Log R-629B

National Transportation Safety Board

Washington, D. C. 20594

Safety Recommendation

Date: AUG 23 1991

In Reply Refer To: R-91-45 and -46

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On Wednesday, November 7, 1990, about 4:11 a.m. Pacific standard time, two Atchison, Topeka and Santa Fe Railway Company (ATSF) freight trains collided head on at milepost (MP) 25.6 in Corona, California. The westbound ATSF freight train 818, which was traveling from Barstow, California, to Hobart yard, City of Commerce, California, was on the Corona siding. It passed the stop signal, and the lead locomotive reentered the main track area, blocking all movement on the main track. The eastbound ATSF freight train 891, which was traveling from Hobart yard to Chicago, Illinois, was on the main track and collided with train 818. Each train had three-person crews.[1]

As a result of the collision, the entire crew of ATSF 818 was killed and four locomotives and three rail cars were derailed. The engineer and conductor of train 891 sustained serious injuries and the brakeman was killed; all three locomotives and five rail cars were derailed. The total damage was estimated to be $4,400,000.

An extensive examination of the engineer's work/rest cycle during the 90 days preceding the accident revealed a wide variation in his reporting times. The purpose of the examination was to determine to what extent the fluctuations in his schedule may have affected the events leading to the accident.

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[1]For more detailed information, read Railroad Accident Report--"Atchison, Topeka and Santa Fe Railway Company (ATSF) Freight Trains ATSF 818 and ATSF 891 on the ATSF Railway, Corona, California, November 8, 1990" (NTSB/RAR-91/03).

Near the beginning of the 90-day period, the engineer took a 3-week vacation, thereby changing his employment-induced work/rest cycle. Consequently, the Safety Board focused on the 64 days from his first day back at work, September 5, through the day of the accident, November 7.

The engineer returned from vacation to his previous freight pool assignment, which required him to operate trains between Hobart yard and Barstow. He remained in the freight pool service for 12 days and then transferred to the extra board. He remained on the extra board for 3 weeks, after which he transferred back to freight pool service.

During the 64-day period, he worked 47 days, averaging 7 hours 26 minutes on duty in a calendar day. However, during the 47 days that he worked, he was called to duty 56 times, meaning that on 7 occasions he worked 2 tours of duty on the same calendar day.

His work schedule was irregular; his duty hours ranged from as few as 2 hours 10 minutes (when he was deadheaded) to as many as 12 hours (when he was operating a train). The amount of rest he had between tours of duty was correspondingly irregular; it ranged from as few as 2 hours to as many as 96 hours.

His work/rest periods were unpredictable. In 54 tours of duty, he had 35 different reporting times. During 14 tours, he worked between 8 a.m. and 4 p.m.; during 15 tours, he worked between 4 p.m. and 12 a.m.; and during 25 tours, he worked between 12 a.m. and 8 a.m.

On 25 occasions he reported to work 8 hours or more later than he had on the previous day, meaning that he changed shifts 46 percent of the time. Figure 4 summarizes this information.

Sleep research suggests that the human body maintains an approximate day-night cycle known as circadian rhythm.[2] Researchers have noted the effect of violating the circadian rhythm:

> . . . the quality and quantity of sleep is degraded and performance is impaired as a result of working at night. These changes are primarily caused by the disharmony between the night worker's schedule and the underlying circadian rhythms of the body. The two are completely out of phase. The body is programmed to be awake and active by day and asleep and inactive by night, and it is extremely difficult to adjust this program in order to accommodate artificial phase shifts in the sleep-wake cycle.[3]

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[2]Circadian rhythm is a term used to define cyclical biological processes which occur at approximately 24-hour intervals in approximate synchrony with the earth's day/night cycle. Sleep/wake patterns, body temperature, hormone levels, and metabolism are some of the processes that have recurring and predictable variations throughout a 24-hour period.

[3]Tilley, A.J., et.al. "The sleep and performance of shift workers." Human Factors, 1982, 24 629-641.

Thus, the biological clock regulating bodily functions and actual time are out of synchronization for workers with schedules like the engineer's. Also, their biological clocks do not adjust quickly or easily to changes in the timing of their sleep that are imposed on them by irregular shift work. The engineer hinted at this problem in his 12-minute conversation with the STO when the STO asked him if he had his rest. He replied, "Well yeah, we've had what they called rest off, but can you force yourself to lay down and go to sleep when you are not tired?"

Indeed, research[4] has shown that shift workers never fully adapt to irregular night shift routines. Workers have difficulty working at night, which the body normally reserves for sleep, and sleeping during the day, when the body is normally awake. When duty times are unpredictable as well as irregular, the conflict can be intensified.

