



Transportation
Safety Board
of Canada

Bureau de la sécurité
des transports
du Canada



RAIL TRANSPORTATION SAFETY INVESTIGATION REPORT R23Q0022

MOVEMENT EXCEEDS LIMITS OF AUTHORITY

Quebec North Shore and Labrador Railway
Ore train W039
Mile 128.3, Wacouna Subdivision
Mai, Quebec
22 February 2023

Canada 

ABOUT THIS INVESTIGATION REPORT

This report is the result of an investigation into a class 3 occurrence. For more information, see the Policy on Occurrence Classification at www.tsb.gc.ca

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.

TERMS OF USE

Use in legal, disciplinary or other proceedings

The *Canadian Transportation Accident Investigation and Safety Board Act* states the following:

- 7(3) No finding of the Board shall be construed as assigning fault or determining civil or criminal liability.
- 7(4) The findings of the Board are not binding on the parties to any legal, disciplinary or other proceedings.

Therefore, the TSB's investigations and the resulting reports are not created for use in the context of legal, disciplinary or other proceedings.

Notify the TSB in writing if this investigation report is being used or might be used in such proceedings.

Non-commercial reproduction

Unless otherwise specified, you may reproduce this investigation report in whole or in part for non-commercial purposes, and in any format, without charge or further permission, provided you do the following:

- Exercise due diligence in ensuring the accuracy of the materials reproduced.
- Indicate the complete title of the materials reproduced and name the Transportation Safety Board of Canada as the author.
- Indicate that the reproduction is a copy of the version available at [URL where original document is available].

Commercial reproduction

Unless otherwise specified, you may not reproduce this investigation report, in whole or in part, for the purposes of commercial redistribution without prior written permission from the TSB.

Materials under the copyright of another party

Some of the content in this investigation report (notably images on which a source other than the TSB is named) is subject to the copyright of another party and is protected under the *Copyright Act* and international agreements. For information concerning copyright ownership and restrictions, please contact the TSB.

Citation

Transportation Safety Board of Canada, *Rail Transportation Safety Investigation Report R23Q0022* (released 09 May 2024).

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

© His Majesty the King in Right of Canada, as represented by the Transportation Safety Board of Canada, 2024

Rail transportation safety investigation report R23Q0022

Cat. No. TU3-11/23-0022E-PDF

ISBN: 978-0-660-71582-7

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.

Table of contents

1.0	Factual information.....	5
1.1	The occurrence.....	5
1.2	Locomotive engineer information.....	7
1.3	Rail traffic controller information.....	7
1.4	Ore train W039.....	7
1.5	Subdivision information.....	7
1.5.1	Track arrangement at Mai.....	8
1.6	Recorded information.....	8
1.6.1	Locomotive voice and video recorder.....	9
1.7	Broadcast of signal indications on railway radio.....	10
1.8	Rules relating to main track occupancy.....	10
1.9	Actions taken after the occurrence.....	11
1.9.1	Actions taken by the locomotive engineer.....	11
1.9.2	Actions taken by the rail traffic controller.....	11
1.10	Re-enactment of the occurrence by TSB investigators.....	11
1.11	Use of braking.....	12
1.11.1	Use of dynamic braking.....	12
1.11.2	Quebec North Shore and Labrador Railway instructions on the use of dynamic braking.....	12
1.11.3	Use of emergency braking.....	12
1.12	In-train forces and braking distances.....	12
1.13	Experience of railway operating employees.....	13
1.14	Supervision of railway operating employees.....	13
1.15	Other similar occurrences at Quebec North Shore and Labrador Railway.....	14
1.16	Mental model and adaptation.....	14
1.17	TSB Watchlist.....	15
1.18	TSB laboratory reports.....	15
2.0	Analysis.....	16
2.1	The occurrence.....	16
2.2	In-train forces.....	16
2.3	Actions taken after the occurrence.....	17
2.4	Supervision of newly trained locomotive engineers.....	17
2.5	Mental model and adaptation.....	18
2.6	Locomotive voice and video recorder.....	18
3.0	Findings.....	20
3.1	Findings as to causes and contributing factors.....	20
3.2	Findings as to risk.....	20
3.3	Other findings.....	20
4.0	Safety action.....	21
4.1	Safety action taken.....	21

4.1.1 Transportation Safety Board of Canada.....21
4.1.2 Transport Canada21
4.1.3 Quebec North Shore and Labrador Railway21

Appendices..... 22

Appendix A – Rules 35, 80, and 125 of the *Canadian Rail Operating Rules*, and Quebec North Shore and Labrador Railway special instructions.....22

RAIL TRANSPORTATION SAFETY INVESTIGATION REPORT R23Q0022

MOVEMENT EXCEEDS LIMITS OF AUTHORITY

Quebec North Shore and Labrador Railway
Ore train W039
Mile 128.3, Wacouna Subdivision
Mai, Quebec
22 February 2023

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. **This report is not created for use in the context of legal, disciplinary or other proceedings.** See the Terms of use on page 2.

Summary

On 22 February 2023, at approximately 2133 Eastern Standard Time, the empty Tacora Resources Inc. ore train W039, operated by Quebec North Shore and Labrador Railway, was travelling northward on Quebec North Shore and Labrador Railway's Wacouna Subdivision when it passed a Stop signal without authority at Mile 128.3 at Mai Station, Quebec. There was no collision or derailment, and there were no injuries.

