



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: SEP 11 1996

In Reply Refer to: R-96-22 through -25

Mr. Lawrence G. Reuter
 President
 New York City Transit
 370 Jay Street
 Brooklyn, New York 11201

About 6:12 a.m. on June 5, 1995, a New York City Transit (NYCT) southbound subway train traveling at maximum attainable speed passed a red signal and collided with the rear car of another NYCT subway train that was stopped on the Williamsburg Bridge, which spans the East River and which links the boroughs of Brooklyn and Manhattan. The operator of the striking train was fatally injured when the lead car of his train partially telescoped into the rear car of the struck train and his cab was totally crushed. Sixty-seven passengers and two emergency responders were treated at area hospitals for serious or minor injuries resulting from the accident.¹

Research showed that the operator of the striking train had been a motorman in the New York subway system for 14 years. His most recent performance evaluation described his overall operation as "good." The Safety Board attempted to determine why a capable train operator proceeded past restrictive signal indications at high speed without slowing and why he failed to take evasive action when the collision was imminent. Another train operator crossing the bridge at that time of day stated that he had no problems seeing the signals or the trains ahead. Witnesses stated that no loud noises or activity occurred either on board the train or on the bridge that may have distracted the operator of the striking train. Moreover, other transit employees did not observe any indication that his performance was impaired.

Despite observations that the operator of the striking train was alert and fit for service, anecdotal evidence suggests that he fell asleep while proceeding up the bridge approach. After applying full throttle on the approach to the bridge, he made no other responses to signal aspects requiring first that he prepare to stop (yellow) and then that he stop (red). As a experienced train operator who had taken trains across the Williamsburg Bridge for several years, he would have known that as a precautionary measure he had to slow his train in order to stop at the red signal. The position of his body after the accident supports the finding that the train operator fell asleep.

¹ For additional information, read Railroad Accident Report *Collision Involving Two New York City Transit Subway Trains on the Williamsburg Bridge in Brooklyn, New York, June 5, 1995* (NTSB/RAR-96/03).

About 7 seconds elapsed between the time that his train went into emergency braking and the time of impact. When a train goes into emergency braking, the brake system emits a distinctive noise, recognizable by any crewmember. Had the train operator been alert, he would have been able to observe that a collision was imminent and probably would have tried to vacate the compartment to avoid injury. However, investigators found no indication that he had turned or moved to leave the compartment. His failure to take action in a life-threatening situation strongly suggests that he was either asleep or had just woken up and was too disoriented or sluggish upon waking to respond.

The Safety Board attempted to determine why the train operator might have been fatigued. The accident happened at 6:12 a.m., a time that coincides with a person's primary period of sleepiness. Further, the accident occurred on Monday, the first day when the train operator changed from his weekend schedule of sleeping at night to his weekday schedule of working at night. Studies have shown that shift workers who rotate schedules are especially prone to fatigue on both the first and second nights of the work week. In this case, the train operator, who was working at the time when he was asleep on the previous day, did not have the necessary time for his circadian rhythm to match his new sleep-wake cycle. As a result, he probably was not prepared to stay awake all night.

Over the last several years, the operator of the striking train had periodically been observed at work in a fatigued condition. His personnel file contained a disciplinary action (reprimand) for sleeping while on duty on January 18, 1989. He had been found napping between runs in a darkened crew room at 2:01 a.m. Another NYCT train operator who had worked with the accident train operator on and off for about 2 years stated that "he and other motormen" had problems trying to stay awake between 3 a.m. and 6 a.m. She stated that contrary to company policy, crewmembers "all took naps at work during the midnight tour."

The Safety Board has been concerned about the factor of fatigue in transportation for many years. In 1990, the Board completed a study of 182 heavy truck accidents that resulted in driver fatalities. The primary purpose of this study was to assess the role of alcohol and other drugs; however, the study found that fatigue was a factor in 31 percent of the accidents.²

The Safety Board has also found fatigue to be prevalent in railroad accidents. The Board determined that the probable cause of a January 1988 head-on collision of two freight trains in which the engineers and brakemen died was the "sleep-deprived condition of the engineer and other crewmembers of [the westbound train], which resulted in their inability to stay awake and alert, and their consequent failure to comply with restrictive signal aspects."³ Investigators found that none of the crewmembers on the westbound train had had more than 2 hours of sleep during the 22 to 24 hours preceding the accident.

² Safety Study *Fatigue, Alcohol, Other Drugs, and Medical Factors in Fatal-To-The-Driver Heavy Truck Crashes*, (NTSB/SS-90/01).

