Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT
R99H0009

COLLISION AT CROSSING

VIA RAIL CANADA INC.
TRAIN NO. 2
MILE 290.50, RUEL SUBDIVISION
HORNEPAYNE, ONTARIO
14 JULY 1999

Canada

Railway Investigation Report

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Synopsis

At approximately 0804 eastern daylight time on 14 July 1999, as VIA Rail Canada Inc. train No. 2 approached a private crossing used by lumber trucks near Hornepayne, Ontario, an empty tractor-trailer proceeded over the crossing. The train crew initiated an emergency brake application, but was unable to stop the train before colliding with the rear portion of the trailer. As a result of the collision, the truck spun and struck the side of the train causing three locomotives and eight passenger cars to derail. The fuel tanks of two of the locomotives were sliced open and their contents fuelled two small fires. As a result of the accident, three people were seriously injured and a total of eight people were taken to the Hornepayne community hospital.

Ce rapport est également disponible en français.

1.0 Factual Information

1.1 The Accident

1.1.1 VIA Rail Canada Inc. Train No. 2

At approximately 0635 eastern daylight time (EDT)[1] on 14 July 1999, the operating crew members for eastward VIA Rail Canada Inc. (VIA) train No. 2 (VIA 2) began their tour of duty at Hornepayne Station. They obtained the various documents needed for their trip from Hornepayne, Mile 296.2 of the Canadian National (CN) Ruel Subdivision, to Capreol, Mile 0.0 of the Ruel Subdivision, and made themselves familiar with those documents. When VIA 2 arrived, consisting of 3 locomotives and 23 cars, the two relieving locomotive engineers met with the arriving train crew, exchanged pertinent information, and departed at approximately 0748. On departure from Hornepayne, there were 260 passengers and 26 on-train service (OTS) employees on the train.

After leaving Hornepayne, the crew performed a running brake test to ensure the efficiency of the train's brakes. The train proceeded to Wicksteed, two miles away, where it met a westward freight train (E2253113). VIA 2 then proceeded up to the maximum allowable speed of 50 mph until it reached Mile 291.3. Once past Mile 291.3, the maximum allowable speed was 60 mph and the speed of VIA 2 began increasing accordingly.

Just after 0800, as VIA 2 approached a private crossing at Mile 290.5 (Becker crossing) at a speed of 53 mph, the locomotive engineer at the controls began sounding the whistle and activating the bell as required by Canadian Rail Operating Rules (CROR). As he was sounding the whistle, he observed an empty tractor-trailer approaching the crossing in a southerly direction. He alerted the second locomotive engineer, who was retrieving some material from his bag. They immediately assessed that the truck was not going to stop and initiated an emergency brake application while continuing to sound the whistle. VIA 2 could not be stopped and collided with the rear portion of the trailer. Upon impact, the three locomotives and the first eight cars derailed but remained upright. Some of the derailed cars struck track material (ties, rails and rail anchors) which had been placed along the main track for future use. As a result of the derailment, the fuel tanks of two of the locomotives were sliced open and began leaking. While one of the locomotive engineers was obtaining track protection from the rail traffic controller (RTC), the other attempted, unsuccessfully, to extinguish two small fires using portable fire extinguishers from the locomotives. There was a fire under the third locomotive and another fire under the first occupied passenger car (the sixth behind the locomotives). The local fire-fighters assisted upon their arrival.

[1] All times are EDT (Coordinated Universal Time (UTC) minus four hours) unless otherwise indicated.

Passengers from the first three occupied cars (sixth, seventh and eighth behind the locomotives) were evacuated to the south side of the main track. The north side consisted of swampy land and a large pond. The evacuated passengers encountered some difficulty walking along the track because of the track material stored immediately south of the main track. Although most of that material was visible as it was left in large piles, some of it was in tall grass and difficult to see. The evacuated passengers and those from the other derailed cars were moved to the cars that had not derailed. A rescue locomotive travelled from Hornepayne to pick up that section of VIA 2, along with all the passengers and OTS employees, and travelled back to Hornepayne.

1.1.2 The Truck

The tractor unit was a 1990 International equipped with standard equipment, as well as an air conditioner, an AM/FM/cassette radio system, a Citizens' Band (CB) two-way radio and a sleeping compartment. On the day of the accident, the truck driver had been working in an area approximately 40 km south of the Becker crossing where the truck was loaded with spruce logs. Once loaded, the truck weighed a total of 54 530 kg. The driver then proceeded to Olav Haavaldsrud Timber Co. Ltd. (Haavaldsrud) which is located approximately 10 km from Hornepayne. The truck travelled to Haavaldsrud on a private dirt road, owned by Donahue Forest Products Inc. (Donahue). After it was unloaded and weighed at the scale, the truck proceeded south towards the Becker crossing, some 235 m away. Music was playing from the truck's cassette player, the air conditioner was functioning, and the driver's side small air vent window was open although the main side window was closed. The overall truck length was 20.73 m.

As the road and crossing were rough, the driver maintained a low rate of speed (approximately 15 km/h). There was a stop sign to the right of the road approximately 3 m before the crossing. The driver was aware of the sign and the requirement to stop. The driver elected not to stop at the stop sign as he believed that his truck could stop if he saw a train approaching and, through habit, never stopped at that crossing. The driver indicated that, at this time, he looked in both directions and did not see or hear a train. The driver stated that, once on the crossing, he again looked in both directions and did not see or hear a train. A few seconds later, as VIA 2 hit the trailer 15.85 m from the front of the truck and 14.02 m from the driver's location, the truck was thrown in an easterly direction and spun around, colliding with the first passenger car behind the three locomotives. The truck came to rest against the seventh passenger car (see Figures 1 and 2).


Figure 1—View of final position of truck and damage to trailer


Figure 2—Damage to trailer

1.2 *Injuries*

As a result of the collision and derailment, six passengers, one OTS employee and the truck driver were taken to the Hornepayne community hospital. Three were admitted with serious injuries[2] (including two passengers); one of the passengers had to be transferred to a larger facility for further treatment. The truck driver, although he had no visible injuries, was admitted for observation. The remaining five injured people, four passengers and the OTS employee, were treated for scrapes and bruises and released.

1.3 *Damage to Equipment*

The collision and subsequent derailment caused significant damage to the train. There was damage to all wheel sets on the three locomotives and the eight derailed cars. The traction motors, gear cases, anti-pollution tank and related brackets, and fuel tanks were damaged on all three locomotives.

Fuel tanks on the first and third locomotives were sliced open and approximately 11 000 litres of diesel fuel was released.