1.0 FACTUAL INFORMATION

1.1 The occurrence

On 22 February 2023, Tacora Resources Inc. ore train W039, operated by Quebec North Shore and Labrador Railway (QNS&L), departed Sept-Îles, Quebec, around 1607 and was travelling northward. The train consisted of 2 locomotives and 127 empty ore cars. The train was operated by a single locomotive engineer (LE).¹ A crew change was scheduled at Mai Station, Quebec, located at Mile 128.3, about halfway between Sept-Îles and Wabush Lake, Newfoundland and Labrador (Figure 1).

¹ QNS&L ore trains are operated by a single employee.

Figure 1. Map showing the occurrence location, the Quebec North Shore and Labrador Railway track (solid line), and the Tshiuetin Rail Transportation track (dotted line) (Source: d-maps.com, with TSB annotations)



As the train approached the South-east Mai controlled location,² travelling at approximately 37 mph, the LE broadcast the Clear to Stop³ indication of signal 1257 on the railway radio. After passing this signal, the LE closed the throttle and set up dynamic braking, which resulted in a train speed reduction to around 12 mph. The LE then momentarily decreased dynamic braking to the minimum. The next signal — signal 1283 indicating Stop⁴ — then entered the LE's field of vision. By the time the LE realized that this signal was indicating Stop, the train was travelling at 9 mph. Approximately 50 feet from the signal, the LE quickly applied full dynamic braking and the emergency brakes. The lead locomotive passed the signal and came to a stop 73 feet past it, interrupting the track circuit in the block and resulting in the cancellation of the route for a southbound work train (WK315). That train was about 4 miles from Mai Station. There was no collision or derailment, and there were no injuries.

At the time of the occurrence, the weather was cloudy, visibility was good, and the temperature was approximately -27°C .

² "A location in CTC [centralized traffic control] the limits of which are defined by opposing controlled signals." (Transport Canada, *Canadian Rail Operating Rules* [09 May 2022, effective 01 October 2022], Definitions).

³ "Proceed, preparing to stop at next signal." (Ibid., Rule 411).

⁴ Stop - Stop. (Ibid., Rule 439).

1.2 Locomotive engineer information

The LE of train W039 had been employed with QNS&L since 12 October 2021. He qualified as an LE on 08 September 2022.

He was called for his assignment at 1530 on 22 February 2023 after a 75-hour rest period at his home terminal in Sept-Îles. He met fitness and rest standards and was qualified for the position. He was familiar with the territory and signal layout at Mai.

When signal 1283 was displaying a permissive indication and the block it was controlling was clear, the LE had developed the habit of stopping the lead locomotive of his train just after this signal, in front of the camp installations (Figure 2) at Mai Station, as this made it easier to perform the crew change.

1.3 Rail traffic controller information

The rail traffic controller (RTC) on duty at the time of the occurrence had been employed by QNS&L since July 2022. He had qualified in February 2023 and was on his 6th shift since qualifying.

1.4 Ore train W039

Tacora Resources Inc. train W039, a unit train,⁵ consisted of 126 tri-pak cylindrical ore hopper cars⁶ and 1 stand-alone hopper car at the rear of the train (position 127).⁷ It weighed 3729 tons and was 5600 feet long. Two locomotives with alternating current traction motors were coupled to the front of the train, which operated as a conventional movement.⁸ Tacora Resources Inc. trains are interchanged between QNS&L and the Société ferroviaire et portuaire de Pointe-Noire at Arnaud Yard in Sept-Îles. Before departing Sept-Îles, QNS&L rail carmen had performed a No. 1 air brake test, and no defects were found.

1.5 Subdivision information

The Wacouana Subdivision is a single main track that connects Sept-Îles (Mile 8.9) to Emeril Junction, Newfoundland and Labrador (Mile 225.30). Train movements are governed by centralized traffic control (CTC) system, as authorized by the *Canadian Rail Operating Rules* (CROR), and supervised by 2 RTCs located in Sept-Îles who share the territory.

⁵ A unit train is a train carrying a single commodity (in this case, iron ore) in cars of similar type, length, and weight.

⁶ Tacora Resources Inc. cylindrical hopper cars operate in compartments. Each compartment is made up of 3 hopper cars linked at the centre by permanent drawbars.

⁷ This car has its own air brake system, allowing the rear of the train to be immobilized in the event of a coupler failure on the last compartment.

⁸ Conventional trains are not equipped with distributed power locomotives.

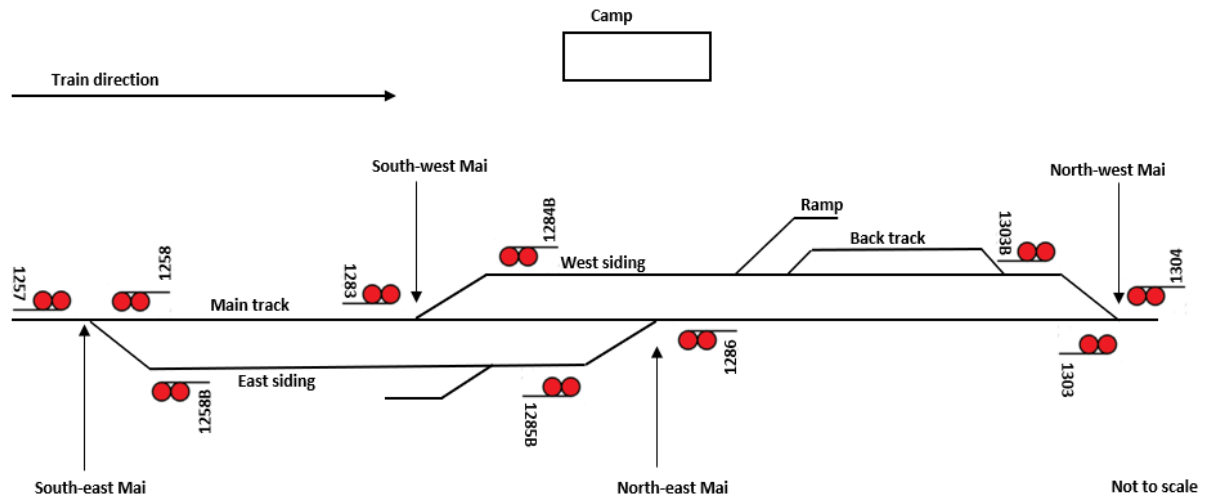
The track is Class 3 according to Transport Canada (TC)–approved *Rules Respecting Track Safety*. The maximum allowable speed for freight trains is 40 mph.⁹ Rail traffic on this subdivision consists of 9 trains per day (ore, freight, and passenger trains), for an annual tonnage of nearly 28 million gross tons.

