U.S. VEHICLE FIRE TRENDS AND PATTERNS

Marty Ahrens
Fire Analysis and Research Division
National Fire Protection Association

July 2008
(Revised: May 2009)

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471
www.nfpa.org

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Abstract

In 2002-2005, U.S. fire departments responded to an average of 306,800 vehicle fires per year. These fires caused an average of 520 civilian deaths, 1,640 civilian injuries, and $1.3 billion in direct property damage. Cars, trucks and other highway vehicles (meaning a vehicle designed for highway use, not that the fire occurred on a highway) accounted for 90% of the vehicle fires and 94% of the vehicle fire deaths. Data from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA's) annual fire department experience survey are used to provide details about the types of vehicles involved in fire and the circumstances of highway vehicle fires.

Mechanical or electrical failures caused roughly three-quarters of the highway vehicle fires, but only 11% of the deaths. Collisions and overturns were factors contributing to the ignition in only 3% of the fires, but fires resulting from these incidents caused 57% of these vehicle fire deaths. Older teens and young adults are the age groups at highest risk of highway vehicle fire death and injuries. One-third (36%) of non-fatal highway vehicle fires injuries occurred when civilians attempted to fight the fire themselves.

Keywords: fire statistics, vehicle, highway, car fires, truck, bus, motorcycle.

Acknowledgements

The National Fire Protection Association thanks all the fire departments and state fire authorities who participate in the National Fire Incident Reporting System (NFIRS) and the annual NFPA fire experience survey. These firefighters are the original sources of the detailed data that make this analysis possible. Their contributions allow us to estimate the size of the fire problem.

We are also grateful to the U.S. Fire Administration for its work in developing, coordinating, and maintaining NFIRS.

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Changes other than editorial are indicated by a vertical rule beside the paragraph, table or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition.

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Vehicle Fires in the U.S. in 2002-2005

U.S. fire departments responded to an average of 306,800 vehicle fires per year in 2002-2005. These fires caused an average of 520 civilian deaths, 1,640 civilian injuries, and $1.3 billion in direct property damage.

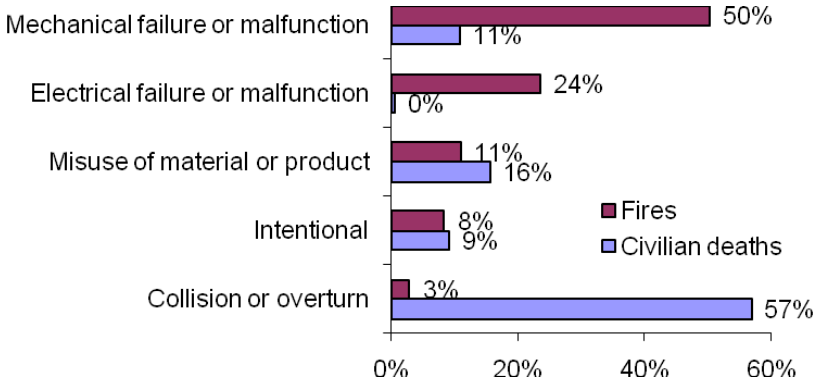
- Highway vehicles[1] accounted for 287,700 (94%) of the reported vehicle fires and 471 (90%) of the associated deaths.
- Aircraft fires accounted for less than 1% of the vehicle fires, but 8% of the associated deaths.
  - The majority of aircraft fire deaths (6% of all vehicle fire deaths) resulted from fires in personal, business, or utility aircraft.
  - Aircraft fires were the only type of vehicle fires with more civilian deaths than civilian injuries.

Highway Vehicle Fires

Overall, highway vehicle fires were involved in 18% of reported U.S. fires, 13% of U.S. fire deaths, 8% of U.S. civilian fire injuries, and 10% of the direct property damage from reported fires.

- On average, 33 highway vehicle fires were reported per hour. These fires killed one person a day.

2002-2005 Highway Vehicle Fires and Deaths by Fire Causal Factors



- Mechanical or electrical failures or malfunctions were factors in three-quarters of the highway vehicle fires.
- Collisions and overturns were factors in only 3% of highway vehicle fires, but these incidents accounted for 57% of the associated deaths.

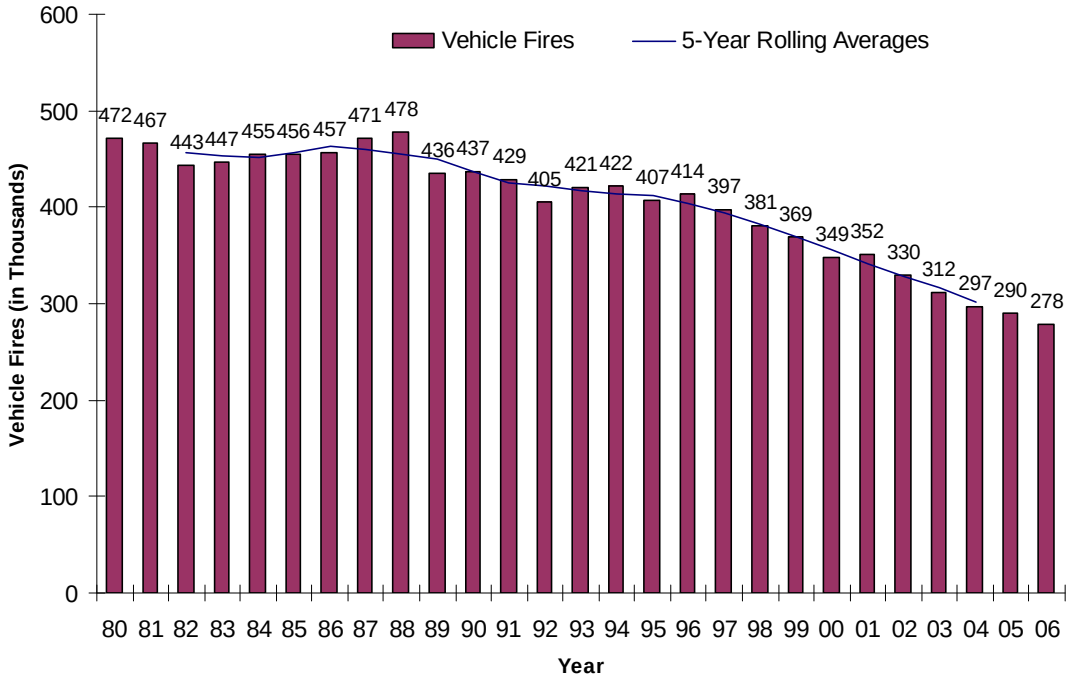
[1] Highway vehicles include cars, trucks, recreational vehicles, motorcycles, and other vehicles intended for road use. "Highway vehicle fire" describes the type of vehicle. It does not mean the fire occurred on a highway.

Overview of the Vehicle Fire Problem

278,000 reported vehicle fires caused 490 civilian deaths in 2006.
U.S. fire departments responded to an estimated 278,000 vehicle fires in the United States during 2006. These fires caused an estimated 490 civilian deaths, 1,200 civilian injuries and $1.3 billion in direct property damage. Vehicle fires accounted for 17% of the 1,602,000 fires reported to U.S. fire departments that year. Vehicle fires also caused 15% of all civilian fire deaths, 7% of all reported civilian fire injuries, and 12% of the nation's direct property damage from fire in 2006. Vehicle fires caused roughly six times the number of deaths as non-residential structure fires.[2]

Vehicles include cars, trucks and other highway vehicles; boats and ships; railroad and mass-transit vehicles; aircraft; and agricultural, construction and yard vehicles. A vehicle that burns inside a structure is counted as a vehicle fire if the structure was not involved. If the structure becomes involved, the incident is counted as a structure fire.

Figure 1. U.S. Vehicle Fires by Year: 1980-2006



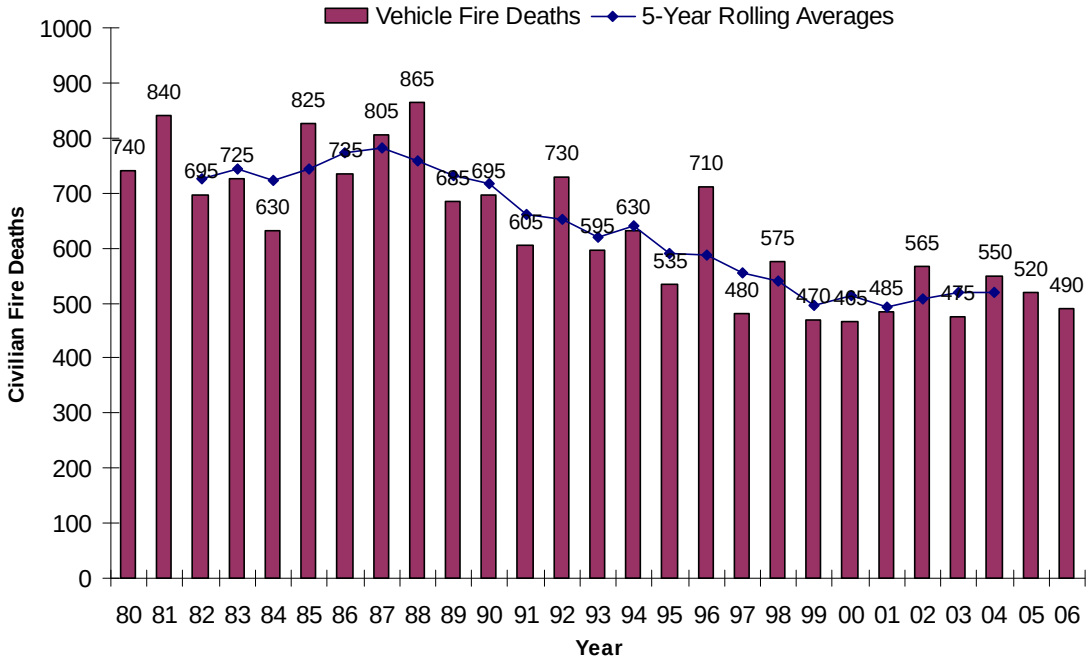
Source: *Fire Loss in the U.S.* series by Michael J. Karter, Jr.

[2] Michael J. Karter, Jr., *Fire Loss in the United States during 2006*, Quincy, MA: NFPA, September 2007. This report summarizes the results of the NFPA Annual Fire Department Survey and is the source for 2009 statistics. Overall vehicle fire trend data was obtained from the *Fire Loss in the United States* annual reports for 1980-2006.

Vehicle fires fell to a record low.
Table 1 shows that the total number of reported vehicle fires fell 4% from the 290,000 reported in 2005 to 278,000 in 2006. Figure 1 shows that this was the smallest vehicle fire incidence since the National Fire Protection Association (NFPA) began tracking vehicle fires and losses with its current methods. After declining in the early eighties, vehicle fires began increasing in 1983 to a peak of 477,500 in 1988. The 9% drop from 1988 to 1989 was the largest one-year decline seen since NFPA began tracking this data. Since 1980, reported vehicle fires have fallen a cumulative 41% compared to a 51% drop in reported structure fires and a 45% drop in fires of all types.

Trend in vehicle fire deaths has been fairly flat in recent years.
Figure 2 shows that the death toll due to vehicle fires fluctuates greatly from year to year. Vehicle fire deaths fell 6% from 520 in 2005 to 490 in 2006. A generally downward trend can be seen in the five-year rolling averages, although the trend line has been fairly flat in recent years. Only fires and fire deaths reported to local public fire departments in the United States are counted. Fires or fire deaths on the open seas or not attended by local fire departments are not captured in these statistics. Only deaths that resulted from a fire are considered fire deaths.

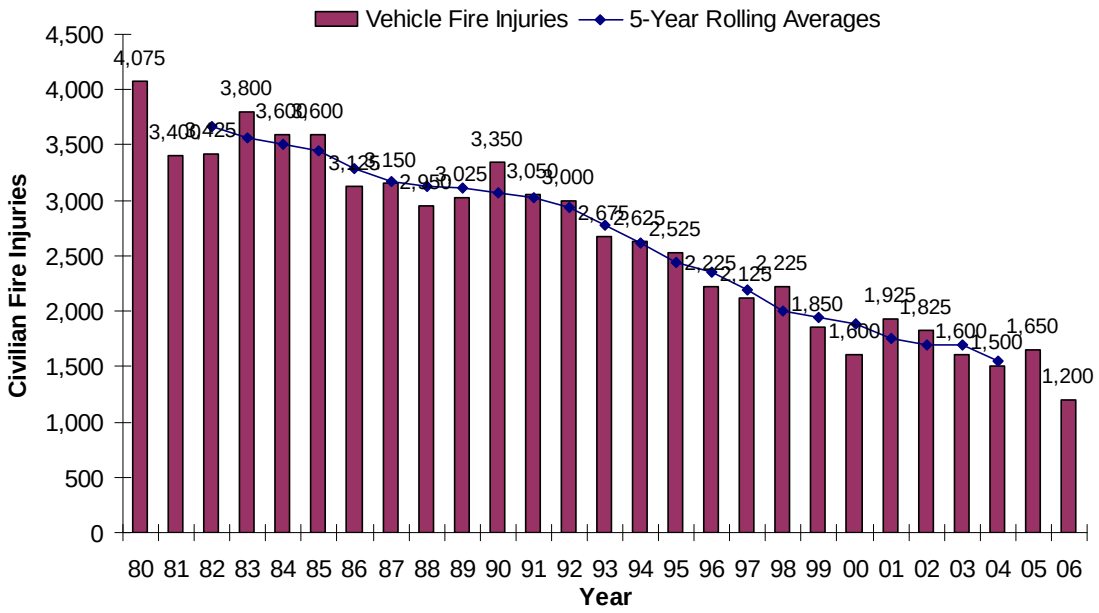
Figure 2. U.S. Vehicle Fire Deaths by Year: 1980-2006



Source: *Fire Loss in the U.S.* series by Michael J. Karter, Jr.

Vehicle fire injuries hit a new low.
Civilian injuries in vehicle fires fell 38% from 1,650 in 2005 to 1,200 in 2006, the lowest point since tracking began. The 71% drop in reported civilian vehicle fire injuries from 1980 to 2006 is larger than the 41% drop in reported vehicle fires and larger still than the 34% drop in reported civilian vehicle fire deaths during the same period.

Figure 3. U.S. Vehicle Fire Injuries by Year: 1980-2006



Source: *Fire Loss in the U.S.* series by Michael J. Karter, Jr.

2006 data came from the NFPA Fire Experience Survey.
The NFPA Fire Analysis and Research Division uses two data sources in most of its analyses. The first, the NFPA Annual Fire Experience Survey, provides an overview of the fire experience in the previous year. Each year, all large departments serving populations over 50,000 and one-third of the smaller departments in a sample stratified by size of population protected, are asked about their fire experience. The final sample of respondents contains roughly one-tenth of all local fire departments. A summary of the fire experience for the previous year is issued in the summer or fall of the following year. The 2006 data cited in this analysis came from the NFPA survey as reported in Michael Karter's *Fire Loss in the United States during 2006*.

NFIRS data provide the details.
The survey provides the big picture; the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) provides the details. Local fire officers complete fire reports describing the facts of the incident – the when, where, what and how of each fire. These reports (or data from these reports) are forwarded to or submitted through state fire agencies. After the states process the data, they forward or release it to the USFA. NFIRS is the largest, most detailed source of incident information about fire in the world.

Version 5.0 of NFIRS was first introduced in 1999. NFPA received the national 1999-2005 databases in the Version 5.0 format. However, in 1999, 93% of the fires were collected in an older format and converted to Version 5.0. The share originally collected in Version 5.0 has increased each year. Data definitions and coding rules are not

identical in the different versions. Some codes have been added, some combined, and others dropped. Estimates for 1999 and later are based on data originally collected in Version 5.0 only. Codes for mobile property type were used to identify highway and other types of vehicles. The code ranges are shown below.

Code Range	Mobile Property Type
	Highway vehicles
10-19	Passenger road vehicles
20-29	Freight road transport vehicles
30-39	Rail transport vehicles
40-49	Water vessels
50-59	Aircraft
60-69	Industrial, agricultural or construction vehicles
70-79	Miscellaneous mobile property
00	Unclassified mobile property

Version 5.0 also includes incident types that describe specific types of vehicle fires. These include:

Code:	Incident Type
131	Passenger vehicle fire, including cars, buses, and pickup trucks
132	Road freight or transport vehicle fire
133	Rail vehicle fire
134	Water vehicle fire
135	Aircraft fire
136	Self-propelled motor home or recreational vehicle fire
137	Camper or recreational vehicle fire in non-self-propelled vehicle
138	Off-road vehicle or heavy equipment fire
130	Unclassified vehicle fire, including all vehicle fires originally collected in an older version of NFIRS

Some inconsistencies exist between the mobile property type and incident type. This analysis uses is based on fires in vehicle incident types (130-139) with mobile property type used for categorization. When the incident type indicates a vehicle fire, but mobile property type was left blank or coded as unknown or none, the incidents were allocated proportionally among vehicle fires with known incident type. No adjustments were made when the incident type and mobile property did not agree.

NFIRS and the NFPA survey were used to develop national estimates.
Because some states and some departments do not participate in NFIRS every year, and reporting practices are not uniform among those who do participate, the raw NFIRS numbers would dramatically underestimate the extent of the fire problem. Total fires, casualties and losses reported to NFIRS (or, in recent years, NFIRS 5.0) are compared to those found in the NFPA Fire Experience Survey. Scaling ratios are then derived to

apply to the raw NFIRS 5.0 numbers to develop national estimates.[3] A more detailed description of this methodology is found in Appendix A.

Highway-type vehicles accounted for 90% of vehicle fire deaths in 2002-2005.
Table 2 shows that 94% of reported vehicle fires and 90% of vehicle fire deaths involved highway-type vehicles such as cars, trucks, buses, and motorcycles. These are discussed in greater detail later in the report. (Highway vehicle fires refer to the type of vehicle not the location of the fire.)

Aircraft under 12,500 pounds were involved in 5% of vehicle fire deaths.
Although aircraft accounted for less than 1% of the vehicle fires, Table 2 shows that these incidents caused 8% of the vehicle fire deaths in 2002-2005. Five percent of the vehicle fire deaths occurred in fires in personal, business or utility aircraft weighing less than 12,500 pounds. Aircraft fires are the only type of vehicle fires with more fatalities than injuries. On average, collisions or overturns were factors in 13% of the aircraft fires and 74% of the aircraft fire deaths. Aircraft accidents are typically investigated by the National Transportation Safety Board's (NTSB). NTSB aircraft accident synopses and investigation reports are available online at http://www.ntsb.gov/aviation/aviation.htm.

