Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT R10Q0011

MAIN-TRACK DERAILMENT

VIA RAIL CANADA INC.
PASSENGER TRAIN No. 15
MILE 100.78, CANADIAN NATIONAL MONTMAGNY SUBDIVISION
SAINT-CHARLES-DE-BELLECHASSE, QUEBEC
25 FEBRUARY 2010

Canada

Railway Investigation Report

Main-Track Derailment

VIA Rail Canada Inc.
Passenger Train No. 15
Mile 100.78, Canadian National Montmagny Subdivision
Saint-Charles-de-Bellechasse, Quebec
25 February 2010

Report Number R10Q0011

Summary

On 25 February 2010, at approximately 0425 Eastern Standard Time, VIA Rail Canada Inc. train No. 15, proceeding westward from Halifax, Nova Scotia, to Montréal, Quebec, entered the siding at Mile 100.78 of the Canadian National Montmagny Subdivision in the municipality of Saint-Charles-de-Bellechasse, Quebec, at about 64 mph and derailed 2 locomotives and 6 passenger cars. Two locomotive engineers and 5 passengers were injured. Approximately 3000 litres of diesel fuel leaked out of the lead locomotive. The lead locomotive, 1 house, 1 garage and 6 motor vehicles were destroyed. The passenger cars, siding track and other private property were extensively damaged.

Ce rapport est également disponible en français.

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5.0 Appendices

1.0 Factual Information

On 24 February 2010, at 1300 Atlantic Standard Time, VIA Rail Canada Inc. (VIA) train No. 15 (VIA 15) departed from Halifax, Nova Scotia, destined for Montréal, Quebec. The westward train was moving into the frontal edge of an eastward-moving storm with strong northeast winds, blowing snow at times mixed with ice pellets, and temperatures near freezing. The train comprised 2 locomotives and 7 passenger cars. It was approximately 710 feet long and weighed about 650 tons. There were 118 passengers on board. The crew consisted of 2 locomotive engineers positioned in the lead locomotive and 8 on-train service employees.

1.1 The Accident

On 25 February 2010, at approximately 0425, [1] VIA 15, travelling at approximately 64 mph, entered a siding at Mile 100.78 of the Canadian National (CN) Montmagny Subdivision in the municipality of Saint-Charles-de-Bellechasse, Quebec, and 2 locomotives and 6 passenger cars of the train derailed. The derailing train downed adjacent hydro lines and struck 2 houses and a garage before coming to a stop (see Photo 1).

Photo 1. Derailed equipment and damage to residential properties

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1 All subsequent times are Eastern Standard Time.

The locomotive crew was based in Charny, Quebec. They had come on duty at approximately 2000 on 24 February 2010 and had worked eastward on VIA train No. 14, travelling to Montagne, Quebec, Mile 140.2, Mont-Joli Subdivision. After meeting VIA 15, the train crew changed assignment and departed westward on VIA 15 at approximately 0140, on 25 February 2010 (see Figure 1).

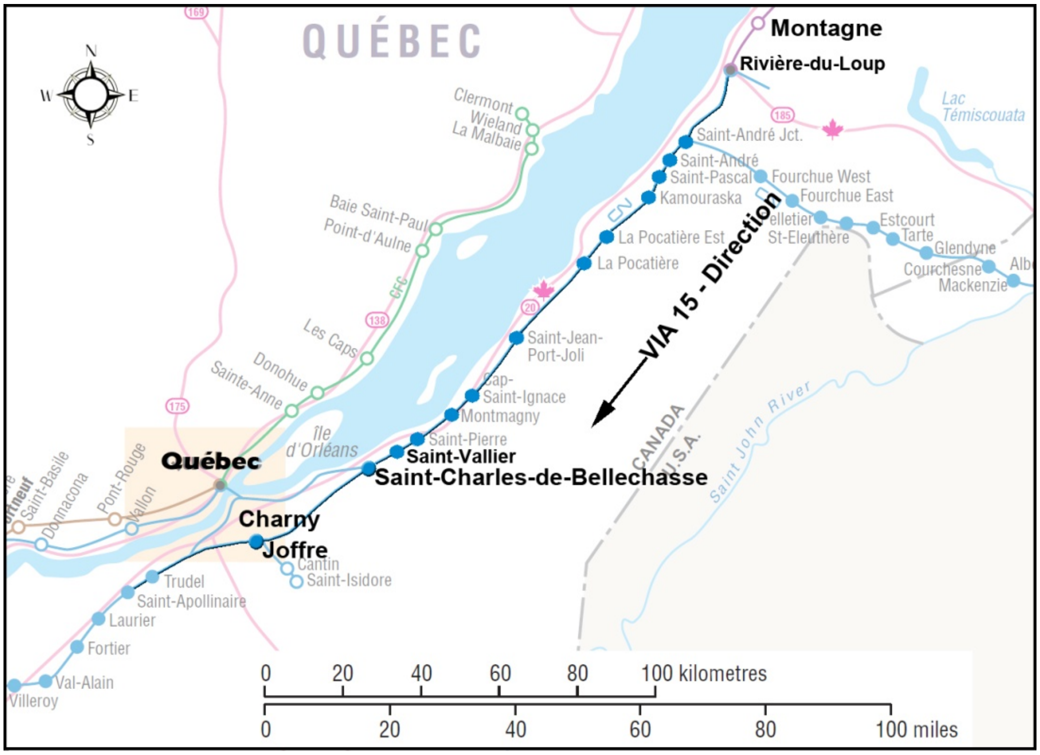

Figure 1. Accident location at Saint-Charles-de-Bellechasse (Source: Railway Association of Canada, *Canadian Railway Atlas*)

The operating locomotive engineer (LE) had more than 31 years of railway experience, almost all with CN. He had transferred to VIA in March 2009 and was working his regular assignment on the day of the accident. The in-charge locomotive engineer (ICLE [2]) had 35 years of railway experience, 21 years with CN and 14 years with VIA. In the previous 2 weeks, he had only worked 1 other assignment. Both were qualified for their positions and were familiar with the territory.

1.2 Track Information

The CN Montmagny Subdivision is a single main track, which extends from Rivière-du-Loup (Mile 0.0) to West Junction near Joffre, Quebec (Mile 118.0), where it connects to the Drummondville Subdivision. The maximum allowable speed was 80 mph for passenger trains.

There is a large, open-deck, plate-girder span bridge between Montmagny and Saint-Charles-de-Bellechasse, located at Mile 97.6. It consists of 3 steel spans totalling a length of approximately 235 feet. The track profiles for Mile 96 to Mile 101 are contained in Appendix A.

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2 The ICLE sat on the left side of the locomotive and performed conductor-related duties.

At Saint-Charles-de-Bellechasse, there is a No. 12 turnout enabling westward movements to take the siding. Train speed is restricted to a maximum of 15 mph through the turnout and to a maximum of 10 mph on the siding track. The siding track consisted of 100-pound Dominion rail, 1943. The rail had 2 mm of vertical wear and minimal lateral wear.

1.3 Weather

On the morning of the accident, the weather station at nearby Beauport, Quebec, reported increasing snow conditions, winds from the east-northeast at 42 km/h gusting to 62 km/h, and a temperature of -0.6°C.

1.4 Centralized Traffic Control

Train movements on the Montmagny Subdivision are governed by the Centralized Traffic Control System (CTC), as authorized by the *Canadian Rail Operating Rules* (CROR) and supervised by a rail traffic controller (RTC) located in Montréal. The CTC employs interconnected track circuits and field signals (controlled, advance and intermediate signals) to control train movements. Computer displays and controls are installed in the RTC office. The design of the system is such that trains are given a series of signal indications that require train crews to take action based on the signal displayed.

When an RTC requests controlled signals for trains, the signal system determines how permissive the signals will be. In the RTC office, track occupancy between controlled locations is displayed on a computer screen. Movements approaching controlled signals are governed by advance signals. Furthermore, intermediate signals are actuated by the presence of a train.

Signal indications convey information to train crews that indicate the speed at which they may operate and how far they are permitted to travel. In addition, signal indications provide protection against certain conditions (for example, occupied block, broken rail or a switch left open).

Crews must be familiar with the signal indications specified in the CROR and are required to control their trains in accordance with these rules. The CTC does not provide automatic enforcement to slow or stop a train if it were to pass a stop signal or other point of restriction.

The field signals used on the Montmagny Subdivision were an arrangement of 1 or 2 lights that display 3 colours (that is, green, yellow or red). The signals were Type SA-1 searchlights manufactured by General Railway Signal Corporation and were equipped with Fresnel [3] type lenses. They were built according to Association of American Railroads specifications.

A westbound train leaving Saint-Vallier, Quebec, proceeding towards Saint-Charles-de-Bellechasse would encounter 3 signals governing its movement: an intermediate signal (939 [4]), an advance signal (971) and a controlled (home) signal (1007). If the main-track switch at Saint-Charles-de-Bellechasse is lined for the train to enter the siding, the signals (see Figure 2) would have the following indications:

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3 Compared to conventional lenses, the design of a Fresnel lens results in a thinner, larger, and flatter lens, capturing more oblique light from a light source, thus allowing light to be visible over greater distances.

4 Signal numbers typically refer to a physical location, for example signal 939 is located at Mile 93.9.

- intermediate signal 939 would display a clear signal (green aspect);
- advance signal 971 would display a clear-to-stop indication (2-aspect signal displaying a yellow over red, which means proceed, prepare to stop at next signal); and
- home signal 1007 would display a restricting signal (red over yellow, which means proceed at restricted speed [5]).

