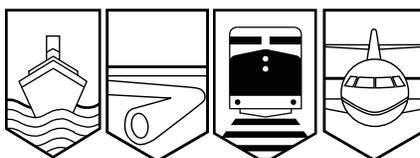


Transportation Safety Board  
of Canada



Bureau de la sécurité des transports  
du Canada

**RAILWAY INVESTIGATION REPORT  
R02T0047**



**MAIN-TRACK COLLISION**

**CANADIAN PACIFIC RAILWAY  
TRAIN NO. 121 AND TRAIN NO. 158  
MILE 143.9, BELLEVILLE SUBDIVISION  
PORT HOPE, ONTARIO  
22 FEBRUARY 2002**

**Canada**

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

### Main-Track Collision

Canadian Pacific Railway  
Train No. 121 and Train No. 158  
Mile 143.9, Belleville Subdivision  
Port Hope, Ontario  
22 February 2002

Report Number R02T0047

### *Summary*

On 22 February 2002, at approximately 1600 eastern standard time, Canadian Pacific Railway train 121, proceeding westward on the main track of the Belleville Subdivision, collided with the side of eastward Canadian Pacific Railway train 158 as it entered the siding at Port Hope, Ontario, at Mile 143.9 of the Belleville Subdivision. The collision derailed two container flat cars on train 158. Train 121 did not derail. Both crew members of train 121 were seriously injured jumping from their train while another employee in the second locomotive remained on the train and was not injured. The crew members of train 158 were not injured.

*Ce rapport est également disponible en français.*

## *Other Factual Information*

At 1600 eastern standard time<sup>1</sup> on 22 February 2002, train 121, proceeding westward on the main track at Mile 143.9 of the Belleville Subdivision at Port Hope, Ontario, collided with the side of train 158. The collision involved the second, third and fourth cars of train 158, which was proceeding eastward into the Port Hope siding at approximately 10 miles per hour (mph). The locomotives on train 121 did not derail but received minor damage. The second and third cars on train 158 derailed, sustained extensive damage, but remained upright. The third car involved (the fourth car in the consist of train 158) carried freight of various kinds, including unidentified dangerous goods, did not derail, lost no product and sustained only minor damage.

Train 121 consisted of 2 locomotives, 0 empties and 38 loads. The train was approximately 3147 feet in length and weighed about 2050 tons. Train 158 was powered by 2 locomotives handling 0 empties and 42 loads, including 9 cars carrying dangerous commodities. Train 158 was approximately 5906 feet in length and weighed about 3995 tons.

The crew of train 121, consisting of a locomotive engineer and a conductor, were ordered for 1300 Friday, 22 February 2002, at Smith Falls, Ontario, Mile 0.0 of the Belleville Subdivision. Although the crews of both trains were qualified for their respective positions and were in compliance with regulatory requirements respecting mandatory time off-duty and maximum hours of service, the conductor of train 121, who was not qualified as a locomotive engineer, was at the controls. The conductor had been assigned to this train service for approximately four years and the locomotive engineer, the past six or seven years. A third employee, deadheading in the second locomotive of train 121, was not in service.

Train 121 departed Smith Falls at 1350 operated by the conductor, under the unofficial supervision of the locomotive engineer. The locomotive engineer on train 121 was qualified and had 28 years of experience. He had also performed the duties of supervisor of locomotive engineers training with Canadian Pacific Railway (CPR) for a number of years. The locomotive engineer and conductor had worked together for approximately two years. In that time, the conductor had expressed a desire to be a locomotive engineer. Confident in the conductor's ability, the locomotive engineer allowed the conductor to operate the locomotive over the past year and a half to two years. The practice of allowing an unqualified employee to operate the locomotive was not permitted by CPR and the locomotive engineer had been directed to cease this practice three weeks prior to the accident.

Qualification as a locomotive engineer, as mandated by Transport Canada's Qualification Standards for Operating Crews, requires training in all aspects of locomotive control and operations, mandatory rules training and rigorous computer simulations as well as numerous on-the-job training trips under the direct supervision of a qualified operator instructor. Upon completing all required training, applicants must pass a final examination.

