Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAIL INVESTIGATION REPORT
R15T0245

RISK OF COLLISION
VIA RAIL CANADA INC.
PASSENGER TRAIN NO. 65
MILE 304, GO TRANSIT KINGSTON SUBDIVISION
WHITBY, ONTARIO
25 OCTOBER 2015

Canada

Transportation Safety Board of Canada
Place du Centre
200 Promenade du Portage, 4th floor
Gatineau QC K1A 1K8
819-994-3741
1-800-387-3557
www.tsb.gc.ca
communications@bst-tsb.gc.ca

© Her Majesty the Queen in Right of Canada, as represented by
the Transportation Safety Board of Canada, 2016

Rail Investigation Report R15T0245

Cat. No. TU3-6/15-0245E-PDF
ISBN 978-0-660-06459-8

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

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.

Rail Investigation Report R15T0245

Risk of collision
VIA Rail Canada Inc.
Passenger train No. 65
Mile 304, GO Transit Kingston Subdivision
Whitby, Ontario
25 October 2015

Summary

On 25 October 2015, VIA Rail Canada Inc. passenger train No. 65 (VIA 65) was proceeding westward from Montréal, Quebec, to Toronto, Ontario, on the south track of the Kingston Subdivision, near Whitby, Ontario. At approximately 1615 Eastern Daylight Time, while travelling at about 38 mph, VIA 65 passed a red flag and entered into the work limits of track workers. 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.

Le présent rapport est également disponible en français.

Factual information

On 25 October 2015 at 0950,[1] the train crew for VIA Rail Canada Inc. (VIA Rail) passenger train No. 65 (VIA 65) came on duty at Montréal station. VIA 65 (the train) departed Montréal, Quebec, at 1150. There were approximately 335 passengers, as well as 1 on-board service manager and 4 senior service attendants, on the train.

That day, a Canadian National Railway (CN) work crew was working on the south track at Mile 304.29 of the Kingston Subdivision, near Whitby, Ontario. The work crew was laying new track panels as part of a project to accommodate a roadway underpass at South Blair Street. The work crew had protection under *Canadian Rail Operating Rules* (CROR) Rule 42[2] on both the north and south tracks between Mile 304 and Mile 305 (Figure 1).

Figure 1. Incident location (Source: Railway Association of Canada, *Canadian Railway Atlas*, with TSB annotations)

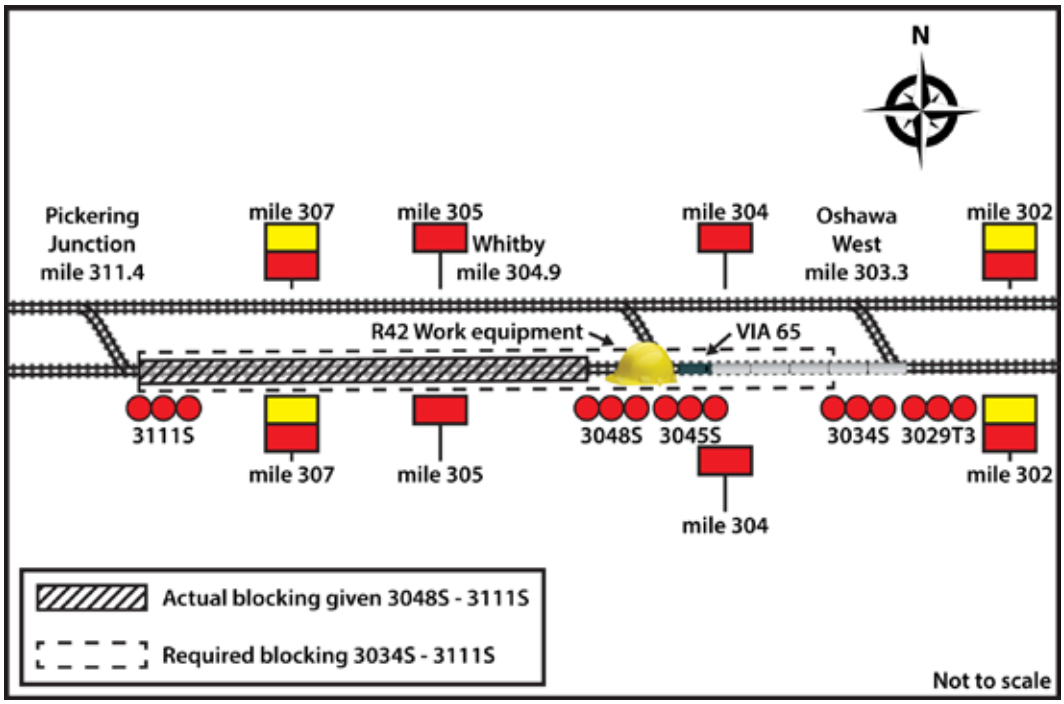
1 All times are Eastern Daylight Time.

2 Rule 42 is positive track protection, documented by a general bulletin order. Every movement routed into such limits must have a copy of it. In multi-track territory, the limits provided are applicable on all tracks. The work limits must be identified by red flags placed to the right of the track as seen by an opposing movement, in either direction of the work limits. A yellow over red flag is placed to the right of the track as seen by an opposing movement, at least 2 miles before the red flags in either direction as a reminder to an approaching movement that the foreman named must be contacted for instructions through the limits. Employees must repeat the instructions and receive acknowledgement from the foreman before passing the red signal.

At 1543, the foreman named on the Rule 42 general bulletin order (GBO) called the CN rail traffic controller (RTC) and requested and received exclusive use[3] of the south track within the Rule 42 limits between Mile 304 and Mile 305. Exclusive use implied that no trains would be permitted to operate on the south track within the Rule 42 limits. The foreman recorded this information in writing. The written agreement that was recorded by the foreman and the RTC was that all trains would use the north track.

