Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAIL TRANSPORTATION SAFETY INVESTIGATION REPORT R18D0096

MOVEMENT EXCEEDS LIMITS OF AUTHORITY

VIA Rail Canada Inc.
Passenger train P02921-31
Mile 99.1, Drummondville Subdivision
Drummondville, Quebec
31 October 2018

Canada

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Citation

Transportation Safety Board of Canada, *Rail Transportation Safety Investigation Report R18D0096* (released 16 September 2020).

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Rail transportation safety investigation report R18D0096

Cat. No. TU3-11/18-0096E-PDF
ISBN: 978-0-660-35899-4

This report is available on the website of the Transportation Safety Board of Canada at www.tsb.gc.ca

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Summary

On 31 October 2018, at approximately 1935,[1] VIA Rail Canada Inc. (VIA) passenger train P02921-31 (VIA 29), proceeding west on the Canadian National Railway Company (CN) Drummondville Subdivision at approximately 32 mph, passed Signal 991 that was displaying a stop indication a few seconds after eastbound VIA passenger train P02821-31 (VIA 28) had cleared the main track. There were no injuries.

1.0 FACTUAL INFORMATION

1.1 The occurrence

On 31 October 2018, at approximately 1745, VIA 29 departed west from Québec, Quebec, on CN's Drummondville Subdivision, and was destined for Montréal, Quebec. VIA 29 consisted of 1 locomotive and 4 light, rapid, comfortable (LRC) passenger coaches. It weighed approximately 365 tons and was 397 feet long. It had 112 passengers on board.

On the same day, VIA 28 departed Montréal at approximately 1825. It was travelling east also on CN's Drummondville Subdivision, en route to Québec. VIA 28 also consisted of 1 locomotive and 4 LRC passenger coaches, weighed approximately 365 tons and was 397 feet long. It had 75 passengers on board.

The operating crews of both trains consisted of 2 qualified locomotive engineers—an operating locomotive engineer (LE) and an in-charge locomotive engineer (ICLE). For each

[1] All times are Eastern Daylight Time.

crew, the LE was positioned at the controls on the right side of the locomotive cab. The ICLE was positioned at the left side of the cab and was responsible for various duties such as radio communications, copying authorities and emergency response.

CN's Drummondville Subdivision is a single main track with several sidings where trains can meet and pass each other. In accordance with VIA's schedule, the 2 trains typically met at Drummondville.[2] At about 1926, in anticipation of the meet, the CN rail traffic controller (RTC), located in Montréal, lined the Drummondville west siding switch for VIA 28 to enter the siding and routed both trains beyond Drummondville by requesting follow-up Signal 984D for VIA 28 and follow-up signals 991, 1005 and 1027 for VIA 29. VIA 29 was to proceed on the main track at Drummondville.

At about 1933, VIA 29 passed Signal 983 displaying Clear to Stop[3] and broadcast the signal indication over the radio as per *Canadian Rail Operating Rules* (CROR) Rule 578.[4] While at the Drummondville Station, located at Mile 98.31, passengers were loaded and unloaded from the station platform located on the main track, within the controlled location at Drummondville East. The LE and ICLE switched positions and briefed on the expected stop at Signal 991. At approximately 1935, VIA 29 departed the station and approached Signal 991 (Figure 1) from the east as VIA 28 was approaching from the west. As VIA 28 was entering the siding, VIA 29, proceeding at approximately 32 mph, passed Signal 991, which was displaying a Stop indication,[5] a few seconds after the last car of VIA 28 cleared the main track. The crew did not broadcast the signal indication of Signal 991.

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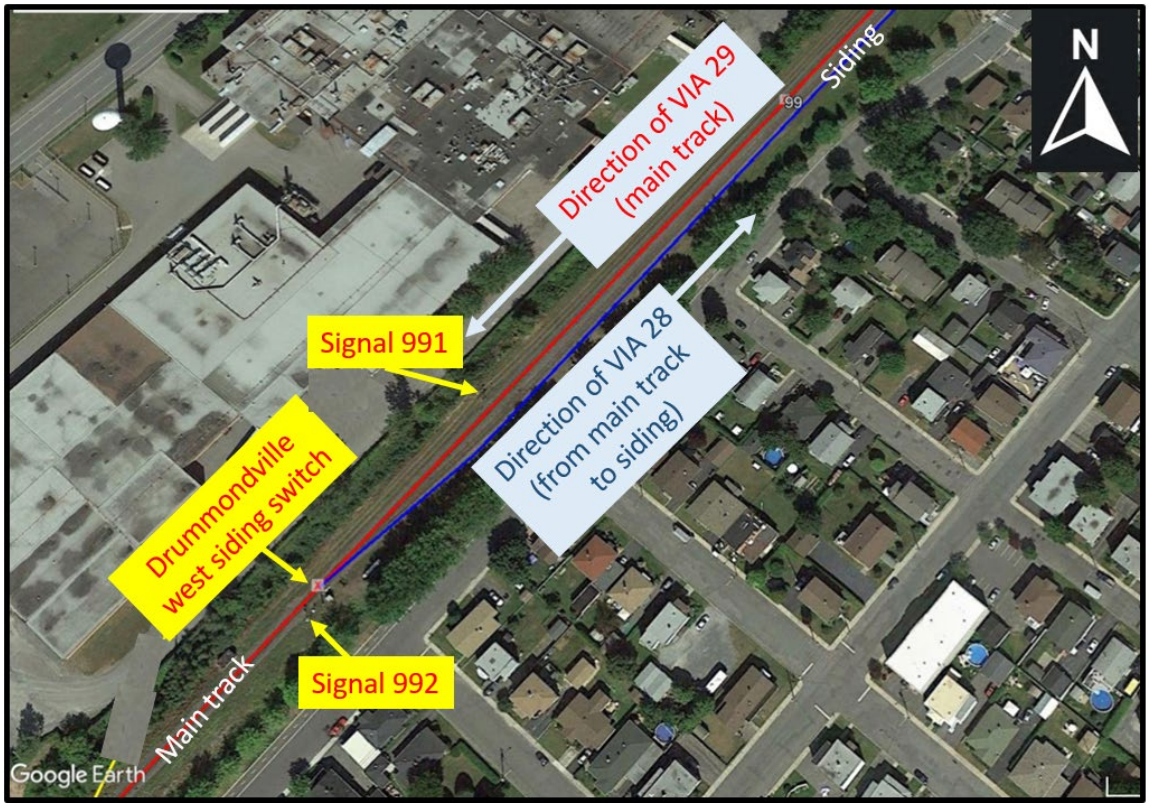
2 Because Drummondville is halfway between Québec and Montréal, crew members usually switch places and roles at the Drummondville Station.

3 Transport Canada, *Canadian Rail Operating Rules* (18 May 2018), Rule 411: Clear to Stop, p. 64.

4 *Canadian Rail Operating Rules* Rule 578 states in part: "(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." (Transport Canada, *Canadian Rail Operating Rules* [18 May 2018], Rule 578: Radio Broadcast Requirements, p. 81.)

5 Transport Canada, *Canadian Rail Operating Rules* (18 May 2018), Rule 439: Stop, p. 72.

Figure 1. Occurrence area (Source: Google Earth, with TSB annotations)



VIA 29 ran through the Drummondville west siding switch and continued westward toward Montréal. VIA 29's crew members were unaware that they had passed a Stop indication or that VIA 28 had only just cleared the main track. There were no injuries.

At about 2047, when VIA 29 was near St-Lambert, Quebec (Mile 70.3 of the St-Hyacinthe Subdivision), CN advised VIA Operations that VIA 29 had passed a Stop indication at Signal 991. Approximately 10 minutes later (3 minutes before VIA 29's arrival in Montréal), VIA Operations called the VIA 29 crew members to inform them that they had passed Signal 991 displaying a Stop indication and advised them to wait at Central Station.

At the time of the occurrence, it was dark and the temperature was 4 °C with cloudy skies.

1.2 Sequence of events

Table 1 provides a summary of the events based on the review of the available information, including locomotive event recorder data, forward-facing video camera recordings, radio communication records, interviews, and signal logs.

Table 1. Sequence of events

Time*	Event
1926:27	The CN RTC lined the Drummondville west siding switch for VIA 28 to enter the siding.
1928:06	Signal 992 displayed a Restricting indication** for VIA 28 to enter the siding.

