# Evaluation of U.S. Department of Transportation Efforts in the 1990s to Address Operator Fatigue

**Safety Report**
**NTSB/SR-99/01**

May 1999
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Notation 7155

**National Transportation Safety Board**
Washington, D.C.

**National Transportation Safety Board. 1999. *Evaluation of U.S. Department of Transportation Efforts in the 1990s to Address Operator Fatigue.* Safety Report NTSB/SR-99/01. Washington, DC.**

During the 1980s, the National Transportation Safety Board investigated several aviation, highway, and marine accidents that involved operator fatigue. Following completion of these investigations, the Safety Board in 1989 issued three recommendations to the U.S. Department of Transportation (DOT) addressing needed research, education, and revisions to hours-of-service regulations. In the 10 years that have passed, the Safety Board has issued more than 70 additional recommendations to the DOT, States, industry, and industry associations to reduce the incidence of fatigue-related accidents. In response to the three 1989 recommendations, the DOT and the modal administrations have, in general, acted and responded positively to those addressing research and education; little action, however, has occurred with respect to revising the hours-of-service regulations. Nevertheless, the Safety Board believes that support has grown in recent years to make substantive changes to these regulations. This report provides an update on the activities and efforts by the DOT and the modal administrations to address operator fatigue and, consequently, the progress that has been made in the past 10 years to implement the actions called for in the three intermodal recommendations and other fatigue-related recommendations. The report also provides some background information on current hours-of-service regulations, fatigue, and the effects of fatigue on transportation safety. As a result of this safety report, the National Transportation Safety Board issued new safety recommendations to the U.S. Department of Transportation, the Federal Aviation Administration, the Federal Highway Administration, the Federal Railroad Administration, the Research and Special Programs Administration, and the United States Coast Guard. The Safety Board also reiterated two recommendations to the Federal Aviation Administration.

The National Transportation Safety Board is an independent Federal agency dedicated to promoting aviation, railroad, highway, marine, pipeline, and hazardous materials safety. Established in 1967, the agency is mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The Safety Board makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

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# Safety Report

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**National Transportation Safety Board**
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# Acronyms Used in the Report

| | |
|---|---|
| **AAA** | American Automobile Association |
| **ANPRM** | advance notice of proposed rulemaking |
| **ARAC** | Aviation Rulemaking Advisory Committee |
| **ASRS** | Aviation Safety Reporting System |
| **CFR** | *Code of Federal Regulations* |
| **DOT** | U.S. Department of Transportation |
| **FAA** | Federal Aviation Administration |
| **FHWA** | Federal Highway Administration |
| **FRA** | Federal Railroad Administration |
| **FTA** | Federal Transit Administration |
| **GT** | gross ton |
| **NASA** | National Aeronautics and Space Administration |
| **NHTSA** | National Highway Traffic Safety Administration |
| **NPRM** | notice of proposed rulemaking |
| **RSPA** | Research and Special Programs Administration |
| **U.S.C.** | *United States Code* |
| **USCG** | United States Coast Guard |

# Executive Summary

During the 1980s, the National Transportation Safety Board investigated several aviation, highway, and marine accidents that involved operator fatigue. Following completion of these accident investigations, the Safety Board in 1989 issued three recommendations to the U.S. Department of Transportation (DOT) addressing needed research, education, and revisions to hours-of-service regulations.

Ten years have passed since these safety recommendations were issued. In the interim, the Safety Board has issued more than 70 additional recommendations to the DOT, States, industry, and industry associations to reduce the incidence of fatigue-related accidents. In response to the three 1989 recommendations, the DOT and the modal administrations have, in general, acted and responded positively to the recommendations addressing research and education; little action, however, has occurred with respect to revising the hours-of-service regulations. Nevertheless, the Safety Board believes that support has grown in recent years to make substantive changes to these regulations.

This report provides an update on the activities and efforts by the DOT and the modal administrations to address operator fatigue and, consequently, the progress that has been made in the past 10 years to implement the actions called for in the three intermodal recommendations and other fatigue-related recommendations. The report also provides some background information on current hours-of-service regulations, fatigue, and the effects of fatigue on transportation safety.

As a result of this safety report, the National Transportation Safety Board issued new safety recommendations to the U.S. Department of Transportation, the Federal Aviation Administration, the Federal Highway Administration, the Federal Railroad Administration, the Research and Special Programs Administration, and the United States Coast Guard. The Safety Board also reiterated two recommendations to the Federal Aviation Administration.

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## Part 1

# Introduction

During the 1980s, the National Transportation Safety Board investigated several accidents that involved operator fatigue.[1] Following completion of these accident investigations, the Safety Board in 1989 issued three recommendations to the U.S. Department of Transportation (DOT):[2]

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

Ten years have passed since these safety recommendations were issued. In the interim, the Safety Board has issued more than 70 additional recommendations to the DOT, States, and industry to reduce the incidence of fatigue-related accidents.[3] The purpose of this report is to provide an update on the activities and efforts by the DOT and the

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[1] (a) National Transportation Safety Board. 1985. *Collision of Tuba City School District Schoolbus and Bell Creek, Inc., Tractor-Semitrailer, U.S. 160 Near Tuba City, Arizona, April 29, 1985.* Highway Accident Report NTSB/HAR-85/06. Washington, DC. (b) National Transportation Safety Board. 1986. *Grounding of the Panamanian-Flag Passenger Carferry M/V* A. Regina, *Mona Island, Puerto Rico, February 15, 1985.* Marine Accident Report NTSB/MAR-86/02. Washington, DC. (c) National Transportation Safety Board. 1986. *China Airlines, Boeing 747-SP, N4522V, 300 Nautical Miles Northwest of San Francisco, California, February 19, 1985*. Aircraft Accident Report NTSB/AAR-86/03. Washington, DC. (d) National Transportation Safety Board. 1987. *Trailways Lines, Inc., Intercity Bus Collision With Rising Fast Trucking Company, Inc., Interstate Highway 40 Near Brinkley, Arkansas, July 14, 1986.* Highway Accident Report NTSB/HAR-87/05. Washington, DC. (e) National Transportation Safety Board. 1988. *Collision Between the* USS Richard L. Page *(FFG-5) and the U.S. Fishing Vessel* Chickadee, *the Atlantic Ocean, April 21, 1987.* Marine Accident Report NTSB/MAR-88/04. Washington, DC. (f) National Transportation Safety Board. 1988. *Collision Between U.S. Passenger/Car Ferries M/V* North Star *and M/V* Cape Henlopen *on Long Island, Orient Point, New York, July 9, 1987*. Marine Accident Report NTSB/MAR-88/06. Washington, DC. (g) National Transportation Safety Board. 1989. *Head-End Collision of Consolidated Rail Corporation Freight Trains UBT-506 and TV-61 Near Thompsontown, Pennsylvania.* Railroad Accident Report NTSB/RAR-89/02. Washington, DC.

[2] The Safety Board's recommendation letter, issued May 12, 1989, is reproduced in appendix A.

[3] See appendix B for the recommendations issued to the DOT and modal administrations.

modal administrations to address operator fatigue and, consequently, the progress that has been made in the past 10 years to implement the actions called for in the three intermodal recommendations and other fatigue-related recommendations. Before addressing the activities and the progress made regarding these recommendations, the report provides some background information on current hours-of-service regulations, fatigue, and the effects of fatigue on transportation safety.

## Current Hours-of-Service Regulations

Hours-of-service regulations specify the length of on-duty and off-duty time for operators in transportation. The current hours-of-service regulations vary from mode to mode. The motor carrier hours-of-service regulations were developed in 1937 and have remained essentially unchanged. The Railroad Hours of Service Act was first enacted in 1907; it was substantially revised in 1969, and amended again in 1976 and 1988. Aviation limits were addressed in the Civil Aeronautics Act of 1938 and the Federal Aviation Act of 1958. In 1985, domestic flight limitations and some commuter limitations were updated; flag and supplemental operations were not. The work-hour regulations for marine are specified in Title 46 *United States Code* (U.S.C.) 8104 and date back to the early part of the 20th century. The Oil Pollution Act of 1990 contained work-hour limitations for tank personnel of 15 hours per 24 hours and 36 hours per 72 hours. In 1997, work-hour regulations from the *Standards for Training, Certification, and Watchkeeping* of the International Maritime Organization became effective, requiring a minimum 10-hour rest period during any 24-hour period. The work and rest provisions for operators in the various modes are summarized in table 1–1.

The regulations for aviation, highway, and some marine vessel types impose weekly work and rest limits. Only the aviation mode has monthly and annual limits as well. The maximum number of hours an employee of each mode is permitted to work in the course of a 30-day period is shown in figure 1–1.[4] A commercial pilot may fly up to 100 hours per month; a truckdriver may be on duty up to about 260 hours per month; licensed individuals on an oceangoing vessel or coastwise vessel of not more than 100 gross tons (GT) may operate up to 360 hours per month when at sea; and locomotive engineers may operate a train up to 432 hours per month.

[4] The time for pilots includes only flying time.

**Table 1–1. Summary of the current hours-of-service regulations, all transportation modes.**

| Aviation (14 CFR Part 121; 14 CFR Part 135) |
|---|
| • Pilots flying domestic Part 121 operations may fly up to 30 hours per week, 100 hours per month, and 1,000 hours per year.<br>• Pilots flying domestic Part 135 operations may fly up to 34 hours per week, 120 hours per month, and 1,200 hours per year.<br>• If the scheduled flight time is less than 8 hours, the minimum rest period in the 24 hours preceding the scheduled completion of the flight segment is 9 hours. This time may be reduced to 8 hours if the following rest period, to begin no later than 24 hours after the commencement of the reduced rest period, is increased to 10 hours.<br>• If the scheduled flight time is 8–9 hours, the minimum rest period in the 24 hours preceding the scheduled completion of the flight segment is 10 hours. This time may be reduced to 8 hours if the following rest period, to begin no later than 24 hours after the commencement of the reduced rest period, is increased to 11 hours.<br>• If the scheduled flight time is equal to or greater than 9 hours, the minimum rest period in the 24 hours preceding the scheduled completion of the flight segment is 11 hours. This time may be reduced to 9 hours if the following rest period, to begin no later than 24 hours after the commencement of the reduced rest period, is increased to 12 hours. |
| **Motor Carrier (49 CFR Part 395)** |
| • Drivers may drive for 10 hours or be on duty for 15 hours.<br>• Drivers must have 8 consecutive hours off following a 10/15 hour on-duty period.<br>• If drivers use a sleeper berth, they may split the 8-hour period into two periods as long as neither period is less than 2 hours.<br>• Drivers may not exceed 70 hours in 8 days, if the carrier operates 7 days a week.<br>• Drivers may not exceed 60 hours in 7 days if the carrier does not operate every day of the week. |
| **Marine (46 U.S.C. 8104; 46 CFR Parts 15.705, 15.710, and 15.1111)** |
| • Hours-of-service or watch requirements vary depending on type of vessel.<br>• An officer must be off duty for at least 6 hours within the 12 hours immediately before leaving port before taking charge of the deck watch on a vessel when leaving port.<br>• On an oceangoing or coastwise vessel of not more than 100 gross tons (GT), a licensed individual may not work more than 9 of 24 hours when in port or more than 12 of 24 hours at sea, except in an emergency.<br>• On a towing vessel operating on the Great Lakes, harbors of the Great Lakes, and connecting or tributary waters between Gary, Indiana; Duluth, Minnesota; Niagara Falls, New York; and Ogdensburg, New York, a licensed individual or seaman in the deck or engine department may not work more than 8 hours in one day, except in an emergency.<br>• On a merchant vessel of more than 100 GT, the licensed individual shall be divided into three watches and shall be kept on duty successively to perform ordinary work incident to the operation and management of the vessel.<br>• On a towing vessel, an offshore supply vessel, or a barge that is engaged on a voyage of less than 600 miles, the licensed individual and crewmembers may be divided, when at sea, into two watches.<br>• On a fish processing vessel, the licensed individuals and deck crew shall be divided into three watches. However, if the vessel entered into service before January 1, 1988, and is more than 1,600 GT or entered into service after December 31, 1987, and has more than 16 individuals on board primarily employed in the preparation of fish or fish products, then the licensed individuals and deck crew shall be divided into two watches. |

**Table 1–1. Summary of the current hours-of-service regulations, all transportation modes (continued).**

- On a tanker, a licensed individual or seaman may not work more than 15 hours in any 24-hour period or more than 36 hours in any 72-hour period, except in an emergency or a drill.
- On a fish tender vessel of not more than 500 GT engaged in the Aleutian trade, the licensed individuals and crewmembers shall be divided into at least three watches. However, if the vessel operated in that trade before September 8, 1990, or was purchased to be used in that trade before September 8, 1990, and entered into that trade before June 1, 1992, the licensed individuals and crewmembers may be divided into two watches.
- On a vessel used only to respond to a discharge of oil or a hazardous substance, the licensed individuals and crewmembers may be divided into two watches when the vessel is engaged in operation less than 112 hours.
- On a towing vessel operating in the Great Lakes, harbors, or connecting or tributary waters or a merchant marine vessel of more than 100 GT, a seaman may not work alternately in the deck and engine compartments, or be required to work in the engine department if engaged for deck department duty or required to work in the deck department if engaged for engine department duty. A seaman cannot be required to do unnecessary work on Sundays, New Year's Day, July 4, Labor Day, Thanksgiving day, or Christmas day, when the vessel is in safe harbor. When a vessel is in safe harbor, 8 hours is a day's work.
- Offices in charge of a navigational or engineering watch on board any vessel that operates beyond the boundary line shall receive a minimum of 10 hours rest in any 24-hour period. The hours of rest may be divided into no more than two periods, of which one must be at least 6 hours in length. The hours of rest do not need to be maintained in an emergency. The hours of rest may be reduced to 6 hours if no reduction extends beyond 2 days and not less than 70 hours of rest are provided in each 7-day period.

**Pipeline**

There are no Federal regulations for operators or controllers of pipeline systems.

**Rail (49 U.S.C. 211; 49 CFR Part 228)**

- Maximum duty limit of 12 hours.
- Must be off-duty for 10 consecutive hours, after working 12 consecutive hours or off 8 consecutive hours if worked less than 12 consecutive hours.
- Time spent in transportation (deadheading) to duty assignment counts toward on-duty time.
- Time deadheading from duty assignment does not count toward on-duty or off-duty time.

CFR = *Code of Federal Regulations*; U.S.C. = *United States Code.*

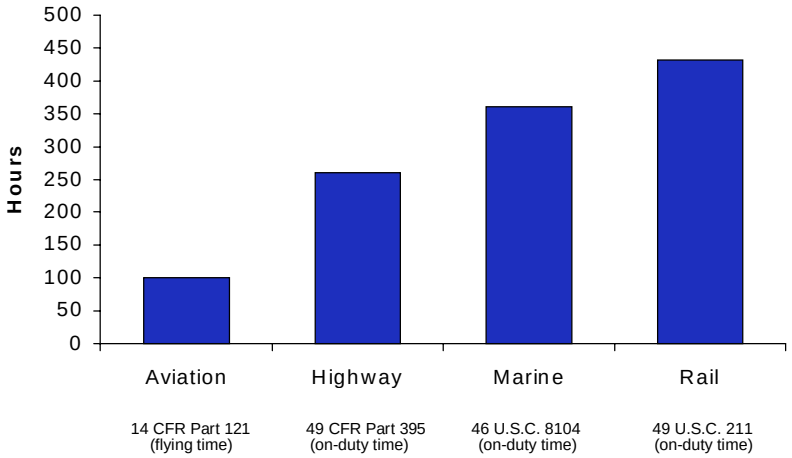


Figure 1–1. Maximum work hours in a 30-day period. For marine, the on-duty and off-duty times are for a licensed individual on an oceangoing vessel or coastwise vessel of not more than 100 gross tons at sea. (CFR = *Code of Federal Regulations;* U.S.C. = *United States Code*)

## What is Fatigue?

Traditionally, fatigue was viewed as a simple condition related to the amount of time spent working on a given task.[5] Scientific research, however, has shown that fatigue is related to much more than just the time on a task.[6] Researchers have studied factors that affect fatigue, such as duration and quality of sleep,[7] shiftwork and work schedules,[8] circadian rhythms,[9] and time of day.[10] Others have examined the influence of drugs and alcohol on fatigue and compared performance impaired by alcohol to performance

[5] McDonald, Nicholas. 1984. *Fatigue, Safety and the Truck Driver.* London and Philadelphia: Taylor & Francis. pp. 104-115.

[6] Kryger, M.H.; Roth, T.; Dement; W.C., eds. 1994. *Principles and Practice of Sleep Medicine*. 2nd edition. Philadelphia: W.B. Saunders Company.

[7] (a) Johnson, L.C.; Naitoh, P. 1974. *The Operational Consequences of Sleep Deprivation and Sleep Deficit.* AGARD-AG-193, NATO. London: Technical Editing and Reproduction. (b) Rosekind, M.R.; Gander, P.H.; Connel, 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. Washington, DC: National Aeronautics and Space Administration. (c) National Transportation Safety Board. 1995. *Factors That Affect Fatigue in Heavy Truck Accidents*. Safety Study NTSB/SS-95/01 and NTSB/SS-95/02. Washington, DC.

[8] (a) Folkard, S.; Monk, T.H.; Lobban, M.C. 1979. "Towards a Predictive Test of Adjustment to Shiftwork." *Ergonomics* 21: 785-799. (b) Thomas, G.R.; Raslear, T.G.; Kuehn, G.I. 1997. *The Effects of Work Schedules on Train Handling Performance and Sleep of Locomotive Engineers: A Simulator Study.* DOT/FRA/ORD-97-09. Washington, DC: Federal Railroad Administration.

[9] Kryger, M.H.; Roth, T.; Carskadon, M. 1994. "Circadian Rhythms in Humans: An Overview." In: Kryger, M.H.; Roth, T.; Dement, W.C., eds. *Principles and Practice of Sleep Medicine.* 2nd edition. Philadelphia: W.B. Saunders Company. pp. 301-308.

[10] Wylie, C.D.; Shultz, T.; Miller, J.C.; and others. 1996. *Commercial Motor Vehicle Driver Fatigue and Alertness Study: Project Report*. FHWA-MC-97-002. Washington, DC: Federal Highway Administration.

impaired by fatigue.[11] Sleep disorders and the characteristics of sleep patterns at different ages have also been studied.[12] Cumulative sleep loss and circadian disruption can lead to a physiological state characterized by impaired performance and diminished alertness.[13] Fatigue can impair information processing and reaction time, increasing the probability of errors and ultimately leading to transportation accidents.[14] A summary of sleep and circadian rhythms was originally completed for the Safety Board's investigation of the 1993 American International Airways accident in Guantanamo Bay, Cuba.[15] An update of that summary is provided in appendix C.

## Scope of the Fatigue Problem

Fatigue has remained a significant factor in transportation accidents since the Safety Board's 1989 recommendations were issued. Although generally accepted as a factor in transportation accidents, the exact number of accidents due to fatigue is difficult to determine and likely to be underestimated. The difficulty in determining the incidence of fatigue-related accidents is due, at least in part, to the difficulty in identifying fatigue as a causal or contributing factor in accidents. There is no comparable chemical test for identifying the presence of fatigue as there is for identifying the presence of drugs or alcohol; hence, it is often difficult to conclude unequivocally that fatigue was a causal or contributing factor in an accident. In most instances, one or more indirect or circumstantial pieces of evidence are used to make the case that fatigue was a factor in the accidents. This evidence includes witness statements, hours worked and slept in the previous few days, the time at which the accident occurred, the regularity or irregularity of the operator's schedule, or the operator's admission that he fell asleep or was impaired by fatigue.[16]

Despite the difficulty in identifying fatigue as a causal factor, estimates of the number of accidents involving fatigue have been made for the different modes of transportation; the estimates vary from very little involvement to as high as about one-third of all accidents.

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[11] (a) Roehrs, T.; Beare, D.; Zorick, F.; Roth, T. 1994. "Sleepiness and Ethanol Effects on Simulated Driving." *Alcoholism: Clinical and Experimental Research* 18(1): 154-158. (b) Dawson, D.; Reid, K. [In preparation]. "Equating the Performance Impairment Associated With Sustained Wakefulness and Alcohol Intoxication." Woodville, South Australia: Centre for Sleep Research.

[12] (a) Aldrich, M.S. 1994. "Cardinal Manifestations of Sleep Disorders." In: Kryger, M.H.; Roth, T.; Dement, W.C., eds. *Principles and Practice of Sleep Medicine.* 2nd edition. Philadelphia: W.B. Saunders Company. pp. 413-425. (b) Bliwise, D.L. 1994. "Normal Aging." In: Kryger, M.H.; Roth, T.; Dement, W.C., eds. *Principles and Practice of Sleep Medicine.* 2nd edition. Philadelphia: W.B. Saunders Company. pp. 26-39.

[13] Rosekind, M.R.; Graeber, R.C.; Dinges D.F.; and others. 1993. *Crew Factors in Flight Operations. IX: Effects of Planned Cockpit Rest on Crew Performance and Alertness in Long-Haul Operations*. NASA Technical Memorandum 108839; DOT/FAA/92/94. Washington, DC: National Aeronautics and Space Administration.

[14] (a) Dinges, D.F. 1989. "The Nature of Sleepiness: Causes, Context, and Consequences." In: Stunkard, A.; Baum, A., eds. *Perspectives in Behavioral Medicine: Eating, Sleeping, and Sex*. Hillsdale, NJ: Lawrence Erlbaum. pp. 147-179. Chapter 9. (b) Dinges, D.F. 1992. "Probing the Limits of Functional Capability: The Effects of Sleep Loss on Short-Duration Tasks." In: Broughton, R.J.; Oglivie, R., eds. *Sleep, Arousal, and Performance*. Boston: Birkhauser-Boston. pp. 176-188. Chapter 12.