Department of Transportation (DOT) has regulatory authority.
The Department of Transportation (DOT) and its divisions regulate vehicles. Questions about regulations or specific makes and models should be addressed to the DOT or its subdivisions. In their chapter "Passenger Vehicle Fires" in the 20th edition of NFPA's *Fire Protection Handbook*, Long et al. (2008) note that the National Highway Traffic Safety Administration (NHTSA) of DOT is responsible for the adoption and enforcement of federal motor vehicle safety standards (FMVSS).[4]

Since its inception in 1966, the NHTSA has issued four fire-safety standards for new motor vehicles. The Federal Motor Vehicle Safety Standard (FMVSS) 301 was developed to reduce the danger from fuel spillage following crashes involving cars, trucks, and buses weighing 10,000 pounds or less. Federal Motor Vehicle Safety Standard 302 sets flammability standards for the materials used in the driver and passenger area of vehicles. This standard aims to reduce the danger of interior fires caused by matches or smoking. The other two standards address vehicles using compressed natural gas.

Vehicle fires have historically received less attention than structure fires.
The fire community has given only intermittent attention to vehicle fires. What attention has been given has typically focused narrowly on major multiple-death incidents. As in buildings, most vehicle fire deaths occur in ones and twos in private settings such as personal cars. Attempts to further reduce fires and their related losses necessitate strategies that reduce both the occurrence and the severity of vehicle fires.

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[3] John R. Hall, Jr. and Beatrice Harwood, "The National Estimates Approach to U.S. Fire Statistics", *Fire. Technology*, May 1989, Volume 25, Number 2, pp. 99-113.
[4] R.T. Long, Jr., Jeff D. Colwell, Rose Ray, Helene L. Grossman, Ben Thomas and Robert Strassberger. "Passenger Vehicle Fires," *Fire Protection Handbook*, 20th edition, Section 21, Chapter 1, Quincy, MA: national Fire Protection Association, 2008.

Vehicle fires are a major component of the fire death problem. In 2002-2005, three-quarters (78%) of vehicle fire deaths resulted from automobile fires. The deadliest highway vehicle fire in recent years was the September 23, 2005 bus fire in Wilmer, Texas claimed 23 lives. This fire occurred during the emergency evacuation in anticipation of Hurricane Rita. The National Transportation Safety Board (NTSB) held hearings on this fire in August 2006.[5] NFPA testified on the scope of the bus fire problem and the sources we use to produce vehicle fire statistics. NFPA's analysis, *Vehicle Fires Involving Buses and School Buses*,[6] was submitted into the record. NTSB's final report on the incident is available at http://www.ntsb.gov/Publictn/H_Acc.htm.

Additional and more in-depth fire testing of automobiles and other vehicles can increase our knowledge of how these fires develop. This detailed information can provide engineers with the information needed to develop solutions to the automobile fire death problem (similar to the advances, such as the airbag, which have resulted from collision testing). The Society of Automotive Engineers (SAE) sponsored its first program on fire safety at its World Congress in Detroit in April 2005, and has included several sessions on fire safety each year since then.

In 2003, NFPA, through its Technical Committee on Hazard and Risk of Contents and Furnishings began work on the development of a new document, NFPA 556, now titled *Guide on Methods for Evaluating Fire Hazard to Occupants of Passenger Road Vehicles.* The deadline for proposals is December 1, 2008 and the document is in the annual 2010 cycle. NFPA 556 can be viewed on NFPA's web site, www.nfpa.org.

In most categories of vehicles, many, if not most, fire deaths occur in fires following survivable collisions. Additional reductions in vehicle fire deaths may result from public safety programs and studies designed to reduce the number of collisions that occur in the United States. This two-pronged approach would very likely produce a positive impact on the vehicle fire death problem.

In October 2005, NFPA and the American Automobile Association (AAA) held a joint press conference in Hialeah, Florida about the importance of maintenance in preventing vehicle fires.[7]

It is hoped that the information in this report will help individuals, industry and regulatory bodies to devise new ways to lessen the vehicle fire problem.

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[5] Additional information on the hearing may be found at http://www.ntsb.gov/Events/2006/WilmerTX/.
[6] Ahrens, Marty. *Vehicle Fires Involving Buses and School Buses*, Quincy, MA: National Fire Protection Association, August 2006.
[7] News Release, *NFPA and AAA Team Up to Prevent Vehicle Fires*, October 13, 2005, online at http://www.nfpa.org/newsReleaseDetails.asp?categoryid=488&itemId=26018.

Table 1.
U.S. Vehicle Fire Problem, by Year: 1980-2006

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions)	Direct Property Damage (in Millions of 2006 Dollars)
1980	471,500	740	4,075	$685	$1,678
1981	466,500	840	3,400	$594	$1,315
1982	443,000	695	3,425	$591	$1,233
1983	447,000	725	3,800	$694	$1,403
1984	454,500	630	3,600	$749	$1,451
1985	455,500	825	3,600	$792	$1,482
1986	456,500	735	3,125	$783	$1,441
1987	471,000	805	3,150	$842	$1,494
1988	477,500	865	2,950	$941	$1,605
1989	435,500	685	3,025	$963	$1,567
1990	436,500	695	3,350	$967	$1,493
1991	428,500	605	3,050	$1,049	$1,552
1992	405,000	730	3,000	$965	$1,387
1993	420,500	595	2,675	$1,030	$1,437
1994	422,000	630	2,625	$1,111	$1,512
1995	406,500	535	2,525	$1,152	$1,524
1996	413,500	710	2,225	$1,333	$1,715
1997	397,000	480	2,125	$1,269	$1,594
1998	381,000	575	2,225	$1,337	$1,655
1999*	368,500	470	1,850	$1,324	$1,602
2000	348,500	465	1,600	$1,381	$1,618
2001	351,500	485	1,925	$1,512	$1,722
2002	329,500	565	1,825	$1,392	$1,560
2003	312,000	475	1,600	$1,356	$1,487
2004	297,000	550	1,500	$1,304	$1,393
2005	290,000	520	1,650	$1,318	$1,361
2006	278,000	490	1,200	$1,319	$1,319

* Changes introduced in 1999 with Version 5.0 of NFIRS can make it advisable to analyze data from 1999 on separately from earlier years. Most of the statistical information in the remainder of this report is presented as 2002-2005 annual averages.

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires were estimated to the nearest five hundred, civilian deaths to the nearest five, civilian injuries to the nearest twenty-five, and direct property damage was rounded to the nearest million dollars.

Source: NFPA survey. Inflation adjustments were based on the consumer price index found in the U.S. Census Bureau's *Statistical Abstract of the United States: 2008*, "Table 702, Purchasing Power of the Dollar: 1950 to 2006."

Table 2.
U.S. Vehicle Fire Problem, by Type of Vehicle
2002-2005 Annual Averages

Vehicle Type	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Highway vehicles	***287,740***	***(94%)***	***471***	***(90%)***	***1,439***	***(88%)***	***$1,027***	***(76%)***
Passenger road vehicles	**263,370**	**(86%)**	**408**	**(78%)**	**1,256**	**(76%)**	**$787**	**(59%)**
Automobile or passenger car	208,600	(68%)	305	(59%)	864	(53%)	$549	(41%)
Motor home, camper or bookmobile	3,080	(1%)	7	(1%)	62	(4%)	$41	(3%)
Bus, school bus, or trackless trolley	2,340	(1%)	11	(2%)	32	(2%)	$27	(2%)
Off-road recreational vehicle	1,870	(1%)	3	(1%)	13	(1%)	$6	(0%)
Motorcycle or trail bike	1,600	(1%)	2	(0%)	22	(1%)	$4	(0%)
Travel trailer designed to be towed	1,260	(0%)	2	(0%)	18	(1%)	$8	(1%)
Collapsible camping trailer	200	(0%)	0	(0%)	6	(0%)	$1	(0%)
Mobile home or building, or manufactured housing	180	(0%)	0	(0%)	4	(0%)	$2	(0%)
Unclassified passenger road vehicle	44,250	(14%)	78	(15%)	236	(14%)	$149	(11%)
Trucks or freight road vehicles	**24,380**	**(8%)**	**62**	**(12%)**	**183**	**(11%)**	**$240**	**(18%)**
General use truck, dump truck or fire apparatus	6,830	(2%)	7	(1%)	51	(3%)	$42	(3%)
Semi-trailer, with or without tractor	6,190	(2%)	27	(5%)	41	(2%)	$89	(7%)
Pickup truck or non-motorized hauling rig	3,690	(1%)	3	(1%)	35	(2%)	$18	(1%)
Garbage, waste or refuse truck	1,980	(1%)	0	(0%)	6	(0%)	$17	(1%)
Tank truck for flammable or combustible liquid or chemical cargo	400	(0%)	7	(1%)	15	(1%)	$14	(1%)
Tank truck for nonflammable cargo	290	(0%)	2	(0%)	1	(0%)	$3	(0%)
Tank truck for compressed or LP-gas	60	(0%)	0	(0%)	0	(0%)	$1	(0%)
Unclassified freight road transport vehicle	4,940	(2%)	15	(3%)	35	(2%)	$56	(4%)

Table 2.
U.S. Vehicle Fire Problem, by Type of Vehicle
2002-2005 Annual Averages
(Continued)

Vehicle Type	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Rail vehicles	**1,410**	**(0%)**	**0**	**(0%)**	**4**	**(0%)**	**$29**	**(2%)**
Box, freight, or hopper car	440	(0%)	0	(0%)	0	(0%)	$3	(0%)
Engine or locomotive	320	(0%)	0	(0%)	2	(0%)	$20	(1%)
Diner or passenger car	180	(0%)	0	(0%)	1	(0%)	$1	(0%)
Maintenance equipment car including caboose or crane	170	(0%)	0	(0%)	0	(0%)	$1	(0%)
Container or piggyback car	60	(0%)	0	(0%)	0	(0%)	$0	(0%)
Rapid transit car or self-powered trolley	50	(0%)	0	(0%)	1	(0%)	$0	(0%)
Tank car	20	(0%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified rail transport vehicle	170	(0%)	0	(0%)	0	(0%)	$4	(0%)
Water vehicles	**2,180**	**(1%)**	**4**	**(1%)**	**90**	**(5%)**	**$39**	**(3%)**
Boat under 65 feet	1,540	(1%)	2	(0%)	69	(4%)	$22	(2%)
Personal water craft	310	(0%)	0	(0%)	13	(1%)	$1	(0%)
Sailboat	80	(0%)	1	(0%)	4	(0%)	$2	(0%)
Boat or ship 65 feet or more and under 1,000 tons	50	(0%)	0	(0%)	1	(0%)	$3	(0%)
Commercial fishing or processing vessel	40	(0%)	1	(0%)	2	(0%)	$2	(0%)
Barge, petroleum balloon or towable water vessel	30	(0%)	0	(0%)	1	(0%)	$8	(1%)
Cargo or military ship of 1,000 tons or more	10	(0%)	0	(0%)	0	(0%)	$0	(0%)
Cruise liner or passenger ship of 1,000 tons or more	0	(0%)	0	(0%)	0	(0%)	$0	(0%)
Tank ship	0	(0%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified water transport vessel	120	(0%)	0	(0%)	1	(0%)	$1	(0%)

Table 2.
U.S. Vehicle Fire Problem, by Type of Vehicle
2002-2005 Annual Averages
(Continued)

Vehicle Type	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Aircraft	**340**	**(0%)**	**39**	**(8%)**	**26**	**(2%)**	**$52**	**(4%)**
Personal, business, or utility aircraft under 12,500 pounds	180	(0%)	25	(5%)	15	(1%)	$5	(0%)
Jet or turbine-powered fixed wing commercial aircraft	50	(0%)	1	(0%)	1	(0%)	$18	(1%)
Propeller-driven or turboprop fixed-wing commercial aircraft	30	(0%)	1	(0%)	5	(0%)	$1	(0%)
Personal, business, or utility aircraft of 12,500 pounds or more	30	(0%)	6	(1%)	3	(0%)	$13	(1%)
Military fixed-wing aircraft	10	(0%)	1	(0%)	0	(0%)	$10	(1%)
Non-military helicopter or gyrocopter	10	(0%)	1	(0%)	1	(0%)	$2	(0%)
Military non-fixed-wing aircraft	0	(0%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified air transport vehicle	30	(0%)	6	(1%)	1	(0%)	$3	(0%)
Industrial, agricultural and construction vehicles	**9,590**	**(3%)**	**5**	**(1%)**	**48**	**(3%)**	**$175**	**(13%)**
Agricultural vehicle including baler or chopper	3,770	(1%)	2	(0%)	12	(1%)	$52	(4%)
Construction vehicle including bulldozer, shovel grader, scraper, trencher and plow	1,940	(1%)	1	(0%)	8	(0%)	$41	(3%)
Industrial loader, fork lift, tow motor or stacker	1,240	(0%)	0	(0%)	15	(1%)	$25	(2%)
Timber harvest vehicle	510	(0%)	0	(0%)	1	(0%)	$21	(2%)
Crane	100	(0%)	0	(0%)	2	(0%)	$5	(0%)
Unclassified industrial, agricultural or construction vehicle	2,030	(1%)	1	(0%)	9	(1%)	$31	(2%)

Table 2.
U.S. Vehicle Fire Problem, by Type of Vehicle
2002-2005 Annual Averages
(Continued)

Vehicle Type	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Miscellaneous vehicles	**5,550**	**(2%)**	**3**	**(1%)**	**37**	**(2%)**	**$21**	**(2%)**
Home or garden vehicle	1,460	(0%)	1	(0%)	20	(1%)	$2	(0%)
Mechanically moved shipping container	60	(0%)	0	(0%)	0	(0%)	$1	(0%)
Armored vehicle	20	(0%)	0	(0%)	1	(0%)	$0	(0%)
Aerial tramway vehicle	10	(0%)	0	(0%)	0	(0%)	$0	(0%)
Missile, rocket or space vehicle	0	(0%)	0	(0%)	0	(0%)	$0	(0%)
Unclassified mobile property	4,000	(1%)	2	(0%)	17	(1%)	$18	(1%)
Total	**306,810**	**(100%)**	**522**	**(100%)**	**1,644**	**(100%)**	**$1,342**	**(100%)**

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Vehicle fires in which the mobile property type was unknown or not reported were allocated proportionally among fires with known mobile property type. Structure fires in which mobile property was involved are not included in this table.

Source: NFIRS 5.0 and NFPA survey.

The U.S. Highway Vehicle Fire Problem

287,700 highway vehicle fires were reported annually in 2002-2005.
Highway vehicles include any vehicle that is customarily used on a highway, including cars, trucks, buses, motorcycles and recreational vehicles. A highway vehicle fire can occur on many different types of properties, not only highways. A vehicle fire that starts inside a structure is counted as a vehicle fire only when the fire does not extend to the structure. If the structure is involved, the incident is counted as a structure fire. A fire in mobile property used as a structure is considered a structure fire. In 2002-2005, the estimated average of 287,700 highway vehicle fires reported to U.S. fire departments per year caused an estimated annual average of 471 civilian deaths, 1,439 civilian fire injuries and $1.0 billion in direct property damage. On average, 33 highway vehicle fires were reported per hour. These fires killed one person a day. Overall, highway vehicles fires were involved in 18% of reported U.S. fires, 13% of U.S. fire deaths, 8% of U.S. civilian fire injuries, and 10% of the direct property damage from reported fires.

Highway vehicle fires hit a new low in 2006.
Table 3 shows that in 2006, highway vehicle fires hit their lowest total since 1980, the first year of available data. In 2006, an estimated 250,000 highway vehicle fires caused 445 civilian fire deaths, 1,075 civilian fire injuries, and $982 million in direct property damage. From 1980 to 2006, these fires fell a cumulative 45%. Structure fires fell 51% during the same period. From 2005 to 2006, highway vehicle fires fell 3%. The trend data in this section is based on national estimates from the NFPA survey only. Detailed analysis about the types of vehicles and circumstances of the fires derived from NFPA's annual fire department experience survey and data from Version 5.0 of the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS). The previous report used data originally collected in older versions of NFIRS and converted to NFIRS 5.0 as well as data originally collected in NFIRS 5.0. Some differences may be due to changes in the data collection rules and definitions rather than actual events.

The 2002-2005 statistics that follow include a proportional allocation of fires in which the mobile property type was unknown or not reported and are based on data collected in NFIRS 5.0 only.

Civilian deaths from highway vehicle fires fell 11% from 500 in 2005 to 445 in 2006. These deaths have fluctuated markedly although the general trend has been downward. Civilian injuries in highway vehicle fires fell 26% from 1,450 in 2005 to 1,075 in 2006. From 1980 to 2006, these injuries fell a cumulative 62%. Direct property damage, adjusted for inflation, fell 13%.

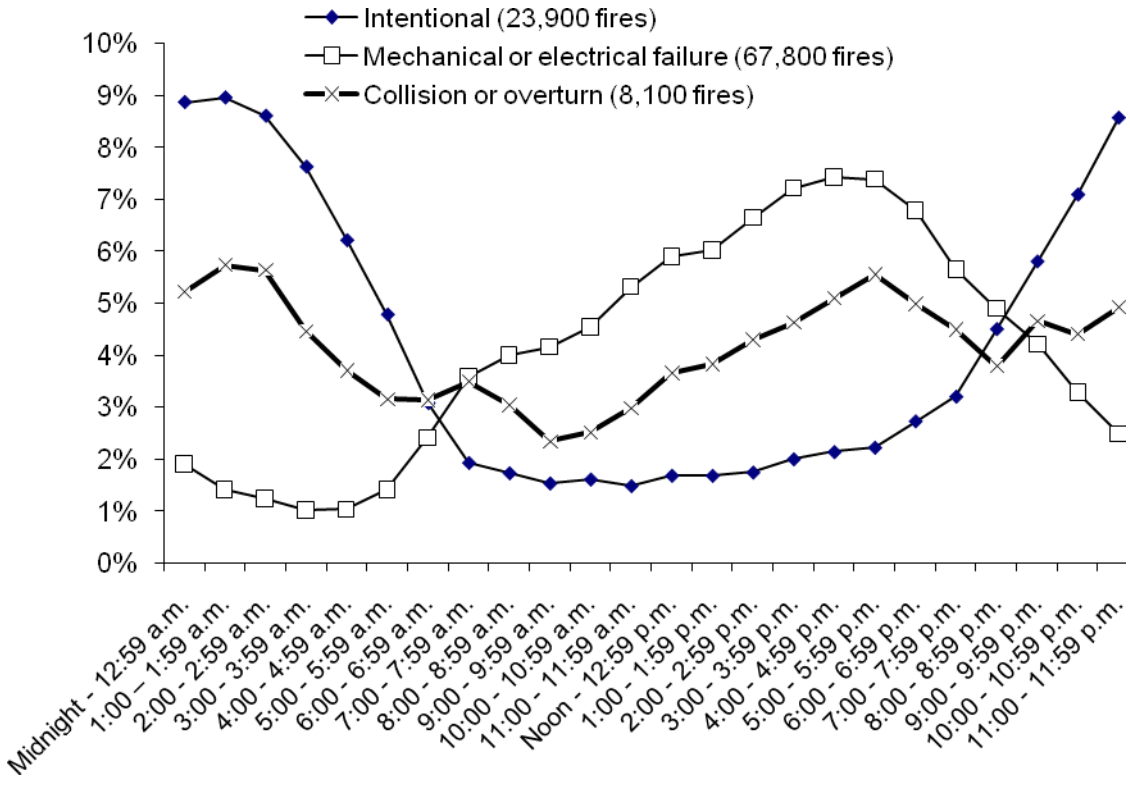
Highway vehicles were involved in the vast majority of vehicle fires and losses.
Table 2 showed that in 2002-2005, highway vehicles were involved in 94% of the 306,810 vehicle fires reported annually, 90% of the 522 associated fire deaths, 88% of the 1,644 associated injuries, and 76% of the $1.3 billion in direct property damage reported per year. Table 4 shows that automobiles or passenger cars were involved in

72% of the highway vehicle fires, unclassified passenger road vehicle fires in 15%, and trucks or freight road vehicles in 8%. The coding system does not have a separate category for sport utility vehicles.

