



U.S. Department of Transportation
Federal Motor Carrier Safety Administration

The Large Truck Crash Causation Study

ANALYSIS DIVISION

FEDERAL MOTOR CARRIER SAFETY ADMINISTRATION

U.S. DEPARTMENT OF TRANSPORTATION





The Federal Motor Carrier Safety Administration (FMCSA) and the National Highway Traffic Safety Administration (NHTSA) conducted the Large Truck Crash Causation Study (LTCCS) to examine the reasons for serious crashes involving large trucks (trucks with a gross vehicle weight rating over 10,000 pounds). From the 120,000 large truck crashes that occurred between April 2001 and December 2003, a nationally representative sample was selected. Each crash in the LTCCS sample involved at least one large truck and resulted in a fatality or injury.

The total LTCCS sample of 963 crashes involved 1,123 large trucks and 959 motor vehicles that were not large trucks. The 963 crashes resulted in 249 fatalities and 1,654 injuries. Of the 1,123 large trucks in the sample, 77 percent were tractors pulling a single semi-trailer, and 5 percent were trucks carrying hazardous materials. Of the 963 crashes in the sample, 73 percent involved a large truck colliding with at least one other vehicle.

DEFINING CAUSATION

Motor vehicle crashes are complex events. Usually they involve two or more vehicles. Elements that influence the occurrence of a crash may take place hours, days, or months before the crash. They include driver training and experience, vehicle design and manufacture, highway condition and traffic signaling, and weather conditions. Other elements may take place immediately before a crash, such as a decision to turn in traffic, a tire

blowout, or snow. Crash reconstruction experts rarely conclude that crashes are the result of a single factor.

Fatigue, drinking alcohol, and speeding are major factors in motor vehicle crashes overall. Although their presence does not always result in a crash, these three factors, as well as other driver, vehicle, and environmental factors, can increase the risk that a crash will occur. In the LTCCS, “causation” is defined in terms of the factors that are most likely to increase the risk that large trucks will be involved in serious crashes.

DATA COLLECTION

Data for the 963 crashes in the LTCCS sample were collected at 24 sites in 17 States. A crash researcher and a State truck inspector traveled to each crash site as soon as possible after the crash occurred. The researchers collected crash scene data through interviews with drivers, passengers, and witnesses, and the inspectors conducted thorough inspections of the trucks, the drivers’ logbooks, and other documentation. After leaving the crash scene, the researchers collected additional data through interviews with motor carriers and, when the actual drivers could not be interviewed, surrogate drivers. The researchers also reviewed police crash reports, hospital records, and coroners’ reports and revisited the crash scenes.

For each crash, data were collected on up to 1,000 elements, including the condition of the truck driver

and the other drivers involved before the crash; the drivers' behavior during the crash; the condition of the trucks and other vehicles; roadway factors; and weather conditions. Data were coded by crash experts, difficult cases were reviewed by FMCSA and NHTSA staff, and completed cases were put into a publicly available electronic database on FMCSA's Web site.

NATIONAL CRASH ESTIMATES

According to NHTSA's estimate, there were approximately 120,000 fatal and injury crashes nationwide during the 33-month study period that involved at least one large truck; 141,000 large trucks were involved in those crashes. Each of the 963 LTCCS study cases was assigned a sampling weight, which allows for national estimates of total fatal and injury truck crashes during the study period.

All study results presented here are national estimates for the 141,000 large trucks that were estimated by NHTSA to have been involved in fatal and injury crashes during the study period. The estimates may differ from true values, because they are based on a probability sample of crashes and not a census of all crashes. The size of the difference may vary, depending on which LTCCS sample is the focus of a particular table or analysis.

CODING CRASH CAUSATION VARIABLES

Many variables were coded from the hundreds of data elements collected on each crash. Three key variables were coded for assessing crash risk:

- **Critical Event:** The action or event that put the vehicle or vehicles on a course that made the collision unavoidable. The critical event is

assigned to the vehicle that took the action that made the crash inevitable.

- **Critical Reason:** The immediate reason for the critical event (i.e., the failure leading to the critical event). The critical reason is assigned to the vehicle coded with the critical event in the crash. It can be coded as a driver error, vehicle failure, or environmental condition (roadway or weather).
- **Associated Factors:** The person, vehicle, and environmental conditions present at the time of the crash. No judgment is made as to whether any factor is related to the reason for a particular crash, just whether the factor was present. The list of the many factors that can be coded provides enough information to describe the circumstances of the crash.

