

The mission of the Federal Motor Carrier Safety Administration 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 the FMCSA.

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

*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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# Driver Alertness and Fatigue: Summary of Completed Research Projects, 1995–98

## Introduction

This document describes projects in the Federal Motor Carrier Safety Administration's (FMCSA) Driver Alertness and Fatigue Research and Technology (R&T) focus area that were completed during the years 1995 to 1998 under the former Office of Motor Carriers (OMC) in the Federal Highway Administration (FHWA). Information on more recently completed, current, and planned projects on driver fatigue is contained in the Driver Alertness and Fatigue R&T Focus Area Summary, which is available on the FMCSA Web site: <http://www.fmcsa.dot.gov>.

## Driver Fatigue and Alertness Study (DFAS)

**FMCSA Project Manager: Deborah Freund, (202) 366-5541**

The DFAS, performed by the Essex Corporation, was the most comprehensive over-the-road study of commercial driver alertness ever conducted. It was a collaborative effort involving FHWA OMC, Transport Canada, the Trucking Research Institute (TRI) of the American Trucking Associations (ATA) Foundation, three motor carriers, and other research and industry organizations.

The study involved real revenue runs, 4 different driving schedules, 80 drivers, and more than 200,000 miles of highway driving. Numerous measures were taken of the drivers' alertness and performance during driving and of their physiology during off-duty sleep periods. The DFAS results are major scientific inputs to the current re-examination of FMCSA's 60-year-old driver hours-of-service (HOS) regulations. Major findings included:

- Driver alertness and performance were more consistently related to time-of-day than to time-on-task. Drowsiness episodes were eight times more likely between midnight and 6 a.m. than during other times.
- During their daily main sleep period, drivers slept for only about 5 hours, which was 2 hours less sleep than their "ideal" requirement of slightly over 7 hours.
- Drivers' stated self-assessments of their levels of alertness did not correlate well with objective measures of performance. Drivers were not very good at assessing their own levels of alertness.
- There were significant individual differences among drivers in levels of alertness and performance.

The DFAS Executive Summary is available on the FMCSA Web site.

**Final Report:** available from NTIS (PB 98-102346)

**Technical Summary:** available from NTIS (PB 97-129688)



## Fitness-for-Duty Testing

**Project Manager: Kate Hartman, (202) 366-2742**

This fatigue management technology involves the administration of psychomotor tests to drivers at the beginning of the job shift and/or during short breaks periodically during the shift. Through the TRI, Evaluation Systems, Inc. developed and evaluated a fitness-for-duty testing device for commercial motor vehicle (CMV) drivers. Thirty drivers were tested on cognitive/psychomotor tasks on two different types of testing platforms: in-terminal desk top computers and truck cab mounted miniaturized computers. Data on the drivers' test results, acceptance of the tasks, the effects of terminal and cab environments on the computer hardware, and system reliability and maintainability all supported the feasibility of using short (5-10 minute) tests to identify fatigued drivers. This study documented the concept and feasibility of employing in-terminal and in-vehicle testing devices for determining the fitness of CMV drivers to safely operate their vehicles. Results were reported in a November 1994 FHWA publication, *Feasibility of Carrier-Based Fitness-for-Duty Testing of Commercial Drivers*.

**Final Report: FHWA-MC-95-011, available from NTIS (PB 95-226908)**

## CMV Rest Areas I: Making Space for Safety

**Project Manager: Bob Davis, (202) 366-2997**

This TRI study determined what public rest area and privately owned rest stop services are needed by CMV drivers and how well the needs were being met. The study documented a significant shortage of rest area parking for commercial vehicles and drivers. It also revealed private sector efforts to expand spaces at truck stops to meet this need. Partly in response to the study, about half of U.S. States now permit their CMV weigh stations to remain open as rest areas when they are not being used as weigh stations.

The U.S. Congress added in the 1995 National Highway System Designation Act a provision for 100 percent Federal funding of safety rest area construction and modification, a measure expected to stimulate expanded rest areas for trucks. The final study report is *Commercial Driver Rest & Parking Requirements: Making Space for Safety*. A conference work session on CMV parking "best practices" was held in June 1999. A TEA21-directed follow-up study is currently underway and is being managed by Ray Krammes of the FHWA Office of Safety Research and Development, (202) 493-3312.