Time*	Event
1930 (approx.)	VIA 29's ICLE advised the service manager by radio to prepare for the arrival at the Drummondville Station, at which time the service manager discussed the fact that VIA 28 was short of some food items.
1933:23	Signal 983 for VIA 29 displayed a Clear to Stop indication.
1933:42	VIA 29 stopped at the Drummondville Station to drop off and pick up passengers.
1933:48	VIA 29 extinguished the headlight as per normal practice while stopped at the station.
1934 (approx.)	VIA 29's LE and ICLE switched places as per normal practice.
1934:05 (approx.)	While switching places, the crew members confirmed that the last signal indication had been written down as Clear to Stop. The service manager advised that VIA 29 could depart the Drummondville Station and that the food items for VIA 28 had been left at the station.
1935:16	VIA 29 departed the Drummondville Station.
1936:28	VIA 28's LE turned off the headlight in preparation for the meet with VIA 29.
1936:28	Signal 991, displaying a Stop indication, was visible to the crew of VIA 29.
1936:31	VIA 29's LE turned on the headlight as per normal practice at the approach of a public crossing.
1936:40	VIA 29's LE turned off the headlight in preparation for the meet with VIA 28.
1936:53	VIA 29's LE throttled up from 0 to 1.
1936:54	VIA 28 entered the siding.
1937 (approx.)	As per normal procedure, VIA 29's ICLE consulted his watch to write the departure time from the Drummondville Station. He deducted 2 minutes from the time as they were already proceeding.
1937:08	VIA 29's ICLE indicated that Signal 1005 (east of Saint-Germain, Quebec) already displayed a Clear indication.
1937:11	VIA 28's last car cleared Signal 992.
1937:11	Signal 1005 extinguished.***
1937:19	VIA 29's ICLE turned on the cab lights and waved at VIA 28's crew and VIA 28's crew waved back.
1937:20	VIA 29's ICLE called VIA 28's ICLE to inform that the food items had been left on an outside bench at the Drummondville Station.
1937:25	VIA 29 passed Signal 991 displaying a Stop indication.
1937:29	VIA 29 travelled through the Drummondville west siding switch at Mile 99.14.
1937:32	The CN RTC received a CROR Rule 439 alarm**** for Signal 991.
1937:33	Signal 1005 re-illuminated.
1937:49	VIA 29 turned on the headlight.
1939:09	The CN RTC acknowledged the Rule 439 alarm for Signal 991.
1945 (approx.)	The CN RTC tried to return the Drummondville west siding switch to its normal position, but could not restore it.
1950	The CN RTC asked a CN Signals and Communications employee to verify the Drummondville west siding switch.
1955	The CN Signals and Communications employee called the CN RTC and reported that the Drummondville west siding switch had sustained damage consistent with a switch that had been run through.*****

Time*	Event
2013	The CN RTC called VIA 29 to enquire what signal indication was displayed at Signal 991; VIA 29 advised that Signal 991 displayed a Clear indication.
2048 (approx.)	CN advised VIA Operations that VIA 29 had passed Signal 991 displaying a Stop indication.
2057 (approx.)	At Mile 73.2 of the St-Hyacinthe Subdivision, VIA Operations advised the crew members on VIA 29 by radio to wait at the Central Station and that they had passed Signal 991 displaying a Stop indication.

* Events that could not be verified with respect to time and/or exact circumstances are identified as "approx."

** Transport Canada, *Canadian Rail Operating Rules* (18 May 2018), Rule 436: Restricting, p. 72.

*** Because VIA 28 was occupying the block between Signal 1005 and Signal 992, Signal 1005 displayed a Clear indication and then extinguished once VIA 28 was completely clear of the block located at the east siding switch.

**** A Rule 439 alarm is both displayed on the rail traffic control screen and sounded whenever rolling stock passes a signal indicating Stop.

***** "Run through" in railway industry terminology indicates that the wheel flanges of rolling stock have forced over a track switch that has not been set. The weight of the rolling stock combines with its momentum to create lateral forces that are transferred to the rails through the wheel flanges as the wheels encounter the narrowing track gauge of a reversed switch.

1.3 Subdivision information

The Drummondville Subdivision belongs to CN and is part of the Québec–Windsor rail corridor. It is used by CN freight trains and VIA passenger trains travelling to and from Ottawa, Ontario; Toronto, Ontario; and northern Quebec. Rail traffic consists of about 20 trains per day, some 11 of which are passenger trains.

The Drummondville Subdivision runs from Saint-Romuald, Quebec, Mile 5.6, to Sainte-Rosalie, Quebec, Mile 125.1, and consists of a single main track with several sidings where trains can meet and pass. VIA trains operate on the Drummondville Subdivision starting at Mile 7.95 (from the Bridge Subdivision). Train movements are governed by the centralized traffic control system (CTC), as authorized by the CROR, and supervised by an RTC located in Montréal.

The maximum authorized speed for LRC trains on the Drummondville Subdivision is 100 mph. Given VIA 29's consist (passenger plus[6]), it was authorized to operate at 85 mph between Mile 66.8 and Mile 125.1; however, a permanent slow order of 30 mph was in effect from Mile 97.5 to Mile 99.0, just before Signal 991. In addition, VIA trains travel at slower speeds through this area because they are stopping at the Drummondville Station.

1.4 Crew information

The crew members of VIA 29 and VIA 28 were qualified for their respective positions, were familiar with the territory, and met established rest and fitness requirements. VIA 29's LE

6 Passenger plus is "[a]pplicable to VIA trains with F40 locomotives and LRC, HEP1, HEP2 or Glen Fraser cars. Also applicable to P42 locomotives or Renaissance cars when mixed with them." (Canadian National Railway Company, Eastern Canada Region, Champlain Sub-Region, Time Table 84 [July 2016], p. 3.)

had about 10 years of experience in train operations, and started working as an LE for VIA in 2011. VIA 29's ICLE had 7 years of experience in train operations, and started working as an LE for VIA in January 2017. This was the first shift for VIA 29's LE since 26 October 2018 and the first shift for VIA 29's ICLE since 20 October 2018.

Data collected during the investigation revealed that none of the factors that can contribute to fatigue[7] were present at the time of the occurrence.

1.5 Centralized traffic control system

CTC is an advanced method of rail traffic control used by railways in Canada. It uses interconnected track circuits and field signals (controlled, advance, and intermediate signals) to control train movements. At each signal location, CTC track circuitry and associated systems allow for the display of a variety of signal indications (combinations of red, yellow, and green signal indications).

Controlled signals[8] are fixed signals situated at the entrance to a block[9] to govern a movement entering or using that block.

Signals are displayed on the rail traffic control screen either as a Stop or as a permissive indication,[10] and the CTC allows the RTC to monitor a train's progress along blocks in a subdivision. Track occupancies (i.e., location of trains) are also displayed; however, the train's exact location within a block is not known. Intermediate signals are actuated by the presence of a train; however, the system does not indicate the direction of travel of the train occupying the block.

Signal indications convey to the train crew information about the speed and other limits within which the train may operate. In addition, signal indications provide protection against some conditions, such as an occupied block,[11] broken rail, or a switch left open.

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7 Factors that can contribute to fatigue include chronic or acute lack of sleep, circadian rhythm impacts, particularly for night shifts, continuous wakefulness for more than 17 hours, sleep disorders, effects from medication or a medical condition.

8 A controlled signal is "[a] CTC block signal which is capable of displaying a Stop indication until requested to display a less restrictive indication by the RTC." (Source: Transport Canada, *Canadian Rail Operating Rules* [18 May 2018], Definitions, p. 7.)

9 A block is a length of track of defined limits. A movement's use of a block is governed by block signals. (Source: Transport Canada, *Canadian Rail Operating Rules* [18 May 2018], Definitions, p. 7.)

10 A permissive signal indication in CTC conveys two things: authority for a movement to pass the signal and occupy a portion of track beyond the signal, and information that governs the operation of a movement over a portion of track beyond the signal.

11 "Occupied" is understood to indicate that either a section of track is occupied by equipment or the track circuit is broken. There are various reasons why a circuit could be broken (e.g., a broken rail, an open switch).

Signal indications are progressive: the preceding signal (advance signal) can indicate what the next signal will display.

Train crews are required to understand the signal indications, communicate their understanding of the signals to those within the locomotive cab, and take appropriate action to comply with signal indications. According to CROR Rule 34, "[i]f no action is […] taken, or if the locomotive engineer 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."[12] The CTC does not provide automatic enforcement to comply with speed restrictions or to slow or stop a train before it passes a restrictive signal.

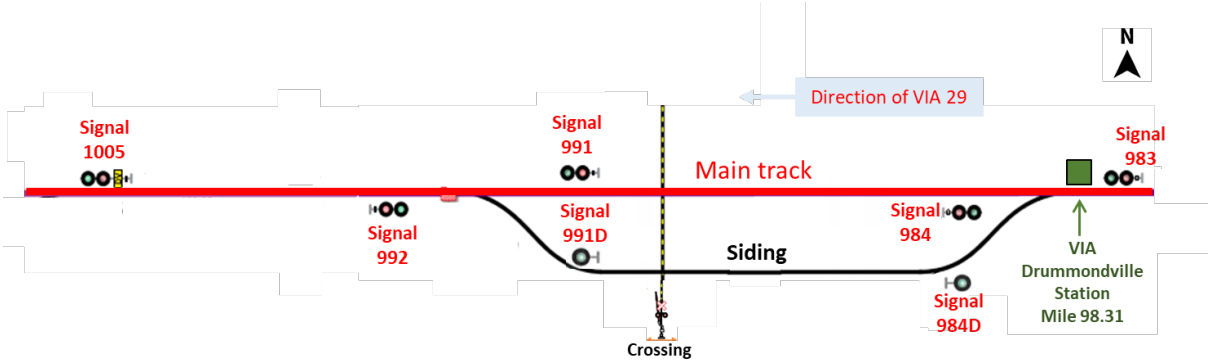
For this occurrence, the signal logs were reviewed to determine the sequence of signals for VIA 29. It was confirmed that the signal system was functioning as designed.

