TechBrief

FEDERAL MOTOR CARRIER SAFETY ADMINISTRATION

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The 100-Car Naturalistic Driving Study: A Descriptive Analysis of Light Vehicle-Heavy Vehicle Interactions from the Light Vehicle Driver's Perspective

The goal of the Federal Motor Carrier Safety Administration (FMCSA) is to reduce the large truck fatality rate by 41 percent from 1996 to 2008. This reduction translates into a rate of 1.65 fatalities in truck crashes per 100 million miles of truck travel.

FMCSA's programs encompass a range of issues and disciplines, all related to motor carrier and bus safety and security. FMCSA's Office of Research and Analysis, which includes the Research and Technology Divisions, defines a "research program" as any systematic study directed toward fuller scientific discovery, knowledge, or understanding that will improve safety, and reduce the number and severity of commercial motor vehicle crashes. Similarly, a "technology program" defines those programs that adopt, develop, test, and/or deploy innovative driver and/or vehicle best practices, and technologies that will improve safety and reduce the number and severity of commercial motor vehicle crashes.

Currently, FMCSA's Research and Technology Divisions are conducting programs in order to produce safer drivers, improve safety of commercial motor vehicles, produce safer carriers, advance safety through information-based initiatives, and improve security through safety initiatives. The study described in this Tech Brief was designed and developed to support the Research and Technology Divisions' strategic objective to produce safer drivers. The primary goals of this initiative are to ensure that commercial drivers are physically qualified, trained to perform safely, and mentally alert.

BACKGROUND

In 2002, 434,000 large trucks (gross weight >10,000 lbs) were involved in vehicle crashes; 4,542 of these crashes resulted in fatalities. In these crashes, 4,897 people died and an additional 210,000 were injured. Though accounting for 4% of all registered vehicles in 2002, large trucks represented 8% of all vehicles involved in fatal crashes. The disproportionate number of vehicles to fatalities among large trucks may contribute to the perception that truck drivers are irresponsible. However, these data do not necessarily signify that truck drivers are the problem. In fact, truck drivers have lower crash rates per million vehicle miles traveled than light vehicles. Nonetheless, light vehicles are extremely vulnerable when they interact with trucks because trucks often weigh 20-30 times as much as light vehicles, and trucks take 20-40% farther to stop than light vehicles. This is best illustrated by the fact that over 75% of multiple vehicle fatal truck crashes resulted in the occupant(s) of the other vehicle being killed.

Project Goals

The data from the 100-Car Study were used to assess the Light Vehicle-Heavy Vehicle (LV-HV) interaction problem from the LV drivers' perspective. There were four primary goals: 1) gain a better understanding of LV-HV interactions on the nation's roadways; 2) continue to develop a classification scheme and corresponding Contributing Factors list for LV-HV interactions and use the terminology and methodology described in the Large Truck Crash Causation Study (LTCCS); 3) compare the current data to the data obtained in the Contributing Factors list for LV-HV interactions study for a more complete picture of the LV-HV interaction problem; 4) provide background information that would serve as a necessary prerequisite to the development of countermeasures for LV-HV interactions.

Method

One hundred participants who commute to and from the Washington, DC metro area were initially recruited as drivers in the 100-Car Study. As some participants had to be replaced for various reasons (e.g., dropped out of the study because they moved from the area), the final number of participants was 109. One hundred LVs were instrumented for this study; 80 vehicles were owned by the participants, while 20 were leased vehicles. The data used in the current effort consisted of video recordings of critical incidents. As such, the primary methodological considerations are those related to the video systems.

Five video cameras were used in the video recording system: (1) a forward-looking camera that captured the forward roadway scene, traffic situation, and possible incidents; (2) a driver's face camera that was used to record facial expressions, eyelid closure, glance position, and head turns; (3) a right-side camera that was mounted on the A-pillar of the passenger side and faced outward; (4) a dome camera that was mounted from inside the vehicle and faced over the drivers shoulder towards the steering wheel, hands, and feet; and (5) a rear camera that was intended to capture the situation behind the vehicle. Infrared lighting was used to illuminate the vehicle cab so that the driver's face as well as their hands could still be viewed by the camera during nighttime driving. The five camera images were multiplexed into a single image as shown in the figure on the following page. The video continuously recorded while the ignition was on, thereby allowing laboratory review and selection of the video, which were selected and keyed to digitally-recorded data.

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Split-screen presentation of the five camera views

RESULT HIGHLIGHTS

Light Vehicle-Heavy Vehicle Interaction Data Set

The 100-Car Study captured 9,125 incidents, which were divided into four categories: (1) LV-LV Interactions; (2) LV-HV Interactions; (3) Single Vehicle Conflicts; and (4) Other. Of the 9,125 events, 246 (2.7%) involved a LV-HV interaction.