CRITICAL EVENTS

Three major types of critical events were assigned to large trucks:

- Running out of the travel lane, either into another lane or off the road (32 percent of the large trucks in the LTCCS sample were assigned this critical event)
- Vehicle loss of control due to traveling too fast for conditions, cargo shift, vehicle systems failure, poor road conditions, or other reasons (29 percent)
- Colliding with the rear end of another vehicle in the truck's travel lane (22 percent).

CRITICAL REASONS

The percentage of large trucks coded with a critical reason depends on the type of crash:

- Of the large trucks involved in *all* LTCCS crashes (single-vehicle and multi-vehicle), 55 percent were assigned the critical reason in crashes.
- Of the large trucks involved in *two-vehicle* LTCCS crashes between one truck and one passenger vehicle (a car, van, pickup truck, or sport utility vehicle), 44 percent were assigned the critical reason.

Table 1 shows the critical reasons assigned, by major categories.

Driver critical reasons are coded in four categories:

- **Non-Performance:** The driver fell asleep, was disabled by a heart attack or seizure, or was physically impaired for another reason.
- **Recognition:** The driver was inattentive, was distracted by something inside or outside the vehicle, or failed to observe the situation adequately for some other reason.
- **Decision:** For example, the driver was driving too fast for conditions, misjudged the speed of other vehicles, or followed other vehicles too closely.
- **Performance:** For example, the driver panicked, overcompensated, or exercised poor directional control.

Vehicle critical reasons include brake failure, flat tires, cargo shift, and vehicle defects. Environmental reasons include adverse weather conditions, roadway defects, and interruptions of traffic flow.

ASSOCIATED FACTORS

Hundreds of associated factors were collected for each vehicle in each crash. In descending order, the top 10 factors coded for large trucks and their drivers were:

- Brake problems
- Traffic flow interruption (congestion, previous crash)

- Prescription drug use
- Traveling too fast for conditions
- Unfamiliarity with roadway
- Roadway problems
- Required to stop before crash (traffic control device, crosswalk)
- Over-the-counter drug use
- Inadequate surveillance
- Fatigue.

RELATIVE RISK

Relative risk analysis of the data on associated factors, using the critical event and critical reason coding, allows the sorting out of factors into those merely present at the time of the crash and those that increase the risk of having a crash. The trucks involved in LTCCS crashes can be divided into two groups: those that were assigned the critical event and critical reason and those that were not. When the presence of associated factors coded to the two groups is compared, the relative risk of each factor can be assessed, as the following examples illustrate:

- If 30 percent of the trucks assigned the critical reason for a crash were coded with the driver associated factor “traveling too fast for conditions,” while only 5 percent of the trucks that were *not* assigned the critical reason were coded with the same associated factor, it can be concluded that speed is a factor that increases the risk of being involved in a crash.
- If 30 percent of the trucks assigned the critical reason for a crash were coded with the driver associated factor “prescription drug use,” while 30 percent of the trucks that were *not* assigned the critical reason were also coded with the same associated factor, it can be concluded that prescription drug use is not a factor that increases the risk of being involved in a crash.

TABLE 1**ESTIMATED NUMBERS OF TRUCKS IN ALL CRASHES, BY CRITICAL REASONS**

CRITICAL REASONS	NUMBER OF TRUCKS	PERCENT OF TOTAL
Driver	68,000	87%
Non-Performance	9,000	12%
Recognition	22,000	28%
Decision	30,000	38%
Performance	7,000	9%
Vehicle	8,000	10%
Environment	2,000	3%
Total Number of Large Trucks Coded with Critical Reason	78,000	100%
Total Number of Large Trucks Not Coded with Critical Reason	63,000	
Total Number of Large Trucks Involved in Crashes	141,000	

Notes: Results shown are national estimates for the 141,000 large trucks estimated to have been involved in fatal and injury crashes during the study period. The estimates may differ from true values, because they are based on a probability sample of crashes and not a census of all crashes. Estimates are rounded to the nearest 1,000 large trucks.



Table 2 shows the 19 associated factors that were coded most frequently for large trucks in the LTCCS, *where there was a statistically significant association between the factor and the assignment of the critical reason*. The order of the factors in the table is based on the number and percentage of trucks assessed with each factor. The relative risk number is a ratio of the critical reason coding for trucks coded with the factor, compared with trucks not coded with the factor. Thus, Table 2 shows that a truck with brake problems was 170 percent more likely to be coded with the critical reason for a crash than a truck that was not coded with the brake problems associated factor.

Of the top 10 associated factors coded for large trucks, 3 do not appear in Table 2. For those three associated factors—traffic flow interruption, prescription drug use, and required to stop before crash—there was no significant difference in the frequency at which trucks with and without the factors were coded with the critical reason for a crash.