1.6 Signal information

Signal 991 is a high-mast, double-aspect signal located at Mile 99.1 of the CN Drummondville Subdivision.

Signal 1005 is also a high-mast, double-aspect signal. It is located at Mile 100.5 of the CN Drummondville Subdivision, 1.4 miles (7392 feet) from Signal 991 (Figure 2). Because of the alignment and elevation of the signals, if Signal 1005 is illuminated, it can be seen by an operating crew before having passed Signal 991.

Figure 2. Location of signals (Source: TSB)



For a westbound movement, such as VIA 29, Signal 1005 would not normally be illuminated at the same time as Signal 991. However, because the railway signalling system is non-directional, if an eastbound train is occupying the block east of Signal 1005, that signal will automatically be illuminated. In this occurrence, when eastbound VIA 28 entered the block east of Signal 1005, that signal illuminated until the train exited the block at Signal 992.

12 Transport Canada, *Canadian Rail Operating Rules* (18 May 2018), Rule 34: Fixed Signal Recognition and Compliance, pp. 25–26.

1.7 Visual perception

Situational awareness can be defined as perception, comprehension, and projection. The awareness of signal indications relies, as a first step, on visual detection. Crew members' accurate and timely visual perception of signals is essential for compliance. The visual perception of signals and the associated crew action is a sequential process involving the following steps: detect and see, identify and call, confirm indication between crew members, and adjust train speed accordingly.

The field of vision includes foveal vision and peripheral vision. Foveal vision is in the centre of the field of vision and is relatively small; however, that is where visual acuity is the greatest. Peripheral vision is characterized primarily by the ability to detect movement and changes in light, but not to distinguish details. Visual attention involves information selectivity. At night, there are less visual cues to facilitate spatial orientation (i.e., one's position relative to the environment and the objects within that environment).

In a complex system, such as rail transportation, even the most rigorous set of rules may not cover every contingency and interpretation by individuals. In addition, even motivated and experienced employees are subject to the normal slips, lapses, and mistakes that characterize human behaviour. The defence in depth philosophy advocated by safety specialists for complex systems involves multiple and diverse lines of defence to mitigate the risks of normal human errors. In some situations, people may fixate on certain information and forget to reinstate their information scan. These situations can also result in inaccurate situational awareness. Therefore, maintaining at least a high-level, overall understanding of events in the environment is essential for determining which factors are most important. Otherwise, it is often the neglected aspects of the situation that prove to be the key factors in a loss of situational awareness.[13]

In this occurrence, VIA 28 extinguished the headlight at 1936:28 while on the main track and entered the siding at 1936:54. The CROR state in part:

> Movements headed by equipment equipped with a headlight must display the headlight:
>
> (a) at full power in the direction of travel approaching all public crossings at grade until such crossings are fully occupied;
>
> (b) at full power in the direction of travel while moving on the main track [....][14]

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13 M. R. Endsley, B. Bolté, and D. G. Jones, *Designing for Situation Awareness: An Approach to User Centered Design* (Taylor & Francis, 2003).

14 Transport Canada, *Canadian Rail Operating Rules* (18 May 2018), Rule 17: Headlight, p. 24.

1.8 VIA Rail Canada Inc.'s instructions (Cab Red Zone)

Following the investigation into the March 2012 derailment and collision of VIA 92 near Burlington, Ontario, on the CN Oakville Subdivision,[15] where the 3 operating crew members were fatally injured and 45 people sustained various injuries, VIA implemented a set of special instructions called the Cab Red Zone (CRZ). CRZ is described as "the environment in the locomotive cab during critical periods, especially when multitasking is required by members of the train crew. Its purpose is to maintain optimal situational awareness to ensure the safety of the movement."[16] It is considered to be a critical time within the cab when there are simultaneous task requirements (e.g., copying an authority while approaching a slow order, or operating on signals that require the train to be prepared to stop at the next signal). When travelling at a time when a CRZ is in effect, communications within the locomotive cab, including the use of the radio, is restricted to immediate responsibilities for train operation. Furthermore, when stopped at a station or within a controlled block, the ICLE will record the indication of the last signal received prior to stopping.[17] Before commencing movement, all employees in the operating cab must confirm with each other the indication of the last signal in their direction of travel. When movement has commenced, CRZ must be applied until the next signal is reached. These instructions are in addition to the requirements of CROR Rule 34, which states the following:

> **34. FIXED SIGNAL RECOGNITION AND COMPLIANCE**
>
> (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.
>
> (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, but crew members must watch for and promptly communicate and act on any change of indication which may occur.
>
> The following signals/operating signs must be communicated:
>
> (i) Block and interlocking signals;
>
> […]
>
> (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 locomotive engineer is observed to be incapacitated, other crew members must take immediate action

15 TSB Railway Investigation Report R12T0038.

16 VIA Rail Canada Inc., *Passenger Train Instructions*, section 8: VIA Special Instructions, sub-section 8.8: Cab Red Zone (CRZ) (01 May 2019), p. 8-5.

17 As per Cab Red Zone special instructions, before stopping at any VIA station, the ICLE records in writing the indication of the last signal received.

> to ensure the safety of the movement, including stopping it in emergency if required.[18]

VIA's special instructions relating to CRZ indicate that not every possible situation can be covered by the CRZ. Consequently, it becomes part of the operating crew's responsibility to utilize the CRZ for any conditions warranted as "critical" to the movement.

In this occurrence, VIA 29 received a Clear to Stop signal indication at Signal 983. The ICLE copied the signal indication as per CRZ procedures. The crew then stopped at the Drummondville Station, switched places, confirmed the signal indication, and proceeded. In compliance with CRZ procedures, as soon as VIA 29 started to proceed, the crew restricted communications within the cab to train operations until the train reached the next signal, Signal 991. However, despite being in CRZ, the operating crew members of both trains discussed the transfer of food items from VIA 29 to VIA 28 over the radio. Furthermore, VIA 29's ICLE turned on the cab lights and the crew waved at VIA 28's crew when the 2 head-end locomotives met. VIA 28's crew waved back. Moreover, VIA 29's ICLE was visually inspecting VIA 28 as it was passing by, even though passenger trains in movement are exempted from inspecting passing trains according to CROR Rule 110.[19]

1.8.1 Crew resource management at VIA Rail Canada Inc.

Crew resource management (CRM) focuses on providing crews with the interpersonal skills required to carry out their tasks safely.

> CRM training typically consists of an ongoing training and monitoring process through which personnel are trained to approach their activities from a team perspective rather than from an individual perspective.[20]

Significant safety benefits were achieved in the aviation and marine industries with the introduction of CRM. Given the prevalence of human factors as indicated in rail accident statistics, this type of training could yield significant safety benefits in the rail industry.[21]

Since 2013, VIA has been providing its LEs with a 4-hour course known as locomotive cab awareness followed by recurrent training every 3 years. The objective of the course is to teach task prioritization, intra-crew communication, conflict resolution skills, techniques to manage distractions, the impact of fatigue on performance, and mitigation measures that

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18 Transport Canada, *Canadian Rail Operating Rules* (18 May 2018), Rule 34: Fixed Signal Recognition and Compliance, p. 25.

19 Transport Canada, *Canadian Rail Operating Rules* (18 May 2018), Rule 110: Inspecting Passing Trains and Transfers, p. 43.

20 S. S. Roop, C. A. Morgan, T. B. Kyte, et al., DOT/FRA/ORD-07/21, *Rail Crew Resource Management (CRM): The Business Case for CRM Training in the Railroad Industry* (Washington, DC: United States Department of Transportation, September 2007), p. 3.

21 S. S. Roop, C. A. Morgan, T. B. Kyte, et al., DOT/FRA/ORD-07/21, *Rail Crew Resource Management (CRM): The Business Case for CRM Training in the Railroad Industry* (Washington, DC: United States Department of Transportation, September 2007), pp. 4–8.

could be used to resolve these issues. In Montréal, the locomotive cab awareness course was mostly given in class; therefore, the LEs did not get to practice the techniques.

The course is part of a 2-week training session that includes first aid, VIA's *Passenger Train Instructions*, emergency response procedures, and a thorough overview of the CROR. The 2-week training is mandatory and is recurrent on a 3-year basis. In addition, VIA's training program includes a 1-day refresher, which takes place around the midterm mark within the 3-year period, before the next recertification session.

1.9 Review of forward-facing camera and observations of TSB investigator

Based on a review of the forward-facing camera recording from VIA 29, it was determined that

- the headlight activated on VIA 28;
- Signal 991 indicated Stop;
- the headlight turned off on VIA 28;
- Signal 1005 at Saint-Germain indicated Clear;
- Signal 1005 extinguished after VIA 28 had completely entered the siding.

In addition, the outside microphone of the forward-facing camera captured the audio while VIA 29 was travelling through the west siding switch.

