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Analysis Brief

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The Bus Crash Causation Study

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Summary

The Motor Carrier Safety Improvement Act of 1999 mandated a study to determine the causes of, and factors contributing to, crashes involving commercial motor vehicles and directed the Secretary of Transportation to transmit the results of the study to Congress. In response, the Federal Motor Carrier Safety Administration and the National Highway Traffic Safety Administration conducted a three-year study of large truck crashes—the Large Truck Crash Causation Study—and a smaller study of bus crashes, the Bus Crash Causation Study (BCCS). This Analysis Brief summarizes the results of the BCCS. Approximately 50 people are killed and fewer than 1,000 are injured annually in cross-country and intercity bus crashes. Given those relatively small numbers of bus-related fatalities and injuries, FMCSA decided to collect crash data in northeastern New Jersey, which is part of the New York City metropolitan area and home to large fleets of various types of buses. The BCCS was designed to collect more than 400 data elements on each crash that included at least one bus and at least one fatality or injury. Data collection included crashes occurring from January 1, 2005, to December 31, 2006.

The BCCS report includes information on 40 buses involved in 39 fatal and injury crashes (Category A, crashes involving fatalities or incapacitating injuries; or Category B, crashes involving non-incapacitating injuries) that occurred in New Jersey in 2005 and 2006. The following key variables were coded for each crash: *critical event* (the event after which a crash is unavoidable); *critical reason* (the immediate reason for the critical event); and *associated factors* (all factors selected from the current understanding of conditions related to crash risk and present at the time of the crash). Human errors by bus drivers, other vehicle drivers, and pedestrians or bicyclists were assigned as the critical reasons for bus crashes in 90 percent of the cases in the BCCS. Of the 19 crashes in which the bus was assigned the critical reason for the crash, driver error was the specific reason in 15 cases. In the 20 cases for which the critical reasons were not assigned to the bus or its driver but to another (non-bus) vehicle, a pedestrian, or a bicyclist, the problem was human error.

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Introduction

The Motor Carrier Safety Improvement Act of 1999 (MCSIA) mandated a study to determine the causes of, and factors contributing to, crashes involving commercial motor vehicles (CMVs). The MCSIA directed the Secretary of the U.S. Department of Transportation (DOT) to transmit the results of the study to Congress. In response, DOT's Federal Motor Carrier Safety Administration (FMCSA) and National Highway Traffic Safety Administration (NHTSA) conducted a three-year study of large truck crashes. FMCSA transmitted a report to Congress on the Large Truck Crash Causation Study (LTCCS) in March 2006. This Analysis Brief summarizes FMCSA's report to Congress providing the results of the Bus Crash Causation Study (BCCS).

Each year in the past decade, more than 4,800 people have been killed and more than 100,000 people have been injured in crashes involving large trucks. For the LTCCS, FMCSA was able to obtain a representative sample of large truck crashes by employing researchers at each of the 24 NHTSA Crashworthiness Data System (CDS) data collection sites across the Nation. In comparison, approximately 50 people are killed and fewer than 1,000 injured annually in cross-country and intercity bus crashes. Using the same data collection strategy for BCCS as LTCCS was not practical. Given the relatively small number of cross-country and intercity bus crashes resulting in fatalities or injuries and the concentration of those crashes in certain metropolitan areas, a nationally representative sample of bus crashes would have been prohibitively expensive to acquire and would have taken many years to complete.

Faced with the challenges of acquiring a representative, national sample of bus crashes, FMCSA decided to collect crash data in northeastern New Jersey, which is part of the New York City metropolitan area and home to large fleets of various types of buses. The goal was to study 50 to 100 crashes in a year. However, the paucity of bus crashes resulting in fatalities or injuries revealed only 39 crashes involving fatalities or incapacitating injuries (Category A) or non-incapacitating injuries (Category B) in 2 years. Despite the small sample, the BCCS is the largest in-depth comprehensive examination of bus crashes ever conducted.

The BCCS database is available electronically to the public. The public copy of the database does not include data from interviews that cannot be validated by a second source. Qualified researchers, academic institutions, and government agencies will be granted full access to the database, including interview data.

Methodology

The BCCS was conducted in New Jersey by FMCSA research staff and State CMV inspectors, in conjunction with New Jersey law enforcement and public safety agencies. The BCCS was designed to collect more than 400 data elements on each crash that included at least one bus and at least one fatality or injury. Generally, the study did not include crashes involving New Jersey transit buses or school buses transporting children from home to school, because most of FMCSA's safety regulations do not apply to those vehicle types. The only exception was to include transit and school buses if the crash involved at least one fatality.

