



ANALYSIS BRIEF

Federal Motor Carrier Safety Administration

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CRASHES INVOLVING TRUCKS CARRYING HAZARDOUS MATERIALS

Summary

Every day there are more than 800,000 shipments of hazardous materials (hazmat) in trucks—usually flammable liquids, such as gasoline, or flammable gas. About 200 hazmat trucks a year are involved in fatal crashes and 5,000 in nonfatal crashes. Although these numbers are small relative to the totals of almost 5,000 trucks involved in fatal crashes and 400,000 involved in nonfatal crashes annually, the potential for human injury and property damage in hazmat crashes is much greater.

Introduction

Crashes involving large trucks—those with a gross vehicle weight rating of more than 10,000 pounds—carrying hazardous materials (hazmat) are relatively rare. Less than 10 percent of truck shipments include hazmat as all or part of the cargo load. Less than 5 percent of large truck crashes involve trucks carrying hazmat. The possibility of a major catastrophe during the transportation of hazmat, however, results in a heightened sense of concern among the traveling public.

This Analysis Brief provides data on trucks involved in fatal and nonfatal crashes that were carrying hazmat, including: truck type, materials being transported, crash characteristics, hazmat spillage or release, and number of deaths and injuries, including those caused by exposure to hazmat in crashes. Comparisons are made between hazmat-carrying trucks involved in fatal crashes and trucks in fatal crashes that were not transporting hazardous materials.

Trucks Transporting Hazardous Materials

Every day in the United States there are more than 800,000 shipments of hazardous materials in trucks. Types of hazardous materials range from relatively innocuous products, such as hair spray and perfumes, to bulk shipments of gasoline by highway cargo tanks, to transportation of poisonous, explosive, and radioactive materials. The 1996 national fleet survey conducted by the Office of Motor Carriers (predecessor to the Federal Motor Carrier Safety Administration) found that 7.2 percent of trucks transported amounts of hazmat large enough to require a placard warning that the truck was transporting hazmat.

The 1997 Vehicle Inventory and Use Survey (VIUS)—the most recent one conducted by the U.S. Census Bureau—identified 4.7 million large trucks registered or licensed in the nation. Of these trucks, 386,000 (8.2 percent) carried hazmat sometime during the year. The VIUS estimated that more than one-half of the hazmat trucks were transporting flammable liquids, such as gasoline, diesel fuel, and fuel oil; more than one-quarter were transporting flammable gas. The 1997 Commodity Flow Survey, conducted by the U.S. Census Bureau, estimated that hazmat accounted for 11 percent of all tons transported by trucks, and 7 percent of truck ton-miles of freight.

Crash Data

The primary crash data source for this brief is the Trucks Involved in Fatal Accidents (TIFA) file, compiled by the Center for National Truck Statistics at the University of Michigan Transportation Research Institute (UMTRI). The TIFA file is based on the National Highway Traffic Safety Administration's (NHTSA) Fatality Analysis Reporting System (FARS) file. TIFA

supplements FARS by providing a careful identification of all large trucks involved in fatal crashes, along with a detailed description of the physical configuration of the truck, including weight and length, cargo body style, cargo, and cargo spillage.

Two sources provided additional data on nonfatal crashes for this brief: the National Automotive Sampling System's General Estimates System (GES) file, produced by NHTSA, and the Motor Carrier Management Information System (MCMIS) Crash File, produced by the Federal Motor Carrier Safety Administration (FMCSA). The GES file is a nationally representative sample of all police-reported crashes. The MCMIS Crash File contains State-reported data on all trucks (defined as a cargo-carrying vehicle with at least two axles and six tires on the ground) involved in a crash that resulted in a fatality, injury, or at least one vehicle towed from the crash scene due to disabling damage sustained in the crash.

While both GES and the MCMIS Crash File have data on fatal crashes, TIFA is a more reliable source for fatal data. GES and the MCMIS Crash File will be used here for data on nonfatal crashes. A major difference between these two files in the nonfatal area is that GES includes data on all property-damage-only (PDO) crashes, while MCMIS contains data on only those PDO crashes that involve a towaway—a small percentage of all PDO crashes.

Results

Crashes involving trucks carrying hazardous materials are examined from four perspectives: the number of trucks involved compared to non-hazmat-carrying trucks; differences between hazmat-carrying trucks and other trucks; spillage or release of hazmat; and persons killed and injured.