### *Aviation*

The Federal Aviation Administration (FAA) reported that 21 percent of the reports in the Aviation Safety Reporting System (ASRS) were related to general issues of fatigue. This includes reports that mentioned fatigue directly or indirectly. When only reports that directly mention fatigue are included, the percentage drops to 3.8 percent.[17]

### *Highway*

The National Highway Traffic Safety Administration (NHTSA) estimates that each year 100,000 crashes, which result in more than 1,500 fatalities and 71,000 injuries, are caused by drowsy drivers.[18] This amounts to about 1.6 percent of all crashes and about 3.6 percent of fatal crashes. In 1998, the Federal Highway Administration (FHWA) derived estimates of the percentages of large truck crashes involving fatigue: all police-reported crashes (0.53 percent to 1.3 percent); all fatal crashes (2.8 percent to 6.5 percent); crashes fatal to the truck occupant only (12 percent to 29 percent); and crashes fatal to nontruck occupants (1.2 percent to 2.8 percent). The FHWA also concluded that more in-depth investigations yield higher percentages of fatigue-related crashes than indicated in comparable samples of police accident reports.[19] The Safety Board's 1990 study of 182 heavy truck accidents that were fatal to the driver showed that 31 percent of the accidents in this sample involved fatigue.[20] This number is frequently cited as an estimate of the incidence of fatigue in truck accidents that were fatal to the truckdriver. The Safety Board's numbers regarding fatigue-involved accidents are more revealing because the Board's in-depth investigations included such surrogate measures as a 72-hour history of rest and duty times, the amount of sleep in the last 24 hours, and the regularity of the work schedule, to name just a few.

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[15] Rosekind, Mark R. [NASA Ames Research Center]; Gregory, Kevin B. [Sterling Software]; Miller, Donna L. [Sterling Software]; and others. 1994. "Analysis of Crew Fatigue Factors in ATA Guantanamo Bay Aviation Accident." In: *Uncontrolled Collision With Terrain, American International Airways Flight 808, Douglas DC-8-61, N814CK, U.S. Naval Air Station in Guantanamo Bay, Cuba, August 18, 1993*. Aircraft Accident Report NTSB/AAR-94/04. Washington, DC: National Transportation Safety Board. pp. 133-144.

[16] The Safety Board recognizes that people have a limited ability to predict the onset of sleep and to determine their level of sleepiness. (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.)

[17] (a) *Federal Register*, Vol. 60, No. 244, dated December 20, 1995. (b) Batelle Memorial Institute. March 1998. *A Review of Issues Concerning Duty Period Limitations, Flight Time Limitations, and Rest Requirements as Stated in the FAA's Notice of Proposed Rulemaking 95-18*. Washington, DC: Federal Aviation Administration.

[18] Knippling, R.R.; Wang, J.S. October 1995. "Revised Estimates of the U.S. Drowsy Driver Crash Problem Size Based on General Estimates System Case Reviews." In: 39th Annual Proceedings, AAAM; October 16–18, 1995; Chicago, IL. Des Plaines, IL: Association for the Advancement of Automotive Medicine.

[19] Federal Highway Administration, Office of Motor Carriers. September 1998. *Crash Problem Size Assessment: Large Truck Crashes Related Primarily to Driver Fatigue*. Washington, DC.

[20] 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 and NTSB/SS-90/02. Washington, DC.

### *Marine*

A 1996 United States Coast Guard (USCG) analysis of 279 incidents showed that fatigue contributed to 16 percent of critical vessel casualties and 33 percent of personal injuries.[21]

### *Railroad*

According to a Safety Board analysis of Federal Railroad Administration (FRA) data from January 1990 to February 1999, only 18 cases were coded "operator fell asleep" as a causal or contributing factor. The Board believes that 18 cases in more than 9 years underestimates the actual number of cases in which fatigue might have been involved. For example, two Safety Board investigations—Sugar Valley, Georgia (August 9, 1990), and Corona, California (November 7, 1990)—in which fatigue was cited by the Safety Board as a causal factor were not coded in the FRA database as fatigue-related but rather as a failure to comply with signals.

In testimony before the Senate Subcommittee on Surface Transportation and Merchant Marine[22] on September 16, 1998, the Administrator of the FRA stated that "about one-third of train accidents and employee injuries and deaths are caused by human factors. We know fatigue underlies many of them."

In summary, although the data are not available to statistically determine the incidence of fatigue, the transportation industry has recognized that fatigue is a major factor in accidents, as was clearly demonstrated at the Safety Board's 1995 symposium on fatigue.[23] Further, the Safety Board's in-depth investigations have clearly demonstrated that fatigue is a major factor in transportation accidents.

[21] McCallum, Marvin C.; Raby, Mireille; Rothblum, Anita M. 1996. *Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Marine Casualties*. CG-D-09-97. Washington, DC: U.S. Department of Transportation, U.S. Coast Guard, Marine Safety and Environmental Protection.

[22] The subcommittee is an entity of the Senate Committee on Commerce, Science, and Transportation.

[23] The symposium is discussed in further detail in part 2 of this report.

## Part 2

# Overview of Safety Board Activity Since 1989

Since 1989, the Safety Board has issued more than 70 fatigue-related safety recommendations,[24] which were the result of major accident investigations, special investigations, or safety studies that identified operator fatigue as a factor (see table 2–1). This includes 11 accident reports or studies in aviation regarding air tours and operations conducted under Parts 91, 121, and 135; 7 in highway regarding busdrivers and truckdrivers; 3 in marine regarding passenger vessels and tankships; 4 in railroad regarding freight trains, passenger trains, and rail transit operations; and 1 in pipeline regarding pipeline controllers.

A 1990 safety study that examined the causes of 182 accidents that were fatal to the driver of heavy trucks[25] found that 31 percent of the fatal-to-the-truckdriver accidents in the sample involved fatigue. A 1995 study of 107 accidents (62 of which were fatigue-related) examined the factors that affect fatigue in heavy truck accidents; the Board found that the three most critical factors that predicted a fatigue-related accident were duration of sleep in the last sleep period, the total hours of sleep obtained during the 24 hours prior to the accident, and the presence of split sleep periods.[26]

The Safety Board has also examined operator fatigue in its safety studies on flight crew errors, commuter airlines, and aviation safety in Alaska.[27] In the flight crew study, the Board found that crews comprising captains and first officers whose time since awakening was above the median for their crew position made more errors overall. In the study on commuter airline safety, the Board found that self-reports from commuter airline pilots indicated that most pilots had flown while fatigued. In the study on aviation in Alaska, the Board concluded that the consecutive, long duty days permitted by Title 14 *Code of Federal Regulations* (14 CFR) Part 135.261 for commuter airline and air taxi flight crews in Alaska can contribute to fatigue and are a detriment to safety.

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[24] Thirty-four of these recommendations were issued to the DOT or modal administrations. The remainder of the recommendations were issued to the States, industry, or industry associations.

[25] 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 and NTSB/SS-90/02. Washington, DC.

[26] National Transportation Safety Board. 1995. *Factors That Affect Fatigue in Heavy Truck Accidents*. Safety Study NTSB/SS-95/01 and NTSB/SS-95/02. Washington, DC.

[27] (a) National Transportation Safety Board. 1994. *A Review of Flightcrew-Involved, Major Accidents of U.S. Air Carriers, 1978 Through 1990.* Safety Study NTSB/SS-94/01. Washington, DC. (b) National Transportation Safety Board. 1994. *Commuter Airline Safety.* Safety Study NTSB/SS-94/02. Washington, DC. (c) National Transportation Safety Board. 1995. *Aviation Safety in Alaska.* Safety Study NTSB/SS-95/03. Washington, DC.

**Table 2–1. Fatigue-related investigations and studies conducted by the National Transportation Safety Board since May 1989, by mode.**

| Location of accident or topic of the study that identified fatigue-related issues[a] | Accident date | NTSB report number |
|---|---|---|
| **Aviation** | | |
| **Accident investigation:** | | |
| Molokai, Hawaii | 10/28/89 | AAR-90/05 |
| Brunswick, Georgia | 04/05/91 | AAR-92/03 |
| Pine Bluff, Arkansas | 04/29/93 | AAR-94/01/SUM |
| Guantanamo Bay, Cuba | 08/18/93 | AAR-94/04 |
| Kansas City, Missouri | 02/16/95 | AAR-95/06 |
| Cheyenne, Wyoming | 04/11/96 | AAR-97/02 |
| Everglades, Florida | 05/11/96 | AAR-97/06 |
| **Special investigation:** | | |
| Commercial space launch incident, Cape Canaveral, Florida | 08/17/93[b] | SIR-93/02 |
| **Safety study:** | | |
| Flight crew-involved accidents | 02/03/94[b] | SS-94/01 |
| Commuter airline safety | 11/30/94[b] | SS-94/02 |
| Aviation safety in Alaska | 12/01/95[b] | SS-95/03 |
| **Highway** | | |
| **Accident investigation:** | | |
| Sutton, West Virginia | 07/26/90 | HAR-91/01 |
| Donegal, Pennsylvania, and Caroline, New York | 06/26/91, 08/03/91 | HAR-92/01 |
| Evergreen, Alabama | 05/19/93 | HAR-94/02 |
| White Plains, New York | 07/27/94 | HAR-95/02 |
| **Special investigation:** | | |
| Selective motorcoach issues | 02/26/99[b] | SIR-99/01 |
| **Safety study:** | | |
| Accidents fatal to the truck driver | 04/04/90[b] | SS-90/01 |
| Truck driver fatigue | 02/07/95[b] | SS-95/01 |
| **Marine** | | |
| **Accident investigation:** | | |
| Valdez, Alaska | 03/24/89 | MAR-90/04 |
| Santa Catalina Island, California | 06/14/89 | MAR-90/05 |
| Lynn Canal, Alaska | 06/23/95 | MAR-97/02 |
| **Pipeline** | | |
| **Accident investigation:** | | |
| Fork Shoals, South Carolina | 06/26/96 | PAR-98/01 |

**Table 2–1. Fatigue-related investigations and studies conducted by the National Transportation Safety Board since May 1989, by mode (continued).**

| Location of accident or topic of the study that identified fatigue-related issues[a] | Accident date | NTSB report number |
|---|---|---|
| **Railroad** | | |
| **Accident investigation:** | | |
| Corona, California | 11/07/90 | RAR-91/03 |
| Sugar Valley, Georgia | 08/09/90 | RAR-91/02 |
| Brooklyn, New York | 06/05/95 | RAR-96/03 |
| **Special investigation:** | | |
| Steam locomotives | 11/26/96[b] | SIR-96/05 |

[a] The titles of the published reports are contained in appendix B.

[b] The date the safety recommendations were issued.

Operator fatigue has been on the Safety Board's list of Most Wanted Transportation Safety Improvements since the list's inception in 1990.[28] Had the DOT acted more aggressively on the three intermodal recommendations issued in 1989, the need for the 70-some additional recommendations to the States and industry may have been minimized. (Pertinent recommendations are discussed in more detail in part 3 of this report in connection with the specific issues of Safety Recommendations I-89-1, -2, and -3: research, education, and revisions to hours-of-service regulations, respectively.)

In November 1995, the Safety Board and the National Aeronautics and Space Administration (NASA) cosponsored a symposium to discuss fatigue countermeasures and to demonstrate how they can be applied to prevent accidents in all modes of transportation.[29] The symposium was designed to practically illustrate the intent of one of the Safety Board's 1989 intermodal recommendations (I-89-2): to develop and disseminate educational material. More than 500 people from 16 countries representing all the modes of transportation attended the symposium, which attests to the magnitude and interest in the fatigue problem. As part of the symposium, the participants were divided into modal-specific groups to discuss scheduling, countermeasures, and education. All of the groups indicated that education was needed for the operators as well as for the management of transport companies. While the groups believed there was a need for additional technological countermeasures, they also believed there were some steps that could already be taken or could easily be implemented. For example, both an aviation group and the railroad

[28] In October 1990, the Safety Board adopted a program to identify the "Most Wanted" transportation safety improvements. The purpose of the Board's Most Wanted list, which is drawn up from safety recommendations previously issued, is to bring special emphasis to the transportation safety issues the Board deems most critical.

[29] National Transportation Safety Board; NASA Ames Research Center. 1996. *Fatigue Symposium Proceedings, November 1–2, 1995*. Washington, DC: National Transportation Safety Board.

group discussed the need for quality sleeping areas while away from home, pointing out that many hotels do not have rooms that are adequate for daytime sleeping. There was broad support voiced regarding a need for changes to the hours-of-service regulations. The participants wanted these regulations to be updated and based on scientific research. The summaries of the working groups are provided in appendix D.

Another product from the symposium was the development of the Fatigue Resource Directory, a tool for researchers, industry, and others to use to share information regarding operator fatigue. Following the symposium, the DOT assumed responsibility for maintaining the directory. It is now available on the World Wide Web at <www.hf.faa.gov/dot/fatigue>. The Web site has search capabilities and entries can be edited or new entries can be added.

## Part 3

# DOT Response to the Safety Board's Intermodal Recommendations

The various Secretaries of the DOT and modal Administrators over the years have expressed their concerns about operator fatigue. In a 1995 summary of the DOT's fatigue safety effort, Federico Peña, then Secretary of the DOT, stated that "fatigue among transportation operators remains a critical safety problem."[30] In a 1999 update, Secretary Rodney Slater stated, "We know that alertness is a key to safe vehicle operation. To reduce crashes and accidents and their personal and financial consequences, we need to ensure that vehicle operators are ready and capable of operating their vehicles or other transportation equipment."[31] Despite the many statements made by the DOT about the importance of addressing fatigue in transportation, only one of the three intermodal recommendations issued to the DOT more than 10 years ago has been fully implemented (I-89-1).

## Safety Recommendation I-89-1

Safety Recommendation I-89-1 asked the DOT to expedite a coordinated research program on the effects of fatigue, sleepiness, sleep disorders, and circadian factors on transportation system safety. In its August 1989 response, the DOT stated that coordinated research efforts on human factors—including the effects of fatigue, sleepiness, sleep disorders, and circadian factors—on transportation safety was a top priority. The Human Factors Coordinating Committee, formed in 1988 and comprising representatives from each of the DOT administrations, serves as a means to share research information. A subcommittee has been created to focus on fatigue-related issues. In addition, the DOT briefed the Safety Board about the various ongoing fatigue-related projects several times over the years. Safety Recommendation I-89-1 was classified "Closed—Acceptable Action" on July 19, 1996, because the DOT had made Department-wide research efforts on operator fatigue. At the time this recommendation was closed, the FAA, FHWA, NHTSA, FRA, and USCG all had fatigue-related research projects underway.[32] In the Safety Board's 1996 letter closing the recommendation, the Board encouraged the DOT to continue its research efforts, which it generally has done.

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[30] U.S. Department of Transportation. November 1995. *Sharing the Knowledge: Department of Transportation Focus on Fatigue*. Washington, DC.

[31] U.S. Department of Transportation. March 1999. *Managing Fatigue: A Significant Problem Affecting Safety, Security, and Productivity.* Washington, DC.

[32] U.S. Department of Transportation. November 1995. *Sharing the Knowledge: Department of Transportation Focus on Fatigue*. Washington, DC.

From fiscal years 1990 through 1998, the DOT spent more than $30 million on fatigue research. A wide range of research projects has been initiated, such as developing in-vehicle alerting systems, using high fidelity simulators to determine how different work schedules affect fatigue and performance, studying the effects of loading and unloading, and evaluating technologies that monitor operator performance to indicate fatigue. Table 3–1 identifies major research projects completed by the DOT since 1989.[33]

The Safety Board is disappointed that more research efforts have not been made by the Research and Special Programs Administration (RSPA) in the pipeline mode. In 1998, the Board asked RSPA to assess the potential safety risks associated with rotating pipeline controller shifts and to establish industry guidelines for the development and implementation of pipeline controller work schedules that reduce the likelihood of accidents attributable to controller fatigue (Safety Recommendation P-98-30).[34] The RSPA responded to the recommendation on May 4, 1999.

The Safety Board is aware that industry groups such as the Association of American Railroads and the American Trucking Associations, Inc., have also participated in and conducted research on operator fatigue since the 1989 intermodal recommendations were issued. Additionally, the transportation industry participates in meetings and shares its research findings with other organizations. The FRA has formed the North American Rail Alertness Partnership comprising railroad management, union leadership, and FRA representatives that discuss fatigue and exchange information on countermeasures to reduce fatigue. The FHWA and NHTSA are participants in the National Drowsy Driving Coordinating Committee sponsored by the National Sleep Foundation. This is a forum for sharing research and educational outreach efforts among government, State, industry, and nonprofit groups in the highway mode.

The DOT's efforts to coordinate operator fatigue research have generally been responsive, with the exception of the RSPA regarding pipeline operations. The Safety Board encourages the DOT to continue its research, particularly on technology and in the pipeline mode, and to share information across the modes and with industry.

[33] The Safety Board notes that many of the research projects listed in the DOT's 1999 update were also listed in the DOT's 1995 publication on transportation fatigue.

[34] National Transportation Safety Board. 1998. *Pipeline Rupture and Release of Fuel Oil Into the Reedy River at Fork Shoals, South Carolina, June 26, 1996*. Pipeline Accident Report NTSB/PAR-98/01. Washington, DC.

## Table 3–1. Fatigue-related research completed in the U.S. Department of Transportation since 1989.

**Federal Aviation Administration:**

Effect of Alcohol and Fatigue on an FAA Readiness-To-Perform Test. (DOT/FAA/AM-95/24)

Handbook of Human Performance Measures and Crew Requirements for Flightdeck Research. (DOT/FAA/CT-TN95/49)

Some Effects of 8- vs. 10-Hour Work Schedules on the Test Performance/Alertness of Air Traffic Control Specialists. (DOT/FAA/AM-95/32)

Shift Work, Age, and Performance—Investigation of the 2-2-1 Shift Schedule Used in Air Traffic Control Facilities: 1. The Sleep/Wake Cycle. (DOT/FAA/AM-95/19)

Human Factors in Aviation Maintenance: Phase 3, Volume 1, Progress Report. (DOT/FAA/AM-95/13)

Handbook of Human Performance Measures and Crew Requirements for Flightdeck Research. (DOT/FAA/CT-TN95/49)

**Federal Highway Adminstration:**

In-Cab Fitness-For-Duty. (FHWA-MC-95-011)

Shipper Involvement in Hours-Of-Service Violations. (FHWA-MC-98-049)

Impact of Local/Short Haul Operations on Driver Fatigue. (DTFH61-C-00105)

Short Haul Trucks and Driver Fatigue. (DTFH61-96-C-00038)

Commercial Motor Vehicle Rest Areas: Making Space for Safety. (PB 97-124705)

Driver Fatigue and Alertness Study. (PB 98-102346)

Local/Short Haul Driver Fatigue Crash Data Analysis. (FHWA-MC-98-016)

Effects of Operating Practices on Driver Alertness. (FHWA-MCRT-99-008)

PERCLOS: A Valid Psychophysiological Measure of Alertness as Assessed by Psychomotor Vigilance. (FHWA-MCRT-98-006)

Electronic On-Board Recorders for Hours-of-Service Compliance. (FHWA-MCRT-99-007)

Conference on Managing Fatigue in Transportation. (cosponsored with NHTSA and the FRA)

Conference on Driver Vigilance Monitoring. (cosponsored with NHTSA)

**Federal Railroad Administration:**

The Effects of Work Scheduling on Train Handling Performance and Sleep of Locomotive Engineers: A Simulator Study. (DOT/FRA/ORD-97-09)

Enginemen Stress and Fatigue. (Issued February 1993)

Issues in Locomotive Crew Management and Scheduling. (DOT/FRA/RRR-91-01)

**National Highway Traffic Safety Administration:**

Crashes and Fatalities Related to Driver Drowsiness/Fatigue. (Research Note, issued November 1994)

Validation of Eye and Other Psychophysiological Monitors. (cosponsored with FHWA) (DOT-HS-808 762)

Research on Vehicle-Based Driver Status/Performance Monitoring: Development, Validation, and Refinement of Algorithms for Detection of Driver Drowsiness. (DOT-HS-808 247)

Research on Vehicle-Based Driver Status/Performance Monitoring: Seventh Semiannual Research Report. (DOT-HS-808 299)

Research on Vehicle-Based Driver Status/Performance Monitoring, Part 1. (DOT-HS-808 838)

Research on Vehicle-Based Driver Status/Performance Monitoring, Part 2. (DOT-HS-808 839)

Research on Vehicle-Based Driver Status/Performance Monitoring, Part 3. (DOT-HS-808 840)

Drowsy Driving and Automoble Crashes. (DOT-HS-808 707)

**Table 3–1. Fatigue-related research completed in the U.S. Department of Transportation since 1989 (continued).**

**United States Coast Guard:**

Fatigue and alertness in Merchant Marine Personnel: A Field Study of Work and Sleep Patterns. (USCG-D-06-97)

Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Marine Casualties. (USCG-D-09-97)

Modeling Techniques for Shipboad Manning: A Review and Plan for Development. (USCG-D-07-93)

**Maritime Administration:**

Shipboard Crew Fatigue, Safety, and Reduced Manning. (issued November 1994)

Sources: (a) U.S. Department of Transportation, Federal Highway Administration, Office of Motor Carriers. December 16, 1998. *Summary of Driver Fatigue Programs.* Washington, DC. (b) Publications on driver fatigue programs listed on the National Technical Information Service World Wide Web home page, <http://www.ntis.gov>, April 22, 1999.