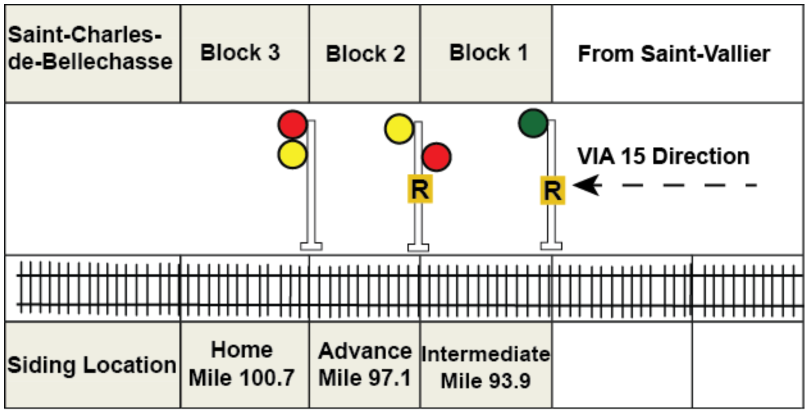

Figure 2. Signal indications when lined for Saint-Charles-de-Bellechasse siding

1.5 *Signal Recognition and Compliance*

Signal recognition and compliance is governed in part by the following rules:

CROR Rule 27, SIGNAL IMPERFECTLY DISPLAYED, states that:

> (a) […] a fixed signal which is imperfectly displayed, or the absence of a fixed signal where one is usually displayed, must be regarded as the most restrictive indication that such signal is capable of displaying. An imperfectly displayed signal must be communicated to the proper authority as soon as possible.

CROR Rule 34, FIXED SIGNAL RECOGNITION AND COMPLIANCE, states that:

> (a) The crew on the controlling engine of any movement and snow plow foremen must know the indication of each fixed signal (including switches where practicable) before passing it.

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5 Restricted speed is defined in part as a speed that will permit stopping within one-half the range of vision of equipment, also to be prepared to stop short of a switch not properly lined and in no case exceeding SLOW speed (not exceeding 15 mph). When crews are travelling at restricted speed, they have to be on the lookout for broken rails.

(b) Crew members within physical hearing range must communicate to each other, in a clear and audible manner, the indication by name, of each fixed signal they are required to identify. Each signal affecting their movement must be called out as soon as it is positively identified [...]

(c) If prompt action is not taken to comply with the requirements of each signal indication affecting their movement, crew members must remind one another of such requirements. If no action is then taken, or if the employee controlling the engine is observed to be incapacitated, other crew members must take immediate action to ensure the safety of the movement, including stopping it in emergency if required.

CROR Rule 578, RADIO BROADCAST REQUIREMENTS, states that:

(a) Within single track, a member of the crew on all trains or transfers must initiate a radio broadcast to the airwaves on the designated standby channel stating the name of the signal displayed on the advance signal to the next controlled location, controlled point or interlocking.

Before departing Charny eastward, the crew confirmed between them the procedure to call the signals. The LE would first call the signal; the ICLE would confirm it and the LE would then call the signal on the radio when applicable. If there was disagreement between crew members, the crew would slow down the train to the most restricting speed. This procedure was consistent with the CROR rules and also similar to the practices of other crews.

1.6 Signal Testing

Shortly after the accident (at 0700 and again at 1130 on the day of the accident), the signal lenses on the advance signal and the home signal were either partially blocked or completely blocked by wet opaque snow (see Photo 2). A review of railway records for the previous year showed that, in this area, there were 6 reports of signals being obscured due to winter conditions. In each case, Signals and Communications technicians responded and cleaned the signal lenses. There were no reports of signal malfunctions at this location.

Photo 2. Top: Snow on signal lenses at home signal 1007 (25 February 2010 at 0700 and 1130). Bottom: Advance signal 971 before and after cleaning lenses (Source*: TSB and CN)*

The signals between Saint-Vallier and Saint-Charles-de-Bellechasse were inspected and tested by technicians from CN and Transport Canada (TC) shortly after the accident. They were all found to be working as designed. Additional testing by an independent consultant also confirmed that the signals were functioning properly. The signals were determined to be functioning in accordance with the CROR, CN's Signals and Communications General Instructions, Code and Practices specifications, and approved plans.

1.7 Recorded Information

Recorded events and crew actions that occurred between Montagne and Saint-Charles-de-Bellechasse are shown in Figure 3.

No.	Location (Mile)	Time	Speed (mph)	Throttle	Description
		0256			The VIA 15 crew phoned the RTC to find out about potential meets. They understood that eastward train CN 308 was ordered at 0215 and that a change to its locomotive consists was needed before departure.
		0356			The crew members of CN 305, while operating west of Joffre on the Drummondville Subdivision, reported to the RTC that they were having difficulties perceiving the signals because of snow accumulation on the signal lenses. The RTC contacted the signal technician who then dispatched a team to clean the signal lenses in that area.
		0403:03	88.0	2	Train speed was 88 mph.
		0406:46	57.9	2	Train speed was 58 mph.
		0407:11			The RTC lined the main-track switch at Saint-Charles-de-Bellechasse in order for train VIA 15 to enter the siding.
		0407:32			The east switch at Saint-Charles-de-Bellechasse was confirmed in the reverse position (that is, lined towards the siding).
	89.3 to 90.6	0416			While travelling through Saint-Vallier, VIA 15 train crew encountered the eastward-moving snow storm that may have impaired signal aspects due to blowing snow conditions.
		0418			CN 308 crew called the signal at Diamond (Mile 114) on the radio.
		0419:04	78.9	5	VIA 15 reached intermediate signal 939.
		0419:24	78.9	4	LE activated whistle for 13 seconds for crossing at Mile 94.79.
1	96.00	0420:39	77.9	5	VIA 15 proceeding westward at throttle position 5.
		0421			CN 308 crew called the signal at Carrier (Mile 110.4) on the radio.
2	96.89	0421:12	79.9	4	Approaching advance signal 971, LE activates the whistle for crossing at Mile 97.23.
3	97.23	0421:28	81.9	4	LE stops the whistle once crossing occupied.
4	98.00	0421:59	79.9	4	Speed reduced below 80 mph.
5	99.00	0422:50	75.0	6	Throttle advanced to position 6.
6	99.49	0423:12	75.0	6	LE activates the whistle for crossing at Mile 99.73.
7	99.73	0423:22	76.0	6	Train occupies crossing at Mile 99.73.
8	99.80	0423:26	76.0	6	LE continues whistle for crossing at Mile 100.11.
9	100.11	0423:42	75.1	6	LE stops the whistle at the crossing Mile 100.11.
10	100.53	0424:02	73.1	3	Between 0423:44 and 0424:02, LE reduced throttle position from 6 through to 3.
11	100.64	0424:10	72.1	3	LE applies minimum air brake reduction.
		0424:12	71.0	3	VIA 15 train crew perceives the home restricting signal for Saint-Charles-de-Bellechasse siding.
	100.68	0424:13	71.0	0	LE reduces throttle to position 0.
12	100.77	0424:18	63.6	0	Train brakes in emergency.
	100.78	0424:18	63.6	0	Train enters east siding switch Saint-Charles-de-Bellechasse.
		0424:19			VIA 15 derails.

Figure 3. Events and crew actions between Montagne and Saint-Charles-de-Bellechasse

A review of the train handling data recorded in the 45 minutes before the accident showed inconsistent tracking to grade, heavy use of the brake and throttle, as well as a few periods of overspeed.

1.8 Radio Broadcast of Signals

In accordance with the CROR, at the intermediate signal (939), the VIA crew had to call the signal in the cab to each other. At the advance signal (971), the VIA crew was required to call the signals to each other and initiate a radio broadcast to the airwaves on the designated standby channel (channel 1) stating the name of the signal displayed.

In-cab communications were not recorded, but radio broadcasts on channel 1 were recorded by CN at Joffre. Based on the radio broadcasts captured at Joffre on the morning of the accident, the radio transmission from VIA 15 at the advance signal could not be heard. The crew of CN 308 was also required by the CROR to call advance signal 114 at Carrier. The recording obtained at Joffre confirmed that this transmission was clearly audible.

After the fact, radio testing was conducted with a VIA 15 crew to determine the audibility of the transmissions at Joffre. All railway signals between Montmagny and Joffre were radio broadcasted and videotaped from the cab. The review of the Joffre recordings determined that, from Saint-Vallier and Saint-Charles-de-Bellechasse, the VIA 15 radio broadcasts were intermittent and non-intelligible; those from Carrier were clearer, but still intermittent.

The Board has previously made recommendations on the topic of on-board voice recordings. In TSB investigation R99T0017, the Board recommended that:

> The Department of Transport, in conjunction with the railway industry, establish comprehensive national standards for locomotive data recorders that include a requirement for an on-board cab voice recording interfaced with on-board communications systems.
>
> (R03-02, issued July 2003)

Considering that TC had implemented partial performance specifications for data collection, the Board assessed TC's response as **Satisfactory in Part**. However, the Board remains concerned that the principle of voice recordings as a valuable safety tool has not been implemented.

