Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT
R04H0009

CROSSING COLLISION

VIA RAIL CANADA INC.
TRAIN NUMBER 49
MILE 17.88, SMITHS FALLS SUBDIVISION
MUNSTER, ONTARIO
28 JUNE 2004

Canada

Railway Investigation Report

Crossing Collision
VIA Rail Canada Inc.
Train Number 49
Mile 17.88, Smiths Falls Subdivision
Munster, Ontario
28 June 2004

Report Number R04H0009

Summary

On 28 June 2004 at 1836 eastern daylight time, VIA Rail Canada Inc. passenger train No. 49, travelling westward at 93 mph, struck an empty 10-ton dump truck at the public crossing at Mile 17.88 of the Smiths Falls Subdivision, near Munster, Ontario. The truck was destroyed, and the occupant was fatally injured. There were no injuries to the passengers or crew on the train.

Ce rapport est également disponible en français.

Other Factual Information

The Accident

On 28 June 2004, westward VIA Rail Canada Inc. (VIA) train No. 49, en route from Ottawa, Ontario, to Toronto, Ontario, was travelling at 93 mph on the Smiths Falls Subdivision (see Figure 1). At 1836 eastern daylight time,[1] as the train approached the Kettles Road level crossing, the crew observed a northbound dump truck enter the crossing without stopping. The impact of the subsequent collision destroyed the truck and the lone occupant was fatally injured. With the train brakes in emergency, the train came to a stop approximately ½ mile west of the crossing. The truck was struck on the passenger-side door, just ahead of the truck box. The truck came to rest in the south ditch, west of the crossing.