Following the occurrence, a TSB investigator accompanied another VIA crew in the locomotive cab while travelling through this location. The following was noted:

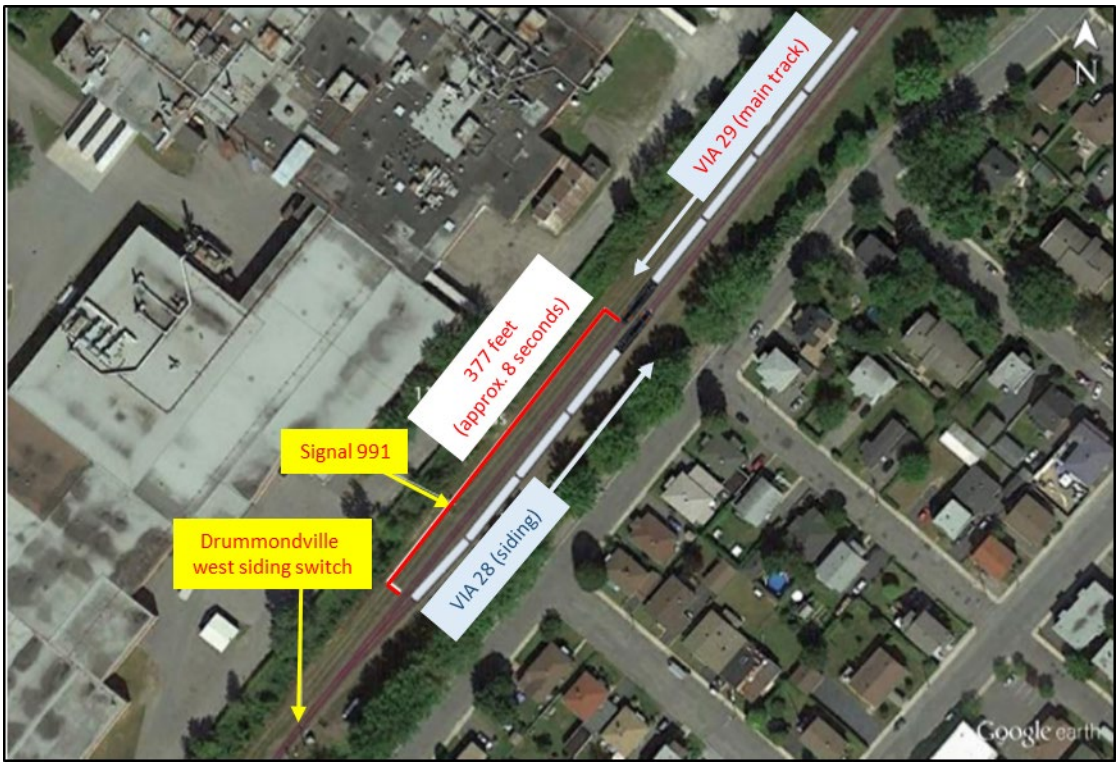
- When trains met, both crews were turning on the locomotive cab light and waving at each other.
- During a meet, when safe to do so, crews adjusted their speed to avoid a complete stop in anticipation of an eventual Clear signal indication.

1.9.1 Photogrammetric video analysis

The recordings from the forward-facing video cameras of the lead locomotives of both VIA 29 and VIA 28 were forwarded to the TSB Engineering Laboratory for analysis to determine the approximate distance between the 2 trains when the tail end of VIA 28 was still on the main track (Figure 3). The analysis concluded the following:

- The distance between the head end of the locomotive on VIA 29 and the tail end of the last LRC passenger coach on VIA 28 was approximately 377 feet at the point when the last coach on VIA 28 was completely in the siding.
- It would have taken VIA 29 approximately 8 seconds to travel that distance at its speed.

Figure 3. Distance between VIA 28 entering the siding and VIA 29 continuing on the main track (Source: Google Earth, with TSB annotations)



1.10 Rail traffic control

1.10.1 Handling of Rule 439 alarms

The CN *Rail Traffic Controller Manual* specifies the actions that must be taken by an RTC following a Rule 439 alarm, which occurs whenever rolling stock passes a signal indicating Stop. The CN *Rail Traffic Controller Manual* states the following:

- Immediately make every effort by radio or whatever means available to advise the locomotive engineer of the movement that passed the signal indicating STOP, to STOP immediately.
- Contact all other movements and foremen in the controlled block affected, advising them of the violation.
- Advise the Chief Dispatcher/MCO as soon as possible.
- Immediately authorize the movement as follows:
  - In CTC issue a Pass Stop 564 for a forward movement and a Work Authority 577 for a reverse movement (if required).
  - Within interlocking limits Rule 609, 610 or 611 apply.
- Instruct crew members to remain stopped until permission to proceed is given.[22]

22 Canadian National Railway Company, *Rail Traffic Controller Manual* (03 June 2016), section 6005: RTC Emergency Procedures, p. 6-3.

According to the CN *Rail Traffic Controller Manual*, when "false Rule 439 alarms" are received, the RTC must "[i]mmediately contact the locomotive engineer of the movement and ascertain what the signal indication in the field was at the time the movement went by the signal."[23] RTCs "must ensure they have read, understood and complied with each computer generated messages [*sic*] and/or alarms [*sic*] prior to acknowledging."[24]

The RTC is notified of a Rule 439 alarm by way of an audible signal as well as a visual display on the RTC screen. The visual display indicates the signal and/or station where the alarm originated. The RTC acknowledges the alarm by clicking on a screen tab, which shuts down the alarm. The RTC is required to investigate the source of the alarm and, when applicable, contact any movement in the block to ascertain whether the alarm is true or false.

There are 4 possible states for an alarm system:

- urgent condition: alarm is on (true positive)
- non-urgent condition: alarm remains off (true negative)
- urgent condition: alarm remains off (false negative)
- non-urgent condition: alarm is on (false positive)

Ideally, the alarm system is activated only when there is an urgent condition (true positive), and remains off because there is no urgent condition (true negative). However, there are conditions of false positives, or nuisance/false alarms, which affect credibility and user/operator responses and behaviours. Conversely, false negatives represent a high risk since the user/operator is not made aware of an urgent condition.

At the Montréal rail traffic control office, false positive alarms had been occurring on a regular basis. With a high number of false positive alarms,[25] procedures were in place to manage the false positives. A rigorous investigation of each alarm was required to confirm the location and source in order to determine if there had been an emergency (i.e., if a Rule 439 alarm was true or false).

1.10.2 Rail traffic controller activity on the day of the occurrence

On the day of the occurrence, the RTC was monitoring multiple screens and coordinating several movements for a number of subdivisions in CTC and some occupancy control system (OCS) territories. Notwithstanding the level of workload, a Rule 439 alarm is a priority. At about 1727, the RTC acknowledged a nuisance/false Rule 439 alarm from a track vehicle located at Joffre Station (Mile 117.1) on the Montmagny Subdivision. At about

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23 Ibid.

24 Canadian National Railway Company, *Rail Traffic Controller Manual* (03 June 2016), section 1001: Rail Traffic Controller Responsibilities, p. 1-1.

25 For example, for a period of 2 weeks (08 to 22 November 2018), 192 false positive alarms were received in the Montréal rail traffic control office.

1743, she acknowledged another nuisance/false alarm from the same track vehicle, which was now located at the West Junction Station (Mile 8.8) on the Drummondville Subdivision.

The RTC had already lined the Drummondville west siding switch for VIA 28 to enter the siding and requested the signals for both VIA trains in preparation for the meet in Drummondville. At approximately 1937, a Rule 439 alarm originating from the Drummondville Station was displayed on the RTC screen and sounded. At that time, the 2 VIA trains were the only trains travelling on the Drummondville Subdivision. The RTC almost immediately shut down the audible alarm. At about the same time, the RTC was giving an exclusive track occupancy permit[26] to a maintenance vehicle. At approximately 1939, the RTC acknowledged the alarm. While the RTC screen displayed information to indicate that the alarm originated from the Drummondville Station where both VIA trains were located, the RTC associated that particular alarm with the track vehicle performing work and assumed it was also a nuisance/false alarm. Based on this assumption, the RTC did not confirm, verify or investigate the reason for the alarm.

1.11 Train control systems

At their most advanced level, train control systems can prevent the following types of occurrences:

- main-track train collisions
- overspeed train derailments
- operation of a train through an improperly lined switch
- incursions into working limits

1.11.1 Enhanced train control (Canadian initiative)

In 2000, the TSB made its first recommendation for implementing additional train control defences following the investigation into the 1998 collision between 2 Canadian Pacific Railway (CP) trains near Notch Hill, British Columbia.[27] After determining that backup safety defences for signal indications were inadequate, the TSB 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.
>
> **TSB Recommendation R00-04**

In 2013, following the investigation into the 2012 derailment and collision of VIA 92 near Burlington, Ontario,[28] the TSB indicated that Transport Canada (TC) and the industry should move forward with a strategy that will prevent accidents like that one by ensuring

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26 An exclusive track occupancy permit is "[a] TOP [track occupancy permit] that provides exclusive occupancy of the track to one foreman. No more than two track units can operate within the limits of an Exclusive TOP." (Transport Canada, *Canadian Rail Operating Rules* [18 May 2018], Definitions, p. 8.)

