



Transportation
Safety Board
of Canada

Bureau de la sécurité
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RAILWAY INVESTIGATION REPORT

R16C0065



Non-main-track train collision and derailment

Canadian Pacific Railway

Freight trains 303-646 and 113-31

Mile 171.1, Brooks Subdivision

Calgary, Alberta

03 September 2016

Canada

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Railway investigation report R16C0065

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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.

Railway Investigation Report R16C0065

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Summary

On 03 September 2016, at about 0925 Mountain Daylight Time, Canadian Pacific Railway train 303-646, proceeding westward at approximately 22 mph at Mile 171.7 of the Brooks Subdivision, collided with the tail end of train 113-31, which was stopped on track PT01, near Alyth Yard in Calgary, Alberta. Two locomotives on the head end of train 303-646 derailed, as did 2 covered hopper cars behind the locomotives. The last car on train 113-31, a 3-platform container car, also derailed. There were no injuries. No dangerous goods were released.

Le présent rapport est également disponible en français.

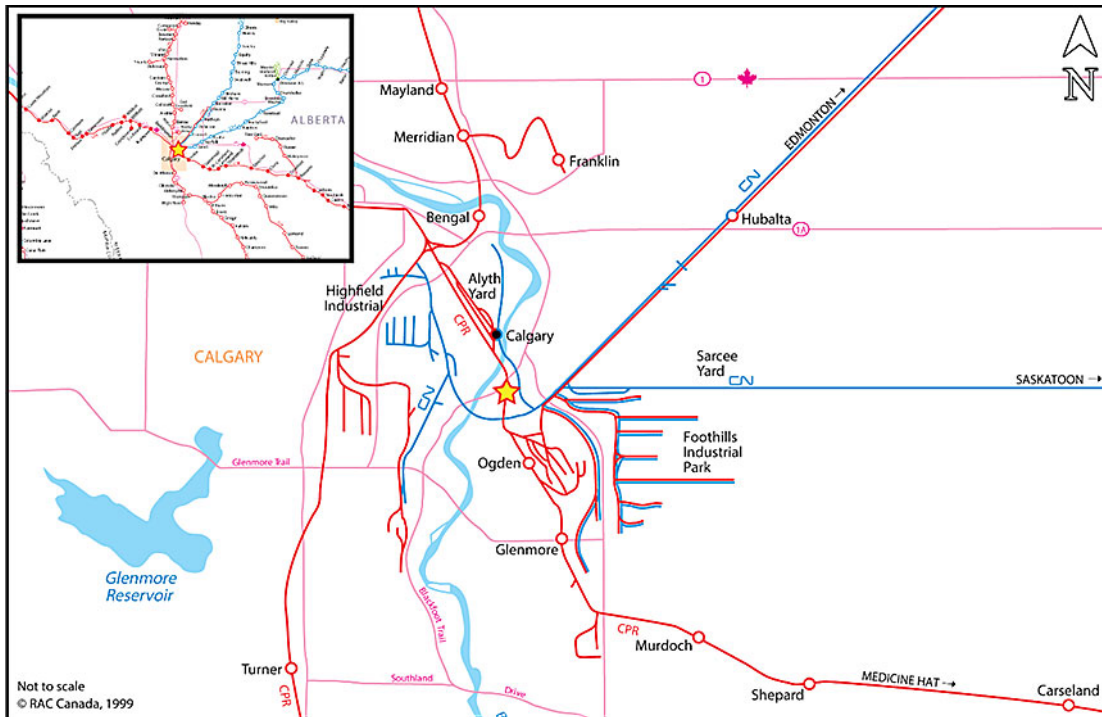
Factual information

The accident

On 03 September 2016, Canadian Pacific Railway (CP) train 113-31 (train 113) departed Medicine Hat, Alberta, at approximately 0045.¹ Travelling westward on the Brooks Subdivision, train 113 was destined for Coquitlam, British Columbia. At approximately 0115, CP train 303-646 (train 303) departed Medicine Hat, also travelling westward on the Brooks Subdivision, destined for Vancouver, British Columbia. Both trains were scheduled for a crew change at Alyth Yard in Calgary, Alberta (Figure 1).

Train 113 consisted of 3 locomotives (2 head-end locomotives and a mid-train locomotive) and 69 loaded intermodal flat cars. The train weighed approximately 9500 tons and was about 12 000 feet long. Train 303 consisted of 3 locomotives (2 at the head end and 1 at the tail end) and 134 loaded covered hopper cars. The train weighed approximately 18 000 tons and was about 8000 feet long.

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



At about 0853, train 113 arrived at Alyth Yard for the scheduled crew change on track PT01. Track PT01 is the continuation of the main track westward beyond Ogden (Mile 171.1). After train 113 came to a stop, the tail-end car was positioned in a curve at about Mile 171.7.

¹ All times are Mountain Daylight Time.

Shortly after the arrival of train 113, the Calgary Terminal trainmaster (TTM) advised the rail traffic controller (RTC) to route train 303 into track PT01, behind train 113.

At 0900, during a follow-up conversation, the RTC and the TTM decided to delay the departure of train 113, in order to operate the business train² westward from Alyth Yard ahead of train 113. The crew of train 303 was not told that train 113's departure would be delayed.

Train 303 had earlier received instructions from the Calgary TTM to operate on track PT01 into Alyth Yard behind train 113 and to change crews at the west end of the yard. At about 0913, the crew members of train 303 discussed their plan to enter Alyth Yard, including operating westward on track PT01 past Ogden to the crew change location.

At 0917, train 303 received a Clear signal indication on signal 1711³ at Ogden, authorizing the train to depart the main track and to continue into the non-main track at Ogden. While proceeding past the signal, the locomotive engineer overheard parts of a radio conversation concerning train 113 and a depot track. Based on this radio communication, the locomotive engineer believed that train 113 was undergoing a passing inspection at the depot track, about 3 miles further west. The crew of train 303 then radioed train 113 for a location report. However, the Calgary TTM responded, indicating that train 113 had not yet departed Alyth Yard. The crew of train 303 then contacted the Calgary TTM to ask about the length of train 113.

At 0917:50, while train 303 was travelling at 36 mph, the crew realized that it was close to reaching the tail end of train 113. Train 303's brakes were applied. At that time, the dynamic brake⁴ on train 303 was already in use to control train speed.

