Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT
R98V0183

MAIN-TRACK COLLISION

CANADIAN NATIONAL RAILWAY TRAIN NO. 792
AND CANADIAN NATIONAL RAILWAY TRAIN NO. 415
MILE 57.8, ASHCROFT SUBDIVISION
BASQUE, BRITISH COLUMBIA
01 OCTOBER 1998

Canada

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Railway Investigation Report R98V0183

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The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Railway Investigation Report R98V0183

Main-track collision
Canadian National Railway train No. 792 and Canadian National Railway train No. 415
Mile 57.8, Ashcroft Subdivision
Basque, British Columbia
01 October 1998

Summary

At approximately 0442 Pacific daylight time on 01 October 1998, two Canadian National Railway (CN) freight trains collided on the Ashcroft Subdivision at Basque, British Columbia. Eastward freight train No. C-792-51-30 (train 792) proceeded on the main track past a stop signal and collided with the side of westward freight train No. A-415-51-30 (train 415), which was proceeding into the siding. Three cars on the westward train and the lead locomotive of the eastward train were damaged and derailed. There were no injuries and no release of dangerous goods.

Le présent rapport est également disponible en français.

Factual information

At 0442[1] on 01 October 1998, train 792, proceeding eastward on the main track at Mile 57.8 of the Ashcroft Subdivision at Basque, British Columbia (B.C.), collided with the side of train 415. The collision derailed the 33rd, 34th, and 35th cars of train 415, which was proceeding westward into the Basque Siding at approximately 10 mph. The lead locomotive of train 792 derailed and sustained extensive damage; the 3 cars on train 415 sustained extensive damage.

Train 415 consisted of 2 locomotives, 25 empties, and 58 loads, which included 9 dangerous goods loads and 2 residue cars that were not directly involved in the collision. The train was approximately 5,900 feet in length and weighed about 7,600 tons. Train 792 was powered by 2 locomotives handling a unit train consisting of 102 empty coal gondola cars. The train was approximately 6,120 feet in length and weighed about 2,880 tons.

The crew of train 415, consisting of a locomotive engineer and a conductor, came on duty at 2330, 30 September 1998, at Kamloops, B.C., Mile 0.0 of the Ashcroft Subdivision. The crew members were to operate their train westward to Thornton Yard, in Surrey, B.C., Mile 113.8 of the Yale Subdivision, a distance of approximately 240 track miles, in double subdivision operation. The crew departed Kamloops at 0045.

The crew of train 792, consisting of a locomotive engineer and a conductor, were called for 2000, 30 September 1998, at Thornton Yard to operate their train eastward to Kamloops. They reported for duty at approximately 1930 and departed Thornton Yard at 2140.

The crews of both trains were qualified for their respective positions and were in compliance with regulatory requirements respecting mandatory time off-duty and maximum hours of service. The formal practice of “extended runs,” or running over 2 subdivisions instead of one, came about as a joint venture between management and the operating unions in 1995; although CN has operated trains over longer distances between some locations for about 30 years. Single subdivision operation had been in practice since the railways were built with their divisional terminals typically spaced approximately 120 miles apart. Train movement over that distance, with the technology of those times, usually demanded a lengthy work period with no regulations on maximum hours of service or minimum rest requirements. There were stimulating demands involved in operating and protecting a train under train order traffic control with no radios for communication. Hand shovelling coal, and operating the locomotive to pick up and set off cars at many locations, which is not performed in extended run operation, demanded attention and maintained alertness by crew members.

Train order operation has evolved into electronic Centralized Traffic Control (CTC) systems and all trains have radios to maintain communication. Train movements are governed and authorized by signal indications. Modern locomotives—equipped with cab amenities designed for effortless operation in a comfortable environment like the lead locomotive on

[1] All times are Pacific daylight time (Coordinated Universal Time (UTC) minus 7 hours) unless otherwise stated.

train 792—and CTC have facilitated the practice of train movement over 2 subdivisions in a single tour of duty.

