TechBrief

FEDERAL MOTOR CARRIER SAFETY ADMINISTRATION

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Impact of Local/Short-Haul Operations on Driver Fatigue: Field Study

The goal of the Federal Motor Carrier Safety Administration (FMCSA) is to reduce the number and severity of large truck-involved crashes through more commercial motor vehicle and operator inspections and compliance reviews, stronger enforcement measures against violators, expedited completion of rulemaking proceedings, scientifically sound research, and effective CDL testing, recordkeeping, and sanctions. The Office of Research and Technology manages research and technology development and deployment programs for the FMCSA.

FMCSA R&T activities encompass a range of issues and disciplines relating to motor carrier safety, including problem assessment; policy, safety management, and outreach; drivers; truck and bus vehicle safety performance; and compliance, enforcement and operations.

***Driver alertness and fatigue* primarily supports current and future hours-of-service rulemaking activities, along with fatigue outreach and fatigue management technology development.**

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Introduction

In local/short-haul (L/SH) operations, commercial motor vehicle drivers primarily make trips of 100 miles or less from their home bases. L/SH activity includes local "pickup and delivery (P&D)" as well as other kinds of operations. Though researchers have examined the effects of driver fatigue and other safety issues in long-haul operations, they know little about how those issues affect L/SH operations—the largest segment of the trucking industry. Local-service trucks account for 58% of large truck registrations, 28% of miles traveled, and 38% of fatal crash involvements.

The Federal Motor Carrier Safety Administration (FMCSA) conducted a two-phased research project on the safety issues in L/SH operations and the extent to which fatigue is an issue in the industry. Researchers convened focus group sessions in Phase I, then conducted a field study in Phase II to determine objectively if fatigue is a safety issue in L/SH trucking.

The Phase I report, *Impact of Local/Short Haul Operations on Driver Fatigue: Focus Group Summary and Analysis,* was published in August 1998. This Tech Brief summarizes the Phase II report, *Impact of Local/Short Haul Operations on Driver Fatigue: Final Report,* published in August 2000.

Background

Long-Haul v. L/SH Operations

Whereas long-haul drivers may be on the road for several days or weeks, driving and sleeping at irregular times, L/SH drivers typically work during daylight hours and return to their homes after a daily shift. Long-haul drivers generally do not perform tasks other than driving, but L/SH drivers may make multiple deliveries during a single trip, load and unload a vehicle, lift and carry packages, interact with customers, and perform other tasks during a daily work routine. Because fatigue is a critical safety issue for long-haul drivers, researchers sought to identify to what extent fatigue and other safety issues affect L/SH operations.

Phase I: Focus Groups

In Phase I of the study, researchers held 11 focus group sessions in 5 states. Eighty-two L/SH drivers participated in the sessions—discussing general safety issues within the industry as well as fatigue-related factors. Drivers identified the following critical safety issues, ranked in order of importance (1 = most important):

1. problems caused by drivers of light vehicles (e.g., cars and pickup trucks),
2. stress due to time pressure,
3. inattention,
4. problems caused by roadway/dock design, and
5. fatigue.

Following are the top fatigue-related issues identified by L/SH drivers, ranked in order of importance (1 = most important):

1. not enough sleep,
2. hard/physical workday,
3. heat/no air conditioning,
4. waiting to unload, and
5. irregular meal times.

In the focus groups, drivers identified fatigue as an issue in the L/SH industry—though they thought it was less critical for them than for long-haul truckers. Participants pointed out that they work during daylight hours, have work breaks that interrupt driving, end their shifts at home, and sleep in their own beds at night. For L/SH drivers fatigue apparently results from a normal day's work and is impacted by their personal lives (e.g., whether they get enough sleep at night)—similar to the fatigue experienced by day-shift workers in non-driving professions.

Purpose

The primary purpose of Phase II of the research was to conduct a field study to determine objectively if fatigue is a safety issue in L/SH trucking. The results of the focus group effort in Phase I served as the foundation for the field study in Phase II.

Methodology

Phase II consisted of an on-road study in which L/SH trucks were instrumented with data collection equipment and driven by L/SH drivers on typical workdays. Researchers collected both quantitative and qualitative data to identify safety issues and determine the extent to which fatigue is an issue in the L/SH industry. Multiple components of fatigue were considered, including those determined through:

- subjective measures, such as self-reported level of stress;
- objective measures, such as the degree of eyelid closure—a reliable measure of driver fatigue; and
- physiological measures, such as indications of sleep quantity and quality as collected by wrist activity monitors.

