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.

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.

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.

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)
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> 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)
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> 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