The extended run crews at Thornton Yard are scheduled in time frames, referenced as "duty windows". They are advised up to 36 hours in advance that their turn to work will be called within a defined six-hour time window. The time at which the windows are established varies with operating requirements. Train crew employees can plan their sleep/wake cycle in order to be rested and alert for duty corresponding with their duty window. However, collective agreement provisions prescribe that, when an off-duty employee books on-duty, or an on-duty employee books off-duty, other employees may be displaced from their duty window, being set back or advanced in turn. If employees do not work in their duty window, they are off-duty until their turn returns. The compensation for a round trip is lost if employees do not work their turn.

After departing from Thornton Yard, train 792 met[2] several trains on the Yale and Ashcroft subdivisions, including a westward train at Martel, the station 10 miles west of Basque. The crew reported that, after proceeding for approximately one-half of the second subdivision of the tour of duty, in an effort to remain alert, they had opened windows, stood up, and drank tea. Both crew members recall seeing an "advance clear to stop" signal at the advance signal to the west end of Basque Siding, Mile 60.3, indicating to them that the next signal, at Mile 59.2, should be displaying "clear to stop," and to be prepared to stop at the second next signal at Mile 57.8. They stated that they communicated the signal name and indication between themselves and that the conductor broadcast the name of the signal, as well as their location over the standby radio channel as per CN's Special Instruction 3 (ii) to Canadian Rail Operating Rules (CROR) Rule 90. They recognized that they might be meeting another train at Basque but did not recollect hearing any radio communications from the crew of the opposing train. The signal system computer records confirmed that the signal at Mile 59.2 at the west end of Basque displayed a "clear to stop" signal, which would have indicated that they could proceed, preparing to stop at the next signal at Mile 57.8, the east convergence of the main track and siding. Neither crew member could recall seeing the signal at Mile 59.2.

The method of train control on the Ashcroft Subdivision is CTC, authorized by the CROR, and supervised by the rail traffic controller (RTC) located in Edmonton, Alberta. Train movements are governed and authorized by signal indications. The signal system was tested after the occurrence and confirmed to be operating as designed. In the area near Basque, the Ashcroft Subdivision is a single main track with a controlled siding located between Mile 59.2 and Mile 57.8. The sight-lines for the 2 eastward signals at Mile 59.2 and at Mile 57.8 are each approximately 1,000 feet.

The locomotive engineer of train 792 stated that he first became aware of train 415 when he saw oncoming locomotive headlights at the east end of Basque, and he dimmed his headlights before applying air and dynamic braking. The conductor stated that, as train 792

[2] A "meet" occurs when 2 trains travelling in opposite directions on single track territory pass each other. This requires one train to diverge from the main track into a siding track.

was approaching the east end of Basque, he was startled by train 415 meeting them on the adjacent track. The conductor saw train 415 heading into the siding to clear the main track and advised the locomotive engineer to place the train brakes into emergency. The locomotive engineer, before applying emergency train brakes as prompted by the conductor, was not immediately aware of his exact location. In the process of stopping, train 792 passed the signal at Mile 57.8 displaying "stop," and struck train 415 as it was entering the siding. The crew members remained in the locomotive and were not injured. After the collision, they initiated emergency response through the RTC.

Recorded information

The event recorder data from train 792 confirm the sequence of events as described by the crew.

The locomotive event recorder indicates that the speed of train 792 had been maintained between 32 mph and 39 mph for about 8.5 miles (14.5 minutes) before the emergency brake application. There was no recorded action by the locomotive engineer other than cycling the throttle control between positions 8 and 7 approximately every 108 seconds, which corresponds with the timing out of the Reset Safety Control (RSC).[3] The locomotive event recorder indicates that dynamic braking was initiated approximately three-tenths of a mile before the collision, while the train was proceeding at 36 mph. The recorder also indicates that the emergency application of the train brakes occurred 12 seconds later, approximately two-tenths of a mile before the collision. The train had slowed to approximately 15 mph before the impact.