A fire erupted under the third locomotive and caused extensive damage to various electrical cables and wires.

2 The *Transportation Safety Board Regulations* define "serious injury" as an injury that is likely to require admission to a hospital.

There was damage to the trucks and truck frames and the outside stainless steel covering of some of the derailed cars. Battery boxes, batteries, water tanks, steps, step wells and vestibule corners were also damaged.

The first car behind the locomotives (8118) sustained significant damage to the south leading-end corner (see Figures 3 and 4). The damage extended to the inside of the car, tearing three sets of seats from their anchors in the floor, damaging the floor and baseboard heater and the overhead luggage rack, and destroying the end-of-car luggage rack and storage locker. The power junction box and cables were also damaged.

Figure 3—Outside damage from corner of tractor-trailer after rotation

Figure 4—Inside damage from same impact

The end sill cracked and the centre sills were damaged on car 8515, the second car behind the locomotives.

The truck side frame was damaged and the bolster plate was bent on car 8610, the fifth car behind the locomotives.

1.4 Other Damage

Approximately 350 m of track was damaged, including the crossing surface, which was destroyed. A temporary track (shoe-fly) was built around the derailed train to allow other trains to go around the derailed train.

The flatbed tractor-trailer was destroyed.

1.5 Personnel Information

1.5.1 Train Crew

The crew on VIA 2 consisted of two locomotive engineers who were qualified for their positions and met applicable fitness and rest standards.

1.5.2 VIA On-train Service Crew

There were 26 OTS crew on board VIA 2.

1.6 Occurrence Site Information

The CN Ruel Subdivision consists of a single main track. It links Capreol to Hornepayne, a distance of 296 miles. The maximum allowable track speed was 70 mph for passenger trains and 60 mph for freight trains. In the accident area, the maximum allowable speed was 60 mph for passenger trains and 55 mph for freight trains. At Mile 290.5, there is a 0.5 per cent descending grade in an eastward direction and there is a slight curve (one degree) beginning approximately 98 m west of the Becker crossing. There is a large pond immediately east of the Becker crossing just north of the main track (see Figure 5).

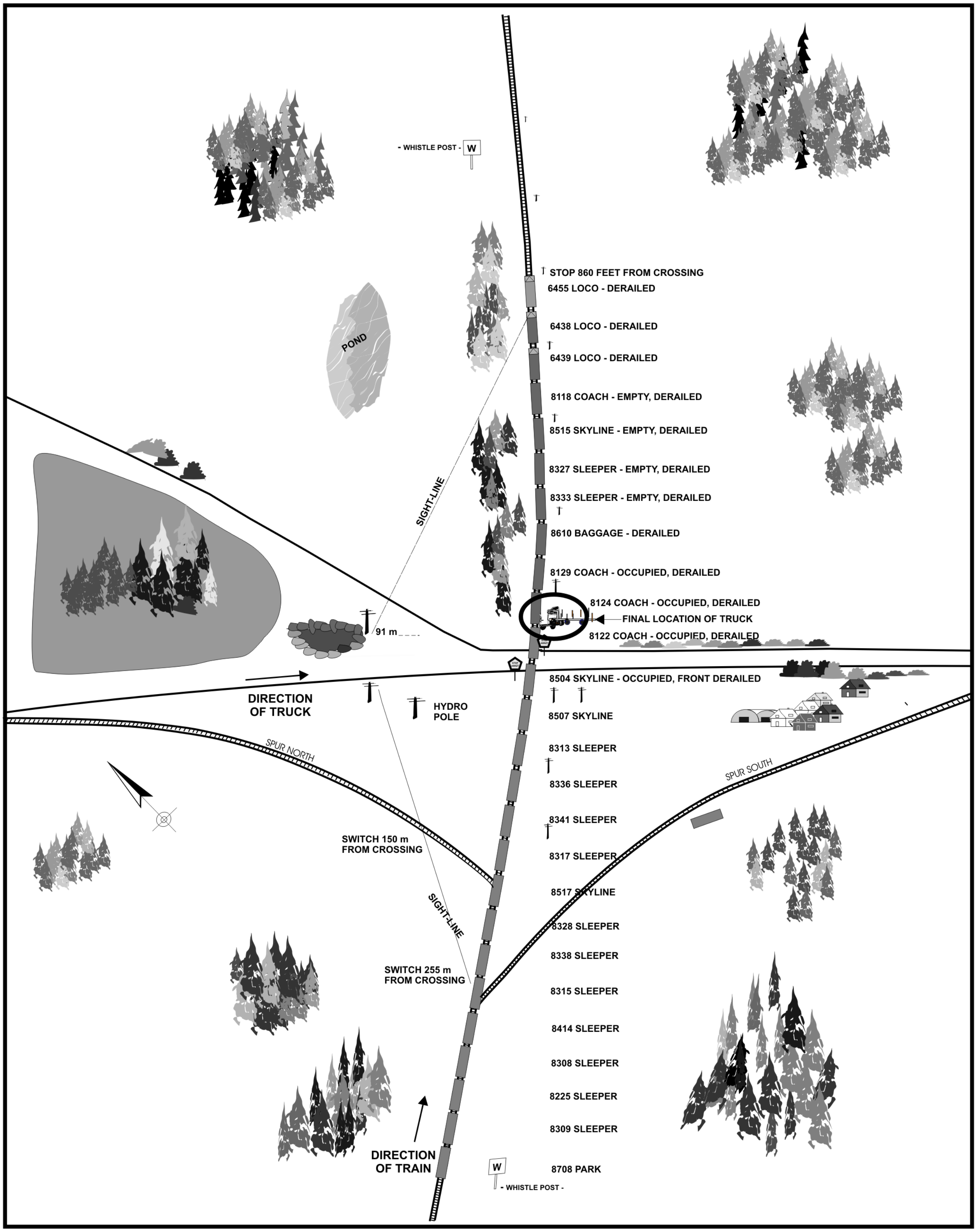

Figure 5—Diagram of the occurrence area

The Becker crossing was a private crossing at grade on a gravel road located at Mile 290.5 and was owned by Donahue. The Becker crossing was equipped with "maximum 30 km/h" signs, stop signs, and additional warning signs indicating "Danger High Speed Trains" on both approaches (see Figure 6). The road was straight and flat.

Figure 6—Signs displayed at the Becker crossing

1.7 Method of Train Control

The CN Ruel Subdivision was controlled using the Centralized Traffic Control System (CTC) method of train control authorized by the CROR and was under the supervision of an RTC located in Toronto, Ontario.

