National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: May 10, 2012

In reply refer to: R-12-25 and -26

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The National Transportation Safety Board (NTSB) is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendations in this letter. The NTSB is vitally interested in these recommendations because they are designed to prevent accidents and save lives.

These recommendations address BNSF Railway (BNSF) fatigue awareness training and medical screening of employees for sleep disorders. The recommendations are derived from the NTSB's investigation of the April 17, 2011, collision of BNSF coal train C-BTMCNM0-26, BNSF 9159 East, with the rear end of standing BNSF maintenance-of-way (MOW) equipment train U-BRGCRI-15, BNSF 9470 East, near Red Oak, Iowa, and is consistent with the evidence we found and the analysis we performed.

As a result of this investigation, the NTSB has reclassified 4 safety recommendations, reiterated 5 safety recommendations, and issued 11 new safety recommendations, 2 of which are addressed to the BNSF. Information supporting these recommendations is discussed below. The NTSB would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendations.

On April 17, 2011, about 6:55 a.m. central daylight time, eastbound BNSF coal train C-BTMCNM0-26, BNSF 9159 East, travelling about 23 mph, collided with the rear end of standing BNSF MOW equipment train U-BRGCRI-15, BNSF 9470 East, near Red Oak, Iowa. The accident occurred near milepost (MP) 448.3 on main track number two on the Creston Subdivision of the BNSF Nebraska Division. The collision resulted in the derailment of 2 locomotives and 12 cars. As a result of collision forces, the lead locomotive's modular crew

cab was detached, partially crushed, and involved in a subsequent diesel fuel fire. Both crewmembers on the striking train were fatally injured. Damage was in excess of $8.7 million.[1]

The NTSB determined that the probable cause of the accident was the failure of the crew of the striking train to comply with the signal indication requiring them to operate in accordance with restricted speed requirements and stop short of the standing train because they had fallen asleep due to fatigue resulting from their irregular work schedules and their medical conditions. Contributing to the accident was the absence of a positive train control system that identifies the rear of a train and stops a following train if a safe braking profile is exceeded. Contributing to the severity of collision damage to the locomotive cab of the striking coal train was the absence of crashworthiness standards for modular locomotive crew cabs.

Events Leading up to the Collision

The engineer and the conductor of the struck MOW equipment train went on duty in Lincoln, Nebraska, at 1:15 a.m., and their train departed about 3:15 a.m. The engineer and the conductor of the striking coal train went on duty at Lincoln, Nebraska, at 2:31 a.m. After completing the required airbrake test, their train departed about 3:45 a.m.

When the accident occurred, the eastbound MOW equipment train was behind two eastbound coal trains, neither of which was involved in this collision. At MP 450.38 the MOW equipment train encountered a red (restricting) grade signal and continued at restricted speed[2] until stopping about 300 feet behind the second uninvolved coal train. While these two trains were stopped at the east end of the multiple tracks on track two, Amtrak (National Railroad Passenger Corporation) No. 6 (the California Zephyr) passed them going eastward on main track number one (track one) about 6:22 a.m. The second uninvolved coal train then received a signal to proceed east and followed Amtrak No. 6. The MOW equipment train then moved up to CP McPherson and stopped at the red stop signal.

While the two uninvolved coal trains and the MOW equipment train were on track two between CP 4580 and CP McPherson, the striking coal train was stopped at Balfour (MP 467.9) on track two. About 6:08 a.m., Amtrak No. 6 passed the striking coal train on the adjacent track, and the Amtrak engineer told NTSB investigators that he was able to see the crewmember on the conductor's side of the striking coal train's lead locomotive. He reported that the crewmember he had observed was in a reclining position.[3]

Data from the signal system and locomotive event recorders indicated that the striking coal train passed a yellow approach signal at CP 4535 while moving about 30 mph in throttle position 1. The train then passed the red "restricting" grade signal, which protected the rear end of the standing MOW equipment train, at MP 450.38, and the train's speed reduced to about

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[1] See *Collision of BNSF Coal Train With the Rear End of Standing BNSF Maintenance-of-Way Equipment Train, Red Oak, Iowa, April 17, 2011*, Railroad Accident Report NTSB/RAR-12/02 (Washington, D.C.: National Transportation Safety Board, 2012) on the NTSB website at <http://www.ntsb.gov>.

