Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT R15D0118

Main-track derailment

VIA Rail Canada Inc.
Passenger train No. 605
Mile 6.30, Canadian National Railway Company
Montreal Subdivision
Montréal, Quebec
11 December 2015

Canada

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Le présent rapport est également disponible en français.

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

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Summary

On 11 December 2015, at approximately 0925 Eastern Standard Time, VIA Rail Canada Inc. passenger train No. 605, carrying 14 passengers, was travelling west on the north track of the Canadian National Railway Company 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.

Le présent rapport est également disponible en français.

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1.0 Factual information

1.1 The accident

On 11 December 2015, at approximately 0910,[1] VIA Rail Canada Inc. (VIA) passenger train No. 605 (the train), travelling to Hervey-Jonction, Quebec, left Montréal Central Station in Montréal, Quebec, carrying 14 passengers. One mile later, the train entered the Montreal Subdivision travelling on the north track to Turcot-Ouest, at Mile 6.20 (Figure 1).

Figure 1. Site map (Source: Google Maps, with TSB annotations)

As the train travelled at about 60 mph,[2] approximately 600 feet from the crossover located at Mile 6.26 (crossover 75), the crew noticed that the switches were in the reverse position, aligned for the freight track. The train brakes were fully applied. As it passed through the crossover at a speed of 55 mph, the train swayed from side to side (Photo 1, Photo 2, and Photo 3), then came to a stop on the freight track, about 1600 feet after the crossover.

Inspection of the train revealed that locomotive VIA 6413, positioned mid-train, had derailed. Passengers were transferred to the head end of the train and returned to Central Station. An on-board service employee sustained minor injuries.

At the time of the accident, the sky was cloudy and the temperature was 10 °C.

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1 All times are Eastern Standard Time.

2 A 60 mph speed restriction was in effect on the north track at Mile 6.26.

Photo 1. View from locomotive before crossover 75 (0923:34)

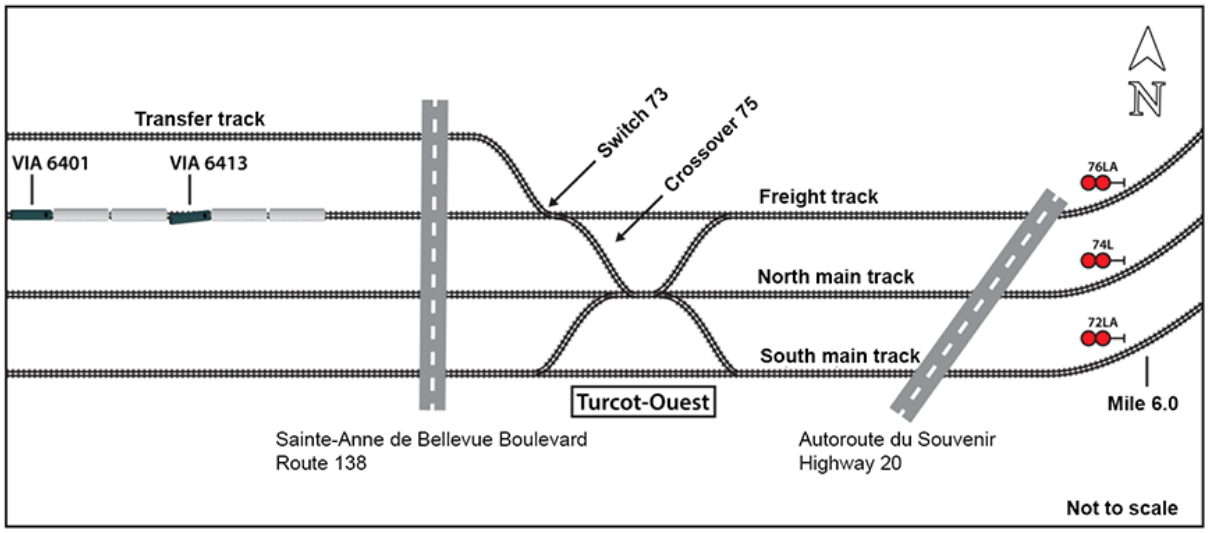
Photo 2. View from locomotive tilted to the left (0923:36)

Photo 3. View from locomotive tilted to the right (0923:38)

1.2 Site examination

The derailment occurred at Turcot-Ouest, on the section of track between the Autoroute du Souvenir (Highway 20) overpass and the Sainte-Anne-de-Bellevue Boulevard (Route 138) overpass. This area is affected by the Turcot interchange reconstruction project, which aims to replace several overpasses and shift the railway tracks to the north. There are 4 signalled railway tracks: the south main track, the north main track, the freight track, and the transfer track. Several crossovers allow movement from one track to another (Figure 2).

Figure 2. Derailment site



The train came to a stop on the freight track, west of the Sainte-Anne-de-Bellevue Boulevard overpass, in way of Mile 6.6. The lead truck of the second locomotive (VIA 6413) derailed and shifted 22 inches to the south of the track. Locomotive VIA 6413 sustained minor damage to the pilot and traction motor gear case of the first axle. The first locomotive and other cars remained on the track, coupled together.

From the derailed truck of locomotive VIA 6413, 2 grooves, one between the rails and the other south of the track, were visible on the ties and ballast. They extended eastward for a distance of about 1600 feet, ending 50 feet from crossover 75. Over this distance, the ties were cut out. Spikes, tie plates, anchors, and one joint bar were damaged.

1.3 Train crew

The train crew consisted of 2 locomotive engineers (LE). They were familiar with the territory and met rest and fitness standards. They both met the requirements of their respective positions and had more than 30 years' experience as LEs. After 4 days off, they had begun their shift at the Montréal Maintenance Centre (MMC) at 0740.

