

Rear-End Large Truck Crashes

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Each year about 400,000 trucks are involved in motor vehicle crashes. Eighteen percent of the trucks are involved in rear-end crashes. For this analysis, rear-end crashes were divided between those where the truck is the striking vehicle and those where the truck is struck by another vehicle. These two crash types are very different.

Many factors can affect the risk and results of rear-end crashes. Trucks can be 40 or more times heavier than the other vehicles in the traffic stream. They are less maneuverable, start more slowly, and take longer to stop. Truck drivers usually sit up much higher than passenger vehicle drivers, so the truck driver can see much further down the road. In addition, trucks are used almost exclusively in a work setting as part of a job. These factors affect the risk and results of rear-end crashes.

Data

This analysis is based on three data set files, which are:

- Trucks Involved in Fatal Accidents (TIFA) from the University of Michigan Transportation Research Institute
- General Estimates System (GES) from the National Highway Transportation Safety Administration (NHTSA)
- Fatal Accident Complaint Team (FACT) from the Michigan State Police Motor Carrier Enforcement Division

The TIFA file is based on a survey of large trucks (gross vehicle weight rating of more than 10,000 pounds) involved in fatal traffic crashes. TIFA starts with large truck crash cases from NHTSA's Fatality Analysis Reporting System (FARS) file. A telephone survey supplements FARS data with extensive physical detail about the configuration of the truck at the time of the fatal crash. The crash type variable used in this analysis is part of the TIFA telephone survey. The driver-related factors used in this analysis are based on data recorded by FARS analysts in each state.

The GES file is a nationally representative sample of police-reported traffic crashes. An extensive list of data elements is coded from the sampled police reports and no additional data are collected. Weights are calculated to provide statistically valid national estimates of crashes. Analytical files for this project were constructed from both the TIFA and GES files, covering 1994 through 1999. TIFA was used to provide estimates for truck crashes in which a fatality occurred. GES was used to provide estimates of non-fatal crashes. Estimates from the two files are combined to provide estimates for all truck crash severities.

The FACT project involved investigating fatal commercial vehicle crashes that occurred in Michigan from 1996 to 2001 to determine why the crashes occurred. The investigation covered many items, including truck configuration, crash events, truck driver and carrier information, and crash related factors. Finally, each truck was subjected to a North American Standard Level 1 inspection evaluating compliance with motor vehicle and driver regulations prior to the crash.

Crashes used in this analysis are classified into three types:

1. Truck strikes other vehicle
Rear-end crashes where the first harmful event was a large truck **striking** another vehicle
2. Truck struck by other vehicle
Rear-end crashes where the first harmful event was a large truck **struck** by another vehicle
3. Other crashes
All non-rear-end crashes

Overview

Table 1 shows annual estimates for the number of large trucks involved in rear-end crashes by the most severe injury in the crash. All other truck crashes are shown for comparison. Six years of data from GES and TIFA were averaged to produce annual estimates.

Table 1: Large Trucks in Crashes by Crash Type and Severity 1994-1999 (annual average)

Maximum Injury Severity	Rear-end Crashes				Other Large Truck Crashes		Total Large Truck Crashes	
	Truck Striking		Truck Struck		Number	Percent	Number	Percent
	Number	Percent	Number	Percent				
Fatal	271	0.6	461	1.7	4,267	1.4	4,999	1.3
Incapacitating	2,000	4.1	2,000	6.6	14,000	4.4	17,000	4.5
Non-Incapacitating	3,000	6.8	3,000	10.7	22,000	7.0	27,000	7.2
Possible	9,000	21.2	4,000	12.5	28,000	9.2	41,000	10.7
No Injury	27,000	64.4	18,000	65.1	226,000	73.2	271,000	71.5
Unknown	1,100	3.8	1,000	3.3	15,000	4.9	18,000	4.7
Total	42,000	100.0	28,000	100.0	309,000	100.0	380,000	100.0

Sources: Trucks Involved in Fatal Accidents (TIFA) and General Estimates System (GES)

Rear-end crashes (both truck-striking and truck-struck) account for 18 percent of all large trucks involved in crashes (70,000 out of 379,000). There are 50 percent more truck-striking, rear-end crashes than there are truck-struck crashes—42,000 to 28,000—but there are important differences among levels of severity. In fatal crashes, trucks are struck in the rear much more often than they strike other vehicles—461 to 271. For injury crashes—incapacitating plus non-incapacitating—the numbers are equal (5,000). When possible injury crashes and no injury crashes are combined, trucks struck other vehicles more often than they were struck by a wide margin (36,000 to 22,000).