To protect the situation, the RTC had to block the south track between Signal 3034S (Mile 303.4, Oshawa West) and Signal 3111S (Mile 311.1, Pickering Junction). However, the RTC incorrectly entered signal blocking between Signal 3048S (located at Mile 304.8 at Whitby) and Signal 3111S on the south track. The RTC advised the foreman that the south track had been blocked between Whitby and Pickering Junction, excluding the crossovers on each side. The foreman did not make a record of this information, nor was he required to do so (Figure 2).

Figure 2. Site diagram



At approximately 1610, VIA 65 was approaching the foreman's limits on the south track. The signal for the westward movement on the south track immediately before the entrance to the work limits was a permissive signal, provided by the RTC.[4] Based on the GBO information provided, the train crew members were aware of the upcoming Rule 42 limits, but were

---

3 "Exclusive use" refers to Rule 42 track work protection on one specified track (agreed upon between the Rule 42 foreman and the rail traffic controller). The agreement must be in writing and should specify on which track other movements will be authorized within the limits.

4 The rail traffic controller is responsible for routing the train through the Rule 42 limits according to the arrangement made with the foreman.

unaware that the work crew was on the south track ahead. The train crew contacted the foreman for permission to proceed through his limits. The crew was given permission to operate through the Rule 42 limits, between Mile 304 and Mile 305 on the north track. The train crew correctly complied with CROR Rule 137, regarding copying routing instructions received from the foreman. While the foreman had exclusive use of the south track from Mile 304 to Mile 305, he did not indicate that the work being conducted was specifically at South Blair Street (east of the Whitby crossover).

The signal blocking meant that the train could be and was lined by Signal 3029T3 (Oshawa West) on the south track into the Rule 42 limits until Whitby, where it was then lined to cross to the north track. Recognizing that their train was being routed through the Rule 42 limits on the south track, the train crew contacted the foreman again to indicate that they would be crossing over at Whitby. However, it was not specified that the train would be approaching the foreman's limits on the south track. The foreman responded affirmatively to the train crew, still not realizing that the train was lined on the south track to Whitby.

While preparing to cross over to the north track at Whitby, train speed was reduced to 38 mph. At approximately 1615, the train crew noticed maintenance equipment positioned on the south track fouling the crossover at Whitby. The brakes were immediately applied, safely stopping the train approximately 500 feet short of the maintenance equipment (Photo 1).

Photo 1. View from VIA 65 stopped, with work equipment approximately 500 feet ahead on the same track (Source: VIA Rail Canada Inc.)

Employee information

Train crew information

VIA Rail passenger trains are operated by 2 qualified locomotive engineers, both located in the cab of the lead locomotive. The operating locomotive engineer (LE) sits at the controls on the right side of the locomotive cab, while the in-charge locomotive engineer (ICLE) sits on the left side and performs the duties of the conductor.

The LE for VIA 65 had more than 34 years of experience as a locomotive engineer, which included 30 years with CN before moving to VIA Rail as a locomotive engineer. The ICLE had 31 years of railway experience, including 29 years as an on-board service employee with VIA Rail, and 2.5 years as a locomotive engineer with VIA Rail. The LE and ICLE were qualified for their positions, met rest standards, and were familiar with the territory. The LE had trained the ICLE on a regular basis over the 6-month period preceding the incident. On the day of the occurrence, it was the first trip they were working together as a train crew.

Foreman information

The foreman in charge of the Rule 42 had about 8 years of railway experience as a flagging foreman with CN. He was qualified for his position, was rested, and was familiar with the territory. He had been working with this rail gang project (South Blair Street) on and off for the previous 2 years.

Rail traffic controller information

The RTC, who was supervising this portion of track for CN, had previously worked as a divisional transportation officer of a Pakistani railway. His duties had included overseeing 2 rail traffic control centres, supervisors, and the crew management of trains. However, prior to working in Canada, he had not worked specifically as an RTC. In 2014, this employee accepted an RTC manager position with CN and passed the required Qualification Standards for Operating Crews course. However, to become more familiar with Canadian RTC operations and operating environment, which he believed were more structured than what he had encountered in the country in which he had worked previously, the employee requested and attended an RTC course. His training included 1½ months on the portion of the Kingston Subdivision where the incident occurred. After completing training in April 2015, he started working as an RTC on the Kingston Subdivision. The RTC was qualified for his position, was rested, and was familiar with the territory.

The RTC's training included information regarding Rule 42 blocking for exclusive use of one track to adequately protect track workers and work within the Rule 42 limits. This training comprised discussions on the difference between what mileages work is being conducted and which signals need to be blocked to prevent other movements from entering.

At the rail traffic control centre, track schematic diagrams are provided to RTCs at their desk to help them cross-reference the location of track work to be conducted. This is to help ensure that RTC blocking will adequately mirror the work limits to prevent lining movements into them. However, there is no requirement to use the diagrams. The occurrence RTC did not consult the diagrams on a regular basis.

The RTC's experience was that the emphasis on operational efficiency relating to train control is more prevalent in Canada than it is in the country in which he had worked previously. At CN, the RTC often felt pressure in trying to perform the required duties in an urgent manner. In addition, the RTC encountered differences in railway operations[5] and in railway terminology between the 2 countries. The RTC often found it challenging to adjust to these changes. It was common for the RTC to have to repeat instructions or use different wording for others to understand what he was trying to communicate.

Subdivision and track information

The portion of the Kingston Subdivision running from Toronto Union Station (Mile 333.8) to Oshawa, Ontario (Mile 301.6) is owned by GO Transit (GO). The portion from Oshawa to Dorval East, Quebec (Mile 10.3), is owned by CN. CN provides rail traffic control and maintenance for the subdivision between Cherry Street (Mile 332.4) and Dorval East. Toronto Terminals Railway provides rail traffic control and maintenance from Union Station to Cherry Street.

In the vicinity of the occurrence, there are 2 main tracks between Oshawa West (Mile 303.3) and Pickering Junction (Mile 311.4). Train movements on the Kingston Subdivision are governed by the centralized traffic control (CTC) system as authorized by CROR and supervised by a CN RTC located in Toronto. Daily train traffic consisted of about 16 freight trains and 30 VIA passenger trains. The maximum authorized timetable speed for passenger trains in the area of the incident was 95 mph. At the time of the occurrence, there was a temporary slow order from Mile 304 to Mile 304.5 on both tracks, restricting trains to a maximum of 65 mph.