1.9 Frequency of Meet for VIA 15 and CN 308

In the 2 months prior to the accident, VIA 15 operated 54 times and CN 308 operated 61 times on the Montmagny Subdivision. The trains met 19 times, including 5 times at Saint-Charles-de-Bellechasse. On the 19 days the two trains met, CN 308 was in the yard at Joffre on average 2.2 hours before departure. The average departure time for CN 308 from Joffre on those days was 0410.

1.10 Crew Perception of Signals

Crew members are expected to know their operating territory, including the location of individual signals. This is to facilitate the detection of a signal and to help recognize the presence of any imperfection or absence of a signal. Perception of signals can be defined as a 3-step process: detect, discriminate and decide on the aspect displayed. This process can be rapid and made from relatively long distances when the signals are not obscured or obstructed, and there are good visibility conditions. Several factors can affect rapid and accurate crew perception of signals, including crew fitness for duty, visibility, perceptual context and the signals themselves.

1.11 Signal Visibility Testing

In good weather visibility conditions, advance signal 971 can be perceived in darkness from as far as 15 000 feet. Home signal 1007 can also be perceived from this distance across the fields as the train is negotiating the curve approaching Saint-Charles-de-Bellechasse. Home signal 1007 would be directly in the crew's sightline from a distance of approximately 8500 feet. Home signal 1007 is located on the edge of the village near buildings with surrounding lights, some of which are the sodium-vapour type that have a yellow hue.

Snow accumulation can obscure signal lenses with partial or complete blockage of the light beam, which can significantly affect the distance and time available to a crew to perceive and confirm the signals. Field testing was conducted to simulate the effects of snow covering on the perception distance of advance signal 971. Field testing was performed using translucent and opaque materials. The translucent tests consisted of covering the entire surface of the lens with incremental layers of translucent materials. In the opaque tests, the lens was partially blocked with an opaque material [6] at levels covering 25%, 50%, 75% and 90% of the lens surface area.

The testing was performed on 19 and 20 May 2010, between 2130 and 0130, under good weather visibility conditions. The signal perception was assessed by 3 observers at distances varying from 0.25 miles to 2.0 miles. In the first series of tests, only the top lens was covered while displaying the yellow aspect.

The tests using translucent material determined that:

- At a given distance, the radius of the yellow signal (circle) becomes smaller with an increasing number of layers. However, it is possible to identify the yellow colour until the signal becomes imperceptible due to the excessive number of layers; and
- The number of layers required to make the light imperceptible is reduced as the distance to the signal is increased.

The tests using opaque material determined that:

- Beyond 1.5 miles, it is difficult to perceive the yellow light if the lens surface area is blocked more than 75%; and
- Within 0.5 mile, it is difficult, but still possible, to perceive the yellow colour if the lens surface area is blocked 90%.

In the second series of tests, the top lens was gradually covered with layers of translucent materials, first while displaying a yellow aspect and then while displaying a green aspect. In each case, the observers could easily distinguish between the colour until the number of layers rendered the light imperceptible.

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[6] Light did not go through the blocked portion.

1.12 Cab Signalling Systems

Cab signalling is a railway safety system that communicates track status information to a display device mounted inside the cab of a locomotive. The simplest systems display the wayside signal indication while more advanced systems also display maximum permissible speeds. These systems can be combined with a train protection system to warn of proximity to points of restriction and to initiate enforcement action to slow or stop a train. [7] Cab signals can reduce the risk of signal recognition errors, particularly when wayside signals are difficult to see.

In 1922, the U.S. Interstate Commerce Commission made a ruling that required U.S. railroads to install some form of automatic train control in one full passenger division by 1925. In response to this ruling, the first cab signalling systems were developed and put into use in the U.S. [8] Cab signalling systems have evolved and remain in use in some U.S. passenger train corridors. In Canada, there are currently no cab signalling systems in use by freight or passenger railways.

1.13 Positive Train Control

Positive Train Control (PTC) is a developing train control system whose core functions are designed to prevent train-to-train collisions, overspeed derailments, incursions into established work zone limits, and the movement of trains through improperly positioned switches. This is achieved by continuously monitoring and positively enforcing points of restriction. PTC systems vary widely in complexity and sophistication based on the level of automation and functionality, system architecture, the wayside systems upon which they are based (that is, non-signalled, block signal, cab signal) and the degree of train control they are capable of assuming.

1.13.1 Mandatory Implementation of Positive Train Control in the United States

Following the investigation of the head-on collision of 2 Penn Central commuter trains near Darien, Connecticut, on 20 August 1969, in which 4 people were killed and 45 people were injured, the U.S. National Transportation Safety Board (NTSB) asked the Federal Railroad Administration (FRA) to study the feasibility of requiring a form of automatic train control system to protect against train operator error and prevent train collisions.

After the rear-end collision involving a Boston and Maine Corporation commuter train and a Consolidated Rail Corporation (Conrail) freight train, on 07 May 1986, in which 153 people were injured, the NTSB recommended that the FRA publish standards requiring the installation and operation of a train control system that would provide for positive train separation (NTSB Recommendation R-87-16, May 1987).

When the NTSB first established its Most Wanted List of Transportation Safety Improvements in 1990, it included the issue of positive train separation, which was later changed to PTC. In September 1997, the FRA asked its Railroad Safety Advisory Committee (RSAC) to address the issue of PTC. A PTC Working Group, which included Transport Canada, was formed. In 1999, the working group submitted a report defining the core functions of PTC.

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7 *Elements of Railway Signalling*, General Railway Signal, June 1979.

8 Transportation Research Board of the National Academies, Transportation Research Circular E-C085: Railroad Operational Safety: Status and Research Needs, January 2006.

Until 2008, PTC systems were being voluntarily installed by a few carriers. However, on 12 September 2008, a collision occurred between a Metrolink passenger train and a Union Pacific freight train in California resulting in 25 fatalities and more than 135 serious injuries. This accident prompted the passage of the U.S. *Rail Safety Improvement Act* (RSIA) (16 October 2008; Public Law 110-432), which mandated that PTC be installed on all rail main lines in the U.S. by 2015. Specifically, the RSIA required:

> . . . the installation and operation of PTC systems on all rail main lines, meaning all intercity and commuter lines—with limited exceptions entrusted to FRA— and on freight-only rail lines when they are part of a Class I railroad system, carrying at least 5 million gross tons of freight annually, and carrying any amount of poison- or toxic-by-inhalation (PIH or TIH) materials.

In 2009, the NTSB issued a recommendation to the Federal Transit Administration to facilitate the development and implementation of positive control systems for rail transit systems nationwide (NTSB Recommendation R-09-8, July 2009).

1.13.2 Development and Implementation of Positive Train Control in the United States

In November 2000, the U.S. National Passenger Rail Corporation (Amtrak) placed in service its Advanced Civil Speed Enforcement System (ACSES) on a section of the northeast corridor between New Haven, Connecticut, and Boston, Massachusetts. The system was added as a supplement to cab signalling and automatic train control (speed control) to enable Amtrak to operate trains at high speeds. Its primary functions were to enforce speed limits and signal compliance. Together, these systems are considered to deliver PTC core functionalities.

The FRA states that it is supporting all rail carriers that are required to install PTC, as well as rail carriers that are continuing to voluntarily implement PTC. This support is provided through a combination of regulatory reform, project safety oversight, technology development and financial assistance.

All of the affected railroads are preparing PTC implementation plans required by the RSIA and are adapting their individual PTC systems to maximize interoperability. There are 11 PTC projects in varying stages of development and implementation, involving 9 railroads in at least 16 states. These pilot projects are not only allowing railroads to advance the various technologies used to implement PTC systems, but are providing the railroads with valuable experience on the installation and test procedures required to meet the 2015 deadline.

After 2015, it is anticipated that there will be 41 U.S. railroads (including Class 1, passenger and intercity) operating with PTC on all or a portion of their lines. Over 60 000 track miles in the U.S. will be equipped with PTC.

1.13.3 Positive Train Control - Canadian Railway Systems

No railway has implemented a PTC system in Canada, except on a limited trial basis. The Board is aware that both Class 1 Canadian railways, CN and Canadian Pacific Railway (CPR), have implementation plans so that they will meet the PTC requirements for their U.S. operations.

CPR's implementation plan indicates that it will equip 460 high horsepower (HHP) locomotives and 110 road and yard switchers with the required on-board systems. CPR will install PTC on approximately 1660 miles of track.

CN's PTC implementation plan indicates that it will equip 820 HHP locomotives and 180 low horsepower locomotives with the required on-board systems. CN will install PTC on approximately 3720 miles of track.

Both CN and CPR are implementing a Vital Electronic Train Management System (V-ETMS). CN will install it on 41 subdivisions, and CPR will install it on 17 subdivisions, corresponding respectively to 62% and 89% of their total U.S. route miles (excluding yard limits). V-ETMS is a locomotive-centric, train control system that uses a combination of locomotive, office and wayside data that is integrated via a radio network. This system provides the following functions:

- alert train crews to pending authority and speed limit violations, including passing a stop signal;
- stop trains before they exceed authority and speed limits, including signals at stop;
- interrogate upcoming wayside signals and switches in a train route when operating in V-ETMS territory; and
- protect work zone limits by enforcing compliance with work zone restrictions.