The crew of train 158, consisting of a locomotive engineer and a conductor, were called on 22 February 2002 at CPR's Toronto Agincourt Yard to operate their train eastward to Smith Falls. They reported for duty and departed Toronto at 1500.

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<sup>1</sup> All times are eastern standard time (Coordinated Universal Time minus five hours) unless otherwise stated.

In the area where the collision occurred, the Belleville Subdivision consists of a single main track with a siding 7083 feet in length, located on the south side of the main track. Train movements in the area are governed by the Centralized Traffic Control System (CTC) authorized by the *Canadian Rail Operating Rules* (CROR) and supervised by a rail traffic controller (RTC) located in Montréal, Quebec. The permissible track speed in this area is 60 mph. The weather was clear, sunny and cold.

Train 121 transports road highway trailers between Montréal and Toronto. The train, referred to as an "Expressway" Class 1 CPR premium service freight train, receives priority handling en route. CPR timetable footnotes define the classification of this train as a non-restricted expedited train. This type of train is allowed to travel 5 to 10 mph faster than restricted freight trains. At single track meets, opposing trains generally take the siding unless they exceed its length, allowing the Expressway train to hold the main track and only incur minimal delays.

There is a single aspect intermediate signal at Mile 140.3 (Signal 1403) in advance of signal 1425 that governs westward movements over the switch at the east end of the Port Hope siding. Train 121 passed by signal 1403 at a speed of approximately 45 mph in throttle position 4 at 1639:19. The crew of train 121 stated that signal 1403 displayed a clear indication telling them to proceed to signal 1425. At 1639:55, train 121 reduced speed to 27.5 mph in throttle position 5 approaching a permanent 45 mph slow order between Mile 141.5 and Mile 141.9. The crew reported that, approaching signal 1425, located at the end of a curve, the setting sun was directly behind signal 1425, making it impossible to determine the indication displayed. At 1642:55, train 121 passed signal 1425 at a speed of 45.6 mph in throttle position 8 (maximum throttle).

Signal 1425 was displaying an aspect of clear to stop (yellow over red). This signal aspect indicates to the crew that they may proceed, preparing to stop at the next signal, which was signal 1439 governing westward movements over the west siding switch at Port Hope. The crew members of train 121 did not call out the signals as they approached and passed signal 1425.

CROR Rule 34 (a) states that:

The crew on an engine and snow plow foreman must know the indication of each fixed signal (including switches where practicable) before passing it.

CROR Rule 34 (b) goes on to state that:

Crew members within physical hearing range must communicate to each other, in a clear and audible manner, the indication by name, or each fixed signal they are required to identify. Each signal affecting their train or engine must be called out as soon as it is positively identified, but crew members must watch for and promptly communicate and act on any change of indication which may occur.

If a signal cannot be identified, or is not properly displayed, CROR Rule 27 (a) states in part that:

Except as provided in paragraph (b), a fixed signal or cab signal which is imperfectly displayed, or the absence of a fixed signal where one is usually displayed, must be regarded as the most restrictive indication that such signal is capable of displaying.

Signal 1425 can display a stop signal or a restriction to the next signal, that is signal 1439.

Subsequent to a TSB investigation into a tail-end collision between two trains on the CPR Shuswap Subdivision in British Columbia in the summer of 1998 (TSB report No. R98V0148), the Board indicated that:

The widespread practice of not calling signals effectively removes the backup safety defence available from the second crew member in ensuring accurate signal interpretation, thus increasing the risk of accidents.

The Board indicated that various measures could be considered to address this safety deficiency, including the use of additional defences that could alert crew members if their actions are not consistent with the signal indication. Given the wide-ranging view of both the extent of the problem and the potential solutions, the Board recommended that:

The Department of Transport and the railway industry implement additional backup safety defences to help ensure that signal indications are consistently recognized and followed.

