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

RAILWAY INVESTIGATION REPORT
R13C0008

CROSSING COLLISION
CANADIAN PACIFIC RAILWAY
FREIGHT TRAIN 118-19
MILE 50.61 BROOKS SUBDIVISION
TILLEY, ALBERTA
19 JANUARY 2013

Canada

Railway Investigation Report R13C0008

Crossing collision
Canadian Pacific Railway
Freight train 118-19
Mile 50.61 Brooks Subdivision
Tilley, Alberta
19 January 2013

Summary

On 19 January 2013, at 1523 Mountain Standard Time, eastward freight train CP 118-19 struck a vehicle at a level crossing at Mile 50.61 of the Brooks Subdivision. As a result of the collision, both the vehicle, a tanker truck loaded with petroleum crude oil (UN 1267), and the lead locomotive caught fire. The driver of the tanker truck and the two train crew members sustained minor injuries.

Ce rapport est également disponible en français.

Factual information

The accident

On 19 January 2013 at approximately 0830,[1] eastward Canadian Pacific (CP) freight train 118-19 (the train) departed Calgary, Alberta, (Mile 174.5) on the Brooks Subdivision, and was destined for Medicine Hat, Alberta, (Mile 0.0) on the Brooks Subdivision (Figure 1). At 1523, as the train approached the public crossing at Township Road 172 (Mile 50.61), a northbound[2] tanker truck (tractor-trailer) loaded with petroleum crude oil (UN 1267) was also approaching the crossing. The crossing was protected with standard reflectorized crossing signs (SRCS).

The locomotive horn and bell were being sounded as required by the *Canadian Rail Operating Rules* (CROR) Rule 14(l).[3] The locomotive head light and ditch lights were displayed on full power.

Realizing that the tractor-trailer was not stopping, the train crew applied the brakes in emergency. The driver of the tractor–trailer did not become aware of the train until just before impact. The vehicle entered the crossing and was struck by the train just behind the cab on the driver's side near the fifth wheel connection. The force of the impact caused the tractor to disengage from the loaded trailer. The cab of the tractor was propelled north of the main line track and the trailer was pushed to the south. The crude oil in the trailer ignited and engulfed both the tractor and the trailer in flames, resulting in extensive fire damage. The driver of the tractor-trailer sustained minor injuries and was taken to hospital for examination.

The train came to rest 2578 feet east of the crossing. It did not derail. The lead locomotive (CP 8713) sustained extensive damage to the front and was covered in burning crude oil. Once the two crew members felt it was safe, they exited the locomotive cab from the rear door. The collision had also caused damage to the rear handrails, which blocked the route to the rear of the locomotive. The crew members had to jump from the side platform of the locomotive, approximately 6 feet to the ground. Both crew members sustained minor injuries as a result of jumping from the train.

At the time of the accident, the temperature was -6˚C. The sky was overcast, and visibility was good.

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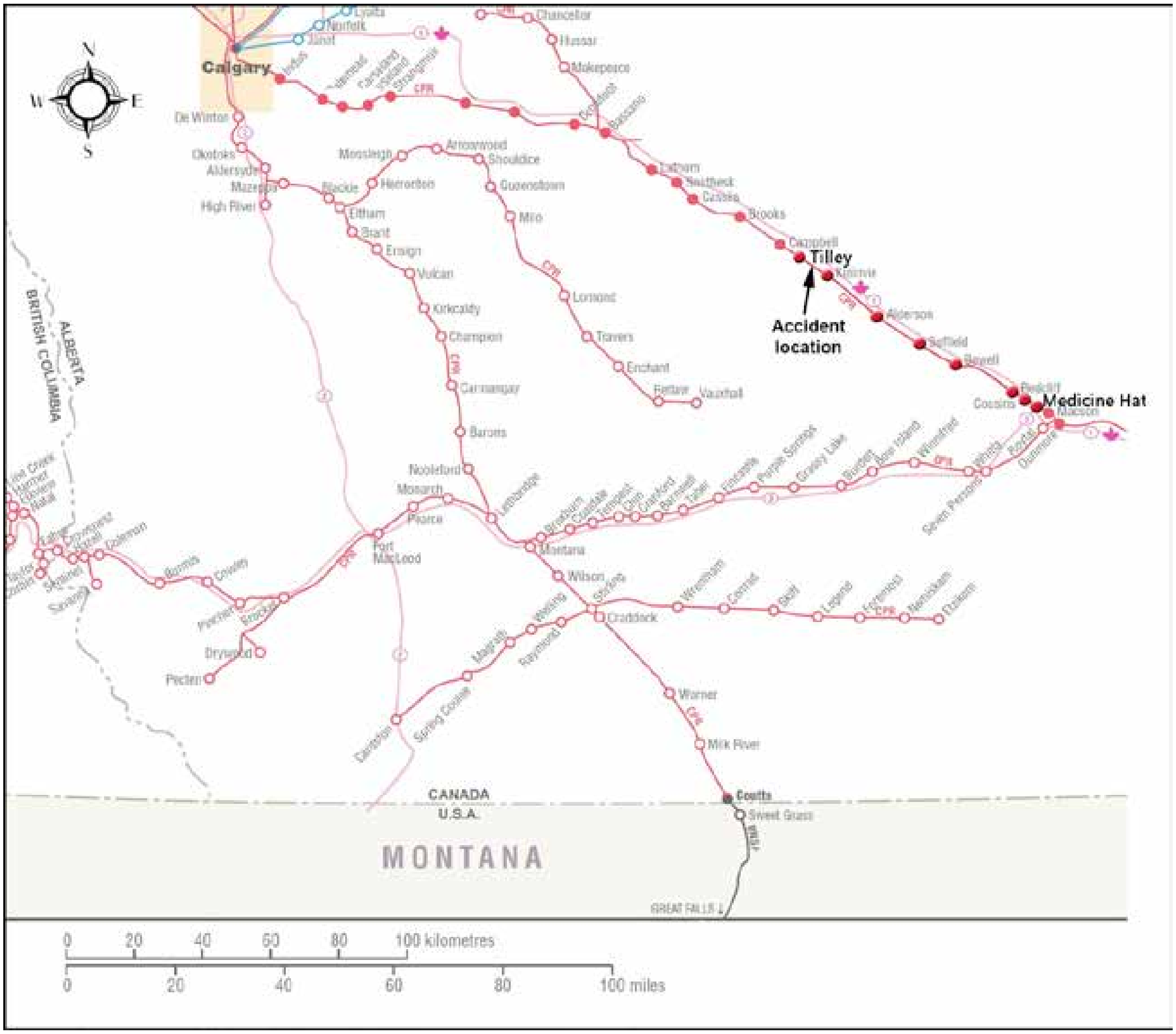
1 All times are Mountain Standard Time (Coordinated Universal Time minus 7 hours).