It is important to note both the number of times an associated factor is coded and its relative risk ratio. For example, the brake problems associated factor is the most frequently coded (29 percent), but it has a lower relative risk ratio than those for 13 other factors. Pre-crash cargo shift, with the highest relative risk ratio (56.3), was reported for only 4 percent of the large trucks involved in LTCCS crashes.

Of the 19 factors listed in Table 2, 15 are driver factors. Those 15 driver factors can be divided into two major groups. One group—fatigue, illness, and drug use (both legal and illegal)—reflects the condition of the driver before the crash. The other group—excessive speed, inadequate surveillance, illegal maneuver, inattention, distraction (outside the truck and inside the truck), and following too close—reflects driving mistakes.

LARGE TRUCK – PASSENGER VEHICLE CRASHES

One-half of the LTCCS crashes involved collisions between a large truck and a passenger vehicle (car, pickup truck, van, or sport utility vehicle). In those crashes, the same associated factors coded most often for the large trucks usually were also coded most often for the passenger vehicles. For both large trucks and passenger vehicles, there was a statistically significant link between the following 10 associated factors (listed in descending order according to how often they were coded for the large truck) and coding of the critical reason:

1. Interruption of the traffic flow
2. Unfamiliarity with roadway
3. Inadequate surveillance
4. Driving too fast for conditions
5. Illegal maneuver
6. Inattention
7. Fatigue
8. Illness
9. False assumption of other road user's actions
10. Distraction by object or person inside the vehicle.

There are some important differences in the coding of associated factors between the two vehicle types. For large trucks, but not passenger vehicles, following too closely (a traffic situation that required a stop before the crash) and distraction outside the vehicle were statistically related to assignment of the critical reason. In addition, vehicle factors that were not coded or examined for the passenger vehicles (brakes, tires, jackknife, and cargo shift) were statistically linked to assignment of the critical reason for large trucks.

For passenger vehicles, but not for trucks, alcohol and illegal drug use have a statistically significant association with coding of the critical reason. These factors, combined with fatigue (coded twice as often for passenger vehicles as for large trucks) and illness (coded five times more often for passenger vehicles), show that passenger vehicle drivers were subject to adverse physical conditions more often than truck drivers were before the crashes occurred.

TABLE 2**ASSOCIATED FACTORS ASSIGNED IN LARGE TRUCK CRASHES AND THEIR RELATIVE RISK IMPORTANCE**

FACTORS	NUMBER OF TRUCKS	PERCENT OF TOTAL	RELATIVE RISK
Vehicle: Brake problems	41,000	29%	2.7
Driver: Traveling too fast for conditions	32,000	23%	7.7
Driver: Unfamiliar with roadway	31,000	22%	2.0
Environment: Roadway problems	29,000	20%	1.5
Driver: Over-the-counterdrug use	25,000	17%	1.3
Driver: Inadequate surveillance	20,000	14%	9.3
Driver: Fatigue	18,000	13%	8.0
Driver: Felt under work pressure from carrier	16,000	10%	4.7
Driver: Made illegal maneuver	13,000	9%	26.4
Driver: inattention	12,000	9%	17.1
Driver: External distraction	11,000	8%	5.1
Vehicle: Tire problems	8,000	6%	2.5
Driver: Following too close	7,000	5%	22.6
Driver: Jackknife	7,000	5%	4.7
Vehicle: Cargo shift	6,000	4%	56.3
Driver: Illness	4,000	3%	34.0
Driver: Internal Distraction	3,000	2%	5.8
Driver: Illegal Drugs	3,000	2%	1.8
Driver: Alcohol	1,000	1%	5.3

Notes: Results shown are national estimates for the 141,000 large trucks estimated to have been involved in fatal and injury crashes during the study period. The estimates may differ from true values, because they are based on a probability sample of crashes and not a census of all crashes. Estimates are rounded to the nearest 1,000 large trucks.

STUDY AND DATA ON FMCSA'S WEB SITE

More information on the Large Truck Crash Causation Study can be accessed from the LTCCS home page on FMCSA's Web site, at www.fmcsa.dot.gov/about/news/news-releases/2006/ltrccs-digest.htm. The LTCCS home page includes links to a downloadable version of the public database; users manual; codebook; 20 sample data tables; Report to Congress; LTCCS Analysis Series reports on the study methodology and on the use of the study data for statistical analyses of crash risk; and an overview presentation (PowerPoint) of the study results. For answers to specific questions, call the FMCSA Analysis Division at (202) 366-4039.