Number of Trucks Carrying Hazmat

The number of large trucks carrying hazmat that were involved in fatal traffic crashes averaged 225 per year from 1980 through 1990. Since 1991, the annual average has dropped to 203 trucks, with the number varying between 175 and 229 a year (Table 1). From 1991 through 2000 there were 48,229 large trucks involved in fatal crashes, but only 2,032 (4.2 percent) of them were carrying hazardous materials. Trucks transporting hazmat accounted for 3.9 to 4.8 percent of annual fatal large truck crash involvements in the 10-year period.

Large trucks carrying hazmat were involved in about 6,000 nonfatal crashes a year from 1996 through 2000, according to GES. These trucks represented only 1.7 percent of the total large trucks involved in nonfatal crashes in those years. In the MCMIS Crash File, the number of trucks

carrying hazmat involved in nonfatal crashes averaged 4,286 a year from 1996 through 2000, accounting for 4.4 percent of the trucks involved in nonfatal crashes in the 5-year period.

In summary, less than 5 percent of the trucks involved in fatal and nonfatal traffic crashes each year were carrying hazardous materials. This relatively small percentage has remained fairly constant over the past two decades.

Hazmat Trucks: Differences and Similarities

Most of the truck-type and crash-event differences between trucks carrying hazardous materials and trucks not carrying hazmat cargoes can be attributed to the type of cargo. As noted above, the latest VIUS survey estimated that one-half of hazmat truck shipments are flammable liquids. A 2001 Battelle report to FMCSA found that Class 3 hazmat (flammable liquids) accounted for 64 percent of hazmat crashes where cargo was released during the crash.

From 1991 through 2000, flammable liquids accounted for almost one-half of hazmat cargoes in trucks involved in fatal crashes, according to TIFA. Gasoline was the hazmat being transported in one-half of those trucks. In the MCMIS Crash File, more than 45 percent of identified hazmat transported in trucks involved in nonfatal crashes from 1996 through 2000 was flammable liquids. Gasoline accounted for most of the cargoes.

The following differences between hazmat trucks and non-hazmat trucks involved in crashes in 1996 through 2000 can be partly explained by the characteristics of the flammable liquids being transported:

- Of the large trucks carrying hazmat in fatal crashes, 67 percent had cargo tank bodies. Only 5 percent of large trucks carrying

Table 1

Involvement of Large Trucks Carrying Hazmat in Fatal Crashes, 1991-2000

Year	Large Trucks in Fatal Crashes		
	Total	Carrying Hazmat Cargo	Percent Carrying Hazmat Cargo
1991	4,404	198	4.5
1992	4,175	202	4.8
1993	4,451	175	3.9
1994	4,795	212	4.4
1995	4,631	180	3.9
1996	5,007	229	4.6
1997	5,130	202	3.9
1998	5,198	222	4.3
1999	5,233	197	3.8
2000	5,275	215	4.1
Annual Average	4,830	203	4.2

Source: Trucks Involved in Fatal Accidents (TIFA), 1991-2000.

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non-hazmat had cargo tank bodies. By contrast, only 21 percent of hazmat trucks in fatal crashes had van cargo bodies, while 44 percent of non-hazmat trucks had van bodies.

- In nonfatal crashes, 69 percent of the trucks carrying hazmat had cargo tank bodies, as opposed to only 4 percent of the trucks carrying other cargo.
- Rollover was the first harmful event in 12 percent of hazmat-carrying trucks involved in fatal crashes, but was the first harmful event in only 4 percent of non-hazmat-carrying trucks. More than one-third of hazmat trucks rolled over as part of the fatal crash, as opposed to only 12 percent of non-hazmat-carrying trucks.
- The most common first harmful event in fatal truck crashes is a collision with another vehicle in transport. For hazmat-carrying trucks, 69 percent of the first harmful events were collision with another motor vehicle, while the number for non-hazmat-carrying trucks was 79 percent.
- Fire was present in 14 percent of the hazmat trucks involved in fatal crashes, but present in only 4 percent of trucks carrying other cargo.