Results

The following sections highlight some of the ways rear-end crashes differ depending on whether the truck was the striking or struck vehicle. In addition, differences between rear-end crashes and other large truck crashes are presented.

Multi-Vehicle Crashes

In 18 percent of all rear-end crashes where the truck was the striking vehicle, there were three or more vehicles involved in the crash. However, there were three or more vehicles involved in only 5 percent of the crashes where the truck was struck in the rear. The difference is even greater in fatal rear-end crashes. Almost 46 percent of fatal rear-end truck-striking crashes involved three or more vehicles, while only 16 percent of fatal truck-struck rear-end crashes involved three or more vehicles.

The large difference between the mass of trucks and the mass of other vehicles may explain this phenomenon. A typical loaded tractor semi-trailer has a gross weight of 80,000 pounds, while most cars weigh less than 4,000 pounds. Striking a passenger vehicle in the rear will not bring a heavy truck to a stop or even slow it appreciably. Thus the impact itself does relatively little to keep the truck from continuing on and involving other vehicles. Conversely, when a car hits a large truck in the rear, it usually does not move the truck.

The formation of truck “convoys,” a common practice during high-speed long distance travel, may also contribute to the large number of multiple-vehicle, truck-striking, rear-end crashes. If trucks in a convoy operate in close proximity, there should be a higher proportion of trucks among the vehicles in multi-vehicle crashes than other crashes. That appears to be the case. In 14 percent of rear-end crashes involving only two vehicles, the truck strikes another truck. In rear-end crashes involving three vehicles, over half (52 percent) had at least two trucks involved. Where there were four vehicles involved, almost two-thirds of the crashes included at least two trucks.

Divided Highways

Rear-end truck crashes are more likely to occur on divided roads than other truck crashes. About 45 percent of all truck-striking rear-end crashes and 42 percent of all truck-struck crashes occurred on a divided road. By contrast, only 33 percent of all other truck crashes took place on divided highways.

Interstate highways are always divided highways. Figure 1 shows that 58 percent of the truck striking crashes that resulted in at least one fatality took place on an interstate highway, as did 41 percent of those crashes where the truck was the struck vehicle. By contrast, only 20 percent of all other fatal truck crashes took place on interstate highways.

