

Driver Fatigue and Alertness Study (DFAS).

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 FHWA's 60-year-old driver 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 8 times more likely between midnight and 6am 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 do 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 through the FMCSA home page: <http://www.fmcsa.dot.gov/safetyprogs/research/researchpubs.htm>. The Technical Summary (PB 97-129688) and the project final report (PB 98-102346) are available from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA, 22161, 703-487-4828. (FMCSA Project Manager: Deborah Freund, 202-366-5541).

Fitness-for-Duty Testing.

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 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 fatigue 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*, FHWA-MC-95-011.

CMV Rest Areas I: Making Space for Safety

This TRI study determined what public rest area and privately owned rest stop services are needed by CMV drivers and how well the current system meets these needs/demands. 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% Federal funding of safety rest area construction and modification, a measure expected to stimulate expanded rest areas for trucks. The final study report, *Commercial Driver Rest & Parking Requirements: Making Space for Safety* (FHWA-MC-96-0010) is available from NTIS (PB 97-124705). A Tech Brief on the project is available. A TEA21-directed follow-up study, as well as a conference work session on CMV parking "best practices" are being initiated and are described in the FMCSA Driver Alertness and Fatigue Focus Area Summary. The project manager for the Rest Parking I study was Bob Davis (202-366-2997). A second project, currently underway, is being managed by Ray Krammes of the FHWA Office of Safety Research and Development (202-493-3312).

Multi-Trailer Combination Vehicle Stress and Fatigue

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. (FMCSA PM: Deborah Freund, 202-366-5541).

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 proceedings are available from Dr. Bill Rogers, TRI, (703) 838-7912.

Conference on Managing Fatigue In Transportation

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 (NTSB), 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 HOS regulation, and new methods and technologies in

fatigue management. Conference proceedings are available from Government Institutes, Inc.; (301) 921-2355.

Assessment of Electronic On-Board Recorders for HOS Compliance

This project, performed by the University of Michigan Transportation Research Institute (UMTRI) through a contract with the Private Fleet Management Institute (PFMI) of the National Private Truck Council (NPTC), assessed the costs and benefits of the use of electronic on-board recorders (EOBRs) for compliance with the HOS regulations. 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. The final report, *Electronic Recorder Study* (FHWA-MC-99-059) is available from NTIS (PB99-111866). A Tech Brief entitled is available from FMCSA (contact Elaine Riccio at 202-366-2981). 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.

Shipper Involvement in HOS Violations

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, 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 (FHWA-MC-98-049) and is available from NTIS (PB-98-172448). A Tech Brief on the project is available from the FMCSA PM for the study, Elaine Riccio, 202-366-2981. The FMCSA PM for a current follow-on study on shipper/receiver-encouraged HOS violations is Albert Alvarez, 202-366-4706.

Local/Short Haul Driver Fatigue Crash Data Analysis

This small analytical study, performed by 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 project final report, *Short-Haul Trucks and Driver Fatigue*, (FHWA-MC-98-016, NTIS PB98-127129) is available from FHWA or NTIS. The FMCSA PM for this study was Ron Knipling, 202-366-2981. The FMCSA PM 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.

Validation of Eye and Other Psychophysiological Monitors

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, *Evaluation of Techniques for Ocular Measurement as an Index of Fatigue and the Basis for Alertness Management* (NHTSA Report No. DOT HS 808 762, April, 1998) is available from NTIS. A Tech Brief is available from the NHTSA project manager, Dr. Paul Rau, 202-366-0418, or from FMCSA. Follow-up laboratory human factors studies of the driver-vehicle interface for PERCLOS-based in-vehicle alertness monitoring are underway.

Further Information

Internet users may access this information through the FMCSA homepage at <http://www.fmcsa.dot.gov/safetyprogs/saftresearch.htm>. For further information on the driver fatigue R&T programs of the FMCSA, please contact Ronald R. Knipling, Ph.D., Chief, Research Division (HCS30), Office of Motor Carrier Research and Standards, U.S. DOT, 400 Seventh Street, SW., Washington, DC 20590; Phone (202) 366-2981; FAX (202) 366-8842; e-mail ron.knipling@fhwa.dot.gov. The FMCSA is also interested in receiving copies of new research relating to driver fatigue. Please send such reports to the address above, or fax/e-mail them to FMCSA, attn: Ron Knipling.

The FMCSA web site provides information on the full range of regulatory and other activities to promote truck and bus safety. The address is: <http://www.fmcsa.dot.gov/safetyprogs/saftprogs.htm>. 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/>. The directory contains a wealth of information on government and non-government fatigue-related R&T and educational programs.