Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT
R13D0001

CROSSING COLLISION

VIA RAIL CANADA INC.
TRAIN NUMBER 601
MILE 98.79, JOLIETTE SUBDIVISION
JOLIETTE, QUEBEC
09 JANUARY 2013

Canada

Railway Investigation Report

Crossing Collision

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Train Number 601
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Summary

On 09 January 2013, at about 0950 Eastern Standard Time, VIA Rail Canada Inc. passenger train No. 601, while proceeding at 60 mph northward on the Canadian National Joliette Subdivision, struck a westbound vehicle at the rang de la Deuxième-Chaloupe public crossing at Mile 98.79 near the town of Joliette, Quebec. As a result of the collision, the vehicle's 2 occupants were fatally injured.

Ce rapport est également disponible en français.

Factual Information

The Accident

On 09 January 2013, VIA Rail Canada Inc. (VIA) passenger train No. 601 (the train) departed Montréal, Quebec, destined for Jonquière, Quebec. The train consisted of 2 sets, each comprising 1 locomotive followed by 2 passenger coaches. The train weighed about 440 tons and was approximately 450 feet in length. At Hervey, Quebec (see Figure 1), Mile 18.1 of the Lac St-Jean Subdivision, the train was to be divided in 2 with the 2nd set continuing to Senneterre, Quebec.

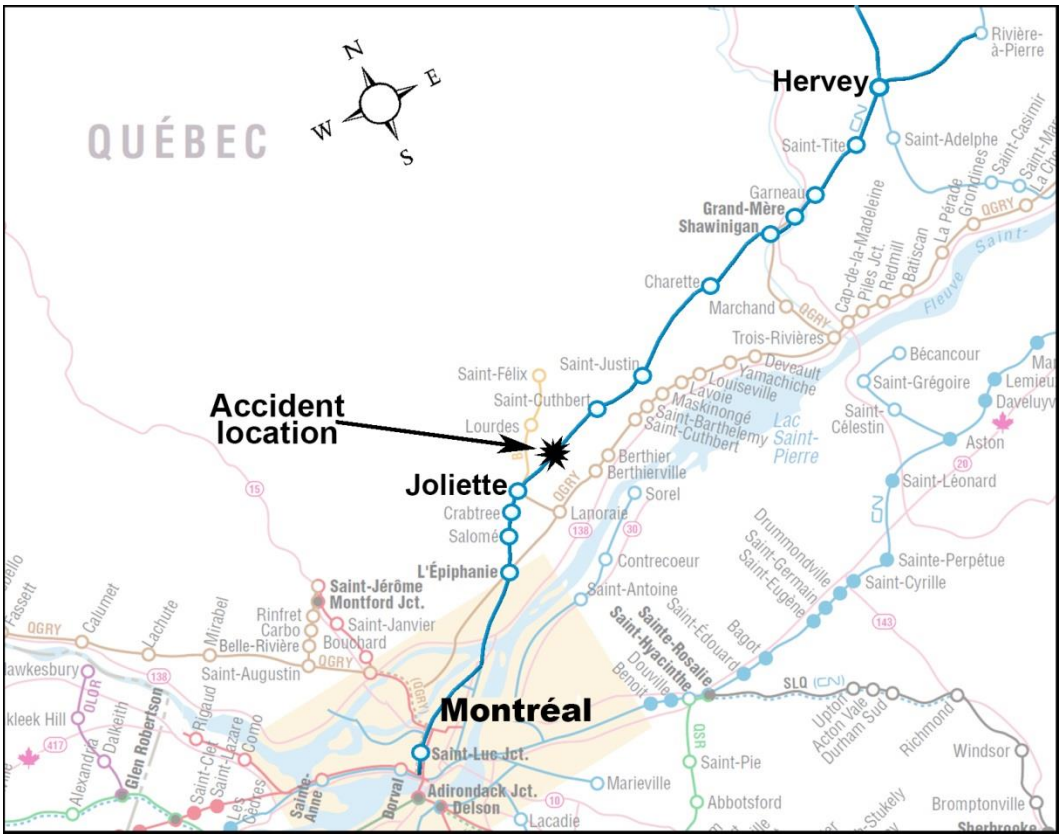

Figure 1. Accident location (source: Railway Association of Canada, *Canadian Railway Atlas*)

The train crew consisted of an operating locomotive engineer and an in-charge locomotive engineer. Both were qualified for their respective positions and met established rest and fitness requirements.