1.14 TSB Recommendation Related to Signal Indications

During a TSB investigation into a train collision involving 2 CPR trains near Notch Hill, British Columbia (TSB report No. R98V0148), the Board determined that backup safety defences for signal indications were inadequate and that distraction attributable to noise significantly affected the communication of safety-critical information between crew members in the locomotive cab. The Board recommended that:

> The Department of Transport and the railway industry implement additional backup safety defences to help ensure that signal indications are consistently recognized and followed.
>
> (R00-04, issued February 2001)

TC supported the intent of this recommendation and increased its compliance monitoring of activities related to signal recognition. While no additional physical safety defences were engineered into the CTC to ensure consistent recognition and response to signal indications, some administrative changes were made by CPR after an accident in Redgrave, British Columbia, in 2009 (TSB report No. R09V0230). The response to Recommendation R00-04 was assessed as **Satisfactory in Part**.

Since 2007, the TSB has conducted a number of investigations in which signal identification and response were determined to be contributing factors in the accident (see Appendix B).

1.15 Work / Rest Rules for Operating Employees

Management and employees have a shared responsibility to ensure railway employees arrive fit and rested for duty. Labour also shares a responsibility when negotiating working conditions to consider their impact on fatigue.

Performance and cognitive functioning are worst during the period when other circadian rhythms dictate sleep. Performance on specific measurements such as random number addition speed (RNAS), [9] reaction time, [10] arithmetic and signal detection, [11] and train safety alarm alerts, [12] all demonstrate the worst performance during the night shift.

No distinction between working day or night shifts is made in the Railway Association of Canada (RAC) Work/Rest Rules for Operating Employees (as approved by TC); nor are any precautions for night work required. This results in the assumption that all hours of the day have similar performance levels. However, performance actually deteriorates and fatigue increases at night because circadian rhythms function at a level of efficiency consistent with the expected state of sleep.

The work/rest rules require that company fatigue management plans encompass both education and training. At CN, employee education consists of regular briefing material on fatigue-related issues. The operating employees are required to carry work/rest rules with them while on duty. At VIA, employees are provided with a copy of the rules concerning fatigue each time they are re-qualified for CROR, which is every 3 years.

In this occurrence, both locomotive engineers had worked within the limits prescribed by work/rest rules. The ICLE was voluntarily working on the spare board and had not worked for over 7 days prior to the accident. His shifts were primarily during the day and he was able to sleep at night. Before the accident, he had a full night's rest, waking up at about 1030. In addition, he had napped in the afternoon prior to reporting for work on 24 February 2010.

During the previous 6 months, the LE normally worked a pattern of 2 to 3 night shifts in a row with 2 to 5 days off. During his time off, he reverted to sleeping at night, normally for 7 to 8 hours before rising early. He had been off-duty for 2 days prior to the occurrence and had slept at night. He also had napped prior to reporting for work on 24 February 2010.

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9 S. Gupta, and A.K. Pati, "Desynchronization of Circadian Rhythms in a Group of Shift Working Nurses: Effects of Pattern of Shift Rotation," *Journal of Human Ergology, 23*(2), 1994, 121-131.

10 A.J. Tilley, R.T. Wilkinson, P.S.G. Warren et al., *Human Factors, 24*, 1982, 629-641.

11 D.I. Tepas, J.K. Walsh, and D.R. Armstrong, in L.C. Johnson, D.I. Tepas, W.P. Colquhoun et al. (Eds.), *Biological Rhythms, Sleep and Shift Work*, New York: Spectrum Publishing, 1981, 347-356.

12 G. Hildebrandt, W. Rohmert and J. Rutenfranz, "Twelve and Twenty-Four Hour Rhythms in Error Frequency of Locomotive Drivers and the Influence of Tiredness," *International Journal of Chronobiology*, 2, 1974, 97-110.

The working conditions of railway locomotive engineers can predispose them to excessive sleepiness.[13] Fatigue has been shown to cause late braking and poor conformance to train driving requirements.[14] Fatigue may slow reaction time, increase risk taking and reduce the ability to solve complex problems.[15] Sleep disorders, such as obstructive sleep apnea, may magnify the effects of fatigue by further reducing the amount of restorative rest obtained.

1.16 Obstructive Sleep Apnea

Obstructive sleep apnea (OSA) is a sleep disorder characterised by repetitive, partial or complete obstruction of upper airway tissues during sleep that results in sleep disruption, gas exchange abnormalities and cardiovascular changes.[16] Motor vehicle drivers with severe OSA have an increased risk of being in a motor vehicle accident [17] and may also suffer from increased fatigue. Performance issues of people diagnosed with severe OSA include specific deficits such as reduced ability to sustain attention as well as broader issues that are central to an individual's ability to organize thoughts and activities, prioritize tasks, manage time efficiently and make decisions.[18] Severe OSA also poses a high risk to the long-term health of individuals, including cardiovascular, endocrine and respiratory diseases.[19] Risk factors for this condition include being male, being of older age, having a high Body Mass Index (BMI) and snoring.[20]

People in occupations with a sedentary component, such as railway locomotive engineers, are at higher risk for having obstructive sleep apnea.[21] The RAC recognized the risk that severe OSA poses to railway safety.[22] The RAC *Canadian Railway Medical Rules Handbook* provides screening criteria to assess an individual's probability of having OSA. A tool for the assessment of the

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13 E. Nena, V. Tsara, P. Steiropoulos et al, "Sleep-Disordered Breathing and Quality of Life of Railway Drivers in Greece," *Chest*, 134, 2008, 79-86.

14 J. Dorrian, F. Hussey and D. Dawson, "Train Driving Efficiency and Safety: Examining the Cost of Fatigue," *Journal of Sleep Research*, Volume 16, Issue 1, 2007.

15 See for examples: T. Maddox et al, "The Effects of Sleep Deprivation on Information-Integration Categorization Performance," *Sleep*, Volume 32, Issue 11, 2009.
M.T. Corfitsen, "Fatigue among Young Male Night-Time Car Drivers: Is There a Risk-Taking Group?" *Safety Science*, Volume 33, Issues 1-2, 1999.

16 The International Classification of Sleep Disorders, *Revised Diagnostic and Coding Manual*, 2001.

17 C.G. George, P. Nickerson, P. Hanly et al., "Sleep Apnea Patients Have More Automobile Accidents," Lancet, I: 447, 1987; R.L. Ellen, S.C. Marshall, M. Palayew et al., "Systematic Review of Motor Vehicle Crash Risk in Persons with Sleep Apnea," *Journal of Clinical Sleep Medicine*, 2, 2006.

18 L. Ferini-Strambi, C. Baietto, M.R. Gioia et al., "Cognitive Dysfunction in Patients with Obstructive Sleep Apnea: Partial Reversibility after Continuous Positive Airway Pressure," *Brain Research Bulletin*, 61, 2003.

19 Q.R. Huang, Z. Qin, S. Zhang et al., "Clinical Patterns of Obstructive Sleep Apnea and its Comorbid Conditions: a Data Mining Approach," *Journal of Clinical Sleep Medicine*, 4, 6, 15 December 2008.

20 T. Young, M. Palta, J. Dempsey et al., "The Occurrence of Sleep-Disordered Breathing among Middle-Aged Adults," *New England Journal of Medicine*, 328, 1993.

21 X. Li, K. Sundquist and J. Sundquist, "Socioeconomic Status and Occupation as Risk Factors for Obstructive Sleep Apnea in Sweden: a Population-Based Study," *Sleep Medicine*, 9, 2008.

22 Railway Association of Canada, *Canadian Railway Medical Rules Handbook*, Section 4.9 - Severe Sleep Apnea, May 2007.

following risk factors was specifically developed to help identify at-risk individuals in safety-critical positions during their periodic medical examinations:

- history of frequent reported snoring;
- history of frequent reported choking or gasping during sleep and/or witnessed apneas;
- systemic hypertension or history of hypertension; and
- large neck circumference.

Some of these factors are required to be self-reported, but are commonly under-reported by individuals. [23] This may be because they are unaware of their condition, [24] which is not uncommon, or because they fear potential consequences of disclosure. [25]

The RAC handbook provides a formula to determine the probability of sleep apnea by calculating the adjusted neck circumference (ANC):

> ANC = neck circumference (in cm) + 4 (if there is history of hypertension) + 3 (if there are reports of frequent snoring) + 3 (if there are reports of frequent choking /gasping /apnea).

Individuals with an ANC greater than 48 have a high level of probability of sleep apnea and should undergo diagnostic testing. If an individual is identified as having severe OSA, treatment is normally suggested, but if the individual does not comply or the treatment is not successful, the employer may need to accommodate the employee by moving the person to a non–safety-critical position.

A recent report from a U.S. Joint Task Force on Severe OSA in Commercial Motor Vehicle Operators [26] identified screening methods that are less reliant on self-reporting (see Appendix C). It also provided guidance on assessing the severity of OSA and direction on whether testing should be carried out if the individual is permitted to drive, or whether driving privileges should be removed until testing takes place. Commercial motor vehicle operators who are required to be tested for OSA are not allowed to stay in service for more than 3 months without being tested.

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23 The International Classification of Sleep Disorders, *Revised Diagnostic and Coding Manual*, 2001, page 53; D. Carmelli, D. Bliwise, G. Swan et al., "Genetic Factors in Self-Reported Snoring and Excessive Daytime Sleepiness: a Twin Study," *American Journal of Respiratory Critical Care Medicine*, 164, 2001.

24 The International Classification of Sleep Disorders, *Revised Diagnostic and Coding Manual*, 2001.

25 N. Hartenbaum, N. Collop, I. Rosen et al., "Sleep Apnea and Commercial Motor Vehicle Operators: Statement from the Joint Task Force of the American College of Chest Physicians, American College of Occupational and Environmental Medicine and the National Sleep Foundation," *Journal of Occupational and Environmental Medicine*, 48, 9, Supplement S4-S37, 2006.

