

Traffic Collisions Involving Fire Trucks in the United States

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by

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16. Abstract <p>One of the more significant occupational risks of injury or death for firefighters is traffic collisions involving fire trucks. This report examines national data on fatal and nonfatal traffic accidents from the Fatality Analysis Reporting System (FARS) and the National Analysis Sampling System (NASS) General Estimates System (GES) data files maintained by the National Highway Traffic Safety Administration (NHTSA) for the three years, 1994 to 1996. Overall, there is an annual average of 2,472 fire trucks involved in police-reported accidents in the United States. These accidents result in 6 deaths to fire truck occupants, 413 fire truck occupant injuries, and a total of 1,076 injured persons involved in these accidents (including a total of 21 deaths) each year. These figures demonstrate the significant risk of traffic collisions to firefighters and the general public. This report examines the characteristics of these collisions and the consequences in terms of injuries and fatalities.</p>			
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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS					APPROXIMATE CONVERSIONS FROM SI UNITS				
Symbol	When You Know	Multiply By	To Find	Symbol	Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH					LENGTH				
in	inches	25.4	millimeters	mm	mm	millimeters	0.039	inches	in
ft	feet	0.305	meters	m	m	meters	3.28	feet	ft
yd	yards	0.914	meters	m	m	meters	1.09	yards	yd
mi	miles	1.61	kilometers	km	km	kilometers	0.621	miles	mi
AREA					AREA				
in ²	square inches	645.2	square millimeters	mm ²	mm ²	square millimeters	0.0016	square inches	in ²
ft ²	square feet	0.093	square meters	m ²	m ²	square meters	10.764	square feet	ft ²
yd ²	square yards	0.836	square meters	m ²	m ²	square meters	1.195	square yards	yd ²
ac	acres	0.405	hectares	ha	ha	hectares	2.47	acres	ac
mi ²	square miles	2.59	square kilometers	km ²	km ²	square kilometers	0.386	square miles	mi ²
VOLUME					VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL	mL	milliliters	0.034	fluid ounces	fl oz
gal	gallons	3.785	liters	L	L	liters	0.264	gallons	gal
ft ³	cubic feet	0.028	cubic meters	m ³	m ³	cubic meters	35.71	cubic feet	ft ³
yd ³	cubic yards	0.765	cubic meters	m ³	m ³	cubic meters	1.307	cubic yards	yd ³
MASS					MASS				
oz	ounces	28.35	grams	g	g	grams	0.035	ounces	oz
lb	pounds	0.454	kilograms	kg	kg	kilograms	2.202	pounds	lb
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")	Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
TEMPERATURE (exact)					TEMPERATURE (exact)				
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celcius temperature	°C	°C	Celcius temperature	1.8C + 32	Fahrenheit temperature	°F
ILLUMINATION					ILLUMINATION				
fc	foot-candles	10.76	lux	lx	lx	lux	0.0929	foot-candles	fc
fl	foot-Lamberts	3.426	candela/m ²	cd/m ²	cd/m ²	candela/m ²	0.2919	foot-Lamberts	fl
FORCE and PRESSURE or STRESS					FORCE and PRESSURE or STRESS				
lbf	poundforce	4.45	newtons	N	N	newtons	0.225	poundforce	lbf
lbf/in ²	poundforce per square inch	6.89	kilopascals	kPa	kPa	kilopascals	0.145	poundforce per square inch	lbf/in ²

* SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.

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Traffic Collisions Involving Fire Trucks in the United States

1 Introduction

Involvement in traffic collisions poses a significant risk for fire trucks due to their operation in emergency service. Available national accident data were analyzed to gather information on the number of fire trucks involved in traffic accidents nationally, and to provide a description of the characteristics of these collisions and the consequences in terms of injuries and fatalities.

Average annual estimates of the involvement of fire trucks in traffic accidents in the United States are shown in Table 1 below. Figures shown are the average of three years of data, 1994 to 1996, from the Fatality Analysis Reporting System (FARS) and the National Analysis Sampling System (NASS) General Estimates System (GES) data files maintained by the National Highway Traffic Safety Administration (NHTSA). Fire trucks included have gross vehicle weight ratings (GVWR) over 10,000 pounds. Most are class 7-8 single-unit trucks (over 26,000 lbs. GVWR).