Along its journey, the train stopped at Joliette (Mile 101.90) to allow passengers to embark and disembark. Visibility at Joliette was good. At 0945, [1] the train departed northward and accelerated to a speed of 60 mph. After the train travelled about 2 miles, the visibility decreased significantly due to the presence of fog. Near the whistle post for the public crossing at Mile 98.79 (that is, rang de la Deuxième-Chaloupe), the train crew began sounding the horn in

1 All times are Eastern Standard Time.

accordance with Rule 14(l) [2] of the *Canadian Rail Operating Rules* (CROR). The crossing's flashing light signals were functioning. Just before the train reached the crossing, the train crew observed a westbound vehicle on the crossing and then exiting the crossing. Shortly thereafter, a sport utility vehicle (SUV), which was following the first vehicle, entered the crossing and was struck by the train.

As a result of the collision, the vehicle's 2 occupants, a 32-year-old female and a 16-month-old infant were fatally injured. The vehicle was destroyed. The lead locomotive (VIA 6404) received minor damage to its pilot and safety appliances.

An examination of the accident vehicle determined that the fan and temperature control knobs had been set almost at their maximum settings. The air flow control knob was set to direct air to the front windshield.

At the time of the accident, the temperature was -3°C and the wind was from the south at 12 km/h. The visibility was reduced to approximately 150 to 200 feet in the vicinity of the crossing due to the presence of heavy fog. The road pavement in the vicinity of the crossing was wet.

Locomotive On-board Video

The video recording from the camera on board the lead locomotive was examined. It was determined that the first westbound vehicle had travelled over the crossing at about 50 km/h and the following vehicle (that is, the SUV) had entered the crossing while travelling at about 60 km/h. The second vehicle was approximately 2 seconds behind the first vehicle.

Vehicle Drivers

At the time of the accident, there were 4 vehicles travelling or stopped in the vicinity of the rang de la Deuxième-Chaloupe crossing. The actions and/or observations of the vehicle drivers include the following:

- The driver of the SUV was a local resident and had been living in the area for the past 13 years. On the day of the accident, she was en route from her residence to Joliette. She drove into Joliette frequently, often using the rang de la Deuxième-Chaloupe crossing. The child was in the rear seat of the vehicle and was buckled into a forward-facing child seat.
- The driver of the preceding vehicle was also a local resident. He used the public crossing at rang de la Deuxième-Chaloupe on a daily basis to travel from his residence to his place of employment in Joliette. He was familiar with the road and the crossing, but had not previously encountered a train at that crossing. For his travel to work, he normally drove along rang de la Deuxième-Chaloupe at 90 km/h. However, on the day of the accident, he drove at a lower speed due to the dense fog conditions. With the reduced visibility, he relied on the road markings to stay on course. The vehicle's windows were

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[2] Two long soundings followed by 1 short and 1 long sounding must be made beginning ¼ mile prior to a public grade crossing (when train speed exceeds 44 mph), at other whistle posts as indicated in special instructions, and at frequent intervals when the view is restricted by weather, curvature or other conditions.

closed and the heater and radio were turned on. While approaching the crossing, the driver noticed the flashing lights. He looked to the left and saw the approaching train and heard the train horn. Believing that he could not stop prior to the crossing, he continued over the crossing, narrowly avoiding the oncoming train.

- An eastbound vehicle had stopped at the west approach of the crossing. This driver had approached the crossing at about 45 km/h and was able to safely stop after seeing the flashing lights. The driver was only able to hear the train horn when positioned close to the crossing. The driver of this vehicle was a local resident and used the road frequently. He was familiar with the crossing and had seen trains on the crossing occasionally.
- At the west approach to the crossing, a second vehicle had been travelling at about 70 km/h toward the crossing. The driver had to brake suddenly to avoid colliding with the stopped vehicle.