26 "Sleep Apnea and Commercial Motor Vehicle Operators: Statement from the Joint Task Force of the American College of Chest Physicians, American College of Occupational and Environmental Medicine and the National Sleep Foundation."

In recent years, OSA has been identified by the NTSB as a factor in several investigations. Following an investigation into a rail transit collision between 2 Massachusetts Bay Transportation Authority trains, which occurred on 28 May 2008, [27] the NTSB made several recommendations specific to this issue.

To the Federal Transit Administration:

> Develop and disseminate guidance for operators, transit authorities, and physicians regarding the identification and treatment of individuals at high risk for obstructive sleep apnea and other sleep disorders. (R-09-09)

To all U.S. rail transit agencies:

> Review your medical history and physical examination forms and modify them as necessary to ensure that they elicit specific information about any previous diagnosis of obstructive sleep apnea or other sleep disorders and about the presence of specific risk factors for such disorders. (R-09-10)
>
> Establish a program to identify operators who are at high risk for obstructive sleep apnea or other sleep disorders and require that such operators be appropriately evaluated and treated. (R-09-11)

The NTSB also reiterated one safety recommendation to the Massachusetts Bay Transportation Authority:

> Ensure that your fatigue educational awareness program includes the risks posed by sleeping disorders, the indicators and symptoms of such disorders, and the available means of detecting and treating them. (R-01-27)

1.17 Railway Medical Assessments for Locomotive Engineers

At CN, occupational health nurses (OHN) carry out the initial screening of medical assessment forms and, if necessary, contact CN's Chief Medical Officer if an issue requires more in-depth examination. As there can be a waiting list to access sleep study facilities, the OHN under guidance of the Chief Medical Officer will make a judgement about whether to remove an employee from service until the test can be carried out. It was common practice for CN medical staff to assess OSA as less urgent if an employee had a large neck circumference, but none of the other characteristics, even when the total ANC score based solely on the neck circumference was over the threshold.

In 2005, the LE underwent a railway medical exam, which was performed by his family doctor. It was noted that the neck circumference exceeded 48 cm; however, there were no other OSA risk factors reported. The LE was considered fit for duty and was issued a medical certificate by CN. However, the CN OHN identified that there was a potential risk for sleep apnea and called the LE twice in the month following the examination to request that he take a sleep apnea test. There are no records of a reply from the LE, nor of a follow-up carried out by the nurse. CN had a computerized system (SAP [28]) to track whether an individual was medically fit.

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[27] National Transportation Safety Board, Railroad Accident Report NTSB/RAR-09/02, Washington, D.C.

[28] CN's SAP system can track medical data, including the need for medical testing, assessments, and follow-up, for all employees in safety-critical positions.

In 2008, a subsequent medical carried out by the same family doctor identified that there was a slight increase in neck circumference and blood pressure since the 2005 assessment. The LE was again considered fit for duty and was issued a medical certificate. Following this examination, another OHN identified the risk of sleep apnea and wrote to the LE requesting that a sleep test be carried out. The LE was advised that, if he did not follow the request, his supervisor would be informed that he was not fit for his current work. A sleep study facility, contracted by CN to carry out the testing, attempted to contact the LE several times with no reply.

In February 2009, CN again requested that the LE undertake testing and that, if the report on the testing was not received, he would be considered unfit for his current job.

In March 2009, the LE who still had a valid medical certificate left CN and transferred to VIA without undertaking the testing requested by CN. CN indicated that the Chief Medical Officer at VIA was called on 19 March 2009 (after the employee transferred) to advise of the potential OSA risk. On 24 March 2009, a follow-up letter was sent to VIA with the same information. VIA has no record of either communication.

In September 2009, a second family doctor applied to a local sleep clinic requesting that an OSA assessment be carried out for the LE, but again this was not conducted.

According to union agreement, there is no requirement for a locomotive engineer with a valid medical certificate to undergo a second medical exam when transferring from CN to VIA. In this occurrence, the railway medical records were not transferred automatically. There had to be cause for concern for VIA to request the medical records, and they could only be transferred with permission from the employee. VIA indicated that they had no information about the outstanding testing required of the LE. Thus, no screening for the presence of OSA was requested or carried out by VIA.

After taking reasonable steps to first inform the employee, physicians under the *Railway Safety Act* are required to report to railway companies when in their opinion an individual in a safety-critical position has a medical condition that is likely to pose a threat to safe railway operations. The RAC issued an information leaflet [29] to medical practitioners outlining their responsibilities for reporting. Similarly, prior to any medical examination, employees must advise their physicians if they hold a safety-critical position in a railway company. Employee responsibilities also include being fit for duty, undergoing proper diagnostic testing and treatment programs, and properly reporting medical conditions to their physicians and companies.

After the occurrence, an independent medical evaluation of the LE confirmed CN's assessment and concluded that, while the LE was not exhibiting any signs of ill-health due to long-term OSA, he was most likely suffering from the condition.

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[29] Railway Association of Canada, *The Railway Safety Act: A Guide to Mandatory Reporting for Physicians and Optometrists*, 2001.

2.0 Analysis

The derailment occurred during inclement weather when the train, while travelling at 64 mph, entered a siding track where the maximum allowable speed was 15 mph. The analysis will focus on the operation of the train, the railway signals and their visibility in poor weather conditions, and railway medical assessments of locomotive engineers.

2.1 The Accident

Beyond Saint-Vallier, VIA 15 crossed the only large, open-deck steel bridge between Montmagny and Saint-Charles-de-Bellechasse. Given the ride characteristics of the bridge, the crew would have been fully aware of their whereabouts. The crew accurately blew the whistle for all road crossings, demonstrating that they were reacting appropriately to visual cues.

A meet with CN 308 at Saint-Charles-de Bellechasse had only occurred 5 times out of 54 assignments. Furthermore, the VIA 15 crew was aware that CN 308 had additional work to do before departure (due to the change required to its locomotive consist), making a meet even more unlikely. Given previous experience on this run, the phone call the crew made to the RTC from Rivière-du-Loup, and the time at which CN 308 was called in Joffre, an expectation may have been created that the 2 trains would not meet at Saint-Charles-de-Bellechasse.

Inspection and testing conducted by CN, TC and an independent consultant did not reveal any signal malfunctions between Saint-Vallier and Saint-Charles-de-Bellechasse. Examination of the signal records indicated that advance signal 971 would have been displaying a clear-to-stop indication (yellow over red) for about 15 minutes before VIA 15's arrival at that location. However, the crew members' handling of the train (that is, near track speed) approaching the home signal at Saint-Charles-de-Bellechasse indicated that they were not proceeding in a manner that allowed them to be prepared to stop as required by the clear-to-stop indication.

Since both clear and clear-to-stop signal indications have a lower red aspect, it is likely that the crew correctly perceived only the lower lens of advance signal 971. With the poor weather conditions, it is likely that the crew misperceived the top lens and interpreted the signal as clear. This would be consistent with the principle of closure or confirmation bias (that is, the tendency to fill in parts that are missing to conform to an overall impression). The crew members continued to operate the train in a manner suggesting that, according to their mental model, they were not meeting CN 308 at Saint-Charles-de-Bellechasse.

Approaching home signal 1007, the LE gradually reduced the throttle from position 6 to position 3, and train speed reduced to 73.1 mph. The further decrease from 73.1 mph to 63.6 mph between Mile 100.53 and Mile 100.78 is consistent with a crew that could not confirm the aspect of home signal 1007 and, therefore, applied a further small reduction of train speed. Under normal weather conditions, the home signal is visible from a distance sufficient to safely slow the train. However, due to the reduced visibility caused by the snow accumulation on the lens and the blowing snow, the signal indication at Saint-Charles-de-Bellechasse was not recognized and acted upon until the crew was within approximately 500 feet from the main-track switch. This distance was insufficient to slow the train; therefore, they entered the siding at an excessive speed and derailed.

2.2 Fatigue

Detecting and reacting to signals and other signs along the right-of-way involves alertness, attention, cognitive functions and ability to react to stimuli, all of which can be impaired by fatigue. Cognitive functions become even more crucial in instances of reduced visibility, such as during blowing snow conditions. Any impairment to these functions can have a significant effect as the time available to detect and react to cues is reduced.

While both train crew members had worked within the limits prescribed by the RAC work/rest rules, these rules do not take into account the time of day that work is conducted, or the degree to which an individual has adapted to working night shifts. Given the sleep-wake schedules, both crew members had been nocturnal sleepers on the days leading up to the occurrence. This means that their bodies and circadian rhythms would not have adapted to night work at the time of the occurrence, increasing the risk of fatigue. Research shows that the 2 periods of maximum sleepiness (occurring during a 24-hour period) are approximately 1500 to 1700 and 0300 to 0500. The latter period coincides with the accident time in this occurrence, which was at 0425.

Given the crew's circadian rhythms were oriented around being awake and functioning well during the day, they were likely suffering from impaired performance due to the circadian timing of the low period in performance and high period of fatigue and extended hours of wakefulness.

An analysis of the train handling data when superimposed with the track profile indicated that the LE was reacting to speed fluctuations of the train, rather than anticipating the changing terrain. This type of reactive train handling is consistent with scientific studies of fatigued operators. [30] The LE would likely have been affected by fatigue at the time of the occurrence due to circadian factors. The risk of fatigue would have been increased if OSA was present.