TABLE 1
Average Annual Accident Experience
of Fire Trucks in the U.S.
FARS and GES 1994-1996

Number of Fire Trucks Involved	2,472
Fire Truck Occupant Fatalities	6
Total Fatalities	21
Fire Truck Occupant Injuries	413
Total Injured and Fatal Persons	1,076
Property Damage Only Involvements	1,882

Overall, there is an average of 2,472 fire trucks involved in police-reported accidents per year in the United States. These accidents result in 6 deaths to fire truck occupants, 413 fire truck occupant injuries, and a total of 1,076 injured persons involved in these accidents (including a total of 21 deaths) each year. These figures demonstrate the significant risk of traffic collisions to firefighters and the general public.

Yearly trends of the involvement of fire trucks in fatal accidents are shown in Figure 1. Some of the fluctuations are probably due to the small numbers. Even discounting the sharp rise from 1994 to 1996, there is still evidence of a gradual increase.

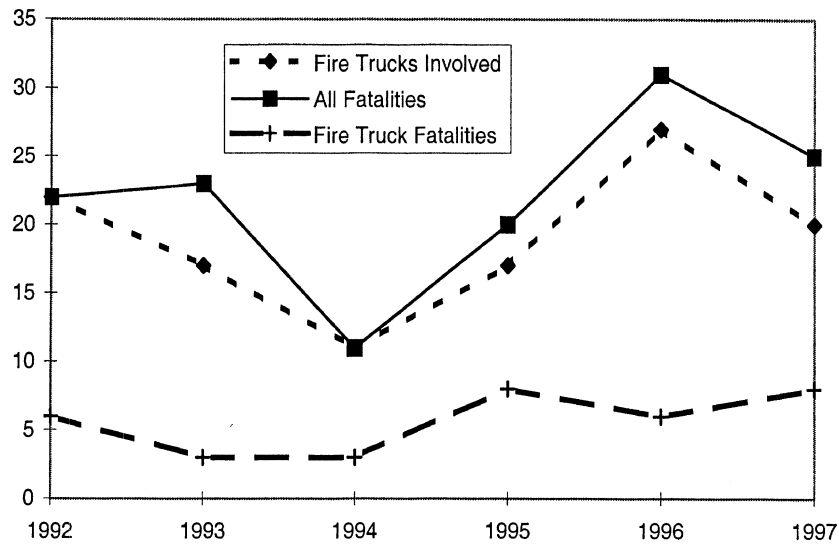


Figure 1: Fire Truck Fatal Accident Involvement by Year in the U.S. (FARS)

2 Data

Due to the very small number of fire trucks involved in accidents, three years of data, 1994 to 1996, were combined to produce the tabulations presented. Both files used are produced by the National Highway Traffic Safety Administration. Information on fatal accidents comes from the Fatality Analysis Reporting System (FARS). The FARS file is a census of all fatal accidents in the U.S. This means that there is information on every vehicle (and occupant) involved in a police-reported fatal traffic accident each year. The 1994 through 1996 FARS files contained data on 55 fire trucks and 150 occupants of fire trucks involved in fatal accidents. The file includes all vehicles and persons involved in these accidents, so the fatality may have been an occupant of the fire truck, an occupant of another involved vehicle, or a nonmotorist (pedestrian or bicyclist).

Information on nonfatal accidents is from the National Analysis Sampling System (NASS) General Estimates System (GES) data files, also maintained by NHTSA. The GES is a probability-based sample of police-reported accidents in the U.S. National estimates are obtained by multiplying the sampled vehicles and occupants by a weighting factor that is derived from the sampling probability. Sample sizes and weighted estimates of fire trucks and fire truck occupants involved in nonfatal accidents from the GES files are shown in Table 2. Data from FARS on fatal accidents and from GES on nonfatal accidents were combined to produce the estimates for all police-reported accidents (as shown in Table 1, for example). This avoids the problem of insufficient sample sizes for fatal accidents in GES.

TABLE 2
Fire Truck Sample Sizes for Nonfatal Accidents in the GES File

Year	Sample Size		Weighted National Estimates	
	Fire Trucks Involved	Fire Truck Occupants	Fire Trucks Involved	Fire Truck Occupants
1994	46	140	3,041	9,477
1995	50	134	2,075	4,211
1996	41	110	2,244	5,051
Total	137	384	7,360	18,739

3 Injury Severity

The consequences of these accidents are described by the injury severity. In Table 3, all fire trucks involved in a police-reported accident are tabulated by the most severe injury to any person in the accident*. Often the most severe injuries occur in the other vehicle. Fatal injuries occur in less than 1 percent of the accidents involving fire trucks, some degree of injury (K, A, B, or C) occurs in about 24 percent, and 76 percent result in property damage only (PDO).

