



# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

LOG 578

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In reply refer to: H-95-1 through -4

Honorable Rodney E. Slater  
Administrator  
Federal Highway Administration  
Washington, D.C. 20590

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A Safety Board analysis of Fatal Accident Reporting System (FARS) data indicates that in 1993 there were 3,311 heavy trucks involved in 3,169 fatal accidents. In these accidents, 3,783 persons died (432 were occupants of the heavy trucks).<sup>1</sup> Research has suggested that truckdriver fatigue may be a contributing factor in as many as 30 to 40 percent of all heavy truck accidents.<sup>2</sup> In 1990, the Safety Board completed a study of 182 heavy truck accidents that were fatal to the truckdriver.<sup>3</sup> These 182 accidents were a census of the heavy truck accidents that were fatal to the driver in the eight States that participated. The primary purpose in investigating fatal-to-the-driver heavy truck accidents was to assess the role of alcohol and other drugs in these accidents. The study found, however, that the most frequently cited probable cause was fatigue. The Board believes that the 31 percent incidence of fatigue in fatal-to-the-truckdriver accidents found in the 1990 study represents a valid estimate of the portion of fatal-to-the-driver heavy truck accidents that are fatigue-related. Little data are available to estimate the incidence of fatigue in the less severe heavy truck accidents.

Because of the significant number of heavy truck-related fatalities and the role of fatigue in such accidents, the Board initiated a study of single-vehicle heavy truck accidents to examine the role of specific factors that affect driver fatigue, such as

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<sup>1</sup> For this analysis, the Board defined a heavy truck as one >26,000 pounds gross vehicle weight.

<sup>2</sup> (a) Knipling, Ronald R.; Wang, Jing-Shiarn. 1994. Crashes and fatalities related to driver drowsiness/fatigue. Research Note. Washington, DC: U.S. Department of Transportation, National Highway Traffic Safety Administration. November. (b) Ryder, Andrew, ed. 1990. A system in need of overhaul. In: Driver fatigue, Part 1. Heavy duty trucking. September: 69-73.

<sup>3</sup> National Transportation Safety Board. 1990. Fatigue, alcohol, other drugs, and medical factors in fatal-to-the-driver heavy truck crashes. Safety Study NTSB/SS-90/01. Washington, DC

drivers' patterns of duty and sleep, in heavy truck accidents and to determine potential remedial actions. Most research of the factors associated with fatigue involve laboratory studies that examine the effect of sleep deprivation on the operator's performance of specific tasks, such as controlled driving in which various physiological measures are documented, or involve retrospective reviews of accident records, such as police records, which contain limited data and are not designed to assess the role of human performance factors in fatigue-related accidents. The Safety Board is in a unique position to study the role of human performance factors that contribute to fatigue-related accidents. Accident investigation is the primary function of the Board, and it has been examining the role of human performance factors (and fatigue in particular) in accidents in all transportation modes for many years. Therefore, this study<sup>4</sup> of actual accidents provides a unique opportunity to examine the factors that contribute to fatigue-related accidents.

Because the purpose of the Board's study was to examine the factors that affect driver fatigue and not the statistical incidence of fatigue, the Board specifically selected truck accidents that were likely to include fatigue-related accidents; that is, single-vehicle accidents that tend to occur at night. The Board desired to obtain approximately an equal number of fatigue-related and nonfatigue-related accidents through its notification process to examine the differences between the two groups. From September 1992 through June 1993, the Board was notified by authorities in the States of Alabama, California, Georgia, New Jersey, North Carolina, and Texas<sup>5</sup> of single-vehicle accidents. During this period, the Board accepted sequentially for investigation, with no prejudgment of fatigue involvement, those accidents that occurred within a reasonable driving distance from the Board's regional offices and in which the vehicle was available for examination and the driver was available to be interviewed.

The Board was specifically interested in obtaining accurate information regarding the truckdrivers' duty and sleep patterns for the 96 hours preceding the accident; therefore, the Board limited the accidents to those in which the driver survived and was available to be interviewed by the Board's investigators to reconstruct the previous 96 hours. The Board did not rely solely on the drivers' official log books because of concern that inaccurate or incomplete information might have been recorded and because total sleep time is not required to be reported.