27 TSB Railway Investigation Report R98V0148.

28 TSB Railway Investigation Report R12T0038.

that signals, operating speeds, and operating limits will always be followed. The TSB therefore recommended that

> the Department of Transport require major Canadian passenger and freight railways to implement physical fail-safe train controls, beginning with Canada's high-speed rail corridors.
>
> **TSB Recommendation R13-01**

In February 2020, the Board reassessed the responses to recommendations R00-04[29] and R13-01[30] as **Satisfactory in Part**. The Board expressed concern that, even though work is ongoing to define a roadmap for enhanced train control (ETC) adoption, no specific plan or timelines have been established for implementation. Furthermore, the Board stated that no specific strategies other than enforcement action (as required) are being used to address the risk of train collisions or derailments in the absence of additional backup safety defences.

A joint TC–industry train control working group was established in 2014 under the Advisory Council on Railway Safety. In 2016, the working group produced a report entitled *Train Control Working Group Final Report*[31] in which it was concluded that a targeted, risk-based, corridor-specific implementation of train control technologies would be the best option for Canada. Such a system could include "a static display of track infrastructure, speed limits and operating restrictions, but provide a dynamic display of current train location"[32] that could provide audible or visual alarms without positive enforcement. However, such a system would still rely on the operating crew for compliance. A more extensive ETC system "could be designed using fail-safe design methods and incorporate positive enforcement capabilities."[33] In Canada, there are no ETC systems in use by freight or passenger railways; however, many commuter rail services have implemented such systems.

In order to meet positive train control (PTC)[34] system requirements for operations in the United States, both CN and CP have PTC implementation plans. As of 30 September 2019, both CN and CP had equipped 100% of their locomotives with the on-board system.

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29 TSB Recommendation R00-04: Consistent recognition of signals, at https://www.tsb.gc.ca/eng/recommandations-recommendations/rail/2000/rec-r0004.html.

30 TSB Recommendation R13-01: Physical fail-safe train controls, at https://www.tsb.gc.ca/eng/recommandations-recommendations/rail/2013/rec-r1301.html.

31 Advisory Council on Railway Safety, *Train Control Working Group Final Report* (September 2016), at https://tc.canada.ca/en/rail-transportation/rail-safety/train-control-working-group-final-report (last accessed 25 August 2020).

32 Ibid.

33 Ibid.

34 In the United States, such a system is called positive train control (PTC).

Furthermore, CN had installed PTC on 86.9% of its routes-miles governed by PTC in the United States, and CP, on 93.7%.[35] Neither railway intends to extend the use of PTC over the Canadian border.

Since 1990, in addition to this investigation, the TSB has investigated 78 occurrences that could have been prevented had an ETC system in its most advanced level been in place (Appendix A). These occurrences resulted in

- 52 derailments (520 derailed rolling stock)
- 40 train collisions, of which 34 resulted in a derailment
- 8 fatalities
- 316 injuries to employees and passengers

1.11.2 Positive train control (United States initiative)

In the United States, the National Transportation Safety Board (NTSB) issued its first recommendation for the development and implementation of a PTC system in 1970 following its investigation into a fatal head-on collision that occurred in August 1969 between 2 Penn Central commuter trains in Darien, Connecticut, where there were 4 fatalities and 43 injuries. The NTSB has observed that in the last half century, it "investigated more than 150 PTC preventable accidents that took the lives of more than 300 people and injured about 6,700 others [....]".[36] From these investigations, the NTSB made another 51 PTC-related recommendations. In 1990, the implementation of PTC was included in the NTSB's first Most Wanted List of Transportation Safety Improvements that served as the NTSB's primary advocacy tool for highlighting the most urgent transportation safety needs. Following its inclusion in that list, PTC was in each subsequent Most Wanted List until the enactment of the *Rail Safety Improvement Act of 2008* (RSIA) that mandated the implementation of PTC by 31 December 2015. The RSIA was in reaction to the 09 September 2008 collision between a Metrolink commuter train and a Union Pacific freight train in Chatsworth, California, which resulted in 25 fatalities and 102 injuries. Following the RSIA enactment, the NTSB removed PTC from its Most Wanted List; however, due to delays in the implementation of PTC and extensions of the deadline to year 2020, in 2014, PTC was reintroduced in the NTSB Most Wanted List.

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35 Federal Railroad Administration, "Each Railroad's Progress Toward Full PTC System Implementation," 2019 Q3, at https://explore.dot.gov/t/FRA/views/PTCImplementationStatusReport/IndividualRailroads?iframeSizedToWindow=true&%3Aembed=y&%3AshowAppBanner=false&%3Adisplay_count=no&%3AshowVizHome=no (last accessed 25 August 2020).

36 National Transportation Safety Board, Member Jennifer Homendy, "Remarks at a Press Conference on Full Implementation of Positive Train Control in Darien, CT," 20 August 2019, at https://www.ntsb.gov/news/speeches/JHomendy/Pages/homendy-20190820.aspx (last accessed 25 August 2020).

1.12 Locomotive voice and video recorders

Following 2 separate investigations[37,38] where it was difficult to identify with certainty the human factors that had contributed to the inappropriate crew response to the signal indications displayed and the dynamics and interaction between the crew members, the TSB 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.
>
> **TSB Recommendation R03-02, issued July 2003**

and that

> the Department of Transport require that all controlling locomotives in main line operation be equipped with in-cab video cameras.
>
> **TSB Recommendation R13-02, issued June 2013**

In February 2020, the Board reassessed the responses to recommendations R03-02[39] and R13-02[40] as **Satisfactory Intent**.

In May 2018, the *Railway Safety Act* (RSA) was amended to mandate the installation of locomotive voice and video recorders (LVVRs) in the locomotive cabs of Canada's federally regulated railways. The *Canadian Transportation Accident Investigation and Safety Board Act* was also amended to permit the use of on-board recorders by TC and operators for proactive safety management purposes. TC has been developing proposed LVVR regulations that will identify the technical requirements for the LVVR equipment and the privacy protections for employees. Final publication of the proposed LVVR regulations was planned for spring 2020 but has been delayed until later in 2020.

Other TSB investigation reports have reiterated the above recommendations.[41] The results of these investigations suggest that the use of LVVRs is the only objective and reliable method to more clearly determine the influence of human factors—such as employee communications, distractions, fatigue, and training—on a railway occurrence. When causal links and related safety deficiencies can be confirmed, any resulting recommendations can be better tailored to address the underlying issues and to maximize rail safety improvements.

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37 TSB Railway Investigation Report R99T0017.

38 TSB Railway Investigation Report R12T0038.

39 TSB Recommendation R03-02: National standards for locomotive data recorders, at https://www.tsb.gc.ca/eng/recommandations-recommendations/rail/2003/rec-r0302.html.

40 TSB Recommendation R13-02: In-cab locomotive video cameras, at https://www.tsb.gc.ca/eng/recommandations-recommendations/rail/2013/rec-r1302.html.

41 TSB railway investigation reports R02C0050, R09V0230, R10Q0011, R11W0247, R13C0049, and R15D0118.

1.13 TSB Watchlist

The TSB Watchlist identifies the key safety issues that need to be addressed to make Canada's transportation system even safer.

1.13.1 Following railway signal indications

In 2012, when the TSB published its Watchlist, it identified **Following railway signal indications** as one of the key safety issues in the Canadian transportation industry, and this issue has remained on the Watchlist ever since.

Between 2010 and 2019, there has been an average of 32 occurrences per year in which a train crew did not respond appropriately to a signal indication displayed in the field. As this occurrence demonstrates, railway signals are not consistently recognized and followed, which poses a risk of serious train collisions and derailments.

Since 1998, the TSB has investigated 15 occurrences where a train exceeded its limits of authority, of which 13 resulted in a collision or a derailment (Appendix B). In each of these investigations, an operating crew member's misperception of wayside signal indications was determined to be a cause or a contributing factor.

ACTIONS REQUIRED

Following railway signal indications will remain on the Watchlist until Transport Canada requires that railways implement additional physical safety defences to ensure that signal indications governing operating speed and operating limits are consistently recognized and followed.

1.14 TSB laboratory reports

The TSB completed the following laboratory report in support of this investigation:

- LP048/2019 – Photogrammetric Video Analysis

2.0 ANALYSIS

The mechanical condition of the locomotives and the signal system were not contributory to the occurrence. It was also determined that fatigue was not a factor. The analysis will focus on signal recognition by the train crew and the handling of Rule 439 alarms.

2.1 The occurrence

Eastbound VIA Rail Canada Inc. (VIA) passenger train P02821-31 (VIA 28) was operating in accordance with signal indications as it was entering the Drummondville siding from the west. Westbound VIA passenger train P02921-31 (VIA 29) passed Signal 991 indicating Stop at a speed of approximately 32 mph a few seconds after VIA 28 had cleared the main track. The head end of the locomotive on VIA 29 and the tail end of the last light, rapid, comfortable passenger coach on VIA 28 were approximately 377 feet and 8 seconds apart, when the last coach on VIA 28 was completely in the siding.