As a result of this these conflicts, shift workers begin to suffer physiological changes and to experience job performance decrements. Significant decrements have been observed in visual acuity, cognitive functions, memory, reaction time, and, particularly, vigilance levels across extended time periods. As alertness decreases, reaction time increases, and the quality of judgment and decisions decreases.

Dr. Donald Tepas[5] noted that studies of industrial workers have shown that people who work irregular shifts sleep less and also report more frequent sleep problems than do people who work regular daylight shifts.

Conversations with shift workers and other anecdotal evidence have shown that it can be difficult for a person to go to sleep when his schedule calls for it but his body does not. If he does manage to fall asleep, he may not be able to stay asleep as long as he should. Consequently, shift workers fail to obtain a sufficient amount of quality sleep and develop a sleep deficit that cannot be made up. This accumulation of sleep deprivation causes chronic[6] fatigue, which they are unlikely to recognize unless they have had specialized training.

Chronic sleep deprivation manifests itself in microsleep and napping. A microsleep is defined as a brief involuntary period of sleep that lasts from a few seconds to minutes and ends spontaneously. A microsleep can be disrupted by external stimuli, but only if they are massively sensory in nature, very unusual, or particularly meaningful. Microsleeps increase in frequency and duration as the loss of sleep increases. The worker may have no warning of either the beginning or end of a microsleep; when he has finished his microsleep, he may not even know that it has occurred.

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[4]Mitler, M.M., et.al. Catastrophes, Sleep and Public Policy: Consensus Report. Sleep, 1988, II No. 1 100-109.

[5]Dr. Tepas testified before the Safety Board during the public hearing regarding the collision of two Consolidated Railroad Corporation freight trains. Please refer to "Head-End Collision of Consolidated Rail Corporation Freight Trains UBT-506 and TV-61 near Thompsontown, Pennsylvania, January 14, 1988." NTSB/RAR-89/02,PB89-916302.

[6]Chronic fatigue is attributed to accumulated sleep deprivatic , due to circadian disharmony (violation of sleep/wake cycle) or circadian desynchronosis (rapid crossing of time zones).

The onset of sleepiness that arises from chronic sleep deprivation is to some degree predictable. Research[7] indicates the existence of a circadian nadir, which occurs between approximately 1 a.m. and 7 a.m., and a secondary trough, which occurs between 1 p.m. and 5 p.m. These are periods of diminished capacity for all workers, even those who are well rested. However, a worker's ability to resist their effects is greatly reduced when he has not slept, and it is during these periods that he is likely to microsleep.

If the work environment lacks stimulation, the worker is more likely to fall asleep. For example, according to a Dinges study:

> Driving, no matter what the vehicle, seems especially prone to drowsiness, errors, missed signals, and accidents at the predicted times. A study[8] of 2,238 failures to respond to warning switches (which then induced automatic braking) by 15,000 German train drivers revealed a temporal function with two peaks, 3 a.m. and 2 p.m.

The engineer of train 818 experienced chronic (long-term) sleep deprivation because of the irregularity and unpredictability of his work/rest cycle. In addition, the chance that he would fall asleep was greatly increased by the fact that he had so little sleep before he started the trip.

After awakening on November 5, he stayed up about 4 hours and had dinner with his family before going to bed for the night. He slept for 5 1/2 hours before receiving a call to work again at 1:30 a.m. on November 6. He did not go back to sleep, but dressed and drove to work. Thus, he began the tour of duty with insufficient sleep and at a time of day when, according to his circadian rhythm, he should have been asleep. The trip to Barstow was, however, successfully completed.

In the 26 hours 41 minutes between the time he was called to work, 1:30 a.m., November 6, and the time of the accident on November 7, he had had very little sleep. The maximum amount of sleep he could have had from the time he finished speaking to the STO until the time he left the Barstow motel to go to work was 1 hour 6 minutes (8:54 p.m. to 10 p.m.).

After being awake for more than 26 hours, the debilitating effects of sleep loss were high and they were greatly enhanced by his working during the low point of his circadian rhythm. These effects may have caused the fluctuation in the speed of the train between San Bernardino and the siding at Corona. During this period of time, train 818 exceeded the maximum speed 13 times.

He had his last radio communication with the San Bernardino dispatcher about 3:52 a.m., when he acknowledged instructions to take the siding at Corona and allow the eastbound train to pass. According to the event recorder printout, a reduction was made to the train's braking system about 4:03 a.m. in order to slow the train to 15 mph. The last action performed on the engineer's stand was about

[7]Dinges, D.F., "The Nature of Sleepiness: Causes, contexts, and Consequences." Chapter 9 in Stunkard, A.J., Baum, A. eds. Perspectives in Behavioral Medicine. 1988, 162.

[8]Hildebrandt, G., et.al. "Twelve and 24-hour rhythms in error frequency of locomotive drivers and the influence of tiredness." International Journal of Chronobiology, 1974, 2, 175-180.