1.8 Weather

The temperature was 25 degrees Celsius. The skies were clear providing unlimited visibility in the early morning daylight conditions.

1.9 Recorded Information

The event recorder data indicate that the train was travelling at a speed of 53 mph with the headlight and ditch lights illuminated. The bell was on and the horn was blown approaching the crossing as required. The event recorder data also indicate that an emergency application of the brakes was initiated at a recorded time of 0804:06. The train had not decelerated at 0804:10 when the sudden change in speed recorded by the event recorder indicates that the collision and derailment took place.

1.10 Other Information

1.10.1 Sight-lines

The distance a vehicle driver can see down the track is referred to as a "sight-line." The following tables show the approximate sight-lines from various distances on the road when approaching the Becker crossing. All distances are in metres.

Table 1

Truck Sight-lines Approaching from the North Side of the Crossing		
Distance from Crossing	Looking West	Looking East
150	120	180
90	255	200
60	255	200
45	255	215
30	255	259
15	clear sight-line 255	365
15	Obstructed[3] 365	365
at STOP sign	365	365

Table 2

Truck Sight-lines Approaching from the South Side of the Crossing		
Distance from Crossing	Looking West	Looking East
60	245	150
45	275	200[3]
30	180[3]	305
15	1220	unlimited
at STOP sign	1220	unlimited

In order to obtain these sight-lines, a similar truck as the one involved in the collision was used and the sight-lines were measured in road increments of 15 m. It was noted that the side mirrors on the tractor unit did not obscure the driver's ability to see either east or west to any significant degree. Figure 7 shows the view from the truck while stopped at the north stop sign with a train approaching from the west (approximately 10 seconds away). The photograph has been taken in such a way as to approximate human eye's magnification.

3 Obstructed: looking through small trees with rear-view mirror interference

Figure 7—TSB simulation of actual view of approaching train from stop sign location

1.10.2 *Transport Canada*

Transport Canada's (TC) Railway Safety Directorate is tasked with regulating railway safety in accordance with the *Railway Safety Act* (RSA), *An act to ensure the safe operation of railways and to amend certain other Acts in consequence thereof*. The objectives of the RSA are to:

a) promote and provide for the safety of the public and personnel, and the protection of property and the environment, in the operation of railways;
b) encourage the collaboration and participation of interested parties in improving railway safety;
c) recognize the responsibility of railway companies in ensuring the safety of their operations; and
d) facilitate a modern, flexible and efficient regulatory scheme that will ensure the continuing enhancement of railway safety.

In order to fulfill that mandate, TC develops regulations, approves rules, and publishes guidelines. Railway Safety inspectors monitor, audit and inspect against those rules, regulations and guidelines as well as identify conditions which represent threats to safe railway operations to fulfill the objectives of the RSA.

Shortly after the accident, a TC Regional Engineer from the Ontario Region inspected the crossing and sight-lines in cooperation with CN and Haavaldsrud. The Regional Engineer concluded and reported that "the crossing was in compliance with all existing guidelines and regulations."[4]

The TC inspection included observations that the crossing was used mostly by large trucks servicing the woodlands operation and that the average clearance times were 23 seconds for loaded trucks and 17 seconds for empty trucks. The time measurements were based upon a vehicle stopped 8 m from the track until it was clear at a point 8 m on the opposite side of the track. The Regional Engineer recommended that 25 seconds be used and that, based on this clearance time and the subdivision speed, the railway should ensure that unobstructed sight-lines of approximately 686 m be obtained and maintained and should install standard railway crossing signs. He also recommended that stop or "Scheme 2" signs be maintained on both approaches and that advance warning signs be installed on both approaches.

There were no rules or regulations relative to sight-lines at crossings. In 1992, TC redrafted a guideline called "Minimum Railway/Road Crossing Sightline Requirements for all Grade Crossings without Automatic Warning Devices - G4-A" (guideline G4-A). This guideline was provided to railways under federal jurisdiction; those railways were requested to apply the guideline. Guideline G4-A required a minimum distance (T) of 275 m of sight-line for a crossing with a maximum train speed of 60 mph and a stop sign; however, it contained a provision which stated:

> Where gradients within 8 m of rail exceed 5% or heavy or long vehicles regularly cross, clear view from a vehicle stopped at the crossing must also extend a minimum of 50% beyond "T", and more if necessary, so stopped vehicles have sufficient time to start up and cross safely.

Guideline G4-A did not outline whose responsibility it was to determine whether the minimum sight-line had to be so increased and there were no requirements for owners of crossings to inform either the railway or TC of the types of vehicles which cross at private crossings. There are no provisions to ensure the safety of tractor-trailers at crossings where there has not been a determination that heavy or long vehicles regularly cross. According to guideline G4-A, the stationary sight-line was supposed to be 275 m, but given that heavy and long vehicles regularly

[4] The Regional Engineer also concluded that this crossing was a "de facto public crossing" (see section 4.0).

crossed, that distance should have been extended by 50 per cent, making the required sight-line 413 m. As previously stated, the actual sight-line in the direction of the train was 365 m, or 88 per cent of what it should have been according to guideline G4-A. Neither the railway nor TC had identified this discrepancy.

On 06 July 1999 (just before this accident), TC produced a draft manual entitled *Road/Railway Grade Crossings—Technical Standard and Inspection, Testing, and Maintenance Requirements* (the draft manual). The requirements contained in the draft manual are intended to apply to grade crossings on federally regulated railways and will be referenced in the upcoming *Grade Crossing Safety Regulations* made pursuant to the RSA. The draft manual varied from guideline G4-A in that the provisions to provide additional sight-line distance where heavy vehicles regularly crossed were deleted. The draft manual stated that "Every party responsible for a road or a railway line involving a grade crossing should consult the *Grade Crossing Regulations*."[5]

Section 9.4 of the draft manual stated in part:

> Stop Signs as specified in the Traffic Control Devices Manual shall be installed at unrestricted grade crossings where it is impossible for drivers to see a train approaching within the sightlines limits specified in Figure 8-1, without first:
>
> - slowing down to a speed of less than 15 km/h; or
> - stopping at the Railway Crossing Sign

The draft manual included a section which dealt specifically with sight-lines (section 8). According to that section, the minimum sight-line at a crossing equipped with stop signs (such as the Becker crossing) for a subdivision where the maximum track speed was 60 mph was 275 m measured from the stop location each way along the track. The new standard differed when a crossing was not equipped with a stop sign, as did guideline G4-A, since it took into consideration the fact that both the road vehicle and the train are moving, typically requiring greater sight-lines and a clear view of an approaching train within those sight-lines. Given the speeds on the road and track at the Becker crossing, the sight-lines would have been greater than 275 m for a vehicle proceeding southward on the road if there were no stop signs. There was a provision in the TC draft manual that indicated that the sight-lines "must not be obstructed by trees, brush, crops, hedges, or other vegetation, plowed snow, or stored equipment or materials." The draft manual further indicated that the sight-lines were to be measured from 1.0 m above the road surface to 1.2 m above the top of the rails. It is important to note that some railway and TC personnel believed they should apply guideline G4-A while others used the draft manual.