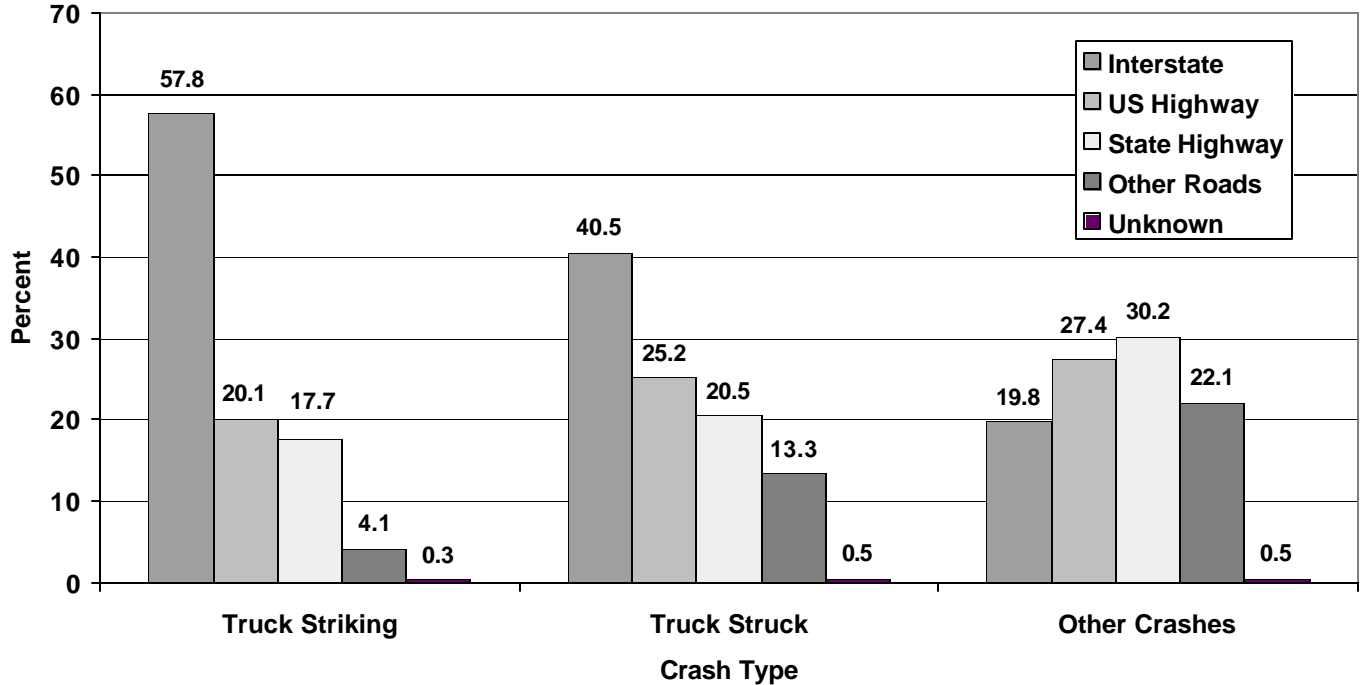


Figure 1: Fatal Rear-end Crashes by Roadway Type (1994-1999)
 Source: Trucks Involved in Fatal Accidents (TIFA).

Non-Junction Crashes

Most truck crashes take place away from junctions – intersections, ramps, driveways, or other points where roadways intersect. Thirty-six percent of all truck crashes are junction-related. However, 42 percent of truck-striking crashes are junction-related, while the figure is only 31 percent of truck-struck crashes. In junction-related rear-end crashes, trucks are more likely to be the striking vehicle than the struck vehicle.

When only fatal rear-end crashes are considered, the difference between truck-struck and truck-striking crashes effectively disappears. However, the contrast with other fatal truck crashes is deepened, as shown in Figure 2. About three-fourths of both truck-striking and truck-struck, fatal rear-end crashes occurred away from intersections, compared with 62 percent of other fatal truck crashes that happened away from junctions. These data are consistent with the analysis in the previous section on divided highways (i.e., rear-end truck crashes are more likely to occur on divided highways, which have fewer intersections per mile than non-divided highways).