Highway vehicle fires tend to be more common in the summer.
Table 5 shows that the peak month for these fires was July. August ranked second and June ranked third. February had the smallest number of fires. Friday was the peak day of the week for these fires; Saturday ranked second. The fewest fires occurred on Sunday. (See Table 6.)

Vehicle fire times correlate with times vehicles are in use and vary by fire cause.
Table 7 shows that highway vehicle fire times appear to be correlated with the times vehicles are in use. The smallest number of fires occurred between 5:00 and 5:59 a.m. These fires increased steadily as the day moved on, peaking between 4:00 and 5:59 p.m. (perhaps related to rush hour traffic). From that point forward, fires steadily decreased. This pattern is very similar to the time of day pattern for home structure fires except that the peak time for fires in homes was during the 6:00 to 6:59 p.m. period when the returning household members may turn up the heat and cook the evening meal.[8]

Figure 4. Highway Vehicle Fires by Causal Factors and Alarm Time 2002-2005 Annual Averages)



Source: NFIRS 5.0 and NFPA survey.

[8] Marty Ahrens. *Home Structure Fires* Quincy, MA: NFPA, Fire Analysis and Research Division, September 2007, p. 22.

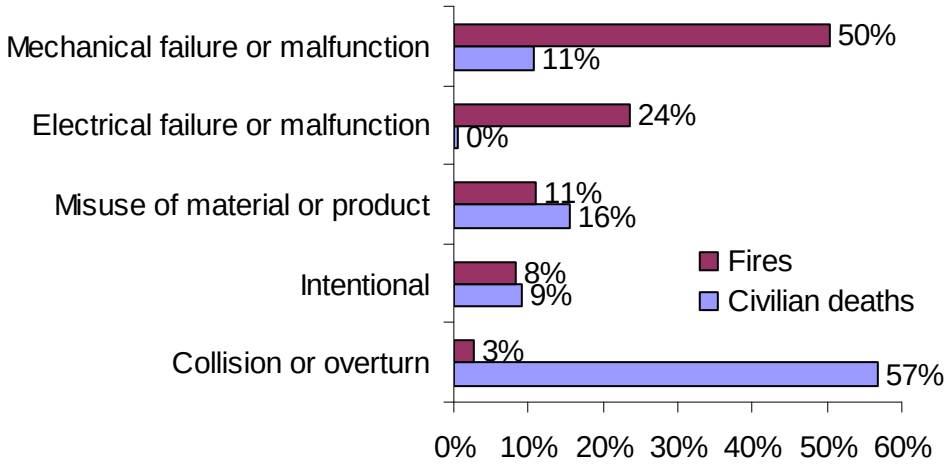
Only 8% of the highway vehicle fires occurred between 1:00 and 3:59 a.m., but these hours accounted for 20% of the highway vehicle fire deaths.

Table 8 and Figure 4 show that the time a highway vehicle fire occurs varies with the cause of the fire. Intentional highway vehicle fires are most common late at night and in the earliest morning hours. Vehicle fires resulting from collision or overturn had two lower peaks, one between 1:00 and 3:00 a.m., and the second between 5:00 and 6:00 p.m. Fires resulting from mechanical or electrical failures or malfunctions begin increasing in frequency with the morning commute, peaking in the late afternoon and early evening.

Most highway vehicle fires occurred on road or parking properties.
Table 9 shows that the two-thirds (68%) of the highway vehicle fires occurred on some type of highway, street or parking area, including 33% on streets, roads or driveways, and 17% in parking lots or parking areas. The 19% that occurred on highways or divided highways accounted for 49% of the associated fire deaths, suggesting a possible association of fatal vehicle fire with higher rates of vehicle speed.

Cause profile differs for fatal vs. non-fatal vehicle fires.
Figure 5 provides a summary of causal factors pulled from Tables 10-12, the NFIRS 5.0 fields for Cause of Ignition and Factors Contributing to Ignition. These causal factors are not mutually exclusive. They are discussed in more detail below.

Figure 5. Highway Vehicle Fires and Deaths by Fire Causal Factors 2002-2005 Annual Averages

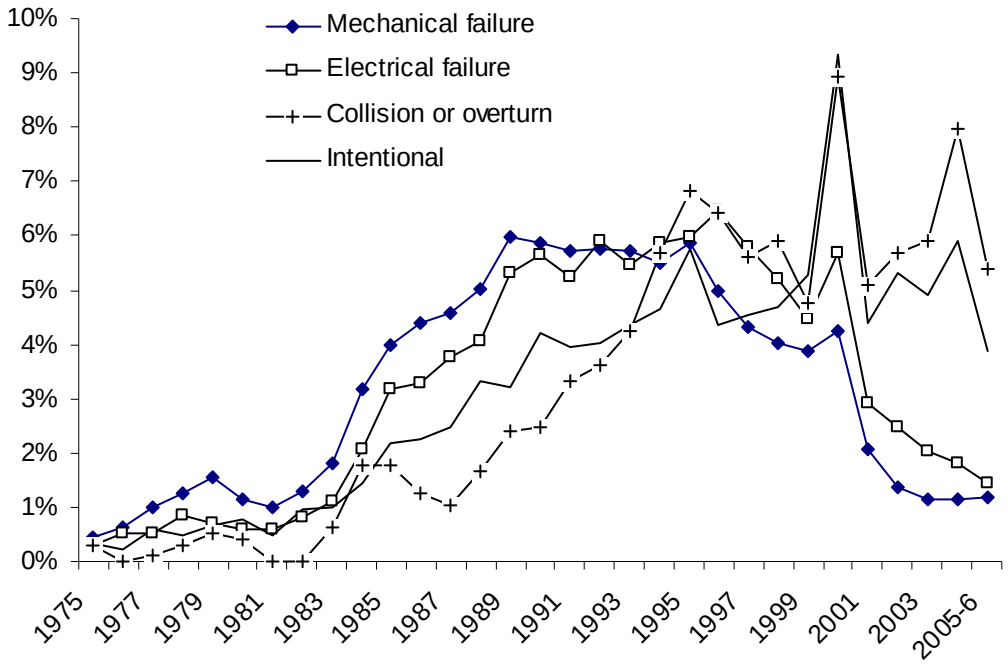


Source: NFIRS 5.0 and NFPA survey.

Eight percent of the highway vehicle fires were intentionally set.
Table 10 shows that during 2002-2005, an annual average of 23,900 intentionally set highway vehicle fires (8%) caused 9% of the highway civilian vehicle fire deaths, 4% of the civilian fire injuries, and 13% of the associated property damage. In earlier versions of NFIRS, the two codes of incendiary and suspicious had generally been grouped together when discussing arson. NFIRS 5.0 has eliminated the code for suspicious and replaced the term "incendiary" with "intentional." Due to inconsistent definitions, tracking trends of vehicle arson across the different versions is problematic.

Figure 6 shows that highway vehicles that were intentionally ignited or that burned after a collision or overturn tended to be much newer than those that resulted from mechanical or electrical failures. For example, 20% of the intentional highway vehicle fires in 2005 involved vehicles of model year 2002 or later. The percentages were calculated based on vehicles with valid model years of 1975 or later.

Figure 6. Model Year of 2005 Vehicle Fires, by Fire Causal Factor



Source: NFIRS 5.0 and NFPA survey.

3 of every 5 highway vehicle fire deaths occurred in fires caused by collisions or overturns.
Table 11 shows that collisions or overturns were factors contributing to the ignition in only 3% of the fires in this group, but these fires caused 57% of these vehicle fire deaths. Collisions or overturns were contributing factors in an average of 8,100 highway vehicle fires per year. These fires resulted in an average of 268 fire deaths per year. Roughly one of every 30 highway vehicle *fires* in which a collision or overturn was a factor resulted in death. This is *not* the same as saying that roughly one of every 30 highway vehicle *collisions* resulted in death. Nevertheless, it is very clear that highway vehicle fires caused by collision or overturn have a high fatality rate.

One-quarter (25%) of highway vehicle fires started by collisions or overturns involved model years of 2002 or later.

According to National Highway Traffic Safety Administration's (NHTSA's) *Traffic Facts 2005*, fires were seen in 15,000, or 0.1%, of the highway vehicle crashes in 2005. However, fire was associated with 1,769, or 3.0%, of the fatal crashes that year.[9] These fatality figures are much higher than NFPA's total vehicle fire death estimates, possibly because no distinction is made about the cause of death. NHTSA's estimate of fires associated with crashes is also higher than NFPA's. It is possible that some of the crash fires in NFIRS were captured under other codes, such as unclassified. It is also possible that some of these incidents were never reported to local fire departments and were handled exclusively by police. Some of the fires in NHTSA may not have involved crashes. Unfortunately, a conclusive explanation for the difference is not available at this time.

Mechanical or electrical failures caused 3/4 of highway vehicle fires, but only 11% of the deaths.

Table 12 shows that some form of mechanical failure or malfunction, such as leaks or breaks, backfires, or worn-out parts, contributed to 50% of the highway vehicle fires reported in 2002-2005. Leaks or breaks were factors in 12% of the fires and 7% of the associated deaths.

Electrical failures or malfunctions contributed to 24% of the highway vehicle fires reported during this time. The heat source was identified as arcing in 15% of the highway vehicle fires. (See Table 13.)

A misused material or product was a factor in 11% of the fires and 16% of the associated deaths. A flammable liquid or gas spill, included in this group, caused 2% of the fires but 8% of the associated deaths.

Older vehicles were more likely to have a fire caused by equipment failure. In 2005, only 5% of vehicles involved in fires resulting from mechanical failure were model year 2002 or later. Eight percent of the fires resulting from electrical failures were model year 2002 or later.

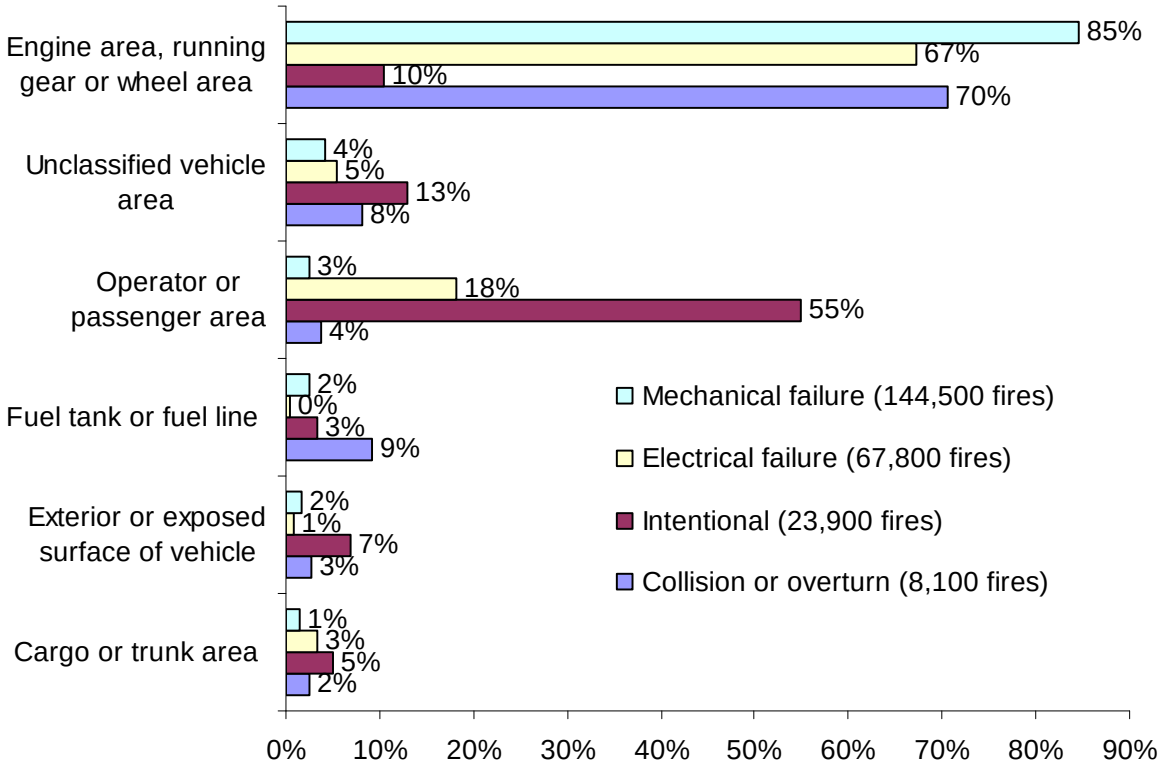
Fires started in the engine, running gear or wheel area most often, but fuel tank or fuel line fires were more likely to result in death.

Two-thirds (65%) of the highway vehicle fires began in the engine, running gear, or wheel area. Table 14 shows that 34% of the civilian fire deaths, 46% of the civilian fire injuries and 53% of the direct property damage resulted from fires that originated in this

[9] The National Highway Traffic Safety Administration, National Center for Statistics and Analysis, U.S. Department of Transportation, *Traffic Safety Facts 2005: A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System*, p. 66, online at http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/TSFAnn/TSF2005.pdf.

type of area. Only 2% of the highway vehicle fires started in the fuel tank or fuel line area, but these fires caused 19% of the associated deaths.

Figure 7. Area of Origin in 2002 2005 Vehicle Fires, by Fire Causal Factor



Source: NFIRS 5.0 and NFPA survey.

The leading areas of origin for highway vehicle fires varied by the cause of the fire. Figure 7 and Table 15 shows that 70% of the highway vehicle fires resulting from collisions or overturns began in the engine, running gear, or wheel area. Forty-two percent of the collision or overturn fire fatalities resulted from fires beginning in these areas. Twenty-six percent of the collision or overturn fire deaths resulted from the 9% of fires originating in the fuel tank or fuel line.

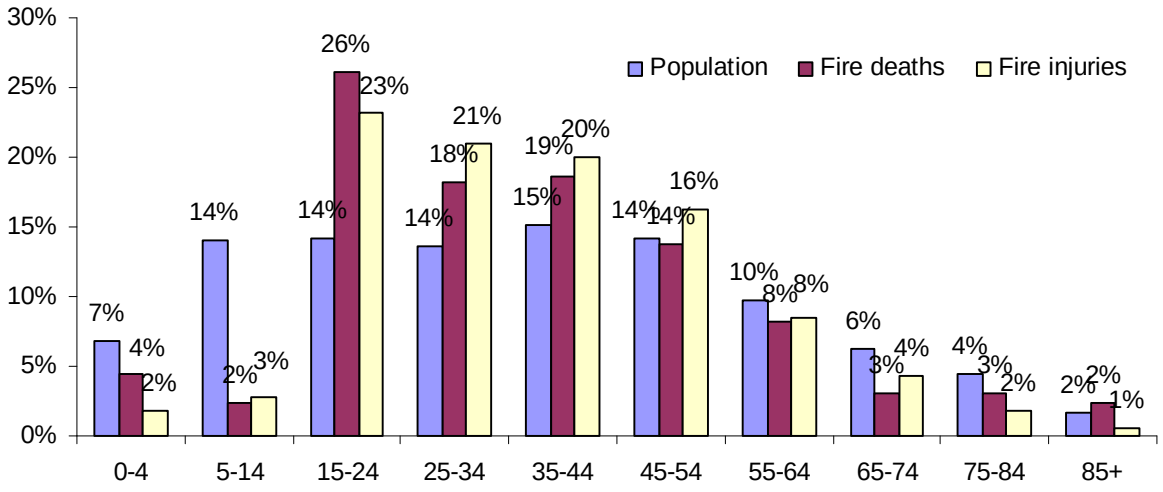
Table 16 shows that more than half (55%) of the intentionally set highway vehicle fires originated in the operator or passenger area. Eighty-five percent of the highway vehicle fires resulting from a mechanical failure or malfunction originated in the engine, running gear or wheel area. (See Table 17.) While 67% of the incidents resulting from electrical failures or malfunctions started in the engine, running gear or wheel area, Table 18 shows that 18% started in the operator or passenger area.

Table 19 shows that electrical wire or cable insulation was the item first ignited in 28% of the highway vehicle fires. These fires accounted for only 1% of the associated deaths and

14% of the associated injuries. One-third (32%) of the highway vehicle fires began with the ignition of flammable or combustible liquids or gases (including fuel and accelerants), piping, or filters. These fires caused 72% of the civilian deaths and 58% of the injuries. Twenty-one percent of the total highway vehicle fires began with the ignition of a flammable or combustible liquid or gas in or escaping from a combustion engine or burner. Thirty-nine percent of the associated deaths resulted from this scenario.

Table 20 shows that in 51% of the fires starting with a flammable or combustible liquid or gas, piping or filter, gasoline was the type of material first ignited.