The rail on both tracks was 136-pound continuous welded rail. The rail was laid on 16-inch double-shouldered tie plates, which were fastened to hardwood ties with 5 spikes per plate. In some spots, there were 14-inch tie plates with 4 spikes per plate. The rail was box-anchored every second tie, and fully anchored at crossings. The cribs were filled with crushed rock ballast and the drainage in the vicinity of the occurrence was good.

---

5 In Canada, rail traffic controller (RTC) blocking includes agreeing to and recording instructions between the foreman and the RTC. In Pakistan, track work after the initial planned protection has been provided is not formally controlled further by the RTC. There, the foreman who is in charge of track work is in direct contact with trains in the area and will establish train routing through the limits. The RTC has nothing to do with these instructions, and is not responsible for providing further blocking on the track to protect the workers.

The track was being inspected in accordance with regulatory and company requirements. The most recent inspection had been conducted 3 days before the occurrence. No anomalies were noted in the vicinity of the occurrence.

At Whitby, just east of controlled signal 3048S, there is a crossover that enables westbound trains to cross from the south track to the north track. Eastbound trains also use this crossover to cross from the north track to the south track. The maximum authorized speed through the crossover is 45 mph.

Weather

At the time of the occurrence, the sky was partially overcast with good visibility. The temperature was 12°C.

Centralized traffic control system

CTC is a method of train control that uses interconnected track circuits and signals in the field to control movements. Computer displays and controls are installed in the rail traffic control centre. Signals are actuated by the presence of a train movement. The signal indications in the field provide

- information to train crews indicating the speed at which they may operate and how far they are permitted to travel; and
- protection against certain conditions that could include an occupied block, a broken rail, or an open main track switch.

Train crews must be familiar with the signal indications specified in CROR and must control their trains accordingly. CTC does not provide automatic enforcement to slow or stop a train before it passes a Stop signal or other point of restriction.

In the rail traffic control centre, track occupancy status is displayed on the RTC's computer screen. Track occupancy normally indicates the presence of a train. However, track occupancy on the RTC screen can also indicate an interrupted track circuit (e.g., a broken rail or a switch left open). The RTC can control certain signals (controlled signals) by setting them to a Stop indication or by requesting that they display permissive indications.

When an RTC requests signals for a train, the signal system determines how permissive the signals will be, based on the presence of other track occupancies and how many consecutive signals have been requested.

Canadian Rail Operating Rules

CROR Rule 42 *Planned Protection* states (in part):

> (b) A movement in possession of the Form Y[6] must not proceed beyond the red signal located at the identifiable location stated in the GBO [general bulletin order], or make a reverse movement within such track limits until instructions have been received from the foreman named in the GBO.
>
> When a specific track is to be used, instructions from the foreman must specify the track upon which the instructions apply.
>
> (c) The instructions must be repeated to, and acknowledged by, the foreman named in the GBO before being acted upon.

CROR Rule 842, *Planned Protection – Rule 42* states (in part):

> (b) 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)[7] 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.

At CN, the foreman uses a train clearing form to record the routing instructions agreed upon with the RTC. This form is used to indicate on which track and limits the workers are permitted to be. The form contains a train clearing record with instructions to each train including route, speed permitted, and instructions such as whistle and bell or no restrictions, along with the time the train cleared the limits. While the first communication with VIA 65 was recorded on the train clearing form, the subsequent communications were not.[8]

Flagmen often have access to track schematics that provide information on where the signals, crossovers, crossings, and other identifiable railway locations are positioned in the field. These schematics can be used to help plan work. However, as the schematics are modified regularly to accommodate track changes, flagmen may not be able to rely on their accuracy unless they are always provided with the current version. The foreman did not have track schematics with him that day.

Engineering employees who conduct track inspections are commonly provided with laptop computers that allow them to request an electronic display of an RTC's overview of the track (Photo 2) if the territory has sufficient cell phone coverage. This can provide employees with information on whether the track they need to patrol is available. After positive track

---

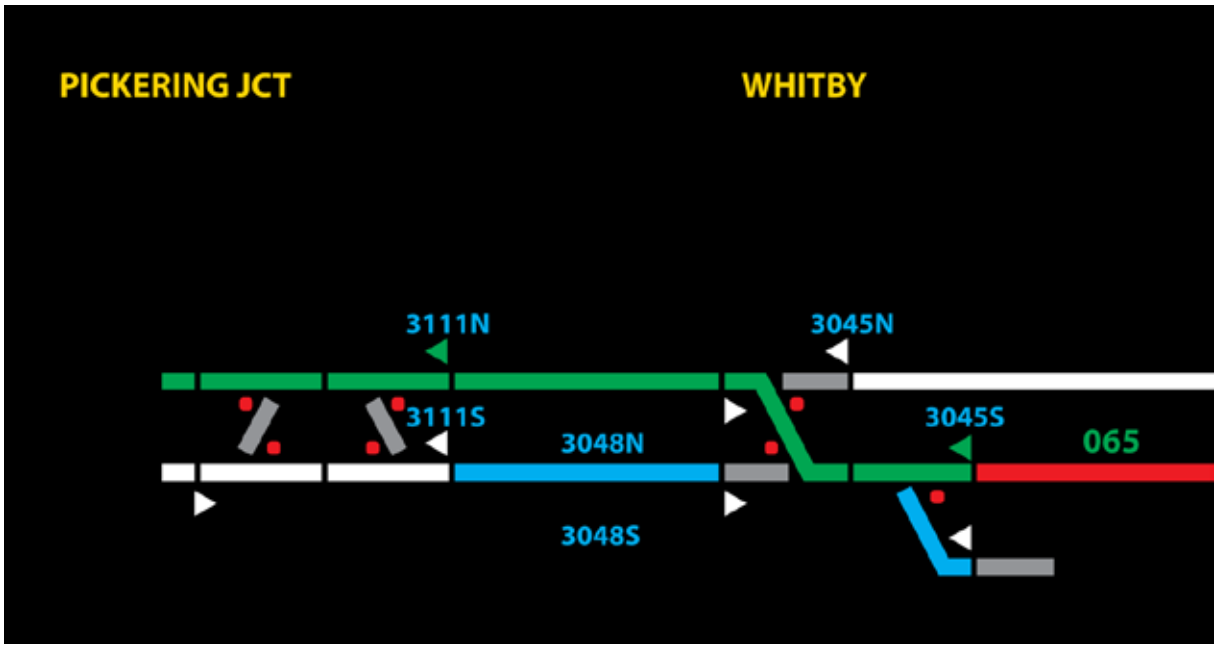
6 "Form Y" refers to the GBO format used to document a Rule 42. It requires displaying the limits of planned protection, the time the order is in effect, and the name of the foreman in charge. It is contained in the Train General Bulletin Orders that identifies all temporary restrictions, such as speed of track and planned Rule 42 limits, and crossing orders, specific to each train.