[2] *Restricted speed* on the BNSF requires operating prepared to stop short of a train ahead within one-half the range of vision not to exceed 20 mph.

[3] BNSF operating rules permit one crewmember to nap while stopped waiting to be met or passed by another train.

12 mph with its throttle in position 7 as it approached the top of the 0.6-percent grade. The speed reduction was consistent with the signal indication, grade, tonnage, and the amount of power the engineer had applied. Until reaching MP 449.4 the striking coal train engineer maintained the speed at between 11 and 12 mph using throttle adjustments. As the striking coal train crested the grade, train speed increased from 11 mph to 23 mph at the point of collision. There were several throttle adjustments during the last 15 minutes of the trip, but no activity was detected during the last 1 minute 53 seconds. At impact, the throttle was in throttle position 4, and brakes had not been applied.

Data from the striking train's (BNSF 9159) event recorder show that during the 15 minutes prior to the collision, the striking train's lead locomotive alerter alarmed three times after periods of engineer inactivity and was reset using the alerter reset button after a strobe displayed for 5 seconds and an audible alarm sounded for an additional 2 to 3 seconds. The collision occurred 1 minute 53 seconds after a throttle movement, and the alerter would have been due to alarm in about 7 seconds had the collision not occurred.

Work-Rest History of Striking Train Crew

During the week leading up to the accident, the BNSF coal train engineer worked both day and night schedules. On the day of the accident, the engineer went on duty at 2:31 a.m. The day before, he was on duty from 4:30 a.m. to 2:30 p.m. Investigators were unable to determine his off-duty activities and rest periods during the 2 previous days on which he had not been called for duty, it is likely that he was awake during the day and slept at night. On the day of the accident, the engineer probably was still adjusting to a nighttime work schedule after spending several days sleeping at night. Consequently, he may have experienced short-term sleep loss resulting in acute fatigue.

The conductor of the BNSF coal train had worked a nighttime work schedule over the 4 days leading up to the accident. Studies have found that the sleep quality of night shift workers, and consequently their alertness levels, is generally inferior to those of people who work a normal (daytime) schedule.[4] Thus the conductor's alertness level also may have been affected by her recent nighttime work schedule.

Both the conductor and the engineer had worked irregular schedules for several weeks leading up to the accident. During this time, work start times often varied significantly from day to day for both crewmembers. Changing work start and end times can make achieving adequate sleep more difficult. That is, irregular work schedules tend to disrupt a person's normal circadian rhythms and sleep patterns, which in turn can lead to chronic fatigue. Moreover, studies of train accidents have shown that very irregular schedules contributed to the accidents by producing sleep loss and fatigue.[5] Therefore, the NTSB concludes that the striking coal train conductor's and the engineer's irregular work schedules contributed to their being fatigued on the morning of the collision.

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[4] G. Richardson and H. Malin, "Circadian Rhythm Sleep Disorders: Pathophysiology and Treatment," *Journal of Clinical Neurophysiology*, vol. 13, no. 1, January (1996), pp. 17–31.

[5] W. Maynard and G. Brogmus, "Shiftwork, work scheduling and safety: How much is too much," 10th Annual Applied Ergonomics Conference (2007).