Crashes involving trucks carrying hazardous materials in the 1996 through 2000 period, however, are similar to those involving other trucks in many ways, including the following:

- In fatal crashes 65 percent of trucks carrying hazmat and 60 percent of those carrying other freight were tractors pulling a semi-trailer. In nonfatal crashes about 50 percent of both hazmat-carrying and non-hazmat-carrying trucks were tractor semi-trailer combinations.
- Rural highways were the location of the fatal crashes for 71 percent of trucks carrying hazmat and 67 percent of those carrying other cargoes or no cargo.
- Rural highways with roads marked by U.S. route designations were the scene of 44 percent of hazmat trucks involved in fatal crashes, and 42 percent of non-hazmat-carrying trucks in fatal crashes.
- Interstate for-hire motor carriers operated 48 percent of the hazmat-carrying trucks involved in fatal crashes and the same percentage of non-hazmat trucks involved in fatal crashes.

Cargo Release

The unique highway safety concern involving trucks carrying hazmat is the release of cargo that can cause injury or death to those who may come in contact with the hazmat. Any heavy non-hazardous cargo, such as steel coils, can cause serious injury if spilled or released during a crash, but hazmat creates an additional risk of exposure to explosions, fire, or inhaling toxic fumes.

There were 636 hazardous materials cargo releases in fatal truck crashes from 1991 through 2000 (Table 2), an average of 64 per year. During the same 10 years there were 6,246 releases of non-hazardous cargoes (Table 2), an average of 625 a year. Though the number of hazmat spills in fatal truck crashes is small, the probability of a spill is 50 percent higher than that for non-hazmat cargoes—31 percent of hazmat cargoes spilled from the cargo compartment in an average year, as opposed to 21 percent of the non-hazmat cargoes. The release of hazmat cargo from trucks involved in fatal crashes varied from 24 percent to 38 percent in 1991 through 2000. The spillage rate of non-hazardous cargoes in fatal crashes for 1991 through 2000 varied from 18 to 22 percent a year.

Part of the difference in spill rate in fatal crashes between hazmat and non-hazmat cargoes is due to different distributions of body type. As noted above, two-thirds of hazmat cargoes are transported in tank bodies, while tank trucks account for less than 10 percent of non-hazmat cargoes. Table 3 presents spill rates for the three most common cargo body types for hazmat and non-hazmat cargo.

For cargo tank body types, 35.7 percent of hazmat cargoes in tanks involved in fatal crashes spilled during the 10-year period from 1991 through 2000, compared with a release of 25.7 percent of non-hazmat cargoes carried in tanks, a difference of

Table 2

Cargo Releases in Large Truck Fatal Crashes, 1991-2000

Year	Hazmat Cargo		Non-Hazmat Cargo	
	Number of Releases	Percent of Trucks	Number of Releases	Percent of Trucks
1991	58	29.3	588	21.2
1992	59	29.2	558	21.6
1993	53	30.3	595	21.5
1994	62	29.3	598	19.7
1995	44	24.4	593	20.6
1996	69	30.1	626	20.4
1997	70	34.7	542	17.9
1998	85	38.3	693	22.7
1999	60	30.1	723	22.2
2000	76	35.4	730	21.9
Annual Average	64	31.2	625	20.9

Source: Trucks Involved in Fatal Accidents (TIFA), 1991-2000.

Table 3

Cargo Spills in Fatal Crashes by Truck Cargo Body Type, 1991-2000

Cargo Body	Hazmat Cargo			Non-Hazmat Cargo		
	Cargo Loads	Number of Spills	Percent Spilled	Cargo Loads	Number of Spills	Percent Spilled
Tank	1,370	489	35.7	1,265	325	25.7
Van	428	82	19.2	15,025	1,848	12.3
Flatbed	121	35	28.9	5,208	1,690	32.5

Source: Trucks Involved in Fatal Accidents (TIFA), 1991-2000.

10 percentage points. For vans, the situation is similar at a much lower spill rate, with 19.2 percent of hazmat cargoes carried in vans involved in fatal crashes released, compared to 12.3 percent of non-hazmat van cargoes. For flatbeds, the percentage of cargoes spilled in fatal crashes is 3.6 percent higher for non-hazmat cargo.