The Rang de la Deuxième-Chaloupe Crossing

Rang de la Deuxième-Chaloupe is a paved, 2-lane, undivided rural road that intersects the track at a 35°/145° angle (see Figure 2). Under normal visibility conditions, sightlines along the railway right-of-way were clear. The crossing is protected by flashing light signals (incandescent) and a bell. In good weather conditions, the light signals are visible to approaching motorists for at least 600 feet. Advanced warning signs are installed about 600 feet from the crossing along the roadway approach in both directions and are visible to approaching motorists for at least another 600 feet. The road has a maximum speed limit of 80 km/h.

The flashing light signals and bell had been tested on the previous day (that is, 08 January 2013). Testing and inspection of the light signals and bell following the accident did not reveal any deficiencies. It was determined that the lenses of the light signals were properly aligned for approaching vehicles.

Prior to the accident, the crossing was last inspected by the railway in May 2008. During this inspection, it was noted that the advanced warning sign, which is maintained by the road authority, was showing the crossing angle to be 90°. This advanced warning sign depicting the crossing at 90° was still present at the time of the accident.

During a traffic count at the crossing, which was conducted on 11 January 2013 between 1100 and 1300, 421 vehicles were recorded travelling over the crossing. No trains were observed during this 2-hour period. Only 8 vehicles slowed.

Based on TSB's Rail Occurrence Database System (RODS), there had been no train/vehicle accidents at this crossing during the 10-year period between January 2003 and January 2013.