2 The tractor-trailer will be considered to have been proceeding north even though its compass direction was predominantely east. The CP Brooks Subdivision will be the reference and train movements on this subdivision are designated east–west.

3 CROR 14(l) Engine Whistle Signals requires, in part, two long–one short–one long whistle signals to be sounded from every whistle post in the approach to a public crossing at grade, and that the signals be prolonged and repeated until the crossing is fully occupied. The whistle post is located approximately ¼ mile before the public crossing.

Figure 1. Accident location (*Canadian Railway Atlas*, Canadian Railway Assocation)



Brooks Subdivision

The Brooks Subdivision extends from Medicine Hat 175.8 miles west to Calgary. The method of train control is the centralized traffic control system (CTC), as authorized by the CROR and supervised by a rail traffic controller (RTC) located in Calgary. The maximum train speed is 55 mph. The train traffic over this subdivision is between 25 and 28 trains per day.

Crew and train information

The train crew consisted of a locomotive engineer and a conductor. Both crew members were qualified for their respective positions, met current fitness and rest standards, and were familiar with the territory.

The train was composed of two 4400 horsepower (hp) locomotives on the head end pulling 57 loads and two empties. It was 7411 feet in length and weighed 6463 tons. The maintenance and repair records for the locomotives and rail cars were reviewed. The locomotives and rail cars were in serviceable condition.

Driver and vehicle information

The driver of the occurrence vehicle began his shift at 0630 in Foremost, Alberta. His first assignment was to pick up a load of crude oil and deliver it to Milk River, Alberta. This task was completed by 1100. The next assignment was to pick up the load of crude oil at DeeThree Battery near Warner, Alberta, and deliver it to the TORQ Transloading Inc. (TORQ) transloading facility located 2.5 miles east of Tilley, Alberta. The driver departed Warner at 1300. He believed that he had to be at the Tilley transloading facility in time for his load of crude oil to be offloaded before 1730. The driver had worked extensively in southern Alberta, but he was not familiar with the specific location of this transload terminal.

The driver of the tractor-trailer was experienced and held a valid Alberta commercial driver's license. He had current certification in Transportation of Dangerous Goods (TDG), Workplace Hazardous Material Information System (WHMIS) and Fundamentals and Hydrogen Sulphide H2S Alive. The driver's work / rest history was reviewed, and there was no information to suggest that fatigue was a factor.

The tractor-trailer was composed of a 2011 Kenworth W900 tractor pulling a 40 foot–long 2005 Heil Tridem tanker trailer with a capacity of 30 000 L. Although the tractor was equipped with a data recorder, the severe damage due to the collision and fire precluded the recovery of any information from the recorder. Maintenance and repair records for the tractor and trailer indicate that they were in serviceable condition prior to the accident.

The tractor was owned and operated by Ridgeview Transport (1990) Ltd. The trailer and its contents were owned by Plains Midstream. The hubodometer[4] on the tractor registered 178 020 km when it was last inspected on 05 March 2012. Employees of Ridgeview Transport receive safety training from Plains Midstream, and attend safety meetings if they are to haul Plains Midstream products. The driver had attended at least four safety meetings per year since 2009, including a safety meeting two days before the accident.

Truck route to Tilley transloading facility

The rural municipality of Tilley is located within the County of Newell, approximately 22 km southeast of the City of Brooks and 78 km northwest of the City of Medicine Hat. The transloading facility is located in Tilley, adjacent to 1st Avenue, which is Township Road 173A within the municipality and becomes Township Road 172A at the crossing where the accident occurred. Both Township Road 173A and Township Road 172A are commonly referred to as Old Highway 1.

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4 A hubodometer is a device mounted on the axle of a vehicle that measures distance traveled.

From the Trans-Canada Highway, the preferred route for trucks travelling to the Tilley transloading facility is to exit south on Range Road 123, turn west onto Township Road 172, and then head northwest on Old Highway 1 (i.e., Township Road 172A, 171A, 173A). Trucks would then enter the Tilley transloading facility from Township Road 173A. Once the trucks are offloaded, the trucks exit the facility at the northwest corner of the site and then head southeast on Old Highway 1, to follow the same route in reverse back to the Trans-Canada Highway.

The preferred route had been established by the municipality, CP, and the transloading facility. It was intended to discourage trucks transporting dangerous goods from driving through residential areas of Tilley (Appendix A). Companies delivering product to the transloading facility are advised of this route by facility managers when the contracts are established.

The driver in this occurrence had been given verbal directions on the preferred route. He was advised to avoid the residential areas, but he was not provided with detailed information on the preferred route. Approaching Tilley, the driver left Highway 36 and continued north via Highway 875. He then took Township Road 172, which would take him to the transloading facility, but would still avoid the town of Tilley.

Track information

The track in the vicinity of the accident consisted of 136 lb. continuous welded rail manufactured by NKK in 2001. The rails were fastened to 14-inch double shoulder tie plates with 3 spikes per plate on hardwood ties. The ballast was in good condition with good drainage.

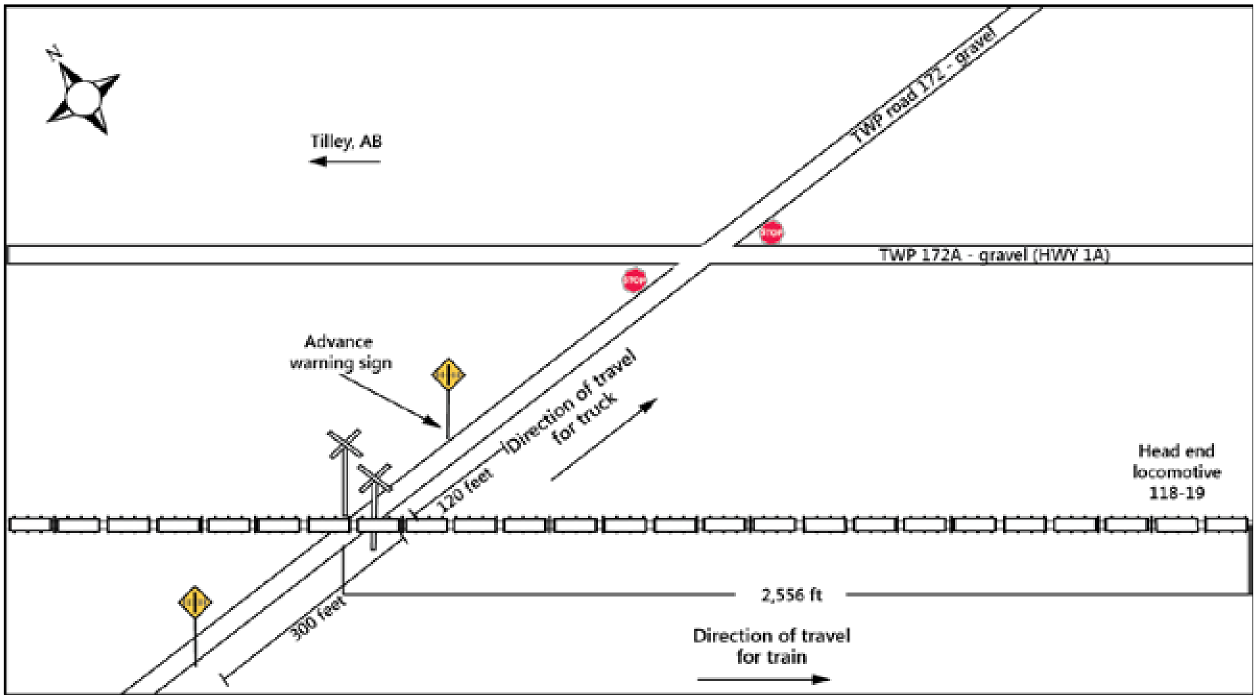
The most recent track inspection prior to the derailment was conducted by the railway on 18 January 2013, with no defects noted in the vicinity of the crossing. The last rail flaw test had taken place on 28 November 2012. No defects were noted in the vicinity of the crossing.