Cargo tanks, with a spill rate of 35.7 percent for hazmat cargoes, are the most common body type for hazmat transfer, and thus they are responsible for pushing the overall hazmat release rate to 31.2 percent. Vans predominate in the non-hazmat transportation sector, and the low 12-percent spill rate for non-hazmat transporting vans is responsible for keeping the non-hazmat release rate to 20.9 percent.

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Fatalities in Hazmat Truck Crashes

Only a small percentage of fatalities in large truck crashes result from the involvement of a truck carrying hazardous materials. An even smaller number result from contact or exposure to the hazmat cargo. From 1991 through 2000, there were 53,021 people killed in crashes involving at least one large truck. Of these, 2,381 (4.5 percent) died in crashes involving a truck carrying hazmat (Table 4). The highest number killed in a year was 277 in 1998, and the lowest was 200 in 1993.

There are no definitive data on the exact number of fatalities in crashes involving trucks carrying hazmat that were the result of contact with the hazardous materials released from the cargo compartment, but the magnitude of the problem can be estimated. From 1991 through 2000 the TIFA file identified 820 people killed in crashes where

there was spillage of cargo from a truck carrying hazardous materials—an average of 73 a year (Table 5). Thus, only 34.4 percent of the deaths in hazmat crashes took place in crashes where some hazardous materials were released from a truck.

The Research and Special Programs Administration (RSPA) of the U.S. Department of Transportation collects crash data from all transportation modes that transport hazardous materials. Two caveats must be kept in mind when using the RSPA data. First, approximately one-quarter of all hazmat trucks in fatal crashes are operated by intrastate motor carriers, and RSPA collects reports only from interstate carriers. Second, the data are based on carrier self-reporting, so it is possible that some fatal hazmat crashes are not reported.

Given these caveats, the data are still instructive. From 1991 through 2000, only 117 people died as a

Table 4

Fatalities in Crashes Involving Large Trucks, 1991-2000

Year	Total Fatalities	Fatalities in Crashes with Hazmat Cargo	Percent with Hazmat Cargo
1991	4,974	230	4.6
1992	4,767	245	5.1
1993	4,981	200	4.0
1994	5,306	238	4.5
1995	5,091	209	4.1
1996	5,395	273	5.1
1997	5,615	228	4.1
1998	5,629	277	4.9
1999	5,696	232	4.1
2000	5,567	249	4.5
Annual Average	5,302	238	4.5

Source: Trucks Involved in Fatal Accidents (TIFA), 1991-2000.

Table 5

Fatalities in Crashes Involving Hazmat-Carrying Trucks, 1991-2000

Year	Total Fatalities	Fatalities in Crashes with Cargo Spills	Percent with Cargo Spills
1991	230	73	31.7
1992	245	75	30.6
1993	200	68	34.0
1994	238	62	26.1
1995	209	45	21.5
1996	273	71	26.0
1997	228	77	33.8
1998	277	107	38.6
1999	232	70	30.2
2000	249	82	32.9
Annual Average	238	73	34.4

Source: Trucks Involved in Fatal Accidents (TIFA), 1991-2000.

result of exposure to hazmat cargo releases during crashes involving a truck, an average of 12 a year. A large majority of these deaths occurred as a result of contact with spilled gasoline, the most common hazmat commodity transported by truck. The 117 people killed represent only 16 percent of the total 730 deaths in hazmat-release crashes.

Deaths in crashes involving hazmat-carrying trucks are due primarily to the same factors that cause death in crashes involving other large trucks. These include: the force of the collision between a large truck (usually a tractor pulling semi-trailer) and a much smaller passenger vehicle or vehicles; trucks hitting fixed objects; trucks hitting pedestrians; and other factors not related to the hazmat transported. As noted above, more than two-thirds of the first harmful events in fatal crashes involving trucks carrying hazmat were collisions with another vehicle in transport.

Injuries in Hazmat Truck Crashes

GES provides an approximation of the annual number of crash involvements for hazmat-carrying trucks, along with information about crash severity. Since GES is a sample file, estimates are subject to sampling error. These errors can be large with regard to trucks, because trucks are a relatively small percentage of total vehicular traffic. Trucks carrying hazmat are an even smaller percentage of total traffic.

From 1996 through 2000, GES estimated 2,000 trucks a year carrying hazmat cargo were involved in injury crashes, or approximately 2 percent of all trucks involved in injury crashes. About 4,000 hazmat-carrying trucks are involved in property-damage-only crashes each year, about 1 percent of the total annual large truck PDO crashes.