Figure 8. Highway Vehicle Civilian Fire Deaths and Injuries by Victim's Age Group 2002-2005



Source: NFIRS 5.0 and NFPA survey; U.S. Census data

Older teens and young adults are at highest risk of highway vehicle fire death.
Although only 14% of the U.S. population was between 15 and 24 in 2002-2005, Figure 8 and Table 21 show that 26% of the people killed in highway vehicle fires during these years were in this age group, giving them a risk of vehicle fire death nearly twice that of the general population. This group also had the highest risk of vehicle fire injury. Older adults at least 85 years of age had the second highest risk of vehicle fire death. In 2005, teens and young adults ages 15-24 had the highest motor vehicle accident death rates, followed closely by people aged 75 or older.[10]

Males are at greater risk of vehicle fire death and injury.
Seventy-seven percent of the people who died from highway vehicle fires and 78% of those who were non-fatally injured were male. This is a far greater gender difference

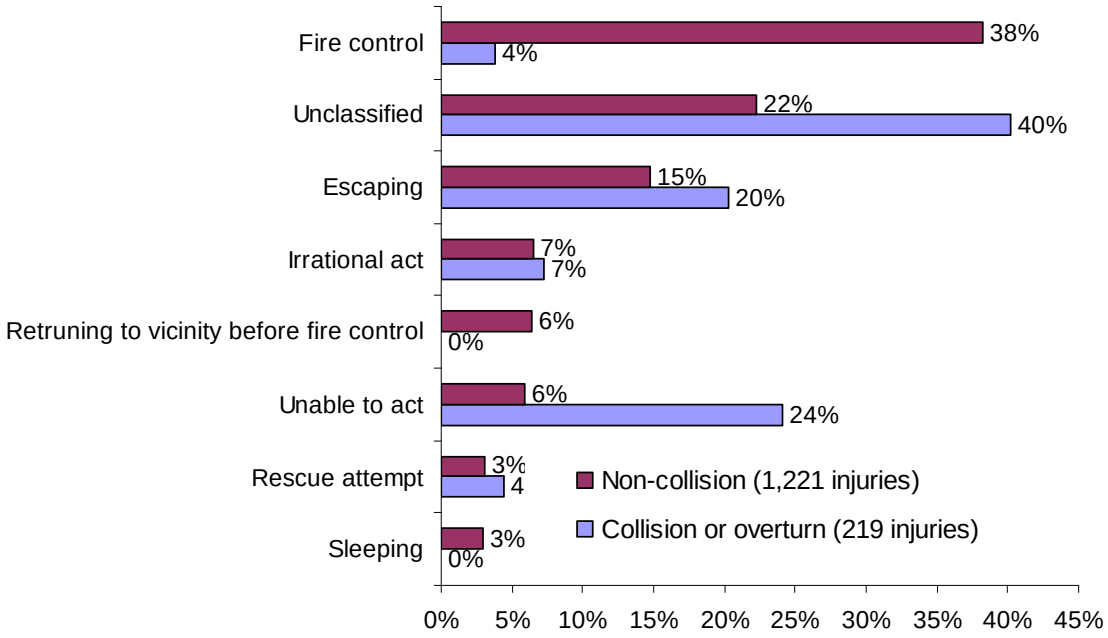
[10] National Safety Council. *Injury Facts ®, 2007 Edition,* Itasca, IL, 2007, p. 88.

than is seen among home fire victims, although males face a greater risk of injury and death from those incidents also.[11]

One-third of non-fatal highway vehicle fires injuries occurred when civilians attempted to fight the fire themselves.
Almost half (46%) of the people who died of highway vehicle fires in 2002-2005 were unable to act at the time of the fire. The victim's activity at time of injury was unclassified in 16% of the highway vehicle fire deaths. Seven percent of the victims were acting irrationally; 5% were escaping. It is possible that activity at time of injury may also include the immediate moments before the fire started. Table 22 shows that one-third (36%) of the people who sustained non-fatal injuries in these fires were engaged in fire control activities when they were injured, 22% were engaged in unclassified activities, 17% were escaping, 7% were unable to act, and 6% were acting irrationally.

Figure 9 shows that 38% of the civilians who were injured in highway vehicle fires that did not result from collision or overturn were fighting the fire themselves when injured. Only 4% of those injured in fires following collisions or overturns were injured when fighting the fire. One-quarter (24%) of the injured in collision or overturn vehicle fires were unable to act compared to only 6% of those injured in vehicle fires due to other factors.

Figure 9. Highway Vehicle Fire Injuries by Factor Contributing to Ignition and Activity when Injured: 2002-2005

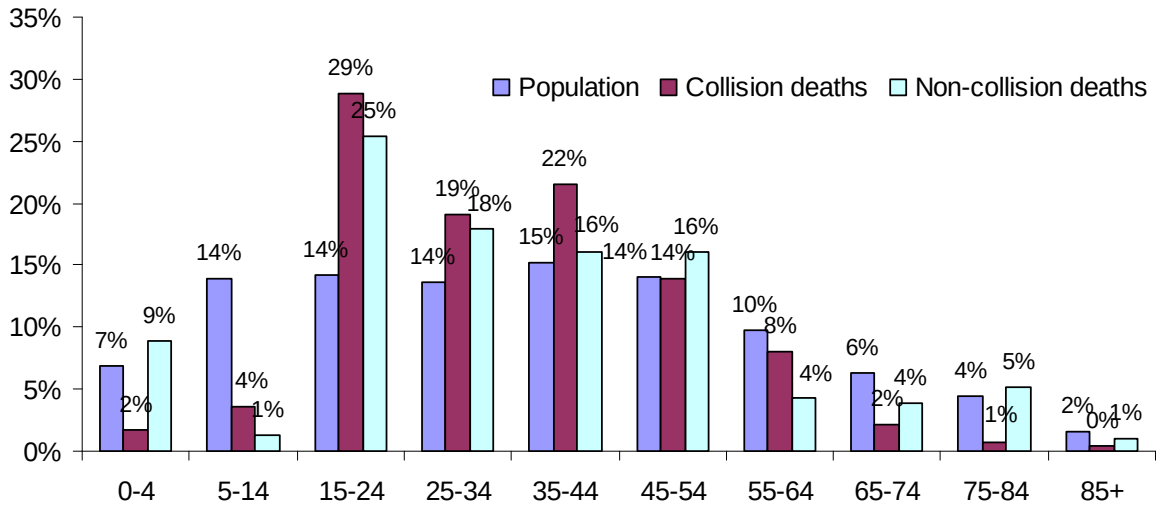


Source: NFIRS 5.0 and NFPA survey; U.S. Census data

[11] John R. Hall, Jr. C*haracteristics of Home Fire Victims,* Quincy, MA: NFPA, Fire Analysis and Research Division, July 2005, p. 1.

More than half of highway vehicle fire deaths resulted from burns *and* smoke inhalation.
Table 23 shows that 58% of the civilian fire deaths and 14% of the non-fatal civilian injuries from highway vehicle fires resulted from a combination of burns and smoke inhalation. Twenty-one percent of the deaths and 46% of the non-fatal injuries were caused by thermal burns only. Internal trauma was the primary apparent symptom in 6% of the deaths and 1% of the injuries while smoke inhalation was the primary symptom in 4% of the deaths and 16% of the injuries.

Figure 10. Collision vs. Non-Collision Vehicle Fire Deaths by Age Group 2002-2005



Source: NFIRS 5.0 and NFPA survey; U.S. Census data

Risk of vehicle fire by age group varies by fire cause.
While the 15-24 age group was at the highest risk of death from both fires resulting from collisions or overturns and vehicle fires or other causes, Table 24 and Figure 10 show that children under five face a very low risk of fire death following a collision or overturn, but an elevated risk of death in vehicle fires in which collisions or overturns were not factors. In Figure 9, "collision" includes both collisions and overturns. The percentage of older adult fire deaths was also a greater share of the non-collision, non-overturn fire deaths than of fire deaths that followed a collision or overturn. These percentages were calculated from deaths with known factors contributing to ignition.

A paper presented at the Society of Automotive Engineers' (SAE's) World Congress examined the circumstances of the 200 fire deaths per year (on average) from vehicle fires that did not result from collisions or overturns.[12] Examples of fires in the report suggest that limited mobility played a role in some deaths.

[12] Marty Ahrens. "Vehicle Fire Deaths Resulting from Fires Not Caused by Collisions or Overturns: How Do They Differ from Collision Fire Deaths?" SP-2166 Fire Safety, 2008, Warrendale, PA: SAE International.

For example, the National Transportation Safety Board found that it took between 1½ and 2 hours to get the assisted living residents on board the bus that burned on September 23, 2005 in Wilmer, Texas during the evacuation from Hurricane Rita, killing 23 passengers. Twenty-two wheelchairs and five walkers were also loaded. Cognitive and mobility impairments were among the factors contributing to the deaths.[13]

Other incidents came from reports in NFPA's files. In June 2002, three of four children, ages 1½ to 4, properly restrained in car seats, died in a Minnesota day care van fire. A mechanical failure started the fire in the fuel tank area under the 1994 van. The driver was only able to get one child out before the fire became too intense. In 2000, two passengers in wheelchairs died in a Maryland handicapped transport van fire that began in the van's interior. The seven passengers in conventional seats and the driver were able to escape. Six shackled prisoners died in a 1997 Tennessee prison van fire.

Other incidents involved improper transport. In 2004, a man died when gasoline was carried inside a car in Arizona. In a 1998 Colorado fire, a man died after gasoline in a milk container on the car seat ignited in a flash fire. Other incidents involved people using vehicles for shelter and makeshift arrangements for heat and electricity.

Appendix B contains a collection previously published incident descriptions about highway vehicle fires that followed collisions or overturns. Appendix C contains a collection of vehicle fire incidents that were not preceded by collision or overturn.

75% of U.K. car fires were "malicious."

In 2005, 65,200 road vehicle fires in the United Kingdom resulted in 62 fatalities and 581 non-fatal injuries. [14] These fires fell 10% from 2004 to 2005 to the lowest point in 11 years. Cars accounted for 81% of the vehicle fires in 2004, vans were involved in 7%, and lorries were burned in 3% of the fires. Seventy-five percent of the car fires were "malicious." As in the U.S., intentional fires were more common at night and unintentional fires were more common during the day. The authors note that improved vehicle licensing, successful programs of vehicle removal, and increases in scrap metal prices have helped reduce the problem of intentional vehicle fires although the percentage of car fires that were deliberately set is still higher than 10 years ago.

Vehicle defects caused 71% of the United Kingdom's unintentional car fires with wiring and battery problems cited as the leading cause. Collisions or crashes caused 7% of the unintentional car fires.

[13] National Transportation Safety Board. Motorcoach Fire during Hurricane Rita Evacuation on Interstate 45 near Wilmer, Texas: September 23, 2005. Highway Accident Report NTSB/HAR – 07/01 PB 2007- 916202, 2007.
[14] Ben Pledger, Jon Gamble, David Bovill, and Peter Antoniades. *Fire Statistics --United Kingdom, 2005*, London, U.K, Department for Communities and Local Development, 2007, pp. 56-58, available from http://www.communities.gov.uk/documents/fire/pdf/320258.pdf.

A variety of organizations are concerned about vehicle fires.
Two chapters in the 20th edition of NFPA's *Fire Protection Handbook,* "Passenger Vehicle Fires" by Long et al., and "Fire Safety in Commercial Vehicles" discuss the different agencies and organizations trying to prevent vehicle fires.[15]

Some of the relevant NFPA codes and standards include NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages;* NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids;* and NFPA 1192 *Standard on Recreational Vehicles.* A new document, NFPA 556, *Guide on Methods for Evaluating Fire Hazard to Occupants of Passenger Road Vehicles,* has been proposed. The deadline for proposals is December 1, 2008 and the document is in the annual 2010 cycle. NFPA 556 can be viewed on NFPA's web site, www.nfpa.org.

The Society of Automotive Engineers (SAE) sponsored its first program on fire safety at its 2005 World Congress in Detroit in April 2005 and has included several sessions on fire every year since then.

The Motor Vehicle Fire Research Institute funds and compiles research on many different aspects of automobile fire safety. Final reports and descriptions of ongoing projects can be found at http://www.mvfri.org/.

The National Highway Traffic Safety Administration regulates highway vehicles and orders recalls.
Passenger road vehicles are regulated by The National Highway Traffic Safety Administration (NHTSA) of the Department of Transportation (DOT). The DOT sets minimum safety standards for new motor vehicles and motor vehicle equipment and investigates reports of defects in motor vehicles, including fire hazards. Recalls are ordered when necessary. Information about safety problems and recalls can be found at http://www-odi.nhtsa.dot.gov/.

The NHTSA has issued four fire safety-standards for new motor vehicles since it was created in 1966. The Federal Motor Vehicle Safety Standard (FMVSS) 301 was developed to reduce the danger from fuel leakage following crashes involving cars, trucks and buses weighing no more than 10,000 pounds.

Flammability standards for the materials used in the driver and passenger area of vehicles were set in Federal Motor Vehicle Safety Standard 302 to reduce the danger of interior fires caused by matches or smoking. The other two standards address vehicles using compressed natural gas.[16]

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[15] R.T. Long, Jr., Jeff D. Colwell, Rose Ray, Helene L. Grossman, Ben Thomas and Robert Strassberger. "Passenger Vehicle Fires," *Fire Protection Handbook,* 20th edition, Section 21, Chapter 1, Quincy, MA: National Fire Protection Association, 2008.
[16] Larry Strawhorn, "Motor Vehicles," *Fire Protection Handbook,* 19th edition, Section 14, Chapter 1, p. 14-5, Quincy, MA: NFPA, 2003.

Burned/Recovered Motor Vehicle Act reduced vehicle fires 74% in Massachusetts.
As mentioned earlier, intentional motor vehicle fires cause a disproportionate share of the vehicle fire dollar loss. The Commonwealth of Massachusetts passed legislation to address the problem of vehicle arson motivated by insurance fraud. Effective August 1987, the Burned/Recovered Motor Vehicle Act required owners of burned motor vehicles to personally appear and complete a report at fire headquarters in the community where the fire occurred before the insurance company could pay their claim for fire damages. Vehicle fires in Massachusetts fell 74% from 1987 to 2006. In 1987, 41% of the Massachusetts vehicle fires were caused by arson. By 1990, 30% were incendiary or suspicious, and from 1995 to 2001, 14-17% of the vehicle fires were incendiary or suspicious. As with national data, a sharp decline in intentional fires was seen when Massachusetts began using NFIRS 5.0 in 2002 and the code for suspicious was dropped.[17, 18]

Different road and vehicle configurations and alternate fuels pose challenges to emergency personnel.
Firefighters and other emergency personnel are often called to vehicle collisions with and without fire. The vast array of vehicle makes and models, the different fuel or power sources, and the different locations of batteries, airbags, and other equipment can make it difficult to conduct operations in ways that maximize the safety of vehicle occupants and the emergency personnel. These issues were addressed in a Fire Protection Research Foundation Report, *Fire Safety of the Traveling Public and Firefighters for Today's and Tomorrow's* Fleets by Milke et al. Alternate fuels are addressed in two chapters in the 20th edition of NFPA's *Fire Protection Handbook:* "Vehicle Fueling Using Gaseous Fuels," by Carl H. Rivkin, and "Fuel Cell Vehicles" by Glenn W. Scheffler and William P. Collins.

Readers may also be interested in NFPA 52, *Compressed Natural Gas (CNG) Vehicular Fuel Systems Code.* The NFPA Standards Council created a new Hydrogen Technology Technical Committee in November of 2005 that will be responsible for producing a comprehensive hydrogen technologies safety code entitled NFPA 2 Hydrogen Technologies.

Vehicle fires in tunnels pose unusual challenges. These are discussed in Arthur G. Bendelius's *Fire Protection Handbook* chapter "Road Tunnels and Bridges." In November, 2007, a workshop was held on the state of the art and research needs for safety and security in roadway tunnels. Kathleen Almand of the Fire Protection Research Foundation prepared a report on the workshop. NFPA 502, *Standard for Road Tunnels, Bridges, and Other Limited Access Highways*, is another resource.

[17] Massachusetts Fire Incident Reporting System - 2006 Annual Report: Stow, Massachusetts, 2007, p. 77.
[18] Massachusetts Fire Incident Reporting System - 1995 Annual Report: Boston, Massachusetts, 1996, p. 44.

Table 3. U.S. Highway Vehicle Fire Problem, by Year: 1980-2006

Year	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions)	Loss in 2006 Dollars (in Millions)
1980	456,000	650	2,850	$462	$1,132
1981	453,000	770	2,900	$500	$1,107
1982	433,000	575	3,250	$525	$1,096
1983	435,500	670	3,400	$591	$1,195
1984	437,000	530	3,250	$630	$1,221
1985	437,000	770	3,250	$683	$1,278
1986	438,000	665	2,850	$673	$1,239
1987	451,000	755	2,900	$738	$1,309
1988	459,000	800	2,750	$798	$1,361
1989	415,500	560	2,750	$795	$1,293
1990	415,000	645	3,025	$825	$1,274
1991	406,500	530	2,675	$827	$1,224
1992	385,500	665	2,750	$834	$1,199
1993	402,000	540	2,400	$875	$1,221
1994	402,000	555	2,325	$961	$1,308
1995	386,000	490	2,275	$1,013	$1,340
1996	395,000	550	2,075	$1,117	$1,437
1997	377,000	450	1,950	$1,084	$1,362
1998	358,500	545	2,050	$1,129	$1,398
1999	345,000	450	1,600	$1,149	$1,390
2000	325,000	450	1,325	$1,187	$1,390
2001	327,000	470	1,750	$1,267	$1,443
2002	307,000	540	1,700	$1,184	$1,327
2003	286,000	455	1,400	$1,101	$1,208
2004	266,500	520	1,300	$969	$1,035
2005	259,000	500	1,450	$1,049	$1,083
2006	250,000	445	1,075	$982	$982

* Changes introduced in 1999 with Version 5.0 of NFIRS can make it advisable to analyze data from 1999 on separately from earlier years. Most of the statistical information in the remainder of this report is presented as 2002-2005 annual averages.

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires were estimated to the nearest five hundred, civilian deaths to the nearest five, civilian injuries to the nearest twenty-five, and direct property damage was rounded to the nearest million dollars.

Source: NFPA survey. Inflation adjustments were based on the consumer price index found in the U.S. Census Bureau's*Statistical Abstract of the United States: 2008*, "Table 702, Purchasing Power of the Dollar: 1950 to 2006."

Table 4. U.S. Highway Vehicle Fire Problem, by Type of Vehicle 2002-2005 Annual Averages

Vehicle Type	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Passenger road vehicles	**263,400**	**(92%)**	**408**	**(87%)**	**1,256**	**(87%)**	**$787**	**(77%)**
Automobile or passenger car	208,600	(72%)	305	(65%)	864	(60%)	$549	(53%)
Motor home, camper or bookmobile	3,100	(1%)	7	(1%)	62	(4%)	$41	(4%)
Bus, school bus, or trackless trolley	2,300	(1%)	11	(2%)	32	(2%)	$27	(3%)
Off-road recreational vehicle	1,900	(1%)	3	(1%)	13	(1%)	$6	(1%)
Motorcycle or trail bike	1,600	(1%)	2	(0%)	22	(2%)	$4	(0%)
Travel trailer designed to be towed	1,300	(0%)	2	(0%)	18	(1%)	$8	(1%)
Collapsible camping trailer	200	(0%)	0	(0%)	6	(0%)	$1	(0%)
Mobile home or building, or manufactured housing	200	(0%)	0	(0%)	4	(0%)	$2	(0%)
Unclassified passenger road vehicle	44,200	(15%)	78	(17%)	236	(16%)	$149	(15%)
Trucks or freight road vehicles	**24,400**	**(8%)**	**62**	**(13%)**	**183**	**(13%)**	**$240**	**(23%)**
General use truck, dump truck or fire apparatus	6,800	(2%)	7	(2%)	51	(4%)	$42	(4%)
Semi-trailer, with or without tractor	6,200	(2%)	27	(6%)	41	(3%)	$89	(9%)
Pickup truck or non-motorized hauling rig	3,700	(1%)	3	(1%)	35	(2%)	$18	(2%)
Garbage, waste or refuse truck	2,000	(1%)	0	(0%)	6	(0%)	$17	(2%)
Tank truck for flammable or combustible liquid or chemical cargo	400	(0%)	7	(2%)	15	(1%)	$14	(1%)
Tank truck for nonflammable cargo	300	(0%)	2	(0%)	1	(0%)	$3	(0%)
Tank truck for compressed or LP-gas	100	(0%)	0	(0%)	0	(0%)	$1	(0%)
Unclassified freight road transport vehicle	4,900	(2%)	15	(3%)	35	(2%)	$56	(5%)
Total	**287,700**	**(100%)**	**471**	**(100%)**	**1,439**	**(100%)**	**$1,027**	**(100%)**

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest ten, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest hundred thousand dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. A proportional share of vehicle fires in which the mobile property type was unknown or not reported are included in this table.
Source: NFIRS 5.0 and NFPA survey.