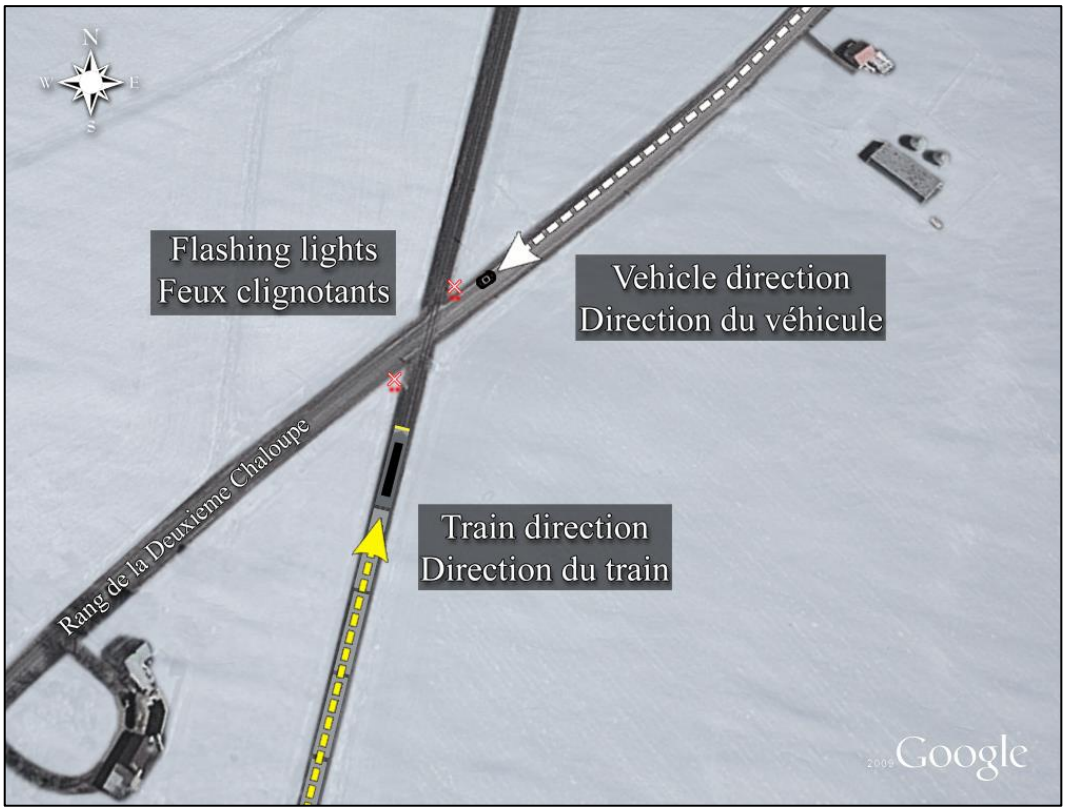

Figure 2. Rang de la Deuxième-Chaloupe crossing

Track Information

The Canadian National (CN) Joliette Subdivision consists of a single main track, extending from Garneau, Quebec (Mile 40.1), to Pointe-aux-Trembles, Quebec (Mile 127.8). Train movements are governed by the Occupancy Control System authorized under the CROR and supervised by a rail traffic controller in Montréal. Traffic on the subdivision consists of about 5 freight trains and 1 passenger train per day.

In the vicinity of the accident, the track is classified as Class 4 according to the Transport Canada-approved *Track Safety Rules*. The maximum speed is 60 mph for passenger trains and 50 mph for freight trains. Whistle posts are located along the railway right-of-way about 1200 feet from the crossing. The track at this location is tangent.

Driving in Fog

The Province of Quebec driver training manual [3] instructs drivers to do the following:

- Slow down, look and listen for an approaching train before entering a railway crossing, and to stop when the railway crossing lights are flashing.
- When driving in adverse weather conditions, since fog has the potential to hide road and traffic conditions due to reduced visibility and reflections from headlights, reduce

[3] Gouvernement du Québec, *Driving a Passenger Vehicle* (Les Publications du Québec: Quebec), 2006, pp. 141-158.

speed to be able to stop in the distance illuminated by the headlights, increase vehicle spacing, and use the lines of the road and the lights of vehicles in front as a guide.

- For dense fog conditions, turn on the hazard lights, stop in a safe place and wait for the visibility to improve.

Research conducted in driving simulators [4] has demonstrated that, when fog is present, drivers reduce speed somewhat, but not enough to be able to stop within the sight distance. In fact, driver speed in fog is determined more by the ability to follow the lane markings than by the sight distance.

The Department of Transport in Utah, United States, installed a low-visibility warning system on a low-lying segment of highway where there have been several multi-vehicle accidents. When fog is present, the system provides motorist with messages indicating the visibility conditions and provides guidance on safe speeds. When visibility is less than 197 feet, the system displays "ADVISE 25 MPH [40 km/h]." Displaying this type of information resulted in a decrease in speed variance, enhanced safety due to more uniform traffic flow, as well as an increase in average speed.

Other Related Occurrences

The TSB has investigated 2 other occurrences in which accidents took place at crossings that were equipped with automatic protection when visibility was restricted by adverse weather conditions:

- R04C0110 - In 2004, Canadian Pacific Railway train 269 was struck by a truck at a crossing near Blackie, Alberta. As a result of the collision, 1 vehicle occupant was fatally injured and the other was seriously injured. Also, 6 loaded tank cars carrying dangerous goods derailed.
- R10E0056 - In 2010, train VIA 1 struck a pick-up truck at a crossing in Edmonton, Alberta, fatally injuring 3 of the vehicle occupants.

In both investigations, the TSB determined that the overall effectiveness of the automatic protection was limited by the weather conditions. The drivers were not able to stop given that the speed of their vehicles was too fast for the visibility and road conditions.

Drivers Approaching Crossings

When approaching a grade crossing, driver behaviour is largely determined by the expectation of seeing (or not seeing) a train. Because drivers do not usually encounter trains at crossings, most encounters with a crossing reinforce the perception that a train is unlikely. A literature review by Yeh and Multer [5] determined that drivers who are familiar with a crossing will be less likely to look for a train at the crossing or to reduce their speed on their approach to the crossing than drivers who are unfamiliar with the crossing. The same review also determined

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4 J.O. Brooks et al., "Speed choice and driving performance in simulated foggy conditions," *Accident Analysis & Prevention*, 43(3), 2011, pp. 698-705.