The crew change location is at Mai camp, located at Mile 128.

1.5.1 Track arrangement at Mai

Mai Station is approximately 4.5 miles long. It comprises a single main track and 2 sidings, one on each side of the main track, with a spur each (Figure 2).

Figure 2. Track arrangement at Mai (Source: TSB)



1.6 Recorded information

The TSB collected and reviewed event recorder data from the locomotives involved, railway radio channel recordings and RTC control screen readings.

A review of the recorded data revealed the following:

- On the approach to Mai, the LE received alarms from the proximity detection device.¹⁰ The alarms indicated the presence of a work train (WK315) heading south toward Mai, and another ore train (PH167) parked in the west siding.
- On approaching the South-east Mai controlled location (signal 1257), the LE broadcast the signal's Clear to Stop indication on the railway radio.
- The LE adjusted the speed of his train to stop in front of the camp beyond signal 1283, as he usually did.

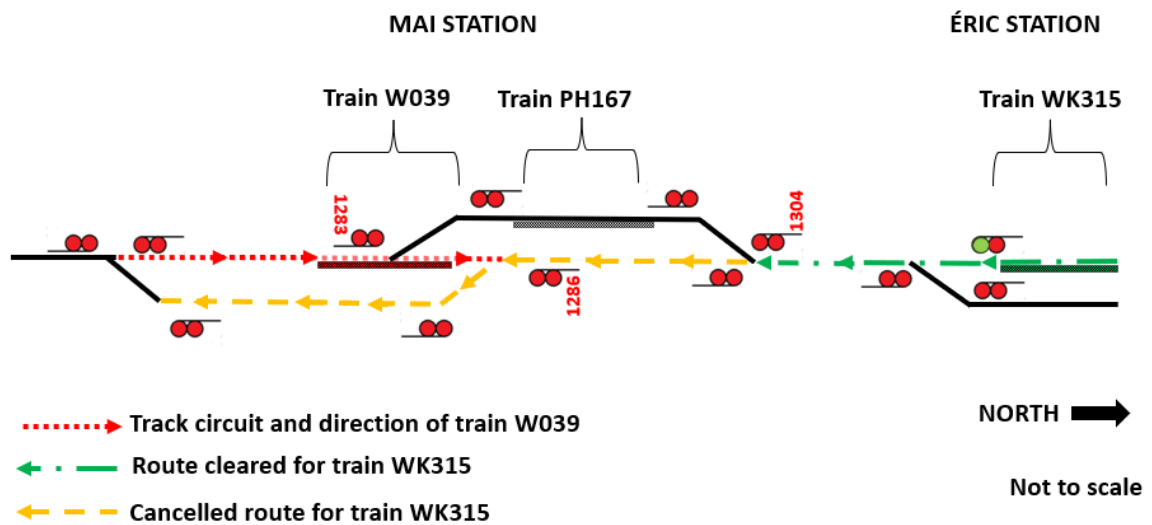
⁹ At QNS&L, maximum allowable speeds for ore trains are 40 mph for empty trains and 35 mph for loaded trains.

¹⁰ All locomotives and maintenance vehicles running on QNS&L are equipped with a proximity detection device capable of receiving and transmitting the position of other trains/transfers and maintenance vehicles. The proximity detection device is used to assist in the operation of trains by a single employee.

- Realizing that signal 1283 was indicating Stop, the LE moved the dynamic brake handle to the maximum position and, a few seconds later, applied the emergency brakes.
- The lead locomotive stopped approximately 73 feet past the Stop signal.
- The train was travelling at about 9 mph before passing signal 1283.

When the train stopped beyond signal 1283, the track circuit in the next controlled block¹¹ was interrupted, resulting in the cancellation of signals 1304 and 1286 governing the route of work train WK315 (Figure 3).

Figure 3. View of the centralized traffic control circuit showing the location and route of the 3 trains at the Mai and Éric stations at the time of the occurrence (Source: TSB)



1.6.1 Locomotive voice and video recorder

Following the TSB's assessment of the occurrence,¹² some 15 hours after it took place, the TSB sent a request to QNS&L to preserve the occurrence-related data on the locomotive voice and video recorder (LVVR) for future retrieval.

After receiving this request, QNS&L initiated its internal process to preserve the most recent 48 hours of data¹³ stored on the LVVR memory modules of the lead locomotive involved in the occurrence, in accordance with current regulations.

During follow-ups carried out by the TSB in the hours and days following the request, QNS&L advised that it was experiencing technical difficulties in accessing the LVVR system. When QNS&L was finally able to access the LVVR system of the occurrence locomotive, the

¹¹ The *Canadian Rail Operating Rules* define a controlled block as "a block in CTC between consecutive controlled locations or points."

