



National Transportation Safety Board

Washington, D. C. 20594

Safety Recommendation

Log R-6/4

Date: March 30, 1989

In reply refer to: R-89-8 through -18

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About 7:54 a.m., e.s.t., 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 (CP) 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 \$6,015,000.¹

The lead unit of UBT-506 was equipped with a deadman pedal that the engineer was supposed to keep depressed with his foot. If he failed to do this, a penalty brake application would be automatically initiated that would stop the train. However, the deadman pedal is an inadequate substitute for a state-of-the-art alerter that requires a recurring and relatively cognitive response from the engineer and provides an audible warning if he fails to respond. Moreover, the deadman device can easily be defeated by placing a heavy object on the pedal, a practice the Federal Railroad Administration (FRA) 1987 Conrail safety assessment reported as being widespread and not uniformly discouraged.

The Safety Board is aware that Conrail has recognized the shortcomings of the deadman pedal and has undertaken a program to replace it with sophisticated alertness devices on all locomotive units. In addition, all new locomotive units being bought have such devices instead of deadman pedals. Nevertheless, the majority of Conrail locomotive units still have the pedals.

According to Dr. Donald Tepas, an expert on shiftwork stress and sleep research, even if the engineer kept the deadman pedal depressed with his foot, as required, he could easily continue to do so while being asleep. The Safety Board finds it inexplicable that Conrail continues to rely on the outmoded deadman device that is so easily defeated and, if not defeated, compels the engineer to remain at his seat at

¹For more detailed information, read Railroad Accident Report--*Head-end Collision of Consolidated Rail Corporation Freight Trains UBT-506 and TV-61, near Thompsontown, Pennsylvania, January 14, 1988 (NTSB/RAR-89/02)*.

all times, unable to move about the operator compartment, or otherwise relieve the monotony of his job. Although Conrail reports it has undertaken a program to phase out the deadman devices in favor of state-of-the-art alerters that cannot be defeated, the Safety Board believes that this program should be expedited for the earliest possible completion.

After viewing a demonstration of the alerter and the automatic cab signal/automatic train stop (ACS/ATS) acknowledging pedal, Dr. Tepas concluded that it was possible for the engineer to respond to the audible alerter by depressing and releasing the pedal in his sleep. Conrail, and the rail industry in general, need to modify the pedal or replace it with a sophisticated alertness device so that the action required by the engineer is more cognitive than a simple reflex motor response.

By riding the trailing unit of UBT-506 and isolating himself unnecessarily from the other crewmembers, the conductor had removed himself completely from what little required activity there was on the lead unit. He also ignored his responsibility to ensure that the other crewmembers complied with the requirements of the rules and timetable. Although Conrail allows its conductors to ride on trailing units, at least on the Allegheny Division, it also places them in charge of their trains. To discharge their responsibility under Conrail rules and to be fully cognizant of what is happening, conductors need to be on the lead unit where they can observe the cab signals and hear the ACS alerter. The Safety Board does not understand this dichotomy in Conrail management policy.

The crewmembers of train UBT-506 had gone on duty at 2:30 a.m. on January 14. During the 90 days preceding the accident, the engineer of UBT-506 took a week of vacation, was off on the usual holidays, and worked 57 tours of duty. Other than the vacation, he worked every tour of duty that was available to him. An individual working a straight 5-day, 40-hour week who took a week of vacation and was off on holidays would also have worked 57 tours during the same period. Excluding several short "deadhead" tours when the engineer performed no duties and was simply transported from one place to another, his average tour of duty was slightly longer than 9 hours. That, too, would be about average for the typical 40-hour, day worker. Additionally, the engineer spent an hour or so each working trip commuting from or to his home, but that was scarcely out of the ordinary for people holding jobs anywhere. The brakeman's work regimen was similar to that of the engineer, except that he spent a little less time commuting. He, too, rarely lost an opportunity to work.