The Safety Board investigated 113 single-vehicle heavy truck accidents in which the driver survived. However, because the 96-hour duty/sleep history that was required for the study was not available for 6 drivers, the 6 accidents in which these

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<sup>4</sup> National Transportation Safety Board. 1995. Factors that affect fatigue in heavy truck accidents. Volume 1: analysis. Safety Study NTSB/SS-95/01. Washington, DC.

<sup>5</sup> According to FARS data, in 1992 about 27 percent of fatal accidents involving large trucks in the United States occurred in these six States.

drivers were involved were not included in the study. The study, therefore, analyzes data from 107 single-vehicle heavy truck accidents.<sup>6</sup>

The Board examined several measures of duty time, driving time, awake time, and sleeping time for the drivers. These measures included (1) the number of hours awake, driving, on duty, and sleeping in the 24-, 48-, 72-, and 96-hour periods before the accident, (2) the number of hours driving since the driver had last slept, (3) the number of hours driving in the period most recent to the accident, (4) the number of hours on duty prior to the accident (including nondriving activities such as loading and unloading cargo, truck inspections, paperwork, calling dispatchers, and waiting at terminals), (5) the number of hours since the driver had last slept, and (6) the number of hours slept in the sleep period most recent to the accident.<sup>7</sup> These measures were taken from the 96-hour logs that were reconstructed from the Safety Board investigators' interviews with the drivers.

The Board also examined the drivers' duty/sleep patterns for the 96-hour period before the accident. The Board established five measures of the drivers' duty/sleep patterns. The five dichotomous (yes/no) measures included irregular duty, irregular sleep, both irregular duty and sleep, regular duty and sleep, and regular sleep with nonclassifiable duty.<sup>8</sup> These five measures are mutually exclusive. The Board also identified three other schedule-related measures that could occur for a driver with either regular or irregular duty/sleep patterns. They include inverted duty/sleep, split sleep patterns, and exceeded hours-of-service limits (exceeded HOS limits).

A total of 21 measures, all derived from detailed driver logs, were used to characterize drivers' patterns and amounts of duty and sleep in the 96 hours prior to the accident.<sup>9</sup> Of the 107 drivers, the complete set of duty/sleep measures could not be computed for 20 drivers; hence, data from only 87 drivers were available for analysis (51 were involved in fatigue-related accidents, 36 were not). As would be expected, the driving and duty times of the 20 excluded drivers were less than those of the 87 drivers who had not had days off. Eleven of the 20 excluded drivers were

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<sup>6</sup> Volume 2 of this study (NTSB/SS-95/02) contains the briefs of the 107 accidents investigated by the Safety Board.

<sup>7</sup> For purposes of discussion in this study, these measures have been termed "duty/sleep time measures"

<sup>8</sup> If a driver did not have at least three consecutive start times, his duty hours were considered "nonclassifiable."

<sup>9</sup> The majority of the single-vehicle accidents in the Safety Board's sample occurred between 2 and 8 a.m. (53 percent), and an even higher percentage of the accidents that were determined to be fatigue-related occurred during these same hours (75 percent). Time of day was not included as one of the 21 measures because of the inherent bias in the sample of cases; that is, single-vehicle accidents are likely to occur at night when traffic is light or sparse.

involved in fatigue-related accidents, and the remaining 9 drivers were involved in nonfatigue-related accidents.

A multiple discriminant analysis<sup>10</sup> was performed to simultaneously evaluate the relationship of a set of 18 predictor measures<sup>11</sup> to the groupings of accidents established by investigators' determination of probable cause (fatigue-related and nonfatigue-related accidents). In the present case, discriminant analysis provides a means of simultaneously examining the capacity of the interrelated sleep, duty, and scheduling measures to classify an accident as either fatigue-related or nonfatigue-related. The combination of measures resulting from the application of the discriminant analysis to the Board's 87 accidents was able to correctly classify 94.4 percent of the nonfatigue-related accidents and 80.4 percent of the fatigue-related accidents—a very high rate of successful classification.<sup>12</sup>