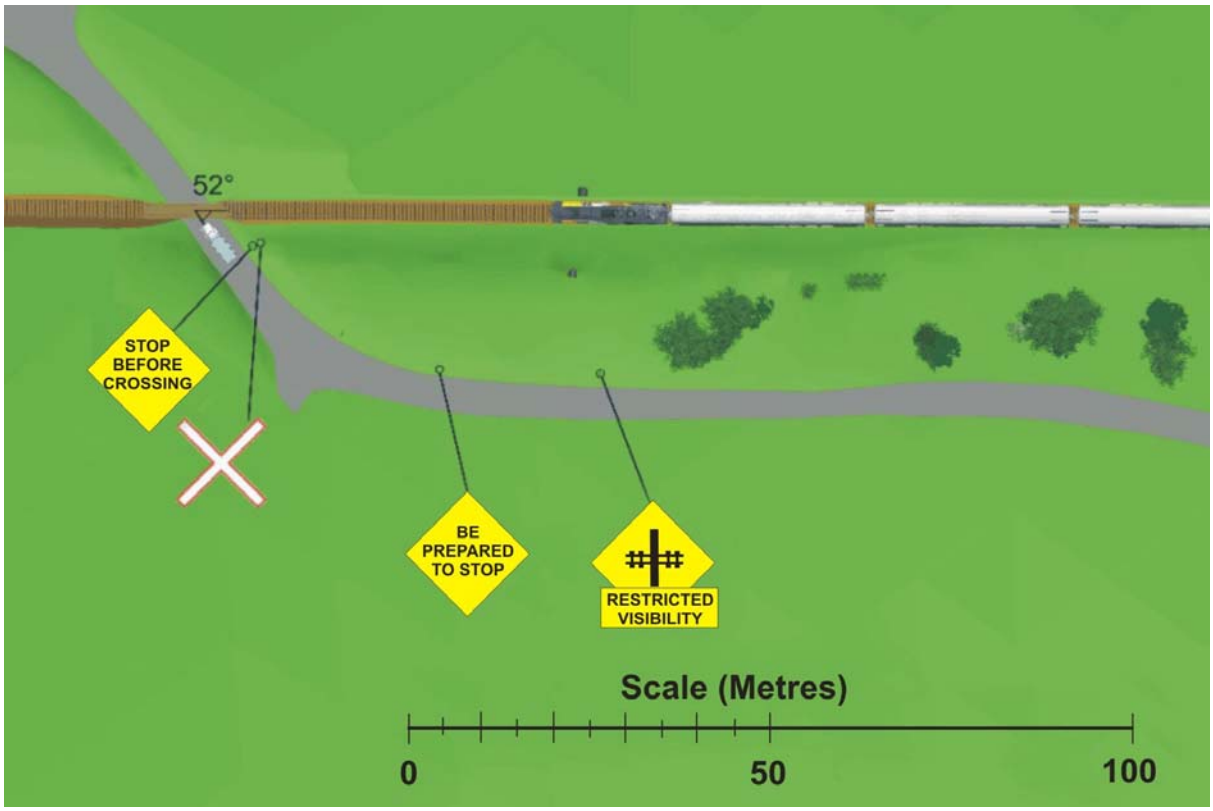

Figure 1. Overhead schematic of Kettles Road crossing, approximately 10 miles southwest of the Ottawa suburbs, just east of County Road 3

The locomotive sustained substantial mechanical damage, including damage to the locomotive snow/plow pilot, side sill frame, side doors, and electrical cabling. Post-accident examination revealed that the north rail at the crossing had shifted approximately 1½ inches (4 cm) to the field side, as a result of the collision force.

---

[1] All times are eastern daylight time (Coordinated Universal Time minus four hours).

Photo 1. Driver's view to the right of the approach of Kettles Road crossing

Weather

At the time of the accident, the weather was partly cloudy with a temperature of 20°C. There was a light wind and clear visibility.

Train Information

The train, which consisted of one locomotive and three passenger coaches, was 311 feet long and weighed approximately 285 tons.

The locomotive, VIA 6405, was a General Motors F40PH-2 series locomotive. The train horn was mounted on the top of the locomotive body, midway between the front and rear of the locomotive.

Personnel Information

The operating crew of the train consisted of two locomotive engineers. They were qualified for their positions, and met company and regulatory fitness and rest standards.

Smiths Falls Subdivision

The Smiths Falls Subdivision is VIA's main line between Ottawa (Mile 3.5) and Smiths Falls (Mile 34.5).

Train movements on the Smiths Falls Subdivision are governed by the Occupancy Control System method of train control, as authorized by the *Canadian Rail Operating Rules* (CROR), and are supervised by a rail traffic controller located in Montréal, Quebec.

The authorized timetable speed in the vicinity of the crossing was 95 mph for passenger trains, and 60 mph for freight trains. Approximately 10 passenger trains traverse this track daily between 0600 and 2200. There is typically no freight traffic over the Kettles Road crossing; however, a way freight operates between Ottawa (Mile 3.5) and Mile 12 every third day. There are 21 public crossings with automated warning systems and 5 public crossings without automated warning systems (known as passive crossings).

Particulars of the Track

The Smiths Falls Subdivision consists of a single main track. The track at the crossing was tangent, with a level grade, and consisted of 115-pound continuous welded rail. Track components were in good condition and met the requirements of Transport Canada–approved *Railway Track Safety Rules*.

Particulars of the Kettles Road Crossing and Approaches

Kettles Road is a two-lane, undivided gravel road, used primarily by local residents. Vehicle traffic on Kettles Road is low, at approximately 10 vehicles per day. The allowable speed for vehicles on this road was not posted. In the City of Ottawa, on roads where the speed limit is not posted, vehicles are permitted to operate at speeds up to 50 km/h.

The Kettles Road crossing was equipped with standard reflectorized crossing signs. For approaching traffic on Kettles Road, there was a sharp right-hand curve in the road just before the crossing. The road intersected the track at an angle of 52 degrees to the right side of an approaching northbound vehicle. The terrain approaching the crossing from the south was initially level, then changed to a 4.55 per cent ascending grade at the crossing within 16 m of the track.

Advance warning signs had been installed in 1992 on the crossing approaches. These signs were the Ministry of Transportation of Ontario (MTO) scheme 2 signs, which indicated sequentially: Restricted Visibility, Be Prepared to Stop, and Stop Before Crossing (see Photo 2). These signs were intended as interim advisory measures, which were to be removed once a permanent improvement to the crossing was made. These warning signs are not regulatory signs, in that they are not enforceable. Scheme 2 signs are yellow-background, diamond-shaped signs with black markings and black lettering. Although the tab at the bottom of the first of the three signs correctly indicated restricted visibility, the sign's graphic indicated that the crossing was at a perpendicular angle to the approaches. Advance warning signs exist that depict acute-angled crossings.

