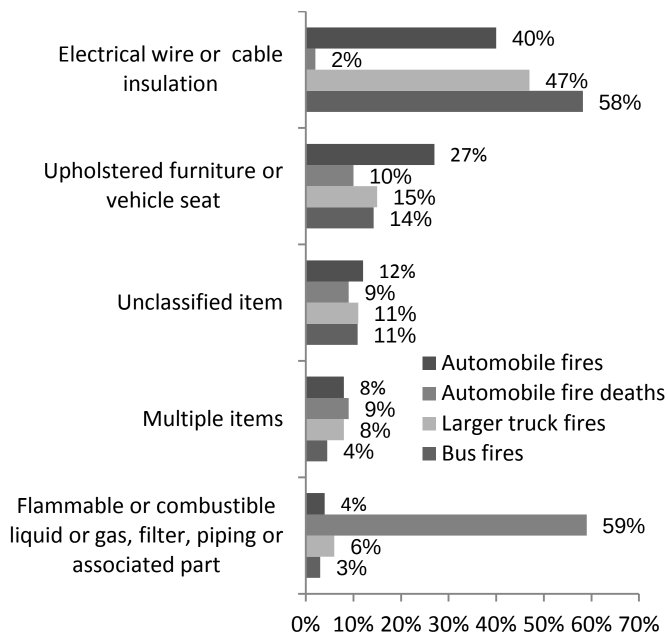

Figure 9. Non-intentional vehicle fires that began in the passenger area by leading items first ignited: 2006-2010

FIRE DEPARTMENT RESPONSE TIME TO VEHICLE FIRES

The time between fire occurrence and the arrival of help can play a role in the outcome. Unfortunately, most vehicles do not have a mechanism to record when a fire starts. Some fires, particularly those in rural areas, are not discovered immediately. Figure 11 shows the response time calculated as the time elapsed between the time the alarm was received by the fire department and the time the first responding unit arrived on scene for the different types of vehicle fires, including both intentional and non-intentional fires, reported in 2006-2010. Note that additional time may be spent in handling a call at a public safety answering point before the call is transmitted to the fire department.

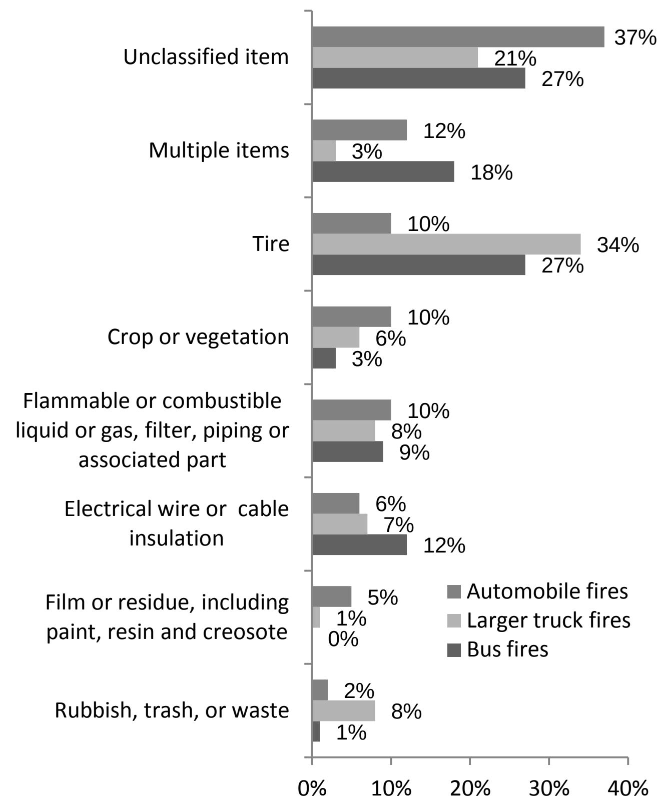

Figure 10. Non-intentional vehicle fires that began on or along the exterior area by leading items first ignited: 2006-2010