Two L/SH companies participated in the study—one that hauls beverages and another that hauls snack foods. Both companies were paid for their participation. Four types of L/SH trucks were used in the study: a 15-foot panel van, an 18-foot panel van, a box truck, and a class B straight truck (generally a single vehicle with a gross vehicle weight rating of more than 26,000 pounds). These trucks represent typical in-service trucks used by each company.

Researchers installed unobtrusive, compact, and reliable "black box" data collection systems in the trucks. Several small video cameras monitored each truck driver and surrounding traffic situation, and sensors collected data from the vehicle's instruments. (See **Figure 1**.) Performance data were collected as 42 drivers worked their typical delivery routes for approximately 2 weeks. The average age of the participants was 31. All drivers took part in the study voluntarily and were paid in addition to their regular compensation.

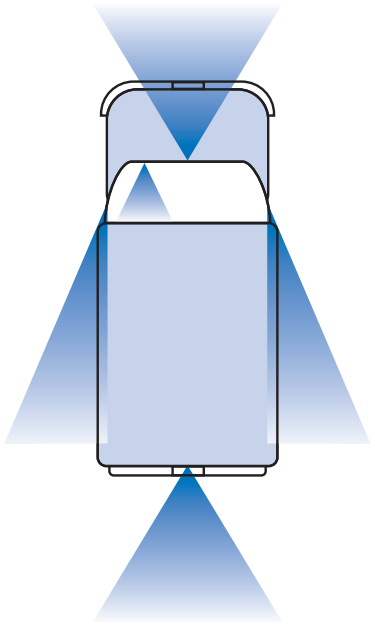
The data collection equipment was designed to capture driver performance associated with "critical incidents," i.e., near-crash events. The data used in the analysis were gathered from three sources:

- truck instrumentation (e.g., equipment measurements of forward velocity, lateral acceleration, and braking sensors, or an analyst's review of composite-image video tapes of the driver and driving environment);
- demographic forms and pre- and post-shift questionnaires completed by drivers; and
- wrist activity monitors, which measure the quantity and quality of drivers' sleep.

Findings

Collectively, participating drivers spent about 28 percent of each workday driving, 35 percent loading and unloading, 26 percent performing other tasks (e.g., merchandising and vehicle inspection), 7 percent waiting to unload, and the remainder of the day eating, resting, or doing other activities.

Figure 1.
Five Video Camera Angles and Approximate Fields of View in L/SH Field Study



Researchers identified 249 critical incidents (i.e., near-crash events), including:

- 137 critical incidents attributed to "other" drivers, i.e., *not* L/SH drivers;
- 77 critical incidents attributed to L/SH drivers;
- 20 critical incidents in which the L/SH driver was involved only as an observer; and
- 15 critical incidents in which the L/SH driver responded to another type of situation, such as an animal in the road. (See **Figure 2**.)

L/SH Driver At-Fault Critical Incidents

L/SH drivers were at fault in 77 of the 249 critical incidents. Researchers reviewed the videotapes and narratives of events and attributed one or more potential causes to each of those critical incidents. For example, if a L/SH driver ran a red light, a researcher might identify both inattention *and* stress due to time pressure as potential causes of the critical incident. Following is a list of the potential causes researchers most often attributed to L/SH driver at-fault critical incidents:

- inattention (57 critical incidents),
- fatigue (28 critical incidents),
- stress due to time pressure (25 critical incidents),
- driver education/protocol (10 critical incidents),
- roadway/dock design (8 critical incidents), and
- overconfidence (7 critical incidents). (See **Figure 3**.)

The majority of L/SH driver-at-fault critical incidents were caused by very few drivers. Two drivers accounted for 26 percent of the 77 critical incidents attributed to L/SH drivers, and 8 drivers accounted for 60 percent of those incidents. Thirty-three percent of the L/SH drivers had no at-fault critical incidents.

L/SH Driver Fatigue

Researchers found evidence of driver fatigue and inattention, to a statistically significant degree, during the interval preceding L/SH driver-at-fault critical incidents. In 21 percent of the 77 critical incidents in which L/SH drivers were at fault, researchers identified fatigue as a contributing factor. In L/SH driver-at-fault critical incidents, the drivers' PERCLOS values (a validated indicator of driver drowsiness based on slow eyelid closure) were significantly higher than in other types of critical incidents. The drivers' OBSERV values (a validated indicator of driver drowsiness based on an observer rating of drowsiness, as determined by facial expression) also were significantly higher than in other types of critical incidents.

L/SH drivers tended to be involved in fatigue-related critical incidents earlier in the workweek: no fatigue-related critical incidents occurred after the fourth day of a driver's workweek. This data may suggest that drivers get less sleep during their "weekend" breaks than during the workweek.