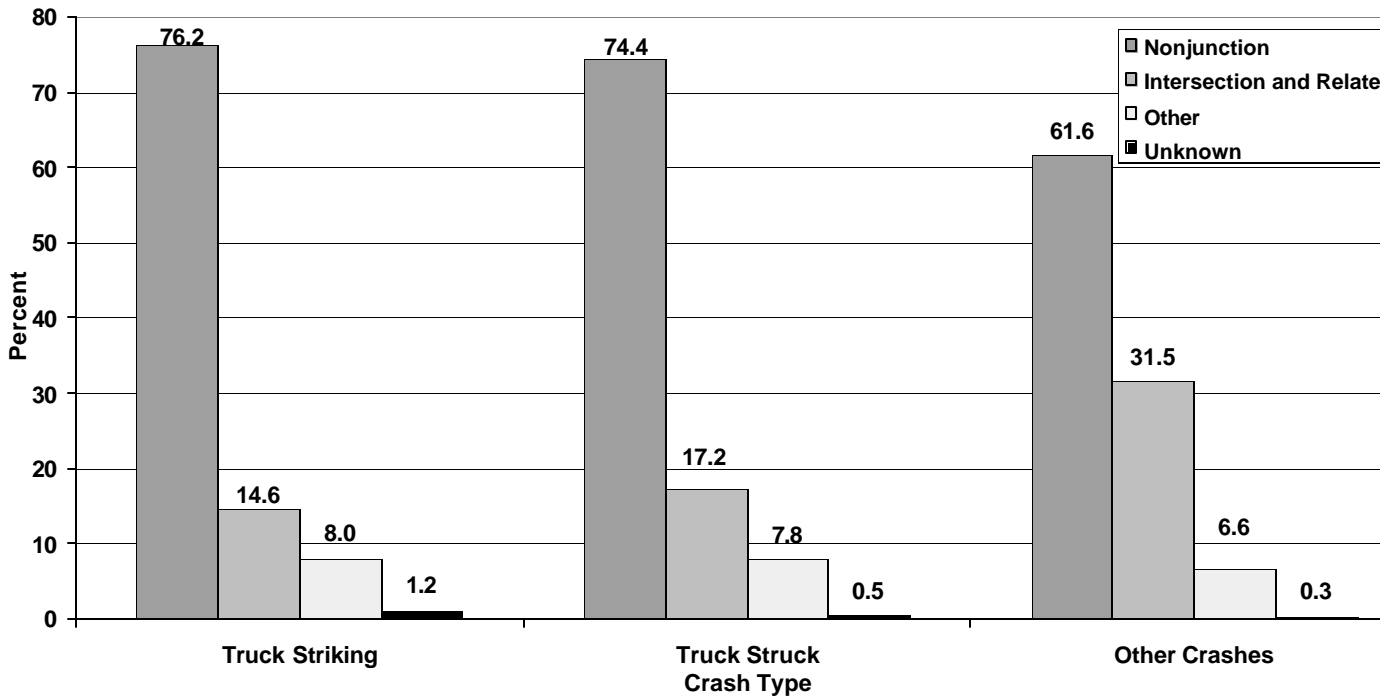


Figure 2: Fatal Rear-End Crashes by Relation to Junction (1994-1999)
 Source: Trucks Involved in Fatal Accidents (TIFA).

Light Conditions

When another vehicle hits the rear of a truck, it is almost twice as likely to be in the dark or in dark but lighted conditions, as opposed to when a truck strikes another vehicle, where almost 90 percent of all truck crashes occurred in daylight. About 87 percent of truck-striking, rear-end crashes happened in the daylight, as well as 77 percent of truck-struck crashes. However, 10 percent of truck-striking, rear-end crashes occurred in dark or dark but lighted conditions, while almost twice as many (18 percent) of truck-struck, rear-end crashes occurred under diminished lighting conditions. Thus, when another vehicle hits the rear of a truck, it is almost twice as likely to occur under diminished lighting conditions.

Fatal rear-end truck crashes are even more associated with dark or dark but lighted conditions, as shown in Figure 3. In fatal rear-end crashes where the truck is the striking vehicle, about 31 percent occurred in dark or dark but lighted conditions. When the truck is struck, the proportion of dark or dark but lighted rises to 46 percent. Thus, almost half of fatal truck-struck rear-end crashes occur when visibility was diminished. Both these numbers are higher than the 29 percent of all other fatal truck crashes that occurred in dark or dark but lighted conditions.