TABLE 3
Number of Fire Trucks Involved by Most Severe Injury in the Accident
Average Annual Frequency
FARS and GES 1994-1996

Injury Severity	Fire Trucks Involved	
	Number	Percent
K-Fatal	18	0.7%
A-Incapacitating	108	4.4%
B-Nonincapacitating	233	9.4%
C-Possible Injury	230	9.3%
No Injury (PDO)	1,882	76.1%
Total	2,472	100.0%

Table 4 includes only the occupants of the fire truck. Overall, the fire truck occupants are about 4 times less likely to be injured than the other people involved. Only 6 out of a total of 21 fatalities were fire truck occupants. This situation is largely a result of the size and weight of fire trucks in comparison to the passenger vehicles they usually collide with. Over 90 percent of the fire truck occupants are not injured.

TABLE 4
Fire Truck Occupants by Most Severe Injury
Average Annual Frequency
FARS and GES 1994-1996

Injury Severity	Fire Truck Occupants	
	Number	Percent
K-Fatal	6	0.1%
A-Incapacitating	244	3.9%
B-Nonincapacitating	47	0.8%
C-Possible Injury	116	1.8%
No Injury (PDO)	5,883	93.4%
Total	6,296	100.0%

4 Collision Type

Fatal accidents involving fire trucks are of two distinct types. Most of the fatalities involve a collision with another (light) vehicle, often at, or related to, an intersection, and the fatalities are among the other involved parties. These collision types are based on the most harmful event for the fire truck. The first three collision types shown in Table 5, rollover, pedestrian/bicycle, and other single vehicle, are all single vehicle collisions. The last four categories are all multiple vehicle collisions. Angle collisions are the most frequent collision (47 percent) in fatal accidents involving fire trucks. Single vehicle rollovers are next most frequent. The proportion of fire truck rollovers in all fatal accidents (20 percent) is nearly double the rollover rate for all medium/heavy trucks involved in fatal accidents. Nearly all the fire truck occupant fatalities result from rollover, as shown in Table 6.

TABLE 5
Collision Type
Annual Average, FARS 1994-1996
All Fire Trucks Involved in Fatal Accidents

Collision Type	Fire Trucks	
	Involved	Percent
Rollover	3.7	20%
Pedestrian/Bicycle	0.7	4%
Other Single Vehicle	1.0	5%
Rear-end	2.3	13%
Head-on	1.3	7%
Angle	8.7	47%
Other M.V.	0.7	4%
Total	18.3	100%

If the fatality is in the truck (6 out of the 21 fatalities per year), the collision is nearly always single vehicle and the truck nearly always rolls (93 percent). There may be a tree or pole impact first, but rollover occurred in all of the single vehicle accidents in Table 6. For fire trucks, rollover is the most significant collision event affecting occupant injury.

TABLE 6
Collision Type
Annual Average, FARS 1994-1996
Fire Trucks with Occupant Fatalities

Collision Type	Fire Trucks	
	Involved	Percent
Rollover	3.7	73%
Pedestrian/Bicycle	0.0	0%
Other Single Vehicle	1.0	20%
Rear-end	0.0	0%
Head-on	0.0	0%
Angle	0.3	7%
Other M.V.	0.0	0%
Total	5.0	100%

The same collision type distribution was also tabulated for nonfatal accidents for comparison. Again, angle collisions are the most common (41 percent). Other single vehicle collisions, collisions with trees, poles, and other fixed objects, are next most frequent (34 percent). Rollover is the most harmful event in only 1 percent of nonfatal accidents. The fact that nearly all of the fire truck occupant fatalities resulted from rollover is a reflection of the high probability of injury for the occupants when the truck rolls.

TABLE 7
Collision Type
Average Annual Frequency
GES 1994-1996
All Fire Trucks in Nonfatal Accidents

Collision Type	Fire Trucks	
	Involved	Percent
Rollover	18	1%
Pedestrian/Bicycle	2	0%
Other Single Vehicle	827	34%
Rear-end	414	17%
Head-on	4	0%
Angle	998	41%
Sideswipe	189	8%
Other M.V.	1	0%
Total	2,453	100%

Intersections pose a significant risk of collision with another vehicle for fire trucks. Overall, nearly 60 percent of nonfatal collisions do not occur at an intersection, but about 40 percent are at an intersection or related to the intersection. The proportion of collisions at or near an intersection increases to 58 percent in fatal accidents, indicating the greater risk of fatality in these collisions.