Crossing information

Township Road 172 is a two-lane, gravel rural road that crosses the railway track at an angle of nearly 40°. The public crossing is protected by standard railway crossing signs, also commonly known as crossbucks. The posted speed limit on Township Road 172 is 80 km/h.

Approximately 264 feet north of the crossing, Old Highway 1A (Township Road 172A) runs parallel to the Brooks Subdivision. This road is a two-lane rural road that runs between Brooks, Alberta, and Suffield, Alberta, and is used as a secondary road between the two towns. As Old Highway 1A intersects Township Road 172 at a 40° angle, it can be difficult for northbound vehicles to execute a left turn onto Old Highway 1A. Stop signs are placed so as to stop traffic in both directions travelling along the Old Highway 1, giving the right of way to traffic moving along Township Road 172 (Figure 2).

Figure 2. Diagram of the occurrence site



The last Transport Canada (TC) crossing inspection was conducted on 03 November 1992. At that time, the traffic count for the crossing was estimated to be 50 cars per day and the number of trains was 28 per day, resulting in a cross product[5] of 1400.

The railway and the road authority have the primary responsibility for the design and maintenance of the crossing: the railway is responsible for the maintenance of the crossing, while the road authority performs visual inspections of crossings and of crossing signage, which are normally conducted during work such as grading and snow removal.

Traffic counts were conducted by local county officials at the intersection of Township Road 172 and Old Highway 1 (TWP 172A) on 31 January 2013 and 01 February 2013. The updated traffic counts were 113 cars per day (2013) and 28 trains per day, resulting in a cross product of 3164.

There have been at least three previous collisions between vehicles and trains at this crossing, two of which involved tractor-trailers. The collisions occurred in 1983 (train / tractor-trailer), 1989 (train / vehicle) and 2004 (train / tractor-trailer).

5 "'Cross-product', with respect to a grade crossing, means the product of the average annual daily traffic of trains and engines on the line of railway and the average annual daily number of vehicles on the road that pass over the grade crossing." Transport Canada, Draft Railway-Roadway Grade Crossings Policy, March 21, 2012, 1(1), p. 1, available at http://www.tc.gc.ca/media/documents/railsafety/draft-grade-crossings-policy.pdf (last accessed 18 July 2014).

Recorded information

The locomotive event recorder (LER) download was reviewed. The following was determined:

- At 1523:16, as the train approached the whistle post, the throttle was in position 8 (maximum) and the train was travelling at 53.8 mph.
- At 1523:17, about 1378 feet prior to the crossing, the locomotive horn was sounded. There were 3 additional horn-sounding events (i.e., at 1523:24, 1523:31 and 1523:33).
- At 1523:33, an operator-initiated emergency brake application occurred, and throttle was automatically reduced from position 8 to position 0.
- At 1523:35, with the almost instantaneous reduction in speed from 53.1 to 51.6 mph, the train collided with the tractor-trailer.
- As the train approached the crossing, the headlight and ditch lights on the lead locomotive were continuously displayed.

Locomotive camera

The lead locomotive was equipped with a forward-facing camera (LocoCam[6]). The video footage was reviewed. The following was determined:

- Approximately 400 feet before the crossing, the tractor-trailer began to slow down.
- The tractor-trailer did not come to a complete stop before entering the crossing.

Requirements for stopping at uncontrolled railway crossings

The Ridgeview Transport guide for its drivers states that any vehicle transporting dangerous goods must come to a complete stop at every uncontrolled railway crossing.

On 05 August 1991, a tractor-trailer loaded with petroleum crude oil collided with a CN freight train at Mile 172.25 on the Wainwright Subdivision near Kinsella, Alberta (TSB Railway Investigation Report R91E0072). The collision resulted in an explosion, fire, and four fatalities. The tractor-trailer did not stop clear of the crossing for the approaching train although the flashing lights and bells were operating. As part of this investigation, the Board recommended that:

> The Department of Transport coordinate with the appropriate provincial authorities to require that tank trucks placarded for the transport of dangerous goods stop at all public crossings before proceeding.
>
> **TSB Recommendation R93-11**

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6 LocoCam is a digital video recording system that captures and stores synchronized audio, video, and key locomotive parameters. The system records images from a forward-looking camera that is mounted below the locomotive engineer's side overhead console and against the windshield. The system also uses an external microphone located in the air rack equipment area to capture the whistle, bell, air brake operation, and rail interface sounds.

In February 2012, TC provided the TSB with data indicating the extent to which each province or territory had addressed the deficiency in their respective traffic legislation (eight of 11 jurisdictions had addressed it), and indicated that it would not be pursuing this issue further. Until the provinces of Ontario and Nova Scotia address the issue, however, the Board considers the response to Recommendation R93-11 to be Satisfactory in Part**.** The TSB continues to monitor progress on this railway crossing safety issue.

In Alberta, the federal *Transportation of Dangerous Goods Act and Regulations* (SOR/2001-286) are made by the provincial *Dangerous Goods Transportation and Handling Act*.

The provincial legislation that governs vehicles transporting dangerous goods that are approaching railway crossings is Section 42 of the *Use of Highway and Rules of the Road Regulation* (AR 304/2002). Section 42(5) specifies that vehicles carrying flammable liquids or gases (loaded or empty) must stop no closer than 5 meters or no further than 15 meters back from the nearest rail of the railway.

Canadian railway–roadway grade crossings standards

TC's draft technical standards document, entitled Draft RTD 10 - Road/Railway Grade Crossings - Technical Standards and Inspection, Testing and Maintenance Requirements,[7] was made available for comment in 2002. It sets out the minimum safety criteria for the construction, alteration, and maintenance (including inspection and testing) of grade crossings and their road approaches. The draft RTD 10 standards are not enforceable, but they have been used as guidelines by TC, the rail industry and road authorities when reviewing safety at grade crossings.

