Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT R17H0015

Crossing collision

Canadian Pacific Railway
Freight train 142-12
Mile 121.36, Belleville Subdivision
Colborne, Ontario
13 February 2017

Canada

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Summary

On 13 February 2017, at about 0732 Eastern Standard Time, Canadian Pacific Railway freight train 142-12, travelling eastward on the Belleville Subdivision, struck a school bus that was immobilized at the Town Line Road public crossing at Mile 121.36 of the Belleville Subdivision, near Colborne, Ontario. The crossing was equipped with flashing lights and a bell. Prior to the collision, the school bus driver and 2 occupants exited the bus and were standing a safe distance away. The bus and the signal mast on the north side were destroyed. The locomotive sustained minor damage. There were no injuries.

Le présent rapport est également disponible en français.

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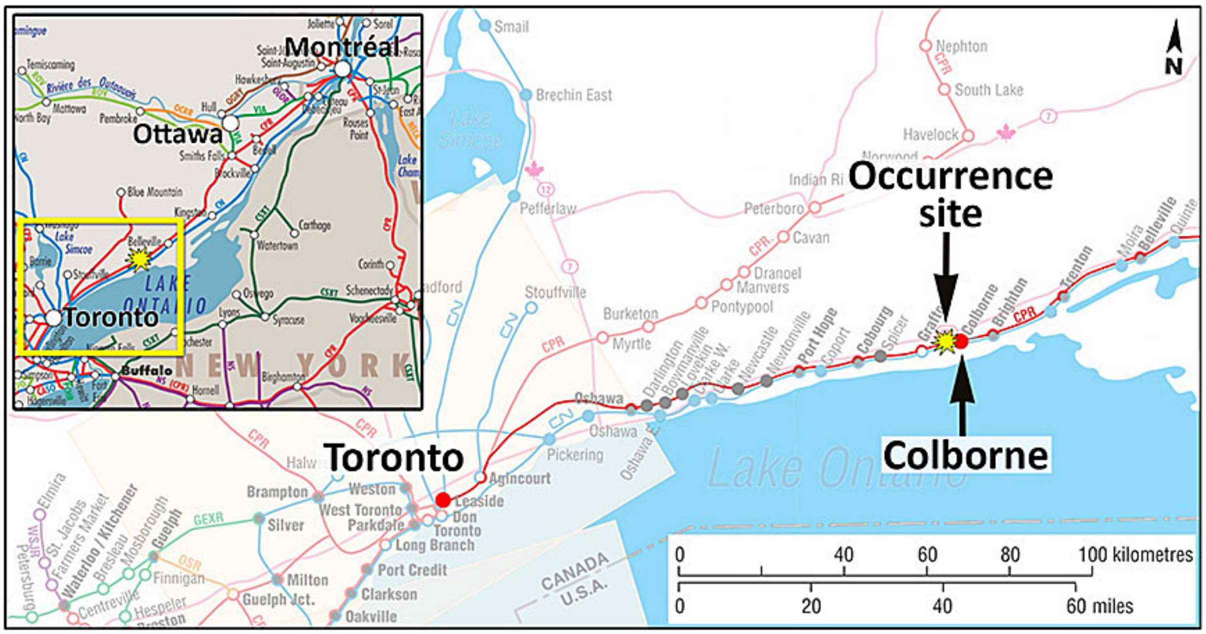
1.0 Factual information

1.1 The accident

On 13 February 2017 at about 0555,[1] Canadian Pacific Railway (CP) freight train No. 142-12 departed Toronto, Ontario, on the Belleville Subdivision and was destined for Montréal, Quebec (Figure 1). The train consisted of 2 head-end locomotives and 73 cars. It weighed 8520 tons and was 8486 feet in length. The train crew consisted of a locomotive engineer and a conductor.

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



At about 0731, as the train approached Colborne, travelling at 52 mph, the train crew saw a school bus that was stationary on the Town Line Road crossing at Mile 121.36, and the crew began sounding the horn.[2] When it became apparent to the crew that the bus was not exiting the crossing, the locomotive engineer initiated an emergency brake application. The train was not able to stop before the crossing and struck the bus. As a result of the collision, the bus and the signal mast on the north side were destroyed. The 3 occupants had exited the bus before the impact. The lead locomotive (CP 8768) sustained minor damage. There were no injuries, and there was no derailment.

Before reaching the crossing, the bus driver had picked up the first student along the route. In addition to the driver and the student, there was an adult assistant for students with

1 All times are Eastern Standard Time.

2 Rule 14(l) of the *Canadian Rail Operating Rules* requires the horn to be sounded ¼ mile in advance of the crossing.

special needs. The driver continued along the route and approached the crossing from the north.

At about 0728, the bus was at the crossing. The driver approached to within 15 feet of the nearest rail, stopped the bus, placed the gear shifter into neutral, applied the parking brake, opened the driver's-side window and the door, looked both ways, closed the windows and doors, and removed the parking brake. The driver then proceeded slowly onto the crossing. Upon entering the crossing, the driver slowed the bus in order to look both ways a second time. After verifying that there were no approaching trains, the driver attempted to accelerate forward, but was unable to do so.

The driver pressed on the accelerator, causing the back wheels to spin. The driver then placed the gear shifter alternately into reverse and forward while pressing on the accelerator, attempting to rock the bus backward and forward to regain motion. However, the back end of the bus slid sideways toward the edge of the road where the snow was deeper and the incline of the road was greater.

Upon realizing that the bus was immobilized on the crossing, the driver directed the occupants to exit the bus and move to a safe location. The driver then contacted the dispatcher at First Student Inc. (First Student) using the bus radio to report the emergency.

The dispatcher dropped all other (non-emergency) calls to focus on the crossing emergency. Being aware that there was more than one level crossing on Town Line Road, the dispatcher referred to a tracking software program to verify the location of the bus using global positioning system (GPS) coordinates.[3] The dispatcher then consulted a crossing reference document containing a list of all railway crossings encountered by First Student buses operating out of the Bowmanville office. This document contained the GPS coordinates of each crossing, the road name, the railway track owner, and the crossing's emergency contact information.

The dispatcher dialled the emergency contact number. While on the line with the railway, the dispatcher received a second radio call from the driver, who indicated that a train was approaching and that a collision with the immobilized bus was imminent. The dispatcher ended the call to the railway and immediately contacted emergency services (911).

1.2 Weather

As reported by the Government of Canada weather station in Trenton, Ontario (approximately 30 km away), on 12 February 2017, the day before the occurrence, the day began with a temperature of −11 °C, which gradually increased to −1 °C at midnight. Snow began to fall at 0800 and continued falling past midnight.

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3 First Student's bus tracking system uses a GPS transponder attached to each bus to update a software program in near-real time (approximately every few minutes).

Starting from about 0200 on 13 February 2017, the snow continued intermittently until 1000. At the time of the occurrence, the temperature was −3 °C.

1.3 Site examination

Following the collision, the bus came to rest off the roadway in the northeast quadrant of the crossing, about 26 m from the roadway (Figure 2). The bus sustained severe impact damage to its head end (cab) and its tail end (Figure 3, Figure 4). The passenger side of the cab was destroyed. The signal mast, positioned in the northwest quadrant of the crossing, was knocked over. Scrape marks were present on the surface of the roadway leading from the tracks toward the location of the bus.