The results of the discriminant analysis indicate that the most critical measures in predicting fatigue-related accidents in the Safety Board's sample are the duration of the most recent sleep period, the amount of sleep in the past 24 hours, and split sleep patterns. It is not surprising that sleep factors rated high in this analysis given the results of extensive scientific research in this area. However, the Board believes that it is noteworthy in this unique sample of actual accidents that factors that affect the ability to obtain adequate sleep, such as irregular duty/sleep and inverted schedules (which are often assumed to be closely associated with fatigue), ranked well below the factors that affect the quantity and quality of sleep.<sup>13</sup>

The truckdrivers in fatigue-related accidents in this sample obtained on average 5.5 hours of sleep in the last sleep period prior to the accident. This is 1.4 hours less than the 6.9 hours they reported needing to feel rested and 2.5 hours less than that obtained by drivers in nonfatigue-related accidents (8.0 hours of sleep in the last sleep period). The findings further indicate that the truckdrivers involved in fatigue-related accidents obtained about 2.4 hours less sleep in the 24-hour period

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<sup>10</sup> A description of discriminant analysis can be found in the following publication: Tabachnick, B.G.; Fidell, L.S. 1989. Using multivariate statistics. 2nd ed. New York: Harper & Row. 746 p.

<sup>11</sup> Because hours awake and hours asleep in the last 24 or 48 hours were complements of one another, only the time asleep measures were included in the analysis. Similarly, the scheduling measure of regular sleep/duty was not included because it is simply the complement of irregular duty/sleep. Thus, the set of predictors was reduced to 18 measures.

<sup>12</sup> Details of the discriminant analysis are contained in chapter 4 and appendix D of the study (NTSB/SS-95/01).

<sup>13</sup> Although the Safety Board examined single-vehicle accidents, there is no reason to believe that the factors that were associated with fatigue-related single-vehicle accidents would be any different in other kinds of accidents. The Board believes, therefore, that the results of this study can be generalized to the trucking population as a whole.

before the accident than the drivers not involved in fatigue-related accidents (6.9 hours compared to 9.3 hours).

The data indicate that the mean time awake, but not on duty, for the drivers in the fatigue-related accidents was about 5.5 hours. This suggests that these drivers could have readily attained more than the mean of 5.5 hours of sleep during the last sleep period prior to the accident. However, the timing of the awake period may not have fit with the driving schedule to permit 8 hours continuous sleep in the last sleep period. Further, the drivers have a need to attend to family duties and other responsibilities. The fact that drivers in nonfatigue-related accidents also were awake about 5.5 hours while off duty (but still attained 8 hours sleep in the most recent sleep period prior to the accident) suggests that 5.5 hours is not an unreasonable period of time to be allocated to such needs. It appears, therefore, that if the driving or on-duty time is pushed to the maximum hours allowed, drivers will reduce the amount of time for sleep rather than the time needed to accomplish other duties and responsibilities.

The HOS regulations currently require drivers to be off duty for a minimum of 8 consecutive hours after reaching the maximum number of hours allowed: 10 hours driving and/or 15 hours on duty. (Drivers are allowed to reach 60 on-duty hours in 7 days or 70 hours in 8 days.) In drafting these regulations in 1937, the Interstate Commerce Commission (ICC) wrote:

It is obvious that a man cannot work efficiently or be a safe driver if he does not have an opportunity for approximately 8 hours sleep in 24. It is a matter of simple arithmetic that if a man works 16 hours per day he does not have an opportunity to secure 8 hours' sleep. Allowance must be made for eating, dressing, getting to and from work, and the enjoyment of the ordinary recreations.<sup>14</sup>

The need for adequate sleep and the effect of inadequate sleep on performance is well documented in the scientific literature. The Board's past safety studies and accident investigations have also highlighted fatigue as a factor in operator performance. The recurring role of fatigue in transportation accidents prompted the Safety Board 5 years ago to recommend that the Secretary, U.S. Department of Transportation:

Expedite a coordinated research program on the effects of fatigue, sleepiness, sleep disorders, and circadian factors on transportation system safety. (I-89-1)

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<sup>14</sup> 3 M.C.C. 673, December 29, 1937

Develop and disseminate educational material for transportation industry personnel and management regarding shift work; work and rest schedules; and proper regimens of health, diet, and rest. (I-89-2)

Review and upgrade regulations governing hours of service for all transportation modes to assure that they are consistent and that they incorporate the results of the latest research on fatigue and sleep issues. (I-89-3).

