AMENDED REPORT

RAILWAY INVESTIGATION REPORT
R99T0298

CROSSING ACCIDENT AND DERAILMENT

CANADIAN NATIONAL
FREIGHT TRAIN NO. M-321-21-22
AND
VIA RAIL CANADA INC.
PASSENGER TRAIN NO. 68
MILE 292.59, KINGSTON SUBDIVISION
BOWMANVILLE, ONTARIO
23 NOVEMBER 1999

Transportation Safety Board
of Canada

Bureau de la scurit des transports

du Canada

Railway Investigation Report

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Synopsis

At approximately 1845 eastern standard time, westward Canadian National freight train No. M-321-21-22 struck an abandoned tractor-trailer at a farm level crossing in Bowmanville, Ontario. The train derailed after dragging the trailer for approximately 2 000 feet along the track. An eastward VIA Rail Canada Inc. train struck the debris and derailed, just before the freight train had come to a halt. A fire ensued because of leaking fuel from the tractor-trailer. There was also leakage of fuel from punctured locomotive fuel tanks. Although some dangerous goods cars on the freight train had derailed, there was no release of product. Minor injuries were sustained by six VIA Rail Canada Inc. employees, including four on-train service personnel, and five passengers.

The evacuation of the train was carried out quickly and efficiently, as was the clean-up of spilled fuel.

Ce rapport est également disponible en français.

1.0 Factual Information

1.1 The Occurrence

On 23 November 1999, at approximately 1845 eastern standard time (EST)[1], Canadian National (CN) freight train No. M-321-21-22 (train 321), travelling westward on the north main track, struck the trailer portion of an abandoned highway tractor-trailer at a farm crossing at Mile 292.59 of the CN Kingston Subdivision, near Bowmanville, Ontario. Both the tractor and the trailer were dragged westward for approximately 2 000 feet. Approximately 800 feet west of the crossing, metal parts from the trailer portion became entangled under the wheels of the lead locomotive, resulting in the derailment of both locomotives and the following 10 rail cars, 4 of which rolled over onto their side into the north ditch and were pushed over when struck by the passing, jackknifing passenger train. The tractor portion remained connected to the trailer and ignited. The local fire department extinguished the fire. Three of the derailed freight cars contained a residue of liquefied petroleum gas (LPG) and five of the derailed freight cars were loaded with butadiene.

Just before the derailed freight train came to a stop, VIA Rail Canada Inc. (VIA) passenger train No. 68 (VIA 68), moving eastward on the south main track, struck the tractor portion of the tractor-trailer hooked onto the lead freight locomotive, tore it away from the trailer portion, and dragged it eastward for approximately 700 feet. Parts of the tractor became lodged under the wheels of the VIA locomotive causing it and the following five passenger coaches to derail. Minor injuries were sustained by six VIA employees, including four on-train service (OTS) personnel, and five passengers.

Approximately 11 350 litres (2 500 gallons) of diesel fuel was released from the VIA locomotive and the lead locomotive of train 321, but did not ignite.

1.2 Method of Train Control

Train movements on the Kingston Subdivision are governed by the Centralized Traffic Control System of the Canadian Rail Operating Rules (CROR) and supervised by a rail traffic controller (RTC) located in Toronto, Ontario.

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

1.3 Particulars of the Track

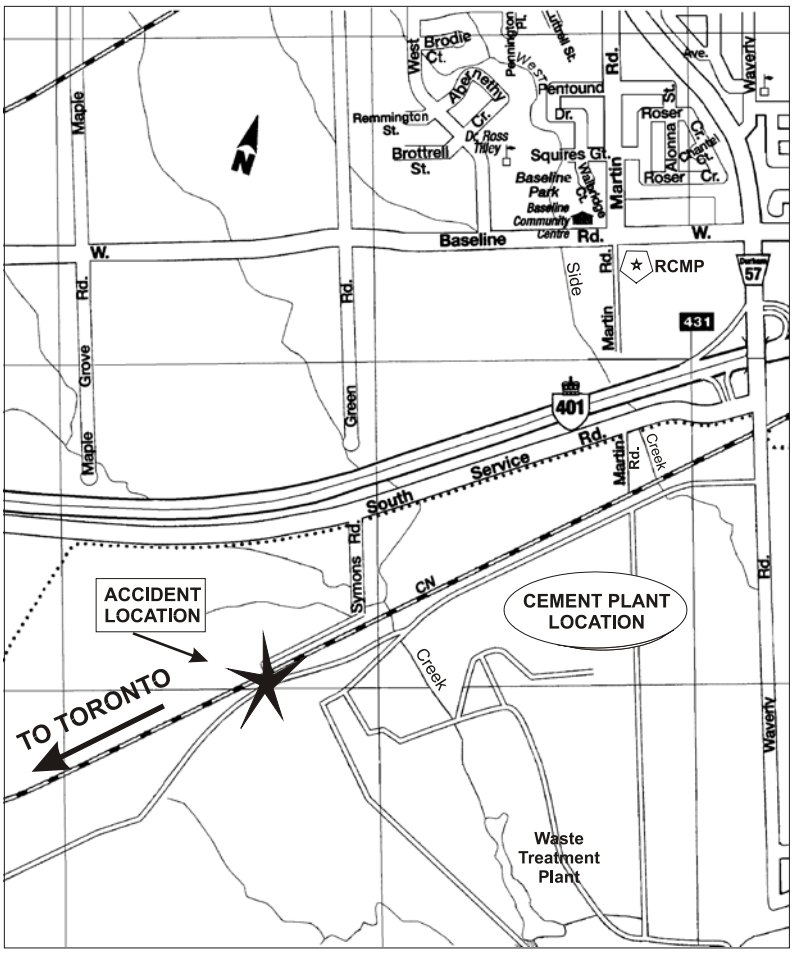
The CN Kingston Subdivision in the accident area consists of two main tracks, identified as the north main track and the south main track. The authorized timetable speed is 100 mph for passenger trains and 60 mph for freight trains. Twenty-four passenger trains and approximately 30 freight trains use the line daily. The Kingston Subdivision is one of the most heavily travelled and highest-speed lines in Canada.