1.4 Train No. 605

The train was made up of 2 trains coupled together (in a "J" configuration). The first train, which was destined to Jonquière, Quebec, consisted of the lead locomotive (VIA 6401) and 2 passenger cars. It was coupled to a second train destined to Senneterre, Quebec, made up of locomotive VIA 6413 and 2 other passenger cars. The 2 trains were to remain coupled up to Hervey-Jonction, where they would be separated and then proceed to their final destinations. No anomalies were noted on the train during its mechanical inspection at the MMC and when the train passed by the wayside inspection system (WIS),[3] located at Mile 4.8. The inspection results were broadcast on the standby channel after the train passed.

1.5 Subdivision information

The Montreal Subdivision belongs to the Canadian National Railway Company (CN). It runs from Cape (junction with the St-Hyacinthe Subdivision), Mile 1.2, near Central Station, to Dorval, Quebec, Mile 11.6. Train movements 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 subdivision consists of 2 main tracks and, on some sections, there are additional signalled tracks. For example, the signalled freight track begins at Mile 3.5 in St-Henri, and extends up to Mile 8.9. In the derailment area, the authorized speed for passenger trains is 70 mph on the north and south main tracks. On the freight track, train movements are limited to 30 mph.

The Montreal Subdivision is part of the Québec–Windsor rail corridor. It is used by VIA trains travelling to and from Ottawa, Ontario, Toronto, Ontario, and northern Quebec. Rail traffic consists of about 50 trains per day, some 30 of which are passenger trains.

1.6 Particulars of the track

In the accident area, the tracks consist of 132-pound rail. The rails are laid on 14-inch double-shouldered tie plates secured to the ties with 4 spikes. Every second tie is box-anchored, and the ballast is made up of ½- to 2-inch crushed stone.

Crossover 75 is made up of 2 No. 10 turnouts equipped with a dual control switch. These turnouts are designed for speeds not exceeding 15 mph. Inspections were conducted according to the provisions of the *Rules Respecting Track Safety*. The last visual inspection of the track, which was on 10 December 2015, revealed no defects.

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[3] Wayside inspection systems include overheated wheel bearing detectors, hot wheel detectors, dragging equipment detectors, and some also have wheel impact load detectors.

1.7 Centralized traffic control system

Train movements on the Montreal Subdivision are governed by the CTC, as authorized by the CROR. The CTC uses interconnected track circuits and field signals (controlled, advance, and intermediate signals) to control train movements. 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 a train, the 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.

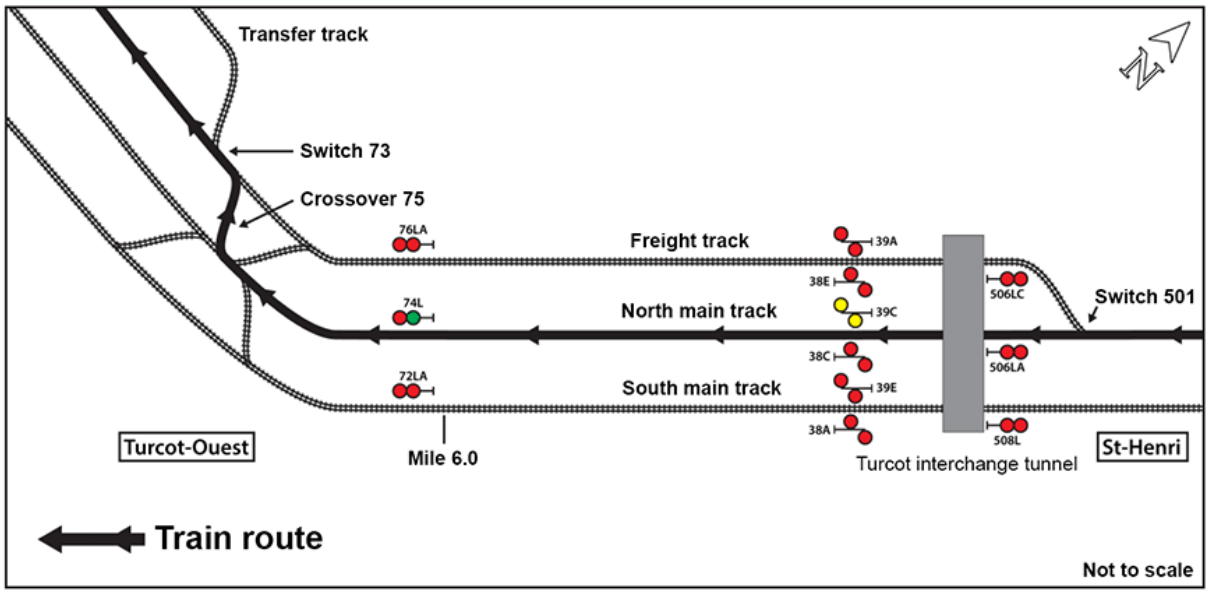
Signal indications inform train crews of the speed at which they may operate. In addition, signal indications provide protection against some conditions, such as an occupied block, broken rail, or a switch left open.

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

1.8 Signal indications

The route established by the RTC for the train from Central Station to Turcot-Ouest was recorded in the rail traffic control system. The route revealed no incompatible movement. It allowed the train to travel on the north track, then switch at crossover 75 to access the freight track. Train movements at this location are governed by advance signal 39C and controlled signal 74L (Figure 3).