At 0918, while train 303 was travelling at about 35 mph and exiting a right hand curve at Mile 171.49, the tail end of train 113 came into view, about 1100 feet ahead. The crew of train 303 then immediately applied emergency braking.

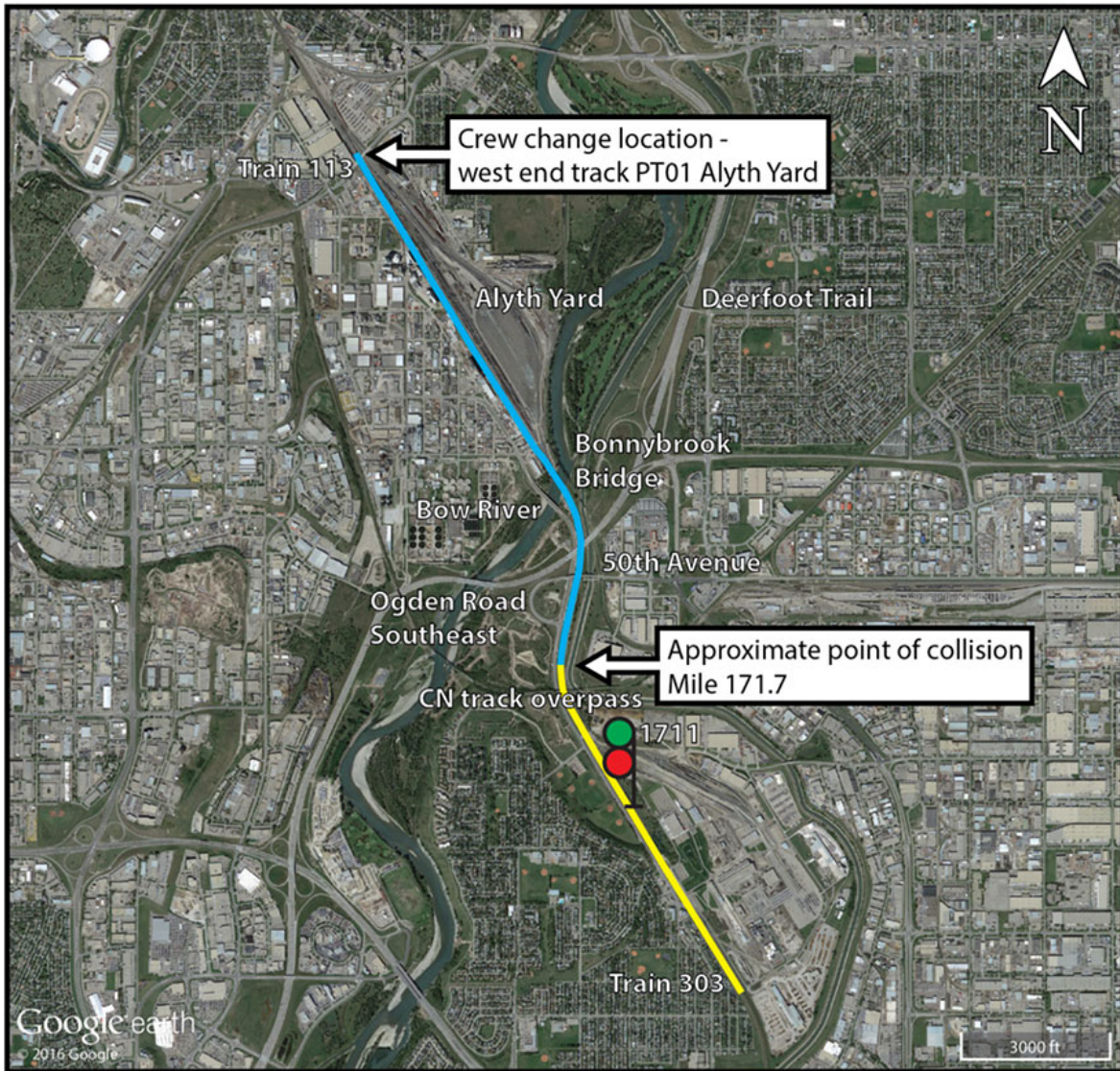
At 0918:25, while travelling at about 22 mph, the lead locomotive of train 303 collided with the tail end car of train 113 at Mile 171.7 (Figure 2).

² An unscheduled private CP passenger train for business clients.

³ This signal governs movement to the Block End sign located about 50 feet west of the signal.

⁴ Dynamic braking is an electrical brake installed on most main-track locomotives to assist braking on descending grades. The dynamic brake reduces locomotive speed by converting the traction motors into generators. Peak dynamic braking is produced at approximately 24 to 28 mph, the dynamic brake handle control mechanism is calibrated from 0 to 8, and the amount of dynamic braking varies accordingly.

Figure 2. Location of collision (Source: Google Earth, with TSB annotations)



A summary of the sequence of events for train 303 and train 113 between Carseland (Mile 144.4) and the point of collision is presented in Table 1.

Table 1. Sequence of events for train 303 and train 113

Time	Event
0717 to 0756	Train 303 was stopped at Carseland to lift 12 cars. The required brake test was conducted, with no exceptions noted.
0835	Train 303 received instructions from the Calgary TTM to operate on track PT01 (behind train 113 at Alyth Yard), and to change crews at the west end of the yard.
0853	Train 113 arrived at Alyth Yard on track PT01 for a scheduled crew change.
0856	The Calgary TTM advised the RTC to route train 303 into track PT01, behind train 113.
0857	Train 303 was stopped at Murdoch (Mile 167.6) to meet train 118.

0900	The RTC suggested to the Calgary TTM that the business train depart westward ahead of train 113.
0906	Train 303 departed Murdoch.
0912	The Calgary TTM confirmed with the RTC that the business train could operate westward ahead of train 113.
0913 (approximate)	Unaware that train 113's departure would be delayed, the crew of train 303 discussed their plan to enter Alyth Yard and to continue westward on track PT01 beyond Ogden.
0915	Train 303 passed a permissive indication on signal 1697 at Glenmore (Mile 169.7)
0917	Train 303 passed a permissive indication on signal 1711 at Ogden (Mile 171.1).
0917:20	The crew of train 303 overheard part of a radio communication concerning train 113 and a depot track inspection.
0917:20 to 0917:50	The crew of train 303 called train 113 to determine their location. The Calgary TTM responded that train 113 was not yet clear of Alyth Yard. The crew of train 303 then asked the TTM what train 113's length was.
0917:50	While train 303 was travelling at 36 mph, the LE applied train brakes to slow the train. The tail end of train 113 was about 1800 feet ahead.
0918	At Mile 171.48, after train 303 exited a right hand curve, its crew observed the tail end of train 113 about 1100 feet ahead.
0918	Travelling at about 35 mph, train 303 was placed into emergency braking.
0918:25	At Mile 171.7, travelling at about 22 mph, train 303 collided with the tail end of train 113.