4:11 a.m., when the throttle position changed from dynamic braking to zero throttle.

Other than having to sound his horn at each grade crossing, there were no other performance demands on him until the train reached the signal at the west end of the siding. The engineer sounded the horn at Cota Street, which was 5,358 feet from Railroad Avenue, where an emergency brake application was made. Since he sounded the horn, he must have been awake at Cota Street. However, the emergency brake application occurred when the train was beyond the stop signal and in the vicinity of the wig-wag grade crossing protection device, as indicated by the trail of air brake sand found on the track structure west of the stop signal. The Safety Board concludes that train 818 traveled over 25 feet from the point when the emergency brake application was initiated to when the sand began to spread onto the rail, based on the speed of the train coupled with the sanding system sequence.

It is likely that the rhythmic sound and motion of the locomotive's engines, the lack of physical activity, and a cab heater turned on full further produced an environment conducive to sleep. The fact that the engineer had opened the cab window and turned on the interior dome light on the engineer's side suggests that he tried to keep himself awake.

Nevertheless, the Safety Board believes that his efforts to stay awake were unsuccessful. As stated in one study:[9]

> . . . when sleep is lost or disrupted, by whatever means, the inevitable consequence is sleepiness during the wake period. If sleepiness becomes excessive, the person ceases to function effectively because ultimately the brain imposes sleep, typically in the form of overwhelming drowsiness or microsleeps, despite the individual's best efforts to stay awake.

The engineer was operating in an unstimulating environment and attempting to function at the lowest point of his circadian rhythm. He may have awakened from a microsleep spontaneously or as a result of stimuli. Possible stimuli included the sight and/or sound of the wig-wag signal, the sight and/or sound of train 891, the jolt from the change in the roadbed as the train crossed the road crossing, or the actions of other crewmembers.

The Safety Board believes that the engineer failed to stop the train at the stop signal because his chronic and acute fatigue[10] caused him to fall asleep for a critical period of time.

When a crewmember completes a tour of duty, he usually goes to bed shortly after coming off duty because he knows that in 8 hours he will be subject to being called for another tour. He is particularly likely to go to bed at an away-from-home terminal, where a layover is usually short. However, sometimes a layover at an away-from-home terminal exceeds 8 hours.

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[9]Dinges, p. 147.

[10]Acute fatigue is attributed to deficient quality and quantity of sleep within one normal circadian cycle.

When the crewmembers arrived in Barstow at 12:40 p.m., both the engineer and the conductor called their wives. Each estimated that he would not go back on duty until about 5 a.m. the following day. The estimates were based on the line-up of trains and on the number of crews in Barstow at the time and on the fact that a traincrew was normally called at 5 a.m. The Barstow terminal had computer monitors that crewmembers used to find out the train line-up and crew information entered into VIPS. According to the crew's estimates, they had enough time to have a meal before they went to bed. After eating, the conductor followed standard practice and went to his room.

The engineer took a different approach to getting his rest. He stayed up, intending (as he told his wife) to go to bed later in the day and sleep until he was called for work. Had he been able to follow his plan, the time between the end of his sleep and the beginning of his tour of duty would have been minimal and he would have been as well rested as possible. In theory, his approach was sound. But because the unexpected occurred, in practice, it was not.

When the crew arrived in Barstow and checked the line-up, it did not show any pending deadhead moves. Based on that information, the engineer's and conductor's estimates of their next duty times were reasonably accurate. During the day the engineer had conversations with members of other crews that were in Barstow, and they were not aware of any pending deadheads. If the deadhead information had been available earlier in the day, it might have been entered in VIPS, and the engineer might have made a different decision about when to go to sleep. Since the information about the deadheading of crews was not available to the engineer, he probably wanted to take his sleep at the time he had been accustomed to during the previous 2 days, which was at night. In following this course of action, he would have been better rested at 5 a.m., when he expected to go on duty. He would have gone to bed about 8 hours before 5 a.m.

However, he should not have relied completely on the information from VIPS or from members of other crews. The carrier's employees knew that the scheduling of trains and crews was subject to change. Nevertheless, the Safety Board believes that the carrier should more closely adhere to the schedule for posting updated train and crew information every 4 hours.

Experience should have tempered the engineer's reliance on VIPS. Because of the weekly traffic cycle of trains, crews were invariably deadheaded from Barstow to Los Angeles on Tuesdays and sometimes on Wednesdays. The engineer should have been aware of the need to check VIPS after 5 p.m. and should not have relied on information obtained earlier that day. However, VIPS was not updated every 4 hours; in this case, he would not have received the correct crew line-up until after 5:28 p.m.