1.4 The Tractor-Trailer

The vehicle, a 23-foot-long highway tractor, pulling a 64-foot flat bed carrying machinery, was en route from Vaughan, Ontario, to Bowmanville. The load of machinery was to be delivered to a cement plant located on the south side of the CN Kingston Subdivision and to the west of Waverly Road.

The driver had been instructed to take Highway 401 (401) west to Bowmanville, exit at Waverly Road and proceed south on Waverly Road to the cement plant. The driver did not check these verbal instructions against a map of the area. The driver exited the 401 as instructed and could clearly see the cement plant to the south-west. However, the exit ramp terminated at an east-west road, marked as the South Service Road. There was an information sign before the intersection of the ramp with the South Service Road, indicating that access to Waverly Road would require a left turn. At this intersection, there was also a stop sign and some tourist information signs. The driver turned right at the intersection and headed west for approximately 3 km. He passed the intersection with Symons Road and continued until he came to the intersection with Holt Road. He then recognized that he had gone too far and turned back. At this point, the driver did not confer with the dispatch centre as to the correct access point to the cement plant.

Halfway between Holt Road and Waverly Road, he arrived at an intersection where Symons Road led southward off the South Service Road. Figure 1 shows a map of the area and the accident location. Symons Road was an unpaved gravel road, approximately 4.6 m wide and in good condition. There was a “No Exit” sign at the south-east side of the intersection facing traffic turning from the South Service Road. The driver turned onto Symons Road, and drove southward for approximately 350 m, where the road turned westward at the railway embankment. The driver proceeded westward on the laneway for another 370 m, where the laneway ascended, at a six per cent grade, and made a tight turn to the south, immediately crossing over the double main tracks of the CN Kingston Subdivision. The driver realized that he had taken the wrong route, but believed he could pull onto the crossing, back the trailer into a farm field on the north side of the crossing and turn around. There was an access gate to the cement plant 17.5 m beyond the south rail of the south track.



As the driver turned south onto the double main line tracks, the rear wheels of the trailer broke through some railway ties spanning the east ditch on the north side of the track. The ties were part of a wood box abutment adjacent to and aiding drainage from the 48-inch steel pipe culvert under the crossing. The truck became immobile with the trailer portion occupying the north main track, and the tractor located on the south main track. The driver then spent approximately 10 minutes trying to remove the trailer from the ditch, including attempting to free the rear wheels by using the trailer's hydraulic system to move them forward on the trailer. When the driver noticed a freight train approaching from the east, he activated the truck's emergency flashers and ran southward away from the tracks. Shortly after the collision, the driver was found by cement company employees near tank cars loaded with dangerous goods. He was advised to leave the area and the cement company employees called for emergency assistance.

1.5 Canadian National (CN) Train No. 321

CN train 321, proceeding westward on the north track, was recorded as travelling at 59 mph approaching the crossing. The train consisted of 2 locomotives and 113 cars, weighed 8 795 tons and was 7 196 feet in length.

The first two cars behind the locomotives were gondola cars filled with wire. The following eight cars were dangerous goods tank cars, either carrying loads or residues. The third and fourth cars contained a LPG residue, UN 1075. LPG is a flammable gas which is heavier than air. Out of the four tank cars that rolled over, one contained an LPG residue and three were loads of butadiene, UN 1010. Butadiene is a flammable product which may polymerize (undergo a chemical reaction where molecules combine) explosively when heated or involved in a fire. The ninth and tenth cars were carrying loads of butadiene. In all, 35 rail cars contained dangerous goods, but there was no release of product.

The train crew members noticed some retroreflective coloured material on the track and initially thought this was cautionary tape, which was encountered frequently at construction sites along the railway track. They applied the train brakes in emergency when it became clear that the reflection was from the side of a tractor-trailer. They also initiated an emergency radio broadcast, in compliance with CROR Rule 102, to warn other trains in the area, and contacted the RTC located in Toronto to request emergency assistance. All rail traffic in the area was instructed to stop by the RTC.

1.6 VIA Rail Canada Inc. (VIA) Train No. 68

VIA 68, approaching Bowmanville on the south main track, was recorded as travelling at 87 mph approaching Mile 293. The train consisted of one locomotive pulling six conventional stainless steel passenger coaches. The first three coaches were occupied by a total of 100 passengers and 4 employees. The last three coaches were unoccupied.

VIA 68 departed Toronto at approximately 1809 and proceeded eastward, stopping to pick up more passengers at the Guildwood Station in Scarborough, Ontario. All passengers were given a safety briefing by the OTS employees. The safety briefing consisted of explanation of the safety features of the coaches, reference to safety cards in the back seat pockets and special briefings for persons sitting by windows which could be broken in case of emergency. Approaching Mile 293.5, both VIA locomotive engineers heard the emergency radio broadcast being transmitted by train 321 and immediately applied the train brakes. A few seconds later, as the train rounded a one-degree curve between Mile 293.6 and Mile 293, the locomotive engineers placed the train brakes in emergency because of the limited visibility ahead. They then saw the freight train ahead. VIA 68 struck the tractor and tore it away from train 321 just before the

freight train came to a stop. VIA 68 was then travelling at a recorded speed of 62 mph. The VIA locomotive event recorder indicated the reduction in train speed from 87 mph to 62 mph over a period of 15 seconds before impact rendered the recorder speed function inoperative.