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5 Transport Canada, DRAFT *Road/Railway Grade Crossings—Technical Standard and Inspection, Testing, and Maintenance Requirements* (Rail Safety Directorate - Safety and Security - Transport Canada, 1999), p. i.

1.10.3 *Storage of Track Material*


Figure 8—View of track material stored along the main track

Track material, consisting of ties stacked approximately 1.2 m high, pieces of rail of various length either resting on the ground or placed on top of the ties and piles of rail anchors and tie plates, was stored adjacent to the main track immediately east of the Becker crossing and on the south side of the main track. The track material had been placed at that location several months before the accident. Because of its proximity to the main track, this material was struck by the derailing train and the truck as it was being pushed along the track.

There are no rules relating to the placement of track material along the main track. This has been a safety issue raised in other TSB investigation reports (R94T0357, R95S0130) with respect to work material being left along the rights-of-way after work had been completed. However, the focus at that time was the risk of vandals causing an accident by placing material on the track rather than the risk of material near a track contributing to accident severity.

1.10.4 *Trucking*

In order to be qualified to drive a tractor-trailer of the type involved in this occurrence in Ontario, a person had to obtain an "A" licence which allowed driving "any tractor-trailer combination."

To obtain an "A" licence, a person had to pass a written test as well as road tests. When preparing for an "A" licence, a person could obtain *The Official Truck Handbook* and *The Official Driver's Handbook* from the Ontario Government. The manual specific to trucks did not make reference to railway crossings while the other contained one page of text with very little information regarding safe passage procedures at crossings and no information for passage over crossings equipped with stop signs (see Appendix A).

The truck driver had a valid class "A" licence required to drive any tractor-trailer combination. He had slept eight hours the night before. He had 17 years' experience driving trucks.

1.10.5 *Truck Acceleration*

There have been a total of 42 collisions between trains and trucks moving over crossings in Canada for the period between 01 January 1999 and 31 May 2000. These occurred at both private and public crossings equipped with differing warning systems (from reflectorized railway crossing signs to automated warning devices).

According to TC's draft manual which contains guidelines on visibility, the truck driver had to be able to see a distance of 275 m down the track at the Becker crossing, and according to guideline G4-A, he had to be able to see a distance of 413 m. At a speed of 60 mph, a train travels a significant distance per second. The following table illustrates these distances:

Table 3

Time (seconds)	Distance Travelled (metres)
10	268
11	295
12	322
13	349
14	375
15	402

Truck acceleration tests were performed by a TC Field Defect Investigator[6] from British Columbia following a request from the TSB. Two series of tests were performed: one to measure the length of time a tractor-trailer could cover its own length starting from a stop on level ground, the other to measure the length of time a tractor-trailer could cover its own length and a distance of 7.32 m (24 feet) ahead of the tractor unit starting from a stop.[7] The distance of 7.32 m was selected to ensure that the measurement would simulate a truck stopped at a stop sign or just before a stop sign at a single track crossing and clear the width of an approaching locomotive. A summary of the results is provided in Appendices B and C.

TC's draft manual stipulated that crossings constructed after 01 June 1999 were not permitted to have a gradient exceeding 1:50 (2 per cent) within 8 m of the nearest rail and either 1:20 (5 per cent) or 1:10 (10 per cent) depending on the type of crossing for 10 m beyond. Public grade crossings built before 01 June 1999 were to conform to a vertical-to-horizontal ratio of 1:20 (5 per cent) unless the crossing had been authorized by the National Transportation Agency before 01 January 1989. The draft manual contained the following for non-public grade crossings: "in the case of other grade crossings, the ascending or descending gradients shall be safe for the use to which the grade crossing is put."

6 Mike Macnabb, P. Eng., "Vehicle Acceleration Measurement Project," and "Vehicle Acceleration Measurement Project - 24 foot gate," 2000.

7 This test was performed on a 6.7 per cent ascending grade.

A previous truck acceleration study was performed by TC's Transportation of Dangerous Goods group in 1995[8] following an accident involving a tractor-trailer and a CN freight train (TSB report No. R91E0072). The study tested acceleration of 215 tractor-trailers of various composition on a flat surface (at a weigh scale) and with maximum possible acceleration. The results indicated that, to clear one track with a tractor-trailer (similar length and weight as the one involved in this occurrence), it would take approximately 12.4 seconds.

Table 4 illustrates the ability of a specified vehicle to cross (√) or not cross (x) a specified number of tracks within the required 10-second railway sight-line guideline which was used for the TC 1995 truck acceleration study.

Table 4

	One Track	Four Tracks
Fully loaded truck	√	x
Empty tractor-trailer	√	x
Fully loaded tractor-trailer	x	x
Empty tractor-train	x	x
Fully loaded tractor-train	x	x
Transport vehicle	x	x

At a train speed of 60 mph, the 275 m minimum sight-line distance specified in the TC draft manual equates to between 10 and 11 seconds of advance warning, while guideline G4-A's 413 m equates to between 15 and 16 seconds. If a train were 11 seconds or more away and the sight-lines just met the requirements of the draft manual, a driver would not be able to see the approaching train and would begin to cross the railway crossing believing it is safe to do so. The various truck acceleration studies demonstrate that this 11-second time frame to cross the tracks is not sufficient as they indicate that a median of 12.4 seconds is required.

8 Transport Canada—Surface, Dangerous Goods, *Transport of Dangerous Goods Truck Acceleration Study* (Transport Dangerous Goods Directorate, Transport Canada, 1995).