The Safety Board believes that had the ATSF made the users of VIPS aware of when the information had last been updated and when they could expect the next update, it might have made a difference. Had the above information about the deadheading of crews out of Barstow been available at 1 p.m. or 5 p.m., when it was supposed to be, the crewmembers of train 818 might have made a different decision about how to spend their off-duty time.

The Safety Board also concludes that the engineer was imprudent in not trying to sleep during the off-duty time that the carrier provided in compliance with Federal regulations. The carrier should be allowed, without running the risk

of contractual violation, to remove an employee from duty if he has admitted to not having enough sleep. When an employee reports that he is, or is reported by another employee to be, suffering from a lack of sleep, a procedure is needed in the crew calling system that allows him to be taken out of board rotation without either the carrier or the employee incurring a penalty. The procedure could work in a manner similar to the current by-pass agreement employed under rule G agreements.[11]

Once the engineer learned that he was being called to work at 10:15 p.m., he complained to the crew caller about the fact that the three crews in front of him were being deadheaded. He complained about not getting his rest, and he implied that he might lay off sick; but he did not, and he accepted the call. He continued his complaint in a conversation with the STO and implied that he had not slept during the day and was just getting ready to go to bed when he was called. He told the STO, ". . . I mean how [do] you plan your life, just live by surprises?"

Had he chosen not to accept the assignment, he would have faced at least one and perhaps as many as four consequences. The first would have been the loss of a tour of duty and no compensation. The second was that he would have had to provide his own transportation home; the carrier would not furnish such transportation. The latter have would been of little consequence since he coowned an automobile that was garaged in Barstow.

A third consequence might have been peer pressure from the other crewmembers. The remainder of the crew could either have been deadheaded home, or it could have had another engineer assigned and taken the trip. If the crewmembers were deadheaded, their pay would have been less than if they worked a train to Hobart yard.

A fourth consequence that might have affected the engineer's decision was the prospect of disciplinary action. The regional manager said ". . . [if the engineer] didn't have a history of it [laying off], and even though if it wasn't perceived as a good reason, I'm confident there wouldn't have been any punitive measures taken . . . ." However, disciplinary action was a possibility because the engineer had laid off twice on call and the ATSF had not taken any action either time. He might have believed that another lay-off on call would have prompted action by the carrier.

During his testimony to the Safety Board, the STO expressed "sympathy" for the engineer's predicament but said that when he had too many crews for the trains available, as he did in this case, he had to deadhead. He said the engineer's situation had never come up before, nor was he aware of anyone ever having laid off at an away-from-home terminal because he was tired. The carrier had not provided policy guidance on what to do when a crewmember notified the STO of not having slept prior to coming on duty. Thus, no precedent seems to have been established on the ATSF for treating sleepiness in the same manner as other sources of impairment.

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[11]Several carriers have agreements with their respective labor organizations about the handling of an employee who has had an alcoholic beverage while on call. If the employee admits to having had the beverage, he is by-passed from duty and dropped to the bottom of the call board. No penalty is incurred by either the employee or the carrier.

The Safety Board believes that outside pressure (personal commitment, peers, and professionalism) and circumstances (being at an away from home terminal) weighed heavily in the engineer's decision to accept the assignment. Despite his fatigue and lack of sleep, he believed that his best recourse was to take the assignment.

Although the ATSF was in complete compliance with the maintenance of hours-of-service records as specified by 49 CFR subpart 228.11, investigators had trouble deciphering the information in these records pertaining to the work/rest cycles of the engineer on train 818. The ATSF developed its own record keeping system because there were no Federal guidelines to assist carriers in providing and maintaining the information. As the importance of tracking work/rest cycles grows within the rail industry, so will the importance of the format used in recording the necessary information. The Safety Board believes that a simple format should be designed by the FRA so that it is easier to follow hours-of-service information.

Therefore, the National Transportation Safety Board recommends that the Association of American Railroads:

> In cooperation with member carriers and the operating unions, develop a policy that would allow the carrier to prevent an employee from accepting assignments and would allow an employee to report off duty when he or she is impaired by lack of sleep. (Class II, Priority Action) (R-91-45)
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> In cooperation with member carriers and the Federal Railroad Administration, develop a uniform simplified format for work-record data collected by the rail carriers. (Class II, Priority Action) (R-91-46)

Also, the Safety Board issued Safety Recommendations R-91-39 and -40 to the Federal Railroad Administration, R-91-41 through -44 to the Atchison Topeka and Santa Fe Railway Company, R-91-47 to the Brotherhood of Locomotive Engineers, R-91-48 to the United Transportation Union, R-91-49 to the California Public Utilities Commission, and R-91-50 to the California State Fire Marshal's Office.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations R-91-45 and -46 in your reply.

KOLSTAD, Chairman, COUGHLIN, Vice Chairman, and LAUBER, HART, and HAMMERSCHMIDT, Members, concurred in these recommendations.

By: James L. Kolstad
Chairman