Table 5. U.S. Highway Vehicle Fires, by Month
2002-2005 Annual Averages

Month	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
January	22,700	(8%)	37	(8%)	98	(7%)	$85	(8%)
February	20,600	(7%)	24	(5%)	109	(8%)	$72	(7%)
March	23,000	(8%)	32	(7%)	113	(8%)	$79	(8%)
April	23,500	(8%)	41	(9%)	122	(8%)	$81	(8%)
May	24,500	(9%)	36	(8%)	130	(9%)	$84	(8%)
June	25,900	(9%)	38	(8%)	135	(9%)	$91	(9%)
July	28,500	(10%)	46	(10%)	158	(11%)	$107	(10%)
August	26,600	(9%)	44	(9%)	140	(10%)	$95	(9%)
September	24,600	(9%)	59	(13%)	136	(9%)	$88	(9%)
October	23,700	(8%)	34	(7%)	106	(7%)	$81	(8%)
November	21,900	(8%)	39	(8%)	102	(7%)	$82	(8%)
December	22,300	(8%)	41	(9%)	90	(6%)	$81	(8%)
Total	287,700	(100%)	471	(100%)	1,439	(100%)	$1,027	(100%)
Average	24,000	(8%)	39	(8%)	120	(8%)	$86	(8%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 6. U.S. Highway Vehicle Fires, by Day of Week
2002-2005 Annual Averages

Day of Week	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Sunday	37,600	(13%)	79	(17%)	225	(16%)	$140	(14%)
Monday	41,900	(15%)	53	(11%)	183	(13%)	$158	(15%)
Tuesday	40,900	(14%)	52	(11%)	197	(14%)	$144	(14%)
Wednesday	40,200	(14%)	65	(14%)	191	(13%)	$144	(14%)
Thursday	40,900	(14%)	65	(14%)	190	(13%)	$137	(13%)
Friday	44,100	(15%)	77	(16%)	217	(15%)	$151	(15%)
Saturday	42,100	(15%)	80	(17%)	235	(16%)	$151	(15%)
Total	287,700	(100%)	471	(100%)	1,439	(100%)	$1,027	(100%)
Average	41,100	(14%)	67	(14%)	206	(14%)	$147	(14%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the day of week was unknown or not reported have been allocated proportionally among fires with known day of week. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 7.
U.S. Highway Vehicle Fires, by Hour of Alarm
2002-2005 Annual Averages

Hour of Alarm	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Midnight - 12:59 a.m.	9,300	(3%)	22	(5%)	48	(3%)	$46	(4%)
1:00 – 1:59 a.m.	8,500	(3%)	34	(7%)	49	(3%)	$48	(5%)
2:00 - 2:59 a.m.	7,900	(3%)	29	(6%)	39	(3%)	$45	(4%)
3:00 - 3:59 a.m.	7,100	(2%)	33	(7%)	46	(3%)	$42	(4%)
4:00 - 4:59 a.m.	6,300	(2%)	21	(4%)	24	(2%)	$37	(4%)
5:00 - 5:59 a.m.	6,100	(2%)	18	(4%)	32	(2%)	$32	(3%)
6:00 - 6:59 a.m.	7,200	(3%)	28	(6%)	31	(2%)	$31	(3%)
7:00 - 7:59 a.m.	9,200	(3%)	13	(3%)	47	(3%)	$32	(3%)
8:00 - 8:59 a.m.	9,900	(3%)	11	(2%)	42	(3%)	$33	(3%)
9:00 - 9:59 a.m.	10,300	(4%)	11	(2%)	56	(4%)	$32	(3%)
10:00 - 10:59 a.m.	11,500	(4%)	10	(2%)	50	(3%)	$46	(4%)
11:00 - 11:59 a.m.	13,000	(5%)	12	(3%)	56	(4%)	$42	(4%)
Noon - 12:59 p.m.	14,700	(5%)	10	(2%)	73	(5%)	$44	(4%)
1:00 - 1:59 p.m.	15,400	(5%)	18	(4%)	76	(5%)	$43	(4%)
2:00 - 2:59 p.m.	16,800	(6%)	25	(5%)	106	(7%)	$53	(5%)
3:00 - 3:59 p.m.	18,300	(6%)	29	(6%)	96	(7%)	$49	(5%)
4:00 - 4:59 p.m.	18,500	(6%)	20	(4%)	102	(7%)	$52	(5%)
5:00 - 5:59 p.m.	18,500	(6%)	21	(4%)	86	(6%)	$48	(5%)
6:00 - 6:59 p.m.	17,000	(6%)	14	(3%)	77	(5%)	$50	(5%)
7:00 - 7:59 p.m.	14,700	(5%)	22	(5%)	72	(5%)	$46	(4%)
8:00 - 8:59 p.m.	13,400	(5%)	20	(4%)	79	(5%)	$47	(5%)
9:00 - 9:59 p.m.	12,500	(4%)	14	(3%)	66	(5%)	$40	(4%)
10:00 - 10:59 p.m.	11,400	(4%)	18	(4%)	49	(3%)	$43	(4%)
11:00 - 11:59 p.m.	10,200	(4%)	19	(4%)	38	(3%)	$44	(4%)
Total	287,700	(100%)	471	(100%)	1,439	(100%)	$1,027	(100%)
Average	12,000	(4%)	20	(4%)	60	(4%)	$43	(4%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 8.
U.S. Highway Vehicle Fires, by Hour of Alarm and Selected Causal Factors
2002-2005

Hour of Alarm	Mechanical or Electrical Failure	Intentional	Collision
Midnight - 12:59 a.m.	2%	9%	5%
1:00 – 1:59 a.m.	1%	9%	6%
2:00 - 2:59 a.m.	1%	9%	6%
3:00 - 3:59 a.m.	1%	8%	4%
4:00 - 4:59 a.m.	1%	6%	4%
5:00 - 5:59 a.m.	1%	5%	3%
6:00 - 6:59 a.m.	2%	3%	3%
7:00 - 7:59 a.m.	4%	2%	4%
8:00 - 8:59 a.m.	4%	2%	3%
9:00 - 9:59 a.m.	4%	2%	2%
10:00 - 10:59 a.m.	5%	2%	3%
11:00 - 11:59 a.m.	5%	1%	3%
Noon - 12:59 p.m.	6%	2%	4%
1:00 - 1:59 p.m.	6%	2%	4%
2:00 - 2:59 p.m.	7%	2%	4%
3:00 - 3:59 p.m.	7%	2%	5%
4:00 - 4:59 p.m.	7%	2%	5%
5:00 - 5:59 p.m.	7%	2%	6%
6:00 - 6:59 p.m.	7%	3%	5%
7:00 - 7:59 p.m.	6%	3%	5%
8:00 - 8:59 p.m.	5%	5%	4%
9:00 - 9:59 p.m.	4%	6%	5%
10:00 - 10:59 p.m.	3%	7%	4%
11:00 - 11:59 p.m.	2%	9%	5%
Total	100%	100%	100%

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Sums may not equal totals due to rounding errors. These percentages were based on known data collected in both Version 5.0 and earlier versions of NFIRS.

Source: NFIRS 5.0 and NFPA survey.

Table 9.
U.S. Highway Vehicle Fires, by Property Use
2002-2005 Annual Averages

Fixed Property Use	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Outside or special property	***211,400***	***(73%)***	***397***	***(84%)***	***1,012***	***(70%)***	***$749***	***(73%)***
Highway, street or parking area	**195,600**	**(68%)**	**366**	**(78%)**	**922**	**(64%)**	**$667**	**(65%)**
Residential street, road or residential driveway	57,400	(20%)	63	(13%)	283	(20%)	$167	(16%)
Highway or divided highway	53,700	(19%)	233	(49%)	308	(21%)	$238	(23%)
Vehicle parking area	48,200	(17%)	18	(4%)	175	(12%)	$156	(15%)
Street or road in commercial area	13,800	(5%)	15	(3%)	48	(3%)	$39	(4%)
Unclassified street	22,500	(8%)	37	(8%)	108	(8%)	$67	(7%)
Open land, beach or campsite	**10,200**	**(4%)**	**21**	**(5%)**	**51**	**(4%)**	**$47**	**(5%)**
Open land or field	5,800	(2%)	14	(3%)	30	(2%)	$29	(3%)
Vacant lot	2,800	(1%)	2	(1%)	3	(0%)	$11	(1%)
Residential	***16,600***	***(6%)***	***13***	***(3%)***	***130***	***(9%)***	***$62***	***(6%)***
One-or-two-family dwelling	12,900	(4%)	10	(2%)	110	(8%)	$49	(5%)
Apartment or multi-family dwelling	2,000	(1%)	0	(0%)	10	(1%)	$6	(1%)
Mercantile or business	***15,200***	***(5%)***	***5***	***(1%)***	***92***	***(6%)***	***$41***	***(4%)***
Service station or gas station	3,800	(1%)	1	(0%)	36	(2%)	$8	(1%)
Motor vehicle or boat sales, service or repair	3,300	(1%)	2	(0%)	25	(2%)	$14	(1%)
Grocery or convenience store	3,300	(1%)	0	(0%)	14	(1%)	$5	(0%)
Storage	***4,300***	***(1%)***	***2***	***(1%)***	***41***	***(3%)***	***$31***	***(3%)***
Vehicle storage, garage or fire station	3,100	(1%)	1	(0%)	35	(2%)	$23	(2%)
Public assembly	***3,000***	***(1%)***	***2***	***(0%)***	***18***	***(1%)***	***$9***	***(1%)***
Industrial, utility, defense, agriculture or mining	***1,300***	***(0%)***	***3***	***(1%)***	***20***	***(1%)***	***$11***	***(1%)***
Educational	***1,100***	***(0%)***	***0***	***(0%)***	***6***	***(0%)***	***$3***	***(0%)***
Health care, detention, and correction	***800***	***(0%)***	***0***	***(0%)***	***5***	***(0%)***	***$2***	***(0%)***
Manufacturing or processing	***700***	***(0%)***	***0***	***(0%)***	***4***	***(0%)***	***$6***	***(1%)***
Unclassified or unknown property use	***33,400***	***(12%)***	***48***	***(10%)***	***114***	***(8%)***	***$113***	***(11%)***
Total	***287,700***	***(100%)***	***471***	***(100%)***	***1,439***	***(100%)***	***$1,027***	***(100%)***

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.
Source: NFIRS 5.0 and NFPA survey.

Table 10.
U.S. Highway Vehicle Fires, by Cause
2002-2005 Annual Averages

Cause	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Unintentional	118,900	(41%)	290	(62%)	848	(59%)	$408	(40%)
Failure of equipment or heat source	118,500	(41%)	33	(7%)	408	(28%)	$365	(36%)
Unclassified	25,500	(9%)	103	(22%)	118	(8%)	$114	(11%)
Intentional	23,900	(8%)	43	(9%)	63	(4%)	$136	(13%)
Act of nature	900	(0%)	3	(1%)	3	(0%)	$3	(0%)
Total	287,700	(100%)	471	(100%)	1,439	(100%)	$1,027	(100%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the cause was under investigation, undetermined or not reported were allocated proportionally among fires with known cause. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 11.
Highway Vehicle Fires, by Factor Contributing to Ignition
2002-2005 Annual Averages

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Unclassified mechanical failure or malfunction	83,800	(29%)	12	(2%)	194	(13%)	$272	(27%)
Leak or break	35,600	(12%)	35	(7%)	168	(12%)	$98	(10%)
Unclassified electrical failure or malfunction	30,500	(11%)	1	(0%)	57	(4%)	$103	(10%)
Unspecified short circuit arc	19,000	(7%)	0	(0%)	65	(4%)	$67	(7%)
Unclassified factor contributed to ignition	17,000	(6%)	59	(13%)	116	(8%)	$90	(9%)
Exposure fire	14,900	(5%)	21	(4%)	24	(2%)	$97	(9%)
Backfire	13,100	(5%)	1	(0%)	87	(6%)	$26	(3%)
Worn out	10,400	(4%)	0	(0%)	17	(1%)	$16	(2%)
Short circuit arc from defective, worn insulation	8,400	(3%)	0	(0%)	18	(1%)	$21	(2%)
Collision or overturn	8,100	(3%)	268	(57%)	219	(15%)	$87	(8%)
Abandoned or discarded materials or products	6,600	(2%)	1	(0%)	36	(2%)	$24	(2%)
Heat source too close to combustibles	6,400	(2%)	8	(2%)	75	(5%)	$24	(2%)
Flammable liquid or gas spilled	6,100	(2%)	38	(8%)	93	(6%)	$24	(2%)
Unclassified misuse of material or product	5,700	(2%)	13	(3%)	76	(5%)	$20	(2%)
Unclassified operational deficiency	4,500	(2%)	2	(0%)	25	(2%)	$16	(2%)
Short circuit arc from mechanical damage	4,400	(2%)	1	(0%)	20	(1%)	$12	(1%)
Arc, spark from operating equipment	3,600	(1%)	0	(0%)	25	(2%)	$10	(1%)
Equipment not being operated properly	2,300	(1%)	10	(2%)	36	(2%)	$10	(1%)
Cutting, welding too close to combustible	1,900	(1%)	0	(0%)	17	(1%)	$3	(0%)
Flammable liquid used to kindle fire	1,800	(1%)	7	(1%)	13	(1%)	$11	(1%)
Installation deficiency	1,800	(1%)	0	(0%)	14	(1%)	$3	(0%)
Arc from faulty contact or broken conductor	1,500	(1%)	0	(0%)	7	(0%)	$5	(0%)
Improper fueling technique	1,500	(1%)	1	(0%)	52	(4%)	$2	(0%)
Failure to clean	1,500	(1%)	0	(0%)	3	(0%)	$2	(0%)
Other known factors	10,300	(4%)	21	(5%)	96	(7%)	$44	(4%)
Total entries*	300,700	(104%)	501	(106%)	1,552	(108%)	$1,088	(106%)
Total fires	287,700	(100%)	471	(100%)	1,439	(100%)	$1,027	(100%)

* Multiple entries are allowed, resulting in sums greater than the totals.

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Property damage figures are not adjusted for inflation. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the factor contributing to ignition was undetermined, not reported, or coded as "none" were allocated proportionally among fires with known factor contributing to ignition. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 12.
Highway Vehicle Fires, by Factor Contributing to Ignition Grouping
2002-2005 Annual Averages

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Mechanical failure or malfunction	**144,500**	**(50%)**	**51**	**(11%)**	**471**	**(33%)**	**$418**	**(41%)**
Leak or break	35,600	(12%)	35	(7%)	168	(12%)	$98	(10%)
Backfire	13,100	(5%)	1	(0%)	87	(6%)	$26	(3%)
Worn out	10,400	(4%)	0	(0%)	17	(1%)	$16	(2%)
Unclassified mechanical failure or malfunction	83,800	(29%)	12	(2%)	194	(13%)	$272	(27%)
Electrical failure or malfunction	**67,800**	**(24%)**	**2**	**(0%)**	**191**	**(13%)**	**$218**	**(21%)**
Unspecified short circuit arc	19,000	(7%)	0	(0%)	65	(4%)	$67	(7%)
Short circuit arc from defective, worn insulation	8,400	(3%)	0	(0%)	18	(1%)	$21	(2%)
Short circuit arc from mechanical damage	4,400	(2%)	1	(0%)	20	(1%)	$12	(1%)
Arc, spark from operating equipment	3,600	(1%)	0	(0%)	25	(2%)	$10	(1%)
Arc from faulty contact or broken conductor	1,500	(1%)	0	(0%)	7	(0%)	$5	(0%)
Unclassified electrical failure, malfunction	30,500	(11%)	1	(0%)	57	(4%)	$103	(10%)
Misuse of material or product	**31,400**	**(11%)**	**73**	**(16%)**	**401**	**(28%)**	**$115**	**(11%)**
Abandoned or discarded material or product	6,600	(2%)	1	(0%)	36	(2%)	$24	(2%)
Heat source too close to combustible	6,400	(2%)	8	(2%)	75	(5%)	$24	(2%)
Flammable liquid or gas spilled	6,100	(2%)	38	(8%)	93	(6%)	$24	(2%)
Cutting, welding too close to combustible	1,900	(1%)	0	(0%)	17	(1%)	$3	(0%)
Flammable liquid used to kindle fire	1,800	(1%)	7	(1%)	13	(1%)	$11	(1%)
Improper fueling technique	1,500	(1%)	1	(0%)	52	(4%)	$2	(0%)
Unclassified misuse of material or product	5,700	(2%)	13	(3%)	76	(5%)	$20	(2%)
Operational deficiency	**19,200**	**(7%)**	**284**	**(60%)**	**313**	**(22%)**	**$129**	**(13%)**
Collision or overturn	8,100	(3%)	268	(57%)	219	(15%)	$87	(8%)
Equipment not being operated properly	2,300	(1%)	10	(2%)	36	(2%)	$10	(1%)
Failure to clean	1,500	(1%)	0	(0%)	3	(0%)	$2	(0%)
Unclassified operational deficiency	4,500	(2%)	2	(0%)	25	(2%)	$16	(2%)
Fire spread or control	**16,400**	**(6%)**	**29**	**(6%)**	**35**	**(2%)**	**$104**	**(10%)**
Exposure fire	14,900	(5%)	21	(4%)	24	(2%)	$97	(9%)
Design, manufacturing or installation deficiency	**2,800**	**(1%)**	**0**	**(0%)**	**21**	**(1%)**	**$7**	**(1%)**
Installation deficiency	1,800	(1%)	0	(0%)	14	(1%)	$3	(0%)
Natural condition	**1,500**	**(1%)**	**3**	**(1%)**	**3**	**(0%)**	**$7**	**(1%)**
Unclassified factor contributed to ignition	**17,000**	**(6%)**	**59**	**(13%)**	**116**	**(8%)**	**$90**	**(9%)**

Table 12.
Highway Vehicle Fires, by Factor Contributing to Ignition Grouping
2002-2005 Annual Averages
(Continued)

Factor Contributing to Ignition	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Total entries*	**300,700**	**(104%)**	**501**	**(106%)**	**1,552**	**(108%)**	**$1,088**	**(106%)**
Total fires	**287,700**	**(100%)**	**471**	**(100%)**	**1,439**	**(100%)**	**$1,027**	**(100%)**

* Multiple entries are allowed, resulting in sums greater than the totals.