Beyond the overall amount of time the engineer and brakeman had to devote to their jobs, there was no similarity between their work/rest cycles and those of a typical day worker. Most striking was the utter lack of regularity and predictability in their work shifts and rest periods. Whereas a day worker who regularly is on the job between 8 a.m. and 5 p.m., Monday through Friday, and is off every weekday for 15 hours and every weekend for 63 hours, the engineer was off anywhere from 12 1/2 to 112 hours at a time and averaged more than 48 hours between work shifts when at home. Away from home, the average rest period was much shorter, almost the same as that of the day worker. However, the amount of time off was never uniform; the spread was from 8 to 30 hours.

When at home, the engineer and brakeman never could be certain when they would have to return to work. In 29 tours of duty beginning at Conemaugh, Pennsylvania, the engineer had 26 different reporting times--8 between 8 a.m. and

4 p.m.; 14 between 4 p.m. and midnight; and 7 between midnight and 8 a.m. Away from home, the engineer's reporting times were just as unpredictable. At Harrisburg, Pennsylvania, he was called at 26 different times of the day for 28 trips. He worked every day of the week, most frequently on Mondays, Wednesdays, and Fridays, but he did work six Saturdays and four Sundays during the 90-day period.

Based on the testimony of Dr. Tepas, the engineer and brakeman could never adapt to this nonsystematic pattern of work times, and they were probably highly susceptible to variations in alertness and consciousness associated with their body clocks; adverse environmental conditions that tend to promote sleep, such as rhythmical motion and sound; and repetitive and monotonous job duties. Also, they probably were susceptible to sleep disorders and chronic sleep deprivation resulting in fatigue, frequent microsleeps or lapses, and napping. According to Dr. Tepas, they were unlikely to have recognized the sleep disorder and never made up their lost sleep.

The wives of the UBT-506 crewmembers all worked daytime jobs with regular hours, and it was around these jobs and the daily regimen of the children, in the case of the engineer, that the family routines revolved. The investigation established that upon returning from work, the crewmembers would immediately fall into their family routines.

The crewmembers ate at the usual times, slept at night, engaged in family activity in the evening, and otherwise lived "normally." If the crewmembers were not called to work for a protracted time, which was almost always the case, they would get one, two, or more nights of sleep. If their next call to duty came late in the day, they probably got little or no rest until after they arrived at Harrisburg. In the engineer's case, he reported for duty between 4:30 p.m. and 7:30 a.m. on 21 of the 29 occasions he worked out of his home terminal during the 90 days preceding the accident. Considering that he was called 3 hours before his reporting time, he probably went to work deprived of sleep to at least some degree in each of those 21 instances. In some, he probably had no meaningful sleep for 24 hours or longer by the time he had completed his trip to Harrisburg.

The testimony of the UBT-506 conductor was probably instructive as to how train crewmembers typically deal with the unpredictable nature of their work. He said he normally went to bed between 11 p.m. and 11:30 p.m., and slept 8 hours. He also said that he needed a minimum of 4 to 5 hours sleep to feel rested, but could get by one night without sleep. Even though he knew well in advance that he would probably have to work some time during the night preceding the accident, he made no effort to get adequate sleep by retiring early. The Safety Board believes that, under the circumstances, it would not be surprising if, at 6 a.m. or so on the morning of the accident, the conductor was seriously fatigued, particularly since his body clock was still at low ebb. Alone on the trailing unit without any compelling duties to keep him busy, it would be easy for him to submit to his fatigue by taking a nap.

The engineer and brakeman also probably understood they might be called out on the night before the accident, yet neither departed from their custom of going to bed in the evening. The brakeman was long conditioned to going to work at any time of the day or night, but from the standpoint of fatigue, he may have been worse off than the other crewmembers. During the 40 hours preceding the accident, he probably had little more than the 1 1/2 to 2 hours bed rest he got before being called to work. The night before, he probably managed to get some sleep while sitting with his terminally-ill mother.