Medical History of Striking Train Crew

Although the conductor had never undergone a sleep study, she had several risk factors for obstructive sleep apnea (OSA), including a body mass index (BMI)[6] of 37.5, a history of hypertension, and long periods of sitting.[7] OSA is a disorder characterized by repeated episodes of upper airway obstruction that results in recurrent arousals during sleep. The "apnea" in OSA refers to a cessation of airflow that lasts at least 10 seconds. The cessation of airflow occurs when the muscles in the back of the throat fail to keep the airway open, despite efforts to breathe. Several studies have shown an association between BMI and the risk of OSA.[8] Significant OSA is present in 40 percent of obese people.[9] The conductor's BMI placed her within this risk group. The conductor was also being treated for high blood pressure with two prescription medications, but she still was hypertensive. OSA is associated with high blood pressure.[10] Since people with sleep apnea tend to be sleep deprived, they often suffer from sleepiness and a wide range of other symptoms such as difficulty concentrating, depression, learning and memory difficulties, and falling asleep while at work, on the phone, or driving. Left untreated, OSA can result in other clinical consequences including disturbed sleep, excessive sleepiness, high blood pressure, heart attack, congestive heart failure, cardiac arrhythmia, stroke, or depression.[11] The conductor was treated for restless legs syndrome (a movement disorder that typically interferes with sleep) with ropinirole. Ropinirole is medication for Parkinson's disease that sometimes results in sleepiness in Parkinson's patients. Additionally, she had been prescribed a medication for insomnia. Thus, it appears that she was not sleeping well, which may have resulted in her being fatigued.

The engineer had never undergone a sleep study, although he, too, had several risk factors associated with OSA: a BMI of 35.7; his gender (men are twice as likely as women to have sleep apnea); and job duties that required prolonged sitting. In addition, he had type 2 diabetes. Recent reports have indicated that the majority of patients with type 2 diabetes also have OSA.[12]

The NTSB concludes that based on their medical histories, both crewmembers on the striking coal train were at high risk for sleep disorders and fatigue.

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[6] Obesity is defined as a BMI of 30 and above, according to the National Institutes of Health. People who fall into the BMI range of 25 to 34.9 and have a waist size of over 40 inches for men and 35 inches for women are considered to be at especially high risk for health problems.

[7] A joint task force of the American College of Chest Physicians, American College of Occupational and Environmental Medicine, and the National Sleep Foundation developed screening recommendations for drivers with possible OSA. Five major categories were identified. Additional evaluation was recommended for commercial drivers that had two or more of the following: A BMI $\geq$ 35; a neck circumference greater than 17 inches for men and 16 inches for women; and hypertension (new, uncontrolled, or unable to control with less than two medications).

[8] T. Young, P.E. Peppard, and S. Taheri, "Excess weight and sleep-disordered breathing," *Journal of Applied Physiology,* 99(4), Oct. (2005), pp. 1592–9 contains a list of studies that show the association between BMI and OSA risk.

[9] A.N. Vgontzas and others, "Sleep apnea and sleep disruption in obese patients," *Archives of Internal Medicine,* vol. 154, no. 15, Aug 8 (1994), pp. 1705–11.

[10] F.J. Nieto and others, "Association of Sleep-Disordered Breathing, Sleep Apnea, and Hypertension in a Large Community-Based Study," *Journal of the American Medical Association*, vol. 283, no. 14 (2000), pp. 1829–1836.

[11] Information from the National Sleep Foundation.

[12] E. Tasali, B. Mokhlesi, and E. Van Cauter, "Obstructive sleep apnea and type 2 diabetes: interacting epidemics," *Ches,* vol. 133, no. 2, Feb. (2008), pp. 496–506.

Striking Train Crew's Actions Leading up to Collision

Based on the indication of the clearly visible red (restricting) signal located almost 2 miles before the point of collision, the crew was required to operate their train at restricted speed—a speed that allowed the train to be stopped within one-half the range of vision short of another train, not to exceed 20 mph. Operating at restricted speed, they should have reduced speed and come to a stop short of the standing train. The crew, however, made no attempt to slow or stop the train during the last 1 minute 53 seconds before impact. As the striking train continued to travel around a curve, the operating crew would have been able to see the clearly visible car at the rear of the MOW train from more than 1/4 mile away (about 46 seconds before impact). This provided adequate time for them to apply emergency brakes that may have stopped, or at least slowed, their train before impact. However, despite having enough time to take action, the crew made no attempt to apply the brakes or stop their train to avoid the collision.

During the last 15 minutes of the trip and while the striking train was approaching the standing MOW equipment train, the engineer reset the alerter by using the reset button three times after prompting by a lengthy strobe and audible alarm sequence.[13] These resets were initiated only after 5 seconds of flashing strobe and an additional 2 to 3 seconds of an increasingly louder audible alarm. The reset button requires less attentiveness than actually manipulating the controls of the engine.

