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NATIONAL TRANSPORTATION SAFETY BOARD  
WASHINGTON, D.C.

ISSUED: August 8, 1984

Forwarded to:

Honorable Ray Barnhart  
Administrator  
Federal Highway Administration  
U.S. Department of Transportation  
Washington, D.C. 20590

SAFETY RECOMMENDATION(S)

H-84-59 and -60

About 5:15 a.m. on November 30, 1983, a Trailways Lines, Inc., intercity bus traveling in the right lane of southbound U.S. 59 about 5 miles north of Livingston, Texas, struck the rear of an unloaded tractor-flatbed semitrailer operated by E. A. Holder, Inc. The bus then veered across the left southbound lane, crashed through a bridge guardrail, and vaulted to a creekbank 26 feet below the bridge deck. It was dark, the weather was cloudy, and there was no roadside lighting. The pavement of the four-lane, divided highway was dry. The truck had turned right onto southbound U.S. 59 about 927 feet before the accident site and according to postaccident tests had accelerated to about 42 mph when it was struck in the rear by the southbound bus. Six of the 11 bus passengers were killed; 5 bus passengers and the busdriver sustained moderate to severe injuries during the accident. The truckdriver later reported that he was injured. 1/

The Safety Board determined that the probable cause of this accident was the busdriver's lack of alertness, possibly due to fatigue, which resulted in his failure to recognize that he was overtaking a slower-moving truck until it was too late to avoid impact.

Research indicates that human performance at certain tasks reaches its lowest level during the early morning hours just preceding dawn. This phenomenon, which is documented in many studies relating to fatigue and human performance during periods of shift work, is attributed to the effects of circadian rhythms--the daily variations in the level of physiological arousal.

The relationship between circadian rhythms and the commercial driving task is best addressed in a research effort initiated by the Bureau of Motor Carrier Safety (BMCS) in 1975 2/ in which the researchers examined, among other things, work periods that are irregular with respect to the day-night cycle. The research indicates that, on the basis of heart rate measurements, diurnal (daily) variations in the level of physiological arousal

1/ For more detailed information read Highway Accident Report—"Trailways Lines, Inc., Bus/E.A. Holder, Inc., Truck, Rear End Collision and Bus Run-Off-Bridge, U.S. Route 59, near Livingston, Texas, November 30, 1983" (NTSB/HAR-84/04).

2/ "A Study of the Relationships Among Fatigue, Hours of Service, and Safety of Operations of Truck and Bus Drivers," U.S. Department of Transportation, Federal Highway Administration, Bureau of Motor Carrier Safety, 1972.

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occurred in professional truckdrivers who drove during both daytime and nighttime hours, but that a disproportionate number of accidents involving "sleepy or inattentive" drivers occurred between midnight and 0800 when physiological indices of arousal are generally at their lowest levels.

Other laboratory studies of human performance during periods of shift work have corroborated the commonly accepted view that human performance reaches its lowest level during the early morning hours. This period of comparatively poor performance represents the trough of a circadian rhythm in task performance. <sup>3/</sup> The tasks examined in the research included the passive monitoring of a monotonously repetitive environment with the requirement that certain, infrequent signals be reliably recognized, and the active processing of information, including the correct visual identification of various objects. As pointed out in the research, these tasks may be considered to be laboratory representations of two major components of highway driving--monitoring the highway for significant occurrences and correctly identifying those occurrences.

The results of the BMCS research showed that a highly disproportionate percentage of "dozing driver" accidents was found to occur in the hours between midnight and 0600. BMCS field experiments on relay truck driving, sleeper truck driving, and bus driving showed pronounced increases in subjective fatigue, marked changes in physiological state, and earlier degradation of performance of trips that involved driving during these hours.