The three safety recommendations are currently classified "Open—Acceptable Response." In response to recommendation I-89-1, the DOT formed the DOT Human Factors Coordinating Committee, comprising representatives from each of the modal agencies, who regularly brief the Safety Board on the progress of the committee and action taken by each modal agency to address these recommendations. According to these briefings, some dissemination of useful information is occurring, as recommended in I-89-2. With respect to I-89-3, the Board recognizes the long-term nature of this recommendation. On October 21, 1994, a representative of the Federal Highway Administration (FHWA) briefed the Safety Board on the status of the fatigue research being sponsored by the FHWA.

The FHWA has several ongoing and planned studies to address fatigue and commercial truckdriving. The Safety Board commends the FHWA and the other modal administrations for their efforts to address the issue of fatigue in transportation. The Board recognizes the importance of laboratory studies and controlled driving experiments and their contributions toward enhancing the general understanding of the physiological mechanisms underlying fatigue, the performance decrements that accompany fatigue, and improved strategies for maintaining alertness. Notwithstanding its support for the ongoing research, the Safety Board believes that the results of this study of actual accidents provides concrete evidence of the measures that affect fatigue in the accident environment and offers a unique opportunity to develop appropriate countermeasures. Studies of subjects in a laboratory environment or controlled driving experiments cannot provide such evidence of the factors that lead to fatigue-related accidents (or any accidents for that matter). Accident investigations provide a much more valid body of information on which to base sound transportation safety policy decisions than what can be obtained in controlled or laboratory studies. This set of accidents provides the necessary data, and the results of this accident-based study clearly demonstrate the need to obtain adequate sleep to avoid the effects of fatigue when operating transportation vehicles.

Research indicates that the amount of sleep needed varies on an individual basis: "...for some it is 5 to 6 hours a night, for others it is...7 or 8 hours, and for still others it is 9 to 10 hours."<sup>15</sup> The Safety Board recognizes that all truckdrivers do not

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<sup>15</sup> Dinges, D.F. 1984. The nature and timing of sleep. Transactions & Studies of the College of Physicians of Philadelphia. Ser.5:6(3): 177-206 (p. 198).

need 8 hours of sleep. However, responsible public policy dictates that drivers of heavy trucks be able to obtain adequate sleep between work assignments. Implementation of this policy, in the form of Federal regulations or industry procedures and practices, cannot generally address drivers on an individual basis. Thus, implementation of this policy must address the norm, which research has determined to be 8 hours—a fact noted by the ICC in 1937.<sup>16</sup> The results of this study support the need by the “average” driver for 8 continuous hours of sleep.

The Board has addressed the issue of adequate rest periods in various modes of transportation. Recently, the Board addressed this issue in the aviation mode. Current regulations require a minimum rest period of 10 hours for a pilot scheduled to fly an 8 to 9 hour flight. The regulations also allow for providing flightcrews with less than the required rest period in exchange for compensatory rest later. For example, if the scheduled flight time for a pilot is 8 to 9 hours, the rest period before duty may be reduced from 10 to 8 hours if the rest period following duty is increased to 11 hours.

The intent of the reduced rest provisions was to provide carriers more flexibility with flightcrew schedules to accommodate extended duty days that result from unforeseen operational delays. However, the current reduced rest provisions allow carriers to establish schedules that result in reduced rest, and many airlines routinely take advantage of the provisions when scheduling their flightcrews rather than using the provisions for unforeseen circumstances, as originally intended. In its recent study on commuter airline safety,<sup>17</sup> the Board expressed disappointment that important issues concerning flightcrew scheduling and rest remain unresolved after 2 years. In that study, the Board reiterated its position that “...rest should be defined as time available for restful sleep, and minimum rest periods should provide the opportunity for adequate sleep, taking into account time needed for travel to and from rest facilities and for attending to nourishment and personal hygiene”—again, a point made by the ICC in 1937.