Part B, Section 8, of the document specifies that that the sightline distance required at crossings is a function of the type of vehicle for which the crossing is designed, the time it takes the design vehicle to pass completely over the crossing from a stop, and the maximum train speed.

The draft RTD 10 indicates that installation of an automatic warning system at a grade crossing is warranted when the cross product is 1000 or more.[8] In addition, gates are warranted when the maximum train speed is greater than 50 mph, or when there are two or more tracks at the crossing.

The draft RTD 10 also indicates that the minimum sightlines for a grade crossing (without a road crossing warning system) must conform to a clear sight triangle. This triangle is based on the maximum train speed for the track and the maximum allowable speed for the road. The sightline distances are measured at a height of 1.0 m (3.3 feet) above the road surface, at the centre of the roadway, and 1.2 m (4 feet) above the top of the track, at the centre of the rail (Figure 3).

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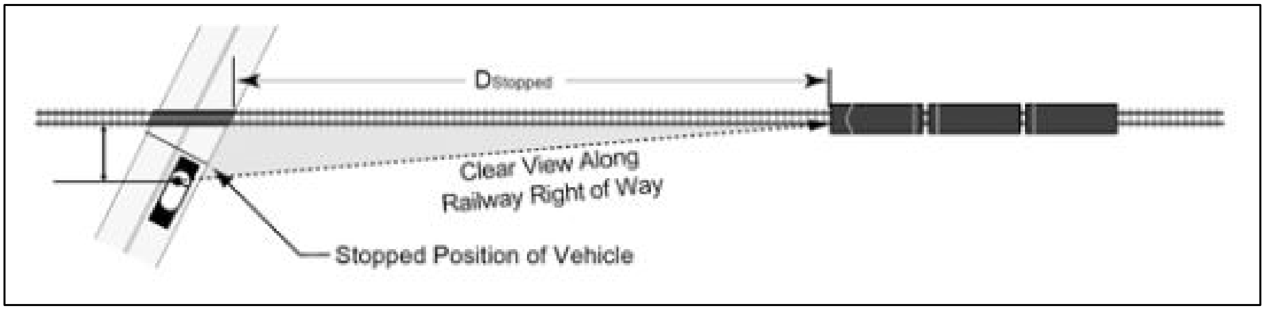
7 Transport Canada, Draft RTD 10 - Road/Railway Grade Crossings - Technical Standards and Inspection, Testing and Maintenance Requirements (24 October 2002), available at http://www.tc.gc.ca/eng/railsafety/rtd10-805.htm (last accessed on 21 July 2014).

8 TC's proposed Grade Crossing Standards (2014 February) now specify a cross product of 2000.

Under the proposed *Grade Crossing Regulations* (GCR) that were published in the *Canada Gazette* Part I on 8 February 2014, "road authorities, private authorities and railway companies would be required to maintain sightlines at the grade crossing."[9]

Figure 3. Minimum sightlines for drivers stopped at a crossing with railway crossing signs or stop signs (Source: Transport Canada, Draft RTD 10 - Road/Railway Grade Crossings - Technical Standards and Inspection, Testing and Maintenance Requirements, Part B, Section 8).



Safety assessments of crossings

Transport Canada indicates that it is the responsibility of the railway company and the road authority to conduct safety assessments at their grade crossings. The proposed GCR would require the railways and road authorities to share detailed information in writing on every crossing within five years of the regulations coming into force. The GCR would not require safety assessments of grade crossings, but Transport Canada expects that sharing this detailed information would make it easier for the railways and road authorities to conduct grade crossing safety assessments voluntarily.

Transport Canada published *The Canadian Road/Railway Grade Crossing Detailed Safety Assessment Field Guide* in April 2005[10] to help railway companies and road authorities with safety assessments; it contains these instructions:

- RTD 10 design standards should be referenced during the safety inspection to determine if the conditions warrant upgrading the crossing protection system to automatic warning systems.
- Data such as the daily train volume, average daily traffic count, and maximum operating speed for trains are essential to the crossing assessment.
- "Crossings can be prioritized on the basis of safety performance and any known problems such as vehicles entering the grade crossing when the warning lights are activated or vehicles recurrently blocking the crossing."

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9 Government of Canada, Grade Crossing Regulations, Regulatory Impact Analysis Statement, *Canada Gazette*, Part I, Vol. 148, No. 6 (08 February 2014), available at http://www.gazette.gc.ca/rp-pr/p1/2014/2014-02-08/html/reg2-eng.php (last accessed 18 July 2014).

10 Transport Canada, TP 14372E, *Canadian Road/Railway Grade Crossing Detailed Safety Assessment Field Guide* (April 2005), available at http://www.tc.gc.ca/eng/railsafety/guideline-tp14372-288.htm (last accessed on 08 July 2014).

Railway companies and road authorities would also be required to share crossing information when a new grade crossing is constructed or when there is an alteration or operational change at an existing crossing. Railway companies would be required to retain the most recent information shared.

Driver attention to visual stimuli

Drivers must continually perform visual scans to monitor the outside environment. The field of view comprises the fovea and peripheral fields. The fovea field of view can be described as a narrow 30° cone at the center where visual acuity (i.e., ability to see details) is the greatest. The peripheral view is approximately 180° forward-facing and is particularly good at detecting motion.[11] The eyes will be oriented towards the direction deemed to be of greatest importance. In the case of drivers proceeding on a road, visual attention will be directed on the road in front of them. How far ahead is dependent on several factors such as traffic, time of day, weather, speed, and road geometry. Drivers periodically shift their visual attention to look further ahead or closer to their vehicle, again depending on traffic flow, presence of vehicles ahead, etc. Drivers will also perform periodic shifts to the left and to the right, specifically to monitor road signs. It typically takes approximately 0.5 seconds to complete these shifts, i.e., to refocus visual attention.

In this occurrence, the angle of intersection of the track at the crossing for the direction of travel (i.e., for an eastward train and a northward vehicle) was greater than 90°and was outside the driver's peripheral field of view. The truck's side mirror and side pillars did not obstruct the driver's view to the left. However, to achieve a clear view of an approaching eastbound train at this crossing, a northbound driver would have to lean forward and rotate his head to the left.

Driver behaviour at grade crossings

When approaching a grade crossing, driver behaviour is largely determined by the expectation of seeing (or not seeing) a train. If drivers do not usually encounter trains at crossings, the perception that a train is unlikely is reinforced. A literature review by M. Yeh and J. Multer[12] determined that drivers who were familiar with a crossing would be less likely to look for a train at the crossing or to reduce their speed on their approach to the crossing than drivers who were unfamiliar with the crossing. The same review also determined that slightly more than one third of drivers approaching passive crossings and almost two thirds of drivers approaching crossings with active warning systems made no head movement to inspect for oncoming trains.

On the day of the occurrence, the driver had traversed nine public grade crossings prior to the accident. Four of the public grade crossings were protected by automated warning systems and five were equipped with standard rail crossing signs. He did not encounter any trains at these crossings.