(R00-04, issued November 2000)

Train 121 proceeded through Port Hope, increasing speed to 49.8 mph, when at Mile 143.2, at 1643:44, they observed train 158 at the west end of the Port Hope siding. Braking was initiated at 1643:56 and an emergency brake application was made at 1643:57. Train 121 collided with the side of train 158 at Mile 143.90 at 1644:17. The crew of train 121, anticipating a collision with train 158 and fearing the involvement of a dangerous commodity, exited the locomotive cab and jumped from the side of the moving train at an approximate speed of 47 mph. They suffered serious injuries, while the third employee in the second unit of train 121, unaware of events unfolding around him, remained in the second locomotive and was not injured. Train 121 proceeded for approximately 750 feet before contacting train 158. The speed and distance from point of impact were calculated based on the marks in the ballast and the location of personal belongings found adjacent to the track.

As train 158 approached signal 1440, which governs eastward movements over the west siding switch at Port Hope, the crew prepared to enter the siding in throttle position 1 at a speed of 9.2 mph when they observed opposing westward train 121 approaching on the main track. Realizing that train 121 was not going to stop, the crew of train 158 decided to continue entry into the siding rather than putting the train brakes into emergency, in the hope that they could enter the siding and avoid a head-on collision. The crew on train 158 saw the crew of train 121 exit the locomotive cab, climb down the steps, hesitate, then jump from the train. A head-on collision was avoided as the locomotives of train 158 succeeded in entering the siding before train 121 collided with the fourth car behind the locomotives.

After both trains came to a stop, an emergency radio broadcast was made to the RTC by the crew of train 158. The CPR RTC called for an ambulance and advised the Canadian National (CN) RTC of the accident due to the close proximity of the CN main line. CN train movements in that area of the Kingston Subdivision were halted. The crew of train 158, fearing that they had run over the locomotive engineer of train 121, searched for and located both crew members of train 121 and assisted them onto the second locomotive of train 158. The crew of train 158 received permission from the RTC to uncouple their locomotives and transported the injured crew members to the ambulance waiting at the crossing at Mile 141.15.

Post-accident inspection of the locomotive operating compartment of train 121 revealed that the radio volume control was on setting 4, or half volume. Channel 7 was selected, the normal standby channel in the Port Hope area. The radio was tested and determined to be operational with the exception of a defective speaker on the conductor's side. The crew members claimed that they had heard other radio communications regarding a train at Spicer, approximately 10 miles east of Port Hope, prior to the accident, but stated that they did not hear any radio communication involving train 158 and were not aware of its presence. Prior to arriving at the west end of the Port Hope siding, the crew of train 158 had received radio instructions east of Bowmanville, Ontario, around Mile 163, from the RTC, to enter into the siding at Port Hope and to allow train 121 to pass on the main track. Train 158 went over the hot box detector at Mile 147.0 and received the report from the detector over the standby channel on their locomotive radio. This communication can normally be heard by other trains and employees in the vicinity.

Calculations made by the TSB Engineering Laboratory (report LP031/02) revealed that, at the time of the accident, the sun's location was almost directly in line with the signal at Mile 142.5, but above it in elevation.

## *Analysis*

The physical information and recorded data support the sequence of events as reported by the respective crew members. The analysis will focus on crew performance, the physical layout of the track and signals in the area of Port Hope, the method and manner of the operation of train 121 and the role of attention, memory and expectation in performance.

The conductor at the controls of train 121 passed signal 1425 not knowing its indication. The crew on train 121 could not identify the indication displayed by signal 1425, but proceeded without reducing speed. Since signal 1425 can display a stop signal or a restriction to the next signal (signal 1439), and since they were unable to determine its indication, the safe course of action for the crew of train 121 would have been to prepare to stop their train before the next signal.

Event recorder data indicate that the only activity after passing signal 1425 was the emergency brake application just prior to impact. There was no reduction in speed after passing signal 1425. The crew members of train 121 did not call out the signals as they approached and passed signal 1425, thus negating one possible defence barrier.

