Tech Brief

Programs of the Federal Motor Carrier Safety Administration (FMCSA) encompass a range of issues and disciplines, related to motor carrier safety and security. FMCSA's Office of Analysis, Research and Technology 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" is a program that adopts, develops, tests, and/or deploys innovative driver and/or vehicle best safety practices and technologies that will improve safety and reduce the number and severity of commercial motor vehicle crashes. An "analysis program" is defined as economic and environmental analyses done for agency rulemakings, as well as program effectiveness studies, state-reported data quality initiatives, and special crash and other motor carrier safety performance-related analyses. A "large truck" is any truck with a Gross Vehicle Weight rating or Gross Combination Weight rating of 10,001 pounds or greater.

Currently, the FMCSA Office of Analysis, Research and Technology is 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 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.

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Driver Distraction in Commercial Vehicle Operations

FMCSA has been addressing crucial driver issues such as distraction for years. Until 2006, driver distraction was widely believed to be a contributing factor in as many as 30 percent of all crashes as indicated by crash databases (comprised of police accident reports, which were the primary data source for understanding pre-crash driver behavior). In 2006, a naturalistic driving study conducted with 100 light vehicles (i.e., primarily passenger automobiles) found driver distraction in 78 percent of crashes.

To gather naturalistic driving data, each vehicle typically contains several video cameras (e.g., recording views of the face, over-the-shoulder, front view, rear-view, right/left side view, and foot pedals) and vehicle sensors to collect data on vehicle speed, global positioning system, braking intensity, steering input, forward range to a lead vehicle, and many additional measures. These data are generally collected continuously; that is, the data collection system is started as soon as the vehicle ignition starts and continues to record until the vehicle is turned off.

For this investigation into the impact of driver distraction on commercial motor vehicle (CMV) operations, data from two earlier naturalistic CMV driving studies were analyzed to produce odds ratios to determine the odds of an outcome (such as a crash) occurring as compared with normal, non-event, baseline driving. From those odds ratios, population attributable risk (PAR) percentages were calculated to consider the frequency of occurrence of each task.

One data set was collected in a 2004 field operational test of a drowsy driver warning system. The second data set was collected in 2007 for the Naturalistic Truck Driving Study. The combined data set consisted of 203 CMV drivers, 55 instrumented trucks from seven trucking fleets, and about 3 million miles of continuously collected kinematic and video data. Analysts scanned the data to identify potential safety-critical events (crashes, near-crashes, crash-relevant conflicts, and unintentional lane deviations). Crashes involve contact with an object. Near-crashes are events that require a rapid evasive maneuver by one of the parties involved. Crash-relevant conflicts are similar to near-crashes, though the severity of the evasive maneuver is less than that in a near-crash. Unintentional lane deviations involve drifting outside of the driving lane.

This scanning process—using kinematic data thresholds, and video review and validation—resulted in 4,452 safety-critical events: 21 crashes, 197 near-crashes, 3,019 crash-relevant conflicts, and 1,215 unintentional lane deviations. In addition, 19,888 baseline epochs (non-events) of normal driving were randomly selected. The amount of time each driver was in the study was used to weight the frequency of baseline epochs per driver. Those who were in the study for a longer duration (e.g., 12 weeks) had more baseline epochs than drivers in the study for less time (e.g., 8 weeks).

Driver behavior was sorted into three broad categories of tasks: primary tasks (required for vehicle control), secondary tasks (driving related, but not required for vehicle control, such as checking mirrors or the speedometer), and tertiary tasks (non-driving related, such as eating). For tertiary tasks, the level of complexity of the task (complex, moderate, simple) was used as a grouping factor.

Key Findings

Of the 4,452 safety-critical events noted in the combined data, 81.5 percent had some type of driver distraction listed as a potential contributing factor. Those tasks that drew the driver's eyes away from the forward road led to a significant increase in risk.

Risk Associated with Distracting Tasks

Odds ratios (OR) were calculated to identify tasks that were high risk. For a given task, an odds ratio of "1.0" indicated the outcome was equally likely to occur in the safety-critical event data as in the baseline, non-event data. An odds ratio greater than "1.0" indicated the outcome was more likely to occur, and odds ratios of less than "1.0" indicated the outcome was less likely to occur. Table 1 shows the results from the odds ratio analyses.

The most risky behavior identified was "text message on cell phone," with an odds ratio of 23.2. This means that the odds of being involved in a safety-critical event is 23.2 times greater for drivers who text message while driving than if they were not text messaging while driving. CMV drivers using a dispatching device while driving increased risk by 9.9 times. Other distracting activities included writing (increased risk of 9.0), using a calculator (increased risk of 8.2), looking at maps (increased risk of 7.0), dialing a cell phone (increased risk of 5.9), personal grooming (increased risk of 4.5), and reaching for an object in the vehicle (increased risk of 3.1).

Other interesting results involve the protective effect (defined as decreasing the risk of a safety critical event) of some tasks. While reaching for or dialing a cell phone was a high risk task, talking or listening on a hand-held phone provided a significant protective effect (OR = 0.4), that is, engaging in the task or behavior provided a safety benefit. Talking or listening to a CB radio also provided a similar significant protective effect (OR = 0.6). One hypothesis for these results is that reaching for a phone and dialing a phone requires substantial visual attention to complete the task, taking the eyes away from the forward roadway. Listening and talking, on the other hand, engages the driver and may provide an alerting mechanism.