The engineer had about 1 1/2 hours of bed rest and a 1-hour nap in the 24 hours or so before the accident, although it is questionable that he actually obtained 2 1/2 hours of meaningful sleep in the process. The Safety Board believes that this sort of behavior may have been typical, not only of this crew, but of other crews on the Allegheny Division and elsewhere on Conrail and other railroads. As Dr. Tepas observed, it is probably not so surprising that the crew of UBT-506 fell asleep and allowed their train to overrun the interlocking at CP Thompson as it is that similarly caused accidents are not more commonplace.

As pointed out in the Safety Board's 1985 report of the Burlington Northern (BN) collisions in Colorado and Wyoming,² railroad train crews are confronted by the most uniquely unpredictable work/rest cycles in the transportation industry. Moreover, there is probably little that is even remotely comparable in other industries. To some degree, unpredictability in work schedules has been generally characteristic of the railroad industry since its inception. However, in the past when there were many scheduled passenger and freight trains, as well as large numbers of yard and local freight runs, that had regularly assigned crews, most of the irregular and unpredictable work fell to local extra boards staffed by younger employees with low seniority. The past 20 to 30 years have brought sweeping changes to the industry, not the least of which have been wholesale elimination of passenger trains, yard operations, scheduled freight trains, and a proliferation of crew pools and division-wide extra boards.

Additionally, larger American railroad systems, such as Conrail and BN, are the result of the mergers of many smaller systems within the past 30 years. As a result of these mergers and competitive forces, many duplicate operations have been eliminated. Because of management-labor agreements protecting employee seniority, this has resulted in widespread relocation of work assignments. Also, railroads have eliminated many operating divisions, resulting in changed reporting points and longer freight runs. All of these changes have brought economic advantages to the railroads, and quite often, to the employees as well. But, the Safety Board believes that neither railroad management nor the railroad unions have adequately considered the adverse impact that many of the changes have wrought on the working regimens of freight train crewmembers. Under present conditions, many train crewmembers may well work their entire careers without ever having a job with regularly assigned working hours and off-duty periods.

The traditional "it goes with the territory" attitude of railroad management toward the unpredictable nature of train crew work was revealed succinctly by Conrail's senior vice president-operations at the Safety Board's public hearing on this accident. The Safety Board understands that freight train operations are subject to fluctuations in traffic, delays in transit, and work rules, and that attempting to return to a higher level of regularly assigned work shifts would be a major undertaking. Nevertheless, as recognized by BN, the situation demands far more than a simplistic "we lived with it, they can live with it or get out" analogy.

²Railroad Accident Reports--*Head-on Collision of Burlington Northern Railroad Freight Trains Extra 6714 and Extra 7820 East, Wiggins, Colorado, April 13, 1984 and Rear-end Collision of Burlington Northern Railroad Freight Trains Extra 7843 East and ATSF 8112 Near East Newcastle, Wyoming, April 22, 1984* (NTSB/RAR-85/04).

In citing his own relatively brief experience as a young brakeman, the Conrail senior vice president failed to consider that many of his employees will have to cope with unpredictable work/rest cycles for their entire working lives, even into their 50s and 60s. The Safety Board believes that Conrail and the rest of the railroad industry need to make an in-depth assessment of what can be done to restructure their cultural approach to train operations and work/rest cycles. In the meantime, they can expand their training and counseling programs to provide sound advice to employees and their families on what constitutes good health and diet regimen, good behavior, and acceptable performance. Such programs will need the endorsement and cooperation of the operating unions, particularly the Brotherhood of Locomotive Engineers and United Transportation Union. In structuring the counseling programs, Conrail and the other railroads ought to take note of what is currently being done on the BN, the nation's largest railroad system.

The Safety Board is particularly encouraged by the initiative BN has demonstrated in providing education and counseling to its employees and their families. Particularly noteworthy, in the Safety Board's opinion, are BN's recognition of the scope of the problem, its efforts to change the traditional thinking of managers and to improve its operational format, and its willingness to undertake the pilot sleep-deprivation workshop. The Safety Board is also encouraged by the Brotherhood of Locomotive Engineers' cosponsorship and cooperation in the BN programs. Hopefully, the United Transportation Union will also support these and/or similar efforts.