7 "Route to be used" refers to track designation only (e.g., north track). It does not refer to switch positions within the limits of the protection leading to or away from that track.

8 There are no specific instructions indicating that subsequent conversations with the same train must be recorded.

protection has been obtained from an RTC, the blocking given would be displayed on the electronic overview display. However, Rule 42 foremen do not usually have access to such laptops. The foreman did not have a laptop to display the RTC screen with him that day.

Photo 2. Rail traffic controller screen (Source: Canadian National Railway)



At CN, in its CROR, System Special Instructions specify that

> When permission is granted from the foreman, the current time and location/mileage of the movement must be recorded next to the Rule 42 GBO. All crew members, other than the employee that recorded it, must acknowledge and initial the time and location. This GBO must be retained until the completion of the shift.

CN's RTC Manual, Item 4009 "Protection of Track Work and Track Conditions," states (in part):

> RULE 42/842 – Foreman's Instructions in Multitrack Territory
>
> RTC Protection will be used to protect this arrangement.
> NOTE: Routing arrangement must be completed before commencement of the Rule 42/842.
>
> Foreman's instructions to the RTC:
>
> - Movements may operate through my entire limits on any track with no restrictions, or
> - Movements may operate on south track between Able and Baker and all tracks between Baker and Charlie.
>
> Recording foreman's instructions: If the foreman instructions to RTC state, there are no routing restrictions, RTC must record this information in the GBO System notepad. If there are routing restrictions, they will be written in the

RTC Protection. This information must be included in all transfers until expiration of the Rule 42/842.

Situational awareness and mental models

Situational awareness (SA) in relation to operational matters refers to the operator knowing what is happening in the immediate environment. There are 3 stages of SA:[9]

- "Perception" refers to the recognition that new, unambiguous cues exist.
- "Comprehension" refers to understanding the order of importance of the new cues.
- "Projection" refers to the ability to forecast future events based on information given.

The overall understanding of a situation is based on experience, knowledge, and perception of external cues resulting in a mental model. It is difficult to alter a mental model once developed, particularly in a short period of time. To change one's thinking, the existing model must be superseded by another model. New information must be provided that is sufficiently noticeable and compelling to result in an update of the mental model.

A CROR Rule 42 foreman's SA comes from various information sources. These can include radio transmissions, observation of the track, environmental conditions, and written information. Railway rules and operating instructions also affect SA. For example, CROR and General Operating Instructions provide information that foremen are required to use. When providing instructions to a movement through CROR Rule 42 limits, decisions and actions greatly depend on the foreman's assessment and understanding of the operational situation.

Other occurrences involving trains entering Canadian Rail Operating Rules Rule 42 or track occupancy limits without adequate permission

TSB Railway Occurrence R15T0121

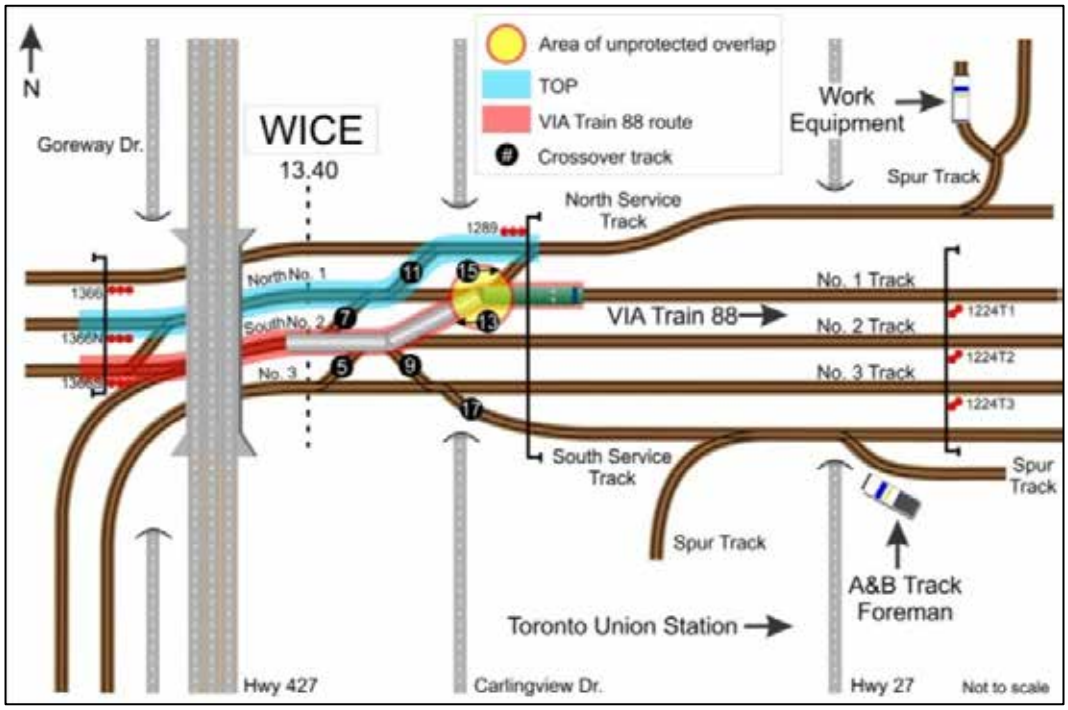
On 02 June 2015, VIA Rail passenger train No. 88 (VIA 88) was proceeding eastward from London, Ontario, to Toronto, Ontario, on the No. 2 track near Mississauga, Ontario. At the time, an A&B track foreman was in possession of a track occupancy permit (TOP) for the North Service Track and the No. 1 track between signal 1289 and signal 1366N at Wice station for track maintenance.