After the passenger train stopped, the two locomotive engineers immediately advised the OTS employees in the coaches by radio to evacuate everyone as quickly as possible to the south side and move westward on the track away from the area, as the fire at the rear of their locomotive was impinging on the bottom of a tank car containing a dangerous good. They also contacted the VIA control centre in Montréal, Quebec, by cellular telephone to request emergency assistance. Both locomotive engineers exited through the side windows on the locomotive as the doors would not open. They sustained minor bumps and bruises, incurred either while the train was travelling derailed, or while exiting the locomotive.

Five passengers and the four OTS employees also sustained minor injuries. The four VIA OTS employees were thrown to the floor or onto seats upon impact. First-aid treatment was not necessary. The locomotive shut down as a result of the collision and the emergency lighting automatically came on. After the train stopped, the VIA employees applied their emergency training. Emergency equipment (megaphones, trauma kits and flashlights) was accessed. The employees distributed the flashlights to passengers and proceeded with evacuating the train.

One of the locomotive engineers contacted the service manager by radio to advise of the situation and the optimal route for escape. The OTS employees then proceeded with an orderly evacuation of the passengers. Before the employees exited the train, they verified that no passengers remained. The evacuation took about five minutes.

All overhead baggage racks on the passenger cars remained closed and all baggage remained secured. Two food carts fell over in the aisles and food packages were strewn throughout the galley area. After the train had stopped, the food carts were pushed from the aisles onto the seats to facilitate the evacuation.

A passenger in the first coach used an emergency hammer to break an emergency exit window in the first coach, but was directed by employees to exit through the rear vestibule. The vestibule door at the front of the third car was blocked by debris, so passengers in that car had to exit by the vestibule door at the rear. The passengers were evacuated through the functioning vestibule doors, which were located at the end of each coach, onto the south side of the tracks, then led along an embankment, westward to the Holt Road overpass at Mile 293.39. This was the most direct and easiest route to follow to get the passengers away from the area.

The local fire department extinguished the fire at the rear of the VIA locomotive at 1940. Ambulance and fire department personnel removed the wire fence at the Holt Road overpass and assisted passengers up the bank. Injured passengers were transported to a local hospital for attention and the remaining passengers were transported by buses to the Oshawa VIA station as a staging area and then by other buses to their destination. There were no persons with physical disabilities on board and the evacuation was accomplished without problems. The emergency lights were still on in all cars at 2230.

1.7 Damage to Train 321 and VIA 68

The tractor portion of the truck, having been struck by the left front of VIA locomotive 6430, was dragged eastward approximately 700 feet. The locomotive derailed approximately 300 feet after contact and travelled in the derailed state for approximately 400 feet. The tractor damaged the south-side fuel tank and rear ladder of the leading freight locomotive and scraped the south side of the second freight locomotive and the following four freight cars. Substantial scraping and impact marks on the south side of the fifth, sixth, seventh and eighth freight cars matched with the crushed parts of the north and leading end of the first coach behind the VIA locomotive, which indicated that the rear of the locomotive and the front of the first coach, which were jackknifing, contacted the south side of the freight train in that area, resulting in the roll over of four tank cars. Damage to the track structure and the derailment of the VIA locomotive resulted in the derailment of the following four passenger cars. However, all passenger cars remained substantially upright with minor interior damage.

The derailment of the VIA locomotive wheels resulted in the bottom of the fuel tank striking the rails, causing the bottom of the fuel tank to be torn open and spill 6 800 litres (1 500 gallons) of diesel fuel, which in turn was ignited by the burning tractor. Both derailed freight locomotives remained upright and close to the rails. The lead locomotive, CN 5382, sustained a gash on the south side of the 3/16-inch-thick steel fuel tank, spilling approximately 4 550 litres (1 000 gallons) of diesel fuel.

1.8 The Crossing

The crossing at Mile 292.59 was originally installed as a farm crossing to provide access between farm buildings on the south side of the tracks and farm fields on the north side. Around 1980, the farm property and buildings on the south side of the tracks were purchased by the cement company; however, a small portion of land on the south side of the tracks was still farmed. In addition to providing access to farm property, this crossing provided a secondary entrance to both the cement plant and an Ontario Hydro property. The crossing was not illuminated.
The crossing planks measured 6.1 m (20 feet) in length, with the approach laneway just before the curve measuring 4.6 m (15 feet) across. There were no gates or barriers on either side of the tracks and no warning signage on the north side of the crossing.

A faded CN private crossing sign was on the south side, 60 cm square, with wording in English and French indicating that people using the crossing did so at their own risk. The approach to the crossing from the north side included a 90-degree left turn within 18 m (57 feet) of the track

with a 6 per cent ascending grade. CN was responsible for maintaining the crossing within the railway right-of-way, but not for maintaining the road approaches, or the warning and/or informational signage for road traffic approaching the crossing.

1.9 The Truck Operator

The driver of the truck had 16 years' experience driving tractor-trailers and had no previous accidents. He started work at his home base in Kitchener, Ontario, at 0700. The truck was equipped with a Citizens' Band (CB) radio and a cellular telephone. The driver was under the impression that the cellular telephone was only capable of communicating with the dispatch office. The driver was not aware of the fact that the 911 emergency telephone number tied in with railway emergency officers. He did not make an emergency call on either system while he was stuck on the crossing or after the derailment.

1.10 Weather

At the time of the accident, the night sky was clear and the temperature was 11 degrees Celsius. Winds were light, out of the south-east.