Recorded information

Information from the locomotive event recorder on train 303 was reviewed and is summarized in Table 2.

Table 2. Recorded information from the lead locomotive on train 303

Event	Time	Speed (mph)	Location (mile)	Train brake	Dynamic brake
Train brakes applied	0917:50	36.3	171.37	Minimum	6.4
Train brakes placed in emergency	0918:02	35.3	171.49	Emergency	8 (full)
Train 303 collides with tail end of train 113	0918:25	22.0	171.7	Emergency	7

Dynamic simulation test for train 303

A train dynamic computer simulation was conducted for train 303 using the Train Energy and Dynamics Simulator program.

The following was determined:

- Given the braking that was applied (i.e., dynamic brake, minimum reduction train brake application followed by emergency train brake application), train 303 would have taken about 2200 feet to come to a stop, if there had not been anything on the track in front of it.
- If an emergency train brake application had been made at the time when the minimum reduction train brake application was initiated, train 303 would have been able to stop in about 1763 feet, avoiding the collision with train 113.

Site examination

The 2 head-end locomotives on train 303 (CP 9765 and CP 9839) had derailed to the south⁵ of track PT01 (Figure 3). All wheels on both locomotives had derailed with the locomotives remaining in an upright position. The first 2 covered hopper cars behind the locomotives (SOO 115071 and CP 608093, which were both loaded with food products) derailed upright. Covered hopper car SOO 115071 sustained damage to its air brake control valve and reservoirs as well as damage to its coupler, draft gear, safety appliances, and hopper doors. Covered hopper car CP 608093 sustained roller-bearing damage.

The tail-end car of train 113 (CP 523216, a loaded 3-platform intermodal car) derailed all wheels. Two derailed platforms from CP 523216 were to the north and one derailed platform was to the south (Figure 4 and Figure 5). The centre sill on this car was damaged.

⁵ The timetable direction for the Brooks Subdivision is east-west.

Figure 3. Position of locomotives and equipment after the collision

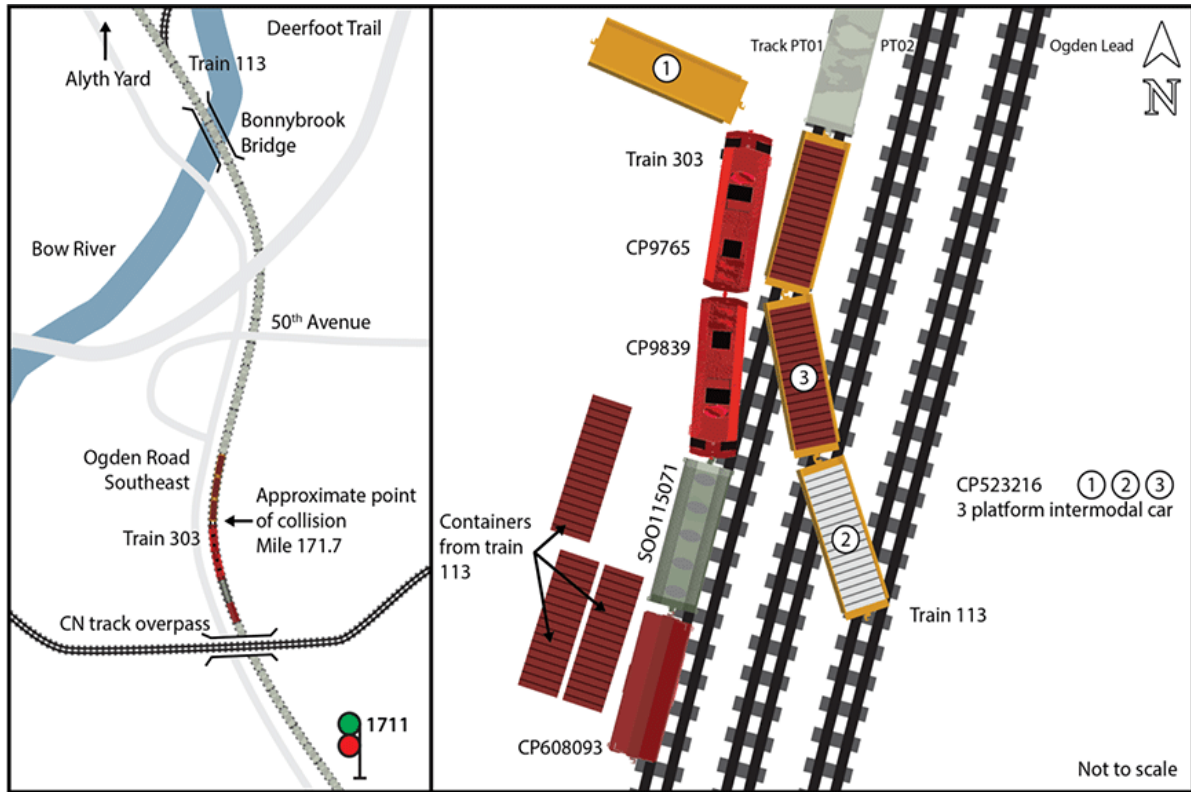
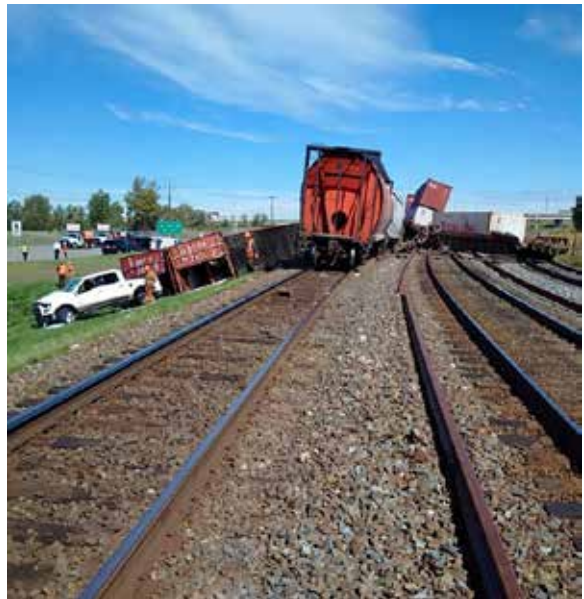


Figure 4. Derailment site (looking east)



Figure 5. Derailment site (looking west)



Train crew information

The crew of train 113 consisted of a locomotive engineer and a conductor. Both crew members were familiar with the territory, met fitness and rest standards, and were qualified for their respective positions.