³ Railroad Accident Report *Head-End Collision of Consolidated Rail Corporation Freight Trains UBT-506 and TV-61 Near Thompsettown, Pennsylvania, January 14, 1988*. (NTSB/RAR-89/02).

Following its investigation of a November 1990 head-on collision of two freight trains near Corona, California, in which the entire 3-man crew of one train and a brakeman on the other train were killed, the Safety Board found that the errant crewmembers were either asleep or too sleepy to respond.⁴

Research at the NASA Ames Fatigue Countermeasure Program has identified effective measures that minimize or mitigate the effects of sleep loss, circadian disruption, and fatigue. According to a study examining the effects of strategic napping during long-haul flight operations, pilots who slept in the cockpit for an average of 26 minutes during low workload periods maintained higher levels of vigilance and alertness compared to pilots who did not nap.⁵ The Safety Board agrees that the use of naps as a means of preventing fatigue before its onset is a worthwhile countermeasure and a strategy that the NYCT should consider acceptable and advantageous. The use of punitive or disciplinary measures, such as employee reprimands or suspensions, simply is not effective in combating a physiological condition. Strategic napping by train operators and conductors could occur during extended non-operational periods on their shifts. The Board cautions, however, that these naps should be a supplement to, not a replacement for, one continuous 8-hour sleep period.

Federal regulations do not require that fatigue educational programs be developed or incorporated in training for employees or supervisors in transit operations. Therefore, the Safety Board is pleased that the NYCT took the initiative of contracting for a fatigue study and is incorporating a fatigue educational awareness program into its fitness-for-duty evaluations. The Board notes, however, that the videotape developed on safe operating procedures for train operators only briefly addresses the need for employees to be rested and alert and the need for employees to get between 6-8 hours of sleep before reporting to work. The video does not discuss other relevant issues regarding fatigue, particularly sleep-related issues relevant to night-shift workers. Although the Safety Board commends the NYCT's initiative in providing this training, the Board believes that the transit company's fatigue educational program should be expanded. The training should include information about the need for an adequate amount of quality sleep, about the fact that a train operator can fall asleep suddenly and without warning regardless of his age or experience, about the behavioral and physiological consequences of sleepiness, and about strategies for avoiding sleep loss, such as strategic napping.

From its investigation, the Safety Board concluded that this accident might have been avoided had the operator of the striking been alerted by the command center that another train was stopped on Williamsburg Bridge. The NYCT employee operating procedures at Rule 40, "Signals," specifically state that train operators encountering a red automatic signal must immediately radio the dispatch command center that they have stopped. In this accident, the operator of the struck train never radioed the command center that he had stopped his train on the bridge.

⁴ 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 7, 1990* (NTSB RAR 91/03).

⁵ Rosekind, M.R., Graeber, R.C., Dinges, D.F., Connell, L.J., Rountree, M.S., Spinweber, C.L., and Gillen, K.A. (1994). *Crew Factors in Flight Operations IX: Effects of Planned Cockpit Rest on Crew Performance and Alertness in Long-Haul Operations*. (National Aeronautics and Space Administration Technical Memorandum 108839)

The Safety Board is concerned that Rule 40 as written and as placed in the employee operating manual and revision bulletin is ambiguous and confusing to train operators. The paragraph about immediately calling the command center at a red signal follows a paragraph about procedures for keying by a red signal. Although these two procedures are independent of each other, their juxtaposition in the rule book suggests that they are linked and that operators are to call the command center only when they are seeking permission to key by a red signal. Consequently, train operators who have to stop and who do not intend to key by a signal may believe that they do not have to call the command center immediately. This problem was identified during interviews conducted separately by the Safety Board and by the New York City Council's Committee on Transportation with NYCT train operators and dispatchers. Few of the individuals interviewed could correctly list the communications procedures they had taken or were supposed to take when they had to stop at a red signal.

The Board is aware that the NYCT tried to address the problem of employees misinterpreting Rule 40 (m) by issuing a special bulletin revising the required procedures. However, as evidenced by the responses from the employees interviewed after the accident, this method of advising employees of a procedural change is not totally effective and results in hit-and-miss compliance, at best. The Safety Board believes that operators would better understand that they must immediately contact the command center under all circumstances upon stopping at a red signal if this procedure were presented at the beginning of Rule 40 (m). Further, the NYCT needs to enact measures to ensure that employees read, understand, and adhere to the rules.