1.10.6 *Locomotive Fuel Tanks*

During the derailment, two locomotive fuel tanks were sliced open and their entire content was spilled. The issue of fuel tank breach has been addressed in other TSB investigation reports, including TSB report No. R94T0357, where a fuel tank on a VIA train was punctured by a piece of rail in Brighton, Ontario. In its report on that accident, the Board recommended that:

> The Department of Transport assess the design of the current passenger locomotive fuel tanks and require, in the short term, that measures be taken to improve their crashworthiness, including limiting fuel spillage; and
>
> (R96-05, issued July 1996)
>
> The Department of Transport require that design standards for new passenger locomotives take into consideration the need for crash-resistant fuel tanks and fuel systems.
>
> (R96-06, issued July 1996)

TC replied that it was gathering information regarding the extent of any problems concerning fuel tanks, their crashworthiness and fuel spillage, and that VIA had no plans to modify the configuration of fuel tanks on the seven locomotives remaining in service (referring only to the type involved in the accident). TC also stated that it had raised the issue with the Railway Association of Canada (RAC) and proposed that the RAC formulate a rule which would include new passenger locomotives as well as new freight locomotives.

The *Railway Locomotive Inspection and Safety Rules* were approved by TC on 18 September 1997 and came into effect on 18 March 1998. Sections 19.1 and 19.2 of the rules read as follows:

> 19.1 Fuel tanks, on new locomotives purchased subsequent to the approval of this rule, are to be of high impact resistant design which meet or exceed current Association of American Railroads Manual of Standards and Recommended Practices (RP-506).
>
> 19.2 Fuel tanks shall be provided with suitable liquid level gauges, so located that the fuel level in the tanks can be determined when the tanks are being filled. Gauges must be protected against accidental breakage where loss of fuel would be incurred.

The Association of American Railroads (AAR) Recommended Practice referred to (RP-506) is entitled *Performance Requirements for Diesel Electric Locomotive Fuel Tanks*. It contains requirements for the structural strength of fuel tanks which explain what the design considerations should be in the event of minor derailments, jackknifed locomotives, side impact, penetration resistance, sideswipe, spill controls and fuelling. Subsection 4.1.4, entitled “Penetration Resistance,” explains:

> The minimum thickness of the sides, bottom sheet and end plates of the fuel tank shall be equivalent to 5/16 inch steel plate at 25,000 psi [pound per square inch] yield strength (where the thickness varies inversely with the square root of yield strength). The lower one third of the end plates shall have the equivalent penetration resistance by the above method of 3/4 inch steel plate at 25,000 psi yield strength. This may be accomplished by any combination of materials or other mechanical protection.

1.10.7 Design Standards for Railway Passenger Cars

As it was considered that, had the first coach behind the locomotives been occupied, serious or fatal injuries to passengers would have resulted, the TSB Engineering Laboratory set out to examine the adequacy of structural design standards as they relate to the sides of passenger cars. This and three other recent accidents investigated by the TSB were reviewed. The study (LP 110/2000) concluded that the current structural design standards for the sides of railway passenger cars do not provide adequate strength and crashworthiness protection for the magnitudes and types of loads that were experienced in these particular accidents.

2.0 Analysis

2.1 Introduction

Crossing accidents involving heavy trucks often result in derailment, fire and significant damage to locomotives and rail cars. Such accidents pose a significant safety risk to motor vehicle occupants, train crews, passengers (if a passenger train is involved) and those living in the immediate area if dangerous goods cars are derailed or damaged.

This accident was fairly typical of a crossing collision where a heavy truck is struck by a passenger train. The train was derailed, fuel was released and ignited, and passenger coaches sustained serious impact damage. For reasons which will be explored in the analysis, the truck was driven onto the tracks in front of the approaching train. The analysis will discuss the safety risks posed by heavy trucks negotiating crossings equipped with passive (non-automated) warning systems, locomotive fuel tanks, the structural features of passenger coaches, and the issue of track-side material storage.

2.2 The Accident

The truck left the scale and accelerated to a low speed of approximately 15 km/h because of the rough road and crossing conditions. It is estimated that it took slightly more than one minute to travel the 235 m from the scale to the crossing.

The truck driver was aware of the stop sign located just before the crossing and knew the requirements of such a sign, but he had negotiated the crossing on many occasions and was used to going over the crossing without stopping, and he believed that, by proceeding slowly and looking in both directions, he would have sufficient time to stop should he see an approaching train. As he approached and once he was on the crossing, the truck driver reportedly looked in both directions but did not observe VIA 2 and continued at a steady speed. The truck driver did not observe the approaching train and consequently drove the tractor-trailer onto the track immediately in front of VIA 2.

On the day of the occurrence, the truck driver approached the crossing with the truck's windows rolled up, the air conditioning functioning, the vent on the driver's side open and music playing on the truck radio. These conditions prevented the truck driver from hearing the train whistle as the train was approaching. Sources of noise inside the truck's cab, along with the windows being rolled up, created an environment where the truck driver did not hear the train whistle and the effectiveness of the train whistle was essentially negated.

As the trailer was struck approximately 4.9 m from the rear and pushed eastward, the acceleration created a pivot motion between the tractor and trailer portions, swinging the trailer and the tractor around. The front corner of the trailer and rear of the tractor, immediately behind the driver, struck the south leading corner of the first passenger car (see Figures 3 and 4). Because that car was empty, the potential for serious injuries was avoided but the car sustained significant damage to seats and also had debris thrown through it. This type of damage was evident in other accidents involving heavy trucks (TSB occurrence No. R92D0016 and occurrence No. R99S0100). Given the amount of damage suffered by the first car behind the locomotives and the conclusions of Engineering Laboratory study LP 110/2000, it is evident that passenger cars are not sufficiently protected against lateral damage, such that serious injuries to passengers are likely when the cars are struck by a heavy vehicle.

Upon impact, the three locomotives and eight cars derailed but remained upright. As a consequence of the wheels of the locomotives being off the tracks, the fuel tanks rubbed against the rails and two were sliced open. The shearing of the fuel tank from the truck as well as the friction caused between the train and truck ignited small fires which were fuelled by the diesel fuel from the locomotives and the truck. The fuel tanks were not shielded against direct rubbing on the turned rail and damage to the lower portion of the tanks resulted in the entire fuel load draining to the ground. Had the tanks been equipped with baffles or had they been compartmentalized or puncture-resistant, and had self-sealing bladders or foam inserts been installed, the quantity of fuel released could have been restricted.

Following two TSB recommendations (R96-05 and R96-06), the RAC adopted the AAR standard for locomotive fuel tank crashworthiness for new locomotives. However, VIA indicated to TC that it would not modify existing locomotive fuel tanks on its remaining locomotives of the series involved in the associated accident and TC opted not to take further action regarding existing locomotives. Locomotive fuel tanks designed to older standards allow large quantities of fuel to be released when the tank integrity is compromised.