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Property damage figures are not adjusted for inflation. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Groups are shown in descending order, and within groups, factors exceeding 1% are also shown in descending order. Unclassified type factors are shown last. Group sums include all factors within the group, even when the factors were under 1% and consequently not shown. Fires in which the factor contributing to ignition was undetermined, not reported, or coded as "none" were allocated proportionally among fires with known factor contributing to ignition. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 13.
U.S. Highway Vehicle Fires, by Heat Source
2002-2005 Annual Averages

Heat Source	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Unclassified heat from powered equipment	63,800	(22%)	67	(14%)	245	(17%)	$209	(20%)
Radiated, conducted heat from operating equipment	50,200	(17%)	66	(14%)	192	(13%)	$149	(14%)
Arcing	43,400	(15%)	13	(3%)	159	(11%)	$137	(13%)
Unclassified heat source	26,300	(9%)	62	(13%)	115	(8%)	$96	(9%)
Spark, ember or flame from operating equipment	24,300	(8%)	86	(18%)	201	(14%)	$82	(8%)
Unclassified hot or smoldering object	17,800	(6%)	14	(3%)	62	(4%)	$58	(6%)
Heat or spark from friction	12,900	(4%)	70	(15%)	107	(7%)	$69	(7%)
Backfire from internal combustion engine	12,600	(4%)	3	(1%)	79	(5%)	$31	(3%)
Match	5,800	(2%)	14	(3%)	16	(1%)	$33	(3%)
Smoking materials	4,400	(2%)	11	(2%)	62	(4%)	$16	(2%)
Radiated heat from another fire	3,900	(1%)	0	(0%)	2	(0%)	$18	(2%)
Multiple heat sources including multiple ignitions	3,400	(1%)	24	(5%)	11	(1%)	$23	(2%)
Hot ember or ash	2,600	(1%)	2	(0%)	29	(2%)	$10	(1%)
Heat from direct flame or convection currents	2,400	(1%)	1	(0%)	1	(0%)	$29	(3%)
Molten or hot material	2,300	(1%)	2	(0%)	5	(0%)	$7	(1%)
Incendiary device	2,200	(1%)	4	(1%)	5	(0%)	$12	(1%)
Cigarette lighter	2,200	(1%)	10	(2%)	75	(5%)	$12	(1%)
Flame or torch used for lighting	1,800	(1%)	2	(0%)	22	(2%)	$8	(1%)
Other known heat source	5,300	(2%)	18	(4%)	53	(4%)	$28	(3%)
Total	287,700	(100%)	471	(100%)	1,439	(100%)	$1,027	(100%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the heat source was undetermined or not reported were allocated proportionally among fires with known heat source. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 14.
U.S. Highway Vehicle Fires, by Area of Fire Origin
2002-2005 Annual Averages

Area of Fire Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Engine are, running gear, or wheel area	185,600	(65%)	162	(34%)	664	(46%)	$545	(53%)
Operator or passenger area	39,800	(14%)	91	(19%)	260	(18%)	$196	(19%)
Unclassified vehicle area	21,100	(7%)	83	(18%)	117	(8%)	$89	(9%)
Cargo or trunk area	10,200	(4%)	12	(3%)	108	(7%)	$50	(5%)
Exterior or exposed vehicle surface	9,100	(3%)	5	(1%)	55	(4%)	$37	(4%)
Fuel tank or fuel line	5,300	(2%)	87	(19%)	148	(10%)	$34	(3%)
Unclassified area of origin	5,300	(2%)	9	(2%)	10	(1%)	$15	(1%)
On or near highway, parking lot or street	3,300	(1%)	6	(1%)	8	(1%)	$11	(1%)
Unclassified outside area	2,200	(1%)	3	(1%)	8	(1%)	$7	(1%)
Other known area	5,800	(2%)	12	(3%)	62	(4%)	$41	(4%)
Total	287,700	(100%)	471	(100%)	1,439	(100%)	$1,027	(100%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest ten, and direct property damage is rounded to the nearest million dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the area or origin was unknown or not reported were allocated proportionally among fires with known area of origin. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 15.
U.S. Highway Vehicle Fires after Collisions or Overturns, by Area of Fire Origin
2002-2005 Annual Averages

Area of Fire Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Engine area, running gear or wheel area	5,700	(70%)	112	(42%)	102	(47%)	$45	(52%)
Fuel tank or fuel line	700	(9%)	70	(26%)	52	(24%)	$14	(16%)
Unclassified vehicle area	700	(8%)	44	(17%)	21	(10%)	$8	(9%)
Operator or passenger area	300	(4%)	19	(7%)	15	(7%)	$3	(4%)
Exterior or exposed surface of vehicle	200	(3%)	0	(0%)	8	(4%)	$2	(2%)
Cargo or trunk area	200	(2%)	9	(3%)	13	(6%)	$13	(14%)
On or near highway, parking lot or street	100	(2%)	7	(3%)	1	(1%)	$1	(1%)
Unclassified area of origin	100	(1%)	4	(1%)	1	(1%)	$0	(0%)
Other known area	100	(1%)	2	(1%)	5	(2%)	$0	(0%)
Total	8,100	(100%)	268	(100%)	219	(100%)	$86	(99%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the area or origin was unknown or not reported were allocated proportionally among fires with known area of origin. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 16.
U.S. Intentionally Set Highway Vehicle Fires, by Area of Fire Origin
2002-2005 Annual Averages

Area of Fire Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Operator or passenger area	13,100	(55%)	32	(74%)	38	(61%)	$81	(60%)
Unclassified vehicle area	3,100	(13%)	2	(4%)	6	(9%)	$20	(15%)
Engine area, running gear or wheel area	2,500	(10%)	0	(0%)	3	(5%)	$10	(8%)
Exterior or exposed surface of vehicle	1,600	(7%)	1	(2%)	5	(9%)	$7	(5%)
Cargo or trunk area	1,200	(5%)	0	(0%)	4	(6%)	$6	(4%)
Fuel tank or fuel line	800	(3%)	3	(7%)	3	(5%)	$3	(2%)
Unclassified	300	(1%)	0	(0%)	0	(0%)	$1	(1%)
Unclassified outside area	300	(1%)	0	(0%)	1	(1%)	$1	(1%)
Multiple areas of origin	200	(1%)	1	(2%)	0	(0%)	$2	(1%)
On or near highway, parking lot or street	200	(1%)	0	(0%)	0	(0%)	$1	(1%)
Other known area	500	(2%)	4	(10%)	2	(3%)	$4	(3%)
Total	23,900	(100%)	43	(100%)	63	(100%)	$136	(100%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the area or origin was unknown or not reported were allocated proportionally among fires with known area of origin. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 17.
U.S. Highway Vehicle Fires Associated with Mechanical Failures or Malfunctions, by Area of Fire Origin
2002-2005 Annual Averages

Area of Fire Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Engine area, running gear or wheel area	122,200	(85%)	18	(36%)	334	(71%)	$330	(79%)
Unclassified vehicle area	5,900	(4%)	7	(13%)	18	(4%)	$16	(4%)
Operator or passenger area	3,700	(3%)	4	(7%)	36	(8%)	$18	(4%)
Fuel tank or fuel line	3,500	(2%)	17	(34%)	28	(6%)	$15	(4%)
Exterior or exposed surface of vehicle	2,500	(2%)	0	(0%)	15	(3%)	$7	(2%)
Cargo or trunk area	2,000	(1%)	3	(5%)	17	(4%)	$17	(4%)
Unclassified area of origin	1,600	(1%)	1	(3%)	3	(1%)	$4	(1%)
On or near highway, parking lot or street	1,400	(1%)	1	(2%)	0	(0%)	$4	(1%)
Other known area	1,800	(1%)	0	(0%)	20	(4%)	$8	(2%)
Total	144,500	(100%)	51	(100%)	471	(100%)	$418	(100%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the area or origin was unknown or not reported were allocated proportionally among fires with known area of origin. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 18.
U.S. Highway Vehicle Fires Associated with Electrical Failures or Malfunctions, by Area of Fire Origin
2002-2005 Annual Averages

Area of Fire Origin	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Engine area, running gear or wheel area	45,600	(67%)	1	(41%)	85	(44%)	$127	(58%)
Operator or passenger area	12,300	(18%)	0	(0%)	51	(27%)	$53	(24%)
Unclassified vehicle area	3,700	(5%)	0	(0%)	12	(6%)	$14	(7%)
Cargo or trunk area	2,300	(3%)	1	(59%)	25	(13%)	$6	(3%)
Unclassified area of origin	800	(1%)	0	(0%)	1	(1%)	$2	(1%)
On or near highway, parking lot or street	700	(1%)	0	(0%)	0	(0%)	$2	(1%)
Exterior or exposed surface of vehicle	600	(1%)	0	(0%)	0	(0%)	$2	(1%)
Separate operating or control area of vehicle	400	(1%)	0	(0%)	1	(1%)	$2	(1%)
Other known area	1,400	(2%)	0	(0%)	17	(9%)	$10	(4%)
Total	67,800	(100%)	2	(100%)	191	(100%)	$218	(100%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the area or origin was unknown or not reported were allocated proportionally among fires with known area of origin. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 19.
U.S. Highway Vehicle Fires, by Item First Ignited
2002-2005 Annual Averages

Item First Ignited	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
General materials	**118,300**	**(41%)**	**45**	**(9%)**	**325**	**(23%)**	**$414**	**(40%)**
Electrical wire or cable insulation	80,900	(28%)	6	(1%)	195	(14%)	$242	(24%)
Multiple items first ignited	14,800	(5%)	31	(7%)	58	(4%)	$75	(7%)
Tire	9,700	(3%)	1	(0%)	30	(2%)	$71	(7%)
Rubbish, trash, or waste	3,400	(1%)	0	(0%)	18	(1%)	$6	(1%)
Conveyor belt, drive belt, or V-belt	2,400	(1%)	1	(0%)	1	(0%)	$5	(0%)
Magazine, newspaper or writing paper	1,600	(1%)	3	(1%)	7	(0%)	$4	(0%)
Unclassified general material	2,000	(1%)	0	(0%)	4	(0%)	$4	(0%)
Flammable or combustible liquids or gases, piping or filters	**93,000**	**(32%)**	**340**	**(72%)**	**832**	**(58%)**	**$344**	**(33%)**
Flammable or combustible liquid or gas in or escaping from combustion engine or burner	61,600	(21%)	186	(39%)	404	(28%)	$182	(18%)
Uncontained flammable liquid or gas, including accelerants	9,300	(3%)	66	(14%)	140	(10%)	$43	(4%)
Flammable or combustible liquid or gas in or escaping from container or pipe	5,600	(2%)	40	(9%)	140	(10%)	$47	(5%)
Flammable or combustible liquid or gas in or escaping from final container or pipe before engine or burner	3,400	(1%)	36	(8%)	79	(5%)	$22	(2%)
Pipe, duct, conduit or hose	2,000	(1%)	0	(0%)	8	(1%)	$4	(0%)
Atomized liquid, vaporized liquid, or aerosol	1,700	(1%)	7	(1%)	27	(2%)	$13	(1%)
Unclassified liquid, gas, piping or filter	7,400	(3%)	5	(1%)	34	(2%)	$22	(2%)
Furniture or utensils	**16,900**	**(6%)**	**8**	**(2%)**	**73**	**(5%)**	**$83**	**(8%)**
Upholstered furniture or vehicle seat	16,000	(6%)	4	(1%)	58	(4%)	$76	(7%)
Organic materials	**6,300**	**(2%)**	**12**	**(3%)**	**28**	**(2%)**	**$22**	**(2%)**
Light vegetation, including grass	3,600	(1%)	9	(2%)	11	(1%)	$12	(1%)
Unclassified organic materials	1,600	(1%)	1	(0%)	1	(0%)	$5	(0%)

Table 19.
U.S. Highway Vehicle Fires, by Item First Ignited
2002-2005 Annual Averages

Item First Ignited	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Soft goods or wearing apparel	**4,100**	**(1%)**	**13**	**(3%)**	**52**	**(4%)**	**$16**	**(2%)**
Storage supplies	**2,000**	**(1%)**	**1**	**(0%)**	**16**	**(1%)**	**$10**	**(1%)**
Other known category of item	**500**	**(0%)**	**0**	**(0%)**	**3**	**(0%)**	**$1**	**(0%)**
Unclassified item first ignited	**46,600**	**(16%)**	**52**	**(11%)**	**112**	**(8%)**	**$137**	**(13%)**
Total	**287,700**	**(100%)**	**471**	**(100%)**	**1,439**	**(100%)**	**$1,027**	**(100%)**

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Groups are shown in descending order, and within groups, items first ignited exceeding 1% are also shown in descending order. Unclassified items in each group are shown last. Group sums include all items first ignited within the group, even when the items were under 1% and consequently not shown. Fires in which the item first ignited was unknown or not reported were allocated proportionally among fires with known item first ignited. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 20.
U.S. Highway Vehicle Fires in which Flammable or Combustible Liquids or Gases, or Piping or Filters Were the Items First Ignited by Type of Material First Ignited 2002-2005 Annual Averages

Type of Material	Fires		Civilian Deaths		Civilian Injuries		Direct Property Damage (in Millions)	
Flammable or combustible liquid	**70,400**	**(76%)**	**285**	**(84%)**	**658**	**(79%)**	**$268**	**(78%)**
Gasoline	47,200	(51%)	235	(69%)	534	(64%)	$158	(46%)
Class IIIB combustible liquid including lubricating, transformer or cooking oil	7,700	(8%)	0	(0%)	23	(3%)	$13	(4%)
Class II combustible liquid including kerosene, numbers 1 and 2 fuel oil and diesel-type liquid	1,300	(1%)	20	(6%)	25	(3%)	$48	(14%)
Unclassified flammable or combustible liquid	13,600	(15%)	30	(9%)	67	(8%)	$47	(14%)
Flammable gas	**10,900**	**(12%)**	**40**	**(12%)**	**127**	**(15%)**	**$40**	**(12%)**
LP gas	500	(1%)	5	(2%)	37	(4%)	$5	(2%)
Unclassified flammable gas	10,200	(11%)	32	(9%)	88	(11%)	$31	(9%)
Plastic	**4,800**	**(5%)**	**0**	**(0%)**	**17**	**(2%)**	**$16**	**(5%)**
Multiple types of material	**1,900**	**(2%)**	**10**	**(3%)**	**13**	**(2%)**	**$6**	**(2%)**
Material compounded with oil	**1,500**	**(2%)**	**3**	**(1%)**	**2**	**(0%)**	**$4**	**(1%)**
Natural product	**1,100**	**(1%)**	**0**	**(0%)**	**2**	**(0%)**	**$2**	**(1%)**
Rubber, excluding synthetic rubber	1,100	(1%)	0	(0%)	1	(0%)	$2	(1%)
Other known type of material	**1,200**	**(1%)**	**3**	**(1%)**	**12**	**(1%)**	**$5**	**(1%)**
Unclassified type of material	**1,200**	**(1%)**	**0**	**(0%)**	**1**	**(0%)**	**$2**	**(1%)**
Total	**93,000**	**(100%)**	**340**	**(100%)**	**832**	**(100%)**	**$344**	**(100%)**

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Fires are rounded to the nearest hundred, civilian deaths and injuries to the nearest one, and direct property damage is rounded to the nearest million dollars. Sums may not equal totals due to rounding errors. Property damage figures are not adjusted for inflation. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Groups are shown in descending order, and within groups, types of material exceeding 1% are also shown in descending order. Unclassified types are shown last in each group. Group sums include all types of material within the group, even when the types of material were under 1% and consequently not shown. This table includes a proportional share of fires in which the type of material first ignited was unknown or not reported. Fires in which the type of material first ignited was unknown or not reported were allocated proportionally among fires with known type of material first ignited. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 21.
Civilian Fire Deaths and Injuries in U.S. Highway Vehicle Fires, by Age Group
2002-2005 Annual Averages

Age Group	2002-2005 Population (in Millions)		Civilian Deaths		Fire Death Risk Index	Civilian Injuries		Fire Injury Risk Index
0-4	19.9	7%	21	4%	0.6	27	2%	0.3
5-14	40.8	14%	11	2%	0.2	40	3%	0.2
15-24	41.4	14%	123	26%	1.8	334	23%	1.6
25-34	39.9	14%	85	18%	1.3	302	21%	1.5
35-44	44.3	15%	88	19%	1.2	287	20%	1.3
45-54	41.2	14%	65	14%	1.0	233	16%	1.1
55-64	28.5	10%	38	8%	0.8	121	8%	0.9
65-74	18.4	6%	14	3%	0.5	61	4%	0.7
75-84	12.9	4%	14	3%	0.7	25	2%	0.4
85+	4.8	2%	11	2%	1.4	9	1%	0.4
Total	292.2	100%	471	100%	1.0	1,439	100%	1.0
65+	36.2	12%	40	8%	0.7	95	7%	0.5

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Civilian deaths and injuries are rounded to the nearest one. Sums may not equal totals due to rounding errors. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the victim's age was unknown or not reported were allocated proportionally among fires with known victim's age. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Sources: NFIRS 5.0 and NFPA survey.
U.S. resident population statistics from the U.S. Census Bureau were obtained from Table 11, "Resident Population by Age and Sex: 1980 to 2003" in *Statistical Abstract of the United States: 2004-2005.*

Table 22.
Civilian Fire Deaths and Injuries in U.S. Highway Vehicle Fires
by Activity at Time of Injury
2002-2005 Annual Averages

Activity at Time of Injury	Civilian Deaths		Civilian Injuries	
Unable to act	218	(46%)	96	(7%)
Unclassified activity	169	(36%)	319	(22%)
Irrational act	34	(7%)	80	(6%)
Escaping	23	(5%)	242	(17%)
Sleeping	20	(4%)	53	(4%)
Fire control	5	(1%)	513	(36%)
Returning to vicinity of fire before control	2	(0%)	82	(6%)
Rescue attempt	0	(0%)	50	(3%)
Returning to vicinity of fire after control	0	(0%)	5	(0%)
Total	471	(100%)	1,439	(100%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Civilian deaths and injuries are rounded to the nearest one. A value of zero may indicate a true zero or that the estimated annual average number of deaths is less than five and rounds to zero. Sums may not equal totals due to rounding errors. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the victim's age was unknown or not reported were allocated proportionally among fires with known victim's age. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 23.
Civilian Fire Deaths and Injuries in U.S. Highway Vehicle Fires
by Primary Apparent Symptom
2002-2005 Annual Averages

Primary Apparent Symptom	Civilian Deaths		Civilian Injuries	
Burns and smoke inhalation	275	(58%)	209	(14%)
Thermal burns only	99	(21%)	658	(46%)
Internal trauma	28	(6%)	10	(1%)
Smoke inhalation	20	(4%)	233	(16%)
Unclassified symptom	15	(3%)	26	(2%)
Crushing	10	(2%)	0	(0%)
Unconscious	10	(2%)	11	(1%)
Cardiac arrest	4	(1%)	2	(0%)
Gunshot or projectile wound	4	(1%)	1	(0%)
Other known symptom	5	(1%)	289	(20%)
Total	471	(100%)	1,439	(100%)

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Civilian deaths and injuries are rounded to the nearest one. A value of zero may indicate a true zero or that the estimated annual average number of deaths is less than five and rounds to zero. Sums may not equal totals due to rounding errors. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the victim's age was unknown or not reported were allocated proportionally among fires with known victim's age. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Source: NFIRS 5.0 and NFPA survey.