Figure 3. Train route



Examination of recordings confirmed the signal indications of these 2 signals. At the exit of the Turcot interchange tunnel (Mile 4.23), advance signal 39C, located 2500 feet further, was visible and displayed "Clear to Slow."[4] The crew members called out signal 39C, and agreed that it displayed "Clear to Slow." Signal 74L became visible at a distance of 1600 feet and displayed "Slow to Clear."[5] The crew members did not call out this signal, contrary to CROR Rule 34.

1.9 *Rule 42 of the* Canadian Rail Operating Rules

When a railway performs planned work, CROR Rule 42 is used to protect the equipment and work crews against train movements. A Rule 42, which is issued as a general bulletin order,[6] indicates the work limits, hours in force, and name of the foreman responsible for its application (the foreman).

Before a Rule 42 comes into force, the RTC and foreman must reach an arrangement regarding the train route when trains have to travel through the protected area. If a track will be taken out of service due to work, the foreman must reach an arrangement with the RTC to ensure that no train will be directed onto that track. These arrangements can be cancelled or modified at any time while the Rule 42 is in force.

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4 "Advance, SLOW Speed [15 mph] approaching next signal." (Transport Canada, TC O-0-167, *Canadian Rail Operating Rules*, Definitions.)

5 "Advance, SLOW Speed passing signal and through turnouts." (Transport Canada, TC O-0-167, *Canadian Rail Operating Rules*, Definitions.)

6 "Instructions regarding track condition restrictions and other information which affect the safety and movement of a train or engine." (Transport Canada, TC O-0-167, *Canadian Rail Operating Rules*, Definitions.)

Rule 42 requires that the foreman protect the work area in compliance with Rule 842 (Planned Protection – Rule 42). This rule states the following:

> […]
>
> In CTC, when protection is in effect on more than one track or when signalled turnouts are within the limits there must be a clear understanding in writing between the foreman and the RTC as to what route(s) movements are to use. The foreman's instructions to the movement must be identical to the routing arrangement with the RTC. Should the foreman require operation on a specific track when the arrangement with the RTC was for more than one route, the foreman must make a new arrangement with the RTC before authorizing the movement.[7]
>
> […]

When trains must pass through Rule 42 limits, train crews must communicate with the foreman to obtain instructions. Foremen must confirm with the employees working under their protection that they can allow a train to pass through the protected area before issuing their instructions to the train crew. They must specify the tracks that can be used and the restrictions, if any. As specified in Rule 842, "[t]he foreman's instructions to the movement must be identical to the routing arrangement with the RTC."[8]

Train No. 605's routing took it through the work limits of the Turcot interchange where several highways cross by means of overpasses and elevated access ramps. In 2012, major work started to rebuild this interchange. Since this work may conflict with the railway right-of-way, CN used Rule 42 to ensure the safe passage of trains. Rule 42 is in force 24 hours per day, 7 days per week.

1.10 Rule 42 management

On the day of the accident, the foreman had 3 groups of employees working under his protection and had to communicate with each of them in order to give permission for a train to enter the work limits. Between the start of his shift (0600) and 0915, the foreman issued instructions to 11 different trains. In addition, he had 8 conversations with the RTC.

At approximately 0658, the foreman and RTC reached the following arrangement:

- From Mile 2.05 to Turcot-Ouest, trains were authorized to travel on the north and south tracks.
- From Turcot-Ouest to Mile 7.0, all tracks could be used.
- No trains would travel on the freight track between switch 501 at St-Henri (Mile 3.5) and signal 76LA at Turcot-Ouest.[9]

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7 Transport Canada, TC O-0-167, *Canadian Rail Operating Rules*, Rule 842.

8 *Ibid*.

9 By extension, the name of the Turcot-Ouest Station is used to designate the location of signals 72LA, 74L, and 76LA located at Mile 6.1.

Between the time the arrangement came into force and VIA train No. 605 arrived, 1 freight train and 2 passenger trains passed through the Rule 42 limits. An examination of the instructions given to trains revealed that the foreman had not included the section of freight track between Turcot-Ouest and Mile 7.0 for VIA trains, although it had been included for the freight train (Appendix A). Other foremen also shared this practice of shortening the instructions provided to VIA trains and omitting some information.

1.11 *Rule 34 of the* Canadian Rail Operating Rules

Pursuant to CROR Rule 34 (Fixed Signal Recognition and Compliance), train crew members must communicate to each other signals that affect the movement of their train. The rule reads as follows:

> […]
>
> (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.[10]
>
> […]

1.12 *VIA Rail Canada Inc. instructions*

VIA LEs are subject to VIA's specific instructions. Section 6 of the *Passenger Train Instructions* pertains to the operation of trains and specifies the following:

> **6.1 General**
>
> Locomotive engineers are responsible for proper locomotive and train handling. They are expected to do everything possible to conserve fuel and minimize brake shoe and wheel wear. Responsible train handling must be performed with consideration of passenger and employee comfort.
>
> […]
>
> (ii) Throttle manipulation must be utilized as the primary means of controlling the train.
>
> (iii) Dynamic brake must be fully utilized as the primary means of controlling the train whenever possible. [...]
>
> (iv) Blended braking must be used if dynamic braking is insufficient.
>
> […]

[10] Transport Canada, TC O-0-167, *Canadian Rail Operating Rules*, Rule 34.

Upon exiting the Turcot interchange tunnel, the crew identified signal 39C while the train was travelling at about 40 mph. The throttle was advanced to notch 8, and the train continued to accelerate up to a speed of 60 mph.