Investigators considered the possibility that both the engineer and the conductor were impaired by fatigue at the time of the accident. In general, fatigue results in a reduction in alertness, longer reaction times, memory problems, poorer psychometric coordination, and less efficient information processing.[14] Fatigue also could lead to the onset of an episode of microsleep, in which a person enters a sleeping period that lasts from a few seconds to as long as half a minute, becomes unresponsive, and fails to respond to outside information.[15] However, given the crew's failure to attempt to slow or stop the train for nearly 2 minutes despite explicit warnings, it is likely that the crew was impaired by more than temporary fatigue-related loss of focus or an episode of microsleep. The NTSB concludes that based on the conductor's and the engineer's irregular work schedules, their medical histories, and their lack of action before the collision, both crewmembers on the striking coal train had fallen asleep due to fatigue.

BNSF Fatigue Training Program

In 2004, the BNSF developed a computer (and later, a web-based) fatigue training program, "The Science of Sleep and Fatigue," that was available to all BNSF employees.[16] This

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[13] When the alerter system does not detect engineer activity, it will alarm (strobe light followed by horn). The alarm can be silenced by moving a control lever or by pressing the reset button.

[14] I.D. Brown, "*Driver fatigue," Ergonomics*, vol. 36 (1994), pp. 298–314.

[15] M.R. Rosekind and others, "Alertness Management in Long-Haul Flight Operations," in *Proceedings of the 39th Annual Corporate Aviation Safety Seminar* (St. Louis, Missouri: Flight Safety Foundation, 1994), pp. 167–178.

[16] The BNSF stated that a significant portion of the information in this training program was originally developed by NASA for the aviation industry and later adapted to other safety-sensitive industries, including the railroad industry.

training could be taken at a BNSF facility or at the employee's home. There are currently no Federal regulations requiring railroads to provide fatigue educational programs, nor does the BNSF require its employees to take this training. At the time of the accident, 239 BNSF employees, or about 1 percent,[17] had voluntarily completed the fatigue training program. Neither the conductor nor the engineer of the coal train had taken this training.

Investigators reviewed the BNSF training program and believe that it presents valuable and scientifically based information that would benefit railroad employees operating in safety-critical positions. The information presented in the BNSF's fatigue training program encourages people who are at risk of suffering from OSA or other sleep disorders to consult a physician. As stated previously, neither the engineer nor the conductor of the striking train had undergone a sleep study, although both were at risk for sleep apnea.

The NTSB has a long history of making recommendations in all modes of transportation to reduce the likelihood of fatigue-related accidents. In the railroad industry, the scope of the NTSB's recommendations have included requiring railroads to use scientifically based principles when assigning work schedules; requiring railroads to design work schedules to minimize irregular and unpredictable work/rest cycles; establishing requirements that limit train crewmember limbo time; developing a standard medical form that includes questions about sleep problems; requiring serious and potentially impairing medical conditions to be reported to and evaluated by the carrier; and requiring railroads to develop fatigue awareness training.

The NTSB concludes that had the two crewmembers on the striking coal train completed the BNSF's fatigue training program, they would have had the opportunity to learn that they were at risk for sleep disorders, and the computer-based training program would have displayed a message advising them to consult with a physician. Therefore, the NTSB recommends that the BNSF require all employees and managers who perform or supervise safety-critical tasks to complete fatigue training on an annual basis and document when they have received this training.

Identification, Diagnosis, and Treatment of Medical Conditions Affecting Fatigue

Based in large part on the NTSB recommendations made after the 2001 train collision in Clarkston, Michigan,[18] the Federal Railroad Administration (FRA) formed a Rail Safety Advisory Committee working group on medical standards for safety-critical personnel. The NTSB safety recommendations from the Clarkston accident investigation are the following:

To Canadian National Railway:

> Require all your employees in safety-sensitive positions to take fatigue awareness training and document when employees have received this training. (R-02-23)

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[17] The fatigue training program is designed for the people (about 20,000) who work in the BNSF transportation department.