The VIA 29 crew members were aware and confirmed that advance Signal 983 was displaying Clear to Stop, and broadcast the signal indication over the radio. The VIA 29 train crew members were unaware that they passed Signal 991 indicating Stop, did not broadcast its signal indication, and continued westward toward Montréal.

Even though Signal 991 would have been visible to the crew of VIA 29 for 57 seconds, a number of factors contributed to the crew members not correctly responding to Signal 991 indicating Stop.

- The VIA 29 crew members likely focused their visual attention on the VIA 28 locomotive as it came in their field of view before Signal 991.
- It is possible that the crew of VIA 29 assumed that VIA 28 was already in the siding because the headlight of the lead locomotive of VIA 28 was extinguished while VIA 28 was still on the main track, contrary to the *Canadian Rail Operating Rules* (CROR).
- At night, there are fewer visual cues to accurately establish an opposing movement's position.
- The VIA 29 operating locomotive engineer (LE) adjusted the train speed to avoid a complete stop in anticipation of a Clear indication at Signal 991. VIA 29's crew did not realize that their train nearly collided with the last car of VIA 28. This suggests that the crew incorrectly perceived that VIA 28 had cleared the main track and had been in the siding.
- The VIA 29 in-charge locomotive engineer (ICLE) indicated to the LE that Signal 1005 (St-Germain) displayed a Clear indication. This signal was visible to the ICLE because VIA 28 was in the block between Signal 1005 and Signal 992. Even though Signal 1005 is 1.4 miles from Signal 991, because of its alignment and elevation, crews can see that signal, if illuminated, before having passed Signal 991.

- Like other VIA crews, crews on both VIA trains turned on the cab lights and waved at each other during the meet. This created a distraction while the crew should have been adhering to the Cab Red Zone (CRZ).
- VIA 29's ICLE was visually inspecting VIA 28 as it was passing by, even though passenger trains in movement are exempted from inspecting passing trains according to CROR Rule 110.

As a result, VIA 29's crew members likely focused their attention on VIA 28, perceived VIA 28 to have cleared the main track before it had, and anticipated a Clear indication at Signal 991. When the VIA 29 ICLE indicated to the LE that Signal 1005 displayed a Clear indication, the LE may have mistakenly assumed that the ICLE was talking about Signal 991.

2.2 Safety defences against signal recognition errors

Rail transportation is a complex system. The defence in depth philosophy advocated by safety specialists for complex systems seeks multiple and diverse lines of defence to mitigate the risks of normal human errors. Wherever possible, a combination of rules-based (i.e., administrative) defences and physical defences should be implemented to address normal slips, lapses, and mistakes that characterize human behaviour.

To ensure that trains are operated in safely and in accordance with the train control system, crew members are required to identify the signal indications and verbally communicate the indications to each other within the locomotive cab. Furthermore, in accordance with VIA's CRZ, VIA crew members need to record the indication of the last signal received prior to stopping at a station and confirm with each other the indication of the last signal before commencing movement. Following this procedure could ensure a common understanding of the signal's aspect and of the necessary train-handling actions, minimizing the potential for signal recognition errors.

There are safety defences in place to help prevent occurrences such as this one. Some of these defences were associated with the train control system and some were associated with rules and procedures, including the CROR and CRZ. However, these defences are administrative in nature. For example, the train control system (based on wayside signals) had the administrative requirement for train crews to follow the signal indication. Specifically, this defence relies on train crews observing each signal indication, broadcasting it, and then taking the appropriate actions. If the crew does not correctly observe the signal indication or does not take the appropriate action, the defence as a whole fails. Physical fail-safe technologies are in use on United States railroads that address the risk of crews misinterpreting or not following signal indications.

In this occurrence, even though both VIA trains were in CRZ, the operating crew members discussed the transfer of food items from VIA 29 to VIA 28 over the radio. They also turned on their cab lights and waved at each other. Moreover, even though passenger trains are exempted from inspecting passing trains, VIA 29's ICLE was visually inspecting VIA 28 as it passed by. Therefore, even though both trains were in CRZ, optimal situational awareness was not maintained by the crews to ensure the safety of their movement.

Between 2010 and 2019, there has been an average of 32 occurrences per year in which a train crew did not respond appropriately to a signal indication displayed in the field. Since 1998, the TSB has investigated 15 occurrences where a train exceeded its limits of authority, of which 13 resulted in a collision or a derailment. These occurrences demonstrate that wayside signals and administrative defences, although usually effective, are not always consistently applied. If train control systems rely only on administrative defences to ensure the safe operation of trains, signal recognition errors will continue to occur, increasing the risk of train collisions and derailments.

2.3 Handling of Rule 439 alarms

When VIA 29 travelled through the Drummondville west siding switch at Mile 99.14, the Canadian National Railway Company (CN) rail traffic controller (RTC) received a Rule 439 alarm for Signal 991, indicating that rolling stock had passed a stop signal indication.

The RTC associated the Rule 439 alarm with a track vehicle and did not investigate and verify the information available. A number of factors contributed to the assumptions made by the RTC.

- The RTC was interrupted while processing other tasks.
- The RTC was aware that a track vehicle was working in the area and that it could be the source of the false alarms.
- The RTC had been experiencing a high number of nuisance/false alarms in the recent past.
- The 2 VIA trains were the only trains travelling on the Drummondville Subdivision at the time of the occurrence and typically met at Drummondville according to VIA's schedule.
- The RTC had already lined the switch and requested the signals for both trains in preparation for the meet.

After the RTC received a Rule 439 alarm, she assumed, based on previous experience, that the alarm was a nuisance/false alarm caused by a track vehicle and acknowledged the alarm without further investigation.

After acknowledging the alarm, the RTC continued with other tasks. When the RTC could not line the west siding switch at the Drummondville Station, she called for a Signals and Communications employee to verify the Drummondville west siding switch. Damage consistent with the switch having been run through prompted the RTC to communicate with the VIA 29 crew who advised that Signal 991 displayed a Clear indication. About 35 minutes after, CN advised VIA Operations that VIA 29 had passed Signal 991 displaying a Stop indication.

In this occurrence, the RTC shut down the alarm, but did not investigate the cause of the alarm.

If Rule 439 alarms are not fully investigated by RTCs, an urgent situation could go unnoticed, increasing the risk of accidents.

2.4 Locomotive voice and video recorders

The use of locomotive voice and video recorders (LVVR) is an objective and reliable method of more clearly determining the role that human factors (e.g., crew communications, distraction, and fatigue) play in a railway occurrence. In this occurrence, without audio or visual recordings inside the locomotive cab, the reasons the crew of VIA 29 proceeded past Signal 991 displaying a Stop indication could not be determined with certainty. The presence of an LVVR would have helped the TSB to confirm the events that occurred in the cab more quickly and comprehensively.

3.0 FINDINGS

3.1 Findings as to causes and contributing factors

These are conditions, acts or safety deficiencies that were found to have caused or contributed to this occurrence.

1. Westbound VIA Rail Canada Inc. passenger train P02921-31 (VIA 29) passed Signal 991 indicating Stop at a speed of approximately 32 mph a few seconds after passenger train P02821-31 (VIA 28) had cleared the main track.

2. The VIA 29 train crew members were unaware that they passed Signal 991 indicating Stop and continued westward toward Montréal.

3. VIA 29's crew members likely focused their attention on VIA 28, perceived VIA 28 to have cleared the main track before it had, and anticipated a Clear indication at Signal 991.

4. When the VIA 29 in-charge locomotive engineer (ICLE) indicated to the operating locomotive engineer (LE) that Signal 1005 displayed a Clear indication, the LE may have mistakenly assumed that the ICLE was talking about Signal 991.

5. Even though both VIA Rail Canada Inc. trains were in Cab Red Zone, optimal situational awareness was not maintained by the crews to ensure the safety of their movement.

3.2 Findings as to risk

These are conditions, unsafe acts or safety deficiencies that were found not to be a factor in this occurrence but could have adverse consequences in future occurrences.

1. If train control systems rely only on administrative defences to ensure the safe operation of trains, signal recognition errors will continue to occur, increasing the risk of train collisions and derailments.

2. If Rule 439 alarms are not fully investigated by rail traffic controllers, an urgent situation could go unnoticed, increasing the risk of accidents.

3.3 Other findings

These items could enhance safety, resolve an issue of controversy, or provide a data point for future safety studies.

1. The presence of a locomotive in-cab voice and video recorder would have helped the TSB to confirm the events that occurred in the cab more quickly and comprehensively.

2. The head end of the locomotive on VIA 29 and the tail end of the last light, rapid, comfortable passenger coach on VIA 28 were approximately 377 feet and 8 seconds apart, when the last coach on VIA 28 was completely in the siding.

4.0 SAFETY ACTION

4.1 Safety action taken

4.1.1 Transport Canada

Following the occurrence, Transport Canada conducted an inspection and issued a letter of non-compliance to VIA Rail Canada Inc. (VIA) for violations of the *Canadian Rail Operating Rules* (CROR).