It is noted, however, that VIA has now updated its locomotive fleet, with the delivery of 21 new units. Forty-six other 95 mph locomotives are continuing in service with the older specification of fuel tank. Some 26 older locomotives have been removed from service, but 16 of these are in storage and may be returned at some point in the future. They all have the older specification of fuel tank. The new locomotive fuel tanks not only meet the more stringent AAR strength requirements but have incorporated fuel loss prevention and puncture mitigation features, such as tank compartmentalization, increased height above the rails (10 cm [4 inches] to 0.74 m [29 inches]), integral design integration to prevent detachment from impact, and forward sloping end plates to deflect materials away from the tanks. It is anticipated that a general acceptance of these standards by the manufacturers and the industry, and the phasing in of new locomotives and retirement of the older models, will see significant improvement to this long-standing safety and environmental issue.

2.3 *Sight-lines*

A train travelling at 60 mph would travel the 365 m sight-line distance (at the stop sign) in between 13 and 14 seconds, and the truck acceleration studies show that a truck of similar length and weight as the subject vehicle can cover its own length in approximately 10 seconds. This leaves only approximately 4 seconds for the rear of the truck to clear the additional distance from the point of stopping to the far rail. If the trailer had accelerated to a speed of 15 km/h, it would have taken approximately 1.6 additional seconds for the rear of the trailer to clear the crossing. This represents a total of approximately 12 seconds which is at the time threshold of safely clearing the crossing. This calculation only takes into account normal operation of the truck; i.e., normal acceleration and good shifting from one gear to another, and flat road surface. The TC acceleration study conducted in 2000 agrees with this calculation as it concludes that a similar truck would need 12.4 seconds to clear one track. Therefore, had the tractor-trailer driver stopped at the stop sign and looked for a train, he would have had at most two extra seconds to clear the crossing if a train had been approaching just outside the sight-lines.

The TC Regional Engineer's study determined that the safe time frame for a crossing where long trucks travel and the train speed is 60 mph is 25 seconds, well in excess of the sight-line at the Becker crossing, guideline G4-A or the 1999 draft manual. TC concluded that, in order to offer a safe passage of long trucks such as those that stop at the Becker crossing, the sight-line had to be cleared for 686 m, which represents 320 m more than was available (almost double). However, on the day of the accident, the tractor-trailer driver did not stop at the stop sign but elected to drive slowly towards the crossing. The sight-line approaching the crossing in the direction travelled by the truck was actually shorter (255 m), which represents a travel time of less than 10 seconds for a train going 60 mph. TC's only method, provided by its guidelines, to ensure safety at crossings not equipped with automatic warning systems is either sight-lines or a combination of stop sign and sight-line which, as explained, either does not offer enough time for some vehicles to safely cross or offers a very thin safety margin to cross. This method of ensuring safety assumes that all humans behave in such a way as to act according to the unstated expectations of the guidelines (looking, seeing and reacting quickly) and that the acceleration or operation of the heavy or long truck is flawless (i.e. travel close to maximum road speed or accelerate quickly from the stop sign position). Therefore, using only sight-lines' length to determine safety at crossings used by heavy or long trucks does not take probable non-optimal human behaviour into account.

At the minimum sight-line distance in the guideline (275 m), a stopped tractor-trailer driver may proceed after looking and not seeing a train and would only have 10.23 seconds to safely clear the crossing if an approaching train were just outside the sight-line distance. It would normally take a tractor-trailer approximately 12 seconds to completely clear the crossing.

The TC acceleration study conducted in 1995 concluded that, even when submitted to maximum acceleration, most tractor-trailers could not cross even one set of tracks within the current guidelines which corroborates this analysis. Although guideline G4-A addresses the situation where heavy or long vehicles may regularly cross a crossing, there are no definitions of "regularly" and no indications as to who makes this determination. There are no sight-line provisions for tractor-trailers at crossings where it has not been determined that heavy or long vehicles regularly cross and there are no methods in place to indicate to a "responsible party" the potential change of traffic on a crossing from light vehicles to heavy and long ones. For these reasons, and in addition to the draft manual not containing the provision from guideline G4-A to add 50 per cent to the sight-line distance for heavy or long vehicles, the TC sight-line guidelines do not provide enough time for a truck to safely cross over a crossing equipped with stop signs if a train is approaching just outside the sight-line.

It is important to note that the two 2000 truck acceleration studies demonstrate clearly that there is an insufficient safety margin for heavy trucks to safely go over a single track level crossing equipped with a stop sign whether there is a grade or not. The safety margin is even smaller if there is more than one track as the travel distance for the truck is greater. Although the second 2000 study was performed on a significant grade (6.7 per cent), current TC guidelines for certain types of crossings allow similar grade approaching a crossing. Because of the lack of a safety margin to allow tractor-trailers to safely cross a non-signalized railway crossing equipped with stop signs, the risks of accidents are high and safety improvements are required to ensure safety.

There were multiple visual cues available to the driver to assist him in seeing an approaching train. When the truck was before the crossing and while on the crossing, the yellow, grey and silver colour of the train would have made it conspicuous against the background sky and trees. When located over the tracks, the visual angle expansion rate (looming rate) was approximately 22 times greater than that required to automatically draw attention to the train. In addition, the headlight and two ditch lights on the locomotive were shining in the direction of the truck while it approached the crossing and directly towards it while it was on the crossing. Given the visual cues and the presence of a stop sign at the Becker crossing, it is unlikely that the driver would not have been able to see the train had he stopped at the stop sign and looked down the track.

Since 1992, railways have been encouraged by TC to comply with guideline G4-A and received copies of the draft guideline. Because of these two documents being used by TC and the railways and the lack of clarity as to which applied, portions of both documents were being applied. If guideline G4-A is used, the sight-lines were shorter than required, while they were longer than required according to the draft manual. Inspections by railway personnel and TC inspectors did not identify a deficiency with the sight-lines at the Becker crossing.

2.4 Storage of Track Material

Track material along the main track has been an item which has been identified by the TSB as a contributing factor to accidents in previous investigation reports. Although the material discussed in previous investigation reports was material left after track work had already been performed (scrap material), storage of new material also represents significant risks to safety should a derailment occur or passengers have to walk in the vicinity of the main track. It is also possible that material stored in this manner could present a risk to employees if they have to detrain from a moving train.