The Safety Board recognizes that regulations cannot assure that adequate sleep will be obtained. Nevertheless, the regulations can and must provide the opportunity to obtain an adequate amount of rest. However, the 8-hour off-duty requirement in the current regulations does not do so because it does not provide time for travel, eating, personal hygiene, and recreation. Further, depending on various factors, including the time of day, a driver may not be able to fall asleep immediately at the beginning of the 8-hour off-duty period. Because the results of this accident sample are unlikely to be substantially enhanced by any further

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<sup>16</sup> (a) Carskadon, M.S ; Dement, W.C. (1994) (b) Carskadon, Mary A., ed 1993 Encyclopedia of sleep and dreaming New York: Macmillan Publishing Company

<sup>17</sup> National Transportation Safety Board. 1994. Commuter airline safety. Safety Study NTSB/SS-94/02. Washington, DC.

research, these results provide a solid basis for sound policy decisions. The Board also recognizes that the inadequate sleep obtained may not be directly related to the 8-hour off-duty requirement in the HOS regulations. However, in the Safety Board's view, a minimum standard that does not provide for at least 8 hours of sleep is not responsible public policy and could be construed as condoning less than 8 hours of sleep as adequate, when the time needed for eating, hygiene, and recreation is considered. Therefore, the Board believes that within 2 years the FHWA should complete rulemaking to revise 49 CFR 395.1 to require sufficient rest provisions to enable drivers to obtain at least 8 continuous hours of sleep. This revision would satisfy the highway portion of the intermodal Safety Recommendation I-89-03.

Given the results of the latest research and studies on fatigue and sleep issues, the Board believes that steps can be taken now to provide truckdrivers with the opportunity to obtain 8 hours of sleep and that the trucking industry can take a lead role in this effort. Therefore, the Safety Board believes that the trucking industry should incorporate into its scheduling practices and procedures the results of the latest research on fatigue and sleep issues, particularly that an 8-hour sleep need is the norm. The Safety Board believes that current scheduling practices can accommodate a change in the rest period without resulting in undue economic hardships. The Safety Board believes that the majority of trucking companies currently comply with the hours-of-service regulations and that an increase in the amount of off-duty time would not change the way they schedule their deliveries or require changes in the locations of terminals. The data in this sample show that the truckdrivers involved in nonfatigue-related accidents were typically on duty 9 hours a day. These drivers had sufficient time to obtain adequate sleep and, in fact, did obtain 8 hours of continuous sleep in their last sleep period.

The Safety Board recognizes that providing the opportunity to obtain adequate sleep will not assure that drivers actually obtain that sleep. The ICC recognized this in 1937, stating:

We fully recognize that regulations of this kind cannot provide a complete answer to the problem of driver fatigue and its effect upon safety of operation. We have no control over the manner in which a driver may spend his time off duty, although some of his spare-time activities may tire him quite as much as any work would do. We can only emphasize, by this comment, the responsibility which is the driver's own to assure himself of adequate rest and sleep, in the time available for this purpose, to ensure the safety of his driving, and likewise the employer's responsibility to see that his drivers report for work in fit condition.

Although drivers have a responsibility to obtain adequate rest and sleep, they must first recognize that they need sleep. Many of the truckdrivers in the Safety Board's accident sample who were involved in fatigue-related accidents did not



recognize that they were in need of sleep and believed that they were rested when they were not. Drivers in both fatigue-related and nonfatigue-related accidents rated themselves as being okay to fully alert before the accident. Further, about 80 percent of the drivers involved in fatigue-related accidents rated the quality of their last sleep before the accident as good or excellent. Drivers in fatigue-related accidents received about 1.4 hours less sleep than they reported needing to feel rested. Research has indicated that people "...have a limited ability to predict the onset of sleep...[and that]...subjects certainly do fall asleep at times when they think sleep is highly unlikely."<sup>18</sup>

"Inadequate sleep, even as little as 1 or 2 hours less than usual sleep, can greatly exaggerate the tendency for error during the time zones of vulnerability (1 to about 8 a.m. and 2 to roughly 6 p.m.)."<sup>19</sup> The majority of the accidents in this sample occurred between 2 and 8 a.m. (53 percent), and an even higher percentage of the accidents that were found to be fatigue-related occurred during these same hours (75 percent). Driving at night, as many truckdrivers must do, is complicated by the effects of circadian rhythms. Thus, a sleep deprived person driving at night is in the highest risk situation—a risk that many drivers may not be aware of or recognize.