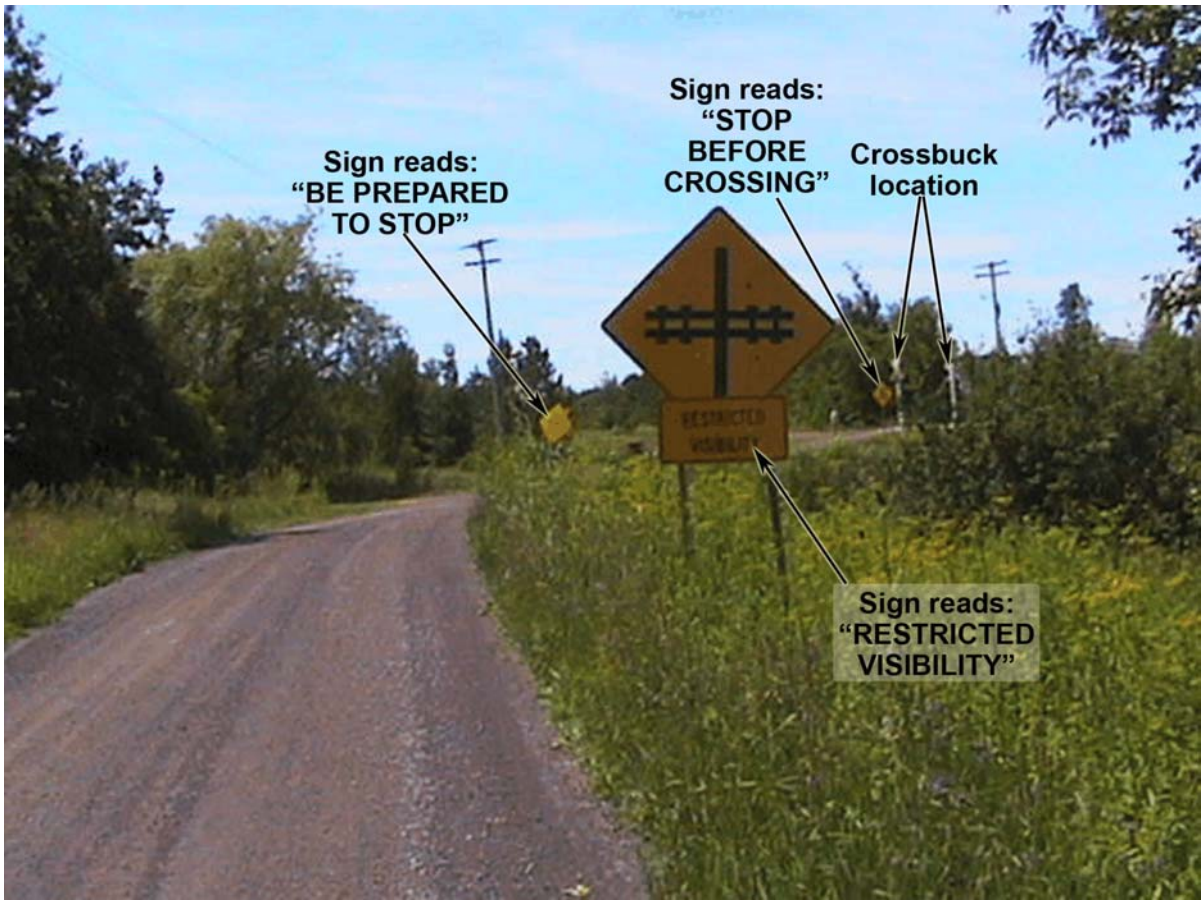

Photo 2. Scheme 2 signs for the acute-angled crossing

Recorded Information

The locomotive event recorder indicated that the train was travelling at 93 mph, in throttle position No. 8 (maximum), as it approached the crossing. Approximately one second before the collision, the train brakes were placed into emergency. The locomotive horn, commonly referred to as the whistle, had been sounded for approximately 10 seconds before entering the crossing. The locomotive's two headlights and two ditch lights were illuminated.

Truck and Driver Information

The truck was a 1989 Ford LNT 8000 dump truck, owned by a local excavation company. Its empty weight was approximately 10 600 kg. The truck driver was licensed to operate a truck of this type. Most commercial trucks such as the one in this accident do not have rear window views by design, and rely on mirrors only. It was not determined whether the driver was wearing a seat belt.