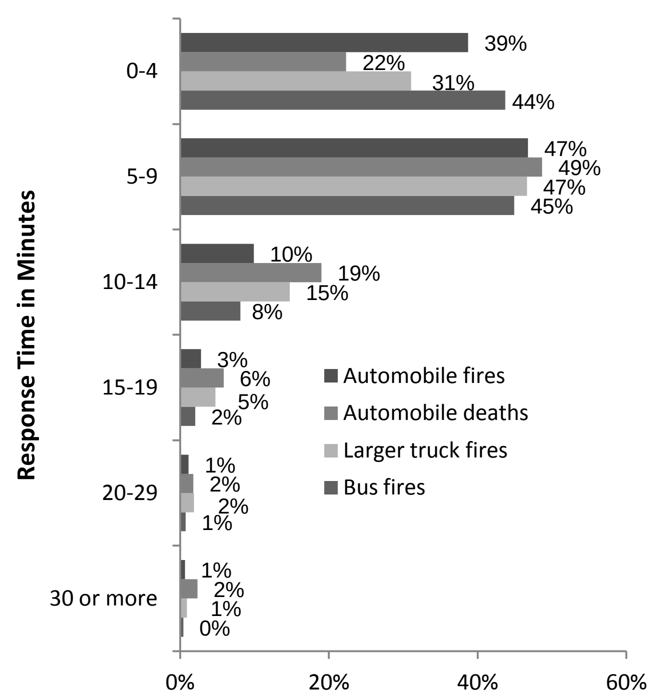

Figure 11. Reported vehicle fires (all causes), by response time for first arriving unit: 2006-2010

Response time was less than five minutes in 39% of the automobile fires, 22% of the deaths, 31% of the fires involving larger trucks, and 44% of the bus fires. The first firefighters arrived in less than 10 minutes in 85% of the automobile fires, 71% of the automobile fire deaths, and 89% of the bus or school bus fires. Response times of ten minutes or less were seen in 82% of the automobile fires resulting from collisions or overturn and 64% of the associated deaths.

TRENDS

While vehicle fires and associated losses still occur with distressing frequency, considerable progress has been made. The trend analysis includes both intentional and non-intentional fires. Figures 12, 13 and 14 show trends from 2002 through 2010 for automobile fires, fires involving larger trucks, and bus fires respectively. Automobile fire death and non-residential structure fire death trends are contrasted in Figure 16. After a generally consistent downward trend, the numbers of reported automobile fires and associated fire deaths respectively were 42% and 49% lower in 2010 than in 2002. Fires involving larger trucks were 30% lower in 2010 than in 2002after dropping sharply from 2007 to 2009. Bus fires were only 8% lower in 2010 than 2002. Total reported fires and fire deaths were only 21% and 8% lower, and structure fires and associated deaths were only 7% and 1% lower. [6]