The crew of train 303 consisted of a locomotive engineer and a conductor. Both crew members were familiar with the territory, met fitness and rest standards, and were qualified for their respective positions.

The crew members for both trains worked in unassigned pool service⁶ between their home terminals of Medicine Hat and Calgary.

Subdivision and track information

CP Prairie Division Time Table No. 32 indicates that the method of train control from Mile 0.0 to Mile 164.0 on the Brooks Subdivision is centralized traffic control (CTC). CTC continues between Mile 164.0 and Mile 171.1. However, the instructions for the Calgary Terminal Module⁷ applied at this location.

Footnotes 11.6 and 11.7 of the Calgary Terminal Module state the following:

- 11.6 Westward trains must obtain permission from Calgary Terminal Trainmaster or Assistant to enter Alyth yard before passing Murdoch,⁸ Brooks Subdivision.
- 11.7 All movements entering, departing, or working within the Alyth yard, must contact the Calgary Terminal Trainmaster or Assistant for instructions.⁹

A sign posted at Mile 171.1 read, "CTC ends and non-main track begins".

The TTM can (and usually does) advise train crews entering Alyth Yard of the instructions relating to footnotes 11.6 and 11.7 in one radio communication. The usual practice was that the TTM would also advise train crews of any other known restrictions before the trains enter the yard. The TTM's advice does not constitute assurance that the track ahead of the train is unobstructed, and it does not relieve crews of the responsibility to operate in accordance with the rules.

⁶ Unassigned pool service refers to working in a first-in/first-out basis within a group or pool of employees. When crews finish a trip, they are placed back into the pool list for reassignment to the next trip, subject to their availability (rest, sick, unfit) and the availability of trains.

⁷ The Calgary Terminal Module provides additional instructions that apply within the terminal.

⁸ Murdoch is located at Mile 167.6 of the Brooks Subdivision.

⁹ Canadian Pacific Railway, "Prairie Division Time Table No 32, Module 40 Calgary Terminal – Effective at 0001 October 14, 2015," footnotes 11.6. and 11.7.

Additionally, the normal practice in situations where westward trains arriving at Alyth Yard were obstructed by preceding trains was to tell the following train that the track at Alyth Yard was occupied and stop it at Glenmore, to avoid blocking public crossings.

The *CP Rule Book for Train & Engine Employees* specifies the following:

9.1 NON-MAIN TRACK

Other Than Non-Signalled Siding In CTC

- (a) Unless otherwise specified in special instructions, when operating on non-main track, a movement must operate:
- (i) prepared to stop:
 - within one-half the range of vision of equipment or a track unit;
 - short of:
 - a red or blue signal between the rails;
 - a switch not lined;
 - derail in the derailing position; and
 - end of track.
 - (ii) at a speed not exceeding 15 MPH on sidings and 10 MPH on other than sidings.¹⁰

In CP Time Table No. 32, a footnote relating to the Calgary Terminal Module specifies the following:

- between Mile 171.1 and Mile 172.4, track speed is 45 mph; and
- between Mile 172.4 and 175.8, track speed is 25 mph.¹¹

The maximum speed that is normally associated with non-main track (i.e., 10 mph on other than sidings) was not applicable due to the additional instructions provided in the Calgary Terminal Module.

The *CP Rule Book for Train & Engine Employees* states the following:

19.1 BLOCK AND INTERLOCKING SIGNALS

- (a) Indications displayed on block and interlocking signals govern operation to the next signal or block end sign.

¹⁰ Canadian Pacific Railway, *CP Rule Book for Train & Engine Employees* (effective 14 October 2015), Section 9 – Methods of Control and Authority, p. 26.

¹¹ Canadian Pacific Railway, "Prairie Division Time Table No 32, Module 40 Calgary Terminal – Effective at 0001 October 14, 2015," footnote 4.1.

(b) Signals to leave the main track and enter non-main track apply to the block end sign or until the leading end of the movement has entered non-main track.¹²

The *Canadian Rail Operating Rules* (CROR), under the heading “General description and location of fixed signals,” states the following:

401.1 SIGNAL DISPLAYED

The indications displayed on block and interlocking signals govern operation to the next signal or block end sign. Except as otherwise specified in special instructions, a signal to leave the main track to enter non-main track applies to the block end sign or until the leading end of the movement has passed entirely through the controlled location and entered non-main track. Speed requirements protecting turnouts must be complied with until the entire movement has cleared the turnout.¹³

Based on the additional instructions in the Calgary Terminal Module, upon receiving a clear signal indication at the occurrence location (i.e., when lined towards track PT01), trains are permitted to transition out of CTC and into non-main track while operating at speeds of up to 45 mph.

System defences against non-main-track collisions

Non-main-track train operations are governed by Rule 105 of the CROR:

Special instructions will indicate when this rule is not applicable on a specific track.

Unless otherwise provided by signal indication, a movement using non-main track must operate at REDUCED speed and be prepared to stop short of the end of track or the red signal prescribed by Rule 41.

- (a) In CTC, movements may only enter a siding by signal indication or with permission from the RTC.
- (b) Unless otherwise provided by signal indication or special instructions, movements operating on non-main tracks must not exceed fifteen (15) MPH.
- (c) In addition to moving at REDUCED speed, a movement using a non-signalled siding or using other non-main tracks so designated in special instructions, must operate at a speed that will allow it to stop within one-half the range of vision of a track unit.¹⁴

¹² Canadian Pacific Railway, *CP Rule Book for Train & Engine Employees* (effective 14 October 2015), Section 19 – Block and Interlocking Signals, p. 52.

¹³ Transport Canada, TCO0-167, *Canadian Rail Operating Rules*, p. 62.

¹⁴ *Ibid.*, p. 41.