Post-accident Examination of Truck

There was no indication of any prior mechanical problem with the truck that may have contributed to the accident. A post-accident examination of the truck was conducted with respect to the cab condition (TSB Engineering Laboratory report LP 091/2004). The post-accident examination indicated the following information:

- The truck was travelling at 16 km/h at the time of impact.
- There was no conclusive evidence to determine whether the heater/air conditioning fan switch was in the ON or OFF position.
- The radio was on, with the volume knob set at the lowest position.
- The driver-side window was fully down.
- Glass fragments were found in the rubber strip along all three sides (that is, top, front, and rear) of the passenger-side window, indicating that this window was closed.

Regulatory Requirements for Railway–Highway Crossings

The Kettles Road crossing installation met the requirements of the existing regulations governing the construction of such crossings as found in CTC 1980-8 RAIL, *Railway–Highway Crossing at Grade Regulations*. The regulations outline basic horizontal and vertical geometric design specifications for crossings, and minimum dimensions for the crossing surface. The only signage requirement referenced is to a standard reflectorized crossing sign. There is no requirement for a minimum allowable crossing angle.

Transport Canada has been developing a technical standards manual (RTD 10)[2] that will be incorporated by reference into the new Grade Crossing Regulations. These latter regulations have been in development since 1988. With respect to passive railway crossings, these new standards and regulations will be more comprehensive than what currently exists. The manual suggests that

- A crossing angle should not be less than 70 degrees.
- Where there are inadequate sight-lines, stop signs shall be installed.

The latest draft of the proposed Grade Crossing Regulation, Section 21, states that no person shall construct a grade crossing if train speeds on that railway line exceed 80 mph.

---

[2] RTD 10: Road/Railway Grade Crossings – Technical Standards and Inspection, Testing and Maintenance Requirements

Several Board investigations have mentioned the lack of new grade crossing regulations. For example, in report R99T0298, the Board made the following recommendation:

> 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, issued October 2001)

While this recommendation was made four years ago, the regulations have still not come into effect, despite Transport Canada's reply to the Board in 2001 that the regulations were expected to come into effect in 2002.

Requirements for Train Horn Use Approaching a Crossing

Under the requirements for engine whistle signals in the CROR, Rule 14(l) indicates that the train horn must be blown using two long, one short, and one long succession of sounds at every whistle post. The rule also states:

> The whistle must be blown at least ¼ mile from every public crossing at grade (except within limits as may be prescribed in special instructions) to be prolonged or repeated according to the speed of the movement until the crossing is fully occupied by the engine or cars. The horn is also to be blown at frequent intervals when view is restricted by weather, curvature, or other conditions.

A change to this rule has been proposed that states: "Whistle signal must provide for a signal warning of 10 seconds minimum duration, or if approaching the crossing in excess of 60 mph, commencing at the whistle post. Whistle signal should not exceed 20 seconds when practicable. NOTE: The whistle post shall be located at least ¼ mile in advance of the crossing unless otherwise designated in special instructions."

Transport Canada has not yet approved this proposal.

Train Horn Audibility

In 1996, the TSB conducted an investigation into a VIA accident near Tecumseh, Ontario (report R96S0106), which involved a trespasser fatality. The investigation determined that the location of the train horn on the model of locomotive involved was problematic.

Transport Canada's *Railway Locomotive Inspection and Safety Rules*, as revised 24 September 2002, state that locomotive horns "must produce a minimum sound level of 96 decibels (dBA) at any location on an arc of 30.5 m (100 feet) radius subtended forward of the locomotive by angles 45 degrees to the left and to the right of the centre line of the track in the direction of travel."

A study[3] conducted by the Volpe National Transportation Systems Center suggests that, for peak safety effectiveness, train horns should be set at approximately 111 to 114 dBA. Horn locations should be as far forward and high as possible to meet requirements that limit sound directed to the side, while minimizing noise levels inside the cab.

Furthermore, a signal level should be 10 dBA above ambient noise to be recognizable as an auditory danger signal.[4]

A Transportation Development Centre study[5] determined that sound output to the front of a locomotive deteriorates with increasing train speed if the horn is not positioned at the front of the locomotive. Horns mounted behind and close to the engine exhaust hood performed much worse than in any other location. Furthermore, regardless of horn position, 10 seconds of warning is beyond the limits of locomotive auditory warning devices at passive grade crossings with high road and rail operating speeds.