¹² The occurrence was reported to the TSB by QNS&L approximately 8 hours and 30 minutes after it happened.

¹³ Transport Canada, SOR/2020-178, *Locomotive Voice and Video Recorder Regulations* (23 August 2020, effective 02 September 2022), paragraph 5d).

data from the corresponding period had already been permanently and automatically deleted from the memory modules.

1.7 Broadcast of signal indications on railway radio

CROR Rule 578¹⁴ requires train crew members to broadcast, on the railway radio standby channel, the signal displayed by the advanced signals at each controlled location. At QNS&L, for trains operated by a single employee, this rule is supplemented by a special instruction to also broadcast the indication of all signals controlling the movement of the train.

Rule 578 states, in part:

(a) Within single track, a member of the crew on all trains or transfers must initiate a radio broadcast to the airwaves on the designated standby channel stating the name of the signal displayed on the advance signal to the next controlled location, controlled point or interlocking. [...] ¹⁵

At QNS&L, the special instruction relating to Rule 578¹⁶ requires certain additional procedures for broadcasting radio messages en route. These instructions state, in part:

- When broadcasting the radio message, a crew member must identify the company name, locomotive number and direction of movement in addition to the signal indication.
- The radio message must be broadcast at every controlled location without exception.
- If movements are operated by a single employee, the radio message must also be broadcast for intermediate signals.
- On trains equipped with a proximity detection device, the LE must also establish a voice link with other trains, transfers, and maintenance vehicles in the vicinity on the designated standby channel upon receiving the first alarm.

On the approach to Mai, the LE broadcast the South-east Mai signal indication (signal 1257)¹⁷ on the railway radio, but did not broadcast a radio message regarding the South-west Mai Stop signal indication (signal 1283).

1.8 Rules relating to main track occupancy

According to CROR Rule 80, when a movement passes a Stop signal without authority, the movement must stop, and the RTC must be notified as soon as possible. In addition, several measures relating to main track occupancy rules must be taken, including (Appendix A):

¹⁴ Rule relating to radio broadcast requirements.

¹⁵ Transport Canada, *Canadian Rail Operating Rules* (09 May 2022, effective 01 October 2022), Rule 578.

¹⁶ Quebec North Shore and Labrador Railway, *Canadian Rail Operating Rules, including Moisie Division Special Instructions and the Special Instructions for one-employee train or transfer operation on the QNS&L Railway* (effective 01 June 2020), Rule 578.

¹⁷ Clear to Stop indication.

- A flagman must position himself to warn and stop other movements until this obligation is lifted (Rule 35);
- Any employee who discovers a dangerous situation must transmit an emergency call (Rule 125).

The RTC will then pass on instructions as necessary. These instructions include issuing the authority required to allow the movement in the controlled block (Rule 564). The RTC may also issue other instructions allowing the train to move forward or reverse.

1.9 Actions taken after the occurrence

1.9.1 Actions taken by the locomotive engineer

When the train stopped after passing the Stop signal (signal 1283), the LE contacted the RTC by radio and informed him of the situation. No emergency call was placed on the railway radio, and no protection was immediately put in place on the main track.

1.9.2 Actions taken by the rail traffic controller

After receiving the call from the LE informing him that the train had just passed the Stop signal (signal 1283), the RTC did not promptly issue an authority allowing the train to pass that signal, as required by Rule 564.¹⁸ He also did not inform the work train WK315¹⁹ crew of the situation.

1.10 Re-enactment of the occurrence by TSB investigators

On the evening of 14 March 2023, TSB investigators and a QNS&L crew performed a re-enactment and a visibility test using a train identical to the occurrence train. This was done to determine the distance from which it would have been possible to see the signals from the cab of a moving locomotive, and to confirm the train handling procedures. The train's route had been set so that the signals provided the same indications as those given to the occurrence train. At the time of the test, the track was clear, the ground adjacent to the track was snow covered and visibility was good. The following observations were made:

- South-east Mai Signal 1257, which was indicating Clear to Stop, was visible at a distance of about 1 mile, at the exit of a 1-degree left-hand curve at Mile 124.73.
- South-west Mai Signal 1283 was visible at a distance of about 0.75 miles, at the exit of a 1-degree left-hand curve at Mile 127.63.
- The railway has a slight gradient of 0.34% in a northerly direction before signal 1283; at a speed of 9 mph, it was possible to bring the train to a controlled stop before this signal using dynamic braking alone.

¹⁸ This authority was issued by the rail traffic controller to the relief locomotive engineer around 30 minutes after the occurrence.

¹⁹ Work train WK315 was travelling southward and was about 4 miles from Mai at the time of the occurrence.

1.11 Use of braking

1.11.1 Use of dynamic braking

When dynamic brakes are used, buff forces are created in the train's couplers. Dynamic braking effort must be properly modulated to allow the slack in the train's couplers to adjust gradually so that the in-train forces are distributed progressively.

In particular, if the buff forces in the couplers are not distributed progressively, a derailment could occur due to the jackknifing effect between the train's cars.

1.11.2 Quebec North Shore and Labrador Railway instructions on the use of dynamic braking

On 06 December 2022, QNS&L issued a circular²⁰ to its train crews governing the use of dynamic braking, particularly on trains with alternating current locomotives,²¹ such as the one involved in this occurrence.

To avoid derailments due to the jackknifing effect between the cars, this circular stressed the importance of properly adjusting the dynamic braking effort to limit excessive buff forces generated in the train's couplers.