1.13 Routing of VIA Rail Canada Inc. trains

The RTC avoids delaying passenger trains. In general, they stay on the south and north main tracks; they rarely travel on the freight track. Between 01 September 2015 and the day of the accident, VIA trains bound for northern Quebec had passed on 43 occasions. After leaving Central Station, the train travelled about 7.5 miles on the Montreal Subdivision. Between St-Henri and Turcot-Ouest, the specific routing of these trains was examined, and the following 2 facts were noted:

- All trains continued on the south and north main tracks up to Turcot-Ouest.
- Trains travelling on the north track stayed on this track and were directed to the freight track through crossover 75 only twice.

The last time the RTC directed a train destined to northern Quebec from the north track to the Turcot-Ouest freight track was 02 December 2015. On that occasion, the same crew was at the controls of the train, and Rule 42 was in force. When the train travelled through the work limits, the Rule 42 foreman authorized the train to go through with the following 3 instructions:

- From Mile 2.05 to Mile 2.6, the train could operate on all tracks at the authorized speed.
- From Mile 2.6 to Turcot-Ouest, the train could operate on the north track or the south track with a speed restriction of 30 mph on the south track, between Mile 3.0 and Mile 4.0.
- From Turcot-Ouest to Mile 7.0, the train could operate on all tracks at the authorized speed.

1.14 Recommendations regarding compliance with signal indications

Following the investigation into the 1998 collision between 2 Canadian Pacific Railway (CP) trains near Notch Hill, British Columbia (TSB Railway Investigation Report R98V0148[11]), the Board determined that backup safety defences for signal indications were inadequate. The Board therefore 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**

[11] Transportation Safety Board of Canada, Railway Investigation Report R98V0148: Rear-end Train Collision, Canadian Pacific Railway, Train No. 839-020 and Train No. 463-11, Mile 78.0, Shuswap Subdivision, Notch Hill, British Columbia, 11 August 1998.

Following the investigation into the 2012 derailment and collision of VIA 92 near Burlington, Ontario, on the CN Oakville Subdivision (TSB Railway Investigation Report R12T0038[12]), the Board indicated that Transport Canada (TC) and the industry should move forward with a strategy that will prevent accidents like this one by ensuring that signals, operating speeds, and operating limits will always be followed. The Board therefore recommended that

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

In March 2016, the Board reassessed the responses to recommendations R00-04[13] and R13-01[14] as Satisfactory in Part. It was acknowledged that action had been taken to study the deficiencies and to potentially find a long-term solution. However, there were no short-term plans to address the risk of a serious train collision or derailment in the absence of additional backup safety defences.

1.14.1 Recent progress relating to Recommendation R13-01

As a follow-up to Recommendation R13-01, the Train Control Working Group was established under the auspices of the Advisory Council on Railway Safety (ACRS) to study train control technologies and their suitability for Canada's railway operations with a special focus on the high-speed corridors. In its final report, presented to ACRS on 20 September 2016, the Working Group recommended that the best option for Canada would be a targeted, risk-based and corridor-specific implementation of enhanced train control (ETC) technologies.

In addition, CN has been collaborating with TC and other industry stakeholders in addressing a common solution to physical fail-safe train controls. CN participates in a steering committee and a technical task force that was created to assist in finding these solutions.

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12 Transportation Safety Board of Canada, Railway Investigation Report R12T0038: Main-track Derailment, VIA Rail Canada Inc., Passenger Train No. 92, Mile 33.23, Canadian National Oakville Subdivision, Aldershot, Ontario, 26 February 2012.

13 Transportation Safety Board of Canada, Reassessment of the Responses to Rail Safety Recommendation R00-04 (March 2016), available at: http://www.tsb.gc.ca/eng/recommandations-recommendations/rail/2000/rec_r0004.asp (last accessed 13 February 2017).

14 Transportation Safety Board of Canada, Reassessment of the Responses to Rail Safety Recommendation R13-01 (March 2016), available at: http://www.tsb.gc.ca/eng/recommandations-recommendations/rail/2013/rec-r1301.asp (last accessed 13 February 2017).

1.15 Train control systems

The rail industry has developed technology to address the risk of misinterpreting or not complying with signal indications. The technologies[15] currently in use or under development include

- in-cab signalling systems;
- positive train control;
- VIA's global positioning system (GPS) train safety system.

1.15.1 In-cab signalling systems

In 1922, the United States Interstate Commerce Commission (ICC) made a ruling that required United States railroads to install some form of automatic train control (ATC) on one full passenger division by 1925. In response to this ruling, in the United States, the first in-cab signalling systems were developed and put into use. Cab signalling systems have evolved to include other technologies, and they remain in use in some United States passenger train corridors. For example, Amtrak Acela locomotive cabs are equipped with in-cab signalling with an automatic train stop overlay. In Canada, there is currently no cab signalling system in use by freight or passenger railways.

Cab signalling is a communications system that provides track occupancy information through a display device mounted inside the locomotive cab. The simplest systems display the wayside signal indication while more advanced systems also display maximum permissible speeds. The cab signalling system can be combined with an ATC system to warn operating crews of their proximity to a point of restriction and to initiate enforcement action to slow down or stop a train.[16]

1.15.2 Positive train control

The September 2008 collision between a Metrolink passenger train and a Union Pacific freight train in Chatsworth, California, prompted the passage of the *Rail Safety Improvement Act of 2008*. This legislation mandated that, by 2015, positive train control (PTC) be installed on higher-risk rail lines in the United States. However, due to a number of technical challenges, it is expected that the installation of this system in the United States will not be completed until 31 December 2018, and may be extended further on a case-by-case basis by individual railroads with the permission of the Federal Railroad Administration (FRA). Furthermore, before it is used in revenue service, the FRA must certify the technology and its application for each railroad.

PTC is a system to prevent

- train-to-train collisions;

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15 TSB Railway Investigation Report R12T0038 contains a full description of many train control systems.