Requirements to Stop at Crossings

The Ontario *Highway Traffic Act* (OHTA 1990) defines an intersection as the intersecting of two or more highways or roads. The requirement to stop at an intersection, as outlined in the Act, makes no specific reference to railway/highway intersections (that is, crossings). As such, stop signs at railway/highway crossings are not enforceable under this Act. Section 137 of the OHTA 2002, under the heading *Stop Signs, Erection at Intersections*, states that:

> In addition to stop signs required at intersections on through highways, a.) the council of a municipality and the trustees of a police village may by by-law provide for the erection of stop signs at intersections on highways under its jurisdiction and b.) the minister may by regulation designate intersections on the King's highway at which stop signs shall be erected, and every stop sign so erected, shall comply with the regulations of the Ministry R.S.O. 1990, CH.8, S137.

---

[3] Federal Railroad Administration, Department of Transportation, *Use of Locomotive Horns at Highway- Rail Grade Crossings*, 1999, page 21.

[4] *Locomotive Horn Evaluation: Effectiveness at Operating Speeds* (TP 14103E), prepared for the Transportation Development Centre, Transport Canada, by TranSys Research Ltd., June 2003.

[5] *Locomotive Horn Evaluation: Effectiveness at Operating Speeds – Project Summary* (TP 14163E), prepared for the Transportation Development Centre, Transport Canada, by TranSys Research Ltd., January 2004.

OHTA 2002 Section 163 refers to vehicles required to stop at railway crossing signals. Under amendments to this section, a note (intended to become a subsection of Section 163) mentions of stop signs at railway crossings: "Every driver of a vehicle approaching a stop sign at a railway crossing shall, unless otherwise directed by a flagman, stop the vehicle at the marked stop line or, if none, then not less than five metres from the nearest rail of the railway, and shall not proceed until he or she can do so safely." (2002, Chapter 18, Schedule P, Section 30) However, this subsection has not yet been proclaimed and, therefore, is not in force.

The Ontario *Driver's Handbook* depicts a stop sign as an octagonal, red sign with a white border and white lettering. The handbook indicates that traffic warning signs are usually diamond-shaped with a yellow background and black letters or symbols. These signs will normally warn drivers of dangerous or unusual conditions ahead, such as a curve, turn, dip, or side road. In this handbook, there is a traffic warning sign for "Railway Crossing Ahead." The handbook indicates that the driver should be alert for trains when encountering this sign.

The handbook, modified in 2003, explains that, as drivers approach crossings, they must slow down, listen, and look both ways to make sure the way is clear before crossing the tracks. If a train is coming, a driver must stop at least five metres from the nearest rail. Furthermore, instructions are given guiding drivers to ensure that all trains have passed before crossing the track.

Advance Warning Signs at Passive Railway Crossings with Restricted Visibility

In September 1991, Transport Canada, in co-operation with the MTO, developed two advance warning signage schemes. These schemes were designed for passive railway crossings where driver visibility is restricted. Scheme 1 applies to situations in which drivers should slow down to a recommended speed before entering the crossing. Scheme 2 applies to situations in which drivers should stop before proceeding onto the crossing.

Transport Canada's Regional Director, Ontario, Railway Safety, stated in a letter dated 11 September 1991 that these advance warning signs were intended only as interim advisory measures. The signs were to be removed when appropriate improvements were implemented at the crossing.

The Transportation Research Board Study[6] on transportation in the new millennium discusses passive traffic control devices. Research findings suggest that the advance warning signs do not adequately alert motorists to the fact that they are approaching a grade crossing. When active yellow flashers were added to a slightly enlarged advance warning sign and were activated by

---

[6] *Transportation in the New Millennium: Railroad-Highway Grade Crossings A Look Forward*, Chairman of Committee, Richard A Maher, Consultant; Fred Coleman III, University of Illinois at Urbana-Champaign; Ronald W. Eck, West Virginia University; Eugene R. Russell, Kansas State University, 2000, published by the Transportation Research Board.

an approaching train, motorist recognition and speed reduction improved significantly. These findings suggest that current advance warning sign design and placement are not effective in producing the desired effect on highway users.