At approximately 2250, VIA 88 was routed to cross over from the No. 2 track to the No. 1 track on a permissive signal indication using crossover No. 13. This crossover is in the vicinity of crossover No. 15, which was within the limits of the TOP (Figure 3). VIA 88's crew was unaware of the TOP and unaware that they had entered a portion of the track foreman's TOP, resulting in an unprotected overlap of authority (Figure 3).

---

9 M.R. Endsley and D.J. Garland, *Situation Awareness Analysis and Measurement* (Mahwah, NJ: Lawrence Erlbaum Associates, Inc., 2000).

Figure 3. Site diagram for TSB Railway Occurrence R15T0121



When the RTC requested the initial TOP for the A&B track foreman, the RTC II system automatically lined crossover No. 11 in the reverse position and placed electronic blocking from signal 1289 on the North Service Track through crossover No. 11, and through the No. 1 track westward to signal 1366N. However, the RTC II system did not specifically block crossovers Nos. 13 and 15. Without these crossovers being blocked, a routing option was available to VIA 88, which resulted in overlapping a portion of the TOP.

The RTC II system is typically programmed such that if a TOP is requested over 2 tracks where there are parallel crossovers, as was the case in this occurrence, the system generates a TOP with automatic instructions specifying which crossover(s) will be used as the intended route. However, the automatic instructions for the track foreman to use crossover No. 11 were not generated. Consequently, the foreman believed that both crossovers Nos. 11 and 15 could be used safely, as they were within his TOP, and he had been given permission by the RTC to use the crossovers as required.

On 03 July 2015, the TSB sent Rail Safety Advisory Letter 08/15 to Transport Canada (TC), indicating that TC may wish to review how the RTC II system handles signal blocking and routing at other parallel crossover locations to ensure that these functions are always performed safely.

The situation on the GO Transit Weston Subdivision was addressed through a software programming update. As well, other similar locations or circumstances on other subdivisions were checked to mitigate the potential of additional unprotected overlaps of authority where routing at other parallel crossover locations existed.

TSB Railway Occurrence R15T0258

On 05 November 2015, a Canadian Pacific Railway (CP) rail gang was laying new rail on the Galt Subdivision near Campbellville, Ontario. Under CROR Rule 42 protection, the foreman had received exclusive use of the south track between Mile 33 and Mile 39 from the RTC. The written instructions between the RTC and the foreman indicated that all movements were required to be on the north track through the Rule 42 limits.

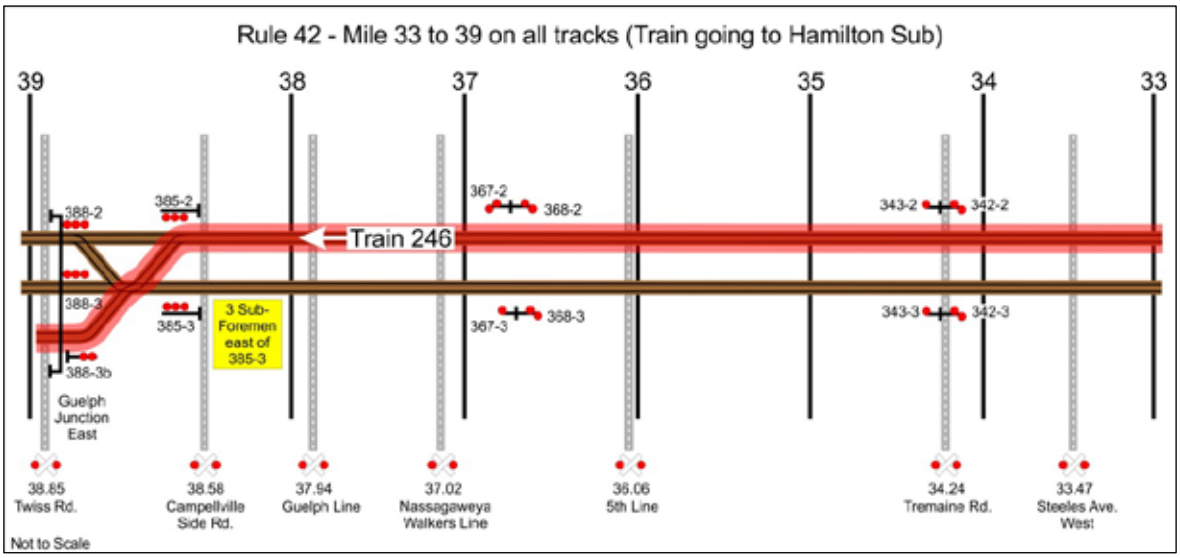
The foreman then cleared[10] 3 sub-foremen from the north track to the south track, as work had to be performed on the south track east of Guelph Junction.

As westbound train 246-04 (the train) approached Mile 33, the train crew called the foreman for permission to operate through his limits. The foreman authorized the train crew to proceed on the north track from Mile 33 to Mile 39. However, the train had been lined by the RTC from the north track to the south track at Signal 385-2 (following a verbal agreement between the RTC and the foreman), as the train was destined for the Hamilton Subdivision, which required accessing the south track at Guelph Junction. The foreman then instructed the train to cross over to the south track at Signal 385-2, with permission to use the south track between Signal 385-3 and Signal 388-3 (Guelph Junction East). These instructions to the train were also in writing.