16 General Railway Signal Company, *Elements of Railway Signalling* (June 1979).

- overspeed derailments;
- incursions into work zone limits;
- movement of a train through a switch left in the wrong position.

In Canada, there is currently no PTC in use on freight or passenger railways, and no planned PTC installation for federally regulated railways. PTC technology will likely not be implemented in Canada until several years after it is in place in the United States.

1.15.3 VIA Rail Canada Inc. GPS train safety system

VIA is in the process of developing a GPS train safety system to assist LEs with train operation. This technology is based on in-cab integration of a GPS communication loop with real-time feedback. The proposed system would consist of the following elements:

- display of route features;
- real-time update of train location;
- real-time display of information that has an impact on train operation, including speed restrictions, the location of signals, and track work; and
- warning on approaching a point of restriction, including the application of brakes.

The concept was tested at the end of 2015 and during 2016 by means of a prototype, and additional tests will continue.

1.16 Other occurrences involving misinterpretation of the instructions of Rule 42 of the Canadian Rail Operating Rules

Other recent occurrences where CROR Rule 42 instructions were misinterpreted occurred include

- **TSB Railway Occurrence R15T0258 –** On 05 November 2015, near Campbellville, Ontario, a CP foreman received exclusive use (Rule 42) of the south track for a section of track. The written instructions between the RTC and the foreman indicated that all movements were required to be on the north track through the limits. The foreman cleared 3 sub-foremen to proceed from the north track to the south track in order to perform work on the south track. A freight train then called the foreman to obtain permission to operate through the protected limits. The foreman authorized the train crew to proceed on the north track and to cross over to the south track, as he had assumed that the 3 sub-foremen were working clear of the location where the train would cross over, creating an unprotected overlap of authorities. The 3 sub-foremen were not informed of this authority, but were able to clear the track before the train arrived. No one was injured.

  On 11 December 2015, the TSB sent Rail Safety Advisory (RSA) 16/15 to TC, indicating that, to properly protect an evolving situation, routing arrangements need to be clear, concise, and consistent among all parties involved. Further, the RSA suggested that, given the risk to track workers from trains operating through Rule 42 limits, TC may wish to review the work procedures and training provided to RTCs relating to Rule 42 limits involving multiple tracks, and to review how routing

arrangements are communicated to all track workers. In response to the RSA, TC conducted an inspection at CP's rail traffic control centre from 07 to 10 March 2016 to monitor RTC activities for compliance with the CROR. As part of the inspection, TC reviewed CP's processes for routing instructions between the RTC and Rule 42 foreman and no non-compliances were identified.

- **TSB Railway Investigation Report R15T0245 –** On 25 October 2015, near Whitby, Ontario, a VIA train travelling at about 38 mph passed a red flag and entered into the work limits of a CN work crew protected under Rule 42. The train stopped approximately 500 feet from the track workers and some of their equipment on the track. There were no injuries, no derailment, and no track damage. The RTC had improperly blocked the Rule 42 limits. Due to incomplete communications between the foreman and the train crew, the foreman was not fully aware of the train's routing through the work limits. As the foreman had been given exclusive use of the south track, he believed that all trains would operate on the north track within the work limits. The VIA passenger train was inadvertently authorized to operate through the exclusive work limits. The train crew believed that the RTC and foreman would ensure that all trains would be routed on the appropriate track.

  On 20 November 2015, the TSB issued RSA 14/15 to TC, in which it stated that, considering the risk of routing trains through CROR limits in signalled territory, TC may wish to review how signal blocking is used to protect for these situations, and how the routing arrangements between the RTC, the foreman, and the train crew are established and communicated. In response to the RSA, TC issued a letter of concern to CN on 04 December 2015 regarding a violation of CROR Rule 137, which states that "[i]nstructions from a foreman must be in writing except when the instructions permit unrestricted operation through the entire limits." On 18 December 2015, CN issued a system notice stating that, in the application of Rule 137, a movement is considered restricted when instructions from a foreman include the use of a specific track or specific tracks, and therefore must be in writing. In January 2016, TC conducted an inspection of all CN rail traffic control centres and reviewed how signal blocking is used to protect Rule 42 foremen. CN also examined how routing arrangements between the RTC and these foremen are established and communicated, and how the foreman communicates with the train crew. No non-compliances were found.

1.17 Deviation on low-speed crossovers

On 18 April 2012, the TSB sent RSA 02/12 to TC following the VIA accident that occurred near Burlington. The RSA stated that, given the serious consequences of a passenger train derailment, TC may wish to review the operating procedures and situations when higher-speed passenger trains are routed through slower-speed crossovers with No. 12 turnouts.

On 30 May 2012, TC responded that it is incumbent on the employee to identify and comply with signal indications. Furthermore, TC indicated that eliminating 15 mph crossovers would not prevent a similar occurrence should an overspeed situation occur while a train is routed through 45 mph crossovers while operating at speeds up to 100 mph.

1.18 Recommendations regarding locomotive recorders

A number of railway accident investigations in North America have led to findings, recommendations, and other safety communications that have identified human factors as an underlying safety issue. Many of these investigations would have benefitted from a recording of crew communications that occurred immediately prior to the accident.

According to the *Canadian Transportation Accident Investigation and Safety Board Act,* these recordings are protected and can only be used in the context of a TSB investigation.