Crew work/rest cycles

The locomotive engineer for train 792 had 4 days off before reporting for duty at 2000, 30 September 1998, and reported that he had no abnormal activities or sleep patterns during these days. He stated that he awoke at about 0730 as usual, on 30 September 1998. At approximately 0900, he was advised that his standing was 6 times out on the third window of the work schedule which indicated that he would likely be returning to work in the late evening or after midnight the next day. The established work schedule for him had been reporting for work between 0200 and 0600. The normal routine would have been to go to bed in the early evening to obtain 6 to 8 hours of sleep before duty. At approximately 1230, while 2 hours away from home, he was paged and advised that he was the next locomotive engineer on the work schedule, estimated to be called at 1830 for a train to Kamloops. From the time he had first received information that he was to go to work at 1830 until the time he reported for work, he had only been able to sleep for approximately one hour. No further rest had been obtained before the occurrence at 0442 on 01 October 1998.

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3 The Reset Safety Control (RSC) is an electronic device designed to activate a train's controlled stop in the event that a locomotive engineer becomes incapacitated. It activates if the locomotive engineer does not perform any activities of normal train operation or push a reset button within a set time to reset the device timer. Transport Canada is presently reviewing the operation of RSCs to determine whether additional enhancements may be necessary.

The conductor on train 792 had 2 days off before accepting a call for train 792 and reported no abnormal activities or sleep patterns. He stayed up until about 2300 on 29 September 1998 and awoke at about 0800 and went to bed again around 1700 on 30 September 1998 but did not have any sleep before his expected call at 1800 and reporting for duty at 1930. Except for the past week, the established work schedule for him had been reporting for work between 0300 and 0700. The normal routine would have been to go to bed in the early evening to obtain 6 to 8 hours of sleep before duty. The past week's train operation, however, had not conformed to that schedule and had proved to be unsatisfactory for him. He had given notice to return to single subdivision duty and was scheduled to revert on 01 October 1998.

Normal sleep/wake cycles

Over time, the daily cycle of light and dark has synchronized our biological clocks to the traditional pattern of daytime wakefulness and nighttime sleep. Continuation of wakefulness into normal sleep hours without restorative rest is an element that contributes to mental fatigue, which normally results in diminished performance capability. The normal sleep/wake cycle follows a 24-hour circadian rhythm with approximately one third of the cycle spent sleeping. Although individual rhythms vary, everybody's cycle has 2 distinct peaks and valleys. The bigger valley, during which it can be particularly difficult to maintain alertness, occurs just before dawn, between 0300 and 0500. However the level of alertness during this low period can be positively influenced by the amount of rest a person has had prior to that time, amongst other influencing factors. Although our biological clocks can adjust by an hour or 2 per day, they cannot immediately shift 8 to 12 hours, as many schedules require. It takes several days for the body to adjust to a new schedule, and during that time, our bodies are "out of synch" with the world around us. When this happens, our body clocks are waking us up when we need to sleep and putting us to sleep when we need to be alert. Scientific studies, such as the *CANALERT '95*, have revealed fatigue countermeasures to promote alertness in railway operating crews and to help mitigate the effects of low periods of alertness and performance.

Sleep deprivation

Researchers at the Defence and Civil Institute of Environmental Medicine conducted sleep deprivation experiments. Standardized tests indicated that performance on cognitive, or mental problem solving, vigilance, and communication tasks showed a 30 per cent decrement after 18 hours of wakefulness. Alertness, being the optimal activated state of the brain, is a dynamic state and may vary from second to second.[4] Performance degradation, or impairment, is progressive, becoming worse as time awake increases.[5] It takes longer to perceive things, longer to interpret or understand them, and longer to react to them once

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4 M. Rosekind et al., *Crew Factors in Flight Operations X: Alertness Management in Flight Operations*, NASA Technical Memorandum DOT/FAA/RD-93/18, NASA Ames Research Centre, 1994.