## Safety Recommendation I-89-2

Safety Recommendation I-89-2 asked the DOT to 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. In its 1989 response, the DOT acknowledged the unique demands placed on transportation workers such as shift-work, long-haul operations, and nighttime duty and that it would review its current policy on developing educational materials. In a more detailed response in 1996, the DOT indicated that it had published its 1995 report *Sharing the Knowledge: Department of Transportation Focus on Fatigue* and produced two videotapes that addressed fatigue: one on human factors and one entitled *Fatigue Busters—How to Survive Fatigue in the '90s*. In addition, the FAA also published a fatigue buster brochure. The Safety Board replied that it was pleased that information had been produced for aviation and highway, but it was concerned that similar information had not been developed for railroad, marine, and mass transit. On May 4, 1999, the DOT provided the Safety Board with an update of FRA education activities. Safety Recommendation I-89-2 is currently classified "Open—Acceptable Response."

Other organizations, agencies, and industry groups—such as the National Sleep Foundation, the AAA Foundation for Traffic Safety, and the American Trucking Associations, Inc.—have also developed educational brochures about fatigue. Two brochures, *Awake at the Wheel* and *Wake Up!*, attempt to educate operators about the need for sleep and to dispel myths such as people can always tell when they are fatigued.[35] Appendix E

[35] The brochure *Wake Up!* was developed jointly by the AAA Foundation for Traffic Safety and the National Sleep Foundation. It was the basis for the brochure *Awake at the Wheel* that was developed for truckdrivers by the FHWA in conjunction with the American Trucking Associations.

contains a list of some educational materials that have been developed since the intermodal recommendations were issued.

In the early 1990s, NASA developed an education and training module entitled "Alertness Management in Flight Operations." It contains information about fatigue with an emphasis on aviation. The module has three primary objectives: to explain (1) the current state of knowledge about the physiological mechanisms that underlie fatigue; (2) misconceptions about fatigue; and (3) fatigue countermeasures. The NASA and the FAA have cosponsored many courses to educate pilots for a large segment of the major U.S. air carriers as well as for corporate management. The FRA, Federal Transit Administration (FTA), and FHWA along with industry organizations have used the NASA countermeasures training module as the basis for training modules in the other modes of transportation.

In addition to Safety Recommendation I-89-2, the Safety Board has issued other recommendations to the individual modal administrations calling for increased educational efforts regarding the effects of fatigue. In 1995, the Safety Board asked the FHWA to develop and disseminate, in consultation with DOT's Human Factors Coordinating Committee, a training and education module to inform truckdrivers of the hazards of driving while fatigued (Safety Recommendation H-95-5).[36] The FHWA and the American Trucking Associations, Inc., adapted the NASA module for use with the commercial driving industry and developed a train-the-trainer course on fatigue and fatigue countermeasures. To date more than 2,000 people have been trained; 16 seminars are being offered in 1999. Safety Recommendation H-95-5 to the FHWA was classified "Closed—Acceptable Action" on July 7, 1998.

In 1996, the Safety Board also asked the FTA, in cooperation with the American Public Transit Association, to develop a fatigue educational awareness program and to distribute it to transit agencies to use in their fitness-for-duty training for supervisors and employees involved in safety-sensitive positions (Safety Recommendation R-96-20).[37] The FTA has developed a seminar, available in four different formats, for a variety of attendees including employees, managers, and persons involved in scheduling. The Safety Board is pleased with this effort of the FTA and is aware that more than 600 persons have attended the seminars. As a result of these efforts, the Safety Board has classified Safety Recommendation R-96-20 "Closed—Acceptable Action."

In aviation, the Safety Board asked the FAA to require U.S. air carriers operating under 14 CFR Part 121 to provide educational programs for pilots (Safety Recommendation A-94-5),[38] to require 14 CFR Part 135 air carriers to provide fatigue countermeasure

[36] National Transportation Safety Board. 1995. *Factors That Affect Fatigue in Heavy Truck Accidents*. Safety Study NTSB/SS-95/01 and NTSB/SS-95/02. Washington, DC.

[37] National Transportation Safety Board. *Collision Involving Two New York City Subway Trains on the Williamsburg Bridge in Brooklyn, New York, June 5, 1995*. Railroad Accident Report NTSB/RAR-96/03. Washington, DC.

[38] National Transportation Safety Board. 1994. *A Review of Flightcrew-Involved, Major Accidents of U.S. Air Carriers, 1978 Through 1990*. Safety Study NTSB/SS-94/01. Washington, DC.

information to air crews in initial and recurrent training (A-94-73),[39] and to provide fatigue information to the general aviation community (A-97-20).[40] The FAA revised Advisory Circular 120-51B to include fatigue as one of the topics discussed in crew resource management training. The FAA also developed educational materials to address the hazards of fatigue for use in safety meetings. These three recommendations have been classified "Closed—Acceptable Action."[41]

In 1997, the Safety Board asked the USCG to advise marine pilots about the effects of fatigue on performance and about sleeping disorders such as sleep apnea (Safety Recommendation M-97-41).[42] In a letter dated November 11, 1998, the USCG indicated that it has discussed the effects of fatigue and sleeping disorders with the American Pilots Association and independent pilot associations, requesting that they inform their members of the dangers of sleeping disorders such as sleep apnea through their internal media. Further, Navigation and Vessel Inspection Circular No. 2-98, *Physical Evaluation Guidelines for Merchant Marine's Documents and Licenses*, contains guidelines for use by physicians performing physical examinations of mariners and includes sleeping disorders as conditions to be evaluated for original and renewals of marine pilots' licenses and for the required pilots' physicals. Safety Recommendation M-97-41 was classified "Closed—Acceptable Action" on April 6, 1999.

The Safety Board is aware that the USCG has developed a research and educational program on crew endurance. The Board is also aware that the USCG held a workshop on fatigue on April 6, 1999, aimed at masters and safety management personnel of tugs and barges, passenger vessels, and fishing vessels as well as USCG personnel. The Board encourages the USCG to add more workshops to its agenda. Such programs could be promoted through the USCG's Prevention Through People program. The USCG has not developed any brochures on operator fatigue for the mariner community.

The Safety Board also issued a recommendation to the FHWA asking that educational materials be developed for commercial truckdrivers (H-90-21, classified "Closed—Acceptable Action"). As shown in appendix E, the FHWA has developed and disseminated the brochure *Awake at the Wheel* and fatigue videos; it has also developed courses to educate truckdrivers about the dangers of driving while drowsy. In February 1999, the Board asked the FHWA to ensure that the dangers of inverted sleep periods are discussed in the fatigue video being developed for motorcoaches (Safety Recommendation H-99-4A).

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[39] National Transportation Safety Board. 1994. *In-Flight Loss of Control, Leading to Forced Landing and Runway Overrun, Continental Express, Inc., N24706, Embraer EMB-120 RT, Pine Bluff, Arkansas, April 29, 1993*. Aircraft Accident Report NTSB/AAR-94/02/SUM. Washington, DC.

[40] National Transportation Safety Board. 1997. *In-Flight Loss of Control and Subsequent Collision With Terrain, Cessna 177B, N35207, Cheyenne, Wyoming, April 11, 1996*. Aircraft Accident Report. NTSB/AAR-97/02. Washington, DC.

[41] Safety Recommendations A-94-5 and A-94-73 were classified "Closed—Acceptable Action" on January 16, 1996; Safety Recommendation A-97-20 was classified "Closed—Acceptable Action" on June 11, 1997.

[42] National Transportation Safety Board. 1997. *Grounding of Liberian Passenger Ship* Star Princess *on Poundstone Rock, Lynn Canal, Alaska, June 13, 1995*. Marine Accident Report NTSB/MAR-97/02. Washington, DC.

The Safety Board is pleased to see the increase in educational efforts on fatigue among the DOT modal administrations, particularly the current activities within the FTA. The Safety Board would like to see more efforts in marine and pipeline to develop and disseminate educational materials on fatigue and will continue to monitor these activities. The FAA, FHWA, FRA, and FTA have satisfactorily met the intent of this recommendation; however, the Board urges these modal administrations to continue their efforts in this area. Pending further efforts by the RSPA and the Coast Guard to develop and disseminate educational information on fatigue in marine and pipeline operations, respectively, Safety Recommendation I-89-2 remains classified "Open—Acceptable Response."

## Safety Recommendation I-89-3

Safety Recommendation I-89-3 asked the DOT to review and upgrade regulations governing hours of service to assure that they are consistent and that they incorporate the results of the latest research on fatigue and sleep issues. In 1989, the DOT stated that it was reviewing the regulations pertaining to hours of service. It had not found research to suggest that the regulations should be consistent across all modes of transportation and that it would continue with research efforts to determine what changes might be made.

The Board has been very disappointed in the DOT's lack of progress in revising the hours-of-service regulations. Subsequently, the Safety Board made specific recommendations to the FAA and FHWA to revise the hours-of-service regulations. In conjunction with its investigation of the crash of American International Airways at Guantanamo Bay, Cuba, in August 1993,[43] the Safety Board recommended that the FAA

> Revise the applicable subpart of 14 CFR Part 121 to require that flight time, accumulated in noncommercial "tail end" ferry flights conducted under 14 CFR Part 91 as a result of 14 CFR Part 121 revenue flights, be included in the flight crewmember's total flight and duty time accrued during those revenue operations. (A-94-105, classified "Closed—Acceptable Action/Superseded" by Safety Recommendation A-95-113)
>
> Expedite the review and upgrade of Flight/Duty time limitations of the Federal Aviation Regulations to ensure that they incorporate the results of the latest research on fatigue and sleep issues. (A-94-106, classified "Closed—Acceptable Action/Superseded" by Safety Recommendation A-95-113)

[43] National Transportation Safety Board. 1994. *Uncontrolled Collision With Terrain, American International Airways Flight 808, Douglas DC-8-61, N814CK, U.S. Naval Air Station, Guantanamo Bay, Cuba, August 18, 1993*. Aircraft Accident Report NTSB/AAR-94/04. Washington, DC.

In its report of the accident involving an Air Transport International DC8-63 at Kansas City International Airport in February 1995,[44] the Safety Board recommended that the FAA

> Finalize the review of current flight and duty time regulations and revise the regulations, as necessary, within 1 year to ensure that flight and duty time limitations take into consideration research findings on fatigue and sleep issues. The new regulations should prohibit air carriers from assigning flight crews to flights conducted under 14 CFR Part 91 unless the flight crews meet the flight and duty time limitation of 14 CFR Part 121 or other appropriate regulations. (A-95-113, currently classified "Open—Acceptable Response")

In its study of aviation safety in Alaska,[45] the Safety Board asked the FAA to

> Develop appropriate limitations on consecutive days on duty, and duty hours per duty period for flight crews engaged in scheduled and nonscheduled commercial flight operations, and apply consistent limitations in Alaska and the remainder of the United States. (A-95-125, currently classified "Open—Acceptable Response")

On June 15, 1992, the FAA announced the establishment of the flight crewmember flight/duty rest requirements working group of its Aviation Rulemaking Advisory Committee (ARAC). In its final report submitted to the FAA on June 30, 1994, the working group indicated that although it had not reached consensus on the specific issues, it did agree on four major areas that should be addressed in FAA rulemaking: absence of a duty time limitation, reserve scheduling, back-side-of-the-clock operations, and scheduled reduced rest.

The FAA issued a notice of proposed rulemaking (NPRM) on December 20, 1995,[46] 6 years after the Board issued Safety Recommendation I-89-3. The proposed flight time and rest requirements are provided in appendix F. Comments on the NPRM were originally due on March 19, 1996; however, the comment period was extended to June 19, 1996. The Board commented on the rulemaking on June 19, 1996, noting several favorable aspects to the NPRM:

- elimination of the ability of carriers to schedule flight crewmember duty during scheduled rest periods, inclusion of standby reserve time, deadheading time, and all duties performed for the airline as duty time in the determination of flight and duty time requirements;

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[44] National Transportation Safety Board. 1995. *Uncontrolled Collision With Terrain, Air Transport International, Douglas DC-8-63, N782AL, Kansas City International Airport, Kansas City, Missouri, February 16, 1995.* Aircraft Accident Report NTSB/AAR-95/05. Washington, DC.

[45] National Transportation Safety Board. 1995. *Aviation Safety in Alaska.* Safety Study NTSB/SS-95/03. Washington, DC.

[46] *Federal Register*, Vol. 60, No. 244, dated December 20, 1995.

- inclusion of ferry, instructional, maintenance, check, and other flights in the determination of flight and duty time requirements, requirements of minimum daily rest periods of at least 10 consecutive hours, and 36 consecutive hours of rest within 7 consecutive calendar days of duty, for flight crewmembers and flight engineers;
- establishment of explicit standards for approving on-board flight crew rest areas;
- permit extensions of daily flight and duty intervals to periods of no more than 2 hours and only for operational reasons beyond the control of the airline; and
- limits of duty periods for crewmembers on reserve assignments depending on the amount of advance notification of reporting time.

In its comments on the rulemaking, however, the Board also expressed concern that the proposed rule did not include effective mechanisms to address flight operation during the circadian night and circadian trough, and it lacked recognition of the fatiguing aspects of multiple takeoffs and landings. There were mixed industry reactions to the NPRM. In general, air carriers and air carrier organizations opposed the NPRM[47] whereas pilot associations supported the proposal with some reservations, primarily a concern with loss of income from reduced flying hours and a desire for a more thorough discussion of back-side-of-the-clock flying time. According to the FAA, it received about 2,000 comments on the NPRM.

With no action since 1996 and the rulemaking effectively abandoned, on July 9, 1998, the ARAC on air carrier operations was assigned to provide a review and analysis of industry practice with regard to reserve duty for flight crewmembers, which is only a small part of the flight and duty time issue. A working group was formed and ultimately delivered recommendations to the FAA on February 9, 1999.[48] The pilots and air carriers on the working group were able to agree on the following:

1. A pilot should be scheduled by the operator to receive a protected time period as an opportunity to sleep for every day of reserve duty. The operator may not contact the pilot during this period.
2. An operator should limit the movement of the pilot's protected time period during consecutive days of reserve duty to ensure circadian stability.
3. A reserve pilot's availability for duty should be limited to prevent pilot fatigue as a result of lengthy periods of time-since-awake.
4. Sufficient advance notice of a flight assignment can provide a reserve pilot with a sleep opportunity.

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[47] Batelle Memorial Institute. March 1998. *A Review of Issues Concerning Duty Period Limitations, Flight Time Limitations, and Rest Requirements as Stated in the FAA's Notice of Proposed Rulemaking 95-18*. Washington, DC: Federal Aviation Administration.

[48] Aviation Rulemaking Advisory Committee, Reserve Rest Working Group. January 8, 1999. *Pilot Members Submission: Proposal of 77,955 Airline Pilots*.

The pilots and the air carriers, however, could not reach agreement about how to meet these goals. The Safety Board understands the difficulty in reaching an agreement on the issue of reserve duty and rest; nevertheless, it remains deeply concerned and disappointed that no further rulemaking action has been taken on the overall issue of hours of service and that duty and rest requirements continue to be different for Part 121 and Part 135 operations. According to the FAA, rather than proceed to a final rule with the NPRM, it will likely issue a supplemental NPRM, which, in the Safety Board's opinion, will only further delay any resolution to this important safety issue.

In its 1995 study on factors that affect fatigue in heavy truck accidents,[49] the Safety Board asked the FHWA to

> 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. (H-95-1, currently classified "Open—Unacceptable Response")
>
> 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. (H-95-2, currently classified "Open—Unacceptable Response")

In November of 1996, the FHWA issued an advance notice of proposed rulemaking (ANPRM) that requested additional fatigue research.[50] Rather than proposing any changes to the current hours-of-service regulations, the ANPRM was a general solicitation for comments on hours-of-service regulations. The comment period closed on March 31, 1997. The FHWA received about 1,600 comments to the ANPRM. An expert panel was convened in the summer of 1998 to review and evaluate, based on selected scientific criteria established by the panel, a series of hours-of-service proposals. None of the proposals met the scientific criteria established. The expert panel also developed an additional proposal intended to meet the scientific criteria established. A summary of these proposed hours-of-service regulations is provided in appendix G.

Currently, the FHWA has reported that it is pursuing two different avenues of rulemaking—traditional rulemaking and negotiated rulemaking.[51] In a letter dated November 3, 1998, the FHWA indicated that it intended to publish an NPRM in early 1999, was contracting with the University of Michigan Transportation Research Institute to perform a cost/benefit analysis, and was considering negotiated rulemaking to expedite the process. In a response dated February 25, 1999, to the FHWA, the Safety Board expressed disappointment that it had taken more than 18 months since the ANPRM comment period

[49] National Transportation Safety Board. 1995. *Factors That Affect Fatigue in Heavy Truck Accidents.* Safety Study NTSB/SS-95/01 and NTSB/SS-95/02. Washington, DC.

[50] *Federal Register*, Vol. 61, No. 215, dated November 5, 1996.

[51] Basically, a procedure by which representatives of all interests affected by a rulemaking are brought together to discuss fully the issues under conditions conducive to narrowing or eliminating differences and to negotiating a proposed rule acceptable to each interest.

closed to reach the NPRM stage and that the FHWA expected that a 120-day comment period on the NPRM would not be sufficiently long to receive comments, thus prolonging activity to issue a final rule. The Safety Board also indicated that it would support a negotiated rule if it would expedite the process. In testimony at the Safety Board's April 14, 1999, public hearing on truck and bus safety,[52] an FHWA representative indicated that a decision on negotiated rulemaking was expected to be made within 2 weeks. The FHWA representative also indicated that development of an NPRM through the traditional process was taking place simultaneously with the discussions on a negotiated rule to avoid any further loss of time.

In a May 4, 1999, letter to the Safety Board, the DOT indicated that "FRA submitted legislation to Congress last year, and may again this year, to require railroads to submit fatigue management plans designed to reduce fatigue experienced by railroad employees." The letter further stated that "should we be successful in gathering support and passage of such a legislative initiative, we believe fatigue will be greatly reduced in railroad operations."

Although the DOT and the modal administrations have taken positive steps in the area of education and research, they have not acted decisively to revise the antiquated hours-of-service regulations. In fact, as outlined above, little regulatory action has been initiated. The DOT believes that countermeasures to fatigue are preferred over regulation because sleep during a rest period cannot be enforced.[53] The Safety Board points out that hours-of-service rules exist to set limits on allowable scheduling practices, not to prescribe those schedules, and while the Board agrees that sleep cannot be regulated, it also believes that time for adequate sleep must be guaranteed by any Federal regulation related to hours of service.

The Safety Board is aware that the FHWA, and others, are looking at onboard devices to test fitness-for-duty and monitor impairment of operator performance. Although the Safety Board supports pre-duty testing for performance as a result of fatigue, alcohol, drugs, or other condition, it does not believe that operators should be driving up to the point that they fail a valid fitness-for-duty test as a result of fatigue, which could occur in the middle of a trip.

In 1998, DOT Secretary Slater launched the ONEDOT program. This program is to build on collaborative efforts among the various transportation agencies to reduce duplication and save resources. One of the goals of ONEDOT is to develop a common, positive framework relating to work hours, overtime, and incentives. Within the concept of ONEDOT, the DOT Safety Council works toward development of a safety policy for the Department. Fatigue is one of the areas on which the Council intends to act.

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[52] The hearing was held April 14–16, 1999, in Washington, D.C. Discussion panels included representatives from the DOT, highway transportation industry, and public safety groups.

[53] U.S. Department of Transportation. 1999. *Managing Fatigue: A Significant Problem Affecting Safety, Security, and Productivity.* Washington, DC.

The Safety Board acknowledges this as yet another initiative to address fatigue and revisions to hours-of-service regulations; nevertheless, the Board remains extremely disappointed in the lack of rulemaking by the DOT.

Scientific research has shown that certain sleep factors can affect fatigue and performance: insufficient sleep, irregular and unpredictable schedules, working during low points in the circadian rhythm. The current hours-of-service regulations do not accommodate these concerns. The Safety Board believes these factors should be considered when revising the hours-of-service regulations. Therefore, the Safety Board recommends that the DOT require the modal administrations to modify the appropriate *Codes of Federal Regulations* to establish scientifically based hours-of-service regulations that set limits on hours of service, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements. The Safety Board also recommends that the DOT seek Congressional authority, if necessary, for the modal administrations to establish these regulations. Based on the issuance of this new recommendation, Safety Recommendation I-89-3 is being classified "Closed—Unacceptable Action/Superseded." The Safety Board is also recommending separately that each modal administration—the FAA, FHWA, FRA, USCG, and RSPA—establish, within 2 years, scientifically based hours-of-service regulations that set limits on hours of service, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements. Further, because the FAA's efforts have not resulted in any changes to the flight and duty time regulations, the Safety Board has reclassified Safety Recommendations A-95-113 and A-95-125 "Open—Unacceptable Response." These recommendations are being reiterated in conjunction with this report. For the FHWA, the revised regulations, at a minimum and as recommended by the Safety Board in 1995, should also (a) 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, and (b) 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. As a result of this new recommendation to the FHWA, Safety Recommendations H-95-1 and -2 are being classified "Closed—Unacceptable Action/Superseded."

# Findings

1. Since 1989, the U.S. Department of Transportation has initiated a wide range of research projects to address the issue of operator fatigue in the transportation environment, with the exception of pipeline operations.

2. Since 1989, the Federal Aviation Administration, the Federal Highway Administration, the Federal Railroad Administration, and the Federal Transit Administration have developed and disseminated various educational materials, including brochures and videotapes, to the industry on the detrimental effects of fatigue in the transportation environment. The Research and Special Programs Administration and the U.S. Coast Guard need to make a more concerted effort to develop and disseminate educational information on fatigue in pipeline and marine operations, respectively.

3. Despite the acknowledgment by the U.S. Department of Transportation that fatigue is a significant factor in transportation accidents, little progress has been made to revise the hours-of-service regulations to incorporate the results of the latest research on fatigue and sleep issues.