The 3 sub-foremen were not advised by the foreman that the train would be crossing over to the south track at Signal 385-2. The foreman had assumed that the 3 sub-foremen were working east of Signal 385-3, clear of where the train would cross over. This created a risk of collision on the south track between the train and the 3 sub-foremen. Prior to lining the train to the south track, there had been no routing arrangement changes or discussions between the RTC and the foreman (Figure 4).

[10] Written instructions were provided to the sub-foremen allowing them to use the south track between Mile 33 and Mile 39.

Figure 4. Site diagram for TSB Railway Occurrence R15T0258



On 11 December 2015, the TSB sent Rail Safety Advisory Letter 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 letter 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.

TSB Railway Investigation Report R98T0141

On 17 June 1998, St. Lawrence & Hudson Railway freight train No. 501-16, travelling westward on the south track of CP's Galt Subdivision, struck 2 stationary track units at Mile 37.8, puncturing the locomotive fuel tank and causing a leak of approximately 2,000 gallons of diesel fuel oil. There were no injuries.

CROR Rule 42 was in effect between Mile 33 and Mile 40.2 for the replacement of track ties. The main portion of the rail gang was located on the south track, west of the crossovers at Guelph Junction East. The RTC assumed they were there as a track circuit displayed their approximate location, which the Rule 42 foreman confirmed. However, a group of workers had sub-foreman protection on the south track at Campbellville to unload ties. These workers were located approximately 1 mile east of the main rail gang, and their presence did not present track occupancy. The RTC, who was not aware of the location of this work group, routed train 501-16 on the south track, resulting in the collision. With respect to the communication between the foreman and the train crew, railway procedures did not require the train crew to advise the foreman on which track they were approaching his work limits. In this occurrence, the foreman believed that the RTC had a clear understanding of the location of the sub-foremen and would therefore have routed the trains onto the north track. The foreman was aware that there were no crossovers between the red flag at Mile 33.0 and the location where his sub-foremen were working. Had the foreman been advised by the

train crew on which track they were approaching, there may have been an opportunity to avert the collision. St. Lawrence & Hudson Railway rail traffic control procedures did not formally require that the RTC communicate with the foreman to establish the desired routing for trains. Railway special instructions issued shortly after this collision formalized partial communication requirements between the foremen and RTCs to establish routing.

Train control systems for protection of work zone limits

In recent years, the rail industry has developed technology to help mitigate the risk of collisions when a train enters the limits of a work zone without adequate permission. The technologies in use or under development include

- proximity detection
- positive train control
- track worker / train operator advance warning device

Proximity detection

A proximity detection device was developed and implemented by Quebec North Shore & Labrador Railway after a 1996 collision involving 2 of its trains (TSB Railway Investigation Report R96Q0050). The proximity detection device is designed to trigger penalty braking if train crews or track unit operators do not acknowledge the alert warning status when they come within a predetermined distance of another movement. No similar systems (except for limited trials) have been implemented on other Canadian railways.

Positive train control

Positive train control (PTC) is an emerging train control technology that is designed to prevent

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

If the operating crew does not initiate an adequate response, the PTC system would automatically slow or stop the train. In the United States, PTC technology has been under development for many years.

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, PTC be installed on the higher-risk rail lines in the United States. However, due to a number of technical challenges, it is anticipated that the United States implementation of PTC will be delayed beyond 31 December 2018.

In Canada, there are currently no PTC systems in use by freight or passenger railways, and there are no planned PTC installations for federally regulated railways. However, to meet the PTC requirements for their United States operations, both CN and CP have PTC implementation plans for their United States routes. As part of CP's implementation plan, 1004 locomotives will be equipped with the required on-board systems, as will approximately 2850 miles of track in the United States. As part of CN's PTC implementation plan, 1000 locomotives will be equipped with the required on-board systems, as will approximately 3720 route miles of track in the United States.

This system will include functions to

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

As this system is under development, the United States Federal Railroad Administration must certify the technology and its application for each railroad prior to use in revenue service.

Track worker – Train operator advance warning device

On 30 January 2008, in response to a southbound Metrorail Red Line subway train that struck and killed a Metrorail employee near the Dupont Circle station in Washington, D.C., the United States National Transportation Safety Board (NTSB) issued Recommendation R-08-04 to the Washington Metropolitan Area Transit Authority. The recommendation required (in part) that the railroad promptly implement appropriate technology that will automatically alert wayside workers of approaching trains and automatically alert train operators when approaching areas with workers on or near the tracks.

On 19 October 2013, Bay Area Rapid Transit train 963 struck and fatally injured 2 engineering department employees on the right-of-way near Walnut Creek, California. The NTSB issued Recommendation R-13-39 and Recommendation R-13-40 to the Federal Transit Administration (FTA):

- Recommendation R-13-39 required that the FTA issue a directive to all transit properties requiring redundant protection for roadway workers, such as positive train control and secondary warning devices.
- Recommendation R-13-40 required in part that the FTA issue a directive ensuring that all transit properties review their wayside worker rules and procedures, and revise them as necessary to eliminate any authorization that depends solely on the roadway worker to provide protection from trains and moving equipment.

On 25 November 2014, the United States Department of Transportation's Federal Railroad Administration (FRA) issued Safety Advisory 2014-02 Roadway Worker Authority Limits—Importance of Clear Communication, Compliance with Applicable Rules and Procedures, and Ensuring That Appropriate Safety Redundancies are in Place in the Event of Miscommunication or Error. This safety advisory stated that if a railroad determines that appropriate safety redundancies are not in place, the railroad should adopt electronic technology that would provide appropriate safety redundancies and adopt certain interim safety measures and procedures at least until such technology is in place.