1.11 Mitigation of Environmental Damage

Berms were built in the ditches on both sides of the tracks to contain the flow of spilled diesel fuel. Retrieval mechanisms were installed to collect diesel fuel that might flush from the surrounding rail roadbed and earth. Environmental damage was minimal.

1.12 Crossing Issues

1.12.1 Public Crossings

Normally, low-traffic volume public crossings are equipped with reflectorized crossing signs (crossbucks) with advance warning signs on the roadway approaches. Crossings with higher traffic exposure are equipped with automated warning devices, typically flashing lights, bell and automatic gates on multi-track and high-speed or high-volume lines. Some public crossings are also equipped with signage warning of high-speed trains. At the time of the accident, there were very few (less than 10) public crossings with passive protection only (crossbucks or crossbucks and stop signs) on the Kingston Subdivision. CROR Rule 14(l)(ii) requires approaching trains to whistle at least one-quarter mile from public crossings at grade, except within limits as may be prescribed in special instructions.

Multiple advance warning signs, including warning signs indicating "High Speed Trains" and "STOP" (not the standard octagonal highway stop sign) have sometimes been used on road approaches to passively protected crossings in Ontario. A toll-free emergency phone number is posted at all CN public crossings throughout Canada, either mounted on the back of a crossbuck or on signal cases or bungalows adjacent to signalized crossings.

1.12.2 Private and Farm Crossings

CN's Standard Practice Circular (SPC) 2700 of January 1998 entitled *Road Crossings* outlined construction requirements for all new crossings (public, private and farm) which were to conform to Transport Canada (TC) standards laid out in General Order E-4 of the former Canadian Transport Commission (CTC). General Order E-4 had been superseded by
CTC 1980-8 RAIL in 1980, which was subsequently amended in 1985 to specify the new pictogram-style crossing signboard requirements. The regulations set standards for the crossing surface, approach gradient (maximum of five per cent) and crossing width. The regulations did not contain standards for the general horizontal alignment or width of road approaches. Sight-lines to permit clear visibility of trains had to adhere to TC Guideline G4-A. This guideline was based on a requirement for roadway vehicles approaching a crossing to have lines of vision sufficient to provide at least 10 seconds of visibility of an approaching train. The minimum sight-line requirements were based on the maximum permissible train speed and the roadway's permissible operating speed.

CN's private crossing agreements outlined the requirements for the licensee. Those parts of the agreement relating to safety included sight-line clearing in accordance with TC Guideline G4-A, and where applicable, the requirement for crossing protection over and above crossbucks was to be listed in an appendix. The agreements also contained a clause indicating licensee responsibilities for ensuring securement from use by unauthorized users and from use by tracked vehicles. Additionally, SPC 2700 specified that all new crossings would be constructed to a safe standard, in accordance, *inter alia*, with General Order E-4 and TC Guideline G4-A. SPC 2700 also stated that any conversion of private or farm crossings to public crossings must be made to safe standards acceptable to TC.

SPC 2700 did not address any construction or upgrading requirements for existing farm or private crossings which did not conform to TC's minimum requirements. According to SPC 2700, a regulatory order or formal agreement is required for new private crossings, but not for new farm crossings.

The *Railway Act* provided an historical right to farm crossings. Where an absolute right to a farm crossing could not be established, the landowner could apply to the CTC and receive an order requiring the railway to construct a crossing where the landowner could prove the crossing was

necessary for the proper enjoyment of the land and safe in the public interest. In 1996, the *Railway Act* was repealed and the farm crossing provisions were amended and enacted as sections 102 and 103 of the *Canadian Transportation Act*.

Farm crossings are an historical right. The circumstances in which new farm crossings would be granted over existing rail lines are typically for activities such as when land is opened up for logging activities, and account for approximately 35 new crossings per year. The provisions in the *Canadian Transportation Act* may be used where new rail lines are constructed. Where this occurs, the determination made by the Canadian Transportation Agency (CTA) hinges on whether there is a right to the crossing or whether it is necessary for the enjoyment of the land. The CTA no longer has the statutory authority to attach safety conditions to its order. Construction standards for these crossings are determined by TC. While CN has been voluntarily applying the standards of the draft crossing regulations, that fact is not referred to in its SPCs which contain no geometric design standards for construction of road approaches to new farm or private crossings. Once a crossing is built, there is no restriction on who can use it or for what purpose it can be used.

There were no requirements for property owners with private or farm crossings to notify the railway if there was a change in intensity of land use (for example, if a farm property was to be used for resource exploitation, such as a gravel pit or a sod farm, which would increase the volume and nature of heavy traffic over the crossing).

Although the *Railway Act* had a requirement for farm crossings to have swing gates remaining closed when not in use, the statutory requirement for them to be closed was removed following the implementation of the *Railway Safety Act* in 1989. There was no equivalent gate requirement for private crossings (crossings not for farm use which provide access to private property through private rights-of-way). No toll-free emergency number was posted at these crossings.

Most private crossings in Canada were equipped with signboards, information or warning signs. In the case of farm crossings, there was typically no protection except swing gates, which could be closed. Road traffic volumes on both private and farm crossings were low in most cases. There were no CROR requirements for whistle signals at private or farm crossings.

A sample examination of 11 farm crossings was made on the Kingston Subdivision in June and July 2000, mostly between Mile 280 and Mile 296, but included some located further to the east as far as Prescott around Mile 106. The majority of these 11 crossings were not heavily used.