“Reduced speed” is defined in the CROR as a “speed that will permit stopping within one-half the range of vision of equipment.”¹⁵

Train crews conducting movements on non-main track can expect to encounter other movements at any time. To avoid a collision, train crews must operate such that they are prepared to stop within half the range of vision. If these provisions are adhered to by all movements, collisions will be avoided.

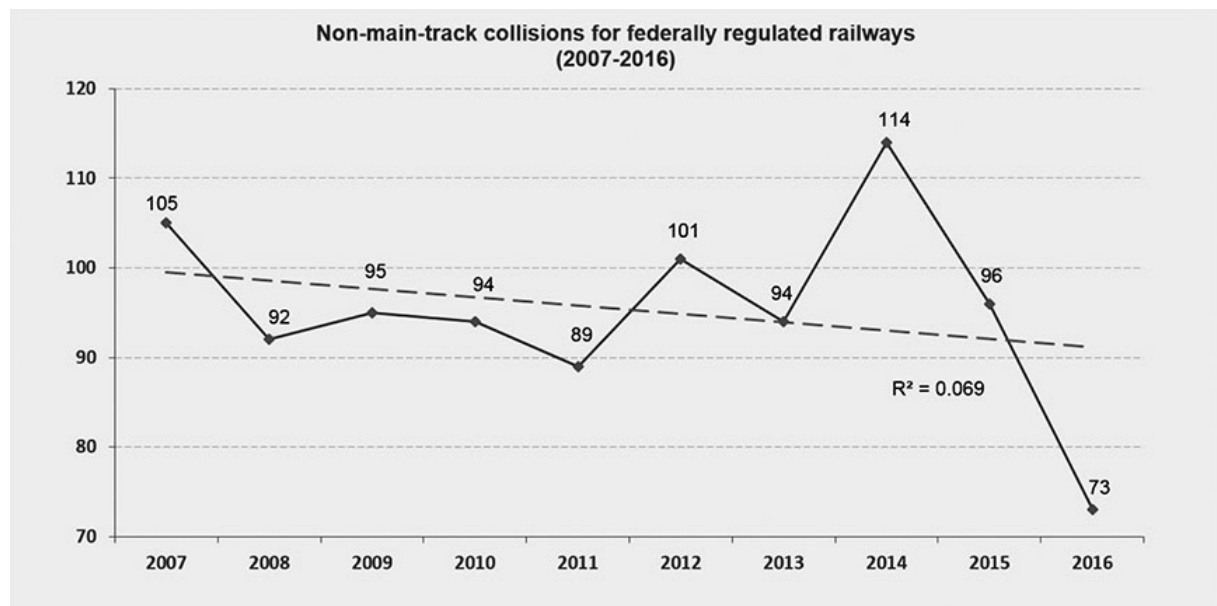
Occurrences involving non-main track collisions

Since 2007, the TSB has investigated one other non-main-track accident involving a tail-end collision.¹⁶

On 19 December 2009, southbound CP freight train 870-013 collided with the tail end of CP freight train 2-298-16, which was stationary at Mile 159.31 of the Weyburn Subdivision, at North Portal, Saskatchewan. Eight residue tank cars from train 2-298-16 derailed. One locomotive from train 870-013 was damaged. There were no injuries.

From 2007 to 2016, there was a slight, but non-statistically significant, decrease each year in the number of non-main track collisions – including head-end, tail-end, and side collisions – on federally regulated railways (Figure 6).

Figure 6. Non-main-track collisions 2007 to 2016



¹⁵ Ibid., p. 12. “Equipment” means one or more engines and/or cars that can be handled on their own wheels in a movement (ibid., p. 8).

¹⁶ TSB Railway Investigation Report R09W0259.

Change to method of train control from Ogden to Alyth Yard

In June 2013, the method of train control on the Brooks Subdivision from Ogden (Mile 171.1) to Mile 174.1 was changed from CTC to non-main track on track PT01, as well as on track PT02 between signal 1723D and signal 1724D. This change was made following the June 2013 Bonnybrook Bridge collapse, at Mile 172.5, due to flooding.¹⁷ As a result, the track was reconfigured and the method of train control was changed while the new bridge was being constructed. The Bonnybrook Bridge reopened in April 2014 following repairs, but CTC was not reapplied to this section of track. CTC was not in effect on this section of track at the time of this occurrence.

In CTC, a block signal governs train movements past the signal, through any associated turnouts¹⁸ and to the next signal or Block End sign. When a CTC signal governs movements into a block,¹⁹ the signal displayed conveys information on the section of track ahead (e.g., whether it is occupied or not).

When the section of track between Ogden and Alyth Yard was re-designated as non-main track, westward signal 1711 no longer governed train movements past the signal, through the turnout, and into a block. Instead, westward signal 1711 governed train movements through the turnout to the Block End sign, located about 50 feet west of the signal. At this location, westbound trains would be transitioning from single track to double track. Westbound trains that diverge through the switch are routed to track PT02. Westbound trains that continue on the through route are routed to track PT01.

In late 2015, there were informal discussions at the CP Calgary Joint Health and Safety Committee regarding some crew members' confusion when operating westward past signal 1711. Given that this concern was only discussed informally, no specific action (such as efficiency testing with respect to speeds) was taken at this location prior to the occurrence.

Railway safety management system regulations

Railway Safety Management System Regulations (2001)

The *Railway Safety Management System Regulations* (the 2001 SMS regulations) required federal railway companies to develop and implement an SMS.

Section 2 of the 2001 SMS regulations stated the following:

2. A railway company shall implement and maintain a safety management system that includes, at a minimum, the following components: [...]

¹⁷ TSB Railway Investigation Report R13C0069.

¹⁸ Turnout is a railway term used to describe the location of a track switch and all associated appurtenances.

¹⁹ A block is a length of track of defined limits, the use of which by a movement is governed by block signals. (Source: Transport Canada, TCO0-167, *Canadian Rail Operating Rules*, p. 7.)

- (e) a process for
 - (i) identifying safety issues and concerns, including those associated with human factors, third-parties and significant changes to railway operations, and
 - (ii) evaluating and classifying risks by means of a risk assessment;
- (f) risk control strategies; [...]
- (l) consolidated documentation describing the systems for each component of the safety management system.²⁰

In this occurrence, when CP changed the method of train control on the Brooks Subdivision between Ogden (Mile 171.1) and Mile 174.1 from CTC to non-main track for track PT01, no risk assessment was conducted, nor was one required.