Following the investigation into the 1999 occurrence involving a VIA train near Trenton Junction, Ontario (TSB Railway Investigation Report R99T0017[17]), 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.
>
> **TSB Recommendation R03-02**

Following the investigation into the 2012 derailment of VIA 92 near Burlington (TSB Railway Investigation Report R12T0038[18]), the Board recommended 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**

In March 2016, the Board reassessed the responses to recommendations R03-02[19] and R13-02[20] as Satisfactory in Part. The Board is pleased that TC and industry stakeholders have agreed to collaborate in the joint study undertaken by the TSB in May 2015 regarding the use of locomotive voice and video recorders (LVVR).

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17 Transportation Safety Board of Canada, Railway Investigation Report R99T0017: Train Passed a Signal Indicating Stop, VIA Rail Canada Inc., Train No. 52, Mile 232.8, Kingston Subdivision, Trenton Junction, Trenton, Ontario, 19 January 1999.

18 Transportation Safety Board of Canada, Railway Investigation Report R12T0038: Main-track Derailment, VIA Rail Canada Inc., Passenger Train No. 92, Mile 33.23, Canadian National Oakville Subdivision, Aldershot, Ontario, 26 February 2012.

19 Transportation Safety Board of Canada, Reassessment of the Response to Rail Safety Recommendation R03-02 (March 2016), available at: http://www.bst-tsb.gc.ca/eng/recommandations-recommendations/rail/2003/rec_r0302.asp (last accessed 13 February 2017).

20 Transportation Safety Board of Canada, Reassessment of the Response to Rail Safety Recommendation R13-02 (March 2016), available at: http://www.tsb.gc.ca/eng/recommandations-recommendations/rail/2013/rec-r1302.asp (last accessed 13 February 2017).

1.19 TSB study on locomotive voice and video recorders

The objective of the study undertaken by the TSB with industry participation was to assess, on a small scale, current technology, legislative and regulatory issues, operational and human factors issues, and potential safety benefits of the expanded use of on-board recorders.

The study identified some best practices, identified and evaluated implementation issues, and collected background information for the development of an action plan to implement LVVRs. There is general agreement among railway industry stakeholders on the fundamental value of this type of data. However, there are a number of outstanding differences of opinions on the appropriate use of LVVRs. If these differing perspectives can be reconciled, implementation of this technology could result in considerable safety benefits to the railway industry. The study was published in September 2016.

1.20 Locomotive VIA 6401

Locomotive VIA 6401 was a model F40PH-2D built by General Motors Electro-Motive Division in 1986, and rebuilt in 2012. This locomotive was equipped with a forward-facing camera. As part of the study undertaken by the TSB on LVVRs, VIA had installed a prototype system to record conversations in the locomotive cab. These video recordings were synchronized with the recording of the forward-facing camera.

VIA was conducting tests of the prototype recording system on locomotive VIA 6401 when it was not in service. On the day of the accident, the prototype system had remained activated, which gave the TSB access to the recordings. The sound quality was poor, and a constant ambient noise interfered with the intelligibility of conversations.

1.21 TSB Watchlist

The Watchlist is a list of issues posing the greatest risk to Canada's transportation system. The TSB publishes it to focus the attention of industry and regulators on the problems that need addressing today.

1.21.1 Following railway signal indications

As this occurrence demonstrates, there is a risk of serious train collisions or derailments if railway signals are not consistently recognized and followed.

Watchlist 2016 states that additional physical defences must be implemented to help ensure that railway signal indications are consistently recognized and followed.

1.21.2 Locomotive voice and video recorders

As this occurrence demonstrates, given that there are no requirements for on-board voice and video recorders on locomotives, key information to advance railway safety may not always be available for accident investigations and proactive safety management.

Watchlist 2016 states that the expanded use of LVVR data within a proactive safety management framework must ensure that the rights and obligations of all parties are appropriately balanced.

The differences of opinions on the appropriate use of the recorders must be resolved and legislation must be adopted to ensure the implementation of LVVR technology without any further delays.

1.22 TSB laboratory reports

The following TSB laboratory reports were completed in support of this investigation:

- LP287/2015 – Audio enhancement – VIA Train 605-11
- LP102/2016 – In-train force analysis – VIA Train 605-11

2.0 Analysis

There were no track or signal defects in the derailment area. Furthermore, the train was in good condition when it departed the maintenance centre, and no anomalies were reported when the train passed by the wayside inspection system. As a result, the analysis will focus on the activities of the Rule 42 foreman, compliance with signals, and the recorders on board the locomotive.

2.1 The accident

When the train entered crossover 75, it was travelling at about 55 mph, while the authorized speed for this type of crossover is 15 mph. Based on still images from the locomotive forward-facing cameras, while negotiating the crossover, the train swayed from side to side. These oscillations are due to dynamic forces caused by the high speed and the change in curvature at the crossover. These forces tend to push rolling stock to the outside of the curve and cause tilting and weight transfer, which could lead to wheel lift. In this occurrence, the angle reached was 17 degrees and, as a result, the wheels completely left the rail surface. The dynamic forces caused by the 55 mph speed of the train and the geometry of crossover 75, which was designed for a speed of 15 mph, caused a transfer of weight that resulted in a wheel lift and the derailment of locomotive VIA 6413.

2.2 Non-compliance with signal

The sight distances of signals 39C and 74L were long enough to allow the train crew to identify the signals, and react and comply with them in a timely manner. Advance signal 39C displayed a "Clear to Slow" indication, which meant that the following signal should be approached at a speed of 15 mph. The throttle was advanced to notch 8, and the train accelerated from a speed of 40 mph to 60 mph.

Although signal 74L, which called for a speed of 15 mph, became visible at a distance of 1600 feet, the crew members did not call out the signal, and no action was taken by the crew to slow down the train. The train crossed that signal at a speed of 60 mph, therefore entering crossover 75 at an excessive speed.