While it is acknowledged that the probability of a passenger train derailing at some specific location where track material is being stored alongside the track is low, the risk to passenger safety associated with such an event would be high. It is also recognized that placing the rails in such a way as they are aligned to be accessible for on-track equipment eases the work of installing them. In this instance, the method used to stack the track material and the fact that the material was stored for several months further increased the risk because the rails were placed in such a way as to facilitate their entry into a derailed passenger car. Entry of such material into an occupied car would cause serious passenger injuries or fatalities. Hardwood ties could also cause severe damage upon impact and entry.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. The truck driver did not observe the approaching train and consequently drove the tractor-trailer onto the track immediately in front of VIA Rail Canada Inc. train No. 2.

2. Sources of noise inside the truck's cab, along with the windows being rolled up, created an environment where the truck driver did not hear the train whistle and the effectiveness of the train whistle was essentially negated.

3. Given the visual cues and the presence of a stop sign at the Becker crossing, it is likely that the driver would have been able to see the train had he stopped at the stop sign and looked down the track.

3.2 Findings as to Risk

1. The Transport Canada sight-line guidelines in the draft manual entitled *Road/Railway Grade Crossings—Technical Standard and Inspection, Testing, and Maintenance Requirements* do not provide enough time for a tractor-trailer to safely cross over a crossing equipped with stop signs if a train is approaching just outside the sight-line.

2. Using only sight-line length to determine safety at crossings used by heavy or long trucks does not take probable non-optimal human behaviour into account.

3. Had the tractor-trailer driver stopped at the stop sign and looked for a train, he would have had at most two extra seconds to clear the crossing if a train had been approaching just outside the sight-lines.

4. The structural design standards for railway passenger cars do not adequately protect against lateral damage and serious injuries to passengers are likely when the cars are occupied.

5. Locomotive fuel tanks designed to older standards offer a greater risk to perforation compared with the new standards, with a resulting release of potentially large quantities of fuel when the tank integrity is compromised.

6. Although the probability of a passenger train derailing at some specific location where track material is stored close to the track is low, any such situation presents an increased risk to passenger safety.

4.0 Safety Action

4.1 Action Taken

The Ontario Ministry of Natural Resources concluded that the crossing was unrestricted and had been used by the public for more that 50 years and that the Ministry would be the road authority for what is a de facto public crossing. The Ministry installed approach signs alerting drivers of the approaching crossing and replaced the stop signs with stop signs of higher reflectivity.

Olav Haavaldsrud Timber Co. Ltd. issued a bulletin to its employees reminding them of the requirement to stop at the Becker crossing.

Since the accident, Transport Canada (TC) has re-issued the *Road/Railway Grade Crossings—Technical Standard and Inspection, Testing, and Maintenance Requirements* (the draft manual). The new version includes provisions for a "design vehicle" and the need to carry out a detailed safety assessment of the crossing. The assessment would take into account the type of vehicular use at the crossing and other characteristics including the road approach gradient and the length of the grade crossing clearing zone for determining, amongst other things, the sight-line requirements. Sight-line distances will be based on the time required for the "design vehicle" to pass completely through the clearance distance.

The results of the Engineering Laboratory study respecting the inadequacy of sidewall protection for passenger cars outlined in 1.10.7 were conveyed to TC via Safety Advisory 02/01 in April 2001. TC replied in May 2001, explaining that it had shared the information with the Federal Railroad Administration (FRA) and will approach the American Public Transit Association (APTA) with these concerns along with the FRA. TC also advised that it is working with the RAC to have the latest APTA standards referenced in the *Railway Passenger Car Inspection and Safety Rules.*

4.2 Safety Concern

TSB data indicate that there have been 738 collisions at crossings of all types on railways under federal jurisdiction resulting in 24 train derailments between 01 January 1999 and 07 August 2001.

The data show that 613 collisions were between trains and road vehicles other than long or heavy trucks and resulted in 6 train derailments, and 125 collisions were between trains and "long or heavy vehicles" (trucks) and resulted in 18 train derailments. Forty-six of these 125 collisions took place at private crossings and 23 of those were at private crossings equipped with stop signs (such as the Becker crossing) and resulted in 7 train derailments. These data indicate a 1 per cent rate of derailment for train/non "truck" collisions and a 14 per cent rate of derailments for train/"long or heavy truck" collisions. The rate of train derailments following a collision between a train and a heavy or long truck is 30 per cent at private crossings equipped with stop signs. It is therefore evident that the risk of a train derailment is far greater when a heavy or long truck is struck by a train and that the risk is again inexplicably increased at private crossings equipped with stop signs. While the exact numbers are not known, it is important to note that the number of private crossings where heavy or long trucks travel is very small compared to the overall number for public crossings; yet, the number of accidents at such private crossings (23) is significant. As the safety of train crews and passengers is dependent on the train remaining on the tracks and coming to a controlled stop, it can be seen that it is important to give extra attention to averting accidents involving "long or heavy vehicles."

While the driver of the subject truck did not stop at the crossing, it has been determined that, should a heavy truck be stopped before such a crossing and if the way is seen to be safe, i.e. no train seen in the available sight-lines, such a vehicle, barring any vehicle performance inhibiting elements, such as a rough crossing surface or mechanical malfunction, could just clear the crossing if an approaching train had been just beyond view. There is a minimal safety margin.

The table below shows what sight-line distances guideline G4-A requires at a minimum at crossings equipped with a stop sign. It also indicates the sight-line distance guideline G4-A requires with the 50 per cent added distance if the determination has been made that long or heavy vehicles regularly cross. The speeds are in miles per hour and the distances are in feet.

Maximum train speed	Guideline G4-A sight-line distance	Sight-line distance + 50 per cent
20	300	450
30	450	675
40	600	900
50	750	1 125
60	900	1 350
70	1 050	1 575
80	1 200	1 800
90	1 350	2 025
100	1 500	2 250

It is the Board's opinion that, should the determination be made that heavy or long vehicles regularly cross at crossings equipped with stop signs, it would be very difficult to clear the sight-lines for the distance indicated in the third column in many Canadian geographical locations. It is important to note that the sight-line distances in the third column are a minimum as the guideline states "and more if necessary."

The Board acknowledges that the newest draft manual contains provisions for a design vehicle to assist in determining safe sight-line distances at crossings. However, it believes that, because of restrictions imposed by the terrain (both natural and man-made), continual vegetation growth and human behaviour, reliance on sight-line distances or sight-line distances and stop signs at crossings where large or heavy vehicles cross is not sufficient to provide an acceptable level of safety.