Figure 2. Site diagram

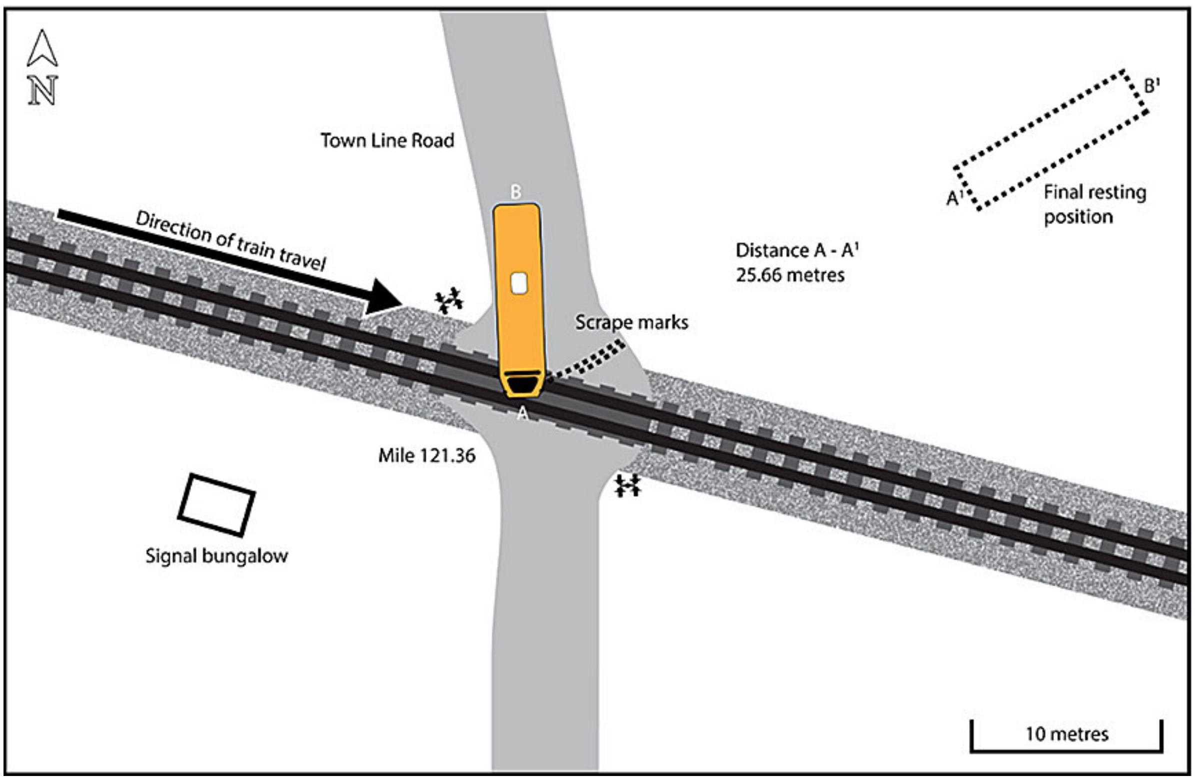


Figure 3. Front passenger side of the damaged school bus

Figure 4. Tail end of the damaged school bus

1.4 Subdivision information

The Belleville Subdivision consists of a single main track that extends between Mile 0.0 (Smiths Falls) and Mile 211.5 (Toronto). Train movements on this subdivision are governed by the centralized traffic control method of train control, as authorized by the *Canadian Rail Operating Rules*, and are supervised by a rail traffic controller located in Calgary, Alberta. Train traffic consists of 8 freight trains per day.

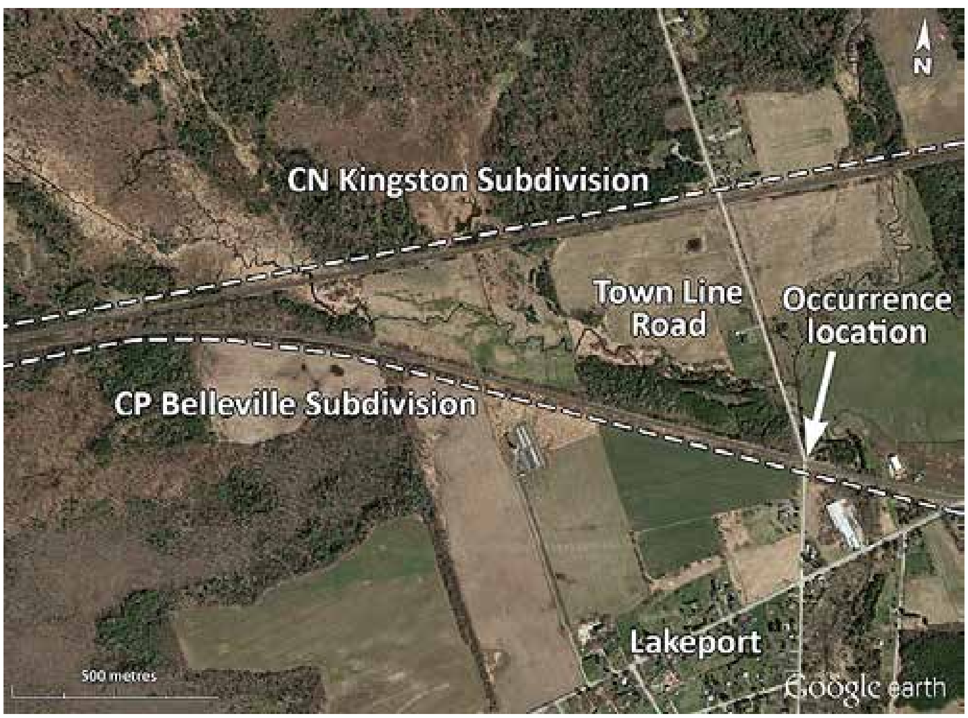
In the vicinity of the crossing, the Belleville Subdivision is tangent and oriented in the east-west direction (Figure 5). The tangent track extends to the west for about 3000 feet, before it curves to the south. The timetable speed for freight trains was 50 mph. At the time of the occurrence, there were no temporary slow orders in the immediate area.

1.5 Crossing information

In addition to the standard railway crossing sign at each approach, the crossing was protected with flashing lights and a bell. This crossing met the applicable regulatory requirements.[4]

The signal mast on each side of the crossing and the back of the railway crossing signs, had a sticker identifying the crossing as a CP crossing. The sticker also listed CP's 24-hour emergency telephone number[5] and its crossing identification number. Both the First Student dispatcher and the driver were aware of this information.

Figure 5. Occurrence location (Source: Google Earth, with TSB annotations)



1.6 Town Line Road information

Town Line Road is an asphalt-paved road oriented in the north-south direction. The posted speed limit was 50 km/h. Two tracks intersect the road about 600 m apart: the Canadian National Railway Company (CN) Kingston Subdivision to the north and the CP Belleville

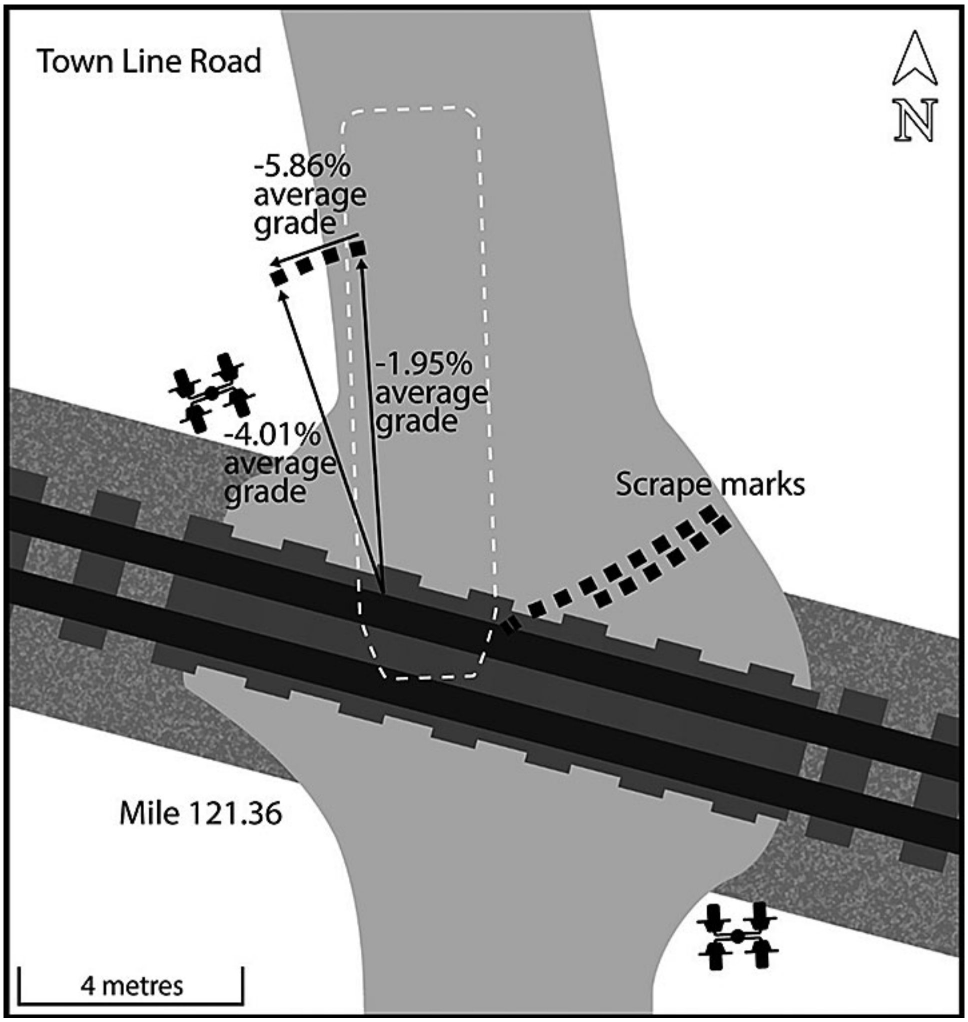
4 Transport Canada, SOR/2014-275, *Grade Crossings Regulations* (November 2014).