Data collection included crashes occurring from January 1, 2005, to December 31, 2006. Buses are defined as vehicles designed or used to transport 9 to 15 people (including the driver) for compensation or more than 15 people for any purpose. New Jersey was selected as the data collection site for the following reasons: a high volume and wide variety of bus traffic; a high level of interest in bus crashes expressed by Federal, State, and local New Jersey government officials; and a strong State bus safety program. To ensure data quality, crash-site investigations began as soon as possible after the crash.

FMCSA developed the BCCS database using a methodology modeled on the LTCCS and

focused on pre-crash factors. State and local police agencies notified an FMCSA researcher when a crash occurred. Data collection was performed at each crash site by a two-person team consisting of a trained researcher and a New Jersey State bus inspector who conducted a North American Standard Level 1 inspection of the bus and bus driver involved in the crash. The researcher and bus inspector collected driver, passenger, and witness interviews at the crash scene. Crash forms were used to record extensive data, including the following:

- Location, time, date, and sequence of the crash event and collision measurements
- Bus and bus driver inspection results
- Roadway conditions, weather conditions, and traffic conditions
- Pre-crash events
- Driver age, sex, physical characteristics, and injury severity
- Drivers' use of drugs or alcohol.

Additional interview data were collected by telephone from the motor carrier responsible for the bus and from the drivers of other vehicles involved in the crash after leaving the crash scene. Researchers also reviewed police crash reports, hospital records, and coroners' reports for fatal crashes. The researcher often revisited a crash scene to refine scene diagrams and search for additional data. Crash case data were provided to FMCSA crash experts for coding, and difficult cases were reviewed by FMCSA New Jersey Division and Headquarters staff before being included in the electronic study database.

Crash Characteristics

This report includes information on 40 buses involved in 39 fatal and Category A or Category B injury crashes occurring in New Jersey in 2005 and 2006. Nationally, during this same time span, buses were involved in 5.6 percent of all large truck and bus fatal crashes; but in New Jersey, buses were involved in 14.5 percent of all truck and bus fatal crashes. Due to the small sample of 39 crashes, only whole numbers are used in the discussion of the BCCS data. There were 14 crashes involving at least one fatality and 25 crashes involving at least one A or B injury.

Eighteen of the 39 crashes included in this report involved a collision between a bus and a passenger vehicle (i.e., passenger car, pickup truck, van, or sport utility vehicle). In other crashes with motor vehicles, three buses collided with commercial trucks, two collided with motorcycles, one collided with a light rail car, and one was a crash between two buses. In eight cases, the bus hit a pedestrian, and in two cases the bus hit a bicyclist. There were four single-vehicle crashes, and in two of the crashes the buses caught fire.

Table 1 presents data on the bus body type for the 40 buses involved in the 39 crashes. More than half of these buses were motorcoaches (intercity buses).

Table 2 presents data on the bus operation for the 40 buses involved in the 39 crashes. Most of the buses were being used in charter or intercity regular route service. Examples of "other" operation types include a van carrying mentally disabled adults to a group home after a day trip and a condominium complex operating a bus service.

Table 1 Bus Body Type

Body Type	Number
Motorcoach	26
Transit bus	5
School bus	3
Large van	3
Small bus	3
Total	**40**

Table 2

Bus Operation

Operation Type	Number
Charter	16
Intercity regular route	10
Private/business	4
Transit	4
School	2
Other	4
Total	**40**

Coding Crash Data

The following key variables were coded for each crash:

Critical event: The event after which a crash is unavoidable. The critical event is the action or event that put the vehicle or vehicles on a course that made the collision unavoidable, given reasonable driving skills and vehicle handling. One vehicle in each crash is coded with the critical event. Examples of critical events include "lane change/run off road" and "loss of control."

Critical reason: The immediate reason for the critical event. The reason is coded to the vehicle that was coded with the critical event. The reason can be assigned to the driver, vehicle, or environmental conditions leading to the critical event. Possible critical reasons include: driver condition and decisions; vehicle failure; and environmental conditions, including weather and roadway conditions or roadway design features.

Associated factors: All factors selected from the current understanding of conditions related to crash risk and present at the time of the crash. No judgment is made as to whether the factor is related to the particular crash, just whether it was present during the crash event. Associated factors are considered in conjunction with the assignment of a critical reason to identify the range of events that lead to a crash. The associated factors provide sufficient information to describe comprehensively the circumstances of the crash. Examples of associated factors include fatigue, making an illegal maneuver, and inattention.