The MCMIS Crash File was established to be a census of all large trucks involved in fatal, injury,

or towaway crashes. It fails to be a complete census, however, because some States do not send reports of all crashes to FMCSA. The coverage of the MCMIS file is somewhat different from the coverage of the GES file, in that the GES file includes all police-reported crashes and the MCMIS file reporting threshold is fatality, an injured person transported for immediate medical attention, or disabling vehicle damage. For the years 1996 through 2000, the MCMIS file indicates that there were 9,262 hazmat-carrying trucks involved in injury crashes, or an average of 1,852 a year, which is close to the GES number. There were 12,169 trucks involved in property-damage-only crashes that resulted in towaways, or an average of 2,433 a year.

RSPA data provide the only count of injuries in truck crashes that result from direct exposure to hazmat releases in highway crashes. For the 10 years of 1991 through 2000, there was an average of 89 such injuries per year. To put the injury number in perspective, according to GES, there was an average of 128,000 people a year injured in crashes involving large trucks during this 10-year period. As noted above, RSPA data may be significantly understated.

Conclusions and Comments

The threat to the public of death or injury due to the normal transportation of hazardous materials by large trucks is minor. Of the 412,558 people killed on the nation's highways in the years from 1991 through 2000, only 730 died in large truck crashes involving a spill of hazardous materials—0.2 percent of the total fatalities. Data from RSPA attribute only 117 of the deaths to exposure to hazardous materials during the crash—only 0.03 percent of the total fatalities. Furthermore, RSPA

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attributes fewer than 100 injuries each year to exposure to hazmat in highway crashes, less than 0.1 percent of all injuries in large truck crashes.

The low number of fatalities reflects the small percentage of trucks that carry hazardous materials involved in crashes. UMTRI's TIFA file shows that only 4 percent of all trucks involved in fatal crashes are carrying hazmat. NHTSA's GES concludes that only 1.7 percent of trucks involved in injury and property-damage-only crashes are carrying hazmat. The MCMIS Crash File shows that fewer than 4 percent of large trucks involved in nonfatal crashes carry hazmat.

Hazmat crashes, fatalities, and injuries are low relative to the amount of hazmat that moves on the highway. The U.S. Census Bureau estimates that 11 percent of all freight transported by trucks is hazmat and 7 percent of all truck ton-miles of freight is hazmat, and the U.S.

Department of Transportation estimates that 7 percent of all trucks are carrying hazmat. Motor carriers that transport hazardous materials, their drivers, and the Federal, State, and local government agencies that regulate the transportation of hazmat can take satisfaction in the fact that hazmat crashes are under-represented in the overall crash picture.

Despite these data, the transportation of hazardous materials by truck imposes significant costs on the transportation system. According to the 2001 Battelle report to FMCSA, highway crashes involving hazmat shipments have a societal cost impact of slightly more than \$1 billion a year. Furthermore, a single crash of a truck transporting hazmat in a crowded area has the potential for deaths and injuries far beyond that of a truck carrying non-hazmat cargo. Extensive property damage and economic and personal disruption from immobilizing traffic and/or evacuation of homes and businesses is not uncommon in hazmat crashes. In this light, the finding that liquid hazardous materials are more likely than liquid non-hazardous cargo to be spilled or released as the result of a highway crash is of great concern. FMCSA recognizes the potential for severe hazardous materials highway crashes and has increased its emphasis on safety programs in this area over the past 3 years.

The goal of the Federal Motor Carrier Safety Administration (FMCSA) is to reduce the number and severity of large truck-involved crashes through more commercial motor vehicle and operator inspections and compliance reviews, stronger enforcement measures against violators, expedited completion of rulemaking proceedings, scientifically sound research, and effective CDL testing, recordkeeping, and sanctions.

The Office of Information Management develops and maintains systems for collecting and analyzing motor carrier data, and disseminates information on the motor carrier industry.

This Analysis Brief was produced by the Analysis Division in FMCSA's Office of Information Management. The division analyzes motor carrier data pertaining to crashes, inspections, compliance reviews, and drug and alcohol testing, and supports research on the effectiveness of FMCSA inspections and compliance review programs.

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