5 The emergency telephone number posted at crossings provides direct access to CP Police, who can then inform the appropriate rail traffic control office.

Subdivision. The road intersects the Belleville Subdivision at 69° from the north and 75° from the south.

Travelling south toward the crossing, the road ascends at a grade of 5.68% until about 8 m (26.2 feet) from the nearest rail, where it levels to an average grade of 1.66%. At 6.1 m (19.9 feet) from the nearest rail (approximately where the rear tires of the stationary bus were situated), the grade of the road was 1.95% (Figure 6). At this location, the perpendicular incline of the road (i.e., toward the west shoulder) was 5.86%, resulting in an effective grade of the roadway near the shoulder of 4.01%.

Figure 6. Roadway grade at the north approach of the crossing



1.7 Grade Crossings Regulations *and* Grade Crossings Standards

The Transport Canada (TC) *Grade Crossings Regulations* (November 2014) do not include a maximum grade for road approaches to railway crossings that existed on the date that the regulations came into force. For new crossings, the regulations reference section 6 of the *Grade Crossings Standards* (July 2014), which states:

> The maximum gradients for road approaches must not exceed the following:
>
> (a) ratio of 1:50 (2 per cent) within 8 m of the nearest rail and 1:20 (5 per cent) for 10 m beyond, at public grade crossings for vehicular use;[6]

Before the 2014 regulations and standards came into force, a draft technical document entitled "Road/Railway Grade Crossings: Technical Standards and Inspection, Testing and Maintenance Requirements" (RTD 10) had been issued in 2002. Although not enforceable, RTD 10 set out the minimum safety criteria for the construction, alteration, maintenance, inspection and testing of grade crossings, and of their road approaches. RTD 10, which was widely distributed, provided guidance to TC, the rail industry, and road authorities.

Subsection 7.2 of RTD 10 states:

> Subject to the conditions in subsection 7.1 and except to provide for vehicular grade crossings of super-elevated track as required in subsection 7.4, the maximum gradients for roads at a grade crossing shall not exceed the following:
>
> (a) ratio of 1:50 (2 per cent) within 8 m of the nearest rail and 1:20 (5 per cent) for 10 m beyond, at unrestricted grade crossings for vehicular use […][7]

1.8 Recorded information

The following was determined on the basis of the GPS records for the bus:

- At 0726:01, the bus stopped at a home north of the CN tracks on Town Line Road.
- At 0726:18, the bus began its journey southward toward the CN crossing.
- At 0727:09, the bus stopped north of the tracks at the CN crossing.
- At 0727:16, the bus began its journey toward the CP crossing.
- At 0728:02, the bus stopped north of the tracks at the CP crossing.

The following was determined from the review of the information from the locomotive event recorder of locomotive CP 8768:

- At 0731:23, the locomotive bell was activated.
- From 0731:23 to 0731:50, while travelling about 2060 feet, the locomotive horn was sounded intermittently.

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6 Transport Canada, *Grade Crossings Standards* (July 2014), subsection 6.3.

7 Transport Canada, Draft Technical Document RTD10, "Road/Railway Grade Crossings: Technical Standards and Inspection, Testing and Maintenance Requirements".

- At 0731:49, the emergency brake was applied.[8]
- At 0731:50,[9] the train struck the bus.

A review of the download from the signal bungalow revealed that the signals functioned as intended and that they had been activated 33 seconds before the train entered the crossing.

1.9 *Snow-clearing activities in the vicinity of the crossing*

The Township of Alnwick Haldimand (the Township) is responsible for the maintenance of Town Line Road, including snow-clearing activities. The snow had last been cleared from the crossing at about 1445 on 12 February 2017. During snow clearing, the plow had spread a mixture of sand and salt. This mixture was applied up to about 10 feet (3.01 m) to 15 feet (4.57 m) from the nearest rail of the crossing.

Snow-clearing guidance from Operation Lifesaver[10] ("Tips for Snow Plow Operators") indicates that sand should not be applied within 3.0 m (9.8 feet) of a crossing to prevent sand from being carried onto the crossing where it can build up and pose a derailment risk. The guidance also indicates that salt and chemicals should not be placed on or near a highway-railway crossing as it could result in the activation of railway signals or the malfunction of train signals.[11]

From the last snow-clearing activity on 12 February 2017 to the time of the occurrence, about 3 cm of snow had accumulated in the vicinity of the crossing. At the time of the occurrence, snow plows had already been deployed by the Township to clear the roads. A snow plow arrived at the crossing shortly after the collision.

Ontario Regulation 239/02, *Minimum Maintenance Standards for Municipal Highways*,[12] sets out the minimum standards for repair for highways under municipal jurisdiction. For the

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8 Train crews are generally accustomed to encountering vehicles that are momentarily stopped at crossings. It is not uncommon for vehicles to remain on the track at crossings until the last possible moment. Because trains have the right-of-way and cannot stop quickly, crew members generally expect that vehicles will comply with the audible warning from the train and the activated grade crossing warning signal.

9 The time of the impact is estimated, because the lead locomotive was not equipped with a forward-facing video recorder.

10 Operation Lifesaver is a partnership initiative of the Railway Association of Canada and Transport Canada and works in cooperation with the rail industry, government, police, unions, and many public organizations and community groups. This initiative is dedicated to saving lives by educating Canadians about the hazards surrounding rail property and trains.

11 Operation Lifesaver, "Tips for Snow Plow Operators," at https://www.operationlifesaver.ca/wp-content/uploads/2012/01/tips-snow-plow.pdf (last accessed on 10 January 2018).

12 Pursuant to Ontario's *Municipal Act, 2001* (S.O., 2001).

purposes of the regulation, Town Line Road is considered a Class 4 highway. The regulation states:

> 4. (1) The minimum standard for addressing snow accumulation is,
>
> (a) after becoming aware of the fact that the snow accumulation on a roadway is greater than the depth set out in the Table to this section, to deploy resources as soon as practicable to address the snow accumulation; and
>
> (b) after the snow accumulation has ended, to address the snow accumulation so as to reduce the snow to a depth less than or equal to the depth set out in the Table within the time set out in the Table […]

The Table within the regulation indicates that, for Class 4 highways, the depth of allowable snow accumulation is 8 cm and the maximum time in which to remove any excess snow is 16 hours.

To ensure that the roads are properly maintained with respect to snow accumulation, the Township monitors Environment Canada's weather forecasts and regularly patrols the roads. The Township normally sends out snow-clearing equipment before the allowable snow accumulation and/or before the maximum time to remove the snow.

1.10 School bus operations in poor weather conditions

During poor weather conditions, the decision to operate the school buses is typically made early in the morning by the Kawartha Pine Ridge District School Board in consultation with the school bus operators. Many factors are considered, including the weather forecast for the rest of the day and the likelihood of icy conditions. Decisions are made on a case-by-case basis. There are no requirements or standards relating to snow accumulation that require school buses to be taken off the road during heavy snowfall.

When a school bus route is cancelled, a notice is posted on an external website hosted by the Student Transportation Services of Central Ontario. These notices are typically posted before 0600, for the drivers to consult. In addition, First Student will broadcast any bus route cancellations directly to the drivers through the company radios.

If drivers feel that the driving conditions on a particular route are unsafe, they contact the dispatcher to report their concerns. In these situations, an alternate route could be considered, or the driver could wait for a snow plow or sander to complete the necessary snow-clearing activities.

On the morning of 13 February 2017, snow was observed on the ground, although no icy conditions were noted. No cancellations were posted on the external website before bus service began. During the day, there were a few reports from First Student drivers regarding the snow. The majority of the drivers did not report any unsafe road conditions. The occurrence driver also judged the road conditions to be safe.

1.11 School bus information

The bus, which was owned and operated by First Student, was an International PB10500 yellow school bus manufactured by American Transportation Corporation in 2008. The bus had a capacity of 70 people and weighed 13 517 kg (29 800 pounds).