Sight-lines were impeded at all 11 crossing locations, with brush, trees or high grass impeding visibility for roadway users. Approach grades were 10 per cent or more in three cases. Roadway width was 2.5 m. Three crossings were equipped with either one or two swing gates and these were all closed. Crossing planking was deteriorated in two cases. Fencing was non-existent in one case where there was a gate which was closed. Eight of the crossings had no warning signage. Two crossings were equipped with pedestrian warning signals; in one case, one of the signal heads was missing. Only one crossing was equipped with signage to warn drivers that high-speed trains operated on the line—a farm crossing at Mile 149.00 which was equipped with one

highway stop sign, including a sign below indicating: "Danger, High Speed Trains." There was no gate at this location and the signage was on the south side only.

1.12.3 Crossing Inventory Data

TC had an integrated rail information system (IRIS) listing over 20 000 public rail/highway crossings in Canada under federal jurisdiction. At least an equivalent number of private and farm crossings was estimated.

TC records indicated that there were 370 crossings at grade over the 330 miles of main track on the Kingston Subdivision between Montréal and Toronto. Of these, 183 were denoted as public crossings, with almost all equipped with flashing lights, bell and gates (the balance being equipped with crossbucks at the crossings and typically with advance warning signs on the approaches). The rest were farm crossings (171) and private crossings (16). Additionally, 154 grade separations were listed, including 1 for a farm crossing. TC did not have records of all farm and private crossings on its database, but data were being entered as and when private and farm crossings were inspected. Comparative CN grade crossing data for the same 330 miles indicated that there were 157 public crossings, 241 farm crossings and 26 private crossings. The CN data indicated that the protection on the farm and private crossings was passive, including signs, except for one crossing equipped with an automated warning light system for farm workers.

Twelve accidents occurred at private and farm crossings on the main tracks of the Kingston Subdivision between January 1990 and September 2000. These accidents resulted in one serious injury. Eight of the twelve accidents involved VIA passenger trains. The vehicles using the private and farm crossings were typically commercial or farm equipment.

In the same time period, there were 29 accidents resulting in 16 fatalities (including 4 train passengers, 2 pedestrians and a cyclist) at public crossings. Sixteen of those accidents involved VIA trains.

1.13 Transport Canada

1.13.1 Inspections

TC's rail safety inspectors worked on an audit and monitoring basis. They had inspection targets for crossings each year, set by TC headquarters. The percentage of crossings inspected each year depended on the TC region, and was based on a stratified sampling and risk-based approach. The larger the number of crossings in a territory, the smaller the proportion of crossings needing to be inspected to quantify the general condition and risk posed by the crossings in the region. The inspections focused primarily on public crossings, which are considered to have a greater number of risk factors than private and farm crossings. However, TC did make cursory inspections of all crossings situated on a portion of a line being inspected as part of the track inspection program.

1.13.2 Regulations

TC had had a major project underway for several years to upgrade and update its crossing regulations. The regulations were intended to incorporate, by reference, design and maintenance standards for road crossings which were far more comprehensive than those specified by the existing regulations, CTC 1980-8 RAIL, as amended. The document which was to be incorporated by reference was the *Road/Railway Grade Crossings—Technical Standard and Inspection, Testing, and Maintenance Requirements* (the draft crossing manual). While drafts of the manual had existed for several years, the best estimate for publication of the new regulations in Part I of the *Canada Gazette* was given as the spring of 2002. The coming into effect of the regulations, upon publication in Part II of the *Canada Gazette*, would occur several months later, to allow for possible modification to the regulations after comments from interested persons have been received.

1.13.3 Direction 2006

Direction 2006 is a partnership sponsored by TC, the railway industry, provincial and municipal governments, law enforcement agencies and railway unions. The goal is to take a comprehensive approach, from engineering, educational, enforcement, legislative, resourcing, research and communications perspectives, to reduce the number of grade crossing and trespassing accidents by 50 per cent by 2006, when compared with 1996. This group has published an information document (27 500 brochures printed) for those persons who have private or farm crossings on their property. The document states, *inter alia*, that:

- one of the keys to crossing safety is an informed user;
- where gated, the crossing gate is to be closed and locked;
- crossing warning signs are to be visible and in good condition; and
- the owner must ensure that all users of the crossing are aware of the safety requirements.

The document is silent on crossing approach roadway geometry or alignment, but it does contain a section which encourages crossing owners to apply for the closure of unnecessary crossings or for the consolidation of a group of crossings.

One of the initiatives of Direction 2006 is to have the railways install toll-free emergency numbers at road crossings across the country to identify crossing-related problems.

1.13.4 Crossing Closures

There were approximately 12 closures of private or farm crossings on the Kingston Subdivision between Brockville and Toronto since 1989. The closures resulted from a safety assessment of the line, relating to the planned increase in passenger train speeds from 95 mph to 100 mph along several sections of the Kingston Subdivision. TC encouraged the closing of two farm crossings, and the change of status of a nearby public crossing to a farm crossing, with a swing gate, which provided access to a handful of properties. The level of safety was improved because the design and construction of the public crossing was superior to that of the other two.

In 1999, the *Railway Safety Act* was amended to allow grants to be made to close grade crossings where safety is an issue. Work was underway to define the process and criteria under which these grants would be made and in what amount. Direction 2006 has targeted the Chatham Subdivision in south-western Ontario as the first line where a project on closures will be carried out.

In the United States, the 125 mph Amtrak corridor between Washington, D.C. and New York has no at-grade public or private crossings. Since the 1970s, all grade crossings had been closed or converted into grade separations (overpasses or underpasses). The number of grade crossings needing to be closed or grade-separated was less than the number which existed on the Kingston Subdivision. The action to take this approach was initiated by Amtrak, and was completed in cooperation with local and state governments aided by federal funding. TC's draft crossing regulations are intended to prohibit any new at-grade crossings for lines where permissible operating speeds are in excess of 80 mph.