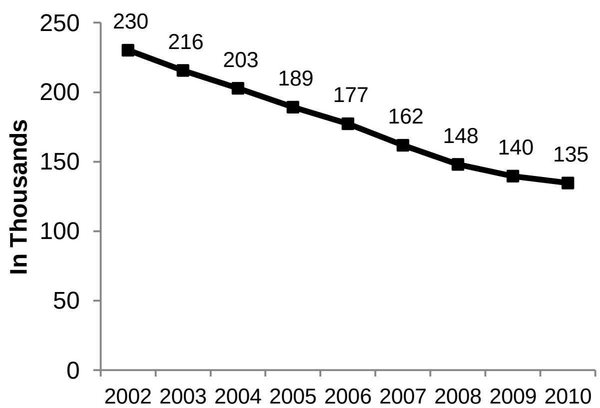

Figure 12. Reported automobile fires (all causes) by year

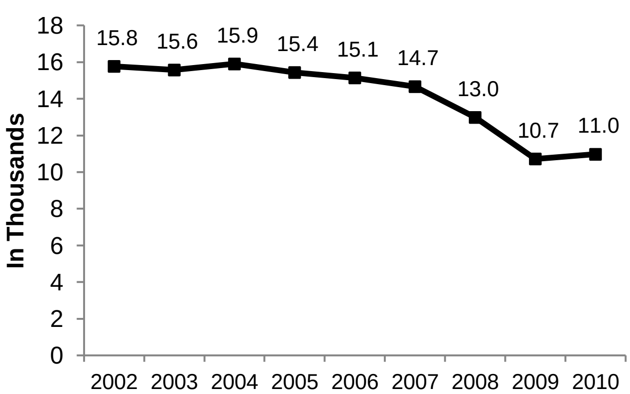

Figure 13. Reported larger truck fires (all causes) by year

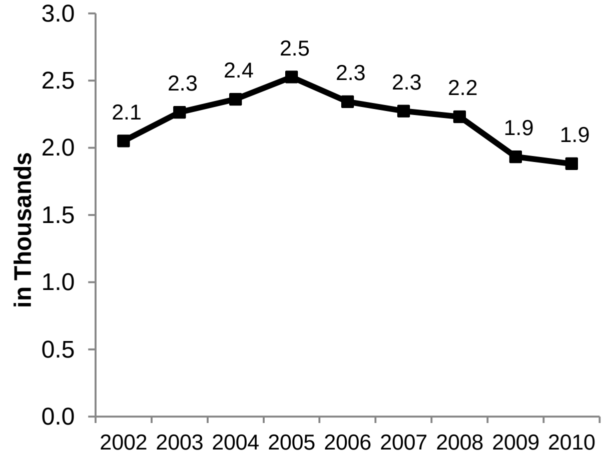

Figure 14. Reported bus fires (all causes) by year

Despite the decreases in automobile fire deaths, Figure 15 shows that in recent years, automobile fires have killed more people per year than were killed in non-residential structure fires. [2]

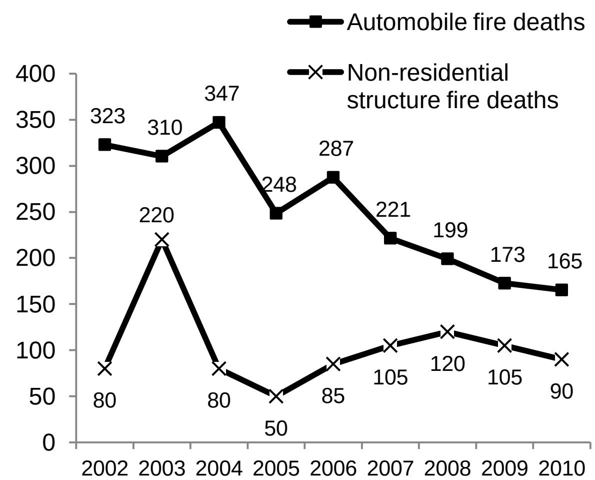

Figure 15. Reported automobile and non-residential fire deaths by year

RISK BASED ON DISTANCE TRAVELLED

Although automobile fires accounted for 10% of reported U.S. fires of all types and 6% of fire deaths during 2006-2010, the risk of such an event is low in terms of the distances driven. The Federal Highway Administration (FHWA) published data on distances travelled. [7] Data specifically for automobiles was provided through 2008. In later years, the vehicle groupings were modified. From 2006-2008, U.S. automobiles were driven an average of 2,671 billion kilometers (1,660 billion miles) per year, larger trucks were driven an average of 363 billion kilometers (226 billion miles) per year and buses were driven 11 billion kilometers (7 billion miles) annually.

The 2006-2008 FHWA data on distance travelled was combined with the 2006-2010 vehicle fire estimates to provide risk estimates based on distance travelled for each type of vehicle. For every billion kilometers travelled, there were 57 reported automobile fires, 36 fires involving larger trucks, and 190 bus fires that resulted in responses from local fire departments. Table 4 shows the risk of vehicle for non-intentional fires starting in different areas of origin and for fires and deaths resulting from collision or overturn. The numbers of bus fires caused by collision or overturn was too small for meaningful analysis.

DATA LIMITATIONS AND ISSUES

Unknown or Missing Data Are Assumed to Resemble Known Data

The fire statistics in this analysis are estimates. In scaling up based on the NFIRS data and in allocating unknown data proportionally, it is assumed fires that had unknown or missing data or were reported to local fire departments but not reported to NFIRS would resemble the fires with reported, usable available data. Table 5 shows that the proportion of unknown or missing data varies considerably by data element or combination of data elements or circumstances.