Also, the Safety Board is concerned that a review of the most recent Conrail medical examinations of the six crewmembers involved in this accident, including three by fee-for-service physicians, revealed considerable disparity in the purview of the examinations. Not all included an electrocardiogram. In the case of the TV-61 engineer, no urinalysis results were shown. Although the TV-61 conductor declared he had difficulty hearing, and hearing deficiencies were evident from the audiometer test results, the medical examiner gave no opinion on the adequacy of the conductor's hearing. The UBT-506 brakeman was allowed to go 15 months past his required physical examination date, during which time his hypertension was diagnosed and treatment was undertaken. In this instance, also, the examiner gave his general impression of the brakeman as "abnormal" without giving a detailed basis for this finding.

The Safety Board's investigation revealed that since its formation, Conrail has relaxed the medical programs and standards followed by its predecessor companies. Mandatory company examinations are required less frequently, and even then, some employees manage to escape examination for protracted periods. Conrail's full-time medical staff has been drastically reduced with greater reliance placed on fee-for-service, private practitioners. While Conrail reportedly makes efforts to familiarize them with its policies and procedures, the Safety Board believes it is unreasonable to expect doctors who occasionally examine and treat Conrail employees as a small part of their practice to understand the physiological implications inherent in railroad job duties and environments. In any event, they can be expected to be less well-informed in this respect than doctors who exclusively deal with railroad employees.

The motivation for requiring periodic company physical examinations has always been the fact that the safe operation of railroads demands a proper level of employee fitness. Unless employees are seriously ill or injured, they cannot be expected to seek regular physical examination. More than ever, railroad employees should be subject to more stringent physical standards and regular, more

comprehensive physical examinations by practitioners who understand what the employees do and under what circumstances they have to do it.

Despite the fact that the "A" desk dispatcher was experienced, fully qualified, and had 3 1/2 years of "hands-on" experience with the computerized traffic control system, he failed to comprehend that UBT-506 had run through the crossover switch at CP Thompson, intruded into the route set up for an opposing train, and, consequently had collided with TV-61. Moreover, he retained a completely erroneous impression as to the relative locations of the two trains until repeated calls from the TV-61 conductor finally apprised him of the actual situation.

The dispatcher's inability to recognize what had occurred was due to inadequacies in the design of the computer-assisted train dispatching (CATD) system. The Safety Board's investigation left little doubt that the system's primary function was to collect data, whereas its function of providing visual information to the dispatcher was secondary and marginally adequate at best.

One serious weakness was the representing of the two signal blocks on each side of an interlocking by a single display circuit together with the displaying of a circuit as occupied until the train cleared the adjoining circuit. Unless the dispatcher happened to be monitoring the CP Port-CP Thompson cathode ray tube screens when TV-61 entered the 1WAK circuit and saw the display for the circuit change from green to red, he had no way of knowing even the approximate location of the train. At that time, all three circuits between the interlockings were displayed in red as being occupied by TV-61. The circuits embraced five blocks between signals with a total distance of 55,754 feet--more than 10 times the length of TV-61 which could not have occupied parts of more than two signal blocks at any given time.

When UBT-506 intruded into the route set up for TV-61 at CP Thompson, the east leg and crossover segments of the 2TK circuit changed from green to red and the TV-61 symbol display moved to the 2TK circuit. These were all events that would occur when TV-61 reached CP Thompson. Both the 1WAK and 1EBK circuits remained displayed in red, as they could be expected to do. Had the system been designed so that the 1EBK circuit changed from red to white when it was no longer occupied, the dispatcher could have recognized that as long as it was still red, TV-61 could not be occupying the 2TK circuit. Hence, the occupancy indication would have to be the result of some other phenomenon.

Another system inadequacy which understandably misled and confused the dispatcher was the continuous red occupied display for the circuit west of CP Thompson, together with the unchanging blue display for the adjoining west leg segment of the 2TK interlocking circuit. The latter represented track 1 between home signal 2E and crossover switch 1E. Had this been represented by a discrete and separate track circuit that would have changed to red when UBT-506 entered it, the dispatcher would have recognized the incursion for what it was. Even so, the system needed some sort of audible and/or visual alarm to alert the dispatcher in the event he was preoccupied with one or more of the other screens he might have to monitor at the critical moment. As it was, the display always indicated that UBT-506 was west, not east, of CP Thompson.