2.0 Analysis

2.1 Introduction

Train 321 and VIA 68 approached the vicinity of Mile 292.5 operating in compliance with company operating procedures and government safety standards. Both crews were alert and responded appropriately to the emergency situation. The emergency radio broadcast by the crew of train 321 and the subsequent reaction of the VIA 68 crew members in braking their train resulted in a significant reduction in speed. This lessened the severity of impact with the tractor and is indicative of the competence of the crews and effectiveness of the particular rules relating to emergency situations.

The analysis will discuss the actions taken by the truck driver, issues of private and farm crossings on high-speed corridors, the design of locomotive fuel tanks and the passenger evacuation process.

2.2 Truck Driver's Actions

Using only the instructions provided to him verbally, the truck driver would have formed a mental model of the directions he needed to take to reach the cement plant. It is apparent from the driver's actions that, once he left the 401, his model could not be sustained, and he began to improvise.

When the driver left the 401 at the Waverly Road exit, it is likely that he believed that he was on Waverly Road. The only visual cue available to him to the contrary was the directional sign before the intersection of the ramp and the South Service Road which indicated that access to Waverly Road required a left turn. When he reached the intersection, there was no other signage to indicate a left turn was required. The one compelling cue he did have, however, was the huge cement plant to the south-west. Not having seen the sign indicating the left turn and with no other informational signs at the intersection to direct him to Waverly Road, the driver turned to the right, a turn which may have been more intuitive for him given the location of the cement plant.

When he reached the intersection of Holt Road, he realized that he had gone too far and turned back. He then turned down Symons Road, notwithstanding the "No Exit" sign and the fact that the road was unpaved and gravel. Only when he reached the point on Symons Road where it made a tight turn to the south did the driver realize that he was again on the wrong route.

As the driver was unfamiliar with the area, consultation with a map or the dispatch office would have solidified the verbal instructions he had received into an accurate mental model of what he could expect in terms of when he was required to turn and which way. Without an accurate model, his decisions were being made on the fly and were based on less-than-reliable cues. These errors were the initial unsafe acts that put the driver at the crossing.

Once at the crossing, the driver was not aware that the track on which his vehicle was immobilized for more than 10 minutes was a double main line, i.e. high-traffic main line. Had the crossing been equipped with signage warning drivers that high-speed trains operated on the track, the driver may have had second thoughts about using the track or, once he was in his predicament, may have immediately tried to warn of the impending danger. A toll-free emergency telephone number, posted at the crossing and similar to that provided on signboards or signal cases or bungalows at public crossings, could also have prompted the driver to call immediately, thereby averting or minimizing the consequences of the accident.

2.3 Farm and Private Crossings

2.3.1 The Crossing at Mile 292.5

The laneway approach to the crossing was poorly aligned and narrow, with a tight left-hand curve onto the crossing. The truck broke through the top of the wooden box abutment, fell partially into the ditch and became immobilized. Had adequate information and warning signage been installed on the crossing approaches, the driver would have had the opportunity to make a more informed choice of route.

The Direction 2006 pamphlet advocates an informed user as being one of the keys to crossing safety. This general principle is most applicable to public crossings where many unfamiliar drivers make use of the crossing. Most farm and private crossings are used almost exclusively by the landowner although some are used for activities such as logging or other resource extraction where use is less restricted. Where members of the public, who are unfamiliar with the crossings, deliberately or inadvertently use these crossings, they may be exposed to hazards. In these situations, more information and warning signage and a closed gate would deter a vehicle driver who wanted to use the crossing. In the absence of this deterrence, improved laneway and crossing approach designs would make these crossings easier to negotiate.

2.3.2 Design and Construction Standards

It is reasonable to assume that most farm owners and private property owners provided with farm and private crossings are not familiar with the standards required to construct and maintain adequate road approaches. The majority of farm crossings have been built for slow-moving farm vehicles and equipment, and the road approaches have been constructed to lower standards than those used for public crossings.
Many factors can contribute to road users proceeding into an unsafe situation. They include: narrow laneways, poor horizontal alignment with sharp turns close to the crossings, the lack of advance information signage, the lack of signage warning of high-speed trains, multiple main tracks, restricted sight-lines because of locations in or at the end of a railway curve, and the lack of gates to prevent unauthorized passage.

Numerous farm and private crossings, even on high-speed, high-density corridors, do not meet standards to permit the safe passage of highway vehicles or even off-road vehicles such as snowmobiles or all-terrain vehicles. CN's SPC is silent on horizontal alignment of approaches. Private and farm crossings with low standards of construction are unlikely to be identified by their owners as deficient in that area since the owners are not usually experts in construction. Additionally, the sample of crossings reviewed along the Montréal-to-Toronto corridor indicated that the level of information and warning signage posted at these crossings is inconsistent from one crossing to the next. As a result of this inconsistency, a road user could be unaware of the potential hazards of using those crossings.

While private and farm crossings do not typically carry high volumes of traffic (anywhere from a few vehicles per day or week to tens of vehicles per day, in comparison with anywhere from 40 or 50 vehicles per day to 10 000 or more per day on public crossings), their design, maintenance and protection systems have been to a much lower standard than those of public crossings, and warning or information signage for regular, occasional and infrequent users is minimal. Because there was no information in the Direction 2006 brochure on the design and maintenance of the road approaches to private and farm crossings, it is unlikely that any changes will be made to crossings which have a low standard of horizontal alignment or construction, such as existed at the crossing at Mile 292.59.