Table 4. Risk of vehicle fire based on distance driven

	Automobiles	Larger Trucks	Buses
Kilometers driven (in billions) in 2006-2008	2671	363	11
Average kilometers (in thousands) driven per vehicle	20	41	13
Fires per billion kilometers driven	57	36	190
Non-intentional fires starting engine, running gear or wheel area	35	19	130
Non-intentional fires starting in the passenger area	6	2	17
Non-intentional areas starting in cargo area	2	5	2
Non-intentional fires starting on the exterior	1	3	15
Fires resulting from collision or overturn	2	1	0
Fire deaths per billion kilometers driven	0.08	0.10	*
Fire deaths resulting from collision or overturn	0.05	0.06	*

* Numbers are too small for meaningful analysis
Source: FHWA, NFIRS and NFPA survey.

Table 5. Incidents in which NFIRS data was unknown, undetermined, left blank, or coded as "none:" 2006-2010

Data Element	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage
Mobile property type (all vehicles)	6%	3%	4%	10%
Cause of ignition in automobile fire	31%	39%	25%	34%
Factor contributing to automobile fire	58%	47%	43%	59%
Heat source in automobile fire	51%	54%	40%	55%
Area of origin in non-intentional automobile fire	12%	24%	6%	13%
Cause of ignition in fire involving larger truck	22%	27%	23%	28%
Factor contributing to fire involving larger truck	58%	47%	43%	59%
Heat source in fire involving larger truck	37%	47%	42%	45%
Area of origin in fire involving larger truck	9%	21%	7%	12%
Cause of ignition in bus fire	23%	NA	18%	32%
Factor contributing to bus fire	49%	NA	53%	52%
Heat source in bus fire	36%	NA	34%	49%
Area of origin in non-intentional bus fire	9%	NA	0%	9%

For Less Common Events, Smaller Numbers Can Result in More Volatility

The lack of complete data becomes a more serious issue when numbers are smaller. Vehicle fire deaths are much less common than vehicle fires. Fires caused by collisions or overturns are much less common than those caused by mechanical or electrical failures or malfunctions. The general patterns have been consistent over time but some volatility is likely due to the smaller numbers involved.

NFIRS Describes All Types of Fires and Has Limited Vehicle-Specific Choices

The NFIRS data system is used to describe all types of fires. It has a very limited number of code choices that specifically relate to vehicles. Individual codes, such as area of origin code 83 - engine area, running gear or wheel area, cannot be broken down further. Wheel areas are very different from engine areas, and the inability to distinguish them is frustrating. Information about specific parts (e.g., spark plug, drive-belt, catalytic converter) involved in the ignition is generally not captured or identifiable in the coded data. Nor is the information linked to police reports or service records. The national NFIRS database does not contain information about rate of speed, vehicle inspection status, last time the vehicle was serviced, after market modifications or non-standard parts. NFIRS can identify general areas for further research. By itself, it does not have the depth to suggest detailed technical solutions to the issues identified.

NFIRS reports are generally completed by firefighters who responded to the fire based on their observations, interviews, and any testing that was done. Data quality is affected by the skills of the individual determining the fire cause and origin and the attention to detail in completing the NFIRS reports.

As noted earlier, NFIRS and the NFPA survey definitions of fire death are restricted to deaths caused by fire. If a death was due to trauma incurred before the fire started, it should not be counted. NFPA follows up on survey reports of vehicle fire deaths to ensure that they meet the criteria. While NFIRS may include some deaths due to trauma, NFPA's estimates of total vehicle fire deaths do not. Differences in fire death definitions used by the National Highway Traffic Safety Administration (NHTSA) are discussed later in this section.

Although Estimates of Alternate Fuel Vehicle Fires Are Not Possible, Other Approaches Can Be Used

Vehicle power source data is also not captured. This has been particularly frustrating to those interested in tracking possible fire risks associated with vehicles using alternate fuels or power sources. Even if NFIRS had that capability, it is unlikely that the meaningful data could be available on electric vehicles until more are on the road Table 6 shows the technology type used by automobiles on the road in 2009 and 2010. [8] In both years, alternate-fuel automobiles accounted for only 2-3% of the cars in use.