In this occurrence, the use of dynamic braking by the LE did not comply with the circular's instructions; the LE moved the dynamic brake handle from position 2 to the maximum position (position 8) in the span of 1 second.

1.11.3 Use of emergency braking

An emergency brake application is the maximum application of a train's air brakes, during which the brake pipe air pressure is rapidly reduced to 0. During emergency braking, the buff forces generated in the train are much higher than during a normal split-service brake application, which can increase the risk of jackknifing and derailment, especially on curves and gradients.

1.12 In-train forces and braking distances

Using the Train Energy and Dynamics Simulator (TEDS) software program, the TSB laboratory performed train dynamics simulations and analyses to determine the in-train forces generated by the combined use of the maximum dynamic braking and the emergency braking.

²⁰ Quebec North Shore and Labrador Railway, Circular No. 22-563 (06 December 2022).

²¹ The dynamic braking system on locomotives equipped with alternating current traction motors can generate a retarding force of up to 105 kips per locomotive (a kip is a unit of force equivalent to 1000 pounds). All QNS&L locomotives maintain dynamic braking during emergency braking.

These forces include buff forces and the effect of these forces on the lateral-to-vertical forces ratio (L/V ratio),²² which is an indication of the probability of wheel derailment.

According to the train dynamics simulations and analyses:

- The improvised use of dynamic braking, combined with the emergency braking, resulted in in-train buff forces in the range of 200 to 220 kips between the 50th and 80th cars.
- Buff forces of 200 to 220 kips increase the probability of jackknifing, especially when the cars are empty and equipped with F-type couplers.²³
- The presence of permanent drawbars between the compartments of the tri-pak cars helped limit lateral forces.
- Using the emergency brake alone would not have significantly changed the stopping distance and in-train buff forces.

1.13 Experience of railway operating employees

In highly practised situations, attention and expectations are often driven by a person's existing mental model of a situation, given that previous experience will dictate what information is important and how the situation may unfold.²⁴ Inaccurate situation assessment can lead to errors in how information is perceived, making it less likely for someone to reassess the initial assessment and update it with new information, while dismissing or not detecting information that is the opposite of what is expected.²⁵

In this occurrence, both the LE and the RTC on duty had limited work experience. They had not had the opportunity to put into practice the procedures and rules to apply in certain emergency situations.

1.14 Supervision of railway operating employees

LE supervision at QNS&L is mainly carried out by the company's Transportation and Traffic supervisors, who conduct spot checks during train trips to assess LE performance, including compliance with current rules and instructions. In addition, LE train-handling methods are assessed every 2 months by examining data from the locomotive event recorders. Every 8 months, a supervisor rides along with each LE on the train circuit between Sept-Îles and Labrador City, Newfoundland and Labrador, to assess their skills and provide real-time feedback.

²² The lateral-to-vertical forces ratio, referred to as the L/V ratio, is a basic measure of the interaction of the lateral and vertical forces. It is calculated as the lateral force pushing outward against the rail, divided by the vertical force pushing downward on the surface of the rail head.

²³ F-type couplers can swivel up to 13 degrees.

²⁴ G. Klein, "Naturalistic decision making," *Human Factors*, Vol. 50, No. 3 (2008), pp. 456–460.

²⁵ A. Tversky and D. Kahneman, "Causal schemas in judgments under uncertainty," in D. Kahneman, P. Slovic, and A. Tversky (Eds.), *Judgment under uncertainty: Heuristics and biases* (1982).

Supervision of the RTCs at QNS&L is carried out by a chief rail traffic controller (CRTC). The CRTC monitors the performance of the RTCs and assists them in exceptional situations. The CRTC is not always on site, but can be called in as required. On the evening of the occurrence, a CRTC was not on site to provide direct supervision; immediately after being informed of the occurrence, the RTC contacted the CRTC by telephone to advise him of the situation.

Over the past 3 years, QNS&L has hired many new employees. The supervisory approach has remained the same for all railway operating employees, whether newly qualified or not.

1.15 **Other similar occurrences at Quebec North Shore and Labrador Railway**

Over the past 10 years, there have been 12 occurrences, including this one, of QNS&L trains passing Stop signals. Human performance was considered a factor in all these occurrences. LEs who had been qualified for 1 year or less were part of the train crews in 4 of these occurrences, while LEs who had been qualified for less than 4 years but more than 1 year were part of the crews in 4 other occurrences.

One of these occurrences took place on 20 July 2023 at Sept-Îles Junction (R23Q0060) during the investigation of this occurrence.

There were also at least 2 occurrences in which LEs used emergency braking to stop their train before a Stop signal or in front of stationary rolling stock on a main track.

On 09 November 2022, the TSB issued Rail Transportation Safety Advisory Letter 04/22 concerning 2 occurrences in which derailments occurred when LEs used maximum dynamic braking within a short period of time. The TSB asked Transport Canada to consider reviewing QNS&L's procedures and guidelines for the use of dynamic braking, especially when operating trains with locomotives equipped with alternating current traction motors.

On 06 December 2022, in response to Rail Transportation Safety Advisory Letter 04/22 and Transport Canada's inspections, QNS&L issued 2 circulars to train crews explaining to LEs the differences between the dynamic braking effort for alternating current and direct current traction units, and the risks associated with the forces generated by dynamic braking. The circulars also include procedures for the use of dynamic braking.