**Final Report: FHWA-MC-96-0010, available from NTIS (PB 97-124705)**

**Tech Brief: FHWA-MCRT-98-002, August 1998**

## Multi-Trailer Combination Vehicle Stress and Fatigue

**FMCSA Project Manager: Deborah Freund, (202) 366-5541**

FHWA and the National Highway Traffic Safety Administration (NHTSA) co-sponsored this study, performed by Battelle, of the effect of multiple-trailer combination vehicle (MTCV) operation on driver stress and fatigue. Its goal was to determine whether there are differences in driver alertness and performance arising from driving single-trailer versus two different types of triple-trailer combinations: those employing A-dollies and those employing C-dollies. Twenty-four experienced MTCV drivers each drove six round trips (two with each configuration). Total mileage per driver was about 2,700 miles. Trailer configuration was found to affect driver stress/fatigue as measured by lanekeeping, driver subjective workload, and physiological state. Task demands were greatest with triple/A-dollies, followed by triple/C-dollies and, last, single-trailers. However, stress/fatigue differences relating to trailer configuration were small compared to the individual differences among drivers. Alertness correlated much more highly with driver individual differences than with vehicle configuration. A summary report was submitted to Congress in March 1996.

## Validation of Eye and Other Psychophysiological Monitors

**NHTSA Project Manager, Dr. Paul Rau, (202) 366-0418**

This Intelligent Transportation Systems/ Commercial Vehicle Operations (ITS/CVO)-funded effort was managed by the NHTSA Office of Vehicle Safety Research. Under the program, the University of Pennsylvania (UPENN) conducted laboratory experiments to evaluate the validity, sensitivity, and reliability of selected personal (psychophysiological) fatigue detection devices and measures, including eye closure measures such as PERCLOS, a measure of eyelid droop identified in earlier NHTSA research as being a promising index of fatigue. Other psychophysiological measures assessed included two eye blink measures, two electroencephalograph (EEG) measures, and a head movement detector. All measures had some validity, but the results corroborated most strongly the validity of PERCLOS. FHWA and NHTSA believe that PERCLOS is the most promising real-time measure of driver alertness for in-vehicle systems. For assured validity, in-vehicle alertness monitors should measure PERCLOS, PERCLOS correlates (psychophysiological or behavioral), or should otherwise be validated in a manner similar to this study. The final report is *Evaluation of Techniques for Ocular Measurement as an Index of Fatigue and the Basis for Alertness Management*. Follow-up laboratory human factors

studies of the driver-vehicle interface for PERCLOS-based in-vehicle alertness monitoring are underway.

**Final Report:** NHTSA DOT HS 808 762, April 1998, available from NTIS (PB 99-150237)

**Tech Brief:** FHWA-MCRT-98-006, October 1998

### Local/Short Haul Driver Fatigue Crash Data Analysis FMCSA Project Manager: Ron Knipling, (202)366-2981

This small analytical study, performed by the University of Michigan Transportation Research Institute (UMTRI), developed several definitions of local/short haul (LSH) versus over-the-road trucks and examined the prevalence of driver fatigue as a principal factor in truck crashes. Data sources included the 1992 Truck Inventory and Use Survey and 1991–93 Trucks Involved in Fatal Accidents files. LSH trucks in these crash data files were defined based on vehicle size (i.e., Class 3-6 single-unit straight trucks) and/or by operational nature (i.e., trip length). Not surprisingly, trip distance was

found to have the most pronounced effect on the percentage of fatal crashes that were fatigue-related; shorter trips are associated with a much lower incidence. The risk of LSH truck involvement in fatigue-related fatal crashes is a fraction of that of over-the-road trucks. The FMCSA Project Manager for a current, larger human factors study of LSH driver fatigue (which has included both focus groups and instrumented vehicle studies) is Bob Carroll, (202) 366-9109.

**Final Report:** FHWA-MC-98-016, available from NTIS (PB 98-127129)

**Tech Brief:** FHWA-MCRT-99-002, November 1998

### Shipper Involvement in HOS Violations FMCSA Project Manager: Elaine Riccio, (202) 366-2981

Congress directed FHWA “to determine the scope, nature, and extent of shipper involvement in driver noncompliance with the safety regulations.” This study, conducted by Global Exchange, Inc., employed focus groups to generate qualitative data about shipper demands on motor carriers and drivers. The study found that pick-up and delivery demands by shippers do lead to HOS violations, but that all involved parties — receivers, shippers, brokers,