The quality of sleep/rest received prior to working irregular hours may help in the control of the circadian rhythm impact. It is noted, however, that those drivers whose schedules end just prior to early morning are perhaps most vulnerable to diurnal variations. This is due to exposure to sleep-disturbing social and environmental stimuli present during daytime hours when these shift workers try to sleep. The cumulative effects of fatigue are felt to be significant for drivers on shift work. Some of the effects of fatigue on operator performance include disruptions in timing, loss of fine motor control, increased variability in performance, and lowering of performance standards. Operational tasks most affected by fatigue are those based upon minute cues in which vigilance and alertness are important. Vigilance appears to be the function most affected by fatigue. <sup>4/</sup>

The busdriver in this accident was exposed to several factors which cause fatigue, such as vibration, monotonous monitoring of a dark highway, and physical inactivity resulting from confinement to his seat. A bus passenger reported that, about 10 minutes before the accident, he saw the busdriver's head nod and that the bus drifted onto the shoulder, an indication that the busdriver might have been fatigued or sleepy. In view of the circumstances of the accident, the driving environment, and the 24-hour work/sleep history of the driver, it is possible that the busdriver's lack of alertness to his driving task was related to the early morning hour of the accident and the effects of fatigue.

<sup>3/</sup> Allusisi, E.A., Coates, G.D., & Morgan, B.B., Jr. Effects of Temporal Stressors on Vigilance and Information Processing. In R.R. Mackie, (ed.), Vigilance: Theory, Operational Performance, and Physiological Correlates, New York: Plenum Press, 1977.

<sup>4/</sup> USN Flight Surgeon's Manual, United States Navy, pp. 651-653.

In 1973, as a result of its investigation of a bus accident in Richmond, Virginia, 5/ the Safety Board issued recommendation H-73-5 that the BMCS:

Assign high priority to a study of practical methods and means to prevent or to minimize dozing at the wheel by drivers of carriers in interstate commerce, toward the end that appropriate rulemaking will follow.

The Federal Highway Administration (FHWA) responded to this recommendation by stating:

In regard to Recommendation H-73-5, there have been numerous "Stay Awake" devices available since 1960 which will warn a driver that he is dozing or is not responding in a normal pattern, implemented by a sensing system on the steering wheel. However, the cost per unit for these devices may be prohibitive. The Bureau of Motor Carrier Safety is of the opinion that these devices can be helpful but are not the answer to the problem. The Bureau believes that proper rest by drivers, sane scheduling of trips, and constant supervision by motor carrier management of drivers can remove the causes that induce drowsiness and instances of drivers falling asleep at the wheel.

Although proper driver rest is essential for the prevention of inattention/fatigue-related accidents, neither the BMCS nor management officials of motor carriers have the means to determine either the amount or the quality of rest obtained during driver "off-duty" periods. Regulations requiring the proper scheduling of trips and driver compliance with hours of service driving and on-duty limitations exist and generally are enforced by the BMCS.

The nature of the over-the-road driving task precludes the constant management supervision envisioned by BMCS as being part of the solution to the inattention/fatigue problem. Drivers for the most part are not in contact with management, nor can motor carrier management observe driver performance while a driver is away from management's direct supervision.

In calendar years 1982 and 1983, 64,938 passenger and property carrier accidents were reported to the BMCS as required by the Federal Motor Carrier Safety Regulations (49 CFR Part 394). In 1.6 percent (1,051) of these accidents, the reporting motor carrier stated that the driver dozed at the wheel, while in 97 percent of the accidents the driver was reported to be "apparently normal." Other driver condition categories included "sick," "had been drinking," "medical waiver," and "other." These other categories account for the remaining 1.2 percent of the driver condition data reported to the BMCS. Seven percent (4,726) of all accidents were single-vehicle non-collision accidents which occurred when the reporting carrier's vehicle ran off the roadway. This category of accident accounted for 26 percent (214) of all driver fatalities and 15 percent (2,426) of all driver injuries reported to the BMCS in 1982 and 1983. 6/ In many cases accidents categorized as "ran off roadway" or accidents which involve striking another vehicle in the rear or striking a fixed object can be attributed to driver inattention or fatigue.