5 M. Yeh and J. Multer, *Driver Behavior at Highway-Railroad Grade Crossings: A Literature Review from 1990-2006*, DOT/FRA/ORD-08/03, U.S. Department of Transportation, 2008, pp. 66- 67.

that slightly more than 1/3 of drivers approaching passive crossings, and almost 2/3 of drivers approaching crossings with active warning systems, made no head movement to inspect for oncoming trains.

Train Horn Audibility

A number of TSB investigations have identified shortcomings in the effectiveness of locomotive train horns to alert vehicle drivers and pedestrians to the presence of a train. In 1996, during investigation R96S0106, the Board found that the placement of the horn behind the exhaust outlet on VIA locomotive 6421 affected the intensity of the sound projected forward, reducing the horn's effectiveness as a warning device.

Subsequent investigations [6] have also concluded that the effectiveness of the horn can be compromised due to a combination of horn placement on the locomotive and ambient noise levels inside the road vehicle (notably large trucks and buses).

Referring to studies conducted in the United States on the effect of horns on crossing safety, Yeh and Multer [7] indicated that the train horn, despite its limitations, has a positive effect on safety. Crossings where whistle bans are in place have higher rates of accidents than those where no whistle bans are in effect.

A 2003 study, [8] prepared on behalf of Transport Canada, analyzed sound measurement data from various types of locomotives travelling at different speeds and with different horn configurations. The study concluded that horns mounted behind and close to the engine exhaust hood (that is, mid-locomotive) performed much worse than those mounted in other locations. The study recommended that existing mainline locomotives with a horn positioned behind and close to the engine exhaust hood should either have its horn moved to the front or have an alternative emergency horn added at the front of the locomotive. If the alternative horn is to be reserved only for emergency use, then the normal horn(s) should be positioned on the locomotive such that it provides a 30.5 m (100 foot) equivalent output of at least 100 dB(A) at angles between 25° and 45° from the forward-facing direction when measured at full operating speed. [9]

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6 TSB investigation reports R11T0175, R10W0123, R08M0002, R04H0014 and R02W0063

7 M. Yeh and J. Multer, *Driver Behavior at Highway-Railroad Grade Crossings: A Literature Review from 1990-2006*, DOT/FRA/ORD-08/03, U.S. Department of Transportation, 2008, p. 54.

8 G.W. English and T.N. Moore, *Locomotive Horn Evaluation: Effectiveness at Operating Speeds*, TP 14103E, TranSys Research Ltd., 2003, pp. 78-79.

9 Ibid., p. 102.

Locomotive Horn

Section 11, Audible Signals, Part II, Locomotives Design Requirements, of the *Railway Locomotive Inspection and Safety Rules* requires the following:

- Locomotives operating in a controlling or lead position on trains in passenger service, travelling at speeds exceeding 105 km/h (65 mph), must be equipped or retrofitted with a horn capable of producing a high [10] and a low [11] level sound.
- This device is to be mounted on the roof near the centreline of the locomotive, not further than 1.5 m (5 feet) behind the rear of the cab.
- It must be positioned in the direction of travel, with no obstructions or exhaust outlets ahead of or beside the horn.
- It can be a single, 5-flute horn capable of producing 2 different sound levels or 2 separate horns for the low and high level sounds.

Locomotive VIA 6404 is a F40PH2D model locomotive built by General Motors in 1987. The original horn on this type of locomotive was a forward-facing 3-flute horn positioned mid-locomotive along its centreline and directly behind the exhaust outlet (see Photo 1). To comply with the *Railway Locomotive Inspection and Safety Rules*, VIA 6404 was recently retrofitted with a second, louder 5-flute emergency horn positioned over the cab (see Photo 2). The 3-flute horn is used during normal service operations, including whistling at crossings. The 5-flute horn is limited to emergency situations in order to reduce the train crew's exposure to high level sounds. *Canada Occupational Health and Safety Regulations* restrict the maximum sound level in the locomotive cab to 96.7 dB(A). No specific instructions are issued to operating crews outlining conditions where the use of the emergency horn is required.