Even though the crew members were likely fatigued, they were able to respond to the discrete, concrete stimuli such as the whistle boards and crossings; however, their planning and reaction to more complex issues was likely degraded.

2.3 Obscuration of Signal Lenses due to Snow

Fixed signal recognition combined with in-cab communication and radio broadcasts (as per CROR Rules 34 and 578) are considered critical tasks for the safe operation of train movements. Although there was no operating rule that instructed crews to slow down in bad weather, CROR Rule 34(a) required that train crews must know the indication of each fixed signal before passing it. Therefore, crews are required to reduce train speed approaching such signals if the signals cannot be positively identified within the train's safe braking distance. Reliance on crew procedures alone does not ensure that signal indications are accurately recognized and followed. The safety defence for an imperfectly displayed fixed signal, or the absence of a fixed signal where one is usually displayed, is CROR Rule 27, which requires that train crews regard such a signal as the most restrictive indication it is capable of displaying, and report the problem to the RTC. In this occurrence, the most restrictive indication that advance signal 971 was capable of displaying was a "restricting signal – proceed at restricted speed" (CROR Rule 436).

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30 J. Dorrian, F. Hussey and D. Dawson, "Train Driving Efficiency and Safety: Examining the Cost of Fatigue," *Journal of Sleep Research*, Volume 16, Issue 1, 2007.

Railway signal lenses are relatively small in size and are viewed from remote distances. It can be difficult for crews to appreciate that a signal is becoming obscured due to snow accumulation. The reduced visibility of a signal lens in these circumstances is not as apparent to crews as the more obvious conditions such as fog, heavy rain or blowing snow.

The accumulation of snow on signals is particularly an issue for faster moving passenger trains given the shorter length of time for crews to identify a signal indication, as compared to slower moving freight trains. Field testing confirmed that a single thin layer of obscurant over the signal lens greatly reduced the distance from which the signal colour could be distinguished and the indication perceived. As the train was moving into the frontal edge of the storm, the strong winds and blowing snow were reducing visibility. Because the temperature was within 1° of freezing, it caused snow to accumulate on the signals. The deteriorating weather conditions and snow affected the crew’s ability to accurately perceive advance signal 971 and home signal 1007 from the usual distance.

In clear visibility, the home signal can be viewed from about 3 miles away, which, at track speed (80 mph), gives a train crew about 2.5 minutes to correctly identify and respond to the signal. However, when visibility is reduced, the time available for the crew is diminished. In this occurrence, field testing determined that, at the speed the train was travelling, the crew had less than 10 seconds to identify and respond to the signal indication. In areas prone to blowing snow conditions, railway signals can be obscured and completely blocked by snow, which significantly reduces crew perception distances and increases the risk of signal misperception.

2.4 Radios and Communications

Field testing determined that radio communications for CN 308 were loud and clear from Saint-Vallier to Joffre (a distance of approximately 27 miles). However, VIA 15’s radio communications from Saint-Vallier on the same evening were not audible and not clear until the train was approaching Joffre. Therefore, the VIA radio transmission range would appear to be poor in this geographic area.

On the day of the accident, while the crew on CN 308 was calling the signal at Carrier West, VIA 15 was approximately 13 miles away. Had the VIA crew heard the communication, it would have provided a cue that a meet would take place. Conversely, the crew of CN 308 did not hear the crew of VIA 15 calling their signals on channel 1. What the VIA crew saw as well as whether they communicated it between themselves and made a radio broadcast on channel 1 could not be verified because there was no in-cab voice recording and forward video capabilities in the lead locomotive.

2.5 Audio and Video Recorders

The Board’s recommendation R03-02, issued in July 2003, addressed the need for on-board cab voice recordings. Objective data are invaluable to investigators in understanding the sequence of events and identifying operational problems and human factors, including crew performance. In this investigation, the absence of voice recordings made it impossible to confirm the nature of VIA 15’s crew communications. Where investigators are not aware of all of the events surrounding an occurrence, and are unable to understand all of the human factors involved, the Canadian railway industry is deprived of valuable information that can improve safety.

Similarly, forward video recorders can quickly direct the focus of an investigation by identifying obvious hazards and providing investigators with a good understanding of the sequence of events leading up to the accident. They also allow the elimination of extraneous factors that are shown not to be involved in the accident. Accident investigation agencies benefit from more efficient, timely, and accurate collection, assimilation, and analysis of information with corresponding benefits of a shortened investigation process and more timely communication of safety deficiencies and accident reports to stakeholders and the public.

In this instance, the lack of audio and forward video recorders prolonged the investigation while tests were conducted to identify potential faults within the railway radio and signal systems, and to conduct visibility tests of railway signals. Although the data obtained were helpful, they were limited in comparison to those that would have been provided by on-board audio and forward video recorders.

Despite the significant safety benefits to the company, investigators, and the travelling public, there is no current requirement for on-board audio recorders. While some railways have implemented forward video recorders, there has not been an across-the-board, consistent implementation. The lack of these tools deprives accident investigators of valuable sources of information that can enhance safety.

2.6 Positive Train Control

The CTC provides train crews with a series of signal indications that require them to take action relative to the signal displayed. The system does not ensure positive train separation. It also does not provide any indication that a train may be about to pass beyond a restricted location, nor does it provide automatic enforcement to slow or stop a train before it passes a stop signal or other point of restriction. The CTC does not display the train's exact location within a block, nor its speed.

During this accident, VIA 15 did not approach the controlled signal at Saint-Charles-de-Bellechasse as if the crew was expecting a restricting signal, requiring the train to enter the siding at 15 mph and prepare to stop. Although the railways have defence mechanisms to help prevent accidents, such as 2-man crews, the CROR, General Operating Instructions and the CTC, none of these defences protect against non-application or misapplication of a rule. This includes occasions when a train crew erroneously perceives signal indications to be more permissive. These defence mechanisms do not consistently provide a reliable safety barrier to prevent train accidents. There are other defences that have the ability to alert crew members if they do not respond appropriately to a signal or other restriction. Some, such as PTC, can (as a last resort) intervene to slow or stop the train by applying the brakes.

The TSB has discussed the benefits of PTC and found that it has the potential to significantly reduce the risk of collision between trains (TSB reports R07E0129, R08W0058, R09W0118 and R09V0230). These investigations involved various types of collisions (head-on, side, or tail-end) between freight trains.

In the U.S., passenger train movements in the northeast corridor have been protected with in-cab signalling for decades. Since 2000, Amtrak has further enhanced the system to provide PTC functionalities. The rest of the railway industry is moving towards the widespread installation of additional system defences, as required by the *Railway Safety Improvement Act* (2008) ruling for Class 1 railroad carriers and entities providing regularly scheduled intercity or commuter rail passenger transportation, with limited exceptions determined by the FRA.

Although there is no similar legislation in place in Canada, both CN and CPR are acquiring expertise as they develop their implementation plans to meet the PTC requirements for their U.S. operations. This accident involved a passenger train with an impending danger to passengers and residents living in the vicinity of the track. Additional defences such as PTC, ACSES, V-ETMS, or in-cab signalling may have prevented the derailment. Without more affirmative types of additional protection in areas where there are elevated hazards, such as high-speed passenger train corridors, there is an increased risk of a passenger train collision or derailment.

2.7 Railway Medical Assessments

It is common practice for companies to require individuals in safety-critical positions to undertake medicals when joining a company. This enables companies to identify and mitigate any potential risks to safety. A valid medical certificate from another company provides some assurance of an employee's fitness for duty. However, it may not provide all the necessary information for the employer to identify and mitigate health risks.

When the LE changed employers, the railway companies did not have a formal process to transfer medical data for all employees switching between companies. Therefore, VIA's medical department did not have access to CN's medical file for the employee. VIA was not aware that the LE had previously been identified by CN as having a risk for OSA and that he had been requested by CN to undergo a sleep study for further evaluation.

In this occurrence, the OSA health concern was not effectively communicated between companies and the condition was not acted upon by the new employer. If medical information is not effectively tracked, transferred and communicated when an employee working in a safety-critical position moves to another railway company, health issues that affect operator performance can remain undetected, increasing the risk of unsafe train operations.

2.8 Medical Guidance to Industry

Medical decisions were made based on the number of attributes present rather than the total ANC score provided by the RAC handbook that the LE was at high risk for severe OSA and required the LE to undergo further testing.

Contrary to the approach used in the U.S. for commercial motor vehicle operators, the RAC handbook does not provide specific guidelines for railway companies to make decisions whether to remove an employee from service until the test could be carried out. Therefore, as evidenced by the CN practice, medical staff may not take the adequate course of action, which increases the risk that employees with severe medical conditions are allowed to continue to work in safety-critical positions for extended periods of time while waiting for testing. Had there been a maximum period of time in the RAC guidelines for testing to be conducted, the LE would not have been allowed to work in a safety-critical position for 5 years without ever being tested.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. The derailment occurred when the train entered the siding track while travelling at excessive speed.
2. The crew's mental model that CN 308 was still at Joffre, combined with the poor weather conditions, likely led to the misperception that the advance signal was clear, rather than clear-to-stop.
3. Due to reduced visibility conditions caused by the snow, the home signal indication at Saint-Charles-de-Bellechasse was not recognized and acted upon until the crew was within approximately 500 feet of the main-track switch.
4. The crew's planning and reaction to more complex issues was likely degraded due to fatigue.