1.16 **Mental model and adaptation**

A mental model is an organized internal structure that enables people to predict, describe, and explain events in their environment, and to develop expectations of what will happen in the future.²⁶ When a mental model is adopted, it is resistant to change. New, compelling, and convincing information must be perceived and assimilated in order to modify a mental model. A mental model can be affected by habit intrusions. The human cognitive system stores patterns of responses and reapplies them when familiar conditions for recall arise.²⁷

²⁶ E. Salas, F. Jentsch, and D. Maurino, *Human Factors in Aviation*, 2nd edition (Academic Press, 2010), p. 266.

²⁷ J. Reason, *Human Error* (Cambridge University Press, 1990), p. 51.

Habit intrusion results in a habitual sequence of actions being performed instead of the desired one.

In this occurrence, the LE had the habit of stopping the train so that the lead locomotive was positioned in front of the Mai Station camp, located after signal 1283, to facilitate the takeover of the train by a relief LE.

Adaptations are intentional deviations from rules or procedures. Routine adaptations are deviations repeated over time. They may have come into being because the procedure is considered unnecessary or redundant, or simply because it is not enforced. When adaptations are performed with no negative consequences, they can persist and become standard practice. This way of working becomes normalized and can erode the safety margins that the rules and procedures were intended to provide. Organizational monitoring of compliance with procedures can identify certain adaptations, such as those related to calling signals on the radio. This monitoring consists of spot-checking radio communications, riding along with train crews during operations, training and periodic certification.

The LE, who was newly qualified, had developed the habit of not always broadcasting radio messages relating to Stop signal indications on the railway radio standby channel. The LE felt that, by stopping before the Stop signal, he was complying with the rules in force.

1.17 **TSB Watchlist**

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

Following railway signal indications is a Watchlist 2022 issue. As this occurrence demonstrates, railway signals are not consistently recognized and followed, which poses a risk of serious train collisions and derailments.

ACTION REQUIRED

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

1.18 **TSB laboratory reports**

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

- LP049/2023 – Train dynamics analysis

2.0 ANALYSIS

The train's air brake system was in good condition. Before the train left Sept-Îles, Quebec, it had been inspected and no braking system defects were noted. The locomotive engineer (LE) met fitness and rest standards and was qualified for his position. Accordingly, the analysis will focus on train handling on the approach to Mai, in-train forces, actions taken after the occurrence, supervision of newly trained LEs, and the mental model and adaptation on the part of the occurrence LE.

2.1 The occurrence

On 22 February 2023, Tacora Resources Inc. ore train W039, operated by Quebec North Shore and Labrador Railway (QNS&L), was travelling northward on the Wacouna Subdivision with a single LE at the controls. A crew change was planned at Mai Station, Quebec, at Mile 128.3. Approaching the station, about 50 feet before signal 1283, while the train was travelling at 9 mph, the LE realized that the signal was indicating Stop and that he would not be able to stop before this signal. The LE's immediate reaction was to increase dynamic braking effort to the maximum and apply the emergency brakes. The lead locomotive came to a stop 73 feet past signal 1283.

In order to bring the train to a controlled stop before signal 1283, the dynamic braking force should have been gradually increased much sooner.

Findings as to causes and contributing factors

Ore train W039, operated by QNS&L, travelling northward on the Wacouna Subdivision, passed signal 1283, which was indicating Stop.

The lead locomotive came to a stop 73 feet beyond signal 1283, after the LE had applied full dynamic braking and the emergency brakes.

Although signal 1283's Stop indication was visible from about 0.75 miles from the signal, the LE did not perform the braking manoeuvres required to bring the train to a stop before this signal.

2.2 In-train forces

In this occurrence, when the LE realized that signal 1283 was indicating Stop, he quickly increased dynamic braking to the maximum and applied the emergency brakes in an attempt to avoid passing this signal.

The combined effect of maximum dynamic braking and the emergency braking generated in-train buff forces in the range of 200 to 220 kips between the 50th and 80th cars. These forces can increase the lateral-to-vertical force ratio (L/V ratio), particularly when the cars are empty and equipped with F-type couplers, as in ore train W039.

When there are high lateral forces (for instance, in sharp curves) combined with low vertical forces (for instance, empty cars), the wheel flanges tend to be pushed up and over the gauge face of the rail, resulting in a wheel-climb derailment. Conversely, when vertical

forces are moderate to high, wheel lift is less likely. However, a high sustained lateral force can cant the rail outward and may cause the rail to roll over, resulting in a derailment.

In this occurrence, despite the strong buff forces generated by the combined braking force, there was no derailment because the train was travelling on tangent track with a low gradient. In addition, the presence of permanent drawbars between the compartments of the tri-pak cars helped to distribute the buff forces, thus limiting lateral forces.

Finding: Other

The improvised use of dynamic braking, combined with the emergency braking, resulted in high buff forces on the train's couplers.

2.3 **Actions taken after the occurrence**

Once the train had stopped beyond the Stop signal (signal 1283), the LE informed the rail traffic controller (RTC) of the situation, but did not make an emergency radio call or set up train protection on the main track, as required by Rule 80 of the *Canadian Rail Operating Rules* (CROR). For his part, the RTC did not promptly issue an authority allowing the train to pass signal 1283 and occupy the block controlled by that signal.

The LE had limited work experience; he had qualified in April 2022, less than 1 year before the occurrence.

The RTC had qualified in February 2023, 2 weeks before the occurrence, and was on his 6th shift since qualifying.

Finding: Other

Due to the limited work experience of the LE and the RTC, the measures required to ensure protection on the main track were not implemented in a timely manner.

2.4 **Supervision of newly trained locomotive engineers**

At QNS&L, the company's Transportation and Traffic supervisors perform spot checks during train trips to assess LE performance. These include monitoring compliance with current rules and instructions, as well as LE train-handling methods.