In addition to the analysis of crash events provided in this report, there are narrative descriptions included with each of the 39 crash case files. The tables in the following section focus on critical events, critical reasons, and associated factors for all cases included in the BCCS. Although critical events, critical reasons, and associated factors do not define the cause of a crash independently, when they are considered together, they provide researchers with the information needed for reasonable reconstruction of the crash events and assessment of crash causation.

Results

Table 3 provides a breakdown by critical event of the 19 crashes where the critical reason was assigned to the bus. "Traveling too fast" means the driver was traveling too fast for the conditions at the time of

Table 3

Crashes by Critical Events Where the Bus Was Coded with the Critical Reason

Event	Number
Pedestrian entering traffic lane	5
Lane change/run off road	4
Other vehicle stopped in lane	3
Traveling too fast for conditions	3
Other	4
Total	**19**

the crash, which may or may not be related to the speed limit. Other events included a bicycle in the roadway and a bus crossing through an intersection.

Table 4 shows the coding of critical reasons assigned to a bus. In 15 of the 19 cases, the critical reason was assigned to the bus driver, including 10 incidents in which the driver was coded with either inadequate surveillance (failed to look; looked but did not see) or inattention (attention wandered from driving task), both of which fall into the category of failing to recognize and react to a situation to avoid a collision. The only critical reasons assigned to the buses were fires on two buses and one incident of failed brakes. In one case, environmental conditions (e.g., roadway condition and design or adverse weather conditions) were coded as the crash critical event.

Table 4

Coding of Critical Reasons to Buses

Reason	Number
Driver	
Inadequate surveillance	6
Inattention	4
Following too close	2
Other	3
Driver total	**15**
Vehicle	
Bus fire	2
Brakes failed	1
Vehicle total	**3**
Environment	
Ice on the road	1
Environment total	**1**
Total assigned to buses	**19**

In the remaining 20 crashes, the critical reasons were not assigned to the bus or its driver. Other vehicles involved in the crashes were assigned the critical reason in 16 of the cases, and pedestrians were assigned the critical reason in 4 of the cases. In each of those 20 cases, the critical reason was assigned to the people involved, as opposed to vehicle failure or adverse environmental conditions. The drivers of the other vehicles were coded with traveling too fast or too slow (5 crashes), being unable to perform the driving task due to falling asleep or illness (4 crashes), being inattentive or distracted (3 crashes), and other factors (4 crashes). In all 4 of the crashes where pedestrians were coded with the critical reason, the critical reason was inattention.

Table 5 shows those associated factors that were coded more than once among all bus drivers in the study. Note that some factors coded for the drivers as being present before the crash were later judged also to be the critical reason for the crash. For example, inadequate surveillance was coded for 10 of the 40 bus drivers and was judged to be the critical reason for 6 crashes. The associated factors are listed in descending order according to how often they were coded for the bus drivers.

Each of the following eight associated factors was cited only one time: aggressive driving; driver distracted by conversation; driver was uncomfortable with passengers; driver made a false assumption; fatigue; illness; traveling too slow; and line of sight obstructed inside the bus.

State bus inspectors conducted a driver and vehicle safety inspection of each bus involved in a crash. The inspections determined whether serious safety problems existed before the crashes happened. These safety problems, if discovered before the crash, would have been enough for the inspector to place the bus out of service until the problems were corrected.

The pre-crash out-of-service (OOS) violations identified by State bus inspectors are shown in Table 6. Five of the bus drivers coded with the crash critical reason were each cited for one driver OOS violation. None of the drivers of the 21 buses that were not assigned the crash critical reason was cited with a driver OOS violation. Five buses coded with the crash critical reason had 12 vehicle OOS violations, and only 2 of the 21 buses *not* coded with the critical reason for the crash had vehicle OOS violations.

Table 5

Associated Factors Coded to Bus Drivers

Associated Factor	Number
Line of sight obstructed by vehicle, object, sign	22
In a hurry	16
Inadequate evasive action taken	15
Uncomfortable/unfamiliar with the road	11
Inadequate surveillance	10
Made an illegal maneuver	9
Prescription drug use	8
Driver had vision problems	6
Inattention/distraction	5
Impending problem masked by traffic flow	4
Distracted by a person, object, or event	4
Line of sight obscured by weather, poor light	4
Misjudged gap or velocity	4
Following too close	3
Driver had hearing problems	2
Traveling too fast	2

Of the 18 bus vehicle OOS violations, 6 involved brakes, 3 involved repair and maintenance problems, and 3 involved lighting devices violations. Other bus OOS violations included problems with the function or condition of steering, suspension, frame, axle, windshield, or emergency exit. Of the 18 bus vehicle OOS violations, 12 were assigned to the buses that were coded with the crash critical reason.