3.2 Findings as to Risk

1. In areas prone to blowing snow conditions, railway signals can be obscured and completely blocked by snow, which significantly reduces crew perception distances and increases the risk of signal misperception.
2. Existing defences, such as 2-man crews and the Centralized Traffic Control System (CTC), do not ensure that signal indications will always be followed. In the absence of additional defences, the risk of serious train collisions or derailments remains.
3. If medical information is not effectively tracked, transferred and communicated when an employee working in a safety-critical position moves to another railway company, health issues that affect operator performance can remain undetected, increasing the risk of unsafe train operations.
4. The Railway Association of Canada (RAC) does not provide specific guidelines for railway companies to make decisions on whether to remove an employee from service until obstructive sleep apnea (OSA) testing is carried out. This increases the risk that employees with severe medical conditions will continue to work in safety-critical positions while waiting to be tested.
5. The absence of voice recordings made it impossible to confirm the nature of VIA 15's crew communications. Where investigators are not able to understand all of the human factors involved, the Canadian railway industry is deprived of valuable information that can improve safety.

3.3 Other Finding

1. The absence of a forward video recording on the lead locomotive led to an extended investigation.

4.0 Safety Action

4.1 Action Taken

4.1.1 TSB Rail Safety Advisory

On 03 August 2010, the TSB issued Rail Safety Advisory (RSA) 02/10 (Reduced Visibility and Signals Obscured due to Poor Weather Conditions). The advisory addressed the application of *Canadian Rail Operating Rules* (CROR) Rule 27, which requires train crews to consider an imperfectly displayed signal as the most restrictive indication that can be displayed and then to report the condition to the rail traffic controller (RTC). Although the RTC must communicate immediately with the Signals and Communications Department so that technicians can take corrective action, the advisory noted that the RTC is not required to issue a warning or a speed restriction. Furthermore, train crews are expected to operate as close as safely possible to track speed unless they are issued a formal speed restriction. The advisory concluded that "Given the serious consequences of this occurrence, Transport Canada may wish to review operating procedures when there are known visibility restrictions due to inclement weather."

Transport Canada (TC) responded to the safety advisory stating that:

- TC Rail Safety has followed up with VIA Rail Canada Inc. (VIA) and VIA has committed to conduct a risk assessment for this accident;
- VIA conducted a debriefing and review of this accident on 12 April 2010 and published the report on 14 October 2010;
- VIA held critical incident workshops across Canada and all of the locomotive engineers from VIA had attended this workshop by the end of November 2010;
- the workshops are now incorporated as part of the 3-year recertification program for all locomotive engineers; and
- TC has copied the Railway Association of Canada (RAC) on its response and also included a copy of TSB's RSA 02/10 in order for the RAC to circulate amongst its member railways so that they may review their own operating procedures.

4.1.2 Railway Medical Assessments

Since February 2011, locomotive engineers transferring from Canadian National (CN) to VIA are provided with an Authorization Form in their VIA "Welcome Package." This is a consent form that the new employee must sign to release his/her CN medical file to VIA.

CN reviewed its internal procedures to ensure that any delay in obtaining medical information or testing is reasonable. CN issued instructions to occupational health and safety staff that, where an employee is required to provide medical testing or results, but based on medical assessment is allowed to remain in service pending receipt of the results, the employee should be given a finite but reasonable period of time (based on individual circumstances). If the information is not provided to the chief medical officer within that finite period, the employee is notified that there will be restrictions from duty.

4.1.3 Fatigue

The RAC advised that, following the release of the *Railway Safety Act* Review Panel report in November 2007, a tri-party working group was established (Labour, Industry and TC) to address report recommendations related to fatigue. In particular, the working group focused on enhanced fatigue management plans (FMP) and developed a document entitled *Fatigue Management Plans: Requirements and Assessment Guidelines* for the industry and their employees. The document was published in September 2010 and revised in March 2011. It has been widely distributed and is available on the TC and RAC websites.

The guidelines make specific references to the need for both education and training related to fatigue. Quality of sleep is designated as a risk factor, as well as undiagnosed or untreated medical conditions (for example, sleep apnea) that may affect fatigue. Education and training outlined in the guidelines cover issues such as: sleep hygiene, sleep disorders, sleep performance, diet, health and lifestyle, stress management, and countermeasures.

The RAC proposed amendments to the work/rest rules to accommodate the new FMP guidelines. TC approved the rule change and has started examining the updated FMPs submitted by railway companies.

4.2 Outstanding Board Recommendations

This accident highlights 2 areas in which the Board has previously made recommendations addressed at reducing the risk to rail safety.

4.2.1 Additional Defences – Signal Indications

In 2001, the Board recommended that:

> The Department of Transport and the railway industry implement additional backup safety defences to help ensure that signal indications are consistently recognized and followed.
>
> (R00-04, issued February 2001)

TC supported the intent of this recommendation and increased its compliance monitoring of activities related to signal recognition. While no additional physical safety defences were engineered into the Centralized Traffic Control System (CTC) to ensure consistent recognition and response to signal indications, some administrative changes were made by CPR after an accident in Redgrave, British Columbia, in 2009 (TSB report R09V0230). The response to Recommendation R00-04 was assessed as **Satisfactory in Part**.

Although the railways have some defence mechanisms to prevent accidents (for example, 2-man crews, *Canadian Rail Operating Rules* (CROR), General Operating Instructions and the CTC), none of these defences ensure that signal indications will always be followed. In this occurrence, the VIA passenger train entered the siding at excessive speed and derailed after the crew misidentified the advance signal during poor visibility conditions.

Additional defences such as Positive Train Control (PTC), Advanced Civil Speed Enforcement Systems (ACSES), Vital Electronic Train Management Systems (V-ETMS), or in-cab signalling may have prevented the derailment. Since 2007, the TSB has conducted a number of investigations in which signal identification and response were determined to be contributing factors in the accident. Therefore, the Board remains concerned that, without additional backup safety defences to help ensure that signal indications are consistently recognized and followed, there remains a risk of a serious train collision or derailment.

4.2.2 Voice Recordings in Locomotives

The Board has previously made recommendations on the topic of on-board voice recordings. In TSB investigation R99T0017, the Board recommended that:

> The Department of Transport, in conjunction with the railway industry, establish comprehensive national standards for locomotive data recorders that include a requirement for an on-board cab voice recording interfaced with on-board communications systems.
>
> (R03-02, issued July 2003)

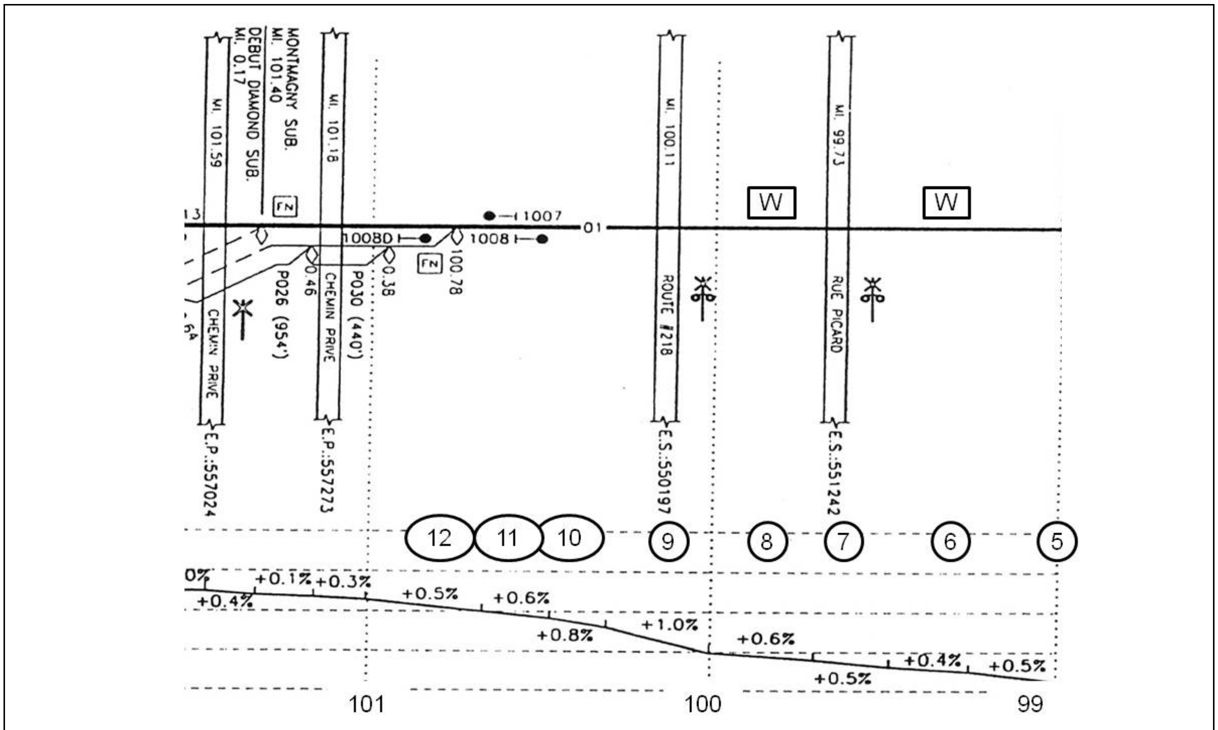
Considering that TC had implemented partial performance specifications for data collection, the Board assessed TC's response as **Satisfactory in Part**.