New employees who have completed the QNS&L LE training program do not receive separate, ongoing systematic supervision following qualification. QNS&L's LE supervision and performance evaluation program applies consistently to all LEs, whether newly qualified or not.

Because new employees have less practical experience in applying newly learned rules and procedures, increased supervision for a certain period following qualification would correct observed gaps or deviations.

In this occurrence, although the LE had completed his training and obtained his qualification, his experience was limited. He had been employed by QNS&L since 12 October 2021 and had obtained his LE qualification on 08 September 2022.

Finding as to risk

If newly trained employees do not receive adequate supervision, any deviations from operating procedures may not be corrected in a timely manner, increasing the risk of accidents.

2.5 Mental model and adaptation

In this occurrence, as he approached Mai Station, the LE adjusted the speed of his train to bring the lead locomotive to a stop in front of the station camp, which is located after signal 1283. He was accustomed to passing a permissive signal at this point. This suggests that the LE had likely developed a mental model driven by habit intrusion.

Although signal 1283 was in the LE's field of vision for about 0.75 miles, it was only about 50 feet from this signal that the LE realized that it was indicating Stop. He then corrected his mental model and immediately reacted by increasing dynamic braking to the maximum and applying the emergency brakes. However, these actions were initiated when it was no longer possible to stop the train before the signal.

Finding as to causes and contributing factors

The LE's mental model was likely affected by a habit intrusion whereby he routinely stopped the lead locomotive of his train in front of the camp located after signal 1283.

In this occurrence, the LE called the signal 1257 indication (Clear to Stop) on the radio as required by the CROR. When approaching signal 1283, the LE did not call the Stop indication on the radio. The LE missed the opportunity to remind himself that he had to be ready to stop the train at this signal, because the previous signal (signal 1257) was indicating Clear to Stop.

In addition, the LE had developed the habit of not always broadcasting Stop signal indications on the railway radio standby channel, as required by the current rules. For the LE, stopping the train before the Stop signals did not require broadcasting the Stop signal indications on the radio. This adaptation by the LE resulted in decreased vigilance, thereby weakening the safety measures provided for by these rules.

Finding as to causes and contributing factors

The LE's vigilance was affected by an adaptation due to the habit he had developed of not broadcasting Stop signal indications.

2.6 Locomotive voice and video recorder

The data recorded by locomotive voice and video recorders (LVVRs) give TSB investigators an objective and reliable method of determining the possible role of human factors in a rail occurrence.

After assessing the occurrence, the TSB sent a request to QNS&L to preserve the occurrence-related LVVR data for future retrieval.

Technical difficulties experienced by QNS&L caused unforeseen delays in responding to this request. As a result, the LVVR data covering the period of the occurrence had been deleted due to the expiry of the 48-hour data holding period in the system.

Finding: Other

Due to the absence of data from the LVVR system, the TSB was unable to confirm all the activities that occurred on board the locomotive in the minutes before the occurrence.

3.0 FINDINGS

3.1 Findings as to causes and contributing factors

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

1. Ore train W039, operated by Quebec North Shore and Labrador Railway, travelling northward on the Wacouana Subdivision, passed signal 1283, which was indicating Stop.
2. The lead locomotive came to a stop 73 feet beyond signal 1283, after the locomotive engineer had applied full dynamic braking and the emergency brakes.
3. Although signal 1283's Stop indication was visible from about 0.75 miles from the signal, the locomotive engineer did not perform the braking manoeuvres required to bring the train to a stop before this signal.
4. The locomotive engineer's mental model was likely affected by a habit intrusion whereby he routinely stopped the lead locomotive of his train in front of the camp located after signal 1283.
5. The locomotive engineer's vigilance was affected by an adaptation due to the habit he had developed of not broadcasting Stop signal indications.

3.2 Findings as to risk

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

1. If newly trained employees do not receive adequate supervision, any deviations from operating procedures may not be corrected in a timely manner, increasing the risk of accidents.

3.3 Other findings

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

1. The improvised use of dynamic braking, combined with the emergency braking, resulted in high buff forces on the train's couplers.
2. Due to the limited work experience of the locomotive engineer and the rail traffic controller, the measures required to ensure protection on the main track were not implemented in a timely manner.
3. Due to the absence of data from the locomotive voice and video recorder system, the TSB was unable to confirm all the activities that occurred on board the locomotive in the minutes before the occurrence.

4.0 SAFETY ACTION

4.1 Safety action taken

4.1.1 Transportation Safety Board of Canada

On 07 September 2023, the TSB sent Quebec North Shore and Labrador Railway (QNS&L) Rail Transportation Safety Information Letter 04/23 on the supervision of newly qualified locomotive engineers (LEs). The TSB suggested that QNS&L consider reviewing its LE training program to ensure that ongoing systematic supervision of new employees is performed in the post-qualification period.

4.1.2 Transport Canada

On 16 February 2023, in its response to Rail Transportation Safety Advisory Letter 04/22, Transport Canada stated that it had carried out regulatory inspections to verify what measures had been taken by QNS&L to prevent similar occurrences in the future. Transport Canada confirmed that QNS&L had no specific instructions at the time of the occurrence governing the use of dynamic braking, particularly on locomotives with alternating current traction motors.

4.1.3 Quebec North Shore and Labrador Railway

Following the occurrence, QNS&L made changes to its evaluation program for apprentice LEs. Field evaluations are now performed by supervisors every 200 hours instead of every 300 hours. For qualified LEs with less than 2 years of experience, field evaluations are performed by supervisors every 4 months instead of every 8 months.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 10 April 2024. It was officially released on 09 May 2024.