In response to NTSB recommendations R08-04, R13-39, and R13-40, and FRA Safety Advisory 2014-02, a number of United States transit properties (including California Public Utilities Commission, Valley Transit, Sacramento Regional Transit District, San Francisco Municipal Transportation Agency, and Bay Area Rapid Transit) began to use the Protracker system. This technology is a Roadway Worker Protection System, based on a track walker/worker – train operator advance warning device (Appendix A).

Other railways using this technology include LA Metro, Greater Cleveland Regional Transit District, Maryland Transit Administration, and Southeastern Philadelphia Transportation Authority. This device allows the system to communicate with vehicle monitors and has a special radio interface that allows the system to report worker location to the control centre. It can also be installed to advise track workers on which track a train is approaching the work limits.

Train control research projects

In 2014, 3 research projects were initiated by the Train Control working group of the Advisory Council on Railway Safety (ACRS) to focus on options with regard to train control systems. In 2015, the working group completed the first 2 phases of its work plan, consisting of a field study of missed signals by rail crews and 2 literature reviews (Technical Overview of Existing Technologies, and Human Factors Literature Review). The third phase (generating and evaluating options) and the fourth phase (preparing recommendations and the final report) are under way. The final report from the working group is expected to be presented to the ACRS in September 2016.

Analysis

There were no equipment defects or track defects that were considered causal in this occurrence. The analysis will focus on train operations, situational awareness, communicating routing arrangements, including rail traffic controller (RTC) blocking, and advance warning of approaching trains to track workers.

The occurrence

The risk of collision occurred when VIA Rail Canada Inc. passenger train No. 65 (VIA 65), operating on the south track with proper authority, entered into the foreman's exclusive work limits. The foreman had exclusive use of the south track between Mile 304 and Mile 305. Written routing instructions between the RTC and foreman established that all trains would be routed on the north track through the foreman's entire limits. The train crew was given a permissive signal by the RTC on the south track that indicated they would be crossing over to the north track at Whitby, Ontario. When the train crew contacted the foreman for permission to proceed through his Rule 42 limits, the foreman gave the train crew permission to operate through his limits on the north track. The foreman had assumed that VIA 65 was on the north track.

Realizing that the route provided by signal indications was conflicting with the instruction received from the foreman, the train crew contacted the foreman a second time and advised that they would be crossing over at Whitby. The foreman then gave VIA 65 a second permission, but did not realize the train was approaching on the south track. The train crew believed that the foreman now knew on which track they were approaching.

When positive protection is given to a foreman in the form of either a track occupancy permit or Rule 42, written routing arrangements must be specific to prevent a train being lined into the protected limits. While the track to be used is agreed upon, there is no requirement for the RTC and foreman to discuss the position of crossover locations within the protected limits. The near-collision occurred when VIA 65, operating on the south track west of Signal 3029T3 (Mile 302.9), entered into the foreman's exclusive work limits (Mile 304 to Mile 305), where track workers and machinery were present. Improper blocking of the Rule 42 limits had been applied by the RTC. Due to incomplete communications between the Rule 42 foreman and the train crew, the foreman was not fully aware of the train's routing through the work limits.

Situational awareness

For the foreman to develop situational awareness, the 2 main sources of information were communications with the RTC and with the train crew. However, incomplete communications among the employees led the foreman to develop an inaccurate mental model of the track on which the train was operating.

In this occurrence, other gaps in situational awareness included the following:

- The train crew was not specifically aware that there were track workers and machinery on the south track at Mile 304.29.
- The foreman was unaware that the RTC had routed VIA 65 on the south track up to the crossover at Whitby.
- The foreman believed that he had successfully apprised the RTC of the location of his track workers.
- The RTC believed that the entire rail gang was located on the south main track, west of the crossovers at Whitby.

When operating a train through a work zone in centralized traffic control territory, a common misleading cue can be the signal indication. For example, the crew may see a permissive signal indication, yet not be authorized to proceed beyond a Rule 42 red flag on that track unless the foreman provides permission. In this occurrence, the signal for the westward movement on the south track immediately before the entrance to the work limits was a permissive signal. The train crew received permission from the foreman to use the north track through his Rule 42 limits. However, being on the south track with a signal indicating that they would cross over to the north track at Whitby, in the middle of the Rule 42 limits, caused concern for the crew. When they called the foreman back for clarification, they did not specifically mention (nor were they required to) that they were on the south track, but only that they were crossing over at Whitby. As there was only one crossover at Whitby, the train crew believed that the foreman would understand on which track they were approaching.

The permissive signal indication at Oshawa West, Ontario, was interpreted by the train crew as confirmation that the correct routing had been established between the foreman and the RTC. When the crew indicated to the foreman that the train was lined to cross over at Whitby, it did not occur to the foreman that the train was operating on the south track, even though the crossover for a westbound train at that location could be accessed only from the south track. The foreman had developed an inaccurate mental model of the track on which the train was operating. As the foreman had been given exclusive use of the south track, he believed that all trains would be operating on the north track through the Rule 42 limits. Based on this mental model, the foreman did not pay sufficient attention to the routing information provided by the train crew, and VIA 65 was inadvertently permitted to operate through the exclusive work limits.

The train crew believed that the RTC and the foreman would ensure that all trains were routed on the appropriate track. Based on this belief, the train crew assigned less importance to this critical communication. If Rule 42 foremen are not advised by the train crew on which track the train is approaching the work limits, the foreman will not have the opportunity to identify situations when a train is lined onto the wrong track, increasing the risk of collisions with track workers and equipment.

Verification of signal blocking by Rule 42 foremen

Signal numbers are used by the RTC to block exclusive use of one track for a Rule 42. The foreman relies on the RTC to ensure that adequate blocking has been placed to protect workers within their identified limits. In this occurrence, the signal numbers entered by the RTC to block the south track were incorrect. These signal numbers were not shared with the foreman, nor were they required to be.

As blocking can extend beyond the work limits, it was felt that a foreman could be misled if the signal blocking information is shared. The concern was that, by having access to this information, a foreman could develop a mental model whereby he believes that his employees and equipment would still be protected when positioned outside the limits stated in the general bulletin order.