At First Student, buses underwent 4 annual preventative maintenance inspections. During the inspections, any required repairs were completed and the tire air pressure was monitored. The occurrence bus was last inspected on 24 January 2017. The inspection included an evaluation of the mechanical components, the interior and exterior functions, the fluids, the engine compartment, the under-vehicle parts, and the tires. At the time of the occurrence, the bus had no known mechanical defects.

The bus was equipped with a single wheel axle in the front and a dual wheel axle in the rear. The front tires were Bridgestone R268 Ecopia, an all-position/steer radial tire designed for long tread life and fuel efficiency. The rear axle was the drive axle. Of the 4 rear tires, 1 was a Bridgestone M850 tire with "M+S" markings on the sidewall,[13] 2 were M711 tires with "M+S" markings on the sidewall, and 1 had an unidentified casing. All 4 rear tires had the BDR-AS retread. Each rear tire had at least 6.5 mm of tread wear remaining. In Ontario, provincial regulations[14] and commercial vehicle maintenance standards[15] require front tires to be removed from service when the tread depth is less than 3 mm. Rear tires must be removed from service when the tread depth is less than 2 mm.

The tire manufacturer[16] considers the BDR-AS tread design to be suitable for winter driving. Two other tread designs (W919 and BDR-W) with the same snow and ice traction ratings as the BDR-AS were deemed suitable for extreme snow conditions.

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13 The "M + S" marking refers to mud and snow. Transport Canada has indicated that all-season tires may not always be suitable for severe snow conditions.

14 Ontario's *Highway Traffic Act*, Regulation 611 – Safety Inspections.

15 Canadian Council of Motor Transport Administrators, *National Safety Code Standard 11: Maintenance and Periodic Inspection Standards*, Section 9 - Tires and Wheels.

16 The tire performance ratings were developed by Bridgestone for its tires based on standard test parameters for winter conditions such as snow depth, compactness, and temperature. In addition, other factors are taken into consideration when rating tires, such as design features as they relate to tread compound, tread depth, and tread pattern characteristics. The suitability of a tire will also depend on vehicle characteristics, environment, and service conditions.

1.12 Winter tire standards

The Tire and Rubber Association of Canada's *2016 Winter Tire Report* reviewed winter tire usage in Canada for passenger vehicles and light trucks.[17] This report did not address trucks and buses. The report stated the following:

> Winter tires provide superior traction and braking on all road surfaces. The superior grip of today's high-tech winter tires is the result of more flexible rubber compounds that provide superior traction even at extremely cold temperatures.[18]

The report further states that winter tires for passenger vehicles and light trucks outperform all-season tires and conventional summer tires when the temperature is below 7 °C. A winter tire is identified by the 3-peak mountain snowflake pictograph on its sidewall, indicating that the tire has met or surpassed minimum industry standards for snow traction performance. The snow traction test assesses the performance of tires in a winter environment on snow- and ice-covered surfaces. While the 3-peak mountain snowflake pictograph is widely used to indicate winter tires for passenger and light trucks, this pictograph had only been recently introduced for tires in the truck and bus market, and its use was not common.[19] There are no regulations in Canada requiring winter tires for trucks and buses to be identified using the 3-peak mountain snowflake pictograph.[20]

There are no federal requirements relating to the use of winter tires; this matter is within provincial jurisdiction.

The requirements relating to winter tire use for various provinces in Canada are as follows:

- The Province of Quebec requires passenger vehicles and taxis to be equipped with tires specifically designed for winter driving conditions between 15 December and 15 March.[21] Quebec's *Regulation respecting the use of tires specifically designed for winter driving* indicates that tires specifically designed for winter driving are those that have the 3-peak mountain and snowflake pictograph on them.
- The Province of British Columbia does not specifically require school buses to be equipped with winter tires. However, Section 208 of the British Columbia *Motor Vehicle Act* provides for the prohibition of "any vehicle or a class of vehicles from

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17 The U.S. Tire Manufacturers Association considers vehicles whose recommended tires have "LT" in their size designation as a light truck.

18 Tire and Rubber Association of Canada, *2016 Winter Tire Report*, at http://www.tracanada.ca/files/TRAC_winter_tire_report_2016-compressed2.pdf (last accessed on 11 January 2018).

19 In October 2017, the U.S. Tire and Rubber Manufacturers Association updated a bulletin (originally released in the 1st quarter of 2017) introducing the 3-peak mountain snowflake pictograph and an associated traction standard for truck and bus winter tires. Shortly after the update was released, the Tire and Rubber Association of Canada endorsed this bulletin.

20 Canada is participating as part of an initiative at the United Nations regarding the development of technical testing requirements for winter tires, including those for heavy-duty vehicles.

21 Quebec's *Highway Safety Code*, item 440.1.

being driven or operated on a highway, unless the vehicle is equipped with chains, winter tires or traction devices, or a combination of these" by public notice or the placing of signs. British Columbia's *Motor Vehicle Act Regulations* require that winter tires be labelled with the 3-peak mountain and snowflake pictograph or be labelled on the sidewall with the "M + S" marking.[22]

- The Province of New Brunswick's *Motor Vehicle Act* has no specific requirements for the use of winter tires on motor vehicles during winter months. However, New Brunswick's Department of Education, in its Policy 513,[23] lays out requirements for the use of winter tires on buses designed for carrying 10 or more passengers (excluding 15-passenger vans). Section 6.8 of Policy 513 indicates that buses must be "equipped with winter tires between November 1 and April 30." Section 3.0 of Policy 513 defines a winter tire as

> a tire that meets the Transport Canada winter snow tire designation, with the inscribed peaked mountain with a snowflake pictograph on the tire sidewall, for passenger vehicles, SUVs and light trucks. For buses, winter tire means a combination of tires that are specifically designed for winter driving conditions (i.e., ribbed front tires and traction tires on the rear).[24]

School bus operators use their best judgment along with tire recommendations from the tire manufacturer when choosing which tires to install. In Canada, there are no regulatory requirements for the use of tires specifically designed for winter driving conditions on school buses during the winter months.

At First Student's Bowmanville office, the majority of the school buses used Bridgestone tires. This tire manufacturer had been selected following a competitive bid process. To help bus and truck companies select tires for particular driving conditions, Bridgestone provides a general guideline that rates tread performance for retread applications based on its internal testing of 5 different criteria (tread wear, wet traction, snow traction, ice traction, and rolling resistance) (Appendix A). In addition, engineering judgment and field performance feedback is considered. Bridgestone uses the data to validate design expectations and for comparative purposes. There is no regulatory or industry standard to evaluate the test results.

In addition to tire performance, there are other factors to consider when selecting a bus/truck tire for use in winter conditions, including vehicle characteristics, environmental differences, and service conditions. Bus/truck tire users will typically evaluate different tire products in direct consultation with the manufacturer or dealer to decide on the best solution. Selecting an appropriate bus/truck tire for use in winter conditions is more

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22 Government of British Columbia, B.C. Reg. 26/58, *Motor Vehicle Act Regulations* (last amended 30 June 2017), subsection 7.162(3).

23 Government of New Brunswick, Department of Education, "Transportation to and from Off-Site School-Related Extra-Curricular Activities," (27 February 2009).

24 Ibid.

complex than choosing an appropriate winter tire for a passenger car due to the wider range of uses and service conditions.

1.13 First Student Inc.

First Student is a North American company that transports students to and from schools. The company has about 57 000 employees and transports about 6 million students per day.

In Canada, First Student operates 7433 buses and has 68 locations across Ontario, Quebec, Manitoba, Saskatchewan, Alberta, British Columbia, and the Northwest Territories. In Ontario, the company operates 4746 buses.

The school board hired First Student to provide school bus service in the Colborne area, which includes the occurrence route. This service was provided from First Student's Bowmanville office, which operated 179 buses over 148 school bus routes.

All routes were determined by the school board and reviewed by First Student. If a driver felt that any portion of a route was unsafe, the school board could be asked to reconsider the route.

The particular route travelled by the occurrence driver had been in use for about 15 years; the bus travelled over the railway crossing at Town Line Road twice per day, once in each direction. This was the only First Student route that included this crossing.