Being a priority premium service freight train, train 121 received special handling en route. Opposing trains normally took the siding, minimizing delays. Train 121 passed signal 1425 even though the crew could not identify the indication, anticipating it to be permissive based on past experience. It was their intent to proceed to the next signal, at Mile 143.9, at the west end of Port Hope siding, expecting it also to display a permissive indication. The crew, having worked this type of train on the Belleville Subdivision for a number of years, would have been familiar with the track and signal layout at Port Hope and therefore aware of the reduced visibility of the sight-lines to signal 1439 due to curvature. The reduced sight-lines would have influenced the time that the crew of train 121 would have had to react when they exited the curve. Even though signal 1439 was displaying a stop signal, the crew members were unable to stop their train before colliding with train 158.

Given the time of day, approximately 1642, the sky was clear and the sun would have been at approximately 45 degrees, just above and to the right of the signal. Because of this, the signal would have been difficult to see against bright sunlight.

Although the conductor had received instructions from the locomotive engineer on locomotive operation, he had not entered or completed any recognized formal training program. Despite this situation, both of them agreed that he would operate the train.

The crew on train 121 did not hear any radio communication involving train 158, were not aware that train 158 was in the area nor that the trains were to meet at Port Hope. Although it is common practice for the RTC to radio trains to advise them of meet locations, it is not a CROR rule requirement. This contact is made primarily to provide information to employees in the area and not to provide any operating authority. This communication would have informed train 121 and any other trains in the vicinity of the location of train 158. With the volume on the radio lowered, in addition to the defective speaker on the conductor's side, the ability of the crew of train 121 to hear this communication, or any other regarding train 158, was reduced.

Many aspects of controlling a train are routine, where the crew members have performed the actions thousands of times before, in sections of track that they have travelled often, and surrounded by an environment with which they are familiar.<sup>2</sup> When a task has become highly routine, the amount of attentional energy that would be required is often less than would be required for an unfamiliar task in an unfamiliar territory. However, attentional checks on progress are still required to ensure that the actions are being carried out according to plan, as well as to ensure that the plan is adequate to achieve the desired outcome.

Even though the crew members on train 121 were aware of their failure to identify signal 1425, their subsequent lack of action can be explained by the fact that the identification of signals constitutes a behaviour that is highly automated. The safety practice requiring that each crew member call, in a clear and audible manner, the indication of each signal as it is observed provides a defence against crew members missing the indication of a signal. Adherence to this practice will increase the likelihood of performing the required attentional check.

A crew member's mental model of a particular situation is strongly influenced by past experience of the territory. Buck's 1963 report<sup>3</sup> summarizes a number of accidents in the British rail system where the driver passed caution and danger signals. In one example, the driver of an express train had been given inaccurate information about the signal from his fireman, but had not felt the need to confirm the information by looking himself, because his express freight train had never been stopped at that location before. Similarly, another driver of an express train passed signals at advance caution, caution and danger, and collided with the train ahead. The driver reported that, because he had seen a proceed aspect at the previous signal, he assumed that he would not be stopped at the next signals because he had never been stopped there

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<sup>2</sup> G. Edkins and C. Pollock (1997). "The influence of sustained attention on railway accidents" in *Accident Analysis and Prevention*. 29, 533-539.

<sup>3</sup> L. Buck (1963). "Errors in the perception of railway signals" in *Ergonomics*. 6, 181-192.

before. These early findings are supported by a 1997 study by Edkins and Pollock<sup>4</sup> who reported that one of the more common errors found in the Australian public rail system were train drivers going through a red signal because they expected it to be green.

An express freight train, like train 121, seldom encounters a stop signal when en route because of its priority status. Train 121 normally takes precedence over all other trains and this generally requires opposing movements to be placed into the siding (which was in fact the case in this accident, as train 158 was taking the siding when struck). The crew of train 121 was the regular crew for this train and familiar with this operating decision. All actions performed by the crew members suggest that they were operating under the assumption that signal 1425 was displaying a permissive indication based on the clear indication provided by the intermediate signal at Mile 140.3 and their past experiences. There was no other information available to the crew members to cause them to update their mental model of the situation. Consequently, the crew members were operating the train under the assumption that everything was as usual at Port Hope, with any train meet occurring being one with the opposing train in the siding. They were expecting that signal 1425 would be displaying a clear signal.