Table 24.
Risk of Civilian Fire Death in 2002-2005 Highway Vehicle Fires from Collisions or Overturns vs. Other Factors, by Age Group

Age Group	2002-2005 Population (in Millions)	Collision or Overturn Fire Deaths	Death Risk Index	Non-Collision Non-Overturn Fire Deaths	Death Risk Index
0-4	7%	2%	0.3	9%	1.3
5-14	14%	4%	0.3	1%	0.1
15-24	14%	29%	2.0	25%	1.8
25-34	14%	19%	1.4	18%	1.3
35-44	15%	22%	1.4	16%	1.1
45-54	14%	14%	1.0	16%	1.1
55-64	10%	8%	0.8	4%	0.4
65-74	6%	2%	0.3	4%	0.6
75-84	4%	1%	0.2	5%	1.2
85+	2%	0%	0.2	1%	0.6
Total	100%	100%	1.0	100%	1.0
65+	12%	3%	0.3	10%	0.8

Note: These are national estimates of fires reported to U.S. municipal fire departments and so exclude fires reported only to Federal or state agencies or industrial fire brigades. National estimates are projections. Casualty and loss projections can be heavily influenced by the inclusion or exclusion of one unusually serious fire. Sums may not equal totals due to rounding errors. Percentages were calculated on the actual estimates, so two figures with the same rounded-off estimates may have different percentages. Fires in which the victim's age was unknown or not reported were allocated proportionally among fires with known victim's age. This table includes a proportional share of fires in which the mobile property type was unknown or not reported.

Sources: NFIRS 5.0 and NFPA survey.
U.S. resident population statistics from the U.S. Census Bureau were obtained from Table 11, "Resident Population by Age and Sex: 1980 to 2003" in *Statistical Abstract of the United States: 2004-2005.*

Appendix A.
How National Estimates Statistics Are Calculated

The statistics in this analysis are estimates derived from the U.S. Fire Administration's (USFA's) National Fire Incident Reporting System (NFIRS) and the National Fire Protection Association's (NFPA's) annual survey of U.S. fire departments. NFIRS is a voluntary system by which participating fire departments report detailed factors about the fires to which they respond. Roughly two-thirds of U.S. fire departments participate, although not all of these departments provide data every year.

NFIRS provides the most detailed incident information of any national database not limited to large fires. NFIRS is the only database capable of addressing national patterns for fires of all sizes by specific property use and specific fire cause. NFIRS also captures information on the extent of flame spread, and automatic detection and suppression equipment. For more information about NFIRS visit http://www.nfirs.fema.gov/. Copies of the paper forms may be downloaded from http://www.nfirs.fema.gov/_download/nfirspaperforms2007.pdf.

Each year, NFPA conducts an annual survey of fire departments which enables us to capture a summary of fire department experience on a larger scale. Surveys are sent to all municipal departments protecting populations of 50,000 or more and a random sample, stratified by community size, of the smaller departments. Typically, a total of roughly 3,000 surveys are returned, representing about one of every ten U.S. municipal fire departments and about one third of the U.S. population.

The survey is stratified by size of population protected to reduce the uncertainty of the final estimate. Small rural communities have fewer people protected per department and are less likely to respond to the survey. A larger number must be surveyed to obtain an adequate sample of those departments. (NFPA also makes follow-up calls to a sample of the smaller fire departments that do not respond, to confirm that those that did respond are truly representative of fire departments their size.) On the other hand, large city departments are so few in number and protect such a large proportion of the total U.S. population that it makes sense to survey all of them. Most respond, resulting in excellent precision for their part of the final estimate.

The survey includes the following information: (1) the total number of fire incidents, civilian deaths, and civilian injuries, and the total estimated property damage (in dollars), for each of the major property use classes defined in NFIRS; (2) the number of on-duty firefighter injuries, by type of duty and nature of illness; and (3) information on the type of community protected (e.g., county versus township versus city) and the size of the population protected, which is used in the statistical formula for projecting national totals from sample results. The results of the survey are published in the annual report *Fire Loss in the United States*. To download a free copy of the report, visit http://www.nfpa.org/assets/files/PDF/OS.fireloss.pdf.

Projecting NFIRS to National Estimates

As noted, NFIRS is a voluntary system. Different states and jurisdictions have different reporting requirements and practices. Participation rates in NFIRS are not necessarily uniform across regions and community sizes, both factors correlated with frequency and severity of fires. This means NFIRS may be susceptible to systematic biases. No one at present can quantify the size of these deviations from the ideal, representative sample, so no one can say with confidence that they are or are not serious problems. But there is enough reason for concern so that a second database - the NFPA survey - is needed to project NFIRS to national estimates and to project different parts of NFIRS separately. This multiple calibration approach makes use of the annual NFPA survey where its statistical design advantages are strongest.

Scaling ratios are obtained by comparing NFPA's projected totals of residential structure fires, non-residential structure fires, vehicle fires, and outside and other fires, and associated civilian deaths, civilian injuries, and direct property damage with comparable totals in NFIRS. Estimates of specific fire problems and circumstances are obtained by multiplying the NFIRS data by the scaling ratios.

Analysts at the NFPA, the USFA and the Consumer Product Safety Commission have developed the specific analytical rules used for this procedure. "The National Estimates Approach to U.S. Fire Statistics," by John R. Hall, Jr. and Beatrice Harwood, provides a more detailed explanation of national estimates. A copy of the article is available online at http://www.nfpa.org/osds or through NFPA's One-Stop Data Shop.

Version 5.0 of NFIRS, first introduced in 1999, used a different coding structure for many data elements, added some property use codes, and dropped others.

Figure 1.

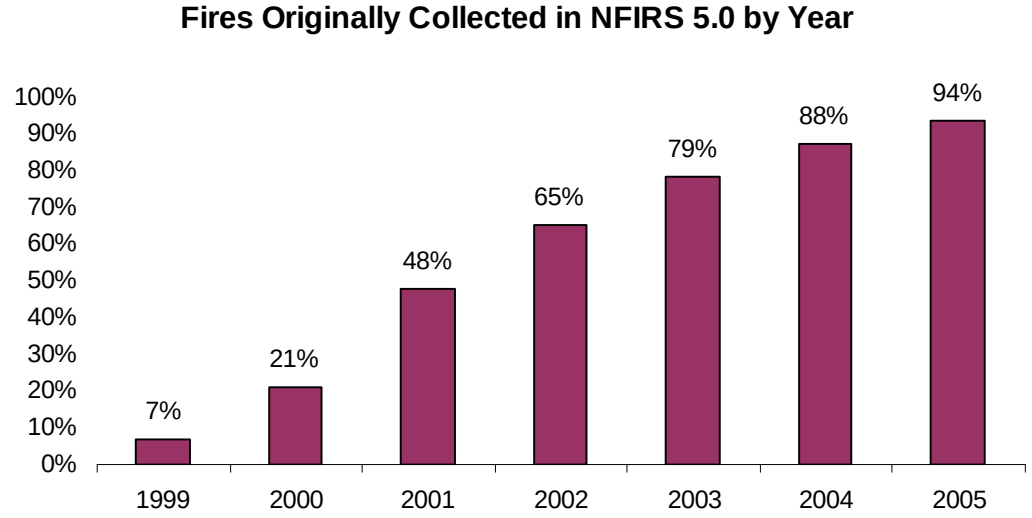

Figure 1 shows the percentage of fires originally collected in the NFIRS 5.0 system. Each year's release version of NFIRS data also includes data collected in older versions of NFIRS that were converted to NFIRS 5.0 codes.

For 2002 data on, analyses are based on scaling ratios using only data originally collected in NFIRS 5.0:

NFPA survey projections
NFIRS totals (Version 5.0)

For 1999 to 2001, the same rules may be applied, but estimates for these years in this form will be less reliable due to the smaller amount of data originally collected in NFIRS 5.0; they should be viewed with extreme caution.

A second option is to omit year estimates for 1999-2001 from year tables.

NFIRS 5.0 has six categories of confined structure fires, including:

- cooking fires confined to the cooking vessel,
- confined chimney or flue fires,
- confined incinerator fire,
- confined fuel burner or boiler fire or delayed ignition,
- confined commercial compactor fire, and
- trash or rubbish fires in a structure with no flame damage to the structure or its contents.

Although causal and other detailed information is typically not required for these incidents, it is provided in some cases. In order for that limited detail to be used to characterize the confined fires, they must be analyzed separately from non-confined fires. Otherwise, the patterns in a factor for the more numerous non-confined fires with factor known will dominate the allocation of the unknown factor fires for both non-confined and confined fires. If the pattern is different for confined fires, which is often the case, that fact will be lost unless analysis is done separately.

For most fields other than Property Use, NFPA allocates unknown data proportionally among known data. This approach assumes that if the missing data were known, it would be distributed in the same manner as the known data. NFPA makes additional adjustments to several fields.

For Factor Contributing to Ignition, the code "none" is treated as an unknown and allocated proportionally. For Human Factor Contributing to Ignition, NFPA enters a code for "not reported" when no factors are recorded. "Not reported" is treated as an unknown, but the code "none" is treated as a known code and not allocated. Multiple entries are allowed in both of these fields. Percentages are calculated on the total number of fires, not entries, resulting in sums greater than 100%. Groupings for this field show all category headings and specific factors if they account for a rounded value of at least 1%.

Type of Material First Ignited (TMI). This field is required only if the Item First Ignited falls within the code range of 00-69. NFPA has created a new code "not required" for this field that is applied when Item First Ignited is in code 70-99 (organic

materials, including cooking materials and vegetation, and general materials, such as electrical wire, cable insulation, transformers, tires, books, newspaper, dust, rubbish, etc..) and TMI is blank. The ratio for allocation of unknown data is:

$$\frac{\text{(All fires – TMI Not required)}}{\text{(All fires – TMI Not Required – Undetermined – Blank))}}$$

Heat Source. In NFIRS 5.0, one grouping of codes encompasses various types of open flames and smoking materials. In the past, these had been two separate groupings. A new code was added to NFIRS 5.0, which is code 60: "Heat from open flame or smoking material, other." NFPA treats this code as a partial unknown and allocates it proportionally across the codes in the 61-69 range, shown below.

61. Cigarette,
62. Pipe or cigar,
63. Heat from undetermined smoking material,
64. Match,
65. Lighter: cigarette lighter, cigar lighter,
66. Candle,
67 Warning or road flare, fusee,
68. Backfire from internal combustion engine. Excludes flames and sparks from an exhaust system, (11)
69. Flame/torch used for lighting. Includes gas light and gas-/liquid-fueled lantern.

In addition to the conventional allocation of missing and undetermined fires, NFPA multiplies fires with codes in the 61-69 range by

$$\frac{\text{All fires in range 60-69}}{\text{All fires in range 61-69}}$$

The downside of this approach is that heat sources that are truly a different type of open flame or smoking material are erroneously assigned to other categories. The grouping "smoking materials" includes codes 61-63 (cigarettes, pipes or cigars, and heat from undetermined smoking material, with a proportional share of the code 60s and true unknown data.

Equipment Involved in Ignition (EII). NFIRS 5.0 originally defined EII as the piece of equipment that provided the principal heat source to cause ignition if the equipment malfunctioned or was used improperly. In 2006, the definition was modified to "the piece of equipment that provided the principal heat source to cause ignition." However, the 2006 data is not yet available and a large portion of the fires coded as no equipment involved (NNN) have heat sources in the operating equipment category. To compensate, NFPA treats fires in which EII = NNN and heat source is not in the range of 40-99 as an additional unknown.

To allocate unknown data for EII, the known data is multiplied by

$$\frac{\text{All fires}}{(\text{All fires} - \text{blank} - \text{undetermined} - [\text{fires in which EII} = \text{NNN and heat source} <> 40\text{-}99])}$$

Additional allocations may be used in specific analyses. For example, NFPA's report about home heating fires treats Equipment Involved in Ignition Code 120, fireplace, chimney, other" as a partial unknown (like Heat Source 60) and allocates it over its related decade of 121-127, which includes codes for fireplaces (121-122) and chimneys (126-127) but also includes codes for fireplace insert or stove, heating stove, and chimney or vent connector. More general analyses of specific occupancies may not perform as many allocations of partial allocations. Notes at the end of each table describe what was allocated.

Rounding and percentages. The data shown are estimates and generally rounded. An entry of zero may be a true zero or it may mean that the value rounds to zero. Percentages are calculated from unrounded values. It is quite possible to have a percentage entry of up to 100%, even if the rounded number entry is zero. Values that appear identical may be associated with different percentages, and identical percentages may be associated with slightly different values.

Appendix B.
Highway Vehicle Fires that Occurred after Collisions or Overturns

This collection of previously published incidents was compiled from NFPA's studies of large-loss fires, catastrophic fires, and "Firewatch" column from NFPA Journal. It is important to remember that these descriptions provide information about what can happen, not what is typical. The following scenarios complement the statistics.

Missouri post-collision fire kills three

In October 2006, a multi-vehicle collision involving at least three semi tractor-trailers and five cars on an interstate highway claimed three lives. The fire was reported at 11:12 p.m. The victims were trapped in their vehicles as the fire quickly engulfed them. It was not reported how the fire originated, but it did involve spilled diesel fuel.

Adapted from Stephen G. Badger's 2007 "U.S. Multiple-Death Fires for 2006," *NFPA Journal,* September/October 63.

Virginia crash causes fatal fire

Fire killed three people and a fourth died of blunt trauma in a November fire that started when a single-vehicle ran off the road on a curve, struck a tree and caught on fire. The fire was reported at 12:05 p.m.

Adapted from Stephen G. Badger's 2007 "U.S. Multiple-Death Fires for 2006," *NFPA Journal,* September/October 63.

Semi-tractor trailer collision with pickup causes fatal fire in Arizona

A pickup truck was rear-ended by an 18-wheel semi-tractor trailer on an interstate highway. Both vehicles ended up off the side of the highway and exploded in fire as the gasoline and diesel fuel were ignited by sparks. The victims were trapped in the wreckage of the pickup truck. Three died of burns, two by smoke inhalation, and the other two by multiple blunt force trauma.

Adapted from Stephen G. Badger's 2007 "U.S. Multiple-Death Fires for 2006," *NFPA Journal,* September/October 62.

Single car crash on New York ramp causes fatal fire

A fire that began when a car reportedly struck a barrier, overturned and caught fire on an expressway off ramp was reported at 4:45 a.m. on a November morning. The fire killed three and another person died of blunt force trauma.

Adapted from Stephen G. Badger's 2007 "U.S. Multiple-Death Fires for 2006," *NFPA Journal*, September/October 62.

Fire after multi-vehicle New York crash kills four

At approximately 9:00 a.m. on a fair June morning, a motor vehicle crash on highway, involving an oil tanker truck and several car, caused a fire that resulted in four deaths. Leaking gasoline and oil from the involved vehicles ignited during the collision. Explosions occurred as vehicles became involved in this chain reaction crash. There were up to eight cars and trucks involved. The tanker truck driver was found in his vehicle, as was the driver of a car pinned against the guardrail. The two other victim locations were not reported.

Adapted from Stephen G. Badger's 2006 "Catastrophic Fires of 2005," *NFPA Journal*, September/October, 63.

Connecticut vehicle fire damages highway

At roughly 10:p.m., a tanker truck carrying 12,000 gallons (54 kiloliters) of fuel oil collided with a car on an interstate highway. The ensuing fireball caused severe damage to the highway and an overpass. The fire burned out of control for several hours causing the elevated section of highway to buckle and sag. One firefighter and one civilian suffered minor injuries. Direct property damage was estimated at $11.2 million.

Adapted from Stephen G. Badger's 2005 "Large-Loss Fire Incidents of 2004 " *NFPA Journal*, November/December, 48.

Locomotive hits tank truck in Louisiana

Three people were killed after a tanker truck carrying approximately 8,000 gallons (3,283 liters) of gasoline was struck broadside by a railroad locomotive at a railroad crossing. Fuel was released and ignited. The incident was reported shortly after 10:00 a.m. on a June morning in 2004. The victims were the truck driver and two operators on the train.

Adapted from Stephen G. Badger's 2005 "Catastrophic Fires of 2004" *NFPA Journal*, September/October, 61.

Motor home and truck collision causes fatal fire in Florida

Three people died in a February 2004 fire that started after a semi-tractor trailer truck struck a motor home on a highway. The collision ignited gasoline from the motor home, and the fire spread to its interior. The victims were trapped in the motor home. The fire was reported at 12:58 p.m.

Adapted from Stephen G. Badger's 2005 "Catastrophic Fires of 2004," *NFPA Journal*, September/October, 60.

Three die in fire after North Carolina breakdown lane crash.

Around 10:30 p.m. on an August night, a vehicle in the breakdown lane was struck in the rear by another vehicle. The impact caused a leak in the fuel tank or fuel line, which ignited. The cause of the ignition is under investigation. Three people died. The occupants were trapped due to vehicle damage from the crash.

Adapted from Stephen G. Badger's 2004, "Catastrophic Multi-Death Fires of 2003" *NFPA Journal*, September/October, 73.

Oregon firefighters die in a fiery truck crash

Around 10:00 a.m. on a sunny August morning, firefighters were returning to Oregon from fighting an Idaho wildland fire when their vehicle was involved in a highway crash. Their van crossed a divided highway, crashed head on with a tractor-trailer truck, and exploded in flames. Two firefighters died of smoke inhalation and six died of traumatic injuries.

Adapted from Stephen G. Badger's 2004, "Catastrophic Multi-Death Fires of 2003" *NFPA Journal*, September/October, 72.

Florida post-crash fire kills three

Around 2:30 a.m. on a December morning, a vehicle swerved off the interstate highway and hit a tree, exploding into fire. The impact of the crash trapped three occupants in the automobile. Two of the victims were found in the front seat, the other was found in the rear.

Adapted from Robert S. McCarthy's 2001, "Catastrophic Fires of 2000," *NFPA Journal*, September/October, 80.

Eight die in fires after multi-vehicle Missouri crash

Around 1:13 on a January afternoon, truck jackknifed on an icy interstate highway causing a fiery multiple-vehicle accident. Many of the vehicles burst into flames on impact. A truck leaking hydrochloric acid may have contributed to the post-impact fires. Eight people were killed.

Adapted from Robert S. McCarthy's 2001, "Catastrophic Fires of 2000," *NFPA Journal,* September/October, 79.

Post-crash Minnesota fire causes four deaths

Around 12:30 a.m. on an October morning, an automobile collided with a refrigeration truck on a limited highway and burst into flames, trapping its occupants. The car lodged under the trailer of the truck. Four people died in the fire.

Adapted from Robert S. McCarthy's 2001, "Catastrophic Fires of 2000," *NFPA Journal,* September/October, 79.