1.14 Qualification, training, and ongoing assessment of school bus drivers

1.14.1 Qualification of school bus drivers

In the Province of Ontario, the Ministry of Transportation (MTO) requires school bus drivers to hold a B class licence or an E class licence. To apply for these licences, applicants must

- be 21 years of age or older;
- pass medical and vision examinations;
- successfully complete a government-approved School Bus Driver Improvement Course;
- pass a criminal record check;
- have fewer than 6 demerit points on their driving record;
- pass a knowledge test; and
- pass a road test.

Medical examinations are required by the MTO every 5 years for school bus drivers up to 45 years old, every 3 years between 45 and 65 years old, and every year over the age of 65.

First Student's School Bus Driver Improvement Course had been approved by the MTO, and company trainers had been certified to issue B class or E class licences.

1.14.2 *Training of school bus drivers*

The New Driver Training Program at First Student consisted of 20 hours of in-class training and 20 hours of on-the-road training. Included in the training material was information on railway crossing procedures and school bus emergency procedures. The module for railway crossing procedures included steps to be taken when crossing a railway track (Appendix B). This is a partial list of those instructions:

1. **Prepare to stop […]**
2. **Quiet the Bus […]**
3. **Stop the Bus**
   - Stop no closer than 15 feet or farther than 50 feet from the nearest rail [First Student recommends 20 feet from the nearest rail]
   - Set the parking brake, shift transmission to neutral (or park if so equipped)
   - Open the service (passenger) door and driver's window
   - Look and listen—left and right—for an approaching train
   - Obtain visual confirmation the track is clear before proceeding
4. **Double check**
   - Look and listen again— it's worth a second look […]
5. **Go—Cross the Tracks**
   - Close the service door
   - Place transmission in drive or in a gear that will not cause the need to change gears during the crossing
   - Release the parking brake
   - Proceed without hesitation […][25]

The training material in the School Bus Emergency section of the New Driver Training Program indicated that, should a school bus become stalled while occupying a crossing, it was to be evacuated immediately. In addition, the procedures at First Student required the school bus driver to contact the dispatcher immediately in the event of an emergency. School bus safety drills were conducted twice annually with the students who ride the buses and included bus evacuation exercises.

School bus drivers at First Student must also undergo ongoing requalification/recertification training. Each year, a driver's abstract[26] was provided to the company for review. Refresher

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25 First Student Inc., *New Driver Training Program Candidate Workbook*, Section 6: Railroad Crossing Procedures, p. 60.

26 In addition to personal identifying information about the driver, the abstract lists demerit points accumulated to date as well as any convictions, discharges, and other action taken against the driver.

workshops were conducted each September (the beginning of the new school year). The training material for the annual September refresher workshop also highlighted railway crossings and included guidance indicating that the traversing of the crossing should be done quickly.

1.14.3 Ongoing assessment of school bus drivers

First Student evaluated the knowledge and competency of each school bus driver at least once a year. This evaluation was conducted with the evaluator riding along with the driver as the route was being serviced. Any deficiencies noted by the evaluator would be communicated to the driver and could result in additional evaluations.

At First Student, the evaluator used a 123-point checklist that was divided into 13 categories. One of the categories was entitled "Railroad Crossings" and contained 8 items to be evaluated:

- Uses reference points
- Uses 4-way flashers
- Master switch on/off
- Silences noises (fans, etc.)
- Quiets passengers
- Secures vehicles (brake/neutral)
- Opens window/door
- Looks/listens

Each item was evaluated using a performance code ("Satisfactory", "Needs Improvement," or "Unsatisfactory"). If an item was not evaluated, a "Not Applicable" performance code was used. The evaluation form included a section for comments by the evaluator.

1.15 School bus driver information

The driver had driven school buses for First Student since December 1998 and had been driving the occurrence route for the past 15 years. He had undertaken all required driver training and had most recently passed the MTO medical assessment in June 2016.

The driver's skills and knowledge had been assessed regularly by First Student. Over the previous five years, the driver had been assessed by an evaluator 4 times (April 2012, March 2013, January 2015, and December 2015). For these evaluations, the driver received a Satisfactory performance code for each item evaluated.

It was the practice of the driver to travel slowly over crossings. Once on the tracks, the driver would reduce speed and look both ways again along the right-of-way. Railway crossings items were evaluated during the 4 evaluations. There were no evaluator comments on the checklist relating to crossings. For example, there were no comments relating to the speed for travelling over a crossing.

1.16 Transport Canada standards for school buses

Transport Canada's *Motor Vehicle Safety Regulations* specify the requirements respecting safety for motor vehicles and motor vehicle components.[27] Pursuant to the Regulations, the *Canada Motor Vehicle Safety Standards* (CMVSS) identify the prescribed tests required for the certification of various categories of vehicles. These requirements vary according to the weight category of vehicle.

For school buses with a gross vehicle weight greater than 4536 kg (10 000 pounds), these are the applicable requirements:

- CMVSS Standard 203 – Driver Impact Protection and Steering Control System
- CMVSS Standard 208 - Occupant Protection in Frontal Impact
- CMVSS Standard 209 - Seat Belt Assemblies
- CMVSS Standard 210 - Seat Belt Anchorages
- CMVSS Standard 216 – Roof Crush Resistance
- CMVSS Standard 220 – Rollover Protection
- CMVSS Standard 221 – School Bus Body Joint Strength
- CMVSS Standard 222 – School Bus Passenger Seating and Crash Protection

1.17 Crashworthiness of a vehicle

Crashworthiness of a vehicle refers to the design characteristics that protect the occupants from injury or death during a crash event.[28] The fundamental principles of crashworthiness are often described using the acronym CREEP:

- Container
- Restraints
- Energy management
- Environment
- Post-crash factors

1.17.1 Container

The container is the portion of the vehicle where the driver and passengers are located. It is the most critical factor for crashworthiness, since a strong, enclosed container must be maintained around the occupants in order to create a survivable space. Failure of the container would generally result in a reduction of livable space due to crushing. It can also

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27 Transport Canada, *Motor Vehicle Safety Regulations* (C.R.C., c.1038), January 2015, Schedule IV, Part III (http://www.tc.gc.ca/eng/acts-regulations/regulations-crc-c1038.htm, last accessed 03 September 2017).

28 D. F. Shanahan, "Basic Principles of Crashworthiness," Research and Technology Organization, Human Factors and Medicine, lecture series on Pathological Aspects and Associated Biodynamics in Aircraft Accident Investigation, Königsbrück, Germany, 2-3 November 2004, published in RTO-EN-HFM-113.

result in the loss of a protective shell for the occupants and/or of supporting structure for the restraint system.

1.17.2 Restraints

The restraint system consists of the seat belt, the seat structure, and their anchorages. This system is used to prevent occupants and objects from striking each other within the vehicle. Failure of any part of the restraint system can result in injury.

1.17.3 Energy management

Energy management refers to impact energy absorption and is typically achieved through plastic deformation of the structural components before their ultimate failure during an impact.

1.17.4 Environment

Environment refers to the space that any portion of an occupant's body may occupy during dynamic crash conditions. Any object within that space may be considered an injury hazard. The crashworthiness requirement is to recognize the items of such potential hazard in the design phase and place them outside the striking zone of an occupant.

1.17.5 Post-crash factors

Post-crash factors refer to fire, fumes, fuel, oil, and water to which the occupants may be exposed after an accident. Crashworthiness requirement in this regard is to control or eliminate the hazard at source and to provide rapid egress channels for the occupants (e.g., an emergency exit door or window).

1.18 Laboratory examination of school bus

1.18.1 Damage to school bus

The detailed examination of the damaged bus, made it possible to determine the following:

- Impact damage to the bus was present on the front-right side, forward of the trailing edge of the main entrance/exit door.
- The maximum crushing depths (in lateral direction) in the front of the bus and at the rear were 25 inches and 32 inches respectively.
- The front-right side of the bus was struck by the locomotive, destroying the main entrance/exit door and the structures of the step well of the bus. The driver's seat was still in its original position. No damage was found to the driver's seat floor anchorage, seat frame, seat pan and backrest. The floor beneath the driver's seat was not damaged. No damage to components of the seat belt (the webbing, tongue, and buckle) was found. The steering column was not damaged, and there were no indications of rearward displacement toward the driver. The main longitudinal beam of the bus chassis was not bent or deformed.