Railway Safety Management System Regulations, 2015

On 01 April 2015, new requirements for safety management systems (Transport Canada's *Railway Safety Management System Regulations, 2015* [the 2015 SMS regulations]) came into force. These regulations set out the circumstances requiring a risk assessment to be conducted, which include changes in technology. Section 15 of the 2015 SMS regulations states the following:

- 15 (1) A railway company must conduct a risk assessment in the following circumstances:
- (a) when it identifies a safety concern in its railway operations as a result of the analyses conducted under section 13;
 - (b) when it proposes to begin transporting dangerous goods, or to begin transporting dangerous goods different from those it already transports; or
 - (c) when a proposed change to its railway operations, including a change set out below, may affect the safety of the public or personnel or the protection of property or the environment:
 - (i) the introduction or elimination of a technology, or a change to a technology,
 - (ii) the addition or elimination of a railway work, or a change to a railway work,
 - (iii) an increase in the volume of dangerous goods it transports,
 - (iv) a change to the route on which dangerous goods are transported, or

²⁰ Transport Canada, SOR/2001-37, *Railway Safety Management System Regulations* (repealed 01 April 2015), section 2.

- (v) a change affecting personnel, including an increase or decrease in the number of employees or a change in their responsibilities or duties.²¹

In 2016, TC audited CP's risk-assessment policy and procedure and noted that CP performs risk assessments as required.

In light of the 2015 SMS regulations, CP modified its internal risk-assessment policy and procedure, including the following changes:

- a revision to ensure roles and responsibilities are clearly defined, as well as clarification of the steps for evaluating effectiveness of remedial actions and the changes that require a risk assessment and ministerial notification;
- an online risk-assessment training program that clearly outlines procedural expectations was developed and rolled out to all operation managers in Canada; and
- a revised risk-assessment e-tool to be used as a framework and to document risk assessments.

Mental models during train operations

Mental models are internal representations that allow individuals to predict and explain the behaviour of the world around them, form expectations for what is likely to occur next, and select an appropriate course of action.²² Mental models are developed based on several factors, including experience, knowledge, and the perception and comprehension of external cues available in the working environment. In highly practised situations, attention and expectancies are often driven by a person's existing mental model of the situation, given that previous experience will dictate what information is important and how the situation will unfold.²³

To reliably predict how events will unfold, a person's mental model must accurately represent the complete situation.²⁴ When information in the working environment is incomplete or ambiguous, operators (e.g., train crew members) can develop inaccurate or incomplete mental assessments of the situation. As a result, operators are more likely to inaccurately predict what is likely to occur next and select actions that are inappropriate to the "reality" of the situation.

²¹ Transport Canada, SOR/2015-26, *Railway Safety Management System Regulations*, 2015 (last amended 01 April 2015), section 15.

²² E. Salas, F. Jentsch, and D. Maurino, *Human Factors in Aviation*, 2nd Edition (Academic Press: 30 January 2010), p. 66.

²³ G. Klein, "Naturalistic decision making," *Human Factors*, Vol. 50, No. 3 (2008), pp. 456-460.

²⁴ T. J. Chermack, "Mental Models in Decision Making and Implications for Human Resource Development," *Advances in Developing Human Resources*, Vol. 5, No. 4 (2003), pp. 408-422.

Positioning crew member outside cab of head-end locomotive

In October 2015, CP issued Bulletin ASA-112-15, which states the following:

For train crews working or operating in yards or Industry tracks, effective immediately when there are two or more employees on the Locomotive, one employee MUST be positioned on the footboard or platform of the Locomotive when the Locomotive is leading in the direction of travel, (this includes Lite Engines).

In instances where there are 3 RTE's [running trade employees] in the cab, 2 employees will be required to be positioned outside of the cab to ensure diligence in protecting the point.

This will improve our ability to work safely and prevent accidents such as run through switches and other unsafe events.²⁵

At the time of the occurrence, the method of control when operating between Ogden (Mile 171.1) and the interlocking limits at Mile 174.1 was non-main track.²⁶ However, track PT01 was not designated as yard track or industry track and was not subject to the instructions outlined in Bulletin ASA112-15. The railway did not expect an operating employee to be outside of the cab of the locomotive until the movement entered the yard (i.e., at Mile 174.1 rather than at Mile 171.1).

However, the investigation found that other operating employees were uncertain about the specific requirements when operating through this location. Some operating employees positioned themselves outside the cab starting at Mile 171.1. Other operating employees did not position themselves outside the cab at this location because of potential safety concerns. When passing signal 1711, many train crews significantly reduced speed to about 25 mph or less, even though the permitted speed was 45 mph.

In this occurrence, the conductor of train 303 opted not to position himself outside the cab. The crew believed that it was not safe for a crew member to be positioned on the platform of the lead locomotive, given that the train was permitted to operate at a speed of up to 45 mph.

²⁵ Canadian Pacific Railway, Bulletin ASA-112-15, "Trains working/travelling in yards/industry tracks" (15 October 2015).

²⁶ As per CP's "Prairie Division Time Table No 32, Module 40 Calgary Terminal – Effective at 0001 October 14, 2015".

Work–rest history of train 303 crew

The locomotive engineer and the conductor for train 303 had been called to work at 2310 and 2210,²⁷ respectively, on 02 September 2016. Both crew members started their shift²⁸ at 0010 on 03 September 2016. The crew had been on duty for just over 9 hours at the time of the occurrence (i.e., 0918).

The work–rest history of each crew member was reviewed and the following was determined:

- The locomotive engineer and the conductor had each been working a sporadic shift schedule. In the days prior to the occurrence, the locomotive engineer and the conductor had worked a combination of day, evening, and night shifts.
- The shift schedules for both crew members in the 4-week period prior to the accident met the requirements of the *Work/Rest Rules for Railway Operating Employees*.

TSB Watchlist

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

Safety management and oversight is a Watchlist 2016 issue. As this occurrence demonstrates, potential hazards involving operational changes must be identified during risk assessments to ensure that appropriate mitigation strategies are developed and implemented.

Safety management and oversight will remain on the TSB Watchlist until

- Companies that do have an SMS must demonstrate that it is working (i.e., that hazards are being identified and effective risk mitigation measures are being implemented).
- When companies are unable to effectively manage safety, TC must not only intervene, but do so in a manner that succeeds in changing unsafe operating practices.

