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

RAILWAY INVESTIGATION REPORT
R06Q0054

MAIN-TRACK DERAILMENT

CANADIAN NATIONAL
FREIGHT TRAIN M-36831-03
MILE 65.02, JOLIETTE SUBDIVISION
CHARETTE, QUEBEC
04 JUNE 2006

Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Railway Investigation Report

Main-Track Derailment

Canadian National Freight Train M-36831-03 