TABLE 8
Relation to Intersection
Fire Trucks Involved in Nonfatal Accidents
Average Annual Frequency
GES 1994-1996

Relation to Intersection	Number	Percent
Nonjunction	1,434	58.5%
Intersection	793	32.3%
Intersection Related	135	5.5%
Driveway, Access, etc.	87	3.5%
Entrance/Exit	4	0.1%
On a Bridge	2	0.1%
Total	2,453	100.0%

Other factors were also examined. Fatal fire truck accidents predominately occurred in the daylight (50 percent) and dark, but lighted (33 percent) conditions, and very seldom in the dark (12 percent). For all medium and heavy trucks involved in fatal accidents, the percentages of dark but lighted and dark are approximately reversed with dark much more common. This difference probably reflects the urban operating environment for fire trucks.

Fire trucks are coded as using the emergency signals on the vehicle in 62 percent of the fatal accidents and 56 percent of nonfatal. This implies that a significant proportion of the accidents occur when the vehicle is not on an emergency run.

Alcohol involvement was also examined. As would be expected, alcohol use was not coded for any of the fire truck drivers but about 12 percent of the other drivers in fatal accidents with fire trucks were drunk, as compared to about 33 percent in all fatal accidents.

Vehicle fire as a result of the collision was not coded for any fire trucks.

5 Fire Truck Occupants

Most of the occupant injury detail is taken from fire trucks that were involved in a fatal accident. Using the FARS data for 1994 to 1996, 55 fire trucks were involved in fatal accidents. These fire trucks had a total of 150 occupants. The distribution of injury severity for these occupants is shown in the Table 9. Over the three years, there were 17 occupant fatalities and 54 injured occupants. Rollover occurred in 16 of the 17 fatalities.

TABLE 9
Fire Truck Occupant Injury Severity
All Fire Trucks Involved in Fatal Accidents
FARS 1994-1996

Injury Severity	Fire Truck Occupants	
	Number	Percent
K-Fatal	17	11.3%
A-Incapacitating	16	10.7%
B-Nonincapacitating	15	10.0%
C-Possible Injury	23	15.3%
No Injury (PDO)	79	52.7%
Total	150	100.0%

While front seat use is the most common, almost 30 percent of the occupants were coded in a second seat or other location. Only 3 were coded as riding on the exterior.

TABLE 10
Seat Position
All Fire Truck Occupants Involved in Fatal Accidents
FARS 1994-1996

Seat Position	Number	Percent
Front Left (driver)	54	36.0%
Front Middle	5	3.3%
Front Right	42	28.0%
Front, unk	1	0.7%
Second Left	12	8.0%
Second Middle	3	2.0%
Second Right	14	9.3%
Other Area	14	9.3%
Riding on Exterior	3	2.0%
Unknown position	2	1.3%
Total	150	100.0%

Fire truck occupant fatalities were in the following positions:

Front Left	10
Front Right	5
Second Left	1
Second Right	1
Total	17

Restraint Use. Restraint use reduces the chances of injury. Overall, 84 out of 150 occupants were restrained, 50 were coded as not restrained and 16 unknown restraint use. But 13 out of the 17 fatalities were not restrained.

Counting any injury, C, B, A, or K:

Not restrained:	35/50 injured, 70%
Restrained:	32/84 injured, 38%
Unknown restraint:	4/16 injured, 25%

Ejection. Ejection greatly increases the chance of injury and restraint use nearly eliminates ejection. There were 14 occupants ejected of the 150 occupants of fire trucks in fatal accidents. Included in the 14 are 8 of 17 fatalities. All of the ejected occupants were injured, B or greater. Eleven were total ejections and 3 were “partial,” and 11 of the 14 ejections were in rollovers. All 8 of the ejection fatalities were unrestrained. Two of the 3 nonfatal ejections were coded with lap and shoulder belts.

Extrication. Three occupants were coded as needing extrication from the vehicle. Two of these were fatalities and one was an A injury. All 3 were in rollovers. The need for extrication suggests substantial damage to the truck cab. The relatively low incidence of extrication implies that cab damage does not play a large role in fire truck occupant injury.