5 R.G. Angus et al., "Sustained-Operations Studies: From the Field to the Laboratory," *Why We Nap: Evolution, Chronobiology, and Functions of Polyphasic and Ultrashort Sleep*, C. Stampi ed., Boston: 1992, pp. 217–241.

they are identified. Fatigue affects the ability to judge distance, speed, and time. Poor judgement, a symptom of fatigue, may be a result of impaired mental functioning or a lack of motivation. Motivation is a factor when a person is so fatigued that he/she is unable to devote the energy required to carefully assess all the relevant factors in making a decision.[6] Selection, training, and motivation are ineffective moderators of performance if the human brain is not alert enough to give due attention to the operation. Attention can be viewed as a continuum of processes between fully automatic processes and fully controlled processes. In general, automatic processes occur outside of conscious awareness, demand little or no effort or even intention, can be performed simultaneous with other operations, and are relatively fast. In contrast, controlled processes are only accessible to conscious control, are performed one step at a time, and take a relatively long time to execute.

Automatic Behaviour Syndrome (ABS) can occur when in a state of fatigue in which we are essentially sleeping with our eyes open. While able to perform simple or familiar tasks by automatic processes, we are unable to respond quickly to more critical tasks and situations by controlled processes.[7] In sleep lab studies, participants experiencing ABS show brain waves characteristic of sleep. The TSB has received reports in SECURITAS, the confidential reporting program of the TSB, of the RSC being used as a recycling alarm clock being automatically reset by fatigued locomotive engineers.

The most extreme symptom of fatigue, in addition to impaired cognizance, is uncontrollable sleep which can be a microsleep, a nap, or a long sleep episode. A microsleep is a very short period of sleep lasting only seconds, when people are "perceptually isolated" and non-cognizant of what is going on around them. Although the existence of microsleeps can be confirmed by electroencephalography (EEG) recordings, people are not generally aware of them, which makes the phenomenon particularly dangerous.

Combatting fatigue

In February 1986, Mr. Justice René P. Foisy was appointed to inquire into the Hinton train collision. The Commissioner concluded that none of the crew of the freight train had adequate rest and that the failure to control the train may have resulted from inattentiveness owing to fatigue. The Commission of Inquiry then went on to examine in detail work/rest rules and to make recommendations aimed at regulating mandatory off-duty times and altering work scheduling in the railway industry. These recommendations resulted in the mandatory off-duty regulations issued by the Railway Transport Committee of the Canadian Transportation Agency[8] in 1987, as an interim measure.

The Commission recommended and subsequently the regulator mandated that Canadian railways install a Reset Safety Control (RSC) vigilance feature on leading locomotives. Each locomotive is equipped with a timed vigilance feature reset either through operator

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6 M. Rosekind et al.

7 R.J. Sternberg, "Controlled Versus Automatic Processes," *Cognitive Psychology*. Orlando: Holt, Rinehart and Winston, Inc., 1996.

8 Formerly called Canadian Transport Commission.

adjustment to locomotive controls and features or through a manual reset in reaction to visual and/or auditory indicators. The timing period is dependent on the speed of the locomotive, varying from 127 seconds at 10 mph to 104 seconds at 20 mph and 88 seconds at 30 mph. At second 0 (end of timing period), the visual indicators start flashing; at second 5, the visual indicators continue and an audible alarm is activated. The audible alarm increases in intensity to a maximum level at second 20. If the feature is not reset, a penalty brake application is triggered at second 23, after which it brings the train to a controlled stop. The visual indicators (flashing lights) are located forward of the locomotive engineer's position, slightly above eye level. The button controlling the manual reset feature is usually mounted on the locomotive console within easy reach of the locomotive engineer.

In 1995, Canadian Pacific Railway (CP), CN, VIA Rail Canada Inc. (VIA), the International Brotherhood of Locomotive Engineers,[9] and Circadian Technologies Inc. cooperated on a program that developed, implemented, and tested an Alertness Assurance Process entitled *CANALERT '95*. The goals for *CANALERT '95* were as follows:

- to develop a set of fatigue countermeasures to be used to enhance alertness levels among a group of locomotive engineers, without adversely affecting operations;
- to validate the effectiveness of these countermeasures;
- to determine the relative alertness and mental workload stress levels of locomotive engineers operating high-speed passenger trains as compared to locomotive engineers operating trains in freight service; and
- to perform an analysis of the schedule-induced fatigue level which might exist in passenger conditions.