Although human error was the immediate cause of this accident, the collision was the result of a system design error. When the train operator failed to stop at a red signal on the bridge, the automatic trip arm properly triggered the train's emergency brakes. However, the train, which was traveling between 34-36 mph, failed to stop before striking the train ahead because of inadequate braking distance within the block. From separate tests conducted by the Safety Board and by the NYCT and from surveys conducted by independent contractors, it was determined that most signal blocks in the NYCT system do not have adequate emergency braking distance.

The Safety Board is aware that the NYCT has ambitious plans to install state-of-the-art technology, including a pilot transponder project on one of its lines in 1997 and computer-based signaling on all lines in the distant future, in an effort to improve safety on its antiquated signal system. The Board is also aware that the transit company has initiated a number of interim changes in an effort to ensure that its trains will stop within a signal block. The NYCT has posted speed limits on the Williamsburg Bridge approach and other selected sites where the emergency braking distance is not sufficient for trains traveling at maximum attainable speed. It is increasing the braking capability on all car models and is retarding the acceleration capability of several of its newer, more powerful car models. The Safety Board acknowledges the efforts of the NYCT to improve its system but believes that these changes neither guarantee that an accident caused by operator error will not occur nor reflect everything that the NYCT can do to maximize safety at this time.

The Safety Board considered a number of additional interim measures, which either alone or in combination with each other, would prevent rear-collisions on the NYCT signal system, including lengthening the control line, removing and/or respacing signals, converting automatic signals to grade time signals, and setting speed limits.

Lengthening the control line or respacing signals, either by physically removing the masts or by deactivating lights, would program greater distance between trains in problem areas.

As noted above, the NYCT already is posting speed limits in selected sites. However, this policy does not prohibit train operators from traveling as fast as the train is capable of moving in other areas, which requires them to make adjustments when they encounter trains that are slowing for traffic or stations ahead. Were the NYCT to impose a lower maximum speed limit on its entire system, the tendency of vehicles on a line to bunch might somewhat be eliminated.

Regardless of whether the NYCT does or does not establish a maximum speed limit on its entire system, the Safety Board believes that the transit company should change its operating rules governing movement under *approach* signal aspects. The employee operating manual at Rule 59 (b) indicates that upon encountering a yellow signal aspect, the train operator is to "Proceed with caution, be prepared to stop." The manual does not stipulate that a train operator should slow down or should not exceed a given speed when operating under a yellow aspect. As a result, train operators can operate at maximum speed when under a caution indication. The Safety Board believes that the NYCT should change its operating rules to restrict train movement under a yellow aspect to a specific maximum speed that is appropriate for all rail conditions.

The NYCT could also slow down speeding train operators by converting more automatic signals to grade time signals. Time signals serve to enforce a speed limit because a train operator who is traveling faster than the programmed time (the established speed limit for an area) and who enters a block before its signal clears risks tripping the automatic stop arm, which will activate the train's emergency braking.

In testimony, NYCT officials characterized their system as safe when their train operators comply with the operating rules. The Safety Board strongly believes that the NYCT's practice of relying on operator compliance to ensure the safety on its system is not adequate. Too many factors at and/or outside the workplace can affect human performance. In the Williamsburg Bridge accident, 1 person was killed and 64 people sustained injuries requiring treatment at area hospitals. Other people on board the two trains were injured but elected to be treated on scene by medics rather than go to the hospital. In the 5 years before this accident, the NYCT had seven operator-error accidents in which a total of 5 people were killed and more than 300 people were injured. The Safety Board believes that the NYCT needs to identify those areas on its system that do not have sufficient braking distance for trains traveling at maximum attainable speed and enact changes that will ensure rear-end collisions will be prevented.

The National Transportation Safety Board therefore issues the following recommendations to the New York City Transit:

Develop and disseminate a training and education module to inform train operators and other employees involved in safety-sensitive positions about the hazards of performing their duties while fatigued. (Class II, Priority Action) (R-96-22)

Clarify Rule 40 (M) to ensure that the requirement for train operators to notify the command center when they are stopped at a red signal is independent of the procedures for keying by a red signal. (Class II, Priority Action) (R-96-23)

Ensure through training, retraining, and testing that employees understand and consistently adhere to the operating procedure at Rule 40 (M) requiring that they immediately contact the command center when they stop their train at a red automatic signal. (Class II, Priority Action) (R-96-24)


Identify those areas on your system that have insufficient braking distance for trains traveling at maximum attainable speed and implement appropriate changes to prevent rear-end collisions caused by operator error. (Class II, Priority Action) (R-96-25)

Also, the Safety Board issued Safety Recommendations R-96-20 to the Federal Transit Administration, and R-96-21 to the American Public Transit Association.

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 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-96-22 through -25.

Chairman HALL, VICE Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By:


Jim Hall
Chairman