The locomotive event recorder from train 601 indicates that the 3-flute horn was first activated about 1450 feet from the crossing. This horn was sounded for about 16 seconds and then stopped just prior to impact. The 5-flute emergency horn was not used during the approach to this crossing.

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10 A minimum sound level, intended for emergency use, of 110 dB(A), at any location on an arc of 30 m (100 feet) radius, and subtended forward of the locomotive by angles 45° to the left and to the right of the centreline of the track in the direction of travel. To achieve this sound level, the rules require the installation of a horn that generates a sound level of 143 dB(A) 1 m from the front of the horn.

11 A minimum sound level, intended for normal train operation, of 96 dB(A) at any location on an arc of 30 m (100 feet) radius, and subtended forward of the locomotive by angles 45° to the left and to the right of the centreline of the track in the direction of travel.

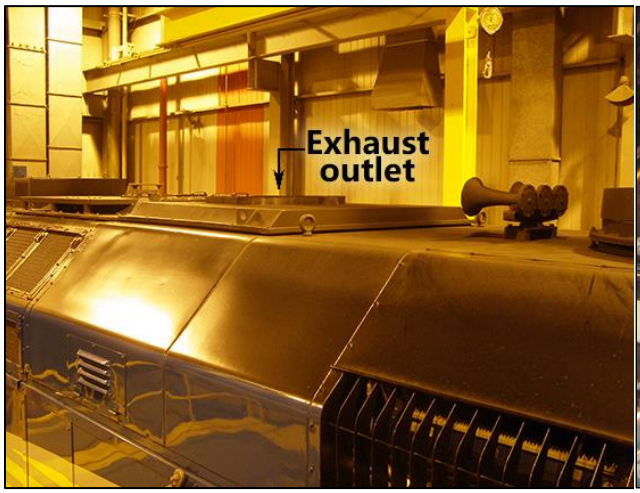

Photo 1. 3-flute horn on locomotive VIA 6404

Photo 2. Emergency horn on locomotive VIA 6404

Use of Incandescent Lights vs Light Emitting Diodes for Crossing Signal Lights

Light emitting diodes (LED) are becoming more prevalent in traffic control and signalization due to their lower power consumption, higher brightness and improved reliability. A 2003 Transport Canada study [12] indicates that LED signal modules provide a broader beam, offering a better opportunity to see the signal under fog conditions.

Under Transport Canada's Grade Crossing Improvement Program, the federal government provides 50% of the funds, to a maximum of $600 per light, to replace incandescent lights with LEDs. CN is engaged in this program and has retrofitted, with the wider 12-inch LED, almost half of its nearly 3000 signalized crossings. At the time of the accident, the crossing at rang de la Deuxième-Chaloupe had been approved for retrofitting, but had not yet been upgraded, as crossings on the core main line with higher rail traffic volumes and passenger train speeds in the 90 to 100 mph range were given higher priority.

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12 Carmanah Technologies Inc., prepared for the Transport Canada Transportation Development Centre, *LED Technology for Improved Conspicuity of Signal Lights at Highway-Railway Grade Crossings*, TP 14043, February 2003.

Analysis

The crossing signals were operating as intended and the train was operated in accordance with company and regulatory requirements. The analysis will focus on the visibility of the signal lights, driver behaviour, and the effectiveness of the train horn to alert vehicle drivers.

The Accident

The drivers of the struck vehicle and the vehicle preceding it were familiar with the road and the crossing. However, the density of the fog present in the vicinity of the crossing severely reduced the sightline distance available and prevented them from observing both the approaching train and the activated railway crossing signals prior to reaching the crossing.

The driver of the first vehicle was travelling below his routine speed for that section of the road but was still not able to stop in the sightline distance available. By the time he noticed the flashing signals, he was too close to stop safely before the crossing. Following the first vehicle over the crossing at a similar speed, the driver of the second vehicle continued on to the crossing and was struck by the train.