Photo courtesy of Volvo Trucks

**Driver fatigue is a significant risk factor in commercial transportation, since drivers may be on the road up to 10 hours without taking a break, often drive at night, and have irregular and unpredictable work schedules. Over the past decade, driver drowsiness has been the subject of intensified Department of Transportation interest and activity.**

schedulers, dispatchers, and drivers themselves — contribute to the problem of HOS noncompliance. Moreover, all of these parties have a role to play in resolving the problem. In particular, the fleet dispatcher plays a crucial role in setting schedules to balance HOS requirements and driver rest needs against delivery requirements. The final report, *A Qualitative Assessment of the Role of Shippers and Others in Driver Compliance with Federal Safety Regulations* has been published. The FMCSA Project Manager for a current follow-on study on shipper/receiver-encouraged HOS violations is Albert Alvarez, (202) 366-4706.

**Final Report:** FHWA-MC-98-049, available from NTIS (PB 98-172448)

**Tech Brief:** FHWA-MCRT-99-004, December 1998

### Assessment of Electronic On-Board Recorders for HOS Compliance FMCSA Project Manager: Ron Knipling, (202) 366-2981

This project, performed by UMTRI through a contract with the Private Fleet Management Institute of the National Private Truck Council, assessed the costs and benefits of the use of electronic on-board recorders (EOBRs) for compliance with the HOS regulations.





## Distribution

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## Availability

Several study final reports are available from the National Technical Information Service, Telephone: (703) 605-6000. More information about each completed fatigue research project can be obtained from the FMCSA project manager.

## Key Words

motor carrier safety, driver fatigue, fitness-for-duty, highway rest parking, multi-trailer combination vehicles, shippers, PERCLOS, vigilance monitoring, electronic on-board recorders.

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Average EOBR acquisition and installation costs averaged approximately \$2,000 per vehicle; annual operating and maintenance costs were about \$200 per vehicle. The use and benefits of EOBRs vary widely for different segments of the motor carrier industry; almost all current use is by private fleets. The benefits associated with electronic HOS recording lie largely in the time savings for drivers in maintaining HOS logs. These savings averaged about 20 minutes per driver per day. Also, managers of fleets using EOBRs saved an additional 20 minutes per driver per month in management review and administration time. A planned FY'00-02 program, Technology Deployment for Improved HOS Compliance, will address EOBRs and related technologies for improving HOS compliance and driver fatigue management.

**Final Report:** FHWA-MC-99-059, available from NTIS (PB 99-111866)

**Tech Brief:** FHWA-MCRT-99-007, February 1999

## Conference on Driver Vigilance Monitoring

In December 1996, OMC and TRI jointly sponsored a conference on technological approaches to counteracting fatigue, with emphasis on in-vehicle monitoring of driver alertness and actigraphic monitoring of driver sleep. Topics addressed included research findings on driver alertness, updates on technology, and strategies for future deployment.

## Conference on Managing Fatigue In Transportation

In April 1997, this international, multi-modal conference, jointly sponsored by FHWA, ATA, NHTSA, the Association of American Railroads, the Federal Railroad Administration, and the National Transportation Safety Board, addressed ways to improve transportation operator alertness and lower crash risk. Expert speakers addressed a variety of topics related to the improvement of operator fatigue management, including improving sleep, monitoring operator alertness, alternative approaches to hours-of-service (HOS) regulation, and new methods and technologies in fatigue management. Conference proceedings are available from Government Institutes, Inc.: (301) 921-2355.

## Conference on Rest Area Parking

In June 1999, FHWA conducted a forum to address CMV rest area availability and safety needs; participants included state enforcement and highway officials, safety advocates and research organizations, and industry associations. The conference identified, considered, and promoted best practices developed by public and private sector organizations and jurisdictions to expand the number of available parking spaces for CMV drivers needing rest. Conference proceedings are available from Ray Krammes, (202) 493-3312.

## Further Information

Internet users may access further information on the FMCSA driver fatigue R&T programs through their Web site: <http://www.fmcsa.dot.gov>. The FMCSA is interested in receiving information about new driver fatigue research. E-mail Ron Knipling at [ron.knipling@fhwa.dot.gov](mailto:ron.knipling@fhwa.dot.gov) or fax (202) 366-8842.

DOT-wide activities related to transportation operator fatigue are described in the DOT's Fatigue Resource Directory at: <http://www.hf.faa.gov/dot/fatigue/>.



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