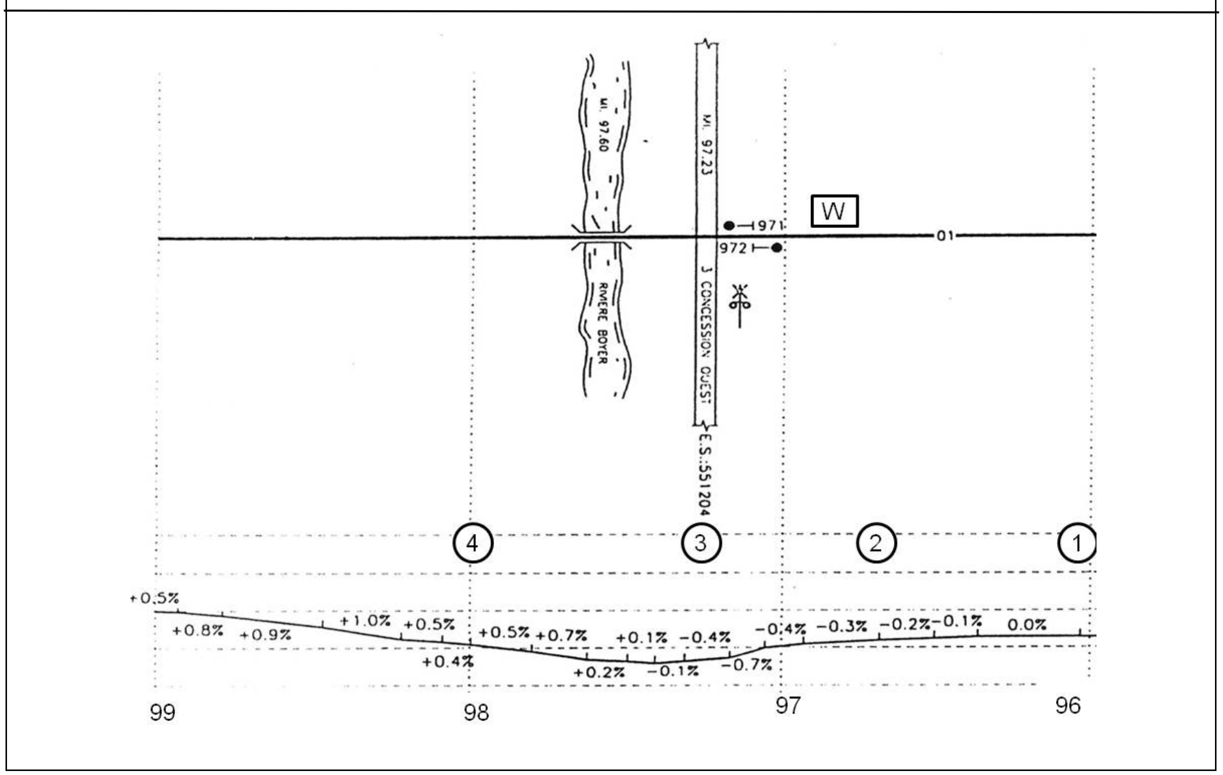
Had the locomotive event recorder in the controlling locomotive cab been equipped with voice recording capability, it may have been possible to determine more definitively the sequence of events as the train approached the occurrence location. Therefore, the Board remains concerned that the use of voice recordings as a valuable safety tool has not been implemented.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 21 December 2011.

Visit the Transportation Safety Board's website (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.

Appendix A – Canadian National Operating Diagrams
(Miles 96 to 101 of the Montmagny Subdivision)





Appendix B – Other Relevant Occurrences

R07E0129

On 27 October 2007, at 0505 Mountain Daylight Time, the crew on Canadian National (CN) train A41751-26 (train 417) operating westward on the main track of the Edson Subdivision initiated an emergency brake application approximately 475 feet from a stop signal at the west end of Peers, Alberta. The train was unable to stop prior to passing the signal and collided with eastbound CN train M34251-26 (train 342) that was entering the siding. As a result of the collision, train 417's locomotives and 22 cars derailed. Ten other cars sustained damage, but were not derailed. Five cars on train 342 derailed and 4 other cars sustained damage, but did not derail. There were no serious injuries and no release of dangerous goods.

R08W0058

On 07 April 2008, at approximately 0807 Central Standard Time, southbound Canadian Pacific Railway (CPR) freight train 498-07 struck the tail end of stationary CPR train 292-05 at Mile 97.5 of the Weyburn Subdivision at Centennial Station near Ralph, Saskatchewan. Seven cars on train 292-05 derailed and 2 cars on train 498-07 derailed. In addition, 2 cars on CPR freight train 497-04, which had stopped adjacent to train 292-05 in Centennial siding, derailed. A fire ensued involving 2 cars loaded with glycol, 1 dangerous goods car containing vinyl acetate, 1 residue liquefied petroleum gas tank car and 1 empty bulkhead flat car. Local residents within a 1-mile radius of the accident were evacuated. There were no injuries.

R09W0118

On 28 June 2009, at 0631 Central Daylight Time, while proceeding westward on the Redditt Subdivision, CN train Q10131-27 (train 101) collided with the tail end of CN train M30131-27 (train 301), which was stopped on the main track at Mile 105.70. As a result of the collision, the 4 tail-end intermodal cars (6 platforms in total) from train 301 and the 3 head-end locomotives from train 101 derailed. The locomotive engineer from train 101 was transported to hospital with minor injuries.

R09V0230

On 30 October 2009, at about 2225 Pacific Daylight Time, CPR train 355-429 operating westward on the signalled siding track at Redgrave, British Columbia, on the Mountain Subdivision, side-collided with eastbound CPR train 110-30 that was stopped on the main track. As a result of the collision, 2 locomotives and 6 cars derailed. There were no serious injuries. Approximately 3000 gallons of diesel fuel spilled.

Appendix C – Screening for Obstructive Sleep Apnea in Commercial Motor Vehicle Operators – In-Service and Out-of-Service Evaluation Criteria

In-service evaluation [31] recommended if driver falls into any 1 of the following 5 major categories (3 months' maximum certification):	*Out-of-service immediate evaluation* [32] recommended if driver meets any 1 of the following factors:
1. Sleep history suggestive of obstructive sleep apnea (OSA) (snoring, excessive daytime sleepiness, witnessed apneas). 2. Two or more of the following: a) Body Mass Index (BMI) ≥ 35kg/m²; b) Neck circumference greater than 17 inches in men, 16 inches in women; c) Hypertension (new, uncontrolled, or unable to control with less than 2 medications); 3. Epworth Sleepiness Scale >10; 4. Previously diagnosed sleep disorder; compliance claimed, but no recent medical visits/compliance data available for immediate review (must be reviewed within 3-month period); if found not to be compliant, should be removed from service (includes surgical treatment). 5. Apnea-Hypopnea Index >5 but <30 in a prior sleep study or polysomnogram and no excessive daytime somnolence (Epworth Sleepiness Scale <11), no motor vehicle accidents, no hypertension requiring 2 or more agents to control.	1. Observed unexplained excessive daytime sleepiness (sleeping in examination or waiting room) or confessed excessive sleepiness. 2. Motor vehicle accident (run off road, at-fault, rear-end collision) likely related to sleep disturbance, unless evaluated for sleep disorder in the interim. 3. Epworth Sleepiness Scale ≥16 or Functional Outcomes of Sleep Questionnaire <18. 4. Previously diagnosed sleep disorder: a) Noncompliant (CPAP [continuous positive airway pressure] treatment not tolerated); b) No recent follow-up (within recommended time frame); c) Any surgical approach with no objective follow-up. 5. Apnea-Hypopnea Index >30.

31 "Sleep Apnea and Commercial Motor Vehicle Operators: Statement from the Joint Task Force of the American College of Chest Physicians, American College of Occupational and Environmental Medicine and the National Sleep Foundation."

32 "Sleep Apnea and Commercial Motor Vehicle Operators: Statement from the Joint Task Force of the American College of Chest Physicians, American College of Occupational and Environmental Medicine and the National Sleep Foundation."

Appendix D – Glossary

ACSES	Advanced Civil Speed Enforcement System
Amtrak	National Passenger Rail Corporation
ANC	adjusted neck circumference
BMI	Body Mass Index
cm	centimetres
CN	Canadian National
Conrail	Consolidated Rail Corporation
CPR	Canadian Pacific Railway
CROR	*Canadian Rail Operating Rules*
CTC	Centralized Traffic Control System
FMP	fatigue management plan
FRA	Federal Railroad Administration
HHP	high horsepower
ICLE	in-charge locomotive engineer
km/h	kilometres per hour
LE	operating locomotive engineer
mm	millimetres
mph	miles per hour
NTSB	National Transportation Safety Board
OHN	occupational health nurse
OSA	obstructive sleep apnea
PIH	poison by inhalation
PTC	Positive Train Control
RAC	Railway Association of Canada
RSAC	Railroad Safety Advisory Committee
RSIA	*Rail Safety Improvement Act*
RTC	rail traffic controller
TC	Transport Canada
TIH	toxic by inhalation
TSB	Transportation Safety Board of Canada
U.S.	United States
V-ETMS	Vital Electronic Train Management System
VIA	VIA Rail Canada Inc.
°C	degrees Celsius