Very few private or farm crossings across Canada have automated warning systems. No comprehensive review has been made of the level of warning systems at all private and farm crossings on high-speed corridors, and the current need for those crossings has not been examined. (One review was done by TC on specific sections of the Kingston Subdivision before the implementation of 100 mph permissible track speeds in certain areas for VIA Light, Rapid, Comfortable (LRC) trains.) The small survey made as part of this investigation indicates that many private and farm crossings are below TC's existing regulatory requirements, which are significantly lower than the planned upcoming regulatory requirements. TC's new legislation allowing funding of closures is a positive step to allow reduction in the number of these crossings.

TC intends to publish its new crossing regulations in the near future. The regulations will address the issue of crossing design standards for private and farm crossings. However, the absence of standards for horizontal alignment at unrestricted private and farm crossings and the absence of standards for horizontal alignment and approach road signage at restricted crossings will limit the overall safety value of this initiative.

2.3.3 Accidents

Between January 1990 and September 2000, 41 main track crossing accidents occurred on the Kingston Subdivision, 12 of which at private or farm crossings. Typically, traffic using private or farm crossings and involved in accidents has been of the commercial type, suggesting that the probability of a train derailment may be proportionally higher at these crossings compared with public crossings. Despite the low traffic volumes at these crossings, low approach speeds, steep grades and slow-moving, long or heavy equipment, the vehicles could take a longer time to pass over private or farm crossings, compared with typical highway traffic on a public crossing. The fact that there are about 200 low highway traffic volume farm and private crossings over railway tracks used by high-speed trains in the Montréal-to-Toronto corridor poses a significant risk to the safety of railway employees and the travelling public.

2.3.4 Rights to Crossings

The requirements for persons to have rights to new private and farm crossings relate solely to their ownership of lands on either side of the line where access is being impeded by that line. While new crossings will be built to a higher standard than the thousands already existing, the safety criteria outlined in CN's SPC are not the optimal criteria. They refer only to the immediate crossing area and remain silent on the design of road approaches to incorporate the load, dimensions and performance characteristics of the equipment.

2.3.5 Regulations and Legislation

TC's draft crossing manual and proposed regulations take a much more comprehensive look at safety issues when compared with the existing crossing regulations, with more detail on design and maintenance criteria for all crossings. However, there is an issue relating to higher-speed, high-density rail lines as to whether it is a good safety practice to keep a large number of private and farm crossings and to allow the number to increase. A collision with any train, particularly with passenger trains, magnifies the potential outcome of a crossing accident, presenting a threat to railway employees, crossing users, the local population and the travelling public. While the draft regulations state that there shall be no new grade crossings on subdivisions where the permissible operating speed is greater than 80 mph, there may be opportunities to close or combine many crossings on the Kingston Subdivision where the authorized speed for trains is 95 mph or more. Grade separations, while perhaps not viable alternatives on an individual basis, could also be considered if a group of crossings could be closed and rerouted, especially if some lower-cost grade separation system could be developed.

Regarding the issue of a database of private and farm crossings, TC was updating its database, but not to the extent where it would quickly be complete and comprehensive. Where private and farm crossings exist, especially over high-density or high-speed tracks, it is in the best interest of safety for the regulator to be aware of their location and characteristics. In order to assess the level of safety of these crossings, the first act would have to be to take inventory. The inventory would have to be continuously maintained to permit ongoing monitoring of the relative level of safety of the crossings.

The concept of continuing to give an automatic right to landowners to new farm crossings anywhere on the federal rail system can be questioned from a safety perspective. This historic right to a crossing, especially when the rail line is high speed or intensively used, increases the risks to train crews, train passengers and the vehicle occupants using the crossing. It creates a situation where traffic exposure occurs at a location with a lower level of protection than would be found at a new public crossing.

While there is a significant number of grade separations over the Kingston Subdivision (TC data listed a total of 154), there are also over 350 private, farm and public grade crossings on the subdivision's 330-mile length. Apart from the 100 mph passenger train study 10 years ago on selected parts of the subdivision, the rest of the crossing issues on the Kingston Subdivision have been addressed only on a case-by-case basis.

The U.S. Amtrak 125 mph corridor (bearing in mind that this is a 25 per cent higher speed on a corridor which had a smaller initial number of crossings) has a significantly higher level of crossing safety requirements when compared with the high-speed (100 mph), high-traffic density Montréal-to-Toronto corridor.

No consideration seems to have been given to treating any Canadian rail high-speed corridor in a similar way to the Amtrak model with grade crossings either being converted to grade separations or else being closed. While there has been a small amount of selective closures and rerouting of traffic over higher-standard grade crossings, there has been no long-term program reducing the number of grade crossings along the Montréal-to-Toronto corridor.

2.4 Integrity of Locomotive Fuel Tanks

Between 01 January 1995 and 31 August 2000, according to TSB records, 170 accidents were reported where locomotives leaked fuel. At least 38 of these leaks resulted in the release of 1 000 imperial gallons (4 540 litres) or more. In one case, three locomotives in a train had their fuel tanks ruptured, resulting in the loss of over 8 000 gallons (36 320 litres). Main track freight locomotives have a fuel capacity of approximately 3 000 imperial gallons.

The puncture and release of fuel from locomotive fuel tanks is a relatively common occurrence when diesel locomotives derail. TSB records for the last 10 years indicate that there are typically 30 punctures and releases per year. When derailments of locomotives are accompanied by fire, it adds to the danger for employees and the travelling and non-travelling public. In the case

where dangerous goods and passenger trains are involved, the situation can become serious. The fire on a VIA train at Brighton (TSB report No. R94T0357) is a good example of the potential for harm to passengers and employees.