By comparison, for territory in which there is sufficient cell phone coverage, foremen who conduct regular track patrols and maintenance commonly use laptops that provide electronic overviews of the RTC screen. By having access to the RTC screen, these foremen are able to check on the availability of a track before contacting the RTC. Once they receive protection from the RTC, the protection is displayed on the foreman's laptop, which is identical to the RTC's display screen. This display would provide additional verification to the foremen that adequate blocking has been established.

If real-time display tools are not available to Rule 42 foremen to help verify RTC blocking for their work limits, improper blocking may not be identified in a timely manner, increasing the risk of a train entering the work limits without adequate permission.

Communications between rail traffic controllers and Rule 42 foremen

Safe railway operations depend on strict employee adherence to procedures and rules. To achieve compliance, railways rely on supervisory activities, such as radio monitoring and proficiency testing, as well as employee knowledge of the importance of communication accuracy.

In this occurrence, existing procedures were generally followed. However, no specific guidelines had been established for communications between RTCs and Rule 42 foremen. The use of consistent, standardized communication procedures for establishing specific written train routing instructions (e.g., designation of track, location and position of crossovers) could be a best practice. Without a standardized procedure, foremen and RTCs are left to determine what must be discussed, including ensuring that routing arrangements are secured and clearly understood.

In multi-track Rule 42 limits, it is not uncommon for track workers to require exclusive use of one track. The Rule 42 foreman and the RTC must have clear, concise written routing arrangements. These routing arrangements must be supported by RTC blocking to prevent trains from entering this portion of track. To be properly protected, workers within the

Rule 42 limits must copy the routing arrangements without error. The content of routing arrangement is crafted by the RTC and the foreman in charge, and can vary according to the communication style. In this occurrence, much of the communications between the foreman and the RTC focused on the wording for the exclusive work limits (which was not reflected in the signal blocking) and only specified the track designation to be used by the train.

If standard communication protocols between the RTC and all Rule 42 workers relating to RTC blocking are not in place, the desired routing of trains, including crossover positions to enter the work limits, may not be clearly understood, increasing the risk of trains entering the work limits without adequate permission.

Advance warning of approaching trains to track workers

If the RTC blocking is entered incorrectly or if any of the involved parties have a different understanding of where they are permitted to work or where trains will travel through the Rule 42 limits, a train can enter the work limits without adequate permission or full awareness of the track workers. To minimize the risk associated with this type of track activity, various technologies have been developed to provide advance warning of approaching trains. These technologies include the following:

- advance warning devices such as Protracker, developed by Protran Technology: this system provides advance warning to track workers and train crews and is used by a number of United States railroads and transit companies; and
- proximity detection device: this system was developed and implemented at Quebec North Shore & Labrador Railway to provide advance warning to trains and to track units.

Implementation of existing technology, such as proximity detection devices and advance warning devices, can be an effective means of warning train crews and track workers that they are approaching one another.

Findings

Findings as to causes and contributing factors

1. The risk of collision occurred when VIA Rail Canada Inc. passenger train No. 65, operating on the south track with proper authority, entered into the foreman's exclusive work limits.

2. Improper blocking of the *Canadian Rail Operating Rules* Rule 42 limits had been applied by the rail traffic controller.

3. Due to incomplete communications between the Rule 42 foreman and the train crew, the foreman was not fully aware of the train's routing through the work limits.

4. The foreman had developed an inaccurate mental model of the track on which the train was operating. As the foreman had been given exclusive use of the south track, he believed that all trains would operate on the north track through the work limits.

5. The foreman did not pay sufficient attention to the routing information provided by the train crew, and VIA Rail Canada Inc. passenger train No. 65 was inadvertently permitted to operate through the exclusive work limits.

6. The train crew believed that the rail traffic controller and the foreman would ensure that all trains would be routed on the appropriate track.

Findings as to risk

1. If Rule 42 foremen are not advised by the train crew on which track the train is approaching the work limits, the foreman will not have the opportunity to identify situations when a train is lined onto the wrong track, increasing the risk of collisions with track workers and equipment.

2. If real-time display tools are not available to Rule 42 foremen to help verify rail traffic controller blocking for their work limits, improper blocking may not be identified in a timely manner, increasing the risk of a train entering the work limits without adequate permission.

3. If standard communication protocols between the rail traffic controller and all Rule 42 workers relating to rail traffic controller blocking are not in place, the desired routing of trains, including crossover positions to enter the work limits, may not be clearly understood, increasing the risk of trains entering the work limits without adequate permission.

Other findings

1. Implementation of existing technology, such as proximity detection devices and advance warning devices, can be an effective means to warn train crews and track workers that they are approaching one another.

Safety action

Safety action taken

Following the occurrence, both the Canadian National Railway (CN) and VIA Rail Canada Inc. conducted their own internal investigations of the occurrence. In addition, CN reviewed the incident with each rail traffic controller (RTC) as part of a course titled Looking out for Each Other.

On 20 November 2015, the Transportation Safety Board of Canada issued Rail Safety Advisory Letter 14/15 to Transport Canada (TC). The letter stated that, considering the risk of routing trains through *Canadian Rail Operating Rules* (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 letter, TC's Ontario Regional Office 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."

CN responded to TC on 13 December 2015, indicating that CN had not considered routing instructions between a foreman and a train crew as a restriction in the application of Rule 137. CN suggested that there would be benefit in clarifying the definition of "restriction." 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(s), and therefore must be in writing.

In January 2016, TC's Ontario Regional Office conducted an inspection at CN's rail traffic control centre and reviewed how signal blocking is used to protect the Rule 42 foreman; how routing arrangements between the RTC and Rule 42 foremen are established and communicated; and how the foreman communicates with the train crew. No non-compliances were found.

This report concludes the Transportation Safety Board's investigation into this occurrence. The Board authorized the release of this report on 10 August 2016. It was officially released on 5 October 2016.

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 – Protracker

Source: Protran Technology