Although the issue of storage of track material related to vandalism has been raised by the TSB in the past and action has been taken to address the removal of track material left after a construction project, this accident has demonstrated that pre-construction storage of such material also presents a safety risk. As explained in the report, the track material which had been stored for a period of months and in a way to permit easy access into occupied compartments created a risk to the safety of the passengers both as the train derailed and during the subsequent passenger evacuation and to railway employees should they be required to detrain from moving equipment at such a location. There are methods to provide track material to work sites in a timely fashion which would lessen the exposure time for such material at such locations and reduce the risk of a recurrent event. The Board is concerned that the risk of injuries to the public and railway employees is increased when track material is stored along the track for extended periods of time.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 16 January 2002.

Appendix A—The Official Driver's Handbook

Here is a relevant section from *The Official Driver's Handbook*[9] published by the Ontario Government.

> Stopping at railway crossings
>
> All railway crossings on public roads in Ontario are marked with large red and white 'X' signs. Watch for these signs and be prepared to stop. You may also see signs warning of railway crossings ahead. On private roads, railway crossings may not be marked, so watch carefully.
>
> As you come to a crossing, slow down, listen and look both ways to make sure the way is clear before crossing the tracks. If a train is coming, stop at least five metres from the nearest rail. Do not cross the track until you are sure all trains have passed.
>
> Some railway crossings have flashing signal lights and some use gates or barriers to keep drivers from crossing the tracks when a train is coming. At a railway crossing where the signal lights are flashing, stop at least five metres from the nearest rail. Do not cross until the signals stop flashing. If the crossing has a gate or barrier, wait until it rises or opens before crossing. It is dangerous and illegal to drive around, under or through a railway gate or barrier while it is being opened or closed.
>
> Be careful in heavy traffic not to drive onto a railway crossing if you may have to stop on the tracks. Always make sure there is enough space to drive across the tracks completely before you begin to cross.

[9] Ontario Government, *The Official Driver's Handbook* (Queen's Printer for Ontario, 1995), p. 28.

Appendix B—Acceleration Study–Truck's Length[10]

* on flat surface

Number	Truck Configuration	Trailer Configuration	Overall Length (m)	Time to Travel One Length (seconds)	Gross Combined Weight (kg)
1	conventional tandem	Super "B" flatdeck	24.8	8.72	46 930
2	conventional tandem	Super "B" chip hauler	25.3	9.3	58 190
3	conventional tandem	Super "B" flatdeck	25.14	14.63	56 710
4	conventional tandem	Super "B" pressurized tanker	24.66	12.1	63 000
5	conventional tandem	Log tri-axle pole	20.74	10.18	50 270
6	conventional tandem	Super "B" flatdeck	25	9.48	61 130
7	conventional tandem	Super "B" chip hauler	24.51	11.72	60 340
8	conventional tandem	Log single axle jeep, tandem pole	23.2	10.78	51 450
9	conventional tandem	Log tridem pole	22.1	9.02	48 200
10	conventional tri-drive, self-loader	Log tridem pole	21.4	9.97	57 980
11	conventional tandem	Super "B" tanker	24.4	9.77	61 000
12	conventional tandem	Super "B" tanker	24.9	11.25	63 030

10 Mike Macnabb, P. Eng., "Vehicle Acceleration Measurement Project," 2000.

Number	Truck Configuration	Trailer Configuration	Overall Length (m)	Time to Travel One Length (seconds)	Gross Combined Weight (kg)
13	conventional tri-drive	Log tridem pole	22.5	11.23	54 970
14	conventional tandem	Super "B" chip hauler	25	11.21	61 420
15	conventional tandem	Super "B" tanker	24.8	11.44	50 970
16	conventional tandem	Log single axle jeep, tandem pole	22.9	12.95	49 310
17	conventional tri-drive	Log tridem pole	22.9	9.43	54 000
18	conventional tandem	Log single axle jeep, tri-axle pole	22.3	11.08	59 500
19	conventional tandem	Log tandem pole	21.3	14.4	40 370
20	conventional tandem	Log tandem pole, single axle dog	23	10.02	50 420
21	conventional tandem	Super "B" flatdeck	25	13.51	50 000
22	conventional tandem	Single axle "A" train	22.9	8.84	22 700
23	conventional tandem	Super "B" flatdeck	25.2	14.14	48 190
24	cab-over tandem	Super "B" flatdeck	23.8	11.56	53 050
25	conventional tandem	Lowbed tridem	22.5	9.99	51 560
26	conventional tandem	Log tandem pole	21.6	10.61	40 590

Appendix C—Acceleration Study–Distance of 7.32 m[11]

* on 6.7 per cent ascending grade

Number	Truck Configuration	Trailer Configuration	Overall Length (m)	Time to Clear 7.32 m Gate (seconds)	Gross Combined Weight (kg)
1	conventional tandem	Log single axle jeep, tandem pole	22.5	15.35	50 610
2	conventional tandem	tandem axle van	20.6	8.92	24 000
3	conventional tandem	Log single axle jeep, tandem pole	23.6	16.38	51 000
4	conventional tandem	Log tridem pole	23.6	11.89	49 000
5	conventional tandem	Log tandem pole, single axle dog	20.9	11.47	50 000
6	conventional tandem tanker	Quad axle tanker	21.6	17.25	58 900
7	conventional tandem (automatic)	Log tandem pole	20.7	9.3	42 000

[11] Mike Macnabb, P. Eng., “Vehicle Acceleration Measurement Project - 24 foot gate,” 2000.

Appendix D—Glossary

AAR	Association of American Railroads
APTA	American Public Transit Association
CB	Citizens' Band
CN	Canadian National
CROR	Canadian Rail Operating Rules
CTC	Centralized Traffic Control System
Donahue	Donahue Forest Products Inc.
draft manual	*Road/Railway Grade Crossings—Technical Standard and Inspection, Testing, and Maintenance Requirements*
EDT	eastern daylight time
FRA	Federal Railroad Administration
guideline G4-A	Minimum Railway/Road Crossing Sightline Requirements for all Grade Crossings without Automatic Warning Devices - G4-A
Haavaldsrud	Olav Haavaldsrud Timber Co. Ltd.
kg	kilogram
km	kilometre
km/h	kilometre per hour
m	metre
mph	mile per hour
OTS	on-train service
psi	pound per square inch
RAC	Railway Association of Canada
RP	Recommended Practice
RSA	*Railway Safety Act*
RTC	rail traffic controller
T	minimum distance
TC	Transport Canada
TSB	Transportation Safety Board of Canada
UTC	Coordinated Universal Time
VIA	VIA Rail Canada Inc.
%	per cent