In order to maintain situational awareness, crew members must stay attentive and, among other things, be able to recognize and communicate signal indications to each other. Had they been more attentive to the route ahead and followed normal operating procedures, they would have been better prepared to stop at signal 1439.

### *Findings as to Causes and Contributing Factors*

1. The accident resulted when the operating crew on train 121 did not properly identify and respond appropriately to the signal indications at Port Hope. As a result, they continued near track speed as they approached the Port Hope siding.
2. Signal visibility at the time of the accident was reduced due to the sun's location behind and just to the right of signal 1425.
3. The combination of the train's speed and the reduced sight-lines to signal 1439 at the west end of Port Hope siding resulted in train 121 not being able to stop before colliding with train 158.
4. Despite the fact that the conductor at the controls was not qualified to operate the locomotive, both crew members had agreed that he would operate the train.
5. The reduced volume and defective speaker on the radio of train 121 would have reduced the crew's ability to hear any radio communications. This reduced the crew's ability to hear rail traffic control and hot box detector communications to train 158, which would have alerted them to its location.

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<sup>4</sup> G. Edkins and C. Pollock (1997). "The influence of sustained attention on railway accidents" in *Accident Analysis and Prevention*. 29, 533-539.

## *Findings as to Risk*

1. Many aspects of controlling a train are routine, where actions are performed repetitively over familiar territory. When a task has become highly routine, the amount of attentional energy that would be required is often less than would be required for an unfamiliar task in an unfamiliar territory.

## *Safety Action Taken*

Following the February 2002 accident at Port Hope, Transport Canada (TC) issued to Canadian Pacific Railway (CPR) a letter of voluntary compliance on 08 March 2002 and a Section 31 Notice on 10 April 2002 in regards to the operation of railway equipment by unqualified employees. Following a separate investigation under Part II of the *Canadian Labour Code*, a directive was issued to CPR in May 2002 concerning unqualified employees operating locomotives.

CPR conducted meetings to review the Port Hope accident. On 01 May 2002, CPR issued an operating bulletin to its Canadian running trade employees. The bulletin added to General Operating Instructions Section 15, *Locomotive and Train Operation*, item 1.4, which stipulates who may operate a locomotive and under what conditions. In addition, CPR is providing specialized training to contractors who operate locomotives within the Vaughan inter-modal facility and the Montréal and Milton Expressway facilities.

Subsequent to this action, a second incident involving unqualified persons operating a locomotive occurred near Kenora, Ontario, in September 2002 (TSB report No. R02W0127). In response to continuing concern, the TSB issued to TC Rail Safety Advisory (RSA) 06/02 titled *Unqualified Personnel Operating Locomotives*. The advisory noted that:

TC may wish to review the level of adherence of CP operating crews to the regulatory requirements for qualified personnel to operate locomotives.

TC met with senior members of CPR's Safety and Regulatory Affairs department. They were informed that the railway is developing and implementing a conductor/locomotive operator program similar to the program developed by Canadian National. TC inspectors continue to closely monitor this and other CPR activities designed to ensure that operating crews are in compliance with regulatory requirements.

On 08 November 2002, CPR issued a second bulletin to all conductors, locomotive engineers and yard crews, reaffirming the company's commitment to ensure that locomotives are operated in compliance with CPR's 01 May 2003 operating bulletin and *Canadian Rail Operating Rules* (CROR). Only employees who are qualified "in accordance with Transport Canada's Minimum Qualification Standards" may operate locomotives. CPR also advised TC that, following the latest incident, pre-departure safety meetings were organized between local managers and their operating crews. In addition, local union members included a review of the Kenora incident in their union meetings.

Most recently, TC has been monitoring CPR's efforts to improve the visibility of signal 1425 that governs westward movements over the switch at the east end of the Port Hope siding. CPR changed the signal lens from 10 degrees to 20 degrees to account for track curvature at that

location. The signal was aligned and tested with a test train. TC is also following up with CPR on other changes, including the removal of a section of the pole line and improvement in the visibility of the signal lights.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 16 July 2003.*