A general analysis of alertness, sleep, and mental workload characteristics was conducted to address the issues of fatigue or impaired alertness, in the Canadian railway system. As a result, specific fatigue countermeasures were developed for railway freight operations. These measures included circadian time pools for establishing a regular and predictable work/rest pattern, both on-duty and off-duty napping practices, improved sleeping accommodations, headsets with music and intercom, and a railway lifestyle training program. Based on the experience gained in the implementation of these fatigue countermeasures, and the results obtained from the general analysis, the May 1996 *CANALERT '95* recommendations included in part that:

- strategies be developed to permit both en route and terminal napping as an alertness program;
- locomotive cab audio systems be installed; and
- a lifestyle training program be conducted and extended.

Scientific studies have provided objective evidence that circadian rhythms can be gradually displaced by about 1 to 1.5 hours per day, and that specific fatigue countermeasures were verifiably effective in mitigating the effect of circadian troughs on alertness. As a result, human beings can safely operate during these periods without performance degrading to

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9 Formerly called Brotherhood of Locomotive Engineers.

unsafe levels of alertness. The *CANALERT '95* initiatives were implemented on some CN subdivisions as a test project and were considered successful in terms of providing an employee a defined work schedule. CN renamed the initiatives to "Alertness Assurance Program" and formed a joint committee with the unions which represent the operating employees. Together, they decided how the concept would work. With the introduction of extended runs, the company and unions agreed to a second locomotive operator in an extended run environment to offset any real or perceived issues peculiar to an extended run environment. However, the windows scheduling system has become a source of contention because of the inability for an employee to make up a missed trip due to issues of seniority and displacement rights. Since not all railway unions agree with the *CANALERT '95* recommendations, some of the recommendations were not implemented. The unions have placed a moratorium on their participation at Winnipeg, Manitoba, and Fort Frances, Ontario, while addressing the issue of guaranteed earnings for their members working in the windows system.

The Railway Association of Canada (RAC), working with its member railways, labour unions, and Transport Canada, is developing new work/rest rules for operating employees to replace the current Maximum Hours of Work Order and Mandatory Off Duty Time Rules. It is anticipated that the Minister of Transport will be reviewing the newly developed work/rest rules for operating employees by May 2001, after submission under Section 20 of the Railway Safety Act. The RAC has expressed to the TSB that "while good scheduling mechanisms and strategies can improve employee alertness, there is no scheduling system in the world that will guarantee that employees will always report to work fully alert for their entire tour of duty."

The *CANALERT '95* initiatives of bunkhouse modifications have been implemented at many CN locations, and lifestyle training sessions have been given where the program has been implemented. However, the initiative which would have allowed the crew of train 792 to have a short nap as a fatigue countermeasure while en route was not in effect on this subdivision.

Analysis

The physical evidence and recorded data support the sequence of events as outlined by the respective crew members. The method and manner of the operation of train 415 was in accordance with regulatory and company requirements and played no part in the accident. Eastward train 792, however, was operated past a stop signal indication into the side of train 415. It is possible that the crew experienced a sleep episode approaching Basque. The effect of fatigue on the crew of train 792 and the current regulatory, industry, and union approach to fatigue issues will be explored.

In the past, the physical nature of train operations was beneficial and sufficiently demanding to hold employees' focus and attention and was conducive to crew members remaining alert. However, the soporific environment[10] of a modern locomotive cab—without the stimulus of physical work—has become conducive to inattention and relaxation abetting loss of alertness and the onset of fatigue in unrested train crew members. The crew fatigue issue is even more pronounced on the second subdivision of extended runs as the distance travelled and time working during one tour of duty is typically doubled.