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[11] W. Karwowski, *Handbook on standards and guidelines in ergonomics and human factors* (Routledge: 2006), p. 401.

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

Transportation and transloading of liquid hydrocarbons

Various modes of transportation, including pipelines, tractor-trailers (i.e., highway), and rail, are used to transport liquid hydrocarbons. One mode or a combination of all three can be used (e.g., crude oil from a pipeline to a storage tank, then into a tractor-trailer that will travel through the highway system to a transloading facility, and then into a rail car to be shipped to a refinery).

This transportation of liquid hydrocarbons has increased exponentially since the mid-2000s and the trend is expected to continue in the coming years. The volume of crude oil shipped by rail has increased dramatically in North America in recent years. For instance, in Canada in 2009, about 500 carloads of crude oil were shipped by rail; in 2013, that had increased to over 160,000 carloads. In North America, roughly 1 million barrels of crude are moved by rail each day—a volume that is expected to grow to 4.5 million barrels a day in the next 10 years. CP currently has three transloading facilities adjacent to its rail lines in Alberta.

TORQ is an oilfield service provider focused on transloading oilfield fluids and materials from truck and pipeline to rail. TORQ currently operates the Tilley transloading facility and five others across Alberta and Saskatchewan.

The loading area at the Tilley facility is approximately 320 meters long by 50 meters wide and is situated between the railway siding and Township Road 173A. The loading area is designed to allow trucks to offload the product (i.e., crude oil) through a mass flow meter into the bottom valve of a railway tank car.

The Tilley facility opened in April 2012. It was designed to be scalable to load up to 15 to 20 rail cars per day. The maximum capacity of each rail car was approximately 597 barrels (94 915 L). The facility has rail car storage capacity for approximately 42 tank cars. When the plant opened, an average of four to five rail cars per day were loaded; volumes were expected to grow in 2012 to eight to 10 rail cars per day. The facility was loading an average of eight rail cars per day at the time of the accident.

TORQ is developing a large-scale unit train crude by rail facility in Kerrobert, Saskatchewan, that will be able to handle two 120-car unit trains per day, or up to 168 000 barrels per day, starting in the third quarter of 2014. The facility is designed to have a storage capacity of 500 000 barrels.

Train horn audibility

Section 11.2 of Transport Canada's *Locomotive Inspection and Safety Rules* specifies (in part) that locomotives must be equipped with a horn that is "capable of producing a minimum sound level of 96 dB(A) at any location on an arc of 30 meters (100 feet) radius subtended forward of the locomotive by angles 45 degrees to the left and to the right of the centerline of the track in the direction of travel". The occurrence locomotives were fully compliant with the Canadian regulatory requirements.

A number of TSB investigations have identified shortcomings in the effectiveness of locomotive train horns to alert vehicle drivers and pedestrians to the presence of a train. In the investigation of a collision between a truck and a VIA Rail passenger train at a passive grade crossing near Munster, Ontario, (R04H0009) the Board found that when a train horn is installed mid-locomotive, the horn is not positioned for maximum sound projection, increasing the risk that vehicle drivers at crossings will not hear the horn.

Subsequent investigations[13] also concluded that the effectiveness of the horn can be compromised due to a combination of horn placement on the locomotive and ambient noise levels inside the road vehicle (notably large trucks and buses).

Referring to studies conducted in the United States on the effect of horns on crossing safety, Yeh and Multer[14] indicated that the train horn, despite its limitations, had a positive effect on safety. It was noted that crossings where whistle bans were in place had higher rates of accidents than those where no whistle bans were in effect.

A TC study in 2003[15] analyzed sound measurement data from various types of locomotives travelling at different speeds with different horn configurations. The study determined that horns mounted behind and close to the engine exhaust hood (i.e., mid-locomotive) performed much worse than those mounted at other locations on the locomotive. The study suggested that existing main line locomotives with a horn positioned behind and close to the engine exhaust hood should either have their horn moved to the front or have an alternative emergency horn added to the front of the locomotive. If the alternative horn is to be used only for emergency situations, then the normal horn(s) should be positioned on the locomotive such that it provides a 30.5 m (100 feet) equivalent output (i.e., sound) of at least 100 dB(A) at angles between 25º and 45º from the forward-facing direction when measured at full operating speed.[16]

The sounding of the locomotive horn as the train approaches a crossing provides an auditory warning to drivers and pedestrians in the vicinity of the crossing. The effectiveness of the horn is diminished by the attenuation of the sound pressure levels. Forward-propagating sound pressure levels are reduced with

- increased distance travelled by the sound waves;
- increased operating speeds of the locomotive;
- reduced proximity of the horn to the front of the locomotive; and
- increased proximity to any obstructions in front of its flutes, such as exhaust vents on the locomotive or nearby buildings and vegetation.

In addition, inside a motor vehicle, the effectiveness of the locomotive horn can be affected by closed windows, engine and road noise, and radio and fan noise. Nevertheless, some frequencies of the horn sound can still be perceived by the human ear inside a vehicle if these are not masked by other sounds with the same frequencies and higher sound pressure levels.

In this occurrence, the locomotive horn on the freight train was positioned on top and in the middle of the locomotive in an area that was recessed (Photo 1).

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13 TSB railway investigation reports R13D0001, R11T0175, R10W0123, R08M0002, and R04H0014.

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

15 G.W. English et al, TP14103E, *Locomotive Horn Evaluation: Effectiveness at Operating Speeds* (Transport Canada: 2003), pp. 78-79

16 Ibid, p. 102.

In comparison, for locomotives in passenger service, TC issued modified *Railway Locomotive Inspection and Safety Rules* in 2010[17] that required the installation of a new horn by 01 January 2012 on locomotives operating in the lead position and travelling in excess of 65 mph. The new horn must be capable of generating two sound levels: a high-level mode used for emergencies and a lower-level mode used in normal train operations. The horn must be placed near the front of the roof, no more than 5 feet behind the rear of the cab, with no obstructions or exhaust outlets ahead of or beside it.

Photo 1. Horn placement on occurrence locomotives

Research into passive crossing safety

In 1998, the U.S. National Transportation Safety Board (NTSB) published a study[18] that identified common causes for accidents at passive crossings and the means to improve safety at crossings. Some of the safety issues included

- the adequacy of warning systems to alert drivers to the location of a passive crossing;
- behavioural factors that can compromise a driver's ability to detect and react;
- the adequacy of driver education on the dangers present at passive crossings; and
- the sufficiency of passive crossing signage.

The study concluded that, while the installation and enforcement of stop signs at passive crossings can provide consistent information, instruction, and regulation to the motoring public, stop signs should be considered only as an interim measure. The study notes that interim intelligent transportation system solutions—such as signs or signals that can alert a motorist to the presence of a train without depending on expensive track circuitry—are possible. While the installation of stop signs may be effective in some cases, the real opportunity to advance public passive crossing safety is through low-cost active warning devices, i.e., devices that warn drivers about the presence of an oncoming train.