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

APPENDICES

Appendix A – Rules 35, 80, and 125 of the *Canadian Rail Operating Rules*, and Quebec North Shore and Labrador Railway special instructions

Rules 35, 80, and 125 of the *Canadian Rail Operating Rules* (CROR) apply when a movement passes a Stop signal without authority. These rules are as follows:²⁸

35. EMERGENCY PROTECTION

This rule does not authorize main track occupancy or track work.

- (a) Any employee discovering a hazardous condition, which may affect the safe passage of a movement, must by the use of flags, lights, fusees, radio, telephone, or other means, make every possible effort to stop and/or provide necessary instructions to any movement that may be affected. Flag protection must be provided on main track unless or until otherwise relieved of the requirement.
- (b) A flagman must go the required distance from the condition, and in each direction when possible, to ensure that an approaching movement will have sufficient time and distance to be able to stop before the condition. Unless otherwise provided, a flagman must go at least two miles from the condition to a location where there will be an unobstructed view of the flagman from an approaching movement.

When a movement is observed approaching, the flagman must display a stop signal using a red flag by day or a lighted red fusee by night or when day signals cannot be plainly seen. The flagman must continue to display a stop signal until the movement being flagged has:

<p>QNS&L Railway – Special instruction One employee train or transfer operation</p> <p><u>RULE 35 (b) – EMERGENCY PROTECTION</u></p> <p>The locomotive engineer will provide flag protection toward the front of the train or transfer. Rear protection will be provided by the RTC [rail traffic controller], who will not allow a train or transfer to overtake another from the rear, if the train or transfer being overtaken is moving in a siding.</p> <p>The RTC will lock the appropriate signals to the rear at Stop, until the train or transfer in the siding has confirmed that it has stopped and that it will not resume movement until the train or transfer operating on the main track has passed.</p>
--

- (i) acknowledged the stop signal with engine whistle signal 14 (b) (two short);
- (ii) come to a stop; or
- (iii) reached the location of the flagman.

²⁸ Quebec North Shore and Labrador Railway, *Canadian Rail Operating Rules, including Moisie Division Special Instructions and the Special Instructions for one-employee train or transfer operation on the QNS&L Railway* (effective 01 June 2020), Rules 35, 80, and 125.

- (c) A movement stopped by a flagman must not proceed until so instructed by the flagman.
- (d) A flagman must be equipped with a red flag and eight red fuses. The presence of an unbroken seal verifies that a flagging kit is properly supplied.

80. MAIN TRACK AUTHORIZATION

- (a) A movement must not foul or enter a main track without authority. Authority is conveyed in:

CTC By signal indication, RTC permission or written authority.

QNS&L Railway – Moisie Division Special Instruction

RULE 80 – MAIN TRACK AUTHORIZATION

In the application of this Rule, a train must not foul or enter a main track without authority; the authority will be conveyed by written permission from the RTC.

CROR Rule 80 applies prior to leaving the following locations:
Sept-Îles Jct., Ross-Bay Jct., Emeril Jct., Wabush Lake Jct.

A transfer may foul the main track at these locations without written permission after having obtained a verbal permission from the RTC.

Note: A written permission is required if one or more GBO's [*sic*] [general bulletin order] of less than 15 MPH are in effect on the section of main track on which the transfer will operate.

Exception: Trains operating through (to or from) Northernland Subdivision may leave South or West Ross-Bay Jct. without obtaining a new permission.

Work trains or other yarded movements will obtain written permission from the RTC at the location where they were yarded prior to departure.

The numbers of all GBO in effect at the time the written transmission is issued will be shown on all written permissions delivered to the locomotive engineer. When there are no GBO for that movement, the word "Nil" will be shown.

The locomotive engineer must be in possession of GBO listed on his written permission. When transmitted by ECM [electronic communications method], he must ensure legibility of each copy before proceeding.

A conventional telephone, satellite telephone or railway radio or ECM may be used to obtain a written permission, a TOP [track occupancy permit], a GBO or any other authority from the RTC.

OCS Clearance

Cautionary Limits Rule 94 (not applicable to QNS&L)

SCS Special Instructions

- (b) If a movement occupies or fouls a main track or siding controlled territory without authority, or passes a block or interlocking signal indicating stop without authority to pass such signal; it must be stopped and protection as required by Rules 35 and 125 initiated. The RTC or signalman must be advised as soon as practicable.
 - (i) The RTC or signalman will issue instructions as necessary.

- (ii) If the instructions include the authority to proceed or reverse direction, unless relieved of the requirement by the RTC or signalman:
- any dual control or power-operated switches occupied by the movement must be examined to ensure that the switch points are properly lined for the route to be used and no part of the switch is damaged or broken.
 - Rule 104.2(b) must be complied with at dual control switch(es). In application of Rule 104.2(b), the movement may be moved before the dual control switch is operated by hand, but only sufficient distance to clear the wheels from the actual switch points.

125. EMERGENCY COMMUNICATION PROCEDURES

- (a) An employee will transmit the word “EMERGENCY” three times at the beginning of the transmission to indicate the report of;
- (i) an accident involving injury to employees or others;
 - (ii) a condition which may constitute a hazard to employees or others;
 - (iii) a condition which may endanger the passage of movements; or
 - (iv) a derailment which has occurred on, or is fouling, a main track.
- (b) When an emergency communication, which is directed to a specific person or movement, has not been acknowledged, any other employee hearing it will, if practicable, relay the communication by any means available. Other employees must not interfere with such communication.
- (c) An emergency communication has absolute priority over other transmissions.