TSB laboratory reports

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

- LP019/2017 – Stopping Distance Analysis

²⁷ The different call times reflect the labour/ management negotiated practice whereby individual employees may select the amount of advance notice to work that they require (typically 1 or 2 hours).

²⁸ The train crew did not operate on a regularly scheduled shift. Most crews in through-freight service are called to work when they reach the top of a list, mandatory or negotiated rest has elapsed, and a train is anticipated to arrive at their terminal or is ready to be operated.

Analysis

No track defects or mechanical issues contributed to the accident. The analysis will focus on safety management oversight, including the change of method of train control, yarding instructions, and point protection while operating at track speed.

The accident

In the vicinity of Alyth Yard, after train 303 rounded a right-hand curve while operating at 35 mph on track PT01, the tail end of train 113 came into view about 1100 feet ahead. The emergency brakes were immediately applied, slowing the train to about 22 mph before it collided with the tail end of train 113. The collision occurred when train 303 was unable to stop after an emergency brake application was initiated, subsequent to the tail end of train 113 coming into view.

About 45 minutes before arriving at Ogden, the crew of train 303 had received instructions to enter the yard on track PT01 behind train 113. At Ogden, train 303 received a Clear signal indication on signal 1711, authorizing the train to depart the main track and to continue into the non-main track.

While train 303 was proceeding past the signal, the locomotive engineer overheard parts of a radio conversation that led him to believe that train 113 was undergoing a passing inspection at the depot track, about 3 miles further west. However, train 113 had been delayed at Alyth Yard and was stopped with its tail-end car at Mile 171.7.

For westbound trains changing crews at Alyth Yard, the normal practice was to hold the train at Glenmore until any preceding trains at Alyth Yard were departing. When train 303 was not held at Glenmore, the crew's mental model that train 113 was departing Alyth Yard was further reinforced.

At Ogden, non-main-track territory began about 50 feet beyond signal 1711. Signal 1711 governed train movements through the switch for tracks PT01 and PT02 up to the Block End sign. This signal effectively functioned as a switch position indicator for westbound trains entering Alyth Yard. Movements beyond the Block End sign were governed by Rule 105 of the *Canadian Rail Operating Rules* and were allowed, by railway special instruction, to proceed at a maximum speed of 45 mph. Given the maximum track speed of 45 mph and the expectation of the crew of train 303 that train 113 was further west, train 303 entered track PT01 at about 36 mph, too fast to stop within half the range of vision of train 113.

In June 2013, as a result of the failure of the Bonnybrook Bridge due to flooding, the railway changed the method of train control at this location – from centralized traffic control (CTC) to non-main track – but did not reduce the maximum track speed. Despite the operational change from CTC to non-main-track operation, the railway did not conduct a risk assessment before implementing the change, nor was one required at that time.

Requesting information on train 113's location

Despite believing that train 113 had already departed, the crew members on train 303 contacted train 113 to request its location. When the Calgary Terminal trainmaster overheard and responded, stating that train 113 was still stationary at the crew change location, train 303's crew immediately applied the train brakes and, shortly after, the emergency brakes, when the tail end of train 113 came into view.

TSB dynamic analysis determined that train 303 could have stopped short of train 113 had the brakes been placed in emergency when the first train brake application was made. However, the crew of train 303 had not yet established an accurate understanding of the location of train 113's tail end. Had the crew of train 303 not questioned their assumption regarding train 113's location and sought clarification, there would have been a further delay in applying the brakes, which would have increased the severity of the collision.

Consequences of non-main-track collisions

The regulatory requirement for non-main-track train movements to be able to stop within half the range of vision of equipment is an effective strategy in most circumstances. However, operating crews do not always comply with this requirement. There has been an average of about 95 non-main-track collisions on federally regulated railways each year. For the majority of these occurrences, the maximum speed was 15 mph. As a result, the consequences of most non-main-track collisions were minor.

Under main-track CTC operation, for trains approaching Ogden and lined for track PT01 with another train in the block, the most permissive signal indication for the approaching train would have been a restricting signal. Based on a restricting signal in CTC, the maximum operating speed for the approaching train would have been at the restricted speed (maximum of 15 mph), rather than at 45 mph, as allowed by Canadian Pacific Railway (CP) Time Table No. 32 (Calgary Terminal Module). In addition, the approaching train would have been required to be able to stop within half the range of vision of equipment. Had train 303 been operating in CTC on a restricting signal indication, it is likely that the collision would have been avoided or the consequences significantly reduced.

If speeds above 15 mph are permitted on non-main track, impact forces during a collision may be greater, increasing the risk of higher-consequence accidents and more severe damage to equipment, track, and people.

Risk assessment for changes to railway operations

In June 2013, following the collapse of the Bonnybrook Bridge, CP changed the designation of track PT01 between Ogden and the begin/end interlocking limits at 12th Street East from main-track CTC to non-main track. CP re-designated track PT02 between signals 1723D and 1724D as non-main track. In the immediate aftermath of the bridge failure, a full risk assessment of this operational change was not conducted. However, when rail traffic over the bridge resumed, CP did not put CTC back in service at this location, and no risk

assessment was conducted for maintaining this location as non-main track with a 45 mph speed limit.

With this re-designation, the signals at each end of this 3-mile stretch of track were left in place. However, the primary function for these signals was as route indicators for eastward and westward movements entering this section of track. These signals no longer provided information concerning the status of the track ahead (e.g., track occupancy).

In late 2015, there were informal discussions at the CP Calgary Joint Health and Safety Committee regarding some crew members' confusion about operating westward pass signal 1711. Because this concern was only discussed informally, no specific action was taken by the railway. However, due to safety concerns, other train crews were reducing speed at this location to about 25 mph or less, even though the permitted speed was 45 mph.

Section 2 of the *Railway Safety Management System Regulations* (2001) indicated that a railway company must have a process for identifying safety issues and concerns, including those associated with significant changes to railway operations, and a process for evaluating and classifying risks by means of a risk assessment. Changing the method of train control from CTC to non-main track is an operational change. When it was decided to keep this section of track designated as non-main track, no risk assessment was conducted, nor was one required at that time.

Without a risk assessment, the railway was not specifically aware of the hazards and safety concerns of train crews when operating through this location. Therefore, no specific action had been taken by the railway to mitigate the potential hazards prior to the occurrence.

If risk assessments are not conducted for changes to railway operations, potential hazards associated with the operational change may not be identified and appropriately mitigated, increasing the risk of accidents.