The ability of the locomotive engineer and conductor of train 792 to recall the meeting of trains and the indications of the signals and their meaning indicates that a level of vigilance was maintained up to and including the approach signal, Mile 60.3 at Basque, approximately the middle of the second subdivision of their tour of duty. The sleep/wake pattern that both crew members experienced on the day they reported for work resulted in the advent of fatigue. The conductor had been awake for almost 21 continuous hours before the occurrence, and the locomotive engineer had been awake for over 21 hours with only one hour of sleep.

The effort used by the crew of train 792 in trying to remain vigilant while approaching Basque is consistent with the onset of fatigue. Even though the crew members suspected that they were meeting a train at Basque, this effort could not negate the effects of extreme fatigue. They did not observe the signal at Mile 59.2 which governs train movements at Basque, a short distance after acknowledging the approach signal at Mile 60.3. As the sight-line to the signal at Mile 59.2 is less than 1,000 feet, and is visible for about 20 seconds, the non-observance of the signal indication is consistent with microsleeping,[11] which lasts for short periods of time as a result of extreme fatigue. During this stage of fatigue, individuals may react to simple or familiar tasks through ABS, but are unaware of what is going on around them as they may involuntarily settle into a momentary state of uncontrollable sleep.

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10 A soporific environment is one in which falling asleep is facilitated or one in which staying alert is not. The environment itself is not sufficient to induce sleep. People only sleep during circadian lows or when they have a sleep debt.

11 Microsleep is a very brief dip, of up to 20 or 30 seconds, into stage one sleep, which is often not remembered. Microsleep and ABS are the 2 conditions in which a signal is most likely to be missed. The CANALERT Guide for Locomotive Engineers and Their Families: Living in a 24-Hour World, Cambridge, Mass.: Circadian Technologies Inc., 1995, p. 29.

It is quite possible that both crew members of train 792 experienced a microsleep as they approached and passed the signal at Mile 59.2.

The locomotive engineer and conductor had a sleep/wake pattern established in their biological clocks for sleep during this working shift. The unexpected change of duty window for the locomotive engineer, which did not allow him to obtain restorative rest, compromised his ability to be rested and resulted in his fatigued condition. The conductor's biological clock had not been adjusted to night working hours. It is also noted that, although the crew members of train 792 were in compliance with regulatory requirements respecting mandatory off-duty time, they had been awake for an extended length of time before reporting for duty and were not rested.

The duty window system of crew management has enabled train crews to have an approximate idea of when they must go to work, which is recognized as a significant improvement over the traditional first-in first-out, no schedule, crew management procedure. Duty windows provide employees with more opportunity to schedule personal time, as well as to predict wages earned. However, the ability to schedule their life can be compromised if, and when, another employee books on or off, and their duty window is changed. A different duty window may be advanced in time, which would negate getting rest, or bumped back, which could result in a rested employee being tired again before going to work. However advantageous this system may be, all benefit to alertness can be lost when employees are unexpectedly displaced and their wake/sleep cycle is disturbed. The financial motivation to report for work, even in an unrested state, is very high. Given a choice between not going to work and not being paid for the trip and going to work in spite of not being sufficiently rested to assure alertness for the entire trip, employees may choose to go to work.

No regulatory requirement nor company or union policy addresses the consideration of crew members' states of alertness in the management of schedules or the consideration of changes to expected work hours and sleep/wake cycles. Such consideration might have resulted in the crew of train 792 reporting for duty capable of maintaining attentiveness and alertness for their complete tour of duty. Irrespective of the personal lifestyle changes (adjustments to the sleep/wake cycle) made to coordinate biological clocks with windows duty hours and however rested individuals may be for a planned tour of duty, if their turn is displaced outside of the hours for which they are rested, there is no mechanism in place to protect train operations with a rested crew. This may result in trains being operated unsafely by unrested employees even though all requirements of the regulator, the railway, and the unions pertaining to maximum working hours and mandatory time off-duty have been met. Successful implementation of a fatigue management strategy will require the active participation of companies, employees, and unions.