- The wall of the bus at its rear-right corner was dented inward about 32 inches. The damage was consistent with the bus coming into contact with the train and being jettisoned across the road in an eastward direction and coming to rest northeast of the intersections.
- The corner pillar and 2 pillars of the right-side body panels and the rear door hinge frame of the bus were bent and their respective bolt joints with the floor frame of the bus had broken. The joint between those body panels and the frame of the rear exit door did not separate.
- The damage had caused a partial reduction of the livable space of the container of the bus and resulted in the last two rows of seats on the right-hand side being dislocated and compressed. The structures of these two seats were damaged.
- The front-left wheel of the bus was torn off from the wheel hub, likely due to the swinging of the bus during impact. The connection between the drive axle and the left-side suspension also failed.
- There was longitudinal displacement between the last 2 rows of seats on the right-hand side. The seat benches of the 3rd to 6th rows of seats on the left-hand side of the bus were displaced between 2 inches and 6 inches in a lateral direction toward the inboard side.
- The bus was equipped with 2 emergency windows on each side. All 4 windows were clearly marked. No post-crash factors were noted that would have affected the egress of any occupants.

1.18.2 Crashworthiness of the school bus

The following observations were made with respect to the crashworthiness of the bus:

- The CMVSS contain specific requirements for a school bus relating to occupant protection. The applicable requirements in this occurrence are the driver's seat belt and its anchorages, school bus body joint strength, school bus passenger seating, and crash protection. No abnormalities with respect to the applicable CMVSS requirements were found.
- The impact damage to the front-right side of the bus was limited to the front wheel, the engine hood, the main entrance door, and the step well. The livable space for the driver and the floor beneath the driver's seat were not damaged, nor was the livable space for the passenger area right behind the main entrance door and in the middle of the bus.
- A secondary impact on the rear-right corner of the bus had caused a reduction of the livable space for the passenger area at the last 2 rows of seats on the right-hand side.
- Due to the speed of the train at the time of the impact (52 mph), the impact force likely exceeded the allowable threshold for body panel joints detailed in Section 221 of the CMVSS, so that the joint failure between body panels and the floor at the rear-right corner of the bus was unavoidable.
- Except for the last 2 rows of passenger seats on the right-hand side of the bus, the anchorages of all the seats with the floor, including the driver's seat, were intact, as were the joints between the components of those seats. Because all occupants of the

bus had evacuated the bus before impact, no acceleration load was transmitted to the seat structure. Therefore, it could not be determined what the performance of the seat anchorage to the floor, and the strength of the seat structure, would have been if there had been occupants on the bus.

- The compartmentalization design for crash protection met the requirements of CMVSS 222, which defines the head protection zone between 2 rows of seats.
- The lateral displacement of several seat benches during the occurrence, likely by the initial impact, could be a safety risk, because it would have resulted in passengers being displaced out of this protection zone, thus reducing the crash protection afforded by the compartmentalized design.
- Despite the initial and secondary impacts and the bus being displaced more than 25.66 m (84 feet), the damage to the bus structure was relatively limited. The 2 longitudinal beams of the bus chassis were not deformed. The relatively limited structural damage during this high-energy impact event indicates that the impact energy was properly absorbed by the structure of the bus.

1.19 Stopping at crossings protected with automated warning devices

The Ontario *Highway Traffic Act* (OHTA) in effect at the time of the occurrence stated that the driver of school buses and other public vehicles,

> upon approaching on a highway a railway crossing, whether or not it is protected by gates or railway crossing signal lights, unless otherwise directed by a flagman, shall,
>
> (a) stop the school bus not less than 5 metres [16.4 feet] from the nearest rail of the railway;
>
> (b) look in both directions along the railway track;
>
> (c) open a door of the school bus and listen to determine if any train is approaching; and
>
> (d) when it is safe to do so, cross the railway track in a gear that will not need to be changed while crossing the track; and
>
> (e) not change gears while crossing the railway track.[29]
>
> 1997, c. 12, s. 13.

In 1985, the United States Federal Highway Administration (FHWA) conducted research looking at the value of requiring certain types of vehicles (not just buses) to stop at railway crossings protected with grade crossing warning devices (GCWDs) when the GCWDs are not activated.[30] The FHWA study indicated that not mandating stops at railway crossings protected with GCWDs when the GCWDs were not activated would result in a net annual

[29] Government of Ontario, *Highway Traffic Act* (R.S.O. 1990, c. H.8), subsection 174(2). Paragraph 174(2)(e) was in effect at the time of the occurrence but was repealed in March 2017.

[30] United States Department of Transportation, Federal Highway Administration, FHWA/RD-86/014, *Consequences of Mandatory Stops at Railroad–highway Crossings* (December 1985).

decrease in train-involved accidents for hazardous material transporters, school buses, and passenger buses of 2.6%, 10.8%, and 17.4%, respectively. This net decrease would occur even though there would be a slight increase in accidents where a train was struck by a vehicle or where the GCWD did not operate.

Following a bus-train collision in September 2013,[31] MMM Group Limited (MMM) produced a study[32] of OC Transpo's operational procedures for traversing at-grade (level) railway crossings and other procedures used throughout Canada and the United States. The study included a literature review of research specific to the risks associated with vehicles stopping at railway crossings protected with GCWDs when the GCWDs were not activated. The study identified that the available technical information was limited and focused mainly on school buses and hazardous load transporters.

The MMM study outlined some of the advantages and disadvantages of requiring buses to stop at railway crossings protected with GCWDs when the GCWDs are not activated, including these:

Advantages

- Such a policy may provide a secondary check that the grade crossing is clear.
- The driver's decision process is simplified as the same procedure would apply to all crossings.

Disadvantages

- Increased motor vehicle-motor vehicle grade crossing collisions due to an increase in traffic conflicts between stopped, slow moving buses and higher-speed general traffic.
- Buses and their passengers would be subjected to a higher risk of train-bus collision as buses crossing railway tracks from a stop require more time to clear the grade crossing than vehicles moving through without stopping.
- Increased driver workload for the bus operator, which is typically associated with a greater potential for driver error.
- There would be negative impacts on traffic operations and the overall capacity and level of service offered by the roadway in the vicinity of the crossing. This is due to the increased traffic turbulence generated by the braking, avoidance, and lane-changing actions of other traffic responding to the presence of a decelerating, stopping bus when such action is not required.

The MMM study concluded that the OC Transpo policy of not stopping at railway crossings protected with GCWDs when the GCWDs are not activated is acceptable.

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31 TSB Railway Investigation Report R13T0192.

32 MMM Group Limited, *Buses at Highway/Railway At-Grade Crossings, An assessment of risk associated with alternative bus crossing policies for at-grade highway/railway crossings*, prepared for the City of Ottawa, 07 April 2014.

1.20 Other similar occurrences

1.20.1 TSB Railway Investigation Report R08T0158 (Mallorytown, Ontario)

On 15 July 2008, at approximately 1525 Eastern Daylight Time, VIA Rail Canada Inc. passenger train No. 60, travelling eastward on the north main track of the Canadian National Kingston Subdivision, struck a loaded tractor-trailer immobilized at the public crossing at Quabbin Road, Mallorytown, Ontario, and derailed. The operating locomotive engineer and 4 train passengers received minor injuries. The truck driver had exited the tractor before impact and escaped unharmed.

When the tractor-trailer became stuck on the crossing, the truck driver was focused on efforts to free it. The investigation determined that

- although the truck had been on the crossing for about 7 minutes, the urgency of alerting railway authorities and stopping approaching trains was not recognized; and
- training of truck drivers is insufficient to ensure drivers will alert railway authorities in the event their vehicle becomes immobilized on a railway crossing.

1.20.2 TSB Railway Investigation Report R13W0083 (Carlyle, Saskatchewan)

On 26 March 2013, at about 1515 Central Standard Time, CN freight train L50041-26 was proceeding eastward at 25 mph (40.2 km/h) on the Lampman Subdivision in Carlyle, Saskatchewan, when it struck a southbound school bus transporting 7 elementary school children at the 4th Street East crossing. One passenger suffered minor injuries. The front end of the bus was damaged.

The roadway consisted of a 2-lane, asphalt-paved residential street with a posted speed limit of 40 km/h. At the crossing, the roadway traversed 2 sets of railway tracks, intersecting them at an angle of 113°. The crossing was protected by a stop sign and a standard railway crossing sign on each side. The crossing was not equipped with advanced warning signs or pavement markings.

The bus stopped at the north side stop sign. The driver looked in both directions and then proceeded into the path of the train. While stopped, the driver did not open the door when looking and listening for the train. In Saskatchewan, school bus drivers were not required to open the driver's side window or the front door when looking and listening for a train at passive railway crossings (those equipped with crossbucks and/or a stop sign).