Furthermore, the United States National Transportation Safety Board (NTSB) conducted a study[7] that considered whether the advance warning sign or crossbuck sign used at passive crossings should be replaced with a sign unique to passive crossings, one that instructed the driver about what action to take at the crossing. This issue was studied because neither the advance warning sign nor the crossbuck sign instruct highway users to stop, yield, or take any action at all.

The NTSB study indicated that the existing signs are sufficient to advise drivers of the presence of a crossing, and in the NTSB's sample, most of the surviving drivers reported that they were aware of the crossing. The NTSB was particularly concerned about drivers who were familiar with an area and aware of the presence of a crossing from previous use. The NTSB determined that, in most cases, if drivers are stopped at a crossing, they are in a better position and are more likely to look for an approaching train. Thus, the NTSB has recommended that stop signs be installed at passive crossings. Although stop signs would not be unique to passive crossings, stop and stop ahead signs adequately communicate the action necessary at a crossing.

Crossing Accident Records for Smiths Falls Subdivision

At the time of the accident, there were 18 public crossings with active crossing protection and seven public passive crossings on this line. Five of the passive crossings intersected the track at a 70-degree angle or less. The TSB occurrence database contains a record of 15 public crossing accidents on the Smiths Falls Subdivision between 1983 and 2004. Eight of these accidents occurred at public crossings with active crossing protection; seven occurred at passively protected public crossings.

The accidents at public passive crossings occurred at three different locations (some sustaining more than one accident). The crossing angle was less than 70 degrees in these three cases. For an approaching driver, two of these crossings intersected the track with the acute angle to the right side of the vehicle, and one to the left side.

On-site Simulation of Crossing Accident

The TSB Engineering Laboratory performed an on-site simulation of the accident (report LP 091/2004). The simulation and related field measurements determined that:

- For a driver of this style of Ford truck, travelling north, a westward train would only be visible when the train was approximately 200 feet (61 m) from the crossing (see Photo 3).

---

[7] PB98-917004, National Transportation Safety Board, *Safety Study: Safety at Passive Grade Crossings*, Volume 1: Analysis.

- The average ambient noise level in the cab of this style of truck, with the driver-side window down and the passenger-side window up, while moving was approximately 76 dBA.

- As the VIA train entered the crossing, the peak sound level of a VIA train, travelling at 93 mph with the train horn being sounded, was approximately 91 dBA, as measured from inside the operating compartment of the stopped dump truck, and 100 dBA when measured from outside.

- When the sound profile of the approaching VIA train was overlaid on the sound profile of the ambient noise in the truck cab, it was determined that the sound level of the locomotive horn would only exceed the ambient noise in the truck cab at a perceptible level for approximately one second before the train entered the crossing.

- It took approximately four to five seconds for a truck moving at 16 km/h to clear the crossing.

Photo 3. Driver's eastward view of tracks

Rail Safety Information Letter

TSB issued a Rail Safety Information Letter (624-15/04) to Transport Canada on 03 December 2004, indicating that:

> At Kettles Road, the acute angle of the crossing, combined with the lack of automated warning devices, has resulted in a situation where trucks, and other vehicles in which the rear window is obstructed, may attempt to cross the track unaware of, and unable to see, an approaching train.

Transport Canada responded to the letter, advising that it had held two meetings with the City of Ottawa and VIA to discuss and assess the options for enhancing safety at the crossing.

Analysis

Introduction

There were no train handling issues, no mechanical problems with the train or truck, and no track problems observed that contributed to this accident. The analysis will focus on regulations for passive public crossings, train horn audibility, and the effectiveness of warning signs at passive crossings where visibility is restricted.

The Accident

As the truck reached the crossing, it was likely oriented at the 52-degree crossing angle. In this position, the driver's right view towards the east was obstructed by the truck's dump box. The only available sight-line towards the east was through the passenger-side window through which the train would have been visible to the driver only when it was approximately 200 feet (61 m) from the crossing. With the train travelling at 93 mph, this distance represented approximately 1.5 seconds of time before the collision. Therefore, the truck driver either did not see the train, or else saw it with too little time to react. The acute angle of the crossing, in combination with the lack of a rear window view, prevented the driver from observing the approaching train.

Analysis of the data collected during the on-site simulation revealed that, when the sound profile of an approaching VIA train is overlaid on the sound profile of the ambient noise in the truck cab, the locomotive horn only provides an audible warning for approximately one second prior to the train entering the crossing. Because of this, it can be concluded that, with normal ambient noise inside the truck, the train horn was only audible to the driver for one second before the collision.