CANALERT '95 provided objective scientific evidence and confirmed that, by implementing its recommendations, the fatigue issues in the railway operating environment could be mitigated. However, while good scheduling mechanisms and strategies can provide the environment for improved employee alertness, there is no guarantee that employees will always report to work fully alert for their entire tour of duty.

Automatic behaviours

Automatic behaviours require no conscious decisions regarding which muscles to move or which actions to take, such as dialing a familiar telephone number or driving a car to a familiar place on an open road. Many tasks start off as controlled processes, but eventually become automatic ones. For example, driving a car is initially a controlled process, but as we master driving, it becomes automatic under normal driving conditions (on familiar roads, in fair weather, with little or no traffic). The characteristics of the processes required to respond to the RSC match those of automatic behaviour, namely they can occur outside of conscious awareness, demand little or no effort, can be performed simultaneously and are performed relatively fast. The phenomenon of ABS becomes more prevalent as the mind becomes fatigued. The preferred method to restore controlled processes would be to obtain restorative rest (i.e. sleep or nap). Had the crew members of train 792 been able to take a nap as a fatigue countermeasure at the siding preceding Basque, they may have restored their vigilance capabilities.

The periodic movement of the throttle control was approximately every 108 seconds, which corresponds closely with the reset time permitted by the RSC. This timing suggests that the locomotive engineer was using the throttle control to reset the RSC. However, given the locomotive engineer’s state of fatigue, this action was probably done outside of the locomotive engineer’s conscious awareness, thereby reducing the effectiveness of the RSC as a safety device. The locomotive engineer had also initiated dynamic braking and a normal but late brake application without being cognitive of his location. The stimulus of the RSC, a flashing light followed by an audible alarm, was not sufficient to the locomotive engineer or the conductor to prompt other than an automatic response to reset the timing feature of the RSC. The fact that the crew was startled by the noise of the locomotives going by them on the adjacent track and then that the conductor prompted the locomotive engineer to apply emergency braking gave sufficient stimuli to the locomotive engineer to return his alertness level from automatic behaviour to a controlled response process.

Findings

1. The physical evidence and recorded data support the sequence of events as outlined by the respective crew members.

2. The method and manner of the operation of train 415 were in accordance with regulatory and company requirements and played no part in the accident.

3. It is quite possible that both crew members of train 792 experienced a microsleep as they approached and passed the CTC signal at Mile 59.2 governing the entrance to Basque.

4. The crew fatigue issue is even more pronounced on the second subdivision of extended runs as the distance travelled and time working during one tour of duty are typically doubled.

5. The current regulatory requirements respecting mandatory time off-duty and maximum hours of service can result in train crews being in compliance with regulatory requirements but not being sufficiently rested.

6. Loss of income from missing a trip will motivate an employee to report for duty with insufficient rest.

7. Consideration of employees' personal sleep/wake cycles in the management of crew scheduling, as identified in *CANALERT '95*, might have resulted in the crew of train 792 reporting for duty capable of maintaining attentiveness and alertness for their complete tour of duty.

8. The *CANALERT '95* provision of en route napping is intended to be a fatigue countermeasure to improve the safety of train operations by providing a train crew with the opportunity for restorative rest.

9. The Reset Safety Control device is not sufficiently demanding or aggressive to negate an automatic behaviour response and may not serve its intended purpose in all circumstances.

10. The full implementation of fatigue countermeasures will require the acceptance and cooperation of all involved persons in the railway industry including management, unions, and employees.

Causes and contributing factors

The collision occurred when the crew members of train 792 operated their train past a stop signal indication. They had become impaired by fatigue—due to excessive waking hours without a restorative rest period—succumbed to fatigue, and possibly experienced a microsleep which may have caused them to miss the stop signal indication.

Contributing to this occurrence was the difficulty the railway industry had scheduling work for employees in train service, in consideration of sleep/wake cycles, to facilitate rest needs.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 20 December 2000.