

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

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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.

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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

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%)
<u>Automobile, passenger car, ambulance, race car or taxi-cab</u>	<u>152,300</u>	<u>(68%) 209</u>	<u>(63%) 764</u>	<u>(63%) \$536 (52%)</u>
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%)
<u>Bus, school bus or trackless trolley</u>	<u>2,100</u>	<u>(1%) 0</u>	<u>(0%) 22</u>	<u>(2%) \$29 (3%)</u>
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%)
<u>Larger trucks</u>	<u>12,900</u>	<u>(6%) 36</u>	<u>(11%) 91</u>	<u>(8%) \$168 (16%)</u>
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%)
<u>Other freight road vehicles</u>	<u>7,600</u>	<u>(4%) 16</u>	<u>(5%) 52</u>	<u>(4%) \$82 (7%)</u>
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.

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.

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.

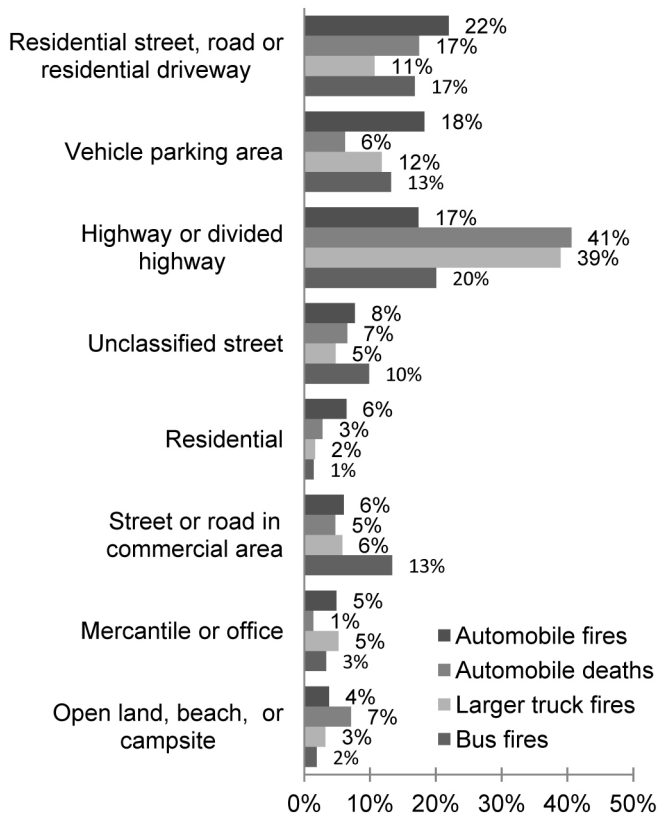


Figure 1. Vehicle fires, by leading location where fire occurred: 2006-2010

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.

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.

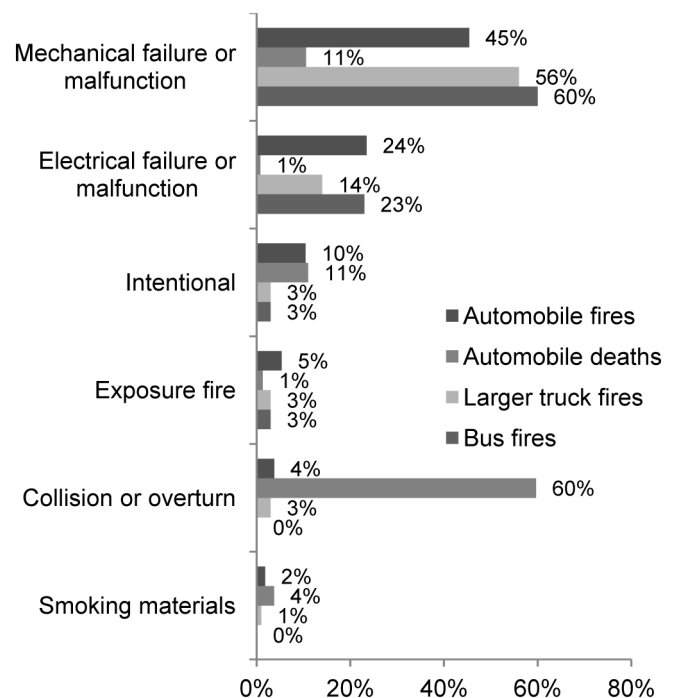


Figure 2. Vehicle fires, by major causal factors: 2006-2010