[18] See *Collision of Two Canadian National/Illinois Central Railway Trains Near Clarkston, Michigan, November 15, 2001*, Railroad Accident Report NTSB/RAR-02/04 (Washington, D.C.: National Transportation Safety Board, 2002) at <http://www.ntsb.gov>.

To the FRA:

> Develop a standard medical examination form that includes questions regarding sleep problems and require that the form be used, pursuant to Title 49 *Code of Federal Regulations* Part 240, to determine the medical fitness of locomotive engineers; the form should also be available for use to determine the medical fitness of other employees in safety-sensitive positions. (R-02-24)
>
> Require that any medical condition that could incapacitate, or seriously impair the performance of, an employee in a safety-sensitive position be reported to the railroad in a timely manner. (R-02-25)
>
> Require that, when a railroad becomes aware that an employee in a safety-sensitive position has a potentially incapacitating or performance-impairing medical condition, the railroad prohibit that employee from performing any safety-sensitive duties until the railroad's designated physician determines that the employee can continue to work safely in a safety-sensitive position. (R-02-26)

The first working group meeting was held 5 1/2 years ago on December 12–13, 2006. The purpose of the working group was to enhance the safety of railroad employees and the public by establishing standards and procedures for determining the medical fitness for duty of personnel engaged in safety-critical functions. A physicians' task force, established by the working group, has been working since May 2007 on developing medical guidelines that will be used to provide consistent criteria for determining the medical fitness for duty of those in safety-critical positions. The task force has been compiling a list of medical conditions that can cause sudden incapacitation and serious impairments of hearing and vision, determining the elements to be included in a health history form that covered employees will complete, and determining the medical criteria (standards) that a covered employee must meet to be certified. A draft Notice of Proposed Rulemaking (NPRM) was developed by the FRA and presented to the working group. The original target date for publishing the NPRM was December 2009. This NPRM was never published. It is disturbing that such an important railroad safety issue is taking this long to address.

The FRA recently has advised the NTSB that a regulation to address medical fitness for duty of railroad safety critical personnel is no longer being considered because of the high cost to railroads. Instead, the FRA indicated that it will produce nonmandatory recommendations for the industry. The Rail Safety Advisory Committee working group will be reconvened at some future date to finalize these recommendations. Obstructive sleep apnea will be addressed separately as part of the fatigue management regulation currently in development. The NTSB is disappointed that the FRA will not promulgate a requirement to ensure that operating employees in safety-sensitive positions are medically fit for duty. The NTSB concludes that had the requirements described in Safety Recommendations R-02-24, -25, and -26 been in place, this crew would likely have been identified as at high risk for sleep disorders, which may have led to appropriate medical intervention. Therefore, the NTSB recommends that the FRA require railroads to medically screen employees in safety-sensitive positions for sleep apnea and other sleep disorders. The NTSB also reiterates Safety Recommendations R-02-24, -25, and -26 to the FRA and hopes that the FRA will take prompt action. Additionally, the NTSB recommends that

the BNSF medically screen employees in safety-sensitive positions for sleep apnea and other sleep disorders.

Therefore, the NTSB issues the following safety recommendations to the BNSF:

> Require all employees and managers who perform or supervise safety-critical tasks to complete fatigue training on an annual basis and document when they have received this training. (R-12-25)
>
> Medically screen employees in safety-sensitive positions for sleep apnea and other sleep disorders. (R-12-26)

The NTSB also issued safety recommendations to the Federal Railroad Administration and the Association of American Railroads. In response to the recommendations in this letter, please refer to Safety Recommendations R-12-25 and -26. We encourage you to submit updates electronically at the following e-mail address: correspondence@ntsb.gov. If your response includes attachments that exceed 5 megabytes, please e-mail us at the same address for instructions. To avoid confusion, please do not submit both an electronic copy and a hard copy of the same response.

Chairman HERSMAN, Vice Chairman HART, and Members SUMWALT, ROSEKIND, and WEENER concurred in these recommendations.

[Original Signed]

By: Deborah A.P. Hersman
Chairman