The calculation of simulated events determined that the truck would have required approximately four to five seconds to pass over the crossing at 16 km/h. Had the truck stopped as expected, based on the existing warning signs, and then proceeded, it would have needed between 10 and 11 seconds to clear the crossing.

However, in either scenario, due to the restricted visibility caused by the acute angle, the train would only have been visible for 1.5 seconds prior to its entering the crossing, and audible for only one second. Therefore, without having sufficient visual or auditory cues of the approaching train, the driver drove onto the crossing, and the truck was struck by the train.

Because of the time it takes stopped trucks to proceed and clear a crossing, pending recommendations to change existing whistle signal regulations to provide an audible warning of only 10 seconds of minimum duration from the current practice may have a detrimental effect on a driver's ability to safely cross.

Acute-Angled Passive Crossings

Six out of the seven passively protected public crossings at the Smiths Falls Subdivision, which have experienced accidents since 1983, had crossing angles less than 70 degrees. Although other factors contributed to these accidents, each of these crossings had restricted driver visibility from one or both approaches. At acute-angled crossings with characteristics similar to Kettles Road, there is no easy way for drivers of any vehicle without a view to the rear to ensure it is safe to negotiate the crossing.

Transport Canada's 1999 assessment of the Kettles Road crossing did not identify any safety concerns. The sight-lines recorded for vehicles stopped eight metres from the crossing were listed as 9999 feet, which essentially indicates a clear view. However, the reality was that heavy trucks using the crossing could have severely impeded sight-line restrictions to the east at the eight-metre distance because of the angle of the crossing and the restrictions on visibility from the cabs' side and rear. Therefore, assessing crossing sight-lines using only an automobile as the design vehicle may overlook certain sight-line deficiencies.

Transport Canada has been developing updated crossing regulations since 1988. The draft technical standards pertaining to these new regulations provide signage requirements and require that minimum crossing angles should not be less than 70 degrees for passive public crossings. However, these specifications were only guidelines at the time of the occurrence and, therefore, carried no regulatory weight. The lack of improved regulatory requirements for acute-angled, passively protected railway crossings presents a risk that highway drivers will not have adequate warning of an approaching train.

Train Horn Audibility

TSB's investigation near Tecumseh, Ontario (report R96S0106), revealed that locomotive horns should be mounted as far forward on the locomotive as possible for optimum effectiveness. However, the railway industry continues to mount the locomotive horn well behind the cab to limit its effect on the operating crew. This position decreases the intensity of sound projected forward. When a train horn is installed mid-locomotive, the horn is not positioned for maximum forward sound projection, increasing the risk that vehicle drivers at crossings will not hear the horn.

While regulations for minimum sound levels (96 dBA) were met, the locomotive horn on an approaching VIA train reached maximum sound levels in the range of 91 dBA as measured from inside the cab of the stopped dump truck. This sound level was not sufficient to warn the truck driver of the approaching train. When highway vehicles have high internal ambient noise, the locomotive horn is not a consistently effective warning of an approaching train.

A number of studies cited earlier have concluded that the location of the horn is an important factor affecting the horn's effectiveness. The Transportation Development Centre study (January 2004) noted that sound output to the front of a locomotive deteriorates with increasing train speed if the horn is not positioned at the front of the locomotive.

While the locomotive horn may not be the primary warning device for an approaching train, it is a necessary line of defence at passive public crossings. The train horn must be installed near the front of the locomotive to ensure maximum forward sound projection. This increases the chances of vehicle drivers at crossings to hear the horn and stop.

Railway Crossings with Restricted Visibility

On Canadian highways, yellow-background, diamond-shaped signs with black letters or symbols are traffic warning signs. Warning signs are intended to provide advance notice to road users about unexpected and potentially dangerous conditions on or near the road. The conditions to which warning signs apply typically require that road users exercise caution, and may require that drivers slow down, stop, or take some other action to ensure safe and efficient traffic operations.

In comparison, drivers are conditioned to interpret a red-background, octagonal-shaped sign with white markings and the word "Stop" in white lettering, as a mandatory stop sign. In fact, the Ontario *Driver's Handbook* describes these signs as those that must be obeyed.