Modifying the regulations to increase the off-duty period will not, by itself, eliminate the problem of truckdriver fatigue. Educating transportation employees about the effects of fatigue, in the Safety Board's view, is a vitally important component of overall efforts to combat fatigue in transportation. The Board recognizes that there is a considerable amount of research underway that could eventually be used to develop or modify programs designed to educate operators of heavy trucks and other industry personnel, in particular management, about the importance of sleep loss and other factors in fatigue-related accidents. However, the Board believes that this study and other research have provided important information that could be provided now to truckdrivers and management about factors leading to fatigue and possible strategies to combat fatigue. In addition to studies discussed above, the NASA Ames Fatigue Countermeasures Program stands out as demonstrating some especially effective countermeasures. This program, which has been underway since 1980, has addressed strategic napping as a preventive strategy and an operational countermeasure to combat sleep loss, circadian disruption, and fatigue that occur as a result of multiple time zone changes,

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<sup>18</sup> Itoi, A.; Cilveti, R.; Voth, M.; and others 1993. Can drivers avoid falling asleep at the wheel? Relationship between awareness of sleepiness and ability to predict sleep onset. Washington, DC: AAA Foundation for Traffic Safety (p 25). 33 p.

<sup>19</sup> Mitler, M.; Carskadon, M.A.; Czeisler, C.A.; and others 1988. Catastrophes, sleep and public policy: consensus report *Sleep*. 11(1): 100-109.

and extended, irregular duty schedules in flight operations.<sup>20</sup> The researchers found that there is scientific evidence showing that as a preventive strategy, napping before fatigue develops is quite effective in an operational setting. A single nap of about 45 minutes in duration prior to a night without sleep can prevent significant loss of performance capability and fatigue throughout the night. The Safety Board agrees that the use of naps as a means to prevent fatigue prior to its onset is a worthwhile countermeasure. The Board cautions, however, that these naps should be a supplement to, not a replacement for, one continuous 8-hour sleep period.

Another measure that was relatively highly correlated with fatigue was split sleep patterns. Split sleep patterns also ranked fifth in importance in discriminating between long-haul and short-haul operations. The HOS regulations contain an exemption that allows drivers using Department of Transportation-approved sleeper berth equipment to accumulate the required 8 consecutive hours off duty resting in a sleeper berth in two separate periods totaling 8 hours (neither period to be less than 2 hours).

The findings of this study show that truckdrivers with split sleep patterns were obtaining about 8 hours of sleep in a 24-hour time period; however, they obtained it in segments, on average of 4 hours at a time. Research, not available at the time the regulations were drafted by the Interstate Commerce Commission, has shown that sleep accumulated in short time blocks is less refreshing than sleep accumulated in one long time period.<sup>21</sup> Other research indicates that "...the more sleep is disturbed or reduced, for whatever reason, the more likely an individual will inadvertently slip into sleep."<sup>22</sup> A review of police accident reports has also demonstrated that decrements in performance occur earlier for drivers using sleeper berths (or drivers with split sleep patterns) than for other drivers. The same research determined that split-shift, sleeper berth use (that is, driving without an 8-hour consecutive rest period) increased the risk of fatality more than two-fold. Sleep duration has been found to be as important to the recovery of performance abilities as is the quality of sleep experience.<sup>23</sup> Of the drivers for whom information on duty hours was available, 19 of 26 drivers with split sleep patterns (73 percent) had slept in a sleeper berth.

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<sup>20</sup> Rosekind, Mark R.; Graeber, R. Curtis; Dinges, David F.; and others. 1993. Crew factors in flight operations. IX: Effects of planned cockpit rest on crew performance and alertness in long-haul flight operations. NASA Technical Memorandum 108839. DOT/FAA/92/24. Washington, DC.

<sup>21</sup> Dinges, D. F. 1989. The nature of sleepiness: causes, contexts, and consequences. In: Stunkard, A. J.; Baum, A. Perspectives in behavioral medicine: eating, sleeping, and sex. Hillsdale, NJ: Lawrence Erlbaum Associates: 147-179. Chapter 9 (p. 147).

<sup>22</sup> (a) Mitler and others (1988, p. 107). (b) Rosekind, M.R.; Gander, P.H.; Connell, L.J.; Co, E.L. 1994. Crew factors in flight operations X: alertness management in flight operations. NASA/FAA Technical Memorandum DOT/FAA/RD-93/18.