Maximum speed on non-main track

Both prior to and after the Bonnybrook Bridge collapse, track PT01 was used to expedite crew changes for trains travelling through Calgary. When the track was re-designated as non-main track, while retaining its principal use, the railway opted to allow trains to travel at higher speeds on portions of this track (i.e., up to 45 mph). Rule 105 of the *Canadian Rail Operating Rules* provides the operational latitude for railways to operate at a maximum speed greater than 15 mph on non-main track. However, higher speeds can lead to situations where trains may not always be able to stop within half the range of vision. In the vicinity of the occurrence, no efficiency tests had been performed to ensure train crews were appropriately applying non-main-track rules.

Positioning crew member outside cab of head-end locomotive

At the time of the occurrence, the method of control for trains operating between Ogden (Mile 171.1) and the interlocking limits at Mile 174.1 was non-main track. Because track PT01 was not designated as yard track or industry track, it was not subject to the instructions

outlined in Bulletin ASA-112-15, which required a crew member to be positioned outside the cab of the head-end locomotive. The railway did not expect an operating employee to be outside of the cab of the locomotive until the movement entered the yard (i.e., at Mile 174.1 rather than at Mile 171.1).

However, the specific requirements when operating through this location were unclear to many operating employees. Some positioned themselves outside the cab starting at Mile 171.1, while others did not position themselves outside the cab at this location because of potential safety concerns.

The occurrence crew believed that it was not safe for a crew member to be positioned on the platform of the lead locomotive, given that the train was permitted to operate at a speed of up to 45 mph. The conductor chose not to position himself in that manner. Had the conductor on train 303 been positioned outside of the cab of the lead locomotive while operating past Ogden, he might have sustained serious injuries as a result of the collision.

Findings

Findings as to causes and contributing factors

1. The collision occurred when train 303 was unable to stop after an emergency brake application was initiated, subsequent to the tail end of train 113 coming into view.
2. The crew of train 303 had received instructions to enter the yard on track PT01 behind train 113. At Ogden, train 303 received a Clear signal indication on signal 1711, authorizing the train to depart the main track and to continue into the non-main track.
3. While proceeding past the signal, the locomotive engineer overheard parts of a radio conversation that led him to believe that train 113 was undergoing a passing inspection at the depot track, about 3 miles further west. However, train 113 had been delayed at Alyth Yard and was stopped with its tail-end car at Mile 171.7.
4. When train 303 was not held at Glenmore, the crew's mental model that train 113 was departing Alyth Yard was further reinforced.
5. Given the maximum track speed of 45 mph and the expectation of the crew of train 303 that train 113 was further west, train 303 entered track PT01 at about 36 mph, too fast to stop within half the range of vision of train 113.
6. The railway had changed the method of train control at this location – from centralized traffic control to non-main track – but had not reduced the maximum track speed.
7. Despite the operational change from CTC to non-main track operation, the railway did not conduct a risk assessment before implementing the change.

Findings as to risk

1. If speeds above 15 mph are permitted on non-main track, impact forces during a collision may be greater, increasing the risk of higher-consequence accidents and more severe damage to equipment, track, and people.
2. If risk assessments are not conducted for changes to railway operations, potential hazards associated with the operational change may not be identified and appropriately mitigated, increasing the risk of accidents.

Other findings

1. Had the crew of train 303 not questioned their assumption regarding train 113's location and sought clarification, there would have been a further delay in applying the brakes, which would have increased the severity of the collision.

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2. Had the conductor on train 303 been positioned outside of the cab of the lead locomotive while operating past Ogden, he might have sustained serious injuries as a result of the collision.

Safety action

Safety action taken

Transportation Safety Board of Canada

On 23 September 2016, the TSB issued Rail Safety Advisory (RSA) Letter 13/16, entitled “Train movements leaving CTC [centralized traffic control] for non-main track at CP’s [Canadian Pacific Railway’s] Calgary Terminal,” to Transport Canada (TC). The letter indicated the following:

Given the risks involved when trains are transitioning from CTC territory to non-main-track operation in the Calgary terminal area, Transport Canada may wish to review the current railway operating practices which permit trains to operate at speeds up to 45 mph at this location.²⁹

On 06 March 2017, TC responded to RSA 13/16, indicating the following:

CP reported that, as of December 6, 2016, it has modified the method of control on this portion of track to CTC. Therefore, there is no longer a requirement for train movements to transfer from CTC to non-main track operations at this location.

On 01 November 2016, the TSB issued RSA 14/16, entitled “Train crew member(s) positioned on the front of locomotives while operating on non-main track,” to TC. The letter indicated the following:

Given the speed at which trains can operate when transitioning from CTC territory to non-main track when approaching the Calgary terminal area, TC may wish to review the requirements of the bulletin with respect to the positioning of the train crew members on the front of locomotives.³⁰

On 24 January 2017, CP responded to RSA 14/16, indicating that it would not have expected an employee to be outside of the cab of the locomotive until the movement entered the yard.

Canadian Pacific Railway

On 06 September 2016, CP issued an operating bulletin (OPER-AB-080-16) revising the speeds on the Brooks Subdivision (Calgary Terminal). The operating bulletin stated the following:

On tracks P1 and P2, do not exceed 20 mph between mile 171.7 (CN [Canadian National Railway Company] overhead bridge) and mile 172.4,

²⁹ Transportation Safety Board of Canada, Rail Safety Advisory Letter 13/16: Train movements leaving CTC for non-main track at CP’s Calgary Terminal (23 September 2016).

³⁰ Ibid., Rail Safety Advisory Letter 14/16: Train crew member(s) positioned on the front of locomotives while operating on non-main track (01 November 2016).

Brooks Subdivision, until the requirements of T&E 9.1 (CROR 105)³¹ have been met.³²

CP also took the following actions:

- On 19 October 2016, CP issued Rule of the Week 035, reminding crews of the requirements of entering non-main track from signalled track.
- Effective 06 December 2016, CTC was reinstalled on track PT01.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 06 December 2017. It was officially released on 17 January 2018.

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

³¹ T&E 9.1: Section 9.1 of the *CP Rule Book for Train & Engine Employees*. CROR 105: Rule 105 of the *Canadian Rail Operating Rules*.

³² Canadian Pacific Railway, Operating Bulletin No. OPER-AB-080-16: Revision to speeds on Brooks Subdivision – Calgary Terminal (06 September 2016).