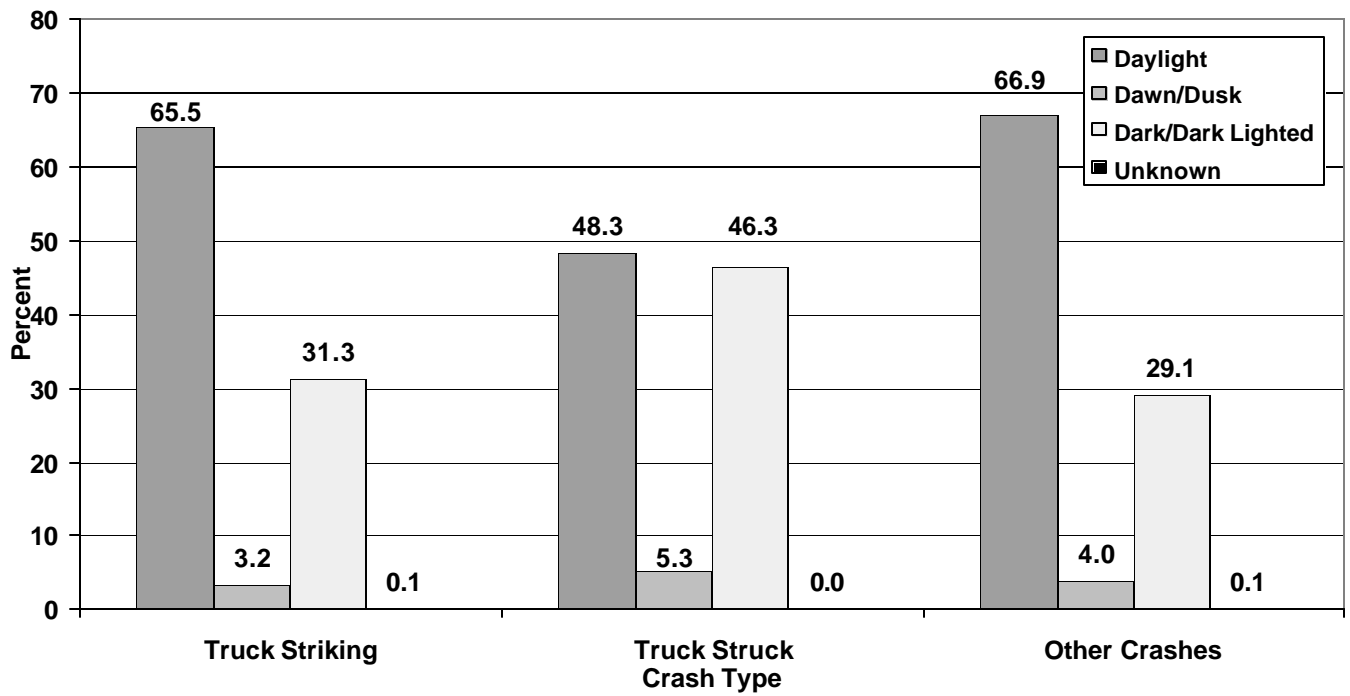


Figure 3: Fatal Rear-End Crashes by Light Conditions (1994-1999)
 Source: Trucks Involved in Fatal Accidents (TIFA).

Alcohol Involvement

Drivers of other vehicles involved in crashes with trucks had been drinking more often than truck drivers. In all types of rear-end trucks crashes, the truck drivers had been drinking in 0.2 percent of the cases, and the other driver had used alcohol in 2.1 percent of the crashes. The greatest disparity is in rear-end crashes in which another driver struck the rear of the truck. When the truck was struck, almost none of the truck drivers had been using alcohol, but about 4.9 percent of the other drivers had been drinking. However, when the truck was the striking vehicle, only 0.2 percent of truck drivers and 0.1 percent of the other vehicle drivers had been drinking.

For fatal crashes, the proportion of drinking drivers is much higher. This is true for both truck drivers and the other drivers in the crash, but the incidence of alcohol use is much higher among the other drivers. In all fatal rear-end crashes, about 1.3 percent of truck drivers had been drinking and about 15.5 percent of the other drivers had been drinking.

When the data are divided between truck-striking and truck-struck crashes (see figure 4), there are greater differences for the drivers of the other vehicles. Truck drivers had been drinking in 2.0 percent of the crashes where the truck was the striking vehicle, and 0.4 percent of the cases where their vehicle was struck. By contrast, other drivers had been drinking in 21.2 percent of the crashes where their vehicle was the striking one, and had been drinking in 4.9 percent of the cases where their vehicle was struck by the truck.