4.1.2 VIA Rail Canada Inc.

Subsequent to the occurrence, VIA took the following safety actions:

- The risks related to radio communications with locomotive engineers (LEs) about non-urgent subjects and their possible distraction were relayed to all employees.
- VIA briefed all Eastern Region LEs about CROR rules 578, 34 and 110 and VIA's Cab Red Zone (CRZ) instructions.
- VIA re-issued the instructions related to the headlight approaching a crossing.
- VIA clarified how to perform CROR Rule 110 (Inspection of Passing Trains) inspections to its Quebec employees. VIA reiterated to them that inspecting trains while both trains are moving is not efficient and that they should be looking at what is coming ahead of them.
- VIA management discussed this occurrence during health and safety summits held at various locations throughout the country in order to raise awareness among LEs.
- VIA management met with senior union leadership to review the events of this occurrence and discussed how to improve its operating environment.
- The crew members involved in this occurrence provided safety talks and a summary of the incident to other LEs of their terminal in order to raise awareness about the application of the CRZ, headlight usage, and the application of CROR rules 578, 34 and 110.
- Before resuming normal duty, both crew members attended a full 2-week recertification session as well as additional training on cab awareness. Additional training on CRZ was provided to confirm their application of the instructions.

4.1.3 Canadian National Railway Company

Management at the Montréal rail traffic control centre reviewed this occurrence with other rail traffic controllers (RTCs) and placed emphasis on following procedures when a CROR Rule 439 alarm occurs. In addition, the RTC screen was modified to include a visual cue (red square) at a location where a CROR Rule 439 alarm occurs. That visual cue helps RTCs identify the location of a CROR Rule 439 alarm and determine if it is related to a train.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 26 August 2020. It was officially released on 16 September 2020.

Visit the Transportation Safety Board of Canada's website (www.tsb.gc.ca) for information about the TSB and its products and services. You will also find the Watchlist, which identifies the key safety issues that need to be addressed to make Canada's transportation system even safer. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.

APPENDICES

Appendix A – TSB investigations of occurrences that could have been prevented if an enhanced train control system in its most advanced level had been in place

TSB investigation report	Occurrence date	Company	Location	Number of derailed rolling stock	Collision	Number of fatalities	Number of injuries
R16T0162	2016-08-21	Canadian Pacific Railway (CP)	Toronto, ON	6	Y	0	1
R16D0073	2016-08-11	Canadian National Railway Company (CN)	Acton Vale, QC	1	N	0	0
R16E0051	2016-06-04	CN	Carvel, AB	0	Y	0	0
R15D0118	2015-12-11	VIA Rail Canada Inc. (VIA)	Montréal, QC	1	N	0	1
R15T0245	2015-10-25	VIA	Whitby, ON	0	N	0	0
R15V0183	2015-09-06	CP	Beavermouth, BC	4	Y	0	1
R15V0046	2015-03-11	CP	Cranbrook, BC	0	N	0	0
R14T0294	2014-10-28	VIA	Newtonville, ON	0	N	0	0
R13C0049	2013-05-18	CP	Dunmore, AB	6	Y	0	1
R13Q0001	2013-01-11	Quebec North Shore and Labrador Railway (QNSL)	near Mai, QC	9	Y	0	2
R12Q0030	2012-08-09	VIA	Hegadorn, QC	0	N	0	0
R12T0038	2012-02-26	VIA	Aldershot, ON	6	N	3	45
R11W0247	2011-10-29	VIA	Meharry, MB	0	N	0	0
R11D0075	2011-09-24	CN	near Pointe-Saint-Charles, QC	6	N	0	0
R11E0063	2011-06-23	CN	Edmonton, AB	2	Y	0	0
R10T0213	2010-10-01	CN	Falding, ON	21	N	0	0
R10V0038	2010-03-03	CP	KC Junction, BC	29	Y	0	2
R10Q0011	2010-02-25	VIA	Saint-Charles-de-Bellechasse, QC	8	N	0	7

TSB investigation report	Occurrence date	Company	Location	Number of derailed rolling stock	Collision	Number of fatalities	Number of injuries
R09W0259	2009-12-11	CP	North Portal, SK	8	Y	0	0
R09V0230	2009-10-30	CP	Redgrave, BC	8	Y	0	2
R09W0118	2009-06-28	CN	Jones, ON	7	Y	0	1
R08W0058	2008-04-07	CP	near Ralph, SK	11	Y	0	0
R07E0129	2007-10-27	CN	Peers, AB	29	Y	0	0
R07C0040	2007-04-22	CP	Bow Island, AB	10	Y	0	2
R06H0013	2006-06-06	VIA	New Hamburg, ON	0	N	0	0
R06W0079	2006-05-22	CP	near Swift Current, SK	22	N	0	0
R02V0057	2002-04-28	CP	Natal, BC	2	Y	0	1
R02C0022	2002-03-24	CP	Glenogle, BC	5	Y	0	1
R02T0047	2002-02-22	CP	Port Hope, ON	2	Y	0	2
R01M0024	2001-04-12	VIA	Stewiacke, NS	9	N	0	22
R01W0007	2001-01-08	CP	near Bowker, ON	59	N	0	0
R00M0007	2000-01-30	VIA	Miramichi, NB	9	Y	0	43
R00T0179	2000-07-09	VIA	Rockwood, ON	3	Y	0	14
R99H0017	1999-04-23	VIA	Thamesville, ON	9	Y	2	77
R99T0017	1999-01-19	VIA	Trenton, ON	0	N	0	0
R98V0183	1998-10-01	CN	Basque, BC	4	Y	0	0
R98V0148	1998-08-11	CP	Notch Hill, BC	3	Y	0	0
R98T0141	1998-06-17	St. Lawrence & Hudson Railway	Campbellville, ON	0	Y	0	0
R98C0022	1998-03-01	CN	Obed, AB	2	Y	0	2
R96C0172	1996-08-12	CN	near Edson, AB	39	Y	3	0
R96Q0050	1996-07-14	QNSL	near Mai, QC	4	Y	0	1
R96W0171	1996-07-02	CN	North Battleford, SK	10	Y	0	1
R96D0018	1996-01-31	CN	Charette, QC	0	Y	0	0
R95V0218	1995-10-01	CP	Greely, BC	0	Y	0	4
R95V0174	1995-08-20	CP	Savona, BC	27	Y	0	2
R95T0152	1995-05-18	CP	Toronto, ON	2	Y	0	2
R95M0027	1995-04-06	CN	Napadogan, NB	8	N	0	0

TSB investigation report	Occurrence date	Company	Location	Number of derailed rolling stock	Collision	Number of fatalities	Number of injuries
R95S0021	1995-02-16	CN	London, ON	8	Y	0	2
R95T0023	1995-01-29	CN	Netherby, ON	7	Y	0	2
R95C0016	1995-01-14	CN	Delia, AB	28	N	0	0
R94Q0065	1994-11-20	VIA	Rimouski, QC	3	N	0	0
R94T0334	1994-10-28	CN	Etobicoke, ON	3	Y	0	0
R94Q0029	1994-06-07	CN	Saint-Georges, QC	1	Y	0	3
R93H0025	1993-12-13	CP/CN	Prescott, ON	0	N	0	0
R93Q0052	1993-08-19	CN	Bruno Junction, QC	0	N	0	0
R93W0169	1993-08-16	CN	Campbell, SK	0	N	0	0
R93V0155	1993-08-13	CN	Longworth, BC	2	Y	0	0
R93M0059	1993-08-10	VIA	Moosehorn, NB	0	N	0	0
R93V0055	1993-03-17	CP	Choate, BC	0	N	0	1
R92M0155	1992-12-23	CN	Egerton, NS	7	N	0	1
R92Q0170	1992-10-22	CN	Pointe Bleue, QC	17	N	0	0
R92T0242	1992-09-01	CN/VIA	Acton, ON	0	N	0	0
R92T0193	1992-08-01	CP	Heron Bay, ON	0	N	0	0
R92H0022	1992-07-20	CN	Credit, ON	0	Y	0	0
R92V0112	1992-06-08	CN	Sapperton, BC	0	N	0	0
R92V0068	1992-04-12	CP	Forth Steele, BC	0	N	0	0
R92T0078	1992-04-03	CP	Prescott, ON	0	N	0	0
R92V0061	1992-04-02	CP	Shuswap, BC	1	Y	0	2
R92T0077	1992-04-02	CN	Nanticoke, ON	4	N	0	0
R92T0047	1992-02-20	CP	Britt, ON	0	N	0	0
R91V0237	1991-09-22	CN	Arnold, BC	15	N	0	0
R91H0026	1991-09-09	CN	North Bay, ON	7	Y	0	66
R91T0162	1991-07-26	CP	Romford, ON	0	Y	0	0
R91D0032	1991-03-02	VIA	Bromptonville, QC	0	N	0	0
R91V0061	1991-02-27	CP	Chemainus, BC	4	N	0	0
R91H0206	1991-02-06	CP/VIA	Smiths Falls, ON	0	N	0	1
R90E0208	1990-11-06	CN	Oliver, AB	10	Y	0	1
R90V0201	1990-10-27	CN	Conrad, BC	12	N	0	0

Appendix B – TSB investigations involving misinterpretation, misperception, and/or misapplication of signal indications

Since 1998, the TSB has investigated 15 occurrences involving misinterpretation, misperception, and/or misapplication of signal indications.