Crossing Warning Systems in Reduced Visibility Conditions

At crossings, visual and auditory warnings are normally used to alert vehicle drivers to the hazards associated with the crossing. However, during conditions of reduced visibility, visual warnings (for example, flashing light signals) are more difficult to see. Unless vehicle speed is adjusted based on weather and visibility conditions, vehicle drivers will have less time to react and take proper action. Moreover, drivers are less likely to slow at crossings that they are familiar with. When drivers travel too quickly for the weather conditions, the effectiveness of the visual warning system at crossings diminishes during periods of low visibility, increasing the risk of crossing collisions.

The replacement of incandescent signal lights with LEDs under the Transport Canada Grade Crossing Improvement Program is a positive step to improve the visibility of flashing lights. The railways have ongoing programs to change out the incandescent lights. However, with the large number of crossings to be retrofitted, it may take some time before all the identified crossings are completed. Had LED lights been in place at the rang de la Deuxième-Chaloupe crossing, the visibility of the crossing signal would have been improved.

Driver Behaviour during Adverse Weather or Visibility Conditions

Guidelines provided by the Quebec government instruct drivers to lower their speed when faced with adverse weather conditions such as dense fog. However, research shows that not all drivers reduce their speed enough to be safe for all eventualities. To increase a driver's warning time to approaching hazards, such as those at a crossing, driver training material advises drivers to be able to stop in the distance illuminated by the vehicle's headlights. Although drivers reduce speed somewhat during adverse weather or visibility conditions, typically the speed adjustment is not sufficient to be able to stop in the sightline distance available.

Train Horn

Train horns can have a positive impact on crossing safety. However, their effectiveness remains limited and many fatalities and injuries still result each year. A recent update to the *Railway Locomotive Inspection and Safety Rules* seeks to improve horn performance by requiring the horn to be placed near the head end of the locomotive. VIA's entire passenger locomotive fleet has been retrofitted with a louder emergency horn being installed near the head end of the locomotive and the normal service horn (that is, the 3-flute horn) remaining behind the exhaust outlet.

In this occurrence, the train horn (that is, the 3-flute horn situated mid-locomotive) was sounded from the whistle post (that is, about 1450 feet from the crossing) to close to the crossing. However, it was not effective in alerting the drivers of both the first vehicle and the following vehicle to the presence of the train. The driver of the first vehicle and the driver of the vehicle that was stopped on the west side of the crossing did not hear the horn until the train was very close to the crossing.

The emergency horn is generally used only for high risk or emergency situations (for example, when trespassers are walking along the track facing away from oncoming trains). However, during severe weather conditions such as dense fog or blowing snow, when visibility in the vicinity of the crossing is hindered, proactive use of the train's emergency horn could provide an effective warning to oncoming vehicles, reducing the risk of crossing collisions.

Findings

Findings as to Causes and Contributing Factors

1. The density of the fog in the vicinity of the crossing severely reduced the sightline distance available and reduced the opportunity for the driver to observe both the approaching train and the activated railway crossing signals prior to reaching the crossing.

2. Although the train horn located mid-locomotive was being sounded, it was not effective in alerting the drivers of both the first vehicle and the following vehicle to the presence of the train.

3. Following the first vehicle over the crossing, the driver of the second vehicle continued on to the crossing and was struck by the train.

Findings as to Risk

1. When vehicle drivers do not adapt their speed to severe weather conditions, the effectiveness of the visual warning system at crossings diminishes during periods of low visibility, increasing the risk of crossing collisions.

2. During severe weather conditions, when visibility in the vicinity of the crossing is hindered, proactive use of the train's emergency horn could provide an effective warning to oncoming vehicles, reducing the risk of crossing collisions.

Other Findings

1. The visibility of the crossing signal would have been improved with the installation of light emitting diodes (LED) lights.

2. Although drivers reduce speed somewhat during adverse weather or visibility conditions, typically the speed adjustment is not sufficient to be able to stop in the sightline distance available.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 18 December 2013. It was officially released on 15 January 2014.

Visit the Transportation Safety Board's website (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. You will also find the Watchlist, which identifies the transportation safety issues that pose the greatest risk to Canadians. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.