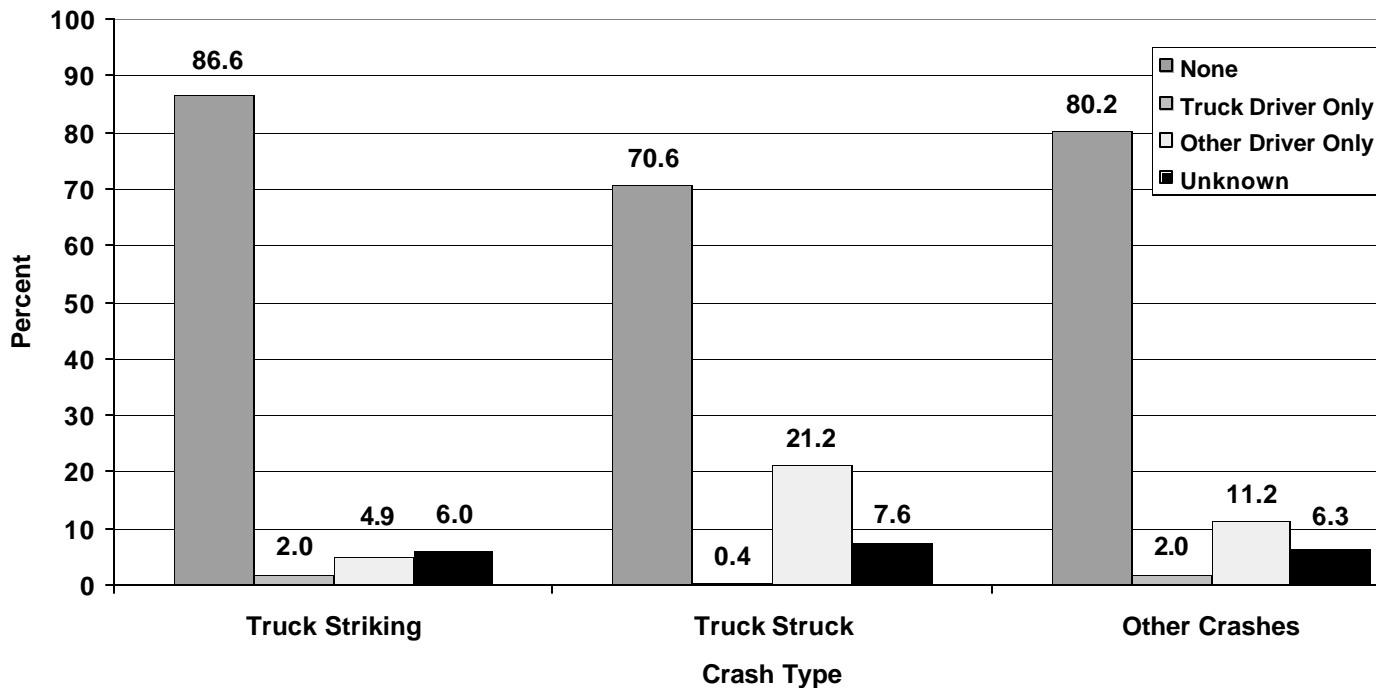


Figure 4: Fatal Rear-End Crashes by Alcohol Use (1994-1999)
Source: Trucks Involved in Fatal Accidents (TIFA).

Alcohol use and light condition are interesting factors when considered together. Night means less light to perceive vehicles ahead, and drinking slows recognition and reaction. In fatal crashes where the truck is struck by another vehicle in dark but lighted conditions, 35 percent of the other drivers had been drinking. For daylight the number

is 9 percent, and for dawn or dusk it is 13 percent. Thus, when other vehicles strike trucks in rear-end fatal crashes, truck conspicuity and driver drinking combined may be important factors.

Michigan FACT Results

The Fatality Accident Complaint Team (FACT) data collected by the Michigan State Police provide excellent information about the relationship between vehicle and driver condition and different crash types. From 1996 through 2001, the FACT program collected data on 480 large truck fatal crashes in Michigan. Distributions in the FACT file show reasonable similarity to comparable variables in the nationwide TIFA file.

Eighty fatal rear-end crashes have been investigated by the FACT team. In 36 of the crashes, the truck struck another vehicle in the rear. In the remaining 44, some other vehicle struck the rear of the truck. Sixty-nine of the trucks in fatal rear-end crashes were given a North American Standard Level 1 safety inspection after the crash. The inspections recorded compliance with driver and vehicle safety regulatory requirements prior to the crash. The data indicated the mechanical condition of truck brakes and lights probably contributes to involvement in rear-end crashes.