At the Kettles Road crossing, the first of the three Ontario scheme 2 signs indicated that the road crossing was perpendicular to the track. But the road crossing is at an angle of 52 degrees, to the right side of an approaching northbound vehicle, and a more appropriate sign exists to indicate an angle crossing.

Since scheme 2 signs are designed and interpreted only as warnings, it is likely that many drivers encountering the "Stop Before Crossing" sign will not stop, unless they see an approaching train.

The NTSB study concerning passive crossings indicated that, while existing advance warning signs provide sufficient warning of crossings ahead, drivers do not necessarily react appropriately. Specifically, drivers who are familiar with the area are more likely to neglect looking for an approaching train at a crossing. For this reason, the NTSB believes that installing standard octagonal stop signs at passive crossings will cause more drivers to stop and look.

Alternatively, the Transportation Research Board Study[8] on transportation in the new millennium found that active yellow flashers activated by an approaching train prompt recognition and speed reduction at passive highway-railway crossings more often than regular advance warning signs.

When high-speed passenger trains operate over passive public crossings where vehicle operators have restricted visibility, drivers must stop to check whether it is safe to cross. To reduce the risk of collisions and derailments, the MTO scheme 2 advance warning signs may not adequately direct drivers to stop.

Advance Warning Signs as Interim Safety Measures

Although the advance warning signage schemes developed by Transport Canada and the MTO are intended to be used as interim advisory measures, the scheme 2 signs at the Kettles Road crossing had been in use for over 10 years.

Findings as to Causes and Contributing Factors

1. Without having sufficient visual or auditory cues of the approaching train, the driver drove onto the crossing, and the truck was struck by the train.

2. The acute angle of the crossing, in combination with the lack of a rear window view, prevented the driver from observing the approaching train.

3. With normal ambient noise inside the truck, the train horn was only audible to the driver for approximately one second before the train entered the crossing.

Findings as to Risk

1. The lack of improved regulatory requirements for acute-angled passive railway crossings presents a risk that highway drivers will not be given adequate warning of an approaching train.

2. At acute-angled crossings with characteristics similar to Kettles Road, there is no easy way for drivers of any vehicle without a view to the rear to ensure it is safe to negotiate the crossing.

3. When highway vehicles have high internal ambient noise, the locomotive horn does not provide an effective warning of an approaching train.

---

[8] *Transportation in the New Millennium: Railroad-Highway Grade Crossings A Look Forward*, Chairman of Committee, Richard A Maher, Consultant; Fred Coleman III, University of Illinois at Urbana-Champaign; Ronald W. Eck, West Virginia University; Eugene R. Russell, Kansas State University, 2000, published by the Transportation Research Board.

4. When a train horn is installed mid-locomotive, the horn is not positioned for maximum forward sound projection, increasing the risk that vehicle drivers at crossings will not hear the horn.

5. When high-speed passenger trains operate over passive public crossings where vehicle operators have restricted visibility, drivers must stop to check whether it is safe to cross. To reduce the risk of collisions and derailments, the Ministry of Transportation of Ontario scheme 2 advance warning signs may not adequately direct drivers to stop.

6. The assessment of crossing sight-lines using only an automobile as the design vehicle may overlook certain sight-line deficiencies.

Other Findings

1. The scheme 2 signs intended as interim advisory measures had been in use at the Kettles Road crossing for over 10 years.

Safety Action Taken

Meetings were held between Transport Canada, the City of Ottawa, and VIA to discuss possible enhancements to the Kettles Road crossing. As a result of these meetings, the City of Ottawa retained a consulting company to undertake an environmental screening and preliminary design for the railway crossing. The proposed design included an improved intersection angle, road profile, asphalt surface, elimination of one private rail crossing, and the installation of railway crossing signals, bells, and short-arm gates. The outcome of the proposals to date includes the interim placement of modified advanced warning signs and stop signs. The grade of the crossing has been widened and paved, sight-lines have been improved, and the intersection angle is now 70 degrees. Installation of an automated crossing warning system consisting of flashing lights, bell, and gates was underway as of January 2006.

With respect to train horn audibility and related limitations, Transport Canada is discussing this issue with the railway industry.

Transport Canada, in collaboration with the Department of Transportation of Saskatchewan and of New Brunswick, have recently initiated low-cost warning system research projects.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 10 January 2006.