# Recommendations

As a result of this safety report, the National Transportation Safety Board made the following safety recommendations:

### To the U.S. Department of Transportation:

Require the modal administrations to modify the appropriate *Codes of Federal Regulations* to establish scientifically based hours-of-service regulations that set limits on hours of service, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements. Seek Congressional authority, if necessary, for the modal administrations to establish these regulations. (I-99-1) (Supersedes I-89-3)

### To the Federal Aviation Administration:

Establish within 2 years scientifically based hours-of-service regulations that set limits on hours of service, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements. (A-99-45)

### To the Federal Highway Administration:

Establish within 2 years scientifically based hours-of-service regulations that set limits on hours of service, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements. At a minimum, and as recommended by the National Transportation Safety Board in 1995, the revised regulations should also (a) 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, and (b) 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. (H-99-19) (Supersedes H-95-1 and H-95-2)

### To the Federal Railroad Administration:

Establish within 2 years scientifically based hours-of-service regulations that set limits on hours of service, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements. (R-99-2)

**To the Research and Special Programs Administration:**

Establish within 2 years scientifically based hours-of-service regulations that set limits on hours of service, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements. (P-99-12)

**To the United States Coast Guard:**

Establish within 2 years scientifically based hours-of-service regulations that set limits on hours of service, provide predictable work and rest schedules, and consider circadian rhythms and human sleep and rest requirements. (M-99-1)

Also as a result of this safety report, the National Transportation Safety Board reiterated the following safety recommendations to the Federal Aviation Administration:

Finalize the review of current flight and duty time regulations and revise the regulations, as necessary, within 1 year to ensure that flight and duty time limitations take into consideration research findings on fatigue and sleep issues. The new regulations should prohibit air carriers from assigning flight crews to flights conducted under 14 CFR Part 91 unless the flight crews meet the flight and duty time limitation of 14 CFR Part 121 or other appropriate regulations. (A-95-113)

Develop appropriate limitations on consecutive days on duty, and duty hours per duty period for flight crews engaged in scheduled and nonscheduled commercial flight operations, and apply consistent limitations in Alaska and the remainder of the United States. (A-95-125)

## By the National Transportation Safety Board

**James E. Hall**
Chairman

**Robert T. Francis II**
Vice Chairman

**John A. Hammerschmidt**
Member

**John Goglia**
Member

**George W. Black, Jr.**
Member

**Adopted: May 17, 1999**

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# Appendix A

## Intermodal, Fatigue-Related Safety Recommendations Issued May 12, 1989

# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

Date May 12, 1989

In reply refer to: I-89-1 through -3

Honorable Samuel K. Skinner
Secretary
Department of Transportation
400 Seventh Street, S.W.
Washington, D.C. 20590

About 7:54 a.m., eastern standard time, on January 14, 1988, westbound Consolidated Rail Corporation (Conrail) "trailer van" freight train TV-61 collided with eastbound Conrail freight train UBT-506 near Control Point Thompson, at Thompsontown, Pennsylvania. The engineers and brakemen on both trains were fatally injured. The conductors on both trains received minor injuries. Damage to the trains was estimated at $6,015,000.

The National Transportation Safety Board determined that the probable cause of this accident was the sleep-deprived condition of the engineer and other crewmembers of train UBT-506, which resulted in their inability to stay awake and alert, and their consequent failure to comply with restrictive signals. Contributing to the failure of the crewmembers were their unpredictable work and rest cycles, their voluntary lack of proper rest before going on duty, and the inadequate alertness and acknowledging devices of the locomotive safety backup systems.

This accident illustrates several aspects of current railroad operations that can adversely affect train crews' performance of their duties and, ultimately, the safety of rail transportation. Specifically, the Safety Board found in this case that the engineer and brakeman of UBT-506 probably were suffering chronic sleep deprivation because their work shifts and off-duty periods at home were unpredictable and irregular. As a result, the crewmembers customarily participated in the normal work and living routines of their families, sleeping during conventional night hours. They did not attempt to get meaningful sleep before anticipated calls to work late in the day or at night, but would try to get by without adequate sleep until their next off-duty period. In this instance, none of the crewmembers of train UBT-506 had more than 2 hours of restful sleep during the 22-24 hours preceding the accident. The Safety Board concluded that the crewmembers' sleep-deprived condition was compounded by the monotonous environment of the locomotive cab and, possibly, by their failure to eat a meal for at least 13 hours before the accident. Finally, the Safety Board found that the UBT-506 engineer was able to prevent the automatic train stop (ATS) device from applying the brakes by simply depressing and releasing the acknowledging pedal in his sleep; the ATS did not incorporate an acknowledging feature that required alertness.

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The Safety Board believes that the work and rest cycles and the behaviors outlined above may have been typical not only of this crew but of other train crews elsewhere on the Conrail system and on other railroads. The changing nature of railroad operations and competitive factors have materially increased the relative number of train crewmembers who must work irregular and unpredictable shifts on a long-term basis. Lacking proper training and education in the physiology of fatigue, many may allow themselves to become chronically deprived of sleep, and develop physiological problems that could adversely affect their performance and the safety of train operations. Other transportation industry operators are exposed to shift work, but the work and rest cycles of railroad extra-board and pool traincrews are often more irregular and unpredictable.

The Safety Board believes that railroad management and unions serving railroad operations have failed to adequately consider the effects of unpredictable work schedules and the relaxation of medical standards and procedures. Moreover, the Safety Board believes cooperative efforts are needed to reduce the element of unpredictability in work scheduling and to train and educate employees and their families about proper regimens of health, diet, and rest. As a result of its investigation of the Thompsontown accident, the Safety Board issued a series of recommendations on these safety issues to Conrail, the Brotherhood of Locomotive Engineers, and the United Transportation Union.

The human performance issues involved in the Thompsontown accident and similar train accidents investigated by the Safety Board in recent years are not unique to the railroad industry. They have frequently appeared in accidents in other transportation modes as well.

Highway

Some of the clearest instances of fatigue-related problems are seen in the Safety Board's investigations of major highway accidents. For example, about 4:15 a.m. on July 14, 1986, an intercity bus operated by Trailways Lines, Inc., collided with a truck operated by Rising Fast Trucking Company on Interstate Highway 40 near Brinkley, Arkansas. The busdriver and 27 bus passengers sustained injuries ranging in severity from minor to serious; the truckdriver and his codriver were not injured. The truckdriver had only a 2-hour nap in the 21 hours before the accident. The Safety Board concluded that the combined effects of fatigue due to sleep deprivation, monotony, and vulnerability to lapses in attention at that hour of day combined to decrease the truckdriver's vigilance, adversely affected his judgment, and contributed to his commission of several errors before the collision.

On April 29, 1985, a tractor-semitrailer collided with the rear end of a schoolbus near Tuba City, Arizona. Of the 32 schoolbus passengers, 2 were fatally injured, 26 sustained serious to minor injuries, and 4 were uninjured. The truckdriver and the schoolbus driver received minor injuries. The Safety Board determined that the probable cause of this accident was the truckdriver's chronic fatigue, which adversely affected his ability to avoid

the collision. His chronic fatigue developed from a loss of sleep due to a combination of excessive duty time and a pattern of prolonged irregular duty time. Contributing to the accident was the failure of the truck company to properly monitor the truckdriver's activities to prevent excessive hours of service.

The truckdriver was found to have kept two sets of logs--one for the company and one for himself--with conflicting entries for the time worked. Fuel receipts conflicted with entries in the driver's logs. The truckdriver said he had slept poorly two nights before the accident due to a cough. The night before the accident he had slept on the floor of a motel room shared with other truckdrivers. After sleeping from around 10 p.m. until 3:30 a.m., he arose, prepared his truck, drove to a ranch, and loaded cattle into the truck trailer. Following breakfast, he left Tonapah, Arizona, destined for Medicine Bow, Wyoming. The accident occurred about 3:15 P.M.

According to the trucking company, the driver had been on duty a total of 88 1/4 hours during the 8 consecutive days before the accident. He was in violation of the Federal rule restricting duty to a maximum of 70 hours in 8 days. He was also in violation of the 10- or 15-hour per day rules, or both, on April 23, 25, 26, 27, and 28. His consumption of a large quantity of sweets several hours before the accident, with the resultant initial elevation in the level of blood sugar, may have led to a rapid depletion of blood sugar and further fatigue.

The Safety Board has issued several safety recommendations related to fatigue, work duty time and its limitations, and record keeping. Recommendations included asking the Office of Motor Carrier Safety (OMCS) to issue "On Guard Notices" warning drivers of the problems of fatigue, and recommending that the OMCS find methods and means to prevent or minimize dozing at the wheel by drivers of carriers in interstate commerce. Based on OMCS's response to this latter recommendation, the Safety Board classified it as "closed, unacceptable action"; but addressee action on the remainder of these recommendations was considered acceptable.

Clearly, the pressure of competition and economics are pervasive factors that tend to complicate and exacerbate the problems of excessive duty time and prolonged irregular duty times in commercial vehicle operations. Therefore, any program of remedial action must address this fundamental reality. It is also apparent to the Safety Board that there are serious deficiencies in the industry's understanding and application of knowledge about sleep, circadian factors, and fatigue as they affect driver performance on the Nation's highways. Additionally, public policy has some serious shortcomings, as reflected in the substance and the lack of enforcement of regulations governing commercial driver duty and rest. The Safety Board believes that these deficiencies in knowledge, policy, and practice warrant an immediate and concerted program of remedial action by the U.S. Department of Transportation (DOT).

Marine

The Safety Board has investigated a number of marine accidents in which crewmember fatigue or sleep deprivation was involved. These accidents, like those cited from other transportation modes, illustrate an inadequate

recognition of the significance and extent of the fatigue problem in the transportation industry.

At 12:20 a.m. on February 15, 1985, a 330-foot Panamanian-Flag passenger/car carrier, the M/V A. REGINA, ran aground on the southeast coast of Mona Island, Puerto Rico. After unsuccessful attempts to refloat the REGINA, the 72 crewmembers and 143 passengers were landed by the vessel's lifeboats and liferafts on Mona Island and subsequently flown back to Mayaguez. One crewmember was injured when leaving the vessel. The stranded vessel, valued at $5 million, was considered a total loss.

The Safety Board determined that the probable cause of the grounding was the failure of the master to monitor the vessel's progress along the charted course line by plotting navigation fixes so as to detect the vessel's set and drift. Contributing to the accident was the master's failure to make a leeway steering allowance for the effects of wind, sea, and current when plotting a course line close to the island, his assuming a watch while on medication and in a fatigued physical condition, and his failure to maintain an adequate lookout.

Evidence indicated that the master was suffering from both chronic and acute fatigue. He had not had a day off during the preceding 12 months. His daily workload varied, depending on whether a trip was made or the vessel remained in port. During the week of the accident, the company had instituted daily roundtrips between Puerto Rico and the Dominican Republic. This schedule allowed the master only about 3 hours to himself each day, in addition to a typical allowance of 7-8 hours for sleep. Insomnia and responsibilities of operation had deprived the master of sleep for a period of about 42 hours when the grounding occurred.

About noon on April 21, 1987, the USS RICHARD L. PAGE collided with the fishing vessel CHICKADEE which was under tow by another fishing vessel. Six feet of the bow of the CHICKADEE was severed and it immediately started taking on water. All three crewmembers on the CHICKADEE abandoned the vessel just before it capsized and sank. Crewmembers were rescued shortly afterward, and no one was injured. The PAGE sustained only minor damage. The CHICKADEE was a total loss. Total damage was estimated at $112,000.

Although visibility was limited at the time of the collision, the captain of the PAGE, a guided-missile frigate, decided to conduct a full power trial to test maximum speed of the frigate. Neither the captain of the PAGE nor of the CHICKADEE sounded fog signals. The officer of the deck (OOD) on the PAGE was advised of intermittent contacts on the radarscope, but because he could not confirm the contact, decided it was not an actual vessel and thus did not report the contact to the captain.

The Safety Board attributed the OOD's behavior the day of the accident partly to his long working hours and disrupted sleep pattern during the several days before the accident. The Board also expressed concern regarding the nature of military operations, which foster almost stoic acceptance on the part of military leaders and their subordinates of an arduous regimen that would be considered unacceptable in most nonmilitary environments.

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At 9:14 A.M. on July 19, 1987, two passenger/car ferries collided near Orient Point, Long Island, New York, during dense fog. The M/V NORTH STAR, a 158-foot ferry, was southbound with 21 passengers on board; the M/V CAPE HENLOPEN, a 308-foot ferry, was northbound with approximately 250 passengers on board. Each ferry was being conned by its master who identified the other vessel on radar and established a meeting agreement by radiotelephone. Both vessels were damaged substantially in the collision but were sufficiently seaworthy to continue on their respective routes. Seventeen passengers and two crewmembers aboard the NORTH STAR were injured; two passengers aboard the CAPE HENLOPEN reported they were injured.

The Safety Board determined that the probable cause of the collision was the failure of the masters of both ferries, while approaching each other in close quarters in reduced visibility, to reduce speed in accordance with the Inland Navigation Rules to a minimum at which courses could be maintained and to specify in their meeting agreement the meeting site and clearance to be maintained.

Investigation disclosed that although the master of the CAPE HENLOPEN, by personal preference, had worked 16 to 17 hours per day during the 4 days before the collision, it could not be established that fatigue played a role in his performance on the morning of the collision. Nevertheless, the Safety Board expressed its concern that current Coast Guard regulations do not specify maximum allowable worktime for crewmembers on ferry vessels. Accordingly, the Board recommended that the Coast Guard establish limitations on watch and duty time for crewmembers on board ferries and other inspected passenger vessels. The Safety Board has classified this recommendation as "open, unacceptable action" pending further response by the Coast Guard.

Aviation

Limitations on flight and duty time for airline pilots generally are more stringent than corresponding limitations for vehicle operators in surface modes of transportation. Fortunately, no recent airline accidents have been attributed to fatigue among flightcrews. Nevertheless, anecdotal and media accounts of pilot complaints about fatigue and sleepiness in the cockpit warrant concern, particularly on extended flights that cross multiple time zones. The Aviation Safety Reporting System of the National Aeronautics and Space Administration continues to receive monthly reports from long-haul flightcrews describing how fatigue and sleep loss have contributed to major operational errors.

On February 19, 1985, China Airlines flight 006, a Boeing 747 en route to Los Angeles, California from Taipei, Taiwan, suffered an inflight upset. The flight from Taipei to 300 nautical miles northwest of San Francisco was uneventful and the airplane was flying at 41,000 feet mean sea level when the No. 4 engine lost power. During the attempt to recover and restore normal power on the engine, the airplane rolled to the right, nosed over, and entered an uncontrolled descent. The captain was unable to restore the airplane to stable flight until it had descended to 9,500 feet and had been subjected to more than 5 G's in the process. After the captain stabilized the airplane, he elected to divert to San Francisco International Airport, where a safe landing was made. The airplane suffered major structural damage during the accident, and two passengers were seriously injured.

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The Safety Board determined that the probable cause of this accident was the captain's preoccupation with an inflight malfunction and his failure to properly monitor the airplane's flight instruments, which resulted in his losing control of the airplane. Contributing to the accident was the captain's over-reliance on the autopilot after the loss of thrust on the No. 4 engine.

Flight 006 had departed Taipei at 12:22 A.M. Pacific standard time (4:22 p.m. Taipei local time) and had been airborne 9 hours 46 minutes when the accident occurred. Because of the scheduled duration of the flight (11 hours), an augmented flightcrew was on board, which included an additional fully qualified captain and flight engineer. At the time of the accident, the primary flightcrew members were on duty. They had been on duty during the takeoff, climb, and initial part of the flight, had been afforded a rest period, and had returned to duty about 2 hours before the accident.

Although preoccupation and over-reliance on the autopilot were cited as significant factors in the accident, the Safety Board also noted that the flight had been airborne nearly 10 hours, that it had traversed several time zones, and that the upset occurred about 2:14 a.m. Taiwan local time--about 4-5 hours after the captain had been accustomed to going to sleep. Thus, his ability to obtain, assimilate, and analyze data presented to him could have been impaired by the effects of boredom, monotony, and fatigue. However, the Safety Board was unable to establish conclusively that the captain's performance was impaired by these factors.

On December 12, 1985, Arrow Air Flight MF1285R, a U.S. registered DC-8-63, crashed and burned approximately one-half mile off the departure end of runway 22 at Gander, Newfoundland. All 248 passengers--U.S. military troops--and eight crewmembers sustained fatal injuries. The Canadian Aviation Safety Board (CASB), which investigated the accident, was unable to determine the exact sequence of events that led to the accident. Although the CASB found no basis to indicate that the crew's performance on the accident flight could have been affected by fatigue, its investigation disclosed that if the flight had successfully continued to its Fort Campbell, Kentucky, destination, the crew would have remained on duty to ferry the aircraft to Oakland, California. The CASB estimated that, at the completion of that subsequent flight, the crew would have accumulated about 15 flight hours in the 24 hours that began with their departure from Cologne, West Germany, and the crew's duty day would have approached 20 hours. However, because the ferry flight would have been flown under 14 CFR Part 91 flight rules, which do not include any flight time limitations or minimum crew rest requirements, it could have been accomplished within the provisions of applicable Federal Aviation Regulations.

In its report of this accident, the CASB stated it believes that flight crews of air carrier aircraft "...require the same degree of vigilance, judgement, and ability to react whether they are conducting a revenue-generating or a non-revenue operation." The National Transportation Safety Board agrees with the CASB on this issue and believes this example illustrates

one of the inadequacies of current Federal Aviation Regulations with regard to flight time, duty time, and crew rest provisions. Moreover, the Board believes the example indicates a need to review and upgrade the rules to assure that they incorporate the latest research on fatigue and sleep matters.

The major transportation accidents outlined above raise serious concerns about the far-reaching effects of fatigue, sleepiness, sleep disorders, and circadian factors in transportation system safety. These and other investigative experiences indicate that poor scheduling of work and rest time continues to affect the performance of operating personnel in virtually all modes of transportation. Safety Board experience also indicates that most employees and supervisors in the transportation industry do not receive training on the problems associated with work and rest schedules and the effects such schedules have on safety and performance. Additionally, proper living habits, including attention to exercise, diet, and rest, are important to good health. However, many transportation operating personnel may not adequately appreciate the importance of these habits in relationship to their fitness for duty and their susceptibility to fatigue in the face of their irregular and often unpredictable work/rest patterns. Therefore, the Safety Board believes there is a need to develop and disseminate educational materials that will assist transportation employees in adapting living habits appropriate to their work/rest patterns.

Furthermore, it appears that, with minor exceptions, neither management nor the labor segments of the transportation industry properly considers the adverse effects of irregular and unpredictable cycles of work and rest on its vehicle-operating personnel. Although some private research has been conducted on this safety issue,[1] the Safety Board is unaware of any systematic activity by the DOT to address the safety concerns of inadequate work and rest scheduling in any of the transportation modes.

Since 1972, the Safety Board has issued about 39 safety recommendations to transportation modal administrations, operators, and associations concerning fatigue, duty time, and hours of service. Collectively, these recommendations addressed most aspects of the fatigue and fitness-for-duty issues, but they constitute uncoordinated and piecemeal efforts directed to various government and industry segments of the transportation community. The Safety Board is aware of the March 1989 DOT report entitled "Transportation-Related Sleep Research," which was prepared in response to a request by the U.S. Senate Committee on Appropriations, and which describes current Departmental activities in this field. This report provides an overview of current diverse

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1 Moore, Ede, Sulzman and Fuller: The Clocks That Time Us, Harvard University Press, 1982. Akerstedt, Torswell, and Gillberg: "Sleepiness and Shift Work; Field Studies," Sleep 5:S95-S106, New York, Raven Press, 1982. Johnson and Naitoh: "The Operational Consequences of Sleep Deprivation and Sleep Deficit," AGARDOGRAPH No. 193, June 1974. "Biological Clocks and Shift Work Scheduling," Hearings before the Subcommittee on Investigations and Oversight of the Committee on Science and Technology, House of Representatives, Ninety-Eighth Congress, March 23, 1983.

activities by various Departmental administrations regarding the role of fatigue, sleep disorders, and sleepiness in their respective modes. However, the Board believes a review of the report also indicates a need for more overall planning, direction, and control of these activities to assure that they are administered as a coordinated, effective program that will provide the best possible safety benefits for the entire transportation community.

Based on its experience in accident investigation, the Safety Board believes it is time for an aggressive Federal program to address the problems of fatigue and sleep issues in transportation safety. Such a program should include a coordinated research effort, an extensive educational effort directed toward all segments of the transportation industry, and a systematic review and improvement of regulations governing hours of service across all transportation modes.

Therefore, the National Transportation Safety Board recommends that the 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. (Class II, Priority Action) (I-89-1)
>
> 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. (Class II, Priority Action) (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. (Class III, Longer-Term Action) (I-89-3)

KOLSTAD, Acting Chairman, and BURNETT, LAUBER, NALL, and DICKINSON, Members, concurred in these recommendations.

By: James L. Kolstad
Acting Chairman

# Appendix B

## Fatigue-Related Investigations and Studies Conducted Since May 1989

This appendix lists the fatigue-related investigations and studies conducted by the National Transportation Safety Board since May 1989. Only the safety recommendations that were issued to the U.S. Department of Transportation (DOT) and the modal administrations are included.

| | |
|---|---|
| **Safety Board Document:** | Aircraft Accident Report |
| **Title:** | Aloha IslanderAir, Inc., Flight 1712, De Havilland Twin Otter, DHC-6-300, N707PV, Halawa Point, Molokai, Hawaii, October 28, 1989 |
| **Report Number:** | NTSB/AAR-90/05 |
| **Date Recommendation(s) Issued:** | November 21, 1990 |
| **Fatigue Cited as a Cause of or Contributing Factor to the Accident:** | No |

**Abstract:**

This report explains the crash of Aloha IslandAir flight 1712, a de Havilland Twin Otter DHC-6-300 near Halawa Bay, Molokai, Hawaii, on October 28, 1989.