The TSB issued Rail Safety Advisory (RSA) 06/13, which indicated that, given the risks involved when a train collides with a school bus, TC, in conjunction with provincial authorities, might wish to review the requirements for school buses when stopping at, and traversing, railway crossings. In response to the RSA, TC indicated that it had informed the provincial authorities of the advisory letter and would be following up. In addition, TC would raise the issue with Operation Lifesaver.

To date, the TSB is unaware of any actions taken or planned to review the requirements for school buses when stopping at and traversing railway crossings.

1.20.3 TSB Railway Investigation Report R13T0192 (Ottawa, Ontario)

On 18 September 2013, at about 0832 Eastern Daylight Time, westbound VIA Rail Canada Inc. (VIA) passenger train No. 51 departed from the VIA Ottawa Station and proceeded en route to Toronto. At about 0847, OC Transpo double-decker bus No. 8017 departed from the VIA Fallowfield Station on the OC Transpo bus transitway. At approximately 0848, while proceeding at about 43 mph, the train entered the transitway crossing, located at Mile 3.30 of VIA's Smiths Falls Subdivision. At the time, the crossing lights, bell, and gates were activated. The northbound bus was travelling at about 5 mph with the brakes applied when it struck the train. As a result of the collision, the front of the bus was torn off. Among the bus occupants, there were 6 fatalities and 9 serious injuries. The train, consisting of 1 locomotive and 4 passenger cars, derailed, but remained upright.

The TSB highlighted the issue of requiring buses to stop at all railway crossings, regardless of whether the grade crossing warning systems were active or not. The report indicated that the studies used to support decision making made on this issue are out of date, incomplete and limited in scope. Therefore, more up-to-date guidance, based on research and science, would be useful for all jurisdictions. The Board is concerned that, given there is no recent comprehensive study that specifically deals with the risks associated with all buses stopping at all railway crossings, decision makers may not make the best choices possible to ensure an adequate level of safety.

1.20.4 TSB Railway Occurrence R14T0081 (Mississauga, Ontario)

On 04 April 2014, at 1456 Eastern Daylight Time, westbound CP freight train 147-04 was proceeding at about 35 mph (56.3 km/h) when it struck a southbound school bus, operated by Stock Transportation, that had stopped between the crossing gate and north track at the Queen Street public crossing located at Mile 20.12 of the CP Galt Subdivision. The bus sustained a broken mirror and a damaged bumper on the front passenger-side corner of the bus. Neither the school bus driver nor the 3 school-age passengers were injured.

The level crossing was equipped with flashing lights, a bell, and gates.

Before the collision, the driver had initially stopped at the stop line on the north side of the crossing. The driver then put the bus in park, opened the driver's-side window and the passenger door, and looked left and right, watching and listening for approaching trains. The driver then slowly moved the bus forward and performed a second check for approaching trains. During this second check, the driver saw the crossing gate on the opposite (south) side of the tracks start to descend to the horizontal position. With the crossing protection activated, the driver, unable to see a train, brought the bus to an immediate stop just foul of the track,[33] rather than continuing through the crossing. The bus was then struck by the train.

1.20.5 TSB Railway Occurrence R14T0290 (Mississauga, Ontario)

On 22 October 2014, at 0806 Eastern Daylight Time, eastbound GO Transit train No. 160 was proceeding at about 20 mph (32.2 km/h) when it struck a southbound school bus operated by Switzer-Carty Bus Lines. The bus had stopped just foul of the north track at the Erindale Station Road public railway crossing, located at Mile 17.35 of the CP Galt Subdivision in Mississauga, Ontario. The bus sustained minor damage. Neither the driver nor the 6 school-age passengers were injured.

The level crossing was equipped with flashing lights, a bell, and gates.

Prior to the occurrence, the driver had stopped in the curb lane at the stop line on the north approach of the crossing. The driver put the bus in park, opened the driver's-side window and the passenger door, and looked left and right while watching and listening for approaching trains.

The driver then slowly moved the bus forward while performing a second check for trains. When the crossing bells activated, the driver immediately stopped the bus and backed up in an attempt to safely clear the north track. As the bus was reversing, the crossing gate descended and struck the roof of the bus. The driver stopped the bus. With the bus stationary, but still foul of the north track, the train struck one of its front mirrors.

1.21 TSB laboratory reports

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

- LP029/2017 – Survey – Grade Analysis
- LP035/2017 – Crashworthiness Examination

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[33] Within 4 feet (1.2 m) of the outside of the nearest rail. (Source: Canadian Pacific Railway, *Minimum Safety Requirements for Contractors Working on CP Property in Canada* [15 September 2010], paragraph 2.1.1(h)).

2.0 Analysis

Neither train operation nor the condition of the track, rolling stock, or signal system played a role in this occurrence. The analysis will focus on the monitoring of school bus speed while travelling over a crossing, the requirement for school buses to stop at level crossings, the selection of winter tires for school buses, and the crashworthiness of the school bus.

2.1 The accident

At about 0726 on 13 February 2017, the First Student bus, being driven by a trained and experienced driver, picked up the first passenger of the route and continued southward along Town Line Road. Ascending the grade approaching the crossing with Canadian Pacific Railway (CP) Belleville Subdivision, the driver came to a stop in advance of the crossing, as required by the Ontario *Highway Traffic Act*. The driver performed the regulated and company-required procedures to safely cross the railway tracks. Once it was safe to do so, the driver continued slowly onto the crossing. The accident occurred after the bus became immobilized on the railway crossing.

Upon entering the crossing, the driver slowed the bus in order to look both ways a second time. After verifying that there were no approaching trains, the driver attempted unsuccessfully to accelerate forward. At that time, the front wheels were between the rails of the track and the rear wheels were on a 1.95% incline.

Given that the bus had come to a stop and that snow had accumulated on the road, the rear tires could not provide the traction required to propel the bus up the incline. The back end of the bus slid sideways toward the edge of the road where the snow was deeper and the incline of the road was greater, immobilizing the bus.

Once it became clear that the bus was immobilized, the driver quickly evacuated the bus passengers and moved them to a safe location. The driver then carried out the company's emergency procedures by calling the First Student Inc. (First Student) dispatcher. A short time later, the bus was struck by train 142. Due to the quick actions of the driver, none of the occupants of the bus was injured.

Once informed of the crossing emergency, the dispatcher confirmed the location of the bus and the identity of the crossing before contacting the railway to have all trains in the area stopped. All of the information needed to determine the identity of the crossing and of the owner of the track was available to and in clear view of the driver at the crossing. Railway companies place this information at the crossing to facilitate quick notification in the event of an emergency.

Notification time likely would have been reduced had the information posted at the crossing been passed immediately to the dispatcher. If emergency response procedures of commercial road transport operators do not include immediate notification to the railway company using the emergency information posted at crossings, opportunities to avoid crossing collisions will be missed.

2.2 Monitoring speed of school bus over crossings during company evaluations

To ensure that all drivers have the knowledge and skills to operate school buses safely and competently, First Student trains all of its drivers. Part of that training program includes a module on railway crossing procedures. To ensure that drivers retain this knowledge, First Student conducts a workshop each September to refresh the driver's understanding just before the new school year begins. In addition, First Student assesses each driver's performance at least once a year by having a company evaluator ride along with the driver while travelling along the route.

The occurrence driver had been assessed by a company evaluator 4 times in the last 5 years. In each assessment, the evaluator did not identify any deficiencies with the way the driver traversed the crossing.

Despite the training program instruction to move quickly and without hesitation across the tracks, the driver believed that crossing the tracks slowly and looking in both directions once occupying the crossing was safer. The driver's practice of reducing speed when travelling over a crossing had not been noted during any of the annual evaluations of the driver's performance. Moreover, speed was not an item listed on the evaluation checklist used by the company evaluators. Company evaluations did not identify the driver's practice of reducing speed when travelling over crossings.

2.3 Requirement for school buses to stop at level crossings

The occurrence bus became stuck on the crossing, which was protected with flashing lights and a bell. The bus could not ascend a relatively modest grade due to the loss of traction between its rear wheels and the ground. Had the bus continued onto the crossing at a speed closer to the posted speed limit for the road, the bus would likely not have become immobilized.