Figure 2.
Critical Incidents in L/SH Field Study

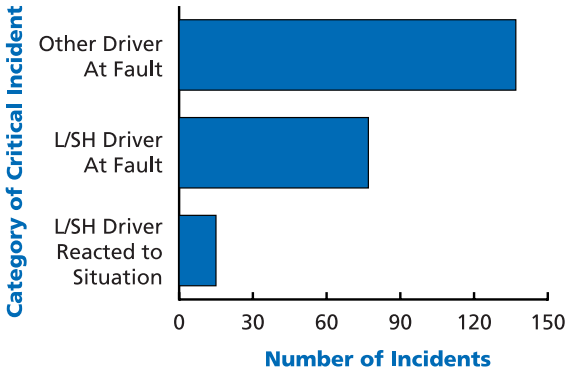
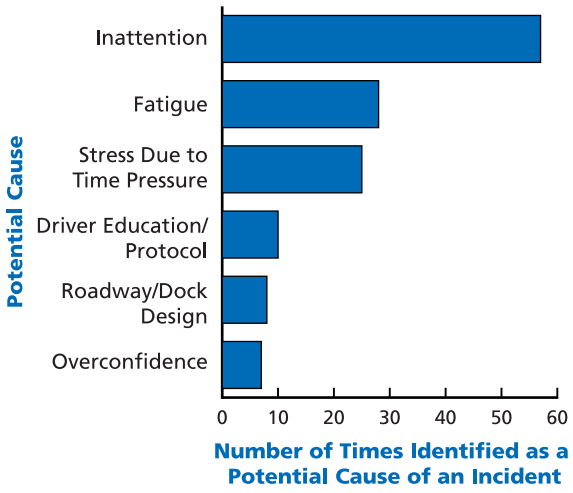


Figure 3.
Potential Causes of L/SH Driver-At-Fault Critical Incidents



The wrist activity monitor data suggested that L/SH drivers who showed signs of fatigue and were involved in at-fault critical incidents had less sleep and poorer quality of sleep than drivers who did not show outward signs of fatigue. The findings agree with the common sense notion that quantity and quality of sleep influence the level of fatigue experienced the next day. Researchers suggested that the off-duty behavior of the drivers was the primary contributing factor in the level of fatigue demonstrated during the workday. Those L/SH drivers who demonstrated fatigue on-the-job likely would have experienced fatigue at any job within or outside of the trucking industry.

Younger/Inexperienced Drivers

The study showed that younger/inexperienced L/SH drivers were significantly more likely to be involved in critical incidents than were older/more experienced drivers. In addition, younger/inexperienced drivers exhibited higher on-the-job drowsiness, as indicated by

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Availability
The study final report is available from the National Technical Information Service, No. PB2001-101416INZ.

Key Words
alertness, driving, fatigue, field study, inattention, instrumented vehicles, local/short-haul, truck

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their PERCLOS and OBSERV measurements. Researchers hypothesized that younger/inexperienced truck drivers may be overrepresented in crashes, like their counterpart younger/inexperienced passenger vehicle drivers.

Lane Change and Backing

In 15 percent of the lane-change critical incidents, researchers identified drowsiness as a contributing factor, compared to 7 percent for non-critical-incident lane changes. During lane-change maneuvers, fatigued drivers spent more time looking straight ahead than drivers who were not fatigued. In backing maneuvers, fatigued L/SH drivers spent more time looking in the right-forward direction. These findings may suggest that fatigued drivers spend less time scanning their environment and tend to fixate on relatively unimportant sections of their field of view.

Recommendations

Based on the results of the study, researchers made the following recommendations.

Drowsiness/Inattention: L/SH companies should encourage drivers to monitor their levels of drowsiness and inattention and institute policies that allow drivers to take breaks for short naps without reprimand.

Sleep Hygiene: L/SH companies should encourage drivers to come to work well rested and train drivers on the hazards of operating heavy equipment when tired.

Driver Training: L/SH companies and federal and state governments should improve the training of younger/inexperienced drivers and consider requiring all L/SH drivers to have special licenses to operate L/SH trucks (similar to the class B licences required for drivers of articulated trucks).

Driver Screening: L/SH companies should improve driver selection and screening to identify unsafe drivers before they are hired.

Public Monitoring of Driver Performance: L/SH companies should consider implementing initiatives similar to the "How's my driving?" program, which provides a phone number on the back of long-haul trucks to solicit feedback from the general public on drivers' performance.

Further Research

The FMCSA currently is conducting research in the related areas of car-truck interaction and on-board systems to monitor driver fatigue and inattention. Researchers also recommended future efforts in the following areas: cellular phone use by L/SH drivers, the impact of driver age on L/SH driving performance, and methods to identify unsafe drivers.

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