<sup>23</sup> Hertz, R.P. 1988. Tractor-trailer driver fatality: the role of nonconsecutive rest in a sleeper berth. *Accident Analysis and Prevention*. 20(6): 431-439.

In drafting its original regulations, the Interstate Commerce Commission (ICC) noted the lack of scientific evidence about the nature of fatigue. The ICC was clearly frustrated at being unable to base its regulations on an empirical understanding of driver fatigue. Given what is now known about the inferior nature of split sleep patterns, it is unclear that the ICC would have permitted sleeper berth drivers to divide their required 8-hour off-duty period into two segments. Although the Safety Board encourages the use of sleeper berths for strategic napping and recognizes that sleeper berths may allow for continuous sleep, truckdrivers should not be encouraged or permitted to split their sleep. The current hours-of-service regulations do not permit drivers who sleep at a residence or in a motel to split their sleep periods. This exemption applies only to drivers who use sleeper berths. The Safety Board understands that in 1937, when these regulations were written, economic considerations required that freight move continuously—to keep produce and dairy products from spoiling, for example. However, the advent of refrigerated trucks eliminated concerns about food spoilage. The Board is also aware that the trucking industry wanted the flexibility provided by having drivers rest in their sleeper berths while waiting for other tasks to be completed (such as loading of tanks with crude oil). This would enable drivers to begin driving as soon as the tasks were completed and to drive for at least the time that they spent resting in their berths.

Although the Board is aware of the importance of just-in-time deliveries to the economic well-being of the manufacturing industry, the Board does not believe that this flexibility should be permitted at the expense of safety. The Safety Board is not aware of any physiological or laboratory research regarding the effect of split sleep patterns on performance; however, the Board's analysis has shown that the length of the most recent sleep period is the most important factor in determining fatigue and that the continuous nature of that sleep also is very important. Consequently, the Safety Board believes that the Federal Highway Administration should complete rulemaking within 2 years to eliminate 49 CFR 395.1 paragraph (h), which allows drivers with sleeper berth equipment to cumulate the 8 hours of off-duty time in two separate periods.

The Safety Board has previously expressed its view that carriers and shippers share responsibility in helping to eliminate fatigue involvement in truck accidents. As a result of its 1990 study on fatal-to-the-driver truck accidents, the Safety Board issued Safety Recommendation H-90-32 to the FHWA, which asked the FHWA to:

Amend CFR part 392 and 395 to prohibit employers, shippers, receivers, brokers, or drivers from accepting and scheduling a shipment which would require that the driver exceed the hours-of-service regulations in order to meet the delivery deadline (similar to current regulations regarding schedules which would require the driver to exceed the speed limit (49 CFR Section 392.6)). In conjunction with the Interstate Commerce Commission, provide for operating certificate and financial penalties appropriate to the offense.

The FHWA has recently indicated to the Safety Board that a research project for FY95 will investigate the role of shippers and other parties in commercial transportation. The Safety Board firmly believes that carriers and shippers share responsibility with drivers regarding adherence to the HOS regulations and the prevention of driver fatigue. The Board is aware that some carriers have implemented satellite tracking as a management tool to track shipments and facilitate communications with the drivers. This existing technology could also serve to monitor on-duty times of the drivers to help drivers plan and obtain adequate rest during their off-duty hours. The Safety Board encourages the FHWA to address the issue of the role of shippers and carriers with respect to adherence to the HOS regulations in its 1995 project. However, the Safety Board recognizes that the role of the Interstate Commerce Commission, which is addressed in the recommendation, has changed. Consequently, Safety Recommendation H-90-32 is being classified "Closed—Acceptable Action/Superseded," and a new recommendation, albeit similar, is being issued in conjunction with this study.

The results of this study also raise questions about the influence of pay policies on truckdriver fatigue. About 65 percent of the drivers (28 of 43) who were paid by the mile had a fatigue-related accident compared to 46 percent of the drivers paid by a percent of load revenue (13 of 28) and 27 percent of drivers paid by the hour (3 of 11). Pay practices in this sample appeared to be associated with the type of trucking operation. About 77 percent of the drivers paid by the mile (33 of 43) were long-haul drivers. In contrast, none of the 11 drivers paid by the hour and only 25 percent of the drivers paid by a percent of load revenue (7 of 28) were long-haul drivers. Further, of the 27 drivers who exceeded the hours-of-service limits, 57 percent (15 drivers) were paid by the mile and 30 percent (8 drivers) were paid by a percent of load revenue. These results raise questions about a possible link between the method of compensation and fatigue-related accidents. It is the Safety Board's understanding that the FHWA has not previously examined any effect between pay policies and truck accidents. The Board believes, therefore, that the FHWA should examine the methods in which truckdrivers are compensated for their trips and determine if there is an effect on hours-of-service violations, accidents, or fatigue.