**Fatigue-Related Conclusions:**

The captain was probably fatigued because of a full-time training schedule with Aloha Airlines, late night habits, and a part-time flight schedule with Aloha IslandAir.

**Fatigue-Related Recommendations Issued to the DOT:**

None

**Safety Board Document:** Aircraft Accident Report

**Title:** Atlantic Southeast Airlines, Inc., Flight 2311, Uncontrolled Collision With Terrain and Embraer EMB-120, N270AS, Brunswick, Georgia, April 5, 1991

**Report Number:** NTSB/AAR-92/03

**Date Recommendation(s) Issued:** May 14, 1992

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** No

**Abstract:**

This report explains the loss of control in flight and crash of Atlantic Southeast Airlines, Inc., flight 2311 while the airplane was conducting a landing approach to runway 07 at the Glynco Jetport, Brunswick, Georgia.

**Fatigue-Related Conclusions:**

Commuter air carriers, including Atlantic Southeast Airlines, use the reduced rest provisions of 14 CFR Part 135 to routinely schedule reduced rest periods in daily operations, contrary to the purpose of the regulation, which is primarily to allow for scheduling flexibility.

**Fatigue-Related Recommendations Issued to the DOT:**

Issue an Air Carrier Operations Bulletin (ACOB) directing Principal Operations Inspectors to clarify with their operators that the intent of 14 CFR Section 135.265 is not to routinely schedule reduced rest, but to allow for unexpected operational delays, and to require compliance with the intent of the regulation. (A-92-28)

| Recipient(s) | Status |
|---|---|
| Federal Aviation Administration | Open—Acceptable Response |

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**Safety Board Document:** Special Investigation Report (Aviation)

**Title:** Commercial Space Launch Incident: Launch Procedure Anomaly, Orbital Sciences Corporation, Pegasus/SCD-1, 80 Nautical Miles East of Cape Canaveral, Florida, February 9, 1993

**Report Number:** NTSB/SIR-93/02

**Date Recommendation(s) Issued:** August 8, 1993

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** No

**Abstract:**

This report explains the procedural anomaly that occurred during the launch sequence of an Orbital Sciences Corporation Pegasus expendable launch vehicle, which was subsequently deployed successfully from an NB-52B airplane on February 9, 1993.

**Fatigue-Related Conclusions:**

There is a high probability that fatigue caused by the disruption of the circadian rhythms and sleep loss adversely affected the performance of some critical personnel during the launch.

**Fatigue-Related Recommendations Issued to the DOT:**

Require that, as a condition for license for commercial space launches, as a minimum, the company applying for the license include in its license application a provision for mandatory rest periods before the launch for key participants that provide for an adequate and specified time period for uninterrupted sleep. The quantitative criteria for such rest periods should be developed by appropriate human performance experts to ensure applicability to the assigned tasks. (A-93-90)

| Recipient(s) | Status |
|---|---|
| U.S. Department of Transportation | Open—Acceptable Response |

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**Safety Board Document:** Safety Study (Aviation)

**Title:** A Review of Flightcrew-Involved, Major Accidents of U.S. Air Carriers, 1978 Through 1990

**Report Number:** NTSB/SS-94/01

**Date Recommendation(s) Issued:** February 3, 1994

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Not applicable

**Abstract:**

U.S. air carrier operations are extremely safe, and the accident rate has declined in recent years. However, among the wide array of factors cited by the National Transportation Safety Board as causal or contributing to airplane accidents, actions or inactions by the flightcrew have been cited in the majority of fatal air carrier accidents. Recognizing that deficiencies in various aspects of the aviation system may adversely influence flightcrew performance, the Safety Board conducted this study to learn more about flightcrew performance by evaluating the characteristics of the operating environment, crewmembers, and errors made in major accidents of U.S. air carriers between 1978 and 1990 in which the flightcrew was cited by the Board. Characteristics of the operating environments and flightcrews were identified from information derived from major investigations of 36 accidents and 1 incident. The errors identified were evaluated in light of the contexts in which they occurred.

**Fatigue-Related Conclusions:**

Half the captains for whom data were available had been awake for more than 12 hours prior to their accidents. Half the first officers had been awake more than 11 hours. Crews comprising captains and first officers whose time since awaking was above the median for their crew position made more errors overall, and significantly more procedural and tactical decision errors.

**Fatigue-Related Recommendations Issued to the DOT:**

Require U.S. air carriers operating under 14 CFR Part 121 to include, as part of pilot training, a program to educate pilots about the detrimental effects of fatigue, and strategies for avoiding fatigue and countering its effects. (A-94-5)

| Recipient(s) | Status |
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| Federal Aviation Administration | Closed—Acceptable Action |

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| **Safety Board Document:** | Aircraft Accident Report |
| **Title:** | In-Flight Loss of Control, Leading to Forced Landing and Runway Overrun, Continental Express, Inc., N24706, Embraer EMB-120 RT, Pine Bluff, Arkansas, April 29, 1993 |
| **Report Number:** | NTSB/AAR-94/02/SUM |
| **Date Recommendation(s) Issued:** | March 17, 1994 |

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Yes

**Abstract:**

This report explains the in-flight loss of control of N24706, leading to a forced landing and runway overrun at Pine Bluff, Arkansas, on April 29, 1993.

**Fatigue-Related Conclusions:**

The crew rest periods scheduled for the trip sequence were within company guidelines and FARs. However, the crew did not take advantage of the rest periods, and the combined effects of cumulatively limited sleep, a demanding day of flying, and a time of day associated with fatigue were factors in the crew's inadequate judgment and performance.

**Fatigue-Related Recommendations Issued to the DOT:**

Require that 14 CFR Part 135 air carriers provide air crews, as part of their initial and recurrent training, information on fatigue countermeasures relevant to the duty/rest schedules being flown by the company. (A-94-73)

| Recipient(s) | Status |
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| Federal Aviation Administration | Closed—Acceptable Action |

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**Safety Board Document:** Aircraft Accident Report

**Title:** Uncontrolled Collision With Terrain, American International Airways Flight 808, Douglas DC-8-61, N814CK, U.S. Naval Air Station, Guantanamo Bay, Cuba, August 18, 1993

**Report Number:** NTSB/AAR-94/04

**Date Recommendation(s) Issued:** May 18, 1994

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Yes

**Abstract:**

This report explains the crash of American International Airways flight 808, a DC-8-61, about 1/4 mile from the approach end of runway 10 at Leeward Point Airfield, U.S. Naval Air Station, Guantanamo Bay, Cuba, on August 18, 1993.

**Fatigue-Related Conclusions:**

The flightcrew members had experienced a disruption of circadian rhythms and sleep loss, which resulted in fatigue that had adversely affected their performance during a critical phase of flight.

The flightcrew had been on duty about 18 hours and had flown approximately 9 hours at the time of the accident. The company had intended for the crew to ferry the airplane back to Atlanta after the airplane was offloaded in Guantanamo Bay. This would have resulted in a total duty time of 24 hours and 12 hours of flight time, the maximum permitted under 14 CFR Section 121.521, supplemental rules for overseas and international flights.

If the flightcrew had been scheduled to conduct a flight within the United States similar to that of flight 808, the flightcrew would have exceeded the flight and duty time requirements of 14 CFR 121.505.

**Fatigue-Related Recommendations Issued to the DOT:**

Revise the applicable subpart of 14 CFR Part 121 to require that flight time, accumulated in noncommercial "tail end" ferry flights conducted under 14 CFR Part 91, as a result of 14 CFR Part 121 revenue flights, be included in the flight crewmember's total flight and duty time accrued during those revenue operations. (A-94-105)

| Recipient(s) | Status |
|---|---|
| Federal Aviation Administration | Closed—Acceptable Action/Superseded |

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Expedite the review and upgrade of fight/duty time limitations of the Federal Aviation Regulations to ensure that they incorporate the results of the latest research on fatigue and sleep issues. (A-94-106)

| Recipient(s) | Status |
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| Federal Aviation Administration | Closed—Acceptable Action/Superseded |

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| **Safety Board Document:** | Safety Study (Aviation) |
| **Title:** | Commuter Airline Safety |
| **Report Number:** | NTSB/SS-94/02 |
| **Date Recommendation(s) Issued:** | November 30, 1994 |

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Not applicable

**Abstract:**

The commuter airline industry has grown dramatically and has experienced significant changes in operating characteristics in the past 15 years. In response to safety recommendations issued by the National Transportation Safety Board and through other initiatives taken by government and industry, regulatory revisions and other actions have resulted in an improved safety record for commuter airlines conducting operations under Title 14 *Code of Federal Regulations* Part 135. However, despite efforts to bring about safety improvements, accident rates for commuter airlines continue to be higher than the rates for domestic Part 121 airlines. The higher accident rate, the differences in regulatory standards between Parts 135 and 121, and findings of the Safety Board's investigations of recent accidents prompted the Board to initiate this study of commuter airline safety.

**Fatigue-Related Conclusions:**

Part 135 regulations on flight time and crew rest allow air carriers to establish schedules that result in reduced rest, and many commuter airlines routinely take advantage of these reduced rest provisions for scheduling flightcrews rather than using the provisions for the intended purpose of accommodating unforeseen circumstances.

Self-reports from the commuter airline pilots surveyed indicate that most have flown while fatigued. The most common reasons given for flying while fatigued were the length of duty days, early shift duty followed by late shift duty, and inadequate rest periods.

The practice of scheduling Part 135 pilots for training, check flights, or other nonrevenue flights at the end of a full day of scheduled revenue flying reduces the value of the training and increases the potential for fatigue-related accidents.

**Fatigue-Related Recommendations Issued to the DOT:**

Require principal operations inspectors to periodically review air carrier flight operations polices and practices concerning pilot task performed between flights to ensure that carriers provide pilots with adequate resources (such as time and personnel) to accomplish those tasks. (A-94-193)

| Recipient(s) | Status |
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| Federal Aviation Administration | Closed—Acceptable Alternate Action |

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Revise the Federal Aviation Regulations contained in 14 CFR Part 135 to require that pilot flight time accumulated in all company flying conducted after revenue operations—such as training and check flights, ferry flights, and repositioning flights—be included in the crewmember's total flight time accrued during revenue operations. (A-94-194)

| Recipient(s) | Status |
|---|---|
| Federal Aviation Administration | Open—Acceptable Response |

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**Safety Board Document:** Aircraft Accident Report

**Title:** Uncontrolled Collision With Terrain, Air Transport International, Douglas DC-8-63, N782AL, Kansas City International Airport, Kansas City, Missouri, February 16, 1995

**Report Number:** NTSB/AAR-95/06

**Date Recommendation(s) Issued:** November 14, 1995

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Yes

**Abstract:**

This report explains the accident involving an Air Transport International DC-8-63, which was destroyed by ground impact and fire during an attempted takeoff at Kansas City International Airport, Kansas City, Missouri, on February 16, 1995.

**Fatigue-Related Conclusions:**

The flightcrew assigned to the ferry had a shortened rest break after performing an international trip. Federal regulations permit companies to eliminate these rest periods after flying a 14 CFR Part 121 operation when the flight will be conducted as a ferry operating under 14 CFR Part 91.

At the time of the accident, the flightcrew was suffering from fatigue as a result of limited opportunities for rest, disruption to their circadian rhythms, and lack of sleep in the days before the accident. However, the Safety Board was unable to determine the extent, if any, to which their fatigue contributed to the accident.

Existing FAR Part 121 flight time limits and rest requirements that pertained to the flights that the flightcrew flew prior to the ferry flights did not apply to the ferry flights flown under FAR Part 91. This permitted a substantially reduced flightcrew rest period when conducting the nonrevenue ferry flights.

**Fatigue-Related Recommendations Issued to the DOT:**

Finalize the review of current flight and duty time regulations and revise the regulations, as necessary, within 1 year to ensure that flight and duty time limitations take into consideration research findings in fatigue and sleep issues. The new regulations should prohibit air carriers from assigning flightcrews to flights conducted under Title14 *Code of Federal Regulations* Part 91 unless the flightcrew meet the flight and duty time limitations of 14 CFR Part 121 or other appropriate regulations. (A-95-113)

| Recipient(s) | Status |
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| Federal Aviation Administration | Open—Unacceptable Response |

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**Safety Board Document:** Safety Study (Aviation)

**Title:** Aviation Safety in Alaska

**Report Number:** NTSB/SS-95/03

**Date Recommendation(s) Issued:** December 1, 1995

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Not applicable

**Abstract:**

Flight operations in Alaska are diverse, and they are responsive to the State's challenging aviation environment and its unique air transportation requirements. The National Transportation Safety Board conducted this study to examine Alaska's current aviation environment and air transportation activities, to identify the associated risk factors and safety deficiencies, and to recommend practical measures for managing the risks to safe flight operations given the reality of Alaska's aviation environment and the potential of new technologies.

**Fatigue-Related Conclusions:**

The consecutive, long duty days currently permitted by Part 135.261 for commuter airline and air taxi flightcrews in Alaska can contribute to fatigue and are a detriment to safety.

**Fatigue-Related Recommendations Issued to the DOT:**

Develop appropriate limitations on consecutive days on duty, and duty hours per duty period for flightcrews engaged in scheduled and nonscheduled commercial flight operations, and apply consistent limitations in Alaska and the remainder of the United States. (A-95-125)

| Recipient(s) | Status |
|---|---|
| Federal Aviation Administration | Open—Unacceptable Response |

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**Safety Board Document:** Aircraft Accident Report

**Title:** In-Flight Loss of Control and Subsequent Collision With Terrain, Cessna 177B, N35207, Cheyenne, Wyoming, April 11, 1996

**Report Number:** NTSB/AAR-97/02

**Date Recommendation(s) Issued:** March 21, 1997

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** No

**Abstract:**

On April 11, 1996, about 0824 mountain daylight time, privately owned Cessna 177B, registration N35207, collided with terrain after a loss of control following takeoff from runway 30 at the Cheyenne Airport, Cheyenne, Wyoming. The pilot-in-command, pilot trainee, and rear seat passenger (the pilot trainee's father) were fatally injured. Instrument meteorological conditions existed at the time, and a visual flight rules flight plan had been filed. The flight, which was a continuation of a transcontinental flight "record" attempt by the youngest "pilot" to date (the pilot trainee), was operated under the provisions of 14 CFR Part 91.

**Fatigue-Related Conclusions:**

The pilot-in-command suffered from fatigue on the day before the accident.

Information on fatigue and its effect, and methods to counteract it, might have assisted the pilot-in-command to recognize his own fatigue on the first day of the flight, and possibly enhanced the safety of the trip.

**Fatigue-Related Recommendations Issued to the DOT:**

Expand the development and increase the dissemination of educational materials on the hazards of fatigue to the general aviation piloting community. (A-97-20)

| Recipient(s) | Status |
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| Federal Aviation Administration | Closed—Acceptable Action |

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**Safety Board Document:** Aircraft Accident Report

**Title:** In-Flight Fire and Impact With Terrain, ValuJet Airlines, Flight 592, DC-9-32, N904VJ, Everglades, Near Miami, Florida, May 11, 1996

**Report Number:** NTSB/AAR-97/06

**Date Recommendation(s) Issued:** September 9, 1997

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** No

**Abstract:**

This report explains the in-flight fire and impact with terrain of ValuJet Airlines flight 592, a DC-9-32, N904VJ, in the Everglades near Miami, Florida, on May 11, 1996.

**Fatigue-Related Conclusions:**

The maintenance duty time limitations of 14 CFR Part 121.377 may not be consistent with the current state of scientific knowledge about factors contributing to fatigue among personnel working in safety-sensitive transportation jobs.

**Fatigue-Related Recommendations Issued to the DOT:**

Review the issue of personnel fatigue in aviation maintenance, then establish duty time limitations consistent with the current state of scientific knowledge for personnel who perform maintenance on air carrier aircraft. (A-97-71)

| Recipient(s) | Status |
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| Federal Aviation Administration | Open—Response Received |

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**Safety Board Document:** Safety Study (Highway)

**Title:** Fatigue, Alcohol, Other Drugs, and Medical Factors in Fatal-to-the-Driver Heavy Truck Crashes

**Report Number:** NTSB/SS-90/01 and NTSB/SS-90/02

**Date Recommendation(s) Issued:** April 4, 1990

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Not applicable

**Abstract:**

This report is an analysis of human factors in fatal-to-the-driver, heavy truck accidents in eight States over a 1-year period, October 1, 1987, through September 30, 1988. Data presented are derived from in-depth investigation of 182 accidents that involved 186 heavy trucks and resulted in 207 fatalities. The accident investigations were conducted in California, Colorado, Georgia, Maryland, New Jersey, North Carolina, Tennessee, and Wisconsin. These accidents represent approximately 25 percent of this type of accident nationwide. Volume 1 (NTSB/SS-90/01) of the study includes an analysis of fatigue, alcohol, and other drug prevalence and medical factors in these accidents, presents findings, and makes recommendations to improve heavy truck safety. Volume 2 (NTSB/SS-90/02) contains the 182 case summaries that provided the data discussed in Volume 1.

**Fatigue-Related Conclusions:**

The most frequently cited accident probable cause or factor in fatal-to-the-driver heavy truck accidents was fatigue (57 cases or 31 percent), followed by alcohol and other drug impairment (53 cases or 29 percent). Of the 57 drivers who were fatigued, 19 were also impaired by alcohol and/or drugs.

Fatigue and fatigue-drug interactions were involved in more fatalities in this study than alcohol and other drugs of abuse.

Fatigue, drugs that are taken to counteract the symptoms of fatigue, drugs that aggravate fatigue, and the interaction of fatigue and drugs appear to be major factors in accident causation.

There is a strong association between violation of the Federal hours-of-service regulations and drug usage. More than half the drivers who had violated Federal hours-of-service regulations tested positive for some drug of abuse. The largest difference among these two groups of drivers appeared to occur with marijuana, which was the most prevalent drug of abuse among the drivers who were in excess of the Federal regulations. Greater use of amphetamines, cocaine, and alcohol by drivers who violated Federal hours-of-service regulations were also indicated.

Drug-free drivers appear more likely to have accidents during certain time periods (when there is increased exposure and at times when people tend to be less alert and in accordance with low periods in circadian rhythm) whereas drug-involved drivers appear to have accidents throughout the day.

Investigators found that logbooks were routinely falsified where they were required by regulation. It was common to find two sets of logbooks (three sets in one case) kept by the accident-involved drivers. In only one case was a vehicle equipped with a tachograph. Five case vehicles were equipped with on-board recorders.

**Fatigue-Related Recommendations Issued to the DOT:**

Conduct a detailed review of, and report on, trucking industry structure, operations, and conditions, especially shipping, dispatching, and receiving requirements, shipment broker operations, just-in-time shipments, and truckload/less-than-truckload operations which may create incentives for drivers to violate hours-of-service regulations and to use drugs of abuse. (H-90-10)

| Recipient(s) | Status |
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| Department of Transportation | Open—Acceptable Response |

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Disseminate safety information to national, State, and local police agencies, public service and safety agencies, professional truckdriver groups and individual truckdrivers, regarding the effects of fatigue, alcohol, and other drug use; the interaction of alcohol, drugs, and fatigue; the prevalence of drug and alcohol abuse among professional commercial vehicle operators; and methods of minimizing conditions which lead to commercial vehicle operators driving while fatigued. (H-90-21)

| Recipient(s) | Status |
|---|---|
| Federal Highway Administration | Closed—Acceptable Action |

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

| Recipient(s) | Status |
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| Federal Highway Administration | Closed—Unacceptable Action |

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As part of the FHWA ongoing study on fatigue and loss of alertness among commercial vehicle operators, investigate the interactions of fatigue and drug usage. (H-90-29)

| Recipient(s) | Status |
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| Federal Highway Administration | Closed—Unacceptable Action |

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Revise 49 CFR Parts 391 and 395 to establish driver hours-of-service violations, logbooks irregularities, or the presence of multiple logbooks as a reasonable cause requiring a drug test of the driver. Amend the regulations and provide notice to drivers of these revised regulations. (H-90-30)

| Recipient(s) | Status |
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| Federal Highway Administration | Closed—Unacceptable Action |

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Amend 49 CFR Parts 392 and 395 to prohibit employers, shippers, receivers, brokers, or drivers form 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 392.6]). In conjunction with the Interstate Commerce Commission, provide for operating certificate and financial penalties appropriate to the offense. (H-90-32)

| Recipient(s) | Status |
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| Federal Highway Administration | Closed—Unacceptable Action/Superseded |

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**Safety Board Document:** Highway Accident Report

**Title:** Multiple Vehicle Collision and Fire in a Work Zone on Interstate Highway 79 Near Sutton , West Virginia, July 26, 1990.

**Report Number:** NTSB/HAR-91/01

**Date Recommendation(s) Issued:** June 20, 1991

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Yes

**Abstract:**

This report explains the multiple vehicle collision and fire in a work zone on interstate Highway 79 near Sutton, West Virginia, on July 26, 1990.

**Fatigue-Related Conclusions:**

The Double B truckdriver drove more than the 10 1/4 hours reported; therefore, it is unlikely that he spent 7 1/2 hours sleeping or resting in the truck's cab the morning before the accident.

Fatigue-induced inattention, exacerbated by an inadequate and unbalanced diet the day of the accident, caused the Double B truckdriver to fail to heed warning signs and to slow the truck in time to avoid the collision.