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17 Transport Canada, TC O 0-112, Railway Locomotive Inspection and Safety Rules, Revised February 4th, 2010, available at http://www.tc.gc.ca/eng/railsafety/rules-tco76-331.htm (last accessed 21 July 2014).

18 National Transportation Safety Board, NTSB/SS-98/02, *Safety study: Safety at passive grade crossings*, Volume 1: Analysis (Washington: 1998), available at https://www.ntsb.gov/doclib/safetystudies/SS9802.pdf (last accessed on 21 July 2014).

In 2010, the U.S. Federal Railroad Administration published a technology assessment of low-cost active warning devices for application at passive highway-rail grade crossings.[19] The research determined that low-cost active warning sign systems can accurately warn drivers of approaching trains and provide adequate warning times.

Other promising, low-cost train-detection technologies that can be used to control active warning signs are based on global positioning systems (GPS), magnetic flux (e.g., wheel sensors), and radar. As these technologies are not track circuit–based, they can be installed, maintained, or replaced without great cost or impact on railway operations. Such systems can be stand-alone, or take advantage of existing smart systems in modern vehicles, locomotives, and wayside signal systems to provide drivers with advance warning of a passive crossing and the presence of a train. However, the use of active warning signs, although showing potential, is not widespread.

In Canada, the TC Rail Safety Directorate is working with the Transportation Development Centre (TDC) to implement a research project to further develop hybrid crossing warning systems for railway–highway grade crossings in Canada. The main objective of this project is to develop an intermediate grade crossing warning system between conventional passive (i.e., just passive signal) and full-scale active warning systems (i.e., signals, flashing lights, bell, and gates).

After the TSB's investigation into the 2012 passive crossing accident near Broadview, Saskatchewan, (R12W0182) the Board issued a Safety Concern that expressed the Board's concern that, in the absence of timely implementation of low-cost alert systems, the risk of accidents at passive crossings would continue.

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19 Ngamdung Hellman, DOT / FRA / ORD-10 / 06, *Low-Cost Warning Device Industry Assessment*, (U.S. Department of Transportation: 2010).

Analysis

The condition of the track, the mechanical condition of the train, and the manner in which the train was operated did not contribute to the accident. There was no indication that the mechanical condition of the tractor-trailer contributed to the accident. The analysis will focus on driver behaviour, tractor cab configuration, and audibility of the locomotive horn.

The accident

As the tractor-trailer approached the crossing travelling northbound on Township Road 172, the vehicle slowed down but it did not stop. The trucking company required trucks to come to a complete stop at every uncontrolled railway crossing if the vehicle was transporting dangerous goods. The collision occurred when the vehicle continued onto the crossing and into the path of the eastbound train and was struck just behind the cab of the tractor-trailer.

The driver was unfamiliar with the exact location of the transloading facility. He had been verbally briefed on the preferred route and was told to avoid the residential areas, when possible. However, he was not provided with detailed information on the preferred route and was not advised to avoid specific railway crossings.

As the driver wanted to reach the transloading facility in time to unload the crude oil, he chose a route that he believed would take him to the facility in an expeditious manner while not travelling through the town. For the chosen route, the tractor-trailer would have to negotiate an acute (40°) left-hand turn onto Township Road 172A almost immediately after clearing the crossing. As the driver approached the crossing, he was preoccupied with reaching the transloading facility in time to have his product offloaded and with the left hand turn beyond the crossing. Consequently, the driver did not stop at the passive grade crossing.

Township Road 172 intersects the Brooks Subdivision at a 40° angle. For the northbound tractor-trailer, the angle of intersection at the crossing meant that the driver's view to the west (i.e., scanning for eastbound trains) was outside his peripheral vision. Approaching the crossing or stopped at the crossing, the driver would have to lean forward to look left out the window. The view from inside the cab of the tractor-trailer that resulted from the acute angle of crossing made it more difficult to see the approaching eastbound train.

Expectation and visual stimuli

Crossing protection systems provide visual and auditory stimuli to warn drivers of danger when approaching railway crossings. These systems can comprise active warnings such as lights, bells and gates or, as in this occurrence, passive warnings such as crossbucks and advance warning signs. For safe operations at a crossing, the stimuli provided by the warning system must be sufficiently compelling for the vehicle driver to become aware of impending dangers and take appropriate action. On the day of the occurrence, the driver had traversed nine grade crossings prior to the accident. He had not encountered any trains, likely reinforcing the perception that a train would not be encountered in this instance. If there are no compelling audio or visual stimuli at grade crossings, and vehicle drivers are not expecting a train, they may not stop, increasing the risk of crossing collisions.

Train horn audibility

The locomotive horn was sounded as the train approached the crossing as required by the *Canadian Rail Operating Rules*. However, the horn did not become audible to the tractor-trailer driver until just before the collision. The locomotive horn was positioned mid-way back on top of the locomotive and slightly recessed, ahead of the exhaust stack. For freight locomotives, this style of horn placement meets current regulatory requirements.

Other TSB investigations have determined, however, that this particular style of locomotive horn placement is suboptimal. In addition, research conducted by Transport Canada indicate that horns mounted behind and close to the engine exhaust hood (i.e., mid-locomotive) performed much worse than those mounted in other locations on the locomotive.

Revised regulatory requirements for passenger locomotives require (in part) that the horn must be placed near the front of the roof, no more than 5 feet behind the rear of the cab, with no obstructions or exhaust outlets ahead of or beside it.

Locomotive horn sound pressure levels are designed to warn those using a railway grade crossing of an approaching train. If the configuration of the locomotive horn, including its location, does not provide sufficient sound pressure levels in the vicinity of the crossing, the horn will not provide adequate warning, increasing the risk of a crossing accident.

Transportation and transloading of liquid hydrocarbons

The transportation of liquid hydrocarbons has increased exponentially since the mid-2000s and this trend is expected to continue in the coming years. In Canada in 2009, about 500 carloads of crude oil were shipped by rail, while in 2013 there were more than 160,000. This dramatic increase in the shipment of liquid hydrocarbons by rail has led to an increase in truck traffic servicing transloading facilities. When the vehicle–train cross product increases, more robust crossing protection systems are often necessary to ensure the interface between vehicular traffic and trains remains safe. If an increase in the transportation of liquid hydrocarbons results in a higher vehicle–train cross product at public grade crossings, there will be an increased risk of crossing accidents.

Findings

Findings as to causes and contributing factors

1. The collision occurred when the vehicle continued onto the crossing and was struck by the eastbound train.

2. As the driver approached the crossing, he was preoccupied with reaching the transloading facility in time to offload the product and with the left-hand turn beyond the crossing. Consequently, the driver did not stop at the passive grade crossing.

3. The view from within the cab of the tractor-trailer that resulted from the acute angle of crossing made it more difficult to see the approaching eastbound train.

Findings as to risk

1. If there are no compelling audio or visual stimuli at grade crossings, and vehicle drivers are not expecting a train, they may not stop, increasing the risk of crossing collisions.

2. If the configuration of the locomotive horn, including its location, does not provide sufficient sound pressure levels in the vicinity of the crossing, the horn will not provide adequate warning, increasing the risk of a crossing accident.

3. If an increase in the transportation of liquid hydrocarbons results in a higher vehicle–train cross product at public grade crossings, there will be an increased risk of crossing accidents.

Safety action

Safety action taken

After the accident, Ridgeview Transport Ltd. suspended all trucking operations. Before resuming operations:

- all drivers attended an Alberta Motor Transport Association Professional Driver Improvement course; and
- the drivers also took part in two Plains Midstream rail crossing safety workshops.

Two rail crossing safety bulletins were prepared and circulated to employees at Plains Midstream (see Appendix B). The bulletins were presented and discussed at a number of Plains Midstream safety meetings.

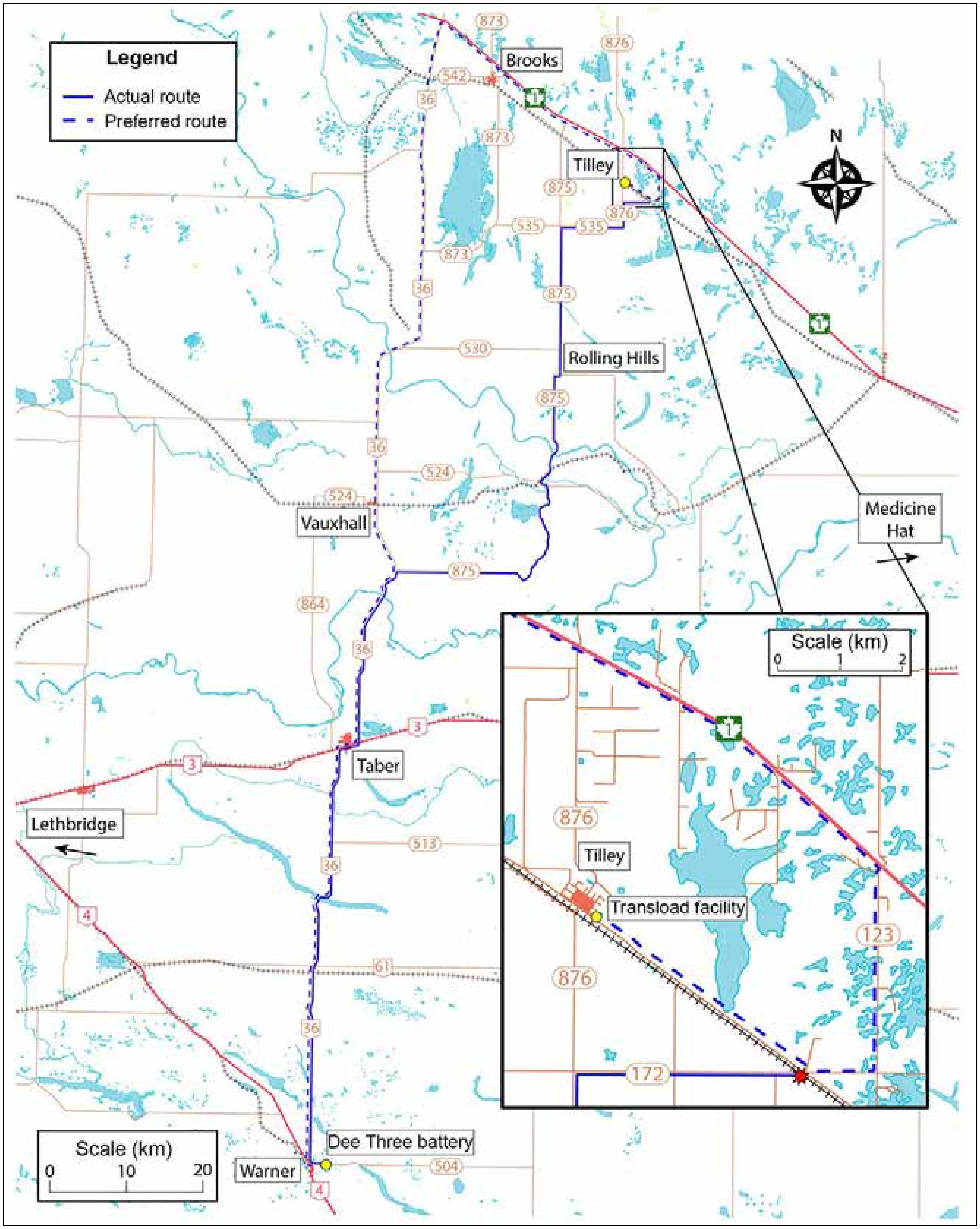
Transport Canada indicated that it had asked the Transportation Development Centre (TDC) to undertake a research project pertaining to the audibility of train horns. The aim of this research project is to analyse a horn's effectiveness with the "long hood leading".

This report concludes the Transportation Safety Board's investigation into this occurrence. The Board authorized the release of this report on 6 August 2014. It was officially released on 12 August 2014.

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

Appendices

Appendix A – Preferred route vs actual route



*Appendix B – Rail Crossing Safety Bulletin #1 disseminated by Plains Midstream Canada**

Sent: Thursday, February 07, 2013 12:33
Subject: FW: Rail Crossing Safety Bulletin #1 (SA 2013-02)
Attachments: TSB Fact Sheet - Trains Colliding with Vehicles.pdf

Rail Crossing Safety Bulletin #1

For distribution to all Truck Transportation Managers, Area Supervisors and EH&S Advisors.

There have been a number of collisions over the past few weeks involving trains colliding with private and commercial motor vehicles at railway crossings.

Driver awareness is key component for the prevention of this kind of incident. Please review the TSB video provided at the link below.

Transport Safety Board Video "Passenger Trains Colliding with Vehicles":
http://www.tsb.gc.ca/eng/medias-media/videos/surveillance-watchlist/rail/rail-video-01.asp

Please complete the following communications tasks:

1. Distribute the attached TSB Fact Sheet "Trains Colliding with Vehicles" to all contract companies involved in transporting product for Plains;
2. Show the above video at the next round of safety meetings; and
3. Engage an open forum discussion at these safety meetings about rail crossing safety.

The risk of passenger trains colliding with vehicles remains too high in busy rail corridors

Background

Over the past 10 years, there have been 257 accidents involving passenger trains colliding with vehicles at level crossings in Canada. Seventy-one of these occurred in the Quebec City–Windsor corridor, Canada's busiest and most travelled train route. Warning signs at both public and private crossings are the first line of defence to help reduce the risk by making drivers aware of the crossing. Approximately one-third of public crossings in Canada have crossing gates and/or flashing lights and bells. Despite these warning devices, collisions between vehicles and passenger trains continue to occur.

Transport Canada has been very active since the Transportation Safety Board of Canada (TSB) highlighted this issue in 2010, and the following improvements have been initiated:

- Developing a program to install warning systems with gates at all public grade crossings where train speeds exceed 128 km/h in the Quebec City–Windsor corridor.
- Working with the railway industry and communities to perform safety assessments along the Quebec City–Windsor corridor.
- Developing grade crossing regulations to provide better standards in high-speed corridors.
- Developing new low-clearance advance warning signs at railway crossings in collaboration with the Transportation Association of Canada.
- Supporting Operation Lifesaver for public education about railway safety.

The railway companies have also been active on this issue since 2010. As of June 2012, CN upgraded the warning systems on 31 public crossings and 24 private crossings in the Quebec City–Windsor corridor. CN also closed 21 crossings on this corridor, and has scheduled 3 additional crossing closures.

While some TSB recommendations have been addressed and are now rated Fully Satisfactory, a number of open recommendations remain, and are rated only Satisfactory Intent. The accident rate has not been significantly reduced since the TSB first placed this issue on the Watchlist.

Solution

Transport Canada must implement new grade crossing regulations, develop enhanced standards or guidelines for certain types of crossing signs, and continue its leadership role in crossing safety assessments. A comprehensive solution must also include further improving public awareness of the dangers at railway crossings.

Truck Transportation EH&S and Regulatory Compliance
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* This is a facsimile of the email disseminated by Plains Midstream Canada. It is available in English only.

*Appendix C – Rail Crossing Safety Bulletin #2 disseminated by Plains Midstream Canada**

Sent: Thursday, February 07, 2013 12:33
Subject: FW: Rail Crossing Safety Bulletin #2 (SA 2013-03)
Attachments: QUIZ-Alive_and_Truckin_EN.pdf; STUDENT-Alive_and_Truckin_EN.pdf; INSTRUCTOR Alive_and_Truckin_EN.pdf; Operation Lifesaver - Tips for Professional Drivers.pdf

Rail Crossing Safety Bulletin #2

For distribution to all Truck Transportation Managers, Area Supervisors and EH&S Advisors.

There have been a number of collisions over the past few weeks involving trains colliding with private and commercial motor vehicles at railway crossings.

Driver awareness is key component for the prevention of this kind of incident. Please review the **Operation Lifesaver** driver training materials listed below.

- Operation Lifesaver **Driver Training Resources** (see attached):
- Alive and Trucking - Instructor Notes
- Alive and Trucking - Student Notes
- Alive and Trucking - Quiz
- Tips for Professional Drivers
- Link to Operation Lifesaver **Professional Driver Video**: http://ohsonline.com/videos/2011/05/operation-lifesaver-professional-drivers.aspx?admgarea=video
- Link to Operation Lifesaver website: http://www.operationlifesaver.ca/

Please complete the following communications tasks:

- Distribute the *Alive and Trucking - Student Notes* and *Tips for Professional Drivers* at the next round of
- safety meetings;
- Show the *Professional Driver Video* at the next round of safety meetings;
- Engage an open forum discussion at these safety meetings about rail crossing safety;
- Have the safety meeting attendees complete the *Alive and Trucking – Quiz*; and
- After everyone has completed the quiz – run through the correct answers as a group, so each person
- can self-evaluate how they did on the Quiz.

Important Facts About Railway Crossing Collisions

- In 2011, there were 169 crossing collisions across Canada, 25 **fatalities (15%)** and 21 **serious injuries (12%)**.
- A motorist is 40 times more likely to die in a crash involving a train than in a collision involving another motor vehicle.
- The average locomotive engine weighs **110 tonnes**.
- The average transportation tractor weighs 9 tonnes.
- The average automobile weighs 2 tonnes.
- Trains CANNOT stop quickly. An average freight train travelling at 100 km/h requires about **2 km to stop**. A passenger train travelling at 160 km/h also requires about the 2 km to stop. Compare that to an automobile travelling at 90 km/h, which requires about 60 m to stop.
- The majority of highway/railway collisions occur when the train is travelling less than **50 km/h.**
- An approaching train activates flashing light signals and gates approximately **20 seconds** before the train reaches the crossing.

Life Saving Tips For Drivers

- Never drive around lowered gates – it's illegal and deadly. If you suspect a signal is malfunctioning, call the 1-800 number posted on or near the crossing signal or your local emergency number.
- Never race a train to the crossing. Even in a tie, you lose.
- Do not get trapped on the tracks. Only proceed through a highway/railway crossing if you are sure you can completely clear the crossing without stopping. Remember, the train is 1 metre wider than the tracks on both sides.
- If your vehicle stalls on a crossing, immediately get everyone out and far away from the tracks. Call 911 or your local emergency number for assistance. Look for a 1-800 emergency notification number nearby to contact the railway.
- At a multiple track crossing waiting for a train to pass, watch out for a second train on the other tracks, approaching in either direction.
- ALWAYS EXPECT A TRAIN! Trains do not follow set schedules.
- Even if the locomotive engineer sees you, a freight train moving at 120 km/h can take up to **2 km or more to stop** once the emergency brakes are applied; more than **18 football fields in length**!
- Don't be fooled by the optical illusion. The train you see is closer and faster moving than you think. If you see a train approaching, wait for it to go by before you proceed across the tracks.

Life Saving Tips For Highway Railway Crossings

- Be prepared to stop at a highway/railway crossing.
- Look for the crossbuck symbol of a highway/railway crossing. Some more-travelled highway/railway

crossings have lights and bells and some include gates.

- Listen for warning bells and whistles. Turn off, or turn down distracting fans, heaters and radios. Ask the passengers to be quiet until the crossing is safely crossed. Opening the window helps you hear.
- Obey the signals. Never attempt to drive under a gate as it is closing, or around a closed gate. If the gate begins to close while you're underneath, keep moving ahead until you clear the crossing.
- If a police officer or a member of the train crew is directing traffic at the crossing, obey their directions.
- Remember, however, that you are not relieved of the responsibility to ensure your personal safety and you must confirm that it is safe to cross the tracks by looking and listening for the approach of a train.
- If one train passes, make sure that a second train isn't approaching on another track. They can, and they do!
- Cross the tracks in low gear. Do not attempt to change gears while crossing.
- If your vehicle stalls on the tracks, get out quickly. Move towards the train and away from the tracks to avoid being hit by debris, because the momentum of the train will sweep your vehicle forward.
- If your view is obstructed for 300 metres in either direction, do not attempt to cross the track until you are certain that no train is approaching. Be especially careful driving during bad weather.
- Walking or playing on train tracks is dangerous and illegal. The only safe way to cross railway tracks is to use a designated crossing and to obey all signs and signals. Be smart. Be safe. Stay alive!

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