Five children die in Arizona post-crash fire

Around 11:11 a.m. on a November morning, a head on collision between an automobile and a van carrying 18 passengers on a state highway caused the van to overturn and burst into flame. The collision pushed the van off the road where it burst into flames. Five of the victims were in the van while 13 others managed to escape. All five victims were under six years old.

Adapted from Robert S. McCarthy's 2001, "Catastrophic Fires of 2000," *NFPA Journal,* September/October, 79.

Seven die in California post-crash fire.

About 7:15 on a March evening, firefighters responded to a one vehicle crash on a paved public road. When they arrived, they found the vehicle on its top and fully involved in flames. The area of origin was the fuel line or fuel tank area. The position of the vehicle impeded escape, although a male passenger managed to escape. Seven people died in this fire. One victim was found outside and six children were trapped inside.

Adapted from Robert S. McCarthy's 2001, "Catastrophic Fires of 2000," *NFPA Journal,* September/October, 79.

Rear-end collision causes fatal Pennsylvania fire

Shortly before 1:00 on a June morning, a tractor trailer hit a van from behind. The impact broke the van's gas tank and sparks were produced when the van's suspension system hit the road and ignited the leaking fuel. Seconds after impact, the van was engulfed in flames. Five people were killed. Amazingly, a woman was able to escape through a back door and return to retrieve her 2-year-old son, who suffered fatal burns.

Adapted from Robert S. McCarthy's 2000, "1999 Catastrophic Multiple-Death Fires," *NFPA Journal*, September/October, 61.

Seven die in post-crash Nevada fire

A two-vehicle crash was reported on an interstate highway at 9:50 on a June evening. When firefighters arrived at the scene of the collision, both the car and the van were on their sides, engulfed in flames. Seven people died in the blaze. The position of the vehicles in relation to the fire prevented escape.

Adapted from Robert S. McCarthy's 2000, "1999 Catastrophic Multiple-Death Fires," *NFPA Journal*, September/October, 61.

Three die in a post-crash fire on remote Washington highway

A single-vehicle crash on a remote highway was reported at 12:42 on an August afternoon. When firefighters arrived, the vehicle was on its roof, engulfed in flames. The position of the vehicle prevented escape. Three people were killed.

Adapted from Robert S. McCarthy's 2000, "1999 Catastrophic Multiple-Death Fires," *NFPA Journal*, September/October, 61.

Five die in Michigan post-crash fire

At about 1:45 a.m. on a July morning. a sport utility vehicle on a paved public street hit a passenger car from behind, rupturing the car's fuel tank. The fuel ignited, and the resulting fire engulfed the passenger compartment, killing five occupants. The victims were a husband and wife, both 51 years old; two of their children, ages 24 and 22, and a 3-year-old grandchild.

Adapted from Kenneth J. Tremblay's 1999, "The Catastrophic Fires of 1998," *NFPA Journal*, September/October, 56.

Six die in multi-vehicle New York post-crash fire

A tractor trailer loaded with cars hit a passenger van that had stopped, with six other vehicles, in the far right travel lane on a limited access highway for a motor vehicle crash. The impact punctured and crushed the van's fuel tank, releasing gasoline, which ignited. The resulting fire spread to six other vehicles that had collided in a chain reaction when the truck hit the van. The plastic fuel tank of another vehicle also failed and released it contents, further fueling the fire. The incident was reported at 3:55 p.m. on a clear, dry, and cool March afternoon. The 71-year-old driver of the passenger van and four passengers, one age 61, one age 60, and two age 52 died. The 29-year-old operator of a third vehicle also died. All the victims died of asphyxia as a result of the post-impact fire. Collision damage prevented them from escaping from the vehicles.

Adapted from Kenneth J. Tremblay's 1999, "The Catastrophic Fires of 1998," *NFPA Journal*, September/October, 56.

Smoke inhalation kills three in Kansas post-crash fire

A half-ton pickup truck traveling on a limited access highway collided with a semi-tractor trailer around 2:35 a.m. on a December morning. The pickup truck was traveling on an icy overpass when the driver lost control and slid sideways. A semi-tractor trailer behind the pickup broad-sided it, and a post-impact fire quickly engulfed the smaller truck. The pickup truck was carrying four passengers. One escaped, but the others died of smoke inhalation.

Adapted from Kenneth J. Tremblay's and Rita F. Fahy's 1998, "Catastrophic Fires," *NFPA Journal*, September/October, 56.

Idaho highway crash causes fatal fire

Shortly before 4:30 p.m. on a clear July afternoon, a passenger vehicle and a sport utility vehicle (SUV) traveling on an undivided state highway collided head-on. The car's driver was speeding and drove onto the shoulder of the road while taking a curve. He overcorrected, swerving left, then crossed the center line and struck the SUV head-on. Fuel leaking from a ruptured fuel tank ignited, and the fire spread to both vehicles. The car's driver, who had a blood alcohol level of 0.059, died of traumatic injuries. A 40-year-old woman seated in the SUV's front passenger seat and two children, ages 12 and 13, seated in the rear died of smoke inhalation. Witnesses reported that the woman's foot was pinned and doors were jammed, preventing escape or rescue. One of the children was also conscious, but unable to escape before fire engulfed the vehicle. The woman's husband, who was driving the SUV, died of traumatic injuries.

Adapted from Kenneth J. Tremblay's and Rita F. Fahy's 1998, "Catastrophic Fires," *NFPA Journal*, September/October, 55

Head-on Oregon SUV crash causes fatal fire

Four people travelling on a limited access highway died when their SUV was struck head-on by another SUV and the ruptured fuel tank ignited. Two adults, ages 43 and 31, and two children, ages 6 and 4, died of smoke inhalation. The driver of the other vehicle died of traumatic injuries. The incident was reported at 5:42 p.m. on a March day.

Adapted from Kenneth J. Tremblay's and Rita F. Fahy's 1998, "Catastrophic Fires," *NFPA Journal*, September/October, 55

Impact with tree causes fatal Florida fire

At 11:22 p.m. on a November night firefighters were called to a fire that began when a car hit a tree on the passenger side and burst into flames. Investigators found that a rod had broken loose and ruptured the fuel tank. Gasoline leaking from the tank spilled onto the catalytic converter and ignited. The driver and two passengers were found in the front seat, and a fourth passenger was found in the back seat. Three of them, ages 15, 16, and 18, died of burns. The fourth, a 16-year-old, died of blunt force head trauma.

Adapted from Kenneth J. Tremblay's 1997, "Catastrophic Fires," *NFPA Journal*, September/October, 55.

Fatal fire starts after car goes over California embankment

Around 3:20 p.m. on a December afternoon, a car left the road and went over an embankment. The fuel tank ruptured when the car hit a rock, and leaking gasoline ignited. The fire spread from the vehicle to surrounding vegetation. The three passengers, two adults and a child, were trapped and couldn't escape the fire.

Adapted from Kenneth J. Tremblay's 1997, "Catastrophic Fires," *NFPA Journal*, September/October, 55.

Kentucky single-car crash kills three

At about 10:00 p.m. on an August evening, a car with a driver and two passengers veered off the right side a limited access highway. The driver overcorrected and veered left onto the road, only to run off the opposite side. StilI trying to correct his course, the driver veered right again and went into a skid, striking a culvert on the right side of the road. The vehicle overturned, hit a tree. landed on its roof and exploded into flames. All three passengers, ages 17, 24, and 25, died of smoke and fire injuries.

Adapted from Kenneth J. Tremblay's 1997, "Catastrophic Fires," *NFPA Journal*, September/October, 54.

Five die in Georgia post-crash fire

Around 5:30 a.m. on an April morning, a small pickup truck rear-ended a passenger car carrying five passengers on a limited-access highway. The collision ignited the car's fuel tank, trapping all five passengers. Five men, all in their 20s, died of thermal burns.

Adapted from Kenneth J. Tremblay's 1997, "Catastrophic Fires," *NFPA Journal*, September/October, 54.

Appendix C.
Highway Vehicle Fires that Did Not Follow Collisions or Overturns

This collection of previously published incidents was compiled from NFPA's studies of large-loss fires, catastrophic fires, and "Firewatch" column from NFPA Journal. It is important to remember that these descriptions provide information about what can happen, not what is typical. The following scenarios complement the statistics.

Texas bus fire kills 23 during hurricane evacuation

Shortly after 6:00 a.m. on a September morning, fire broke out in the right rear wheel well of a bus carrying 38 patients and six staff members being evacuated from a nursing home located in the predicted path of Hurricane Rita. Many of the patients were non-ambulatory. Twenty-three people died in the fire. NTSB's final report on the incident is available at http://www.ntsb.gov/Publictn/H_Acc.htm.

Adapted from Stephen G. Badger's 2006 "Catastrophic Fires of 2005," *NFPA Journal*, September/October, 63.

Gas in Water Bottle Ignites, Kills Driver, Arizona

A 25-year-old man was killed and a 32-year-old woman was severely burned when gasoline they were transporting in a 2-gallon (7.6-liter) water-cooler-type bottle inside a car ignited and fire engulfed them. Two firefighters in an apparatus two car lengths behind the vehicle saw the explosion, immediately went to help the victims, putting the fire out with water and foam.

The bottle was in the front seat on the passenger side of the car. While waiting for the light to change, one of the two victims used a cigarette lighter igniting the gasoline vapors from the container. Both victims jumped out of the burning car, which came to a stop a short distance away.

The man who was driving died of burns and smoke inhalation injuries. His passenger, whose location in the car could not be determined, sustained life-threatening injuries. The car was a total loss.

Kenneth J. Tremblay, 2005, "Firewatch," *NFPA Journal*, March/April, 28.

Fireworks explosion in Florida causes five deaths

Around 2:10 p.m. on a sunny and warm July day, workers unloaded fireworks from one truck to another. An explosion occurred in the cargo area of the truck. Five people were killed when the explosion prevented their escape. The cause is under investigation.

Adapted from Stephen G. Badger's 2004, "Catastrophic Multi-Death Fires of 2003" *NFPA Journal*, September/October, 73.

Four die in motor home fire in Nebraska

On a May afternoon, a fire broke out in the engine compartment of a motor home traveling on an interstate highway when gasoline from a rubber or plastic fuel line leak ignited. An electric fuel pump continued to operate, pumping fuel onto the fire. The vehicle was traveling at approximately 40 miles per hour (64 kilometers per hour), pushing the fire and smoke into the passenger compartment. Eight people were in the vehicle at the time. The driver escaped by jumping out of the moving vehicle. Rescuers were hindered because the rear door was jammed due to damage when the vehicle left the road and traveled through a ditch and into a pasture. Four people died.

Adapted from Stephen G. Badger's 2004, "Catastrophic Multi-Death Fires of 2003" *NFPA Journal*, September/October, 73.

Florida man burns car in murder-suicide

Around 2:00 p.m., on a December afternoon, a despondent driver set his car on fire, which involved the vehicle interior, two children and himself. The car then crashed into an occupied house. The fire was confined to the vehicle and didn't involve the house. All three occupants of the car died.

Adapted from Stephen G. Badger's 2004, "Catastrophic Multi-Death Fires of 2003" *NFPA Journal*, September/October, 73.

Tour bus fire injures two passengers, West Virginia

Two passengers, one of whom fell from an exit window, were hurt trying to escape from a burning tour bus. The bus was carrying 47 passengers, many of them older adults, when the fire occurred.

The fire started after a dragging brake caused a rear tire to ignite. The fire spread into the bus's passenger compartment and is believed to have burned for nearly seven minutes before a passerby detected it.

The fire department received a 911 call reporting the fire at 5:55 p.m. and two engine companies responded. By the time firefighters arrived, the rear of the bus was heavily involved, and several passengers were injured. The company officer sounded and additional alarm and requested several emergency medical units as fire crews used two hose lines to attack the blaze. With the help of several other agencies, a HAZMAT team contained oil and fuel runoff.

Three passengers were taken to the hospital, including an 87-year-old woman suffering from smoke inhalation and the 70-year-old woman who had fallen while exiting from the window. The bus, valued at $250,000 and its contents, valued at $50,000, were destroyed.

Kenneth J. Tremblay, 2004, "Firewatch," *NFPA Journal*, July/August, 16.

Fire strikes retail propane storage facility, Georgia

Two vehicles, including a liquid propane delivery vehicle, were involved in a fire at a retail propane filling station. The incident occurred when a hose fell off a rack and was jarred into the open position. The release of pressurized liquid propane caused the hose to whip around, hitting nearby metal components and striking a spark that ignited the leaking propane.

An employee who saw the fire start immediately called 911, and the fire department responded at 9:05 a.m. Employees tried to control the blaze with hand-held fire extinguishers, but they were ineffective.

Flames impinging on the large storage vessel caused the pressure relief valve to operate, venting more propane, which contributed to the fire. Several redundant shut-off valves were later found in the open position.

There were no reports on the dollar amount of damage, and no one was injured during the incident.

Kenneth J. Tremblay, 2000, "Firewatch," *NFPA Journal*, November/December, 14

Propane leaking from delivery truck kills one, California

Propane leaking from a delivery truck ignited and flames spread to a resort clubhouse and two 3,785- liter (1,000-gallon) propane storage tanks. When the operator of the delivery truck tried to stop the release of propane, she was caught in a vapor cloud, which ignited. She suffered burns over 80 percent of her body and later died. Four others were injured, and the complex suffered a multi-million dollar loss.

The resort included a two-story motel and a two-story clubhouse, each constructed of unprotected wood framing. The clubhouse was protected by a wet-pipe sprinkler system, as was the 20-room motel next door. Information about smoke detection equipment wasn't reported. Both buildings were occupied at the time of the fire.

A propane delivery truck was refueling the propane storage tanks in the service area between the motel and the clubhouse when a leak developed at the track near a bypass line. The truck's operator, a 38-year-old woman, was walking back to the truck when the fuel ignited and flashed back towards the vehicle.

The fire department received a 911 call reporting the fire at 2:50 p.m., and firefighters arrived 22 minutes later. By that time, the fire had spread to the delivery truck, another vehicle, the clubhouse, and the motel. The two 3,785-liter (1,000-gallon) propane tanks were also exposed to the flames, and their pressure relief valves were operating.

Using multiple companies and calling for additional resources, the incident commander divided operations into two divisions. Firefighters in the first division made an interior attack, provided ventilation, and held the fire to half of the clubhouse. Those in the second division also made an interior attack, ventilated the motel, and maintained exposure protection, cooling the propane tanks and limiting fire spread to the top floor of the motel. EMS crews attended the five burn victims, taking the most critical to the hospital by helicopter.

In all, 16 units, including 9 engine companies, helped control the fire, which was pushed along by winds over 56.33 kilometers (35 miles) per hour. Thirty sprinklers operated, helping to control the rate of fire spread. However, they couldn't control the blaze.

The propane delivery truck, valued at $50,000, and a passenger vehicle, valued at $12,000, were destroyed. The motel, valued at $2 million, suffered a property loss of $1 million; damage m its contents was estimated at $250,000. Damage to the clubhouse, valued at $2 million, was estimated at $750,000, while damage to its contents came to $250,000. Combined, the loss totaled $2.312 million. Four civilians suffered moderate to severe burns to their faces and hands. No firefighters were injured.

Kenneth J. Tremblay, 1998, “Firewatch,” *NFPA Journal,* May/June, 42.

Five vehicle occupants die at Mississippi service station fire

While a tanker truck operator was filling the service station's underground storage tanks around 1:00 a.m. on an August morning, he removed the cap from a dipping lid to speed the process, inadvertently bypassing the normal venting and overfill protections. Nearly 750 gallons of gasoline spilled onto an adjacent road, where an undetermined source ignited it. The ensuing fire engulfed three vehicles. The tanker truck and a nearby restaurant suffered radiant heat damage. The five occupants of the three vehicles died when flames engulfed them. The two male victims were 58 and 18 years old, and the three female victims were 56, 40, and 20 years old.

Adapted from Kenneth J. Tremblay's 1999, "The Catastrophic Fires of 1998," *NFPA Journal*, September/October, 55.

Transport vehicle fire kills six prisoners in Tennessee

A passenger van converted to transport prisoners in secured cages holding up to nine prisoners, a driver/guard, and another guard was traveling on an interstate highway on an April morning. A U-joint failed, releasing the drive shaft, which spun violently and struck the fuel tank, creating a 2-inch (5-centimeter) hole. Thirty-seven gallons (140 liters) of gasoline spilled out and were ignited either by the catalytic converter or by a spark from the dragging metal. Flames were visible under the vehicle before it stopped, and the passenger compartment became fully involved as the vehicle slowed. The guards escaped, but they couldn't reach the rear or side doors or unlock the two deadbolt-and-locking-hasp systems on the three cages, which held two prisoners each. One guard was injured. Six prisoners died in this fire. The incident was reported at 10:50 a.m.

Adapted from Kenneth J. Tremblay's and Rita F. Fahy's 1998, "Catastrophic Fires," *NFPA Journal*, September/October, 55

Metal in road causes fatal California fire

At roughly 8:18 p.m. on a May evening, a passenger van traveling on an undivided public street struck a large piece of metal, which punctured the vehicle's fuel tank and lodged itself under the moving vehicle. The metal scraped along the road, causing sparks that ignited leaking fuel. The driver lost control of the van, which hit a utility pole, jumped a curb, and came to rest against a tree. Flames engulfed the van once it stopped. The driver, a 30-year-old woman, escaped, but she was severely burned and later died of her injuries. Her three children, ages 10, 7, and 4, were trapped in the back of the van and died of smoke inhalation. The accident occurred at night, which made the dark-colored metal difficult to see.

Adapted from Kenneth J. Tremblay's and Rita F. Fahy's 1998, "Catastrophic Fires," *NFPA Journal*, September/October, 55

Kentucky vehicle fire was murder-suicide

A passenger vehicle parked in open field was the site of a murder-suicide that killed three in September. A 24-year-old man tried to strangle a 19-year-old woman, then doused himself, the woman, and a 5-month-old baby with gasoline. He ignited the fuel with an open-flame device and flames engulfed the interior of the car. The coroner reported that the woman was still alive when the fuel was ignited. She and the man died of smoke inhalation and burns. The vehicle was found three days after the fire. The fire department never responded since the fire extinguished itself.

Adapted from Kenneth J. Tremblay's 1997, "Catastrophic Fires," *NFPA Journal*, September/October, 55.

Fire kills two homeless men, Massachusetts

Two homeless men died when they lit a fire in a panel truck to keep warm and were overcome by carbon monoxide. The fire ignited the vehicle and spread to a nearby furniture repair shop that was closed for the night.

The vehicle was parked next to a two-story repair shop, an unprotected, wood-frame building that measured 80 by 40 feet. The structure had no sprinklers or detectors.

A police officer on rounds discovered the fire and called the fire department at 11:00 p.m.

Damage to the building was estimated at $150,000 and to its contents at $50,000. Damage to the vehicle wasn't reported.

Kenneth J. Tremblay, 1997, "Firewatch" *NFPA Journal*, September/October, 24.