R16T0162 (Toronto, Ontario) – On 21 August 2016, Canadian Pacific Railway (CP) freight train 235-21, proceeding westward with 2 locomotives only, collided with the tail end of train 118-18, which was crossing from the north to the south track at approximately Mile 3.3 on the North Toronto Subdivision in Toronto. Four of train 118-18's intermodal cars (10 platforms) were struck and damaged, and 4 of the platforms derailed upright. The 2 locomotives of train 235-21 derailed upright. The fuel tank on train 235-21's lead locomotive was punctured, resulting in the release of about 2500 litres of diesel fuel. A number of small fires were extinguished. The conductor of train 235-21 sustained injuries. The investigation determined that, if train control systems rely only on administrative defences rather than physical defences to ensure the safe operation of trains, signal recognition errors may not be adequately mitigated, increasing the risk of train collisions and derailments.

R16E0051 (Carvel, Alberta) – On 04 June 2016, Canadian National Railway Company (CN) freight train Q11251-03 was proceeding eastward on the Edson Subdivision when it collided at 18 mph with the tail end of train M30251-02 at Mile 34.9 near Carvel. No cars derailed as a result of the collision. There was minor damage to 1 empty hopper car on train M30251-02. There were no injuries. The investigation determined that, if existing signal systems do not include physical fail-safe capabilities, signal recognition or application errors by operating crew members may not be detected, increasing the risk of train collisions and derailments.

R15D0118 (Montréal, Quebec) – On 11 December 2015, VIA Rail Canada Inc. (VIA) passenger train No. 605, carrying 14 passengers, was travelling west on the north track of CN's Montreal Subdivision. At Mile 6.30, the train derailed while negotiating a crossover at 55 mph, where the authorized speed was 15 mph. About 1600 feet of railway track was damaged. An on-board service employee sustained minor injuries. The investigation determined that, if other physical defence methods for controlling trains in signalled territory are not in place, the risks of collision and derailment are increased when signal indications are not correctly recognized or followed.

R15V0183 (Beavermouth, British Columbia) – On 06 September 2015, CP train 602-242 collided with westbound CP train 113-01, which was entering the siding track near Beavermouth. As a result of the collision, 2 locomotives and the first car behind the locomotives derailed on train 602-242 as well as one set of trucks on the 64th car on train 113-01. The conductor sustained a serious injury. No dangerous goods were released. The investigation determined that, if existing signal systems are not enhanced to include physical fail-safe capabilities, signal indications will continue not to be followed, increasing the risk of train collisions and derailments.

R14T0294 (Newtonville, Ontario) – On 28 October 2014, VIA train 62 (coupled to train 52's equipment), proceeding east on the Kingston Subdivision at 85 mph with a permissive signal indication, approached Signal 2784S, which was displaying a Stop indication. The crew applied emergency brakes and passed the signal, coming to a stop approximately ¼ mile ahead. There were no injuries or conflicting movements. The investigation determined that, if additional physical fail-safe train control defences in signalled territory are not available when signal indications are not correctly identified and followed, train movements will not be adequately protected, increasing the risk of collisions and derailments.

R13C0049 (Dunmore, Alberta) – On 18 May 2013, CP train 351 was operating westward on the north main track of the Maple Creek Subdivision. Approaching Dunmore, the train struck the side of eastbound CP train 100, which was departing Dunmore from the north main track through the crossover onto the Depot 1 track. As a result of the collision, the 2 lead locomotives and the following 2 cars on train 351 derailed. On train 100, 2 cars derailed and several other cars sustained damage. The conductor of train 351 sustained minor injuries and was taken to hospital. The investigation determined that, if the existing centralized traffic control system (CTC) is not enhanced to include physical fail-safe capabilities, signal recognition errors will remain undetected, increasing the risk of train collisions and derailments.

R13Q0001 (Mai, Quebec) – On 11 January 2013, Quebec North Shore and Labrador Railway (QNS&L) freight train FCN 05 collided with the rear end of iron ore train BNL-005 at Mile 124.2 on the QNS&L Wacouna Subdivision, near Mai. The first locomotive on train FCN 05 was destroyed and the second locomotive derailed. Eight cars on train BNL-005 derailed. The crew members on train FCN-05 sustained minor injuries. Approximately 40 feet of track was damaged. The investigation determined that, in the absence of additional physical fail-safe train controls in signalled territory, the existing defences proved inadequate to prevent the collision.

R12T0038 (Aldershot, Ontario) – On 26 February 2012, VIA train No. 92 (VIA 92) travelled east from Niagara Falls to Toronto, Ontario, on track 2 of the CN Oakville Subdivision. Beyond the stop at Aldershot Station, the track switches were lined to route the train from track 2 to track 3. The last signal required the train to proceed at 15 mph. VIA 92 entered the crossover at about 67 mph, causing the locomotive and all 5 coaches to derail. The operating crew was killed; 44 passengers and the VIA service manager were injured. About 4300 litres of diesel fuel spilled from the locomotive fuel tank. The Board subsequently recommended that

> The Department of Transport require major Canadian passenger and freight railways to implement physical fail-safe train controls, beginning with Canada's high-speed rail corridors.
>
> **TSB Recommendation R13-01**

R11E0063 (Bailey, Alberta) – On 23 June 2011, CN freight train Q10131-21, proceeding westward at 25 mph on the Wainwright Subdivision, collided with the tail end of CN freight

train A41751-23 at Mile 262.30. As a result of the collision, 2 intermodal flat cars derailed (3 car bodies) and locomotive CN 2234 was damaged. The investigation determined that, in the absence of additional backup safety defences in signalled territory, when signal indications are not correctly identified or followed, existing defences may not be adequate to reduce the risk of collision and derailment.

R10V0038 (KC Junction, British Columbia) – On 03 March 2010, CP train 300-02, operating eastward on the north track of the Mountain Subdivision approaching KC Junction, collided with the side of westbound CP train 671-037 when it was departing Golden from the north track through the crossovers onto the south track. As a result of the collision, 3 locomotives and 26 cars derailed. The crew members of train 300-02 were transported to hospital for observation. The investigation determined that, in the absence of enhanced protection against signal recognition errors, such as that provided by cab signalling systems or positive train control (PTC), CTC and its current defences do not always adequately ensure that the requirements of signals are followed.

R10Q0011 (Saint-Charles-de-Bellechasse, Quebec) – On 25 February 2010, VIA train No. 15 was proceeding westward from Halifax, Nova Scotia, to Montréal, Quebec. At approximately 0425 Eastern Standard Time, near Saint-Charles-de-Bellechasse (Mile 100.78 of the CN Montmagny Subdivision), the train entered a siding switch, which had an authorized speed of 15 mph, while travelling at approximately 64 mph. Two locomotives and 6 passenger cars derailed. Two locomotive engineers and 5 passengers were injured. In this accident, advance knowledge of the location of an opposing CN train influenced the crew's expectation that they would not be taking the siding. The investigation determined that existing defences, such as 2-person crews and the 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.

R09V0230 (Redgrave, British Columbia) – On 30 October 2009, CP train 355-429, operating westward on the signalled siding track at Redgrave (Mountain Subdivision), collided with the side of eastbound CP train 110-30, which had stopped on the main track. As a result of the collision, 2 locomotives and 6 cars derailed. The investigation determined that intervention from a system such as PTC may have been able to compensate for the signal misidentification and prevent the collision.

R07E0129 (Peers, Alberta) – On 27 October 2007, a collision between CN trains 417 and 342 at Peers derailed 1 locomotive and 27 cars and damaged an additional 14 cars. There were no serious injuries. The investigation determined that intervention from a PTC-type system may have been able to compensate for the locomotive engineer's loss of situational awareness and prevent the collision.

R99T0017 (Trenton Junction, Ontario) – On 19 January 1999, VIA train 52 travelled east passed Signal 2328S at Mile 232.8 of the CN Kingston Subdivision at the Trenton Junction Station while the signal was indicating Stop. The train subsequently passed through a main-track switch, which was in the reverse position in a trailing movement direction, and came to a full stop at Mile 232.17. There were no injuries, and there was no derailment or damage

to property other than the switch that was forced open by the train wheels as it passed. The investigation determined that Signal 2352S was displaying a Clear to Stop indication that the crew on VIA train 52 did not recognize and act upon. The report also makes reference to TSB Recommendation R00-04 issued as a result of TSB investigation report R98V0148.

R98V0148 (Notch Hill, British Columbia) – On 11 August 1998, CP train 463-11 collided with the rear end of CP train 839-020 at Mile 78.0 of the CP Railway Shuswap Subdivision, near Notch Hill. One car on train 463-11 and 2 cars on train 839-020 derailed. There were no injuries. The TSB identified 2 safety deficiencies related to the backup safety defences for signal communication and the impact of noise on the communication of safety-critical information between crew members in locomotive cabs. The Board subsequently 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.
>
> **TSB Recommendation R00-04**

and that

> the Department of Transport assess the impact of noise on voice communication in locomotive cabs and ensure that crew members can effectively communicate safety-critical information.
>
> **TSB Recommendation R00-05**