Roughly 140,000 automobile fires were reported in 2009 and 135,000 in 2010. That translates to rates of one automobile fire for every 945 and 964 automobiles per year, respectively, or rates of 1,035-1,060 automobile fires per million automobiles. Estimates of conventional types of automobile fires or fires associated with other uses of similar technology can be used to develop likely fire scenarios. Investigations of any fires that do occur can also provide valuable information. Laboratory tests can then be used to better predict the risks.

Even with the limitations discussed above, NFIRS provides sufficient detail to identify general problem areas that warrant further research, and, when combined with data from other sources, to provide general guidance to the public, manufacturers, and policy makers about how these fires might be prevented.

Table 6. Technology type used in car stock in the U.S. in 2009 and 2010. **[8]**

Technology Type (in millions)	**2009**	**2010**
Conventional automobiles	**128.74**	**126.20**
Gasoline	128.12	125.47
Diesel	0.62	0.73
Alternate fuel automobiles	**3.18**	**3.58**
Ethanol-flex fuel	1.71	1.88
100 mile electric vehicle	0.01	0.01
Electric-gasoline hybrid	1.32	1.55
Compressed natural gas	0.03	0.03
Compressed natural gas bi-fuel	0.05	0.05
Liquefied petroleum gas	0.02	0.02
Liquefied petroleum gas bi-fuel	0.03	0.03
Total automobile stock	**131.91**	**129.77**

Source: U.S. Energy Information Administration. *Annual Energy Outlook 2012*

Different Data Sources Use Different Definitions

Anyone who works with databases from different organizations knows that scope, definitions, and sources vary based on the mission and priorities of each organization. Consequently, results may differ. Each year, NHTSA's *Traffic Safety Facts* series, contains a table indicating the number of crashes with fire involved. In 2009, they reported 6,000 passenger car crashes with fire involved, including 527 fatal crashes. [9] Overall, 0.1% of the crashes involved fire, but fire occurred at 2.9% of the fatal crashes. NHTSA's estimate of the number of fire-involved crashes (or collisions or overturns in this study) is fairly consistent with NFPA's. The victim total in their analysis is much higher because they also include people who died of trauma instead of fire-related injuries only. NHTSA estimates benefit from law enforcement detail and more information about the nature of any impacts. However, NHTSA collects far less information on circumstances specific to fires.

CONCLUSION

During 2006-2010, U.S. firefighters responded to an average of 417 automobile fires, 35 fires involving larger trucks, and 6 bus fires every day. Automobile fires killed an average of four people every week.

While the risk of automobile fires and associated deaths is low in terms of the distance driven and progress has been made in reducing the number of automobile fires and associated deaths, more needs to be done. Losing roughly 200 people annually to these fires is unacceptable. Even if passengers escape unscathed, the loss of transportation and property poses major problems. Although fires involving larger trucks were less likely based on distance travelled than automobile or bus fires, when they occurred, they were more likely to result in death or greater property damage. Although bus fires are less common in terms of actual numbers, they had a much higher rate of fire based on distance travelled.

Estimates derived from NFIRS and NFPA's annual fire department survey show that the majority of vehicle fires are due to mechanical or electrical problems. However, three out of automobile fire deaths were due to fires resulting from collisions or overturns. Leading causal factors and items first ignited varied by the area of fire origin. Mechanical failures or malfunction were the leading factors in fires originating in the engine, running gear or wheel area while electrical failures or malfunctions were the leading factors in fires starting in the passenger area. Initial design, maintenance or lack thereof, aftermarket equipment, and other factors, alone or in combination with each other, can play a role. The findings suggest a need for further research into the root causes of mechanical and electrical failures leading to fire and of factors leading to post-impact fires. More detailed information is needed before specific improvements or strategies can be developed.

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CONTACT INFORMATION

Marty Ahrens can be reached at the National Fire Protection Association by e-mailing mahrens@nfpa.org or calling (617) 984-7463.