TechBrief

FEDERAL HIGHWAY ADMINISTRATION • **OFFICE OF MOTOR CARRIER AND HIGHWAY SAFETY**

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The mission of the Office of Motor Carrier and Highway Safety is to develop and promote, in coordination with other Departmental modes, data-driven, analysis-based, and innovative programs to achieve continuous safety improvements in the Nation's highway system, intermodal connections, and motor carrier operations. The Office of Motor Carrier Research and Standards manages the safety regulatory program and the central research management function for Motor Carrier and Highway Safety.

There are eight major research and technology focus areas: regulatory evaluation and reform; compliance and enforcement; commercial driver performance enhancement; driver alertness and fatigue; driver physical qualifications; car-truck proximity; HAZMAT safety and cargo tank integrity; and crash causation and profiling.

***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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Effects of Operating Practices on Commercial Driver Alertness

Introduction

The Federal Highway Administration s (FHWA) Office of Motor Carrier and Highway Safety (OMCHS) currently sponsors a multifaceted research program examining commercial motor vehicle (CMV) driver fatigue. OMCHS's constituency, including the public, highway safety advocates, the CMV industry, and researchers, have identified driver fatigue as a top-priority CMV safety issue. FHWA began the study described here in fiscal year 1996, as directed by Congress in the Department of Transportation Appropriations Act (Public Law 104-50). This project was designed to: (1) characterize the operating practices of CMV drivers and (2) to assess the relationship of these practices to driver fatigue.

Researchers began by conducting focus groups, a driver survey, and interviews with CMV drivers to understand the physical (loading or unloading) requirements across the industry. They found that the amount of physical labor associated with CMV driving varies, depending upon type of cargo and other factors. In many settings, people other than CMV drivers (e.g. shipper and receiver personnel or dock workers) do most of the loading/unloading of trucks. Far more complaints were heard about fatigue due to lengthy waiting periods associated with loading and unloading than from actual physical activity.

In commodity groups representative of those who regularly do significant amounts of loading/unloading (e.g., household goods movers and grocery haulers), drivers reported that they often become fatigued during and after the loading/unloading tasks. In some cases, they claimed this physical activity subsequently affects their driving alertness.

The second half of the study was a driving simulator study; it sought to assess truck driver fatigue or alertness as affected by non-driving, but on-duty, activities, such as loading/unloading a vehicle. It also examined the effects of driver performance on extended hours of service—14 hours on duty/10 hours off duty (12 hours driving). This tech brief summarizes the study's final report, which can be obtained from the National Technical Information Service.

Purpose

This driving simulator study was designed to investigate the following:

- Fatigue-related decline in driving performance resulting from loading and unloading cargo.
- Nonduty time (rest and recovery) required to reestablish baseline fitness for duty.
- Driver performance under a sustained 14 hours on/10 hours off (12 hours daytime driving, 7 a.m. to 9 p.m.) schedule. Researchers examined driver performance over a 15-day period.

Methodology

Ten male drivers participated in this study. All were experienced CMV drivers with long haul experience. Researchers screened participants for smoking habits (no smokers participated), general medical history, and susceptibility to simulator sickness. Drivers each stayed in an apartment near the test site for approximately 16 nights.

The study used a driving simulator in order to examine the effects of an extended duty period without risking unsafe driving conditions and to examine driver performance in challenging, crash-likely situations, which cannot be induced safely as a part of on-the road tests.

Participants operated a driving simulator in simulated long-haul runs for a period of 15 days, including occasional loading/unloading sessions and a relatively high frequency of simulated crash-likely events. On 3 days during one duty week, a loading/unloading task required drivers to move 44-pound boxes from one pallet to another without the use of material handling equipment. Then drivers shuttled the load to a second location using a pallet jack. Loads were identical in weight and volume and drivers were instructed to work at a comfortable pace. This activity continued for 90 minutes.

A complete test cycle for each driver required 17 days. The flow of activities was as follows:

- Pre-test sleep patterns: Drivers wore a wrist activity monitor for the 48 hours preceding the start of the experiment to observe the driver's habitual sleep habits.
- Days 1–2: Included 4–5 hours per day of practice on the simulator and familiarization with psychomotor vigilance reaction time tests and subjective fatigue rating scales.
- Days 3–7 (Week 1): Five days (Monday through Friday) during which the drivers spent 14 hours per day on duty followed by 10 hours off duty. Drivers were given 1.75 hours of scheduled breaks. During 90-minute driving periods, performance measures were maintained and recorded by computer into 10-second time intervals. Half of the drivers conducted loading/unloading operations on three days this week. The remaining drivers performed the loading/unloading exercise in Week 2.
- Days 8–9: This 58 hours off duty approximated a traditional weekend. Drivers left their lodging for short trips, or to eat or exercise. Sleep technicians periodically measured sleep latency (how quickly the drivers fell asleep) and administered reaction time tests and subjective fatigue rating scales during this recovery period.
- Days 10–14 (Week 2): This period was identical to Week 1, except drivers who did not perform the loading/unloading task in Week 1 did so in Week 2.
- Days 15-16: Off-duty rest days identical to Days 8–9.
- Day 17: One last driving day, following the final full driving week, was conducted to verify full performance recovery from driving Week 2.