The first visual sign of a problem was the change of the crossover and east leg segments of circuit 2TK from red to flashing red which occurred after UBT-506 cleared the interlocking just moments before the collision. Because of frequent software problems, including false train occupancy indications and erroneous train

symbol displays that created a lack of confidence in the system's reliability, the dispatcher and the technician were convinced that the flashing red signal indicated an "out-of-correspondence" switch display resulting from some malfunction within the system.

The Safety Board believes that in its design of the Allegheny Division CATD system, Conrail failed to comprehend that a train crew might not comply with the signal system and intrude into an interlocking that had been aligned for the movement of an opposing train. Moreover, Conrail failed to correct known problems with the software systems that provide information to the dispatcher, even after these were well understood and had been delineated in the FRA safety assessment. Apparently, the Conrail systems department, both in its design of the CATD system and its response to demonstrated problems, was satisfied that the loss of the track code occasioned by undesired intrusion was sufficient to protect against a collision. But neither the loss of the track code nor the addition of ATS to locomotives was sufficient to prevent the accident and the casualties that resulted from it. Had the dispatcher immediately understood what had happened at CP Thompson, he may not have been able to arouse the crew of UBT-506, but he probably could have apprised the crew of TV-61 early enough for them to stop their train or at least to slow it enough for the engineer and brakeman to evacuate safely.

Also potentially troublesome was the lack of redundancy in qualified personnel in the Altoona, Pennsylvania, train dispatching office. This was brought out by the "A" desk dispatcher's testimony that aside from a "couple of days a week," he could not eat his lunch or take a restroom break because he was too busy and no one in the office could step in and take over for him. Even if he became ill on the job, the dispatcher would presumably have to continue to the end of his work shift. The Safety Board believes that the continual stress of so demanding a situation could impact unfavorably on dispatchers' performance and the safety of train operations.

The Safety Board notes that no supervisor was on duty at Conemaugh, an important main line reporting point, except on the first shift. Although the Conemaugh supervisor testified that he often worked past his 2 p.m. quitting time, no one was on hand to monitor the condition of train crews reporting at night. During the 90 days preceding the accident, the UBT-506 engineer reported at Conemaugh 21 times out of 26 between the hours of 4 p.m. and 8 a.m. Although these reporting times may not have been completely representative of all crews working into and out of Conemaugh, the Safety Board believes that it does suggest that a high percentage of crews at that point were not observed by a supervisor for fitness for duty.

The Safety Board's investigation indicated that Conrail may have allowed aberrations as well in the strength of the Allegheny Division supervisory force and its relative effectiveness. During the Chase, Maryland accident investigation,³ the Safety Board learned that road foremen on the Harrisburg Division had an average of 20 engineers to supervise; on the neighboring Allegheny Division, the average per road foreman was 43. This disparity may account for the fact that Harrisburg Division road foremen were able to meet the requirement that they ride with engineers for their entire runs when evaluating their proficiency, whereas this was not being done on the Allegheny Division. A road foreman or other supervisor rode

³Railroad Accident Report--Rear-end Collision of Amtrak Passenger Train 94, the Colonial, and Consolidated Rail Corporation Freight Train ENS0121, on the Northeast Corridor, Chase, Maryland, January 4, 1987 (NTSB/RAR-88/01).

with the UBT-506 engineer from Altoona to Harrisburg only once in the 3 years preceding the accident. All other proficiency evaluation rides had been confined to the 14-mile section between Gallitzen and Altoona or for even shorter distances at Altoona proper.

The Safety Board's investigation confirmed the FRA assessment's allegation that there was much duplication of testing with a high percentage of tests done on the basis of event recorder evaluations rather than "surprise" wayside observations on the Allegheny Division. The Safety Board finds no fault with supervisors routinely evaluating event recorder printouts as long as this evaluation is only part of a comprehensive, safety-oriented approach to rules enforcement. The Safety Board is not convinced that 5,934 rule 285 signal tests could result in only a single failure being observed as long as the tests were conducted properly and the reported number of tests were actually made. Certainly, the results of testing made in the presence of FRA inspectors bears out that contention.