2.3 Mental model

The overall understanding of a situation is based on several factors, including the experience, knowledge, and the perception of external cues that create a mental model, that is, a mental representation of the understanding of the situation. Mental models enable people to describe, explain, and predict events and situations in their environment.[21] Locomotive engineers (LE) maintain their knowledge of the situation by continuously creating mental models. It is difficult to alter a mental model once developed. To change one's thinking, the

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[21] E. Salas, F. Jentsch, D. Maurino, *Human Factors in Aviation*, 2nd Edition, Academic Press, 30 January 2010, p. 66.

existing mental model must be superseded by another model by providing new information that is sufficiently noticeable and compelling to result in an update of the mental model. Working memory is limited in capacity. Consequently, only a portion of the perceptible cues are retained in memory. As a result, simple and incomplete mental models are created to understand a dynamic and complex work environment.[22]

In this accident, the train did not approach the Turcot-Ouest controlled signal as if the crew expected to encounter a "Slow to Clear" signal, requiring the train to enter the freight track at a speed of 15 mph. When signal 39C was identified, the train was already travelling at about 40 mph, and the next signal was approximately 1 mile away. Furthermore, the throttle was advanced to notch 8, and the train continued to accelerate to a speed of 60 mph. Since, according to VIA operating instructions, the LE should have begun planning to slow down the train in compliance with the signal indication, the operation of the train suggests a mental model in which the train was to remain on the Turcot-Ouest north track.

Although the train destined to Jonquière can, exceptionally, be diverted to the freight track at Turcot-Ouest, as had occurred 9 days before the accident, its regular route was the north track. On the day of the accident, VIA train No. 605 had received permission from the foreman to take the north track or the south track up to Mile 7.0; there was no mention of the freight track in the instructions provided. As a result, the regular route of the train, as well as the foreman's instructions, which did not include the freight track, led the crew members to anticipate that they would remain on the north track at Turcot-Ouest and that they could proceed without reducing speed.

2.4 Rule 42 management

Given the magnitude of the work and the volume of rail traffic, the work limits of the Turcot interchange presented special challenges for the implementation and management of *Canadian Rail Operating Rules* (CROR) Rule 42. Indeed, the foremen in charge of Rule 42 were responsible for protecting several work teams spread over the entire construction area and had to manage some 50 trains daily, including about 30 passenger trains. Since the protection of train movements required multiple calls to the rail traffic controller (RTC), train crews, and track crews, the foreman's workload and its complexity could become high, particularly during the day, given the greater frequency of VIA trains.

Furthermore, it was noted that VIA trains generally travelled on the north and south main tracks, and were rarely diverted to the freight track by the RTC. As a result, some foremen were led to believe that VIA trains were not diverted to the freight track.

The regular route of VIA trains led some foremen to give shortened instructions to VIA trains in order to lighten the procedures for authorizing trains through the work limits; these shortened instructions did not include the freight track, as illustrated by the scenario that unfolded on the morning of the accident. The Rule 42 foreman had reached an arrangement

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[22] J.A. Wise, V.D. Hopkin, D.J. Garland, *Handbook of Aviation Human Factors*, 2nd Edition, CRC Press, 19 April 2016, p. 12-6.

with the RTC for the exclusive use of a portion of the freight track. As a result, the RTC had, as routes available for trains, the north track or the south track from Mile 2.05 to Turcot-Ouest, and all tracks starting at Turcot-Ouest. When the foreman communicated these instructions to trains, the instruction had to coincide with the RTC routes. However, when the foreman communicated with VIA trains, he did not include the section of the freight track between Turcot-Ouest and Mile 7.0, but included it for the freight train. If track foremen give CROR Rule 42 instructions that do not coincide with all potential train routes, train crews could misunderstand and misinterpret the instructions, increasing the risk of accidents.

2.5 Compliance with signal indications

With respect to train operations in signalled territory, the railways and Transport Canada (TC) have based their safety philosophy on strict rules compliance. Train crews are expected to react to the progression of wayside signal indications.

In a complex system, such as rail transportation, even the most rigorous set of rules will 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 seeks multiple and diverse lines of defence to mitigate the risks of normal human errors.

The centralized traffic control system (CTC) employs interconnected track circuits and field signals to control train movements. Signals inform train crews of the speed at which they may operate. This defence relies on the train crew to observe the signal, recognize the intent of the signal, and take appropriate action. To reinforce this line of defence, CROR Rule 34, an additional administrative measure, requires that all signals be identified and called out within the cab in order to reduce the risk of non-compliance with signals.

However, Rule 34 is not consistently followed. In this accident, the train crew complied with this rule to identify advance signal 39C; however, signal 74L was not communicated by crew members, as required by Rule 34. The train did not approach the Turcot-Ouest controlled signal 74L as it should have in accordance with the signal indications, that is, at 15 mph in order to safely pass through crossover 75. Given that CROR Rule 34 is not consistently followed, this additional safety measure is not always reliable in reducing instances of non-compliance with signals.

Even though railway companies have implemented safety measures to help prevent accidents, such as using 2-person crews, CROR Rule 34, General Operating Instructions, and the CTC system, none of these measures fully protects trains against the situation where the non-application or misapplication of a rule may occur. These safety measures do not ensure protection at all times against train accidents. There are other safety measures that offer the possibility of alerting the crew members when they do not react correctly to a signal or other restriction. Some of these systems, such as positive train control (PTC), can intervene (as a last resort) to initiate a brake application and slow down or stop the train.