New locomotives constructed and delivered in North America are now equipped with heavier gauge fuel tank walls. There are no plans to retrofit the 3 000 or so locomotives operating in Canada and not so equipped. Other than the current requirement for new locomotive fuel tanks to be made of heavier gauge steel, the Board is not aware of any plans to install systems such as baffles or bladders in fuel tanks to mitigate release of fuel in the event of a puncture.

2.5 The Evacuation

Passengers were evacuated and removed from the site in a quick and efficient manner. Both freight and passenger train employees responded efficiently and effectively to protect the travelling public as a priority over their own safety in the presence of fire and flammable gases.

3.0 Conclusions

3.1 Findings as to Causes and Contributing Factors

1. The truck driver, without appreciating the difficulty and risk involved, inappropriately attempted to use the farm crossing as a means to turn his vehicle.

2. The tractor-trailer became immobilized when the rear wheels of its trailer broke through wooden ties covering a ditch on the poorly aligned, signed, constructed and maintained southward approach.

3. The truck driver was not aware of or trained in the emergency communications tools available to him. The prompt use of these tools may have averted the accident.

3.2 Findings as to Risk

1. The design, construction, signage and maintenance of many existing private and farm crossings are of a lower standard than those of public road crossings. New private and farm crossings are built to a higher standard in the immediate vicinity of the crossings, but do not have any horizontal alignment standards for the approaches to the crossings.

2. The existence of hundreds of private and farm crossings over railway tracks used by high-speed trains in the Montréal-to-Toronto corridor poses a risk to the safety of railway employees and the travelling public.

3. There is no long-term program for reducing the number of grade crossings along the Montréal-to-Toronto corridor.

4. The concept of allowing automatic crossing rights to landowners for new farm crossings, where property is owned on both sides of the track, increases the risk to the safety of train crews, train passengers and vehicle occupants using the crossing, especially on high-speed lines.

5. The design, location and material specifications of the majority of locomotive fuel tanks leave them susceptible to puncture. The leakage of diesel fuel and the resultant potential for fire poses a risk to the environment and to the safety of employees and the travelling public when passenger trains are involved.

6. The availability of a toll-free emergency number posted at the crossing might have averted or minimized the consequences of this accident.

4.0 Safety Action

4.1 Action Taken

The farm crossing has been closed. Transport Canada (TC) officials held a site meeting on 07 December 1999 at the crossing, with representatives of Canadian National (CN), the cement company, Ontario Hydro and the local municipality, to discuss safety concerns regarding the crossing. By that time, three large concrete blocks, approximately 1 m by 0.7 m by 0.7 m, had been positioned on either side of the crossing to prevent further vehicular usage. Additionally, the planking from the north track had been removed and placed to the side of the tracks. Barriers already had been installed by CN on both sides of the crossing to prevent vehicular usage. All persons at the meeting agreed that the crossing should be closed permanently.

Supervisors of the driver's trucking company acknowledged the lack of awareness of the use of the 911 system. Consequently, they have since included the use of the cellular telephone as a tool to be used to call for emergency assistance. Their drivers have been instructed in the use of the 911 emergency system.

4.2 Action Required

The Board recognizes that the Department of Transport has done much work over the past 10 to 13 years to develop new crossing regulations. However, the Board is concerned about the time taken to replace the existing regulations, which are minimal and essentially obsolete. The delay in publishing new regulations is not advancing crossing safety in Canada. The Board therefore recommends that:

> The Department of Transport expedite the promulgation of new grade crossing regulations.
>
> R01-05

This investigation demonstrated that a lack of geometric design criteria for crossings can lead to accidents. Because there is no horizontal alignment standard for road approaches to private and farm crossings outside railway rights-of-way, it is believed that an unnecessary risk is posed to the travelling public, train crews and users of those crossings. Therefore, the Board recommends that:

> The Department of Transport's new regulations include horizontal alignment standards for approaches to private and farm crossings.
>
> R01-06

Finally, the Board is particularly concerned about the high number (approximately 200) of private and farm crossings on the high-speed Kingston Subdivision. The subdivision is one of the highest speed and heaviest used subdivisions in Canada, with around 50 trains operating over it on a daily basis, 18 of which are passenger trains carrying a total of 2 400 passengers. With urban development likely to increase along this corridor, the use of private and farm crossings is likely to increase, which will in turn increase the probability of an accident at these crossings unless significant safety action is taken. While some effort has been made in the past to close or consolidate crossings, significant action has been taken only once. Because of the large number of private and farm crossings, most of which having very limited warning systems, users of those crossings, the travelling public as well as train crews are exposed to unnecessary risks. Therefore, the Board recommends that:

> The Department of Transport, in cooperation with Canadian National, comprehensively examine all private and farm crossings on the Kingston Subdivision with a view to closing or consolidating crossings, and where identified as necessary, upgrade those remaining to lessen the safety risk.
>
> R01-07

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 11 September 2001.

Appendix A - Glossary

CB	Citizens' Band
cm	centimetre
CN	Canadian National
CROR	Canadian Rail Operating Rules
CTA	Canadian Transportation Agency
CTC	Canadian Transport Commission
draft crossing manual	*Road/Railway Grade Crossings—Technical Standard and Inspection, Testing, and Maintenance Requirements*
EST	eastern standard time
IRIS	integrated rail information system
km	kilometre
LPG	liquefied petroleum gas
LRC	Light, Rapid, Comfortable
m	metre
mph	mile per hour
OTS	on-train service
RTC	rail traffic controller
SPC	Standard Practice Circular
TC	Transport Canada
TSB	Transportation Safety Board of Canada
U.S.	United States
UTC	Coordinated Universal Time
VIA	VIA Rail Canada Inc.