Three of the 19 drivers for the buses coded with the critical reason either carried an expired medical certificate or did not have a medical certificate. It is worth noting that not being able to present a medical certification is not an OOS violation. For 28 of the 40 drivers in the BCCS, data about medical certification were unknown.

Conclusion

Human errors by bus drivers, other vehicle drivers, and pedestrians or bicyclists were assigned as the critical reasons for bus crashes in 90 percent of the cases in the BCCS. Of the 19 crashes in which the bus was assigned the critical reason for the crash, driver error was the specific reason in 15 cases. In the 20 cases for which the critical reasons were not assigned to the bus or its driver but to another (non-bus) vehicle, a pedestrian, or a bicyclist, the problem was human error. The only cases for which the critical reason was not assigned to a driver, pedestrian, or bicyclist were two cases in which the buses caught fire, one case in which the bus brakes failed, and one case in which ice on the roadway resulted in a crash.

These results are very similar to the results in the LTCCS. In that study of 963 fatal and injury crashes involving large trucks, when the critical reason was assigned to the truck, it was assigned to the driver in 88 percent of the cases. When the critical reason was assigned to another vehicle—almost always a passenger vehicle—the reason was coded to the driver in 92 percent of the crashes. The only major difference between the studies is the almost total lack of pedestrians and bicyclists in the truck study.

Although the BCCS cannot be considered a representative sample of bus crashes (unlike the larger LTCCS, which was a nationally representative sample of fatal and injury crashes involving large trucks), it stands as an important study that has yielded worthwhile insight into crash risk factors for buses. Many of the human errors assigned to bus drivers, including inattention, distraction, haste, and misjudgments, are not violations of laws or regulations. On the other hand, some of the human errors are chargeable offenses—such as making illegal maneuvers and following too close. In many instances, human errors were accompanied by Federal OOS violations, such as violations of hours-of-service regulations or vehicle safety standards.

While better enforcement can improve the safety climate, producing safer drivers cannot be ensured solely by police enforcement actions. Finally, numerous vehicle OOS violations were found in BCCS post-crash inspections. The interaction of defective vehicles with driver errors cannot be ignored in assessing reasons for the crashes.

Table 6

Driver and Vehicle Out-of-Service Violations for All Buses in the Study

Violation	Number of Buses Coded with Critical Reason	Number of Buses Not Coded with Critical Reason	Total
Driver violations			
No commercial drivers license (CDL)	1	0	
10-hour rule	1	0	
No passenger endorsement on CDL	1	0	
Reckless operation	2	0	
Total driver violations			**5**
Vehicle violations			
Brakes	5	1	
Repair and maintenance	2	1	
Lighting devices	2	1	
Other	3	3	
Total vehicle violations			**18**
Total OOS violations			**23**

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The primary mission of the Federal Motor Carrier Safety Administration (FMCSA) is to reduce crashes, injuries and fatalities involving large trucks and buses. In carrying out its safety mandate, FMCSA develops and enforces data-driven regulations that balance motor carrier (truck and bus companies) safety with industry efficiency; harnesses safety information systems to focus on higher risk carriers in enforcing the safety regulations; targets educational messages to carriers, commercial drivers, and the public; and partners with stakeholders including Federal, State, and local enforcement agencies, the motor carrier industry, safety groups, and organized labor on efforts to reduce bus and truck-related crashes.

The mission of the Office of Analysis, Research and Technology is to reduce the number and severity of commercial motor vehicle crashes and enhance the efficiency of CMV operation by conducting systematic studies directed toward fuller scientific discovery, knowledge, or understanding; adopting, testing, and deploying innovative roadside practices and technology; analyzing trends, costs, fatalities and injuries in large truck and bus crashes; monitoring data quality; and preparing economic and environmental analyses for FMCSA's rulemakings.

This Analysis Brief was produced by the Analysis Division in FMCSA's Office of Analysis, Research and Technology. The Analysis Division provides the transportation industry and the public with analytical reports on trends, costs, and fatalities and injuries in large truck and bus crashes. The division also monitors data quality to ensure an accurate measurement of safety performance, so effective countermeasures can be developed to reduce the occurrence and severity of commercial motor vehicle crashes. In addition, the Analysis Division prepares all the economic and environmental analyses for FMCSA's significant rulemakings to ensure changes to motor carrier regulations are based on sound analysis and data.

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