Findings

Effects of Loading and Unloading

The effects of the physical loading/unloading activities on driving performance were mixed.

Photo courtesy of Road King Magazine

The study used a driving simulator to examine driver performance in challenging, crash-likely driving conditions. On the road, crash-likely situations are rare, but can be induced more frequently, without risk, in a simulator.

On loading days, drivers performed two 90-minute loading/unloading sessions during the driving day, one in the morning and one in the afternoon. After the morning physical activity, there was an improvement in driver response to crash-likely simulated situations, probably due to a short-term invigorating effect associated with physical exercise and a break in the driving routine.

The afternoon loading/unloading session did not have the same effect on drivers. Driving performance deteriorated more rapidly after the afternoon physical activity, suggesting that cumulative physical/general fatigue and time-of-day effects are sufficient to overpower some short-term effects of a change in activity. Driving performance did return to starting levels near the end of the day.

Nonduty Time Required to Reestablish Baseline Alertness and Fitness for Duty

Multiple measures were employed to gauge recovery, including sleep patterns, sleep latency, subjective sleepiness, and reaction time performance. These measures were repeated regularly 4 times each day during the 58-hour rest and recovery period.

Most drivers managed to get between 6 and 7 hours of sleep per night during the duty week. Sleep was relatively uniform throughout the driving week, followed by a brief increase in sleep on the first recovery night. Experimenters observed certain common characteristics in recovery sleep patterns.

"Unwinding" after completing the workweek, most drivers did not readily go to sleep early on Friday, the first recovery night, and put off additional sleep until the following day. Since the first set of alertness tests was scheduled at 9:00 a.m. on Saturday, there was no opportunity for drivers to sleep in. By the 1:00 p.m. test on Saturday, drivers were free to enjoy additional sleep and almost all did so by taking afternoon naps.

Drivers returned to baseline reaction time performance and alertness within 24 hours after the end of a driving week, as shown by sleep latency, reaction time testing, and driver rating of subjective sleepiness. In daytime driving schedules like this one, resuming work after 24 hours of rest would cause severe circadian disruption. Drivers ought to be ready to resume duty only after a minimum of 36 hours rest.

Effects of a 14/10 Driving Schedule

In general, drivers performed well working a schedule of 14 hours on duty/10 hours off duty, with 12 hours daytime driving and adequate nightly sleep. Duty-day subjective sleepiness, reaction time response, and measures of driving performance showed a slight but statistically significant deterioration over the driving week, but driver response in crash-likely situations did not show cumulative deterioration. The schedule of 14 hours on duty/10 hours off duty (12 hours driving) for a 5-day week did not appear to produce significant cumulative fatigue over the 2-week testing period.

Photo courtesy of Star Mountain, Inc.

Many CMV drivers load and unload their vehicles as part of their daily routine. This study found that such physical activity has a mixed effect on drivers, and may not always lead to a decline in driving performance.

The principal measure of safety, i.e., driver performance in crash-likely situations, shows a distribution across time for first few driving days of each week that is typical of the entire period: a gradual decline in driver response quality over time (hours at the wheel). That is, there were slight performance degradations in the mid-afternoon, but there were improvements after each break, whether for rest, meals, or loading activities.

The ability to maintain speed within posted limits and gear shifting performance both deteriorated somewhat during the latter part of the driving day. The simultaneous occurrence of the two suggests a deterioration in physical coordination and vigilance late in the day, but there was no consistent linear relation to hours of driving.

Subjective feelings of tiredness measured by the Stanford Sleepiness Scale followed a pattern similar to that of driver performance, but with a less dramatic discontinuity following the mid-day break. This effect is largely attributed to time-of-day and time-on task.

Further Research

Driver drowsiness/fatigue is the dominant human factors research issue in the OMC Research and Technology program. Other OMC fatigue-related studies currently ongoing or planned include studies on the modeling of driver performance under various work/rest cycles; technological fatigue countermeasures; CMV driver sleep apnea; crash investigation/causation; scheduling practices and fatigue; local/short haul driver fatigue; sleeper berth usage and fatigue; CMV crash rate by time-of-day; truck stop fitness facilities; driver compensation practices and safety; in-vehicle alertness monitoring; shipper-encouraged safety violations; and intelligent vehicle initiative driver monitoring research.

Researcher
This study was performed by Star Mountain, Inc., 3601 Eisenhower Ave., Suite 450, Alexandria, VA 22304. Contract No. DTFH61-96-X-00022.

Distribution
This Tech Brief is being distributed according to a standard distribution. Direct distribution is being made to the Resource Centers and Divisions.

Availability
The study final report will be available from the National Technical Information Service, Telephone: (703) 605-6000.

Key Words
CMV driver, operating practices, driver fatigue, loading, unloading, physical activity, driving alertness, driving simulator, driving performance.

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