5/ Highway Accident Report--"Runoff and Overturn of Intercity Bus on Interstate 95, Richmond, Virginia, September 3, 1972" (NTSB-HAR-73-2).

6/ Property carrier accident data for 1982 were obtained from "Accidents of Motor Carriers of Property 1982," U.S. Department of Transportation, Federal Highway Administration, Bureau of Motor Carrier Safety, 1983. Property carrier data for 1983 and passenger carrier data for 1982/1983 are preliminary information obtained from the BMCS.

The Safety Board concludes that the FHWA's response to Recommendation H-73-5 only partially addresses the monitoring and reporting problem, and that driver inattention/fatigue probably remains an underlying, although not clearly identifiable, cause of many commercial vehicle accidents for which the driver's condition is reported to the BMCS as being "apparently normal."

In January 1984, the National Highway Traffic Safety Administration (NHTSA) awarded a contract to investigate the problem of fatigue in driving. The contract effort, "Driver Vehicle Monitoring to Reduce Inattention Related Accidents," reviewed current countermeasure technology, identified other related research projects, and recommended an experimental approach to the problem. As a result of the recommendations of this research, the NHTSA has requested the development of a detailed experimental plan to further study inattention-related accidents. The Safety Board supports the NHTSA's work in this area.

There are several types of devices available on the market designed to alert a driver that fatigue is setting in. Two common devices are readily available to the public. One device is activated when steering wheel adjustments become irregular, and the other, which is worn like a hearing aid, is activated when the driver's head begins to nod. Both of these devices emit a signal to warn the driver.

During the field experiments in the BMCS research, in those instances where devices designed to alert a driver of fatigue setting in were installed in the vehicle, drivers disconnected the devices because they believed the devices were faulty. This occurred because the devices alerted the drivers of changes in the drivers' performance before the drivers themselves were conscious of the changes.

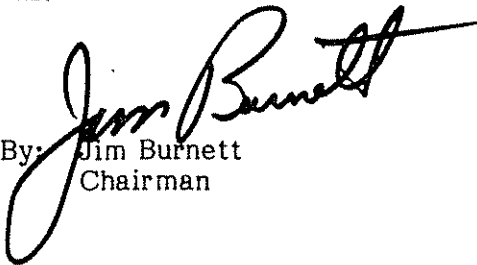
Based on the circumstances of this accident and the frequent occurrence of inattention/fatigue accidents among drivers in interstate commerce, the Safety Board is placing Recommendation H-73-5 in a "Closed-Superseded" status and is issuing a new recommendation that the BMCS initiate a study to determine practical methods and means to prevent or minimize dozing at the wheel by drivers of carriers in interstate commerce, and advise the Safety Board on the findings of this study. In addition, the BMCS should issue an "On-Guard" notice to carriers and drivers advising them of the circumstances of this accident and the findings of the BMCS research on driver alertness and fatigue, and the degradation of driver performance during early morning hours.

As a result of its investigation of this accident, the National Transportation Safety Board recommends that the Bureau of Motor Carrier Safety of the Federal Highway Administration:

Issue an "On-Guard" notice to carriers and drivers advising them of the circumstances of the bus accident near Livingston, Texas, on November 30, 1983, and of the research findings of the Bureau of Motor Carrier Safety on fatigue and the degradation of driver performance and alertness during early morning hours. (Class II, Priority Action)  
(H-84-59)

Determine practical methods and means to prevent or minimize dozing at the wheel by drivers of carriers in interstate commerce, and advise the Safety Board of its findings. (Class III, Longer-term Action) (H-84-60)

BURNETT, Chairman, GOLDMAN, Vice Chairman, and BURSLEY and GROSE, Members, concurred in these recommendations.

  
By: Jim Burnett  
Chairman