The Transportation Safety Board of Canada (TSB) has 2 outstanding recommendations calling for additional defences in signalled territory to ensure that signal indications are consistently recognized and followed. In this occurrence, the signal indications were appropriate, but they were not followed. This is also true for other accidents the TSB has investigated, and indicates that the current methods of defence are insufficient to reduce the risks of collision and derailment when signal indications are not correctly recognized or followed. 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.

2.6 Locomotive voice and video recorders

Objective data are valuable in helping investigators understand the sequence of events that lead to an accident and in identifying operational problems where human factors and crew performance are at play. Audio-visual recordings would make it possible for TSB investigators to confirm communications between crew members and to observe their actions and interactions. As a result, investigators would be able to focus on the fundamental factors of an accident and more quickly rule out those that did not play a role.

Although the recording of conversations in the locomotive cabin was of poor quality, the TSB Laboratory was able to restore it and make it intelligible. Furthermore, the usefulness and relevance of the recording were improved by synchronizing the audio with the video recording of the forward-facing camera. The recording of in-cab conversations synchronized with video recording of the forward-facing camera assisted greatly in the investigation by making it possible to confirm the actions of the train crew and the dynamics of the derailment.

3.0 Findings

3.1 Findings as to causes and contributing factors

1. The dynamic forces caused by the 55 mph speed of the train and the geometry of crossover 75, which was designed for a speed of 15 mph, caused a transfer of weight that resulted in a wheel lift and the derailment of locomotive VIA 6413.

2. Although signal 74L, which called for a speed of 15 mph, became visible at a distance of 1600 feet, the crew members did not call out the signal, and no action was taken by the crew to slow down the train. The train crossed that signal at a speed of 60 mph, therefore entering crossover 75 at an excessive speed.

3. The regular route of the train, as well as the foreman's instructions, which did not include the freight track, led the crew members to anticipate that they would remain on the north track at Turcot-Ouest and that they could proceed without reducing speed.

3.2 Findings as to risk

1. If track foremen give *Canadian Rail Operating Rules* Rule 42 instructions that do not coincide with all potential train routes, train crews could misunderstand and misinterpret the instructions, increasing the risk of accidents.

2. 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.

3.3 Other findings

1. Given that *Canadian Rail Operating Rules* Rule 34 is not consistently followed, this additional safety measure is not always reliable in reducing instances of non-compliance with signals.

2. The recording of in-cab conversations synchronized with video recording of the forward-facing camera assisted greatly in the investigation by making it possible to confirm the actions of the train crew and the dynamics of the derailment.

4.0 Safety action

4.1 Safety action taken

4.1.1 Transportation Safety Board of Canada

On 16 March 2016, the TSB sent Rail Safety Advisory (RSA) 06/16 to Transport Canada (TC) regarding instructions from Rule 42 foremen at Turcot-Ouest. The TSB suggested that TC review the management of Rule 42, given that instructions from Rule 42 foremen provided to train crews did not coincide with the route options of the rail traffic controller (RTC).

In response to the RSA, the TC Québec Regional Office conducted an inspection of Canadian National Railway Company (CN) to verify if the foreman and RTC had given different track permissions to oncoming trains. As a result of that inspection, TC issued a Letter of Non-Compliance to CN for non-compliance with *Canadian Rail Operating Rules* (CROR) Rule 842(b), Planned Protection – Rule 42.

4.1.2 VIA Rail Canada Inc.

On 12 December 2015, VIA Rail Canada Inc. (VIA) issued bulletin HQ15-22 detailing the circumstances surrounding the accident and the importance of maintaining vigilance at all times. VIA issued a second bulletin containing special instructions and requiring the in-charge locomotive engineer (ICLE) to initiate a radio broadcast to the airwaves on the designated standby channel stating the signal indication displayed on the advance signal of the next controlled location, controlled point, or interlocking when this indication displays an indication other than clear.

VIA expanded its physical and computerized monitoring program to ensure that train crews comply with speed limits.

4.1.3 Canadian National Railway Company

In collaboration with TC, CN implemented several mitigating measures to ensure that employees are in full compliance with CROR 842(b), Planned Protection – Rule 42. These measures included

- assigning a pool of flagmen to work on rotation at Turcot-Ouest, providing consistency in the application of Rule 842;
- changing the work assignment cycles at Turcot-Ouest from 12-hour shifts with 7 days on and 7 days off, to 8-hour shifts with 5 days on and 2 days off;
- mentoring the employees that were directly involved in the occurrence;
- issuing a circular to all foremen, flagmen and RTCs explaining the requirements between the foreman and the RTC, and how to authorize a movement within Rule 42 limits; and
- conducting regular efficiency tests, specifically on Rule 42 protection.

This report concludes the Transportation Safety Board's investigation into this occurrence. The Board authorized the release of this report on 15 February 2017. It was officially released on 27 February 2017.

Visit the Transportation Safety Board'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 transportation safety issues that pose the greatest risk to Canadians. 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 – Instructions given to trains

Instructions given to train CN 7275 West at about 0802:

- Proceed on all tracks from Mile 2.05 to Mile 2.6.
- Proceed on all tracks from Mile 2.6 to St-Henri (Mile 3.5).
- Proceed on north track and south track from St-Henri to Turcot-Ouest.
- Proceed on all Turcot-Ouest tracks to Mile 7.0.

Instructions given to train VIA 6418 East at about 0812:

- Proceed on north track and south track from Mile 7.0 to Mile 5.0.
- Proceed on north track and south track from Mile 5.0 to Mile 2.05.

At about 0900, the foreman's instructions to locomotive VIA 6405 West (train VIA 33) were as follows:

- Proceed on all tracks from Mile 2.05 to Mile 2.6.
- Proceed on north track and south track from Mile 2.6 to Mile 7.0.