Brakes

Truck brake problems appear to be associated with rear-end crashes. Over 53 percent of the trucks striking other vehicles in fatal Michigan crashes had at least one brake safety violation, compared with only 30 percent of the struck trucks. Level 1 inspections cover a wide variety of other mechanical areas, including lights, coupling devices, fuel systems, steering mechanisms, wheels and tires, and other areas. About 31 percent of the trucks striking other vehicles had at least one non-brake safety violation, but an even higher, 36 percent of the trucks, struck by other vehicles also had at least one non-brake safety violation. Therefore, brakes do not appear to be an indication of an overall poor truck mechanical condition.

Lights

An association between truck lighting and rear-end crash type is also discernable in the FACT data. The condition prior to the crash of headlights, turn signals, stop lamps, and marker lights is part of the Level 1 vehicle inspection. Forty percent of trucks struck by other vehicles in rear-end crashes had at least one lighting violation, compared with less than half that number (13 percent) of trucks that were the striking vehicle.

Marker and other lights should be most important in dim lighting conditions, when the various truck lights can make the most contribution to the conspicuity of the vehicle. Fatal rear-end crash crashes in dawn, dusk, dark, or dark/lighted conditions were examined for the effect of non-front light violations on truck-struck, rear-end crashes. The relationship found for all light conditions remained the same. Eleven percent of trucks striking other vehicles had some rear or marker light violation when the crash took place in poor light conditions, compared with 39 percent of the trucks struck by other vehicles. However, these results are based on only 27 crashes.

Analysis and Summary

Overall, trucks strike other vehicles in the rear much more often than they are struck by other vehicles. This finding is expected, given the more difficult task of slowing a large truck versus a small passenger vehicle. However, there are major differences when the severity of the crash is taken into account. In fatal crashes, trucks are struck in the rear much more often than trucks striking other vehicles (461 cases to 271 cases).

The explanation may lie in part with the data on light conditions and alcohol use. Even though most truck crashes take place in daylight, almost half of fatal rear-end crashes where trucks are struck by other vehicles occur in dark but lighted conditions. In these degraded light conditions, recorded in nationwide TIFA data, truck conspicuity may be one factor. The Michigan FACT data also suggests that trucks that are hit in the rear have more lighting violations than those that hit other vehicles.

Alcohol may also contribute to truck-struck rear-end crashes at night. FARS data indicates that alcohol use by other drivers in rear-end crashes is much higher than among truck drivers. In fatal rear-end crashes, 1 percent of the truck drivers had been drinking and 16 percent of the other drivers had been drinking. But in fatal truck-struck, rear-end crashes in dark or dark but lighted conditions, 36 percent of the other drivers had used alcohol at the time of the crash. The FACT data do not include information on the condition of the non-truck drivers, so they cannot cast any light on the issue of alcohol use by drivers of the other vehicles.

The Michigan FACT data also suggest that truck brake conditions may play a role in crashes where trucks strike other vehicles. In rear-end crashes in which a truck was the striking vehicle, the incidence of defective or poorly adjusted truck brakes was almost twice as high as in cases where other vehicles struck trucks. TIFA and GES databases do not have detailed data on truck mechanical condition.

A variety of road type factors were considered in this analysis. The TIFA and GES data show that rear-end truck crashes are more likely to occur on divided roadways and interstate highways—overlapping categories—than other truck crashes. Over 40 percent of all truck-striking and truck-struck, rear-end crashes take place on divided highways, as opposed to one-third of all other truck crashes. With regard to fatal crashes, 58 percent of truck striking crashes and 40 percent of truck struck crashes occurred on interstate highways, as opposed to 19 percent of all truck fatal crashes. Given that divided highways have fewer junctions per mile than other roadways, and that the junctions have fewer or no (in the case of interstates) stoplights or stop signs, the finding that most rear-end truck crashes take place away from intersections is not unexpected.

Taking the roadway data results together, one prevailing theme is that rear-end crashes are more likely to occur on divided highways, often Interstates. In these situations vigilance, both that of truck drivers and drivers of other vehicles, may be relaxed so that when a stopped or slower-moving vehicles appears in front, the driver is unable to quickly respond. This is true in both the cases of the truck striking another vehicle, and the truck being struck by another vehicle.