The Safety Board concurs in the FRA assessment that Conrail's systemwide "Conrail Operating Rules Promote Safety" (CORPS) program had permitted a high degree of autonomy to division-level supervision in the program's implementation without adequate management input and oversight. If, as a result, and as the FRA assessment asserted, the Allegheny Division program had "degenerated into a numbers exercise," without regard to enhancing the safety of train operations, then the program had ceased to have real value. The program's degeneration was especially probable since supervisors had no mandatory quota of tests that were highly critical to safety, such as were required on the Harrisburg Division, and the supervisors may have become primarily preoccupied with operational performance and economy.

The sense that the Allegheny Division CORPS testing program and the general thrust of supervision had become misapplied is reinforced by the way signal tests were being performed. The Safety Board found that most signal tests were focused on compliance with the rule 285 "approach" aspect without the logical following rule 292 "stop" test. The Safety Board believes that this misapplication is a strong indication that supervisors making the tests were loathe to stop the trains they were testing. It may have been, in fact, the result of divisional or regional policy, and it is doubtful that this was not recognized and understood by the train crews.

Therefore, the National Transportation Safety Board recommends that the Consolidated Rail Corporation:

Expedite the current program for replacing the deadman safety control with state-of-the-art alertness devices. (Class II, Priority Action) (R-89-8)

Redesign the cab signal acknowledging device to require action that is more cognitive than a simple reflex motor response and that cannot be performed by a sleeping engineer. (Class II, Priority Action) (R-89-9)

Require road freight conductors to locate themselves on the controlling locomotive units of their trains, and enforce the provisions of operating rule 937. (Class II, Priority Action) (R-89-10)

Provide education and counseling to employees and their families on proper health and diet regimens, as well as the avoidance of sleep deprivation. (Class II, Priority Action) (R-89-11)

Improve the current methods of utilizing train crews to reduce the irregularity and unpredictability of crewmembers' work/rest cycles. (Class II, Priority Action) (R-89-12)

Provide train crewmembers with uniform periodic physical examinations that are based on reasonable standards and are consistent with current physiological findings and practices. (Class II, Priority Action) (R-89-13)

Take action to ensure that fee-for-service physicians perform all test and evaluation requirements that are prescribed for periodic physical examinations for train service employees, and implement methods to review their examination reports. (Class II, Priority Action) (R-89-14)

Correct the identified software anomalies in the Allegheny Division computer-assisted train dispatching system that result in improper train identification displays. (Class II, Priority Action) (R-89-15)

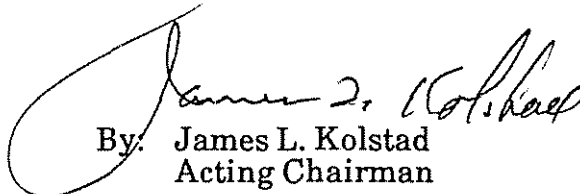
Modify the computer-based traffic control system displays to provide discrete track circuits for the various segments of the interlockings and for the approach blocks, as well as audible and/or visual alarms when trains intrude into aligned opposing routes. (Class II, Priority Action) (R-89-16)

Provide train dispatchers on all shifts with qualified backup relief, a mandatory lunch break, and at least one additional break in each half of any 8-hour tour of duty. (Class II, Priority Action) (R-89-17)

Amend the Conrail Operating Rules Promote Safety testing program priorities to ensure that the program is uniformly applied on all parts of the Conrail system. (Class II, Priority Action) (R-89-18)

Also, as a result of its investigation, the Safety Board issued Safety Recommendations R-89-19 and -20 to the Brotherhood of Locomotive Engineers and the United Transportation Union and R-89-21 through -23 to the Association of American Railroads.

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


By: James L. Kolstad
Acting Chairman