Incident Types

With the 246 LV-HV interactions recorded in the data set, the next step in the analysis was to determine the vehicles' actions for each incident. The video and relevant data for each incident were carefully reviewed and then classified according to "Incident Type." Twenty-seven different Incident Types were identified in the data set.

The most frequent Incident Type involving a LV-HV interaction was Late Braking for Stopped/Stopping Traffic. Of all 246 incidents, this particular Incident Type occurred 66 times and accounted for 26.8% of the incidents captured. Most of the incidents (48.8%) involved one of two different Incident Types: Late Braking for Stopped/Stopping Traffic, and Lane Change Without Sufficient Gap.

Descriptive statistics for the Incident Types were also calculated for incidents as a function of the at-fault driver. The at-fault driver is the driver that was assessed, by the analyst, to have been responsible for causing the event. Of the 246 LV-HV interaction incidents recorded, 138 (56%) were judged to have been the fault of the LV driver, while 79 (32%) were attributed to the HV driver. For the remaining 29 incidents (12%), it was unclear which driver was at-fault. By removing the "unknown" cases from the LV-HV driver at-fault analyses, it was found that the LV driver was at-fault in 64% (138/217) of the LV-HV interaction incidents, while the HV driver was at fault in 36% (79/217) of the incidents.

The most frequent Incident Type for HV driver at-fault incidents was Lane Change Without Sufficient Gap (26.6%), followed by Lateral Deviation of Through Vehicle (21.5%), and Left Turn Without Clearance (13.9%). The most frequent Incident Type for LV driver at-fault incidents was Late Braking for Stopped/Stopping Traffic (41.3%), followed by Lane Change Without Sufficient Gap (21.7%), and Aborted Lane Change (8%). The most frequent Incident Type for Unknown at-fault incidents was Late Braking for Stopped/Stopping Traffic (27.6%), followed by Conflict With Oncoming Traffic (13.8%), Lane Change Without Sufficient Gap (10.3%), and Unable to Determine (10.3%).

Driver Distraction

A substantial number of the LV-HV incidents had Distraction listed as a Contributing Factor. As indicated above, the incidents where Driver Distraction was mentioned refer to the behavior of the LV driver. The Distraction Contributing Factor was sub-divided into more distinct categories. The table on the following page shows the frequency, percentage, and rank ordering for each sub-category in the Distraction Contributing Factor. As can be seen in the following table, the most frequent sub-category for the Distraction Contributing Factor was Talking/Listening on Cell Phone (21.7%), followed by Passenger in Adjacent Seat (13%), and Dialing Hand-Held Phone (8.7%).

Availability: The report "The 100-Car Naturalistic Driving Study: A Descriptive Analysis of Light Vehicle-Heavy Vehicle Interactions from the Light Vehicle Driver's Perspective" will be available from NTIS at www.ntis.gov.

Key Words: Driver Distraction, Fatigue, LV-HV, Truck Driving, Vehicle Distraction, Vehicle Interaction

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Frequency, percentage, and rank ordering of each sub-category in the distraction contributing factor (n = 46)

Distraction	Frequency of Distraction Incidents	Percentage of Distraction Incidents	Combined Rank of Distraction Incidents
Talking/listening on cell phone	10	21.7%	1
Passenger in adjacent seat	6	13.0%	2
Dialing hand-held cell phone	4	8.7%	3
Looking out center mirror	3	6.5%	4.5
Looking out left mirror	3	6.5%	4.5
Other external distraction	2	4.3%	9
Adjusting radio	2	4.3%	9
Cognitive – Other	2	4.3%	9
Combing or fixing hair	2	4.3%	9
Lost in thought	2	4.3%	9
Smoking cigar/cigarette	2	4.3%	9
Talking/singing/dancing (not on cell phone)	2	4.3%	9
Eating with utensils	1	2.2%	15.5
Lighting cigar/cigarette	1	2.2%	15.5
Operating PDA	1	2.2%	15.5
Reaching for object (not cell phone)	1	2.2%	15.5
Reading	1	2.2%	15.5
Looking out right window	1	2.2%	15.5

CONCLUSIONS

The analyses that were conducted with the LV-HV interactions captured in the 100-Car Study provide convincing evidence to support the contention that LV-HV interactions are a serious problem.

Based on these findings, the authors suggested that focusing on the LV driver and their errors may provide the largest area of opportunity for reducing such events. Listed below are several suggestions from the authors that should be considered for reducing LV-HV interactions:

- Addressing the LV-HV interaction problem should focus on the driving behaviors of the LV driver.
- The primary area for LV that should be addressed involves their driving techniques and aggressive driving behaviors.
- The primary area for HV drivers that should be addressed involves driving techniques.
- Drivers and/or company dispatchers should be cognizant of problematic sections of routes, and avoid such locations to the greatest extent possible.
- More research studies should use data collection in a naturalistic environment to identify potential crash countermeasures.