The Province of Ontario requires school buses to stop in advance of all railway crossings, even when the crossing warning systems are not activated. Many jurisdictions require school buses to stop at all railway crossings, even those protected by active warning systems that have not been activated. Although this practice is believed to improve safety, there have been a number of recent crossing accidents where the school bus stopped in advance of a crossing protected by grade crossing warning devices and then proceeded onto the crossing and was struck by an oncoming train.

The practice of school buses stopping at actively protected crossings, even when the crossing protection is inactive, is widespread. However, the 1985 Federal Highway Administration study suggested that not mandating stops at actively protected railway crossings when the protection is inactive would result in a net annual decrease in train-involved accidents for hazardous material transporters, school buses, and passenger buses.

The more recent 2013 MMM Group Limited study also looked at the practice of stopping at actively protected crossings when the protection is inactive. This study highlighted a number of advantages and disadvantages of stopping at the crossing. However, the study was not intended to provide definitive guidance for the relative risk of stopping at railway crossings when grade crossing warning devices are not activated.

In the absence of up-to-date risk analysis to determine whether buses should stop at railway crossings, even when the grade crossing warning devices are not activated, there is a risk of railway crossing safety not being optimized.

2.4 *Winter tires for school buses*

The slow-moving bus was not able to travel over a modest incline at the railway crossing. This was primarily due to the loss of traction between the rear tires and the snow-covered road surface.

In Canada, there are no regulatory requirements for school buses to use tires specifically designed for winter driving conditions during the winter months. School bus operators use their best judgment and consider recommendations from the tire manufacturer when choosing which tires to install. In this occurrence, the rear tires of the bus were all-season tires that were deemed suitable for winter conditions by the tire manufacturer.

To help school bus companies select tires for particular driving conditions, Bridgestone provided a general guideline that rates tread performance for retread applications based on its internal testing of 5 different criteria (tread wear, wet traction, snow traction, ice traction, and rolling resistance). Engineering judgment and field performance feedback are also considered. Bridgestone uses the data to validate design expectations and for comparative purposes. However, there are no regulatory or industry standards to evaluate traction test results in order to determine which tires were most suitable for winter driving.

In comparison, for passenger vehicles and light trucks, winter tires display the mountain and snowflake pictograph, assuring users of a minimum level of performance for traction in snow- and ice-covered conditions. For larger vehicles, like school buses, a standard for winter tires had only recently been introduced and was not widely used. However, there was no requirement for tire manufacturers to use the standard. Although choosing the most appropriate winter tire for trucks and schools buses is made more complex by the wide range of uses and service conditions they are subject to, an objective standard for traction performance can provide useful assistance to the vehicle owner. If school bus operators do not have access to independent and objective assessments of winter tire performance, there is an increased risk that the most suitable winter tire will not always be chosen.

2.5 *Crashworthiness of the school bus*

During a collision, structural deformation within the vehicle can be beneficial in order to increase occupant survivability, as energy is absorbed and dissipated that would otherwise be transmitted directly to the occupants. The basic principle of crash energy management is to ensure that, during a collision, the structure of unoccupied spaces deform before that of the occupied spaces. Survivability is influenced by how well the impact is absorbed by features of the vehicle and directed away from the occupants. Any structural damage of the container should not reduce the size of the survivable volume or open it up to the elements to the point where it compromises occupant survivability.

In this occurrence, the initial impact on the front-right side of the bus did not cause a reduction in livable space for the driver and passengers at the front of the bus. The second impact on the rear-right corner did reduce the livable space in the last 2 rows on the right-hand side of the bus. However, considering the speed of the train at the time of the impact (52 mph) and the magnitude of the impact force involved, there was relatively limited damage to the bus structure and the longitudinal beam of its chassis.

The structural integrity and robustness of the occurrence bus permitted it to absorb and dissipate energy during a collision and protect its occupants.

3.0 Findings

3.1 Findings as to causes and contributing factors

1. The accident occurred after the bus became immobilized on the railway crossing.

2. Upon entering the crossing, the driver slowed the bus in order to look both ways a second time. After verifying that there were no approaching trains, the driver attempted unsuccessfully to accelerate forward.

3. Given that the bus had come to a stop and that snow had accumulated on the road, the rear tires could not provide the traction required to propel the bus up the incline.

4. The back end of the bus slid sideways toward the edge of the road where the snow was deeper and the inclination of the road was greater, immobilizing the bus.

5. Despite the training program instruction to move quickly and without hesitation across the tracks, the driver believed that crossing the tracks slowly and looking in both directions once occupying the crossing was safer.

3.2 Findings as to risk

1. If emergency response procedures of commercial road transport operators do not include immediate notification to the railway company using the emergency information posted at crossings, opportunities to avoid crossing collisions will be missed.

2. In the absence of up-to-date risk analysis to determine whether buses should stop at railway crossings, even when the grade crossing warning devices are not activated, there is a risk of railway crossing safety not being optimized.

3. If school bus operators do not have access to independent and objective assessments of winter tire performance, there is an increased risk that the most suitable winter tire will not always be chosen.

3.3 Other findings

1. Due to the quick actions of the driver, none of the occupants of the bus were injured.

2. Company evaluations did not identify the driver's practice of reducing speed when travelling over crossings.

3. At the time of the occurrence, there were no regulatory or industry standards to evaluate traction test results in order to determine which tires were most suitable for winter driving.

4. The structural integrity and robustness of the occurrence bus permitted it to absorb and dissipate energy during a collision and protect its occupants.

4.0 Safety action

4.1 Safety action taken

The TSB is not aware of any specific safety action taken following the occurrence.

This report concludes the Transportation Safety Board of Canada's investigation into this occurrence. The Board authorized the release of this report on 17 January 2018. It was officially released on 23 February 2018.

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

Appendices

Appendix A – General guideline for Bridgestone tires relating to tread performance

OVER-THE-ROAD DRIVE	TREAD WEAR	WET TRACTION	SNOW TRACTION	ICE TRACTION	ROLLING RESISTANCE
MegaTrek	A+	B	B	B	B
Ultra Drive	A+	B	B	B	C
BDR-HG	A+	A	A	A	C
BDR-HT3	A+	B	B	C	C
B710 FuelTech	B	B	B	B	A+
BDR-W	A	B	A	A	C
BDR-AS	B+	B	A	A	C
BDR-AS w/MilEdges	B+	B+	A+	A+	C
FuelTech Drive	B	B	B	B	A+
FCR Drive	B+	B	D	B	B+
B835 FuelTech	B	B	B	B	A
BDR-UWB	A	B	B	B	B
BDL	C	C	C	C	C
BTT2	D	C	C	C	C

Source: Bridgestone Canada Inc.

Appendix B – First Student Inc. New Driver Training Program

Crossing the Tracks

First Student and Operation Lifesaver require these five key elements to cross the railroad crossing safely—every time.

1. **Prepare to stop**
   - Pay attention to advanced warning signs and pavement markings designed to alert the driver
   - Activate the hazard flashers at least 200 feet before the crossing
   - Turn off master switch
   - Scan the surrounding area and check traffic behind your vehicle.
   - Pull as far to the right of the roadway as safety allows
2. **Quiet the Bus**
   - Turn off noisy equipment – radios, fans and blowers
   - Silence the passengers using a pre-arranged signal
3. **Stop the Bus**
   - Stop no closer than 15 feet or farther than 50 feet from the nearest rail [First Student recommends 20 feet from the nearest rail]
   - Set the parking brake, shift transmission to neutral (or park if so equipped)
   - Keep foot on service brake to keep brake lights lit (this is to alert traffic behind the bus)
   - Open the service (passenger) door and driver's window
   - Look and listen— left and right—for an approaching train
   - Rock and Roll in the seat— move forward and back to see around obstructions
   - Obtain visual confirmation the track is clear before proceeding
   - Check travel lane to ensure there is enough room to cross the railroad tracks while leaving at least 15 feet to the nearest rail behind the bus
4. **Double check**
   - Look and listen again— it's worth a second look
   - If no train is seen or heard, prepare to cross the tracks
5. **Go—Cross the Tracks**
   - Close the service door
   - Place transmission in drive or in a gear that will not cause the need to change gears during the crossing
   - Release the parking brake
   - Proceed without hesitation

- Once clear of tracks and at least 15 feet away, turn off hazard flashers and turn on the master switch.

If distracted at any point during the safe crossing procedure steps, start over, LOOK and LISTEN again in both directions before crossing.[34]

[34] First Student Inc., *New Driver Training Program Candidate Workbook*, Section 6: Railroad Crossing Procedures, p. 60.