Another countermeasure to reduce the number of fatigue-related accidents is the use of on-board electronic recording devices in trucks. These monitors have been proposed by the Safety Board as a means to identify drivers who exceed the hours-of-service limits. As a result of its 1990 study on fatal-to-the-driver truck crashes, the Safety Board recommended that the FHWA "require automated/tamper-proof on-board recording devices such as tachographs or computerized logs to identify commercial truck drivers who exceed hours-of-service regulations" (Safety Recommendation H-90-28).<sup>24</sup> The Board reasoned that if law enforcement personnel could routinely examine data from on-board recorders instead of written logbooks, these devices could, in theory, reduce HOS violations by discouraging carriers from

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<sup>24</sup> National Transportation Safety Board. Safety Study NTSB/SS-90/01

setting unrealistic delivery times as well as discouraging drivers from driving too long or exceeding the speed limit. The FHWA has not agreed with the intent of this recommendation stating that the recommendation was tantamount to a design standard and not in keeping with agency policy to issue performance standards whenever possible and that the devices have not yet been proven to be of such value as to warrant mandatory use. In its response to the FHWA, dated August 4, 1994, the Board reiterated its position that because the recommendation calls only for a tamper-proof means of recording data and does not specify the means, the Board is asking only for a performance standard and not a design standard. The Board further noted that new trucks are highly computerized with automated fuel management and maintenance systems built into the vehicles and that some carriers are now requiring on-board recording devices as part of driver speed control and fuel incentive pay systems. The Board continues to believe in the merits of Safety Recommendation H-90-28, which is currently classified "Open—Unacceptable Response," and is reiterating the recommendation as a result of this study.

Therefore, as a result of this study, the National Transportation Safety Board recommends that the Federal Highway Administration:

Complete rulemaking within 2 years to revise 49 CFR 395.1 to require sufficient rest provisions to enable drivers to obtain at least 8 continuous hours of sleep after driving for 10 hours or being on duty for 15 hours. (Class II, Priority Action) (H-95-1)

Complete rulemaking within 2 years to eliminate 49 CFR 395.1 paragraph (h), which allows drivers with sleeper berth equipment to cumulate the 8 hours of off-duty time in two separate periods. (Class II, Priority Action) (H-95-2)

Examine truckdriver pay compensation to determine if there is any effect on hours-of-service violations, accidents, or fatigue. (Class II, Priority Action) (H-95-3)

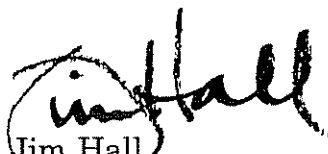
Complete rulemaking within 2 years to amend 49 CFR Part 392 and 395 to prohibit employers, shippers, receivers, brokers, or drivers from accepting and scheduling a shipment which would require that the driver exceed the hours-of-service regulations in order to meet the delivery deadline (similar to current regulations regarding schedules which would require the driver to exceed the speed limit [49 CFR 392.61]). (Class II, Priority Action) (H-95-4) (Supersedes H-90-32)

As a result of this study, the National Transportation Safety Board also reiterates the following safety recommendation to the Federal Highway Administration:

Require automated/tamper-proof on-board recording devices such as tachographs or computerized logs to identify commercial truck drivers who exceed hours-of-service regulations. (H-90-28)

Also as a result of the study, the Safety Board issued safety recommendations to the Professional Truck Driver Institute of America, the American Trucking Associations, Inc., the Commercial Vehicle Safety Alliance, the National Private Truck Council, the Independent Truck Owner Operators, the Owner-Operator Independent Driver's Association, the International Brotherhood of Teamsters, and the National Industrial Transportation League.

Chairman HALL and Members HAMMERSCHMIDT and FRANCIS concurred in these recommendations.

By:   
Jim Hall  
Chairman