Visual Demand for Distracting Tasks

Eye glance analyses were conducted and provided the "why" for the findings in the odds ratio analysis. Put simply, tasks that draw the drivers' eyes away from the forward roadway were those with high odds ratios. For example, texting, which had the highest odds ratio of 23.2, also had the longest duration of eyes off forward roadway (4.6 s over a 6-s interval). This equates to a driver travelling the length of a football field (end zones included), at 55 mi/h, without looking at the roadway. Other high visual attention tasks included those that involved the driver interacting with technology: calculator (4.4 s), dispatching device (4.1 s), and cell phone dialing (3.8 s).

Technology-related tasks were not the only ones with high visual demands. Non-technology tasks, including mundane or common activities, with high visual demands (all over a 6 s time interval) included: writing (4.2 s), reading a book/newspaper/other (4.3 s), looking at a map (3.9 s), and reaching for an object (2.9 s).

Population Risk for Distracting Tasks

Odds ratios only inform part of the analysis findings (i.e., which tasks are shown to increase the risk of involvement in a safety-critical event). Other analysis efforts consider the frequency of occurrence of each task (i.e., which task, if removed, would increase safety most). Table 1 shows the results from the PAR analysis for tasks with an odds ratio greater than "1.0". High PAR percentages occurred for commonly performed tasks. Specific tasks with the largest PAR percentage included: reaching for an object (PAR = 7.6), interacting with a dispatching device (PAR = 3.1), and dialing a cell phone (PAR = 2.5). The PAR percentages for these tasks were

Table 1. Odds Ratio and Population Attributable Risk Percentage by Task

Task	Odds Ratio	Population Attributable Risk Percentage*
Complex Tertiary Task		
Text message on cell phone	23.2	0.7
Other – Complex (e.g., clean side mirror)	10.1	0.2
Interact with/look at dispatching device	9.9	3.1
Write on pad, notebook, etc.	9.0	0.6
Use calculator	8.2	0.2
Look at map	7.0	1.1
Dial cell phone	5.9	2.5
Read book, newspaper, paperwork, etc.	4.0	1.7
Moderate Tertiary Task		
Use/reach for other electronic device	6.7	0.2
Other – Moderate (e.g, open medicine bottle)	5.9	0.3
Personal grooming	4.5	0.2
Reach for object in vehicle	3.1	7.6
Look back in sleeper berth	2.3	0.2
Talk or listen to hand-held phone	1.0	0.2
Eating	1.0	0
Talk or listen to CB radio	0.6	*
Talk or listen to hands-free phone	0.4	*

*Calculated for tasks where the odds ratio is greater than one.

greater than for the other tasks because the drivers commonly performed them.

On the other hand, although text messaging had a very high odds ratio, this task was performed infrequently by drivers, thus it does not have a high PAR percentage. However, this does not mean that it should be ignored. On the contrary, it suggests that as texting while driving becomes more prevalent, the frequency of safety-critical events is likely to increase.

Some tasks have both high odds ratios and high PARs. Specifically, driver interaction with a dispatching device was a risky, commonly performed task, as indicated in the high odds ratio (OR = 9.9) and PAR percentage (PAR = 3.1) for this task. Reaching for an object was another task with a high odds ratio (OR = 3.1) and PAR percentage (PAR = 7.6). Dialing a cell phone also had a high odds ratio (OR = 5.9) and PAR (PAR = 2.5).

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Environmental Conditions

Task involvement as a function of environmental conditions was also analyzed. An odds ratio analysis was performed to approximate the increased risk of being involved in a safety-critical event, as compared to baseline epoch, while engaging in various tasks in eight environmental conditions, including lighting levels, weather, and traffic density. While some interesting findings resulted from this analysis, no obvious conclusions could be made from relationships between tasks and different environmental conditions.

Summary Findings and Recommendations

The following findings and recommendations by the authors to address driver distraction in CMV operations were formulated through a review of this study. These findings and recommendations provide a summarized list of critical issues and are ordered from general recommendations (e.g., maintain eyes on forward roadway) to more specific recommendations (e.g., no texting). These recommendations focus on improving CMV safety by reducing driver distraction and are intended to provide key take-aways for fleet-safety managers on how they might improve safety by applying the findings from the current study. The authors found and recommended that:

- Fleet safety managers educate their drivers on the importance of being attentive and not engaging in distracting tasks or behaviors while driving.
- Fleet safety managers develop policies that minimize or eliminate the use of in-vehicle devices (e.g., a calculator) while driving.
- Drivers not use dispatching devices while driving.
- Drivers not text while driving.
- Drivers not manually dial cell phones while driving.
- Activities such as reading, writing, and looking at maps never be performed while driving.
- Talking, either on a cell phone or CB radio, be allowed as it was not found to increase risk.
- Designers of dispatching devices work to develop more user-friendly interfaces that do not draw the driver's eyes from the forward roadway. One possible solution is a hands-free dispatching device or blocking use while the vehicle is on and in motion.
- Designs of instrument panels be intuitive, user-friendly and not require long glances away from the forward roadway.
- Further research be undertaken to investigate the protective effects of performing certain tasks. If certain tasks or behaviors provide an alerting component, this could lead to countermeasures aimed at reducing drowsiness or inattentiveness.