**Fatigue-Related Recommendations Issued to the DOT:**

Encourage the use of work zone safety devices and procedures, such as "rumble strips," that alert the various senses. (H-91-28)

| Recipient(s) | Status |
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| Federal Highway Administration | Closed—Acceptable Action |

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**Safety Board Document:** Highway Accident Report

**Title:** Greyhound Bus Run-Off-the-Road Accidents: Donegal, Pennsylvania, June 26, 1991; and Caroline, New York, August 3, 1991

**Report Number:** NTSB/HAR-92/01

**Date Recommendation(s) Issued:** April 1, 1992

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** No

**Abstract:**

On June 26, 1991, about 1:50 p.m., a greyhound bus traveling from Cleveland, Ohio, to Washington, D.C., ran off the right side of the roadway and overturned on the Pennsylvania turnpike near Donegal, Pennsylvania. One passenger was fatally injured, the driver and 14 passengers were injured, and 1 passenger was uninjured. On August 3, 1991, about 6:45 a.m., a greyhound bus traveling from New York City to Buffalo, New York, ran off the right side of the roadway, and overturned on State Route 79 near Caroline, New York. The driver and 33 passengers were injured, and 5 passengers were uninjured.

**Fatigue-Related Conclusions:**

The limited rest both busdrivers had received prior to the accident trips was one of several physiological factors that may have caused these busdrivers to be inattentive to their driving tasks.

**Fatigue-Related Recommendations Issued to the DOT:**

None

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**Safety Board Document:** Highway Accident Report

**Title:** Tractor-Semitrailer Collision With Bridge Columns on Interstate 65, Evergreen, Alabama, May 19, 1993

**Report Number:** NTSB/HAR-94/02

**Date Recommendation(s) Issued:** May 4, 1994

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Yes

**Abstract:**

On May 19, 1993, a tractor with bulk-cement-tank semitrailer was traveling southbound on Interstate 65 near Evergreen, Alabama, and collided with a supporting bridge column of the County Road 22 overpass. Two spans of the overpass collapsed onto the semitrailer and the southbound lanes of the Interstate. An automobile and a tractor-semitrailer then collided with the collapsed bridge spans. The cement-tank truckdriver was seriously injured; the drivers of the other vehicles were killed.

**Fatigue-Related Conclusions:**

The truckdriver exhibited a reduced alertness that is consistent with falling asleep.

**Fatigue-Related Recommendations Issued to the DOT:**

None

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**Safety Board Document:** Safety Study (Highway)

**Title:** Factors That Affect Fatigue in Heavy Truck Accidents

**Report Number:** NTSB/SS-95/01 and NTSB/SS-95/02

**Date Recommendation(s) Issued:** February 7, 1995

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Not applicable

**Abstract:**

Because of the significant number of heavy truck-related fatalities and the significant role of fatigue in such accidents, the Board initiated this study of single-vehicle heavy truck accidents to examine the role of specific factors, such as drivers' patterns of duty and sleep, in fatigue-related heavy truck accidents and to determine potential remedial actions. The purpose of the Board's study was to examine the factors that affect driver fatigue and not the statistical incidence of fatigue. The study analyzes data from 107 single-vehicle heavy truck accidents in which the driver survived. Volume 1 of the study contains the Board's analysis of the data and its conclusions and recommendations. Volume 2 of the study contains the summaries of the 107 accidents.

**Fatigue-Related Conclusions:**

The most critical factors in predicting fatigue-related accidents in the 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.

Whereas sleep measures were the critical factors in discriminating between a fatigue-related and nonfatigue-related accident, schedule irregularity was the major factor in discriminating between a long-haul and a short-haul operation.

The truckdrivers in fatigue-related accidents in this sample obtained an average of 5.5 hours sleep in the last sleep period prior to the accident. This was 2.5 hours less than the drivers involved in nonfatigue-related accidents (8.0 hours).

The truckdrivers involved in fatigue-related accidents obtained 6.9 hours sleep in the 24 hours prior to the accident (the amount they reported usually needing to feel rested). This was 2.4 hours less sleep than the drivers involved in nonfatigue-related accidents (9.3 hours).

The hours-of-service regulations currently do not provide the opportunity to obtain an adequate amount of sleep (at least 8 continuous hours) because they do not consider time needed for travel, eating, personal hygiene, recreation, or inability to fall asleep immediately at the beginning of the 8-hour off-duty period.

Many of the truckdrivers in the 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. 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.

The data from this study indicate that driving at night with a sleep deficit is far more critical in terms of predicting fatigue-related accidents than simply nighttime driving.

Truckdrivers with split sleep patterns obtained 8 hours sleep in a 24-hour time period; however, they obtained it in small segments, on average of 4 hours at a time. The data and research indicate that sleep accumulated in short time blocks impedes the recovery of performance abilities.

The use of the sleeper berth exemption [now found in 49 CFR 395.1(h)] promotes split sleeping that can result in performance decrements earlier than for drivers who obtain sleep in longer continuous periods.

About 67 percent of the drivers with schedule irregularities were involved in fatigue-related accidents (48 of 73), and about 38 percent of drivers with regular schedules had fatigue-related accidents (13 of 34). Seventeen of the 107 drivers had inverted their duty/sleep periods on the accident trip; that is, the accident occurred at a time when on the previous day the driver had been sleeping. All but one of these drivers (94 percent) had a fatigue-related accident. Irregular and inverted schedules can result in longer hours awake than normal and can prevent drivers from obtaining adequate sleep without careful planning.

Twenty-seven of the 107 drivers exceeded the hours-of-service limits at least once in the 96 hours preceding the accident. Of those drivers who exceeded the limits, about 82 percent (22 of 27) had a fatigue-related accident. The obvious implication for drivers who exceed the hour-of-service limits is the fewer number of hours available to obtain adequate sleep.

Providing education to transportation employees about the factors affecting fatigue is a vitally important component of overall efforts to combat fatigue in transportation.

The results of this study suggest a possible link between the method of driver compensation and fatigue-related accidents—an issue that has not been previously addressed in detail.

**Fatigue-Related Recommendations Issued to the DOT:**

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. (H-95-1)

| Recipient(s) | Status |
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| Federal Highway Administration | Closed—Unacceptable Action/Superseded by H-99-19 |

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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. (H-95-2)

| Recipient(s) | Status |
|---|---|
| Federal Highway Administration | Closed—Unacceptable Action/Superseded by H-99-19 |

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

| Recipient(s) | Status |
|---|---|
| Federal Highway Administration | Open—Acceptable Response |

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Complete rulemaking within 2 years to amend 49 CFR Parts 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]. (H-95-4) (Supersedes H-90-32)

| Recipient(s) | Status |
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| Federal Highway Administration | Open—Unacceptable Response |

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Develop and disseminate, in consultation with the U.S. Department of Transportation Human Factors Coordinating Committee, a training and education module to inform truckdrivers of the hazards of driving while fatigued. It should include information about the need for adequate amount of quality sleep, strategies for avoiding sleep loss such as strategic napping, consideration of the behavioral and physiological consequences of sleepiness, and an awareness that sleep can occur suddenly and without warning to all drivers regardless of their age or experience. (H-95-5)

| Recipient(s) | Status |
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| Federal Highway Administration | Closed—Acceptable Action |

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| **Safety Board Document:** | Highway Accident Report |
| **Title:** | Propane Truck Collision with Bridge Column and Fire, White Plains, New York, July 27, 1994 |
| **Report Number:** | NTSB/HAR-95/02 |

**Date Recommendation(s) Issued:** November 27, 1995

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Yes

**Abstract:**

On July 27, 1994, a tractor cargo-tank semitrailer loaded with 9,200 gallons of propane (a liquefied petroleum gas) and traveling east on Interstate 287 in White Plains, New York, drifted across the left lane onto the left shoulder and struck the guardrail. The tank hit a column of the Grant Avenue overpass. The tractor and the semitrailer separated, and the front head of the tank fractured, releasing the propane, which vaporized into gas and ignited. The tank was propelled northward about 300 feet, landing on a frame house and engulfing it in flames. The driver was killed, 23 people were injured, and an area within a radius of approximately 400 feet was engulfed by fire.

**Fatigue-Related Conclusions:**

The driver chose to sacrifice his rest in order to complete his deliveries within his normal schedule. At the time of the accident, he had probably fallen asleep because he was suffering from acute fatigue.

The carrier's policy of paying by the load instead of by the hour appeared to encourage drivers to violate hours-of-service regulations.

The driver might have rested before trying to complete his last load had he been trained in understanding the effects of deficit sleep and irregular or inverted rest schedules.

The carrier's oversight of the driver's hours of service was inadequate.

**Fatigue-Related Recommendations Issued to the DOT:**

Cooperate with the American Association of Motor Vehicle Administrators and the American Trucking Associations to review and augment the commercial drivers license manual and test materials to include information on the role of fatigue in commercial vehicle accidents and methods to identify and address fatigue. (H-95-36)

| Recipient(s) | Status |
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| Federal Highway Administration | Open—Acceptable Response |

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**Safety Board Document:** Special Investigation Report (Highway)

**Title:** Selective Motorcoach Issues

**Report Number:** NTSB/SIR-99/01

**Date Recommendation(s) Issued:** February 26, 1999

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Not applicable

**Abstract:**

This report contains the findings of a special investigation conducted as a result of two fatal motorcoach accidents. In the first accident, on October 14, 1995, two passengers sustained fatal injuries, 13 sustained serious injuries, and 26 received minor injuries when a 1989 Eagle motorcoach operated by Hammond Yellow Coach Lines, Inc., overturned upon entering an Interstate 70 exit ramp in Indianapolis, Indiana. In the second accident, on July 29, 1997, 1 passenger sustained minor injuries, the driver and 3 passengers sustained serious injuries, and 28 passengers sustained minor injuries when a 1985 Transportation Manufacturing Corporation (TMC) motorcoach operated by Rite-Way Transportation, Inc., drifted off the side of Interstate 95 near Stoney Creek, Virginia, and down an embankment into the Nottoway River, where it came to rest on its left side, partially submerged in water.

**Fatigue-Related Conclusions:**

The Rite-Way busdriver fell asleep and ran off the road.

The Rite-Way driver became fatigued because the Pathways to Freedom tour schedule imposed inverted duty-sleep periods and because additional well-rested drivers were not provided for relief.

Although the exact cause of the Hammond driver's failing to respond appropriately cannot be determined, several factors, including fatiguing conditions and the driver's unfamiliarity with the route, may have contributed to his failing to slow down for the exit ramp.

**Fatigue-Related Recommendations Issued to the DOT:**

Require that the Federal Highway Administration's fatigue video that is being developed for motorcoaches discuss the dangers of inverted duty-sleep periods (H-99-4A)

| Recipient(s) | Status |
|---|---|
| Department of Transportation | Open—Await Response |

♦ ♦ ♦

In the assessment that is mandated by the Transportation Efficiency Act for the 21st Century, include the inverted work schedules of motorcoach carriers in the study of how the operations of shippers, brokers, freight forwarders, consignees, or others, such as tour or charter operators, encourage the violations of the hours-of-service rules (H-99-5)

| Recipient(s) | Status |
|---|---|
| Department of Transportation | Open—Await Response |

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**Safety Board Document:** Marine Accident Report

**Title:** Grounding of the U.S. Tankship *Exxon Valdez* on Bligh Reef, Prince William Sound Near Valdez, Alaska, March 24, 1989

**Report Number:** NTSB/MAR-90/04

**Date Recommendation(s) Issued:** September 18, 1990

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Yes

**Abstract:**

This report explains the grounding of the U.S. tankship *Exxon Valdez* near Valdez, Alaska, on March 24, 1989.

**Fatigue-Related Conclusions:**

The performance of the third mate was deficient, probably because of fatigue, when he assumed supervision of the navigation watch from the master about 2350.

The third mate's failure to turn the vessel at the proper time and with sufficient rudder probably was the result of his excessive workload and fatigued condition, which caused him to lose awareness of the location of Bligh Reef.

There were no rested deck officers on the *Exxon Valdez* available to stand the navigation watch when the vessel departed from the Alyeska Terminal.

Many conditions conducive to producing crew fatigue on the *Exxon Valdez* exist on other Exxon Shipping Company vessels because many are three-mate vessels and because the company has pursued reduced manning procedures.

Exxon Shipping Company manning policies do not adequately consider the increase in workload caused by reduced manning.

The Exxon Shipping Company had incentives and work requirements that could be conducive to fatigue.

The Exxon Shipping Company had manipulated shipboard reporting of crew overtime information that was to be submitted to the U.S. Coast Guard for its assessments of workloads on some tankships.

The Coast Guard was unduly narrow in its perspective when it evaluated reduced manning requests for the *Exxon Valdez*; it based manning reductions primarily on the assumption that shipboard hardware and equipment might reduce the workload at sea but did not consider the heavier workload associated with cargo operations in port and the frequency of such operations.

**Fatigue-Related Recommendations Issued to the DOT:**

Develop a means for rigorous enforcement of 46 U.S.C. 8104(a) to ensure that officers on watch during departures from ports have had at least 6 hours of off-duty time in the previous 12 hours. (M-90-32)

| Recipient(s) | Status |
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| U.S. Coast Guard | Closed—Unacceptable Action |

♦ ♦ ♦

Increase the manning level at the Marine Safety Office, Valdez, Alaska, to provide the following: enough watchstanders to plot all participating vessels between the pilot station south of Bligh Reef and their berths in Port Valdez; an officer-in-charge of the Vessel Traffic System who will have time to manage and supervise the system effectively; and sufficient additional officers to staff a duty officer watch with officers capable of monitoring and supervising vessel traffic watchstanders outside normal working hours. (M-90-37)

| Recipient(s) | Status |
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| U.S. Coast Guard | Closed—Acceptable Action |

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| **Safety Board Document:** | Marine Accident Report |
| **Title:** | Sinking of the U.S. Tug *Barcona* by the U.S. Navy Nuclear Attack Submarine *USS HOUSTON* (SNN713), San Pedro Channel Near Santa Catalina Island, California, June 14, 1989 |
| **Report Number:** | NTSB/MAR-90/05 |
| **Date Recommendation(s) Issued:** | October 20, 1990 |
| **Fatigue Cited as a Cause of or Contributing Factor to the Accident:** | No |

**Abstract:**

This report explains the sinking of the U.S. tug *Barcona* by the U.S. Navy nuclear attack submarine *USS Houston* (SSN 713) in San Pedro Channel near Santa Catalina Island, California, on June 14, 1989.

**Fatigue-Related Conclusions:**

The *Houston*'s officer of the deck was fatigued when he assumed the navigation watch prior to this accident.

The fatigued condition of the *Houston*'s officer of the deck did not contribute to the failure of the navigation watch to detect the presence of the *Barcona* and its tow before the submarine reached periscope depth.

Current U.S. Navy operational instructions are not adequate to ensure that officers of the deck are sufficiently rested when they assume underway watches.

**Fatigue-Related Recommendations Issued to the DOT:**

None

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| **Safety Board Document:** | Marine Accident Report |
| **Title:** | Grounding of Liberian Passenger Ship *Star Princess* on Poundstone Rock, Lynn Canal, Alaska, June 23, 1995 |
| **Report Number:** | NTSB/MAR-97/02 |
| **Date Recommendation(s) Issued:** | June 26, 1997 |
| **Fatigue Cited as a Cause of or Contributing Factor to the Accident:** | Yes |

**Abstract:**

On June 23, 1995 the passenger vessel *Star Princess*, traveling from Skagway to Juneau, Alaska, grounded on Poundstone Rock, Lynn Canal, about 21 miles northwest of Juneau. The vessel's bottom sustained significant damage. No injuries or death resulted from this accident. The total cost resulting from required repairs and delay before the vessel could return to service was estimated at $27.16 million.

**Fatigue-Related Conclusions:**

The pilot was chronically fatigued as a result of obstructive sleep apnea.

Fatigue may have reduced the pilot's ability to appropriately assess and respond to the developing situation.

**Fatigue-Related Recommendations Issued to the DOT:**

Advise pilots about the effect of fatigue on performance and about sleeping disorders such as sleep apnea. (M-97-41)

| Recipient(s) | Status |
|---|---|
| U.S. Coast Guard | Closed—Acceptable Action |

♦ ♦ ♦

Review, in consultation with experts in occupational health, your medical standards, guidelines, and examination forms to ensure that they require the disclosure and appropriate evaluation of the history of presence of any medical conditions, symptoms, or medication use that would affect an individual's fitness to pilot a vessel. (M-97-42)

| Recipient(s) | Status |
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| U.S. Coast Guard | Open—Acceptable Response |

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**Safety Board Document:** Pipeline Accident Report

**Title:** Pipeline Rupture and Release of Fuel Oil Into the Reedy River at Fork Shoals, South Carolina, June 26, 1996

**Report Number:** NTSB/PAR-98/01

**Date Recommendation(s) Issued:** November 18, 1998

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** No

**Abstract:**

About 11:54 p.m. eastern daylight time on June 16, 1996, a 36-inch-diameter Colonial Pipeline Company pipeline ruptured where a corroded section of the pipeline crossed the Reedy River at Fork Shoals, South Carolina. The rupture pipeline released about 957,600 gallons of fuel oil into the Reedy River and surrounding areas. The estimated cost to Colonial for cleanup and settlement with the State of South Carolina was $20.5 million. No one was injured in the accident.

**Fatigue-Related Conclusions:**

Fatigue resulting from the relief controller's inverted work schedule may have affected his alertness, vigilance, and responsiveness during the accident sequence.

**Fatigue-Related Recommendations Issued to the DOT:**

Assess the potential safety risks associated with rotating pipeline controller shifts and establish industry guidelines for the development and implementation of pipeline controller work schedules that reduce the likelihood of accidents attributable to controller fatigue. (P-98-30)

| Recipient(s) | Status |
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| Research and Special Programs Administration | Open—Await Response |

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**Safety Board Document:** Railroad Accident Report

**Title:** Atchison, Topeka and Santa Fe Railway Company (ATSF) Freight Trains ATSF 818 and ATSF 891 on the ATSF Railway Corona, California, November 7, 1990

**Report Number:** NTSB/RAR-91/03

**Date Recommendation(s) Issued:** August 23, 1991

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Yes

**Abstract:**

This report explains the collision between two Atchison, Topeka and Santa Fe Railway freight trains in Corona, California, on November 7, 1990.

**Fatigue-Related Conclusions:**

The engineer of train 818 failed to stop his train on the Corona siding at the stop signal because he was asleep or in a microsleep brought about by chronic and acute fatigue.

The chronic and acute fatigue of the engineer of train 818 was a result of the irregularity and unpredictability of his work schedule.

Because of fatigue the conductor of train 818 either was asleep or experienced a microsleep as his train approached the stop signal on the west end of the Corona siding.

The brakeman of train 818 failed to take action to stop the train probably because she fell asleep as a result of fatigue.

The Atchison, Topeka and Santa Fe Railway Company did not have a policy or procedure in place to address the issue of an employee notifying the carrier of his or her lack of sufficient sleep.

**Fatigue-Related Recommendations Issued to the DOT:**

None

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| **Safety Board Document:** | Railroad Accident Report |
| **Title:** | Collision and Derailment of Norfolk Southern Train 188 With Norfolk Southern Train G-38 at Sugar Valley, Georgia, August 9, 1990 |
| **Report Number:** | NTSB/RAR-91/02 |
| **Date Recommendation(s) Issued:** | September 16, 1992 |
| **Fatigue Cited as a Cause of or Contributing Factor to the Accident:** | Yes |

**Abstract:**

This report explains the 1990 collision of two Norfolk Southern freight trains near Sugar Valley, Georgia.

**Fatigue-Related Conclusions:**

The engineer of train 188 had changed his work and rest routine just before the accident.

The engineer's failure to bring the train to a stop at the signal probably was caused by a microsleep or inattention due to distraction.

The conductor of train 188 was either distracted or fell asleep sometime after verifying the signal status at CP Davis.

The engineer of train 188 could have canceled the alerter system while he was asleep by a simple reflex action that he performed without conscious thought.

**Fatigue-Related Recommendations Issued to the DOT:**

In conjunction with the study of fatigue of train crewmembers, explore the parameters of an optimum alerter system for locomotives. (R-91-26)

| Recipient(s) | Status |
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| Federal Railroad Administration | Closed—Unacceptable Action |

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**Safety Board Document:** Railroad Accident Report

**Title:** Collision Involving Two New York City Subway Trains on the Williamsburg Bridge in Brooklyn, New York, June 5, 1995

**Report Number:** NTSB/RAR-96/03

**Date Recommendation(s) Issued:** September 11, 1996

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** Yes

**Abstract:**

This report explains the collision of two New York City Transit subway trains on the Williamsburg Bridge in Brooklyn, New York, on June 5, 1995. One person was killed and 69 people were treated at area hospitals for minor injuries sustained in this accident. The total estimated damages exceeded $2.3 million.

**Fatigue-Related Conclusions:**

The J train operator failed to take action to stop his train on the Williamsburg Bridge because he was asleep.

**Fatigue-Related Recommendations Issued to the DOT:**

In cooperation with the American Public Transit Association, develop a fatigue educational awareness program and distribute it to transit agencies to use in their fitness-for-duty training for supervisors and employees involved in safety-sensitive positions. (R-96-20)

| Recipient(s) | Status |
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| Federal Transit Administration | Closed—Acceptable Action |

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**Safety Board Document:** Special Investigation Report (Railroad)

**Title:** Steam Locomotive Firebox Explosion on the Gettysburg Railroad near Gardners, Pennsylvania, June 16, 1995

**Report Number:** NTSB/SIR-96/05

**Date Recommendation(s) Issued:** November 26, 1996

**Fatigue Cited as a Cause of or Contributing Factor to the Accident:** No

**Abstract:**

On June 16, 1995 the firebox crownsheet of Gettysburg Passenger Services, Inc., steam locomotive 12378 failed while the locomotive was pulling a six-car excursion train about 15 mph near Gardners, Pennsylvania. The failure resulted in an instantaneous release (explosion) of steam through the firebox door and into the locomotive cab, seriously burning the engineer and the two firemen. This accident illustrates the hazards that are always present in the operation of steam locomotives.

**Fatigue-Related Conclusions:**

Gettysburg Passenger Services, Inc., management was not aware of the Hours of Service Act.

**Fatigue-Related Recommendations Issued to the DOT:**

In cooperation with the Tourist Railway Association, Inc., promote awareness of and compliance with the Hours of Service Act. (R-96-56)

| Recipient(s) | Status |
|---|---|
| Federal Railroad Administration | Open—Acceptable Response |

# Appendix C

## Summary of Sleep and Circadian Rhythms

The summary in this appendix is an excerpt from information prepared by Dr. Mark Rosekind in April 1999 for the National Transportation Safety Board. The summary was adapted from material included in the Safety Board's report on its investigation of a 1993 aircraft accident. (Rosekind, Mark R. [NASA Ames Research Center]; Gregory, Kevin B. [Sterling Software]; Miller, Donna L. [Sterling Software]; and others. 1994. "Analysis of Crew Fatigue Factors in ATA Guantanamo Bay Aviation Accident." In: *Uncontrolled Collision With Terrain, American International Airways Flight 808, Douglas DC-8-61, N814CK, U.S. Naval Air Station in Guantanamo Bay, Cuba, August 18, 1993*. Aircraft Accident Report NTSB/AAR-94/04. Washington, DC: National Transportation Safety Board. pp. 133–144.)

# Fatigue in Transportation: Physiological, Performance, and Safety Issues[1]

Mark R. Rosekind
Alertness Solutions
April 1999

## Introduction

Maintaining safe transportation operations is a complex task. The undertaking must address a range of issues from the functioning of large systems to the individual human operator. For the foreseeable future, the human operator (pilot, driver, maintenance person, etc.), remains central to safe, efficient, and reliable transportation activities. Therefore, the importance of addressing human-related error, which accounts for at least 70% of transportation accidents, remains critical to maintaining and improving safety (Ref 1).

Fatigue, sleep loss, and circadian disruption created by transportation operations can degrade performance, alertness and safety. An extensive scientific literature exists that provides important physiological information about the human operator, which can be used to guide operations and policy. For example, there are human physiological requirements for sleep, predictable effects of sleep loss on performance and alertness, and patterns for recovery from sleep loss. Additionally, the circadian clock is a powerful modulator of human performance and alertness, and in transportation operations, it can be disrupted by night work, time zone changes, and day/night duty shifts. Scientific examination of these physiological considerations has documented a direct relationship to errors, accidents, and safety. This scientific information can provide important input to policy and regulatory considerations.

Managing fatigue in the complex and diverse transportation environment requires an integrated and multi-component approach. The complexity and diversity of operational requirements preclude a simple solution, and managing fatigue will benefit from addressing education, hours of service, strategies, technology, design, and research. The transportation industry has established a strong safety record by identifying and proactively addressing both substantiated and potential risks. Effectively managing fatigue in transportation operations offers the opportunity to further reduce risks and improve safety.

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[1]Adapted from the following references: (a) Rosekind MR, Gregory KB, Miller DL, Co EL, and Lebacqz JV. "Analysis of crew fatigue factors in AIA Guantanamo Bay Aviation Accident." *Uncontrolled Collision With Terrain, American International Airways Flight 808, Douglas DC-8-61, N814CK, U.S. Naval Air Station in Guantanamo Bay, Cuba, August 18, 1993*. Aircraft Accident Report NTSB/AAR-94/04. Washington, DC: National Transportation Safety Board, 1994. (b) Rosekind, MR, Neri, DF, and Dinges, DF. (1997). "From laboratory to flightdeck: Promoting operational alertness." *Fatigue and Duty Time Limitations—An International Review: Proceedings of the Royal Aeronautical Society, London, UK, 16 September 1997.*

This overview provides an introduction to the scientific foundation that exists regarding the physiology of and performance related to fatigue in transportation. It also examines the human physiological requirement for sleep and the functioning of the circadian clock.

## The Biological Imperative: Human Sleep Need and the Circadian Clock

### *Human Sleep Requirements*

Sleep is a vital physiological function. Historically, sleep has been viewed as a state when the human organism is turned off. However, scientific findings have clearly established that sleep is a complex, active physiological state that comprises different stages. On average, most people physiologically require about 8 hrs of sleep per night. When provided adequate time to sleep, humans can average about 8.25 to 8.5 hrs of physiological sleep (Refs 2,3). Laboratory studies use physiological measures (i.e., brain, eye, and muscle activity) of sleep quantity and quality and daytime sleepiness to determine the number of hours of sleep that provide an optimal level of waking alertness (Refs 4–6). It is important to distinguish this physiologically determined sleep requirement from both habitual and reported sleep amounts. Some studies have examined the reported amount of habitual sleep over time and other studies have collected one-time surveys inquiring about average sleep amounts. Overall, most adults report an average of about 7–7.5 hrs sleep per night (Ref 7). However, data obtained in controlled laboratory settings challenge whether this “reported” amount of sleep is sufficient for optimal levels of waking alertness. Studies have demonstrated that extending sleep beyond the reported 7–7.5 hrs of “usual” sleep significantly increases daytime alertness (Refs 3,8). The National Sleep Foundation commissioned a Gallop survey examining the report of daytime sleepiness in a random sample of 1,001 individuals. The findings demonstrated that 75% reported daytime sleepiness, with 32% of these reporting severe levels. Thirty-two percent reported that their sleepiness interfered with activities and 82% of the respondents believe that daytime sleepiness has a negative effect on their productivity (Ref 9).

These amounts are averages and there are individuals at both extremes of short and long sleep requirements. These sleep requirements change significantly with age (Ref 10). Younger individuals require more total sleep and this amount decreases to that needed by adults (although it is not the case that older people need less sleep than other adults). Sleep structure also changes with age (e.g., less deep sleep, more awakenings in older adults). In summary, humans physiologically require about 8 hrs of sleep, though they report usual sleep amounts of about 7–7.5 hrs. A majority of the adult population report daytime sleepiness, and when sleep is extended, there is a significant increase in alertness.

### *Effects of Sleep Loss*

Sleep loss is common and can be acute or cumulative. In an acute situation, sleep loss can occur either totally or as a partial loss. Total sleep loss involves a completely missed sleep opportunity and continuous wakefulness for about 24 hrs or longer. Partial sleep loss occurs when sleep is obtained within a 24-hr period but in an amount that is reduced from the physiologically required amount or habitual total. Sleep loss also can

accumulate over time into a "sleep debt." For example, an individual who requires 8 hours of sleep and obtains only 6 hours is essentially sleep deprived by 2 hours. If the individual sleeps only 6 hours over 4 consecutive nights, then the 2-hour-per-night sleep loss would accumulate into an 8 hour sleep debt. Sleep loss, whether total or partial acute or cumulative, results in significantly degraded performance, alertness, and mood (Refs 7, 11–21).

The reduced human performance capability that results from total sleep loss is well documented (Refs 11–18). However, perhaps the most common occurrences in transportation operations are acute partial sleep loss and accumulation of a sleep debt. A review of the relevant scientific literature indicates that as little as two hours of sleep loss on just one occurrence can result in "impairment of performance and levels of alertness" (Ref 7). Therefore, an average individual with a physiological requirement of 8 hours sleep who obtains only 6 hrs of sleep may demonstrate significantly degraded waking performance and alertness. Cumulative sleep debt also significantly reduces alertness and performance (Refs 19–21). Studies have demonstrated that not only does the sleep loss accumulate but that the negative effects on waking performance and alertness also are cumulative and increase over time (Ref 20).

Performance decrements due to sleep loss can occur across diverse functions. For example, studies have demonstrated slowed reaction time, reduced vigilance, cognitive slowing, memory problems, time-on-task decrements, and optimum response decrements (e.g., Refs 13,14,16,18). Performance variability also increases with sleep loss. Therefore, overall performance can be significantly reduced with an increased variability or unevenness in responding (Ref 16). Consider that these findings occur in some of the simplest performance challenges, such as reaction time to a single stimulus or minimal choice memory task. These basic psychomotor and cognitive functions are the foundation for any task requiring complex, higher-order performance.

An important phenomenon, highly relevant to operational environments, is that there is a discrepancy between the subjective report of sleepiness/alertness and physiological measures. In general, individuals will report higher levels of alertness than indicated by physiological measures (Refs 22–24). Data from an international study of flight crews had an example where the highest subjective rating of alertness occurred at a time when physiologically the individual was falling asleep within 6 minutes (an indicator of severe sleepiness) (Ref 22). Likewise, subjective and physiological self-assessment of performance can differ significantly. The operational relevance of this phenomenon is clear. For example, an individual might report a low level of sleepiness or fatigue but could be carrying an accumulated sleep debt with a high level of associated physiological sleepiness. This individual, in an environment stripped of factors that conceal the underlying physiological sleepiness, would be susceptible to the occurrence of spontaneous, uncontrolled sleep episodes and to the performance decrements associated with sleep loss.

### *Recovery from Sleep Loss*

When determining requirements for providing a recovery opportunity from sleep loss, two factors should be considered. First, when does the internal sleep architecture return to usual levels? Second, when do waking performance and alertness levels return to

their baseline? After sleep loss, recovery is not accomplished through an hour-for-hour restitution. Even after extremely prolonged wakefulness, initial recovery sleep may last only 12–15 hrs (Ref 25). Rather, recovery is accomplished through an increase in deep sleep (Non-Rapid-Eye-Movement or NREM slow wave sleep) observed starting on the first night of regular sleep (Refs 26–28). Generally, two nights of recovery sleep (slightly longer than an average night's sleep) are needed to resume a normal baseline sleep pattern (Refs 26,29), though this can be dependent on the duration of the continuous wakefulness. Also, typically, two nights of recovery sleep are needed to return to a normal baseline of waking performance and alertness (Refs 20,30), though this too can be dependent on the length of prior wakefulness (e.g., Ref 3).

### *The Circadian Clock*

Besides sleep, the other major physiologic determinant of waking performance and alertness is the internal circadian clock (Refs 31–33). Circadian (*circa* = around, *dies* = day) rhythms fluctuate on a 24-hr cycle with peaks and troughs occurring in a regular pattern. These patterns are controlled by a circadian pacemaker located in the suprachiasmatic nucleus (SCN) in the brain. The SCN is the circadian timekeeper for a wide range of human functions. One of the most prominent is the 24-hr sleep/wake cycle programmed for a daytime period of consolidated wakefulness and a nighttime period of consolidated sleep. There are circadian patterns for cognitive and psychomotor performance, physiological activity (e.g., digestion, immune function, thermoregulation, DNA synthesis), alertness, and mood (Refs 34–38). Even birth and death have circadian patterns that peak during the night (see Ref 31).

Body temperature is often used as a marker of the internal circadian clock (sometimes referred to as the "hands of the clock"). The trough or low point of the clock is around 3 am to 5 am, with many functions demonstrating reduced levels from 12 am to 6 am. The lowest level of function (e.g., alertness, performance, subjective mood, temperature) occur within the 3 am to 5 am trough. Sleepiness has bimodal distribution (i.e., two peaks and two troughs each day), being most severe at 3 am to 5 am with a less marked but significant expression between roughly 3 pm to 5 pm. This afternoon increase in sleepiness occurs whether or not a meal has been consumed, though the meal may exacerbate the underlying sleepiness (Ref 39).

Zeitgebers ("time givers") are cues that synchronize circadian rhythms to their 24-hr pattern. To date, light has been demonstrated to be among the most powerful zeitgebers to synchronize the circadian pacemaker. Bright light can dramatically shift the phase of the human circadian clock when applied at responsive times in the 24-hr cycle (Refs 40–42). Without cues, the intrinsic rhythm of the clock is longer than 24 hrs. Generally, data have demonstrated a free-running pattern approximating 24.9 hrs, though recent findings suggest this may be closer to 24.2 hrs (Refs 31–33,43). An intrinsic period longer than 24 hrs provides an inherent tendency to support circadian delays (e.g., staying awake longer) and to oppose advances (e.g., trying to go to sleep earlier).

Moving to a new light/dark schedule, such as a shift to nightwork or a time zone change, can create internal and external desynchronization. These involve an internal

desynchrony among circadian rhythms and a discrepancy between internal circadian timing and external/environmental cues, respectively. The internal clock can take from several days to weeks for adjustment or, in some circumstances, not fully resynchronize at all. Scientific studies have demonstrated these findings in the laboratory and in field studies conducted during actual transportation operations (e.g., Refs 31–33, 44–54).

[Additional discussion is not included in this appendix.]

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# Appendix D

## Summaries of Fatigue Symposium Working Groups, 1995

The working group summaries in this appendix are reprinted from the proceedings of the 1995 multimodal symposium on fatigue in transportation. (National Transportation Safety Board and NASA Ames Research Center. 1996. *Fatigue Symposium Proceedings, November 1–2, 1995*. Washington, DC: National Transportation Safety Board. pp. 91–105.

# THE AVIATION WORKING GROUP #1

Moderator Dr. Barry Strauch, National Transportation Safety Board
Analyst Dr. Ben Berman, National Transportation Safety Board

***Technical Representatives***
Mr. Bob MacIntosh, National Transportation Safety Board
Mr. David Schroeder, Federal Aviation Administration

## ***Hours of Service and Scheduling***

The group expressed the view that, because of the criticality of scheduling on human fatigue and alertness, that duty time limits should be upgraded for flightcrew members and established for flight attendants, as well as address issues of circadian rhythms and human performance. All proposed rule changes should be based on the results of scientifically sound sleep research. In addition, it was suggested that rules be promulgated to establish controlled rest during long-haul flight operations.

Nevertheless, concerns were raised that revised flight and duty time rules not be so rigid as to create their own safety hazards. For example, an issue in the Tenerife ground collision between KLM and Pan American Boeing 747s was the inflexible flight and duty time restriction the KLM flightcrew faced at the end of the scheduled flight to Amsterdam. One suggestion was to pattern rules after the advanced qualification program (AQP), which provide airlines considerable flexibility to tailor pilot training to their own needs and circumstances, while maintaining a high degree of FAA oversight. Finally, some attendees expressed concern that proposed rules not place United States aviation interests in the global economy in jeopardy against those of nations that have less restrictive rules and regulations in place.

## ***Personal and Technological Countermeasures***

Many innovative proposals were offered during the session. For example, one attendee suggested that airlines and flightcrews work together to obtain "circadian friendly" hotel rooms in which quiet corridors would be maintained, blackout curtains hung in the rooms, and other measures implemented to enhance rest during those periods when most people are active. An additional proposal called for using FOQA (flight operations quality assurance) data to match pilot performance against flight schedule and other data that have been associated with fatigue. Also, expert systems could be used that, with existing data on sleep, help pilots bid schedules, and airlines employ pilot bids, that could minimize the emergence of fatigue during subsequent flight operations. Similarly, a proposal was offered to employ automatic devices in cockpits that would alert crewmembers or require crewmember responses during a flight, to assure that pilots would remain alert during a long flight.

### *Education and Training*

Attendees suggested that education for all personnel was critical to the effectiveness of countermeasures. Further, the group believed that successful countermeasures against fatigue require the active participation of all corporate levels, execute/managerial as well as those directly involved in flight operations. Attendees expressed the view that, following the conclusion of the conferences, the NTSB and NASA inform airline executives directly of the results of the Symposium to help obtain their cooperation in reducing the effects of fatigue at their airline. In addition, basic guidelines should be provided to airlines to assist their management in implementing fatigue countermeasures program at their airline.

Some attendees, representing general aviation interests, also raised the issue of educating general aviation pilots and corporate aviation departments in the need for effective fatigue countermeasures.

## SUMMARY VIEWGRAPH

### Scheduling

- Upgrade Flight/Duty/Rest (F/D/R) rules
- Regulate, not negotiate, F/D/R rules
- Apply science to F/D/R rules
- Finalize rule on F/D/R
- Avoid rigidity in F/D/R rules
- Level the F/D/R playing field world wide

### Countermeasures

- Sleeping quarters at duty site and "circadian-friendly" hotel rooms
- Correlate flight data recorder readouts with crew fatigue factors
- Expert systems to help managers design crew schedules and help pilots bid schedules
- Educate top managers
- Cockpit crew alertness monitoring devices

### Education

- Educate personal countermeasures, and educate the family
- Big and small airlines need basic guidelines
- Top-level buy-in is essential
- Integrate personal and company countermeasures
- Don't forget general aviation

# THE AVIATION WORKING GROUP #2

***Moderator*** Mr. Jim Danaher, National Transportation Safety Board
***Analyst*** Dr. Malcolm Brenner, National Transportation Safety Board

***Technical Representatives***
Mr. Bob Benzon, National Transportation Safety Board
Mr. Ronald Simmons, Federal Aviation Administration

## ***Hours of Service and Scheduling***

The Aviation Group 2 felt that government regulation of flight and duty time standards was the starting point and foundation for all activities at controlling fatigue in operations. These regulations set the minimum standards for operations beyond which personal and company countermeasures can be applied. The group felt that it was important that the regulations provided core guidelines but also captured important differences in the industry, especially, for example, by providing special provisions applicable to overnight operations. The group felt that "rest" should be defined more operationally than the present definition as the number of hours off-duty. That is, "off duty" time rarely equals "rest" time. It is necessary to allow time for commuting, personal hygiene, and sustenance. Fatigue issues should be addressed more actively in accident and incident reports by the NTSB and the FAA. Fatigue should be assumed to be present until the investigation can rule it out.

## ***Personal and Technological Countermeasures***

The group felt that technology was a support, but not a substitute for personal management. Industry and individuals both have responsibilities for minimizing fatigue in operations. Industry can help by developing procedures so pilots can report themselves "too fatigued" to work without punishment, and by providing rest accommodations for quality sleep without noise interruptions. Employees can help by arriving at work rested, arranging their commutes from home and activities during the off-duty time so they are properly rested. When technology is developed, it should not be used to erode other existing or future fatigue countermeasures based on scheduling or personal management.

## ***Education and Training***

The group felt that there should be a clearing house to collect and make available successful training materials on fatigue developed by different transportation modes, different disciplines, and different nations. Education is the

most basic countermeasure for fatigue. It should be provided to managers, schedulers, and the general public to change attitudes and recognize the importance of fatigue. Pocket checklists, and checklists integrated into normal operations should address fatigue issues in heightening awareness of the fatigue-producing aspects of duty periods and in judging personal fitness for flight. ASRS reporting forms should enhance their reporting of fatigue, and NTSB/FAA investigations should enhance their monitoring of fatigue issues. Fatigue should be examined on the part of pilots, air traffic controllers, mechanics, and all other personnel in the operational system.

## SUMMARY VIEWGRAPH

### Scheduling

- Overnight flying – special regulations
- Address fatigue in mishaps
- Government regulation essential
- Define "rest" more operationally

### Countermeasures

- Technology supportive of personal management
- Industry support of individual management and decisionmaking – industry support systems and "too fatigued"
- De-link technology and punitive actions
- Balance between industry/individual responsibility – commutes, rest accommodations, and rest periods

### Education

- Intermodal, international, interdisciplinary training clearinghouse
- Mangers, schedulers, and the public need education
- Fatigue-related work schedule guidelines
- Enhance ASRS, NTSB, and FAA monitoring of fatigue

# THE RAIL WORKING GROUP

***Moderator*** Mr. Bruce A. Magladry, National Transportation Safety Board
Analyst Mr. David Mayer, National Transportation Safety Board
***Technical Representatives***
Mr. Robert Lauby, National Transportation Safety Board
Mr. Garold Thomas, Federal Railroad Administration

## ***Hours of Service and Scheduling***

The lack of schedule predictability and regularity were identified by the group as the number one fatigue producing problems for both train crews and management. For, without timely, accurate schedule information, railroad employees cannot effectively manage their off-duty time to minimize fatigue. The scheduling difficulties that give rise to unpredictability and irregularity are derived from several interrelated, but often conflicting demands that the railroads themselves cannot fully control. Factors that impact scheduling include: equipment breakdowns, emergencies, and power failures, imbalances in the direction of traffic flow, and the demands of customers who have increasing moved to just-in-time pick-up and delivery. Pool dispatch, extra board scheduling, and deadheading of crews also contribute to the problem.

Exacerbating scheduling difficulties is the Hours of Service (HOS) Act developed in 1907. It was not based on science and does not necessarily permit sufficient' continuous sleep periods. nor does it incorporate modem knowledge of circadian rhythms. Historically, it has also promoted an adversarial relationship between labor and management. The group felt it no longer works well. In a spirit of cooperation, government, management and labor should seek innovative and flexible schedule solutions and HOS reforms through pilot projects. However, as a basic tenet of railroad operations, the HOS should not be changed without a firm scientific basis and careful review by all the affected parties.

## ***Personal and Technological Countermeasures***

Currently employed fatigue countermeasures are not adequate. Alerters, for example, can be complied with while an employee is severely fatigued. Some existing crew quarters, intended to facilitate rest away from home, are not adequate for daytime sleeping because of noise or lighting or even maid service. Another countermeasure, albeit an unauthorized one, napping, can actually bring on disciplinary action. Nevertheless, there are times when it could be safely and effectively used to reduce fatigue and improve alertness. The group felt appropriate napping should be legitimized.

Group members felt some conditions and procedures seemed to induce fatigue, like poor locomotive cab environments and boring tasks. It was suggested crew input could improve both cab and task design. It was also suggested that various communications equipment and methods should be explored to give employees the

most up to date and valid line-up information so that they plan their sleep accordingly in order to report to work well rested. However, when significant line-up changes occur and an employee is called to duty early without having slept, there should be a mechanism to allow him to mark off without penalty. To do otherwise, may force a fatigued employee to work and create a danger to himself, his railroad and the public.

Fitness for duty testing was also addressed. It was felt that current tests are not yet valid and reliable, and that they miss the point anyway. Efforts should be directed toward developing schedules and working conditions that prevent fatigued employees rather than keeping the current conditions in place and trying to detect fatigued employees. Finally, responsibility for developing and promoting effective countermeasures was believed to belong to all affected parties.

### *Education and Training*

Addressing fatigue through education and training was deemed essential and was considered a win-win proposition for labor and management, improving safety and productivity for each. The group felt that employees should receive training about sleep, sleep disorders, sleep strategies, and fatigue countermeasures. Both labor and management employees should receive the training in order to provide a common understanding of the issue. The training should be based on science with practical solutions, but should not ignore the important components of personal responsibility and behavioral change. Follow-up and feedback were also considered essential to determine efficacy and to reinvigorate individual efforts.

Several railroads already have fatigue education programs in place. The group acknowledged the value of such programs if they do not stand alone. They should be part of a multifaceted approach designed to manage fatigue and promote alertness. Training must accompany other efforts from labor and management to alter operations to facilitate individual employee actions to alleviate fatigue. Thought should also be given for protection of the jobs of employees who come forward after recognizing they have a sleep disorder.

## SUMMARY VIEWGRAPH

### Scheduling

- Schedule predictability and regularity
- Hours of service flexibility; Minimize deadheading and overnights
- Hours of service provisions based on science and modem demands
- Railroads should conduct hours of service pilot projects
- Enhanced trust to promote innovative thinking

### Countermeasures

What is needed:

- Crew quarters suited for sleep
- Crewmembers should be able to mark off when fatigued without penalty
- Tasks that minimize boredom

- Legitimize sensible crew napping
- Fitness for duty testing -- not yet valid or reliable and misses the point
- Improved cab design using input from locomotive crews

**Education**

- Addressing fatigue is a win-win situation
- Education and training is essential – not a stand alone component
- All labor and management should receive training
- Training must be based on science with practical solutions
- Follow-up and feedback are essential
- Job protection for those who seek treatment

# THE HIGHWAY WORKING GROUP

***Moderator*** Dr. Vern Ellingstad, National Transportation Safety Board
***Analyst*** Ms. Elaine Weinstein, National Transportation Safety Board

***Technical Representatives***
Mr. Joe Osterman, National Transportation Safety Board
Mr. Ron Knipling, National Highway Traffic Safety Administration
Ms. Deborah Freund, Federal Highway Administration

## ***Hours of Service and Scheduling***

There is more than enough research today to begin to effect changes in the scheduling practices of the trucking industry. The hours-of-service regulations are 50 years old and need to be changed. They do not fit with the circadian clock. The trucking industry is behind other modes in making changes to the hours-of-service regulations and scheduling practices based upon current research knowledge. The industry can initiate changes separately from federal regulation. The changes cannot be done in a vaccuum and need to consider employee, shipper and customer needs. There is also a need to address the problem across the industry and consider the differences between large and small companies. Some of the implications for public policy include the shortage of parking and driver safety at rest stops.

The solutions include regulatory and performanced-based measures.

- Revise the hours-of-service regulations
- Increase the number of driver rest areas
- Consider large versus small companies
- Develop performance-based measures

## ***Personal and Technological Countermeasures***

Personal and technological countermeasures should be explored and implemented on parallel tracks. Technology includes fitness-for-duty and alerting methods. Fitness-for-duty technologies are about three years away; alerting method technologies are five-ten years away. Personal countermeasures include napping, education, and medical fitness. They can be implemented immediately.

New technologies must be cost effective, show a safety benefit, and maintain the current level of productiveness. There was some concern expressed that fitness-for-duty detection would give drivers a false sense of security and they would thus be more likely to drive drowsy. Consideration to inter-individual differences needs to be considered along with how the fitness-for-duty testing device would be used. Is it for the driver, the employer, or the regulator? There was agreement that there should be penalties for failing a fitness-for-duty test.

*Education and Training*

Society needs to undergo major attitudinal changes towards driving when fatigued, similar to that experienced with drunk driving. Some promising efforts have been made in the area of education, such as the Wake UP brochure developed by the AAA Foundation and the American Trucking Associations. There is a need to evaluate the effectiveness of these educational materials to determine if they actually change behavior.

Training for management and drivers is not widespread. ATA Safety Management Council is developing a best practices manual to help educate drivers on how to prepare for work.

- Enforcement training is needed for inspectors and police officers.

**SUMMARY VIEWGRAPH**

**Scheduling**

- Revise hours of service regulations
- Increase driver rest areas
- Consider small vs. large companies
- Also performance based measures

**Countermeasures**

- Technology -- there is none -- it is five-ten years away
- Personal – napping, medical screening, adequate sleep

**Education**

- Major cultural change toward fatigue needed -- like drunk driving
- Promising efforts toward general education have been made
- Specific training for drivers and management have been less widespread
- Enforcement training is needed

# THE MARINE WORKING GROUP

***Moderator*** Dr. Gerald D. Weeks, National Transportation Safety Board
***Analyst*** Dr. Meg Sweeney, National Transportation Safety Board
***Technical Representatives***
Ms. Marjorie Murtagh, National Transportation Safety Board
Mr. Alexander C. Landsburg, Maritime Administration
Dr. Marc B. Mandler, United States Coast Guard

The working group consisted of more than 80 representatives from various sectors of the maritime industry. Their affiliations reflected the breadth and diversity of the industry. Shoreside managers and shipboard personnel represented many shipping companies in the inland towing, coastwise, and oceangoing trades. Other attendees came from six maritime schools, seven pilots' associations, and a variety of government agencies.

The group's task was to discuss three topics on managing fatigue in the marine industry: Hours of Service & Scheduling, Personal & Technological Countermeasures, and Education & Training. Discussions of each topic addressed three questions concerning implementation: What is currently used, what is needed, and who is responsible? Highlights of the discussions follow.

## *Hours of Service and Scheduling*

Most mariners stand two- or three-section watches when at sea and so they have multiple work periods in a day. The group felt that although the watch system satisfies current hours-of-service regulations, problems of sleep fragmentation and sleep deprivation can arise. The group noted that the potential for long-term fatigue must also be considered--crew members may sign contracts of 10-12 months duration when sailing on foreign flag vessels. Some members of the group observed that an important issue underlying fatigue is workload. In turn, workload is correlated with manning levels. The group felt that there is a need to conduct shipboard workload assessments before regulators consider changes to hours-of-service or to manning regulations. The group concluded that industry should take the lead, in coordination with the regulators, to initiate such workload assessments.

## *Personal and Technological Countermeasures*

Several of the attendees reported that their companies had implemented a variety of fatigue countermeasures. The countermeasures do not have to be "hi tech" to be effective. Even little things like having decaffeinated coffee available near the end of the watch can facilitate sleep during the off-duty period. As another example, some companies had installed acoustic insulation in berthing spaces or relocated those spaces to provide a more restful sleeping environment. Other companies had delegated certain tasks to ratings so as to relieve the workload of the licensed officers. The group

determined that a continued effort was needed to promote both corporate and personal alertness management strategies. They felt that additional interdisciplinary meetings, similar to this Symposium, would be useful for exchanging ideas and experiences with successful fatigue countermeasures. The participants concluded that it is the industry's responsibility to take the initiative in this area.

### *Education and Training*

Currently, there is only a modest amount of education being conducted on fatigue and fatigue countermeasures. The attendees agreed that more education was needed and several of the maritime educators in attendance reported that their institutions were developing courses or course modules on the physiological basis, consequences, and ways of managing fatigue. The group felt that the first and foremost need was to shift the mariners' cultural attitudes concerning fatigue--to dispel the "iron-man" myth that fatigue can be overcome by increased motivation and experience. The group concluded that the greatest likelihood of success for developing and disseminating education was to forge a partnership triangle among management, labor, and government.

## SUMMARY VIEWGRAPH

### Scheduling

- Duration of the tour
- Review manning
- Industry led initiatives

### Countermeasures

- Some countermeasures are being used in the industry
- Continued effort
- Industry initiatives

### Education

- Training and education is available
- Shift culture
- Partnership triangle

# THE PIPELINE WORKING GROUP

***Moderator*** Mr. Barry Sweedler, National Transportation Safety Board
Analyst Mr. Bill Gossard, National Transportation Safety Board

***Technical Representatives***
Mr. Bob Chipkevich, National Transportation Safety Board
Ms. Linda Daugherty, Research & Special Projects Administration

Three distinct topical areas were discussed at the Fatigue Symposium addressing fatigue in the pipeline industry: hours of service and scheduling; personal and technological countermeasures; and education. A summary of the pipeline group discussion follows.

## *Hours of Service and Scheduling*

In the area of hours of service and scheduling, it was determined that there currently are neither Federal or State standards nor are there any industry guidelines or recommended practices. Therefore, there are great differences in scheduling from company to company. Some general observations were that many employees in the industry rely on unscheduled overtime; in many companies employees have significant input into the schedules that they work; and that most schedules are rotating with 12 hour shifts. Most employees have little idea of the effects of fatigue and there is very little technical information available specific to the pipeline industry.

It was the group's conclusion that there is a definite need for information and guidance on fatigue/alertness issues. It also was concluded that there is a need for all levels (senior management, supervisors and employees) to learn about fatigue concerns. It was noted that there are industry associations such as the American Gas Association, American Petroleum Institute, the Institute of Gas Technology, and others that could address fatigue concerns and proper interventions in the area of hours of service and scheduling for the industries.

## *Personal and Technological Countermeasures*

Presently, fatigue has not been considered as a problem by much of this industry, therefore, there has been little focus on personal or technological countermeasures. However, the industry does use a number of interventions that have been successful in mitigating some fatigue concerns such as; 2-hour call-ins to remote locations, deadman alarms, video cameras, bright lights and temperature control in control rooms. These interventions were not developed specific to fatigue concerns. The participants agreed that a "napping strategy" could possibly be a useful countermeasure, however, considerable education and understanding by senior management and supervisors of this fatigue countermeasure would be necessary.

There are no fitness for duty countermeasures in this industry with the exception of the liquified natural gas industry where Federal standards require a self-reporting system that the person leaving a shift must state that the person coming on duty is fit to work. The participants concluded that personal countermeasures could be addressed by company employee assistance programs.

### *Eduation and Training*

Education on fatigue issues is scant. There is some abstract concern about fatigue by senior management and supervisors, however, that concern is not necessarily directed to operational concerns. In other words, most concern over fatigue involves emergency response conditions not day-to-day operations and shift work. The participants agreed that educational programs for senior management, supervisors and employees on fatigue/alertness issues could be conducted for employees first through company employee assistance programs and then to families, if employees saw the merit. It also was agreed that if fatigue countermeasures were marketed as a performance enhancement tool, perhaps senior management would support fatigue safety improvements such as scheduling strategies. The participants indicated there is a need for data on the relationship of fatigue and productivity in order to sell this initiative as an opportunity to top management. There was interest in tailoring the NASA/ Ames program on fatigue to make it more specific to the pipeline. industry.

## SUMMARY VIEWGRAPH

### Scheduling

- Employee reliance on unscheduled overtime
- Employees have significant input into schedules
- All schedules are rotating
- Currently there are no guidelines
- Need information and guidance on fatigue
- Need for more awareness by all

### Countermeasures

- Use techniques for monitoring
- Bright lights and temperature control- these techniques are not specific to fatigue
- Napping strategy may work with education
- No fitness for duty countermeasures
- EAP address seminar on fatigue

### Education

- Abstract concern about fatigue
- Some knowledge not very detailed

- Need for programs on expectations and fatigue
- Performance enhancement tool – scheduling strategy
- Data relationship fatigue-productivity
- Work smart - Play smart

# Appendix E

## Sampling of Educational Materials Regarding Operator Fatigue

**Table E–1. Sampling of fatigue-related educational material by agency or organization.**

| Organization | Type of material | Title or topic |
|---|---|---|
| **U.S. Department of Transportation** | | |
| **Aviation:** | | |
| Federal Aviation Administration | Brochure | Fatigue Busters |
| **Highway:** | | |
| Federal Highway Administration | Brochure (developed for truckdrivers) | Awake at the Wheel[a] |
| | Radio public service announcements | Awake at the Wheel |
| | Placemats (in future) | Awake at the Wheel |
| | Videotape | Training |
| | Instructional program | Train-the-trainer |
| | Dissemination of brochures (in future) | Driver Wellness Program |
| National Highway Traffic Safety Administration | Report | Drowsy Driving and Automobile Crashes |
| | Report | Educating Youth About Sleep and Drowsy Driving |
| | Brochure | Safe Driving Tips |
| **Private Sector Organizations** | | |
| AAA Foundation for Traffic Safety | Audio cassette | Wake Up! |
| | Brochure | Wake Up! |
| National Center for Sleep Disorders Research | Report | Drowsy Driving and Automobile Crashes |
| | Report | Educating Youth About Sleep and Drowsy Driving |
| National Heart, Lung, and Blood Institute | Brochure (emphasis on teenage drivers) | Awake at the Wheel |
| National Sleep Foundation | Fact sheets | Drowsy Driving |
| | Videotape | Heads Up at the Wheel: Home Safe |
| | Videotape | Driver Fatigue: Deadly Slumber |
| | Videotape | Day/Night Strategies for Shift Workers |
| | Brochure | Day/Night Strategies for Shift Workers |
| | Newsletter | President's Circle Update |
| | Consensus | Use of Continuous Shoulder Rumble Strips |
| | Report | Report of the National Sleep Foundation |
| | Audio cassette | Wake Up! |
| | Brochure | Wake Up! |
| | Bumper Stickers | I'm Alert. Are You? |

[a] This brochure uses the same information as *Wake Up!*, which was developed jointly by the AAA Foundation for Traffic Safety and the National Sleep Foundation.

# Appendix F

## Flight Time and Rest Requirements Proposed by the FAA

The tables in this appendix were contained in the FAA's notice of proposed rulemaking "Flight Crewmember Duty Period Limitations, Flight Time Limitations and Rest Requirements," Docket No. 28081; Notice No. 95-18, *Federal Register* Vol. 60, No. 244, December 20, 1995.

**Table F–1. Proposed pilot duty period, flight time, and rest requirements.**

| Number of pilots | Duty period hours | Flight time hours | Minimum rest hours | Reduced rest hours[a] | Rest hours following reduced rest (compensatory) | Extended duty period hours[b] |
|---|---|---|---|---|---|---|
| 1 (Part 135) | No more than 14. | No more than 8. | 10 | 9, May only be reduced if duty period has not exceeded 14. | 11 | Up to 16 only if due to operational delays. |
| 2 | No more than 14. | No more than 10. | 10 | 9, May only be reduced if duty period has not exceeded 14. | 11 | Up to 16 only if due to operational delays. |
| 3 | No more than 16. | No more than 12. | 14 | 12, May only be reduced if duty period has not exceeded 16. | 16 | Up to 18 only if due to operational delays. |
| 3 Each pilot must have sleep opportunity, and approved sleeping quarters must be available. | More than 16, but no more than 18. | No more than 16. | 18 | 16, May only be reduced if duty period has not exceeded 18. | 20 | Up to 20 only if due to operational delays. |
| 4 Each pilot must have sleep opportunity, and approved sleeping quarters must be available.[c] | More than 18 but no more than 24. | No more than 18. | 22 | 20, May only be reduced if duty period has not exceeded 24. | 24 | Up to 26 only if due to operational delays. |

[a] Rest periods may be reduced only when the actual duty period does not exceed the maximum scheduled duty period for that crew composition and if the pilot is provided a compensatory rest period. This compensatory rest period must be scheduled to begin no later than 24 hours after the beginning of the reduced rest period.

[b] The flights to which the pilot is assigned must at block out time be expected to reach their destination within the extended duty period.

[c] Applies only to duty periods with one or more flights that land or take off outside the 48 contiguous States and the District of Columbia.

**Table F–2. Proposed flight engineer duty period, flight time, and rest requirements.**

| Number of flight engineers | Duty period hours | Flight time hours | Minimum rest hours | Reduced rest hours[a] | Rest hours following reduced rest (compensatory) | Extended duty period hours[b] |
|---|---|---|---|---|---|---|
| 1 | No more than 14. | No more than 10. | 10 | 9, May only be reduced if duty period has not exceeded 14. | 11 | Up to 16 only if due to operational delays. |
| 2 | No more than 16. | No more than 12. | 14 | 12, May only be reduced if duty period has not exceeded 16. | 16 | Up to 18 only if due to operational delays. |
| 3 Each flight engineer must have sleep opportunity, and approved sleeping quarters must be available. | More than 16, but no more than 20. | No more than 16. | 18 | 16, May only be reduced if duty period has not exceeded 18. | 20 | Up to 20 only if due to operational delays. |
| 4 Each flight engineer must have sleep opportunity, and approved sleeping quarters must be available. | More than 18 but no more than 24.[c] | No more than 18. | 22 | 20, May only be reduced if duty period has not exceeded 24. | 24 | Up to 26 only if due to operational delays. |

[a] Rest periods may be reduced only when the actual duty period does not exceed the maximum scheduled duty period for that crew composition and if the flight engineer is provided a compensatory rest period. This compensatory rest period must be scheduled to begin no later than 24 hours after the beginning of the reduced rest period.

[b] The flights to which the flight engineer is assigned must at block out time be expected to reach their destination within the extended duty period.

[c] Applies only to duty periods with one or more flights that land or take off outside the 48 contiguous States and the District of Columbia.

# Appendix G

## Summary of Expert Panel on FHWA Hours-of-Service Proposals for Commercial Drivers, 1998

The information in the table was summarized from the following report:

Transportation Research Institute, University of Michigan. 1998. *Potential Hours-of-Service Regulations for Commercial Drivers*. Contract DTFH61-96-C-00038. Washington, DC: Office of Motor Carriers, Federal Highway Administration, U.S. Department of Transportation.

**Table G–1. Summary of the expert panel who reviewed the candidate options for hours-of-service regulations.**

| Federal Highway Administration candidate option | Evaluation criteria[a] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Option A, Current Policy:** Current hours-of-service regulations. Drivers may work a 15-hour shift, with a maximum of 10 hours of driving. Must have an 8-hour off-duty period after the first 10 hours of duty. | F | F | F | F | F | F | F | F | F |
| **Option B:** Based on a 24-hour cycle. Requires minimum of 9 consecutive hours off duty for sleep (12 hours for home-base drivers) with the recommendation that this 9-hour period begin at the same time each day. Minimum of 1 hour off allowed for any combination of rest, personal and family activity, etc. For regional drivers sleeping at home and split-shift drivers, the 1-hour minimum is extended to 3 hours. A maximum of 14 hours on-duty time is allowed, with a maximum of 12 hours for driving. The maximum on-duty time is 12 hours for regional drivers sleeping at home, split-shift, and home-base drivers. For labor primarily other than driving, the maximum on-duty time is extended to 15 hours, only 6 for driving. | P | F | F | F | F | F | F | F | F |
| **Option C:** Similar to option B. It increases the minimum additional hours off duty allowed for long distance drivers and regional drivers away from home, for personal and family activities to 2 hours, and maximum time on one shift is reduced from 14 hours to 13 hours. Drivers away from home may accumulate 78 hours in 7 days but not more than 130 hours in 14 days. Drivers not away from home may accumulate no more than 65 hours in 7 days. | P | F | P | F | F | F | F | P | F |

**Table G–1. Summary of the expert panel who reviewed the candidate options for hours-of-service regulations (continued).**

| Federal Highway Administration candidate option | Evaluation criteria[a] | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Option D:** Based on 24-hour cycle. Minimum of 9 consecutive hours off for sleep (12 hours off for home-base drivers and 8 hours for labor primarily other than driving), plus a minimum of 3 hours for long distance, regional, and split shift for rest or personal activities. For labor primarily other than driving, 1 hour is required for these activities. On-duty time is maximum of 12 hours, except for labor primarily other than driving where it is 15 hours. Maximum driving time is 12 hours except for labor primarily other than driving where it is 6 hours. A maximum of 72 hours can be accumulated in a 6-day period, and all hours can be for driving. For home-based drivers, the maximum is 60 hours within a 7-day period. | P | F | P[b] | F | P[b] | F | P[c] F[d] | P | F |
| **Option E:** Retains 10-hour driving limit in current system but based on a 24-hour cycle. Allows for up to 2 additional hours for on-duty time. | P | F | P | F | P | F | P[e] | P[e] | F |
| **Option F:** All drivers have a maximum of 12 hours on duty, all available for driving, with a 24-hour day. A minimum of 12 hours off, including 9 hours for sleeping. Drivers may not be on duty for more than a total of 18 hours during the interval of midnight and 6:00 a.m. in a 7-day period. Drivers may not be on duty for more than 120 hours in a 14-day period. For drivers who return home each day, on-duty time may not exceed 60 hours in a 7-day period. | This policy attempts to meet all evaluation criteria. | | | | | | | | |

P = pass (meets criterion); F = fail (does not meet criterion).

[a] The evaluation criteria are defined as follows: (1) 24-hour cycle; (2) nighttime differential; (3) continuous time off duty daily; (4) split-shift drivers; (5) on-duty versus driving time; (6) sleeper berth use; (7) limits on cumulative on-duty time; (8) adequate recovery time; (9) foreknowledge of work schedule.

[b] Except for labor primarily other than driving.

[c] For daytime driving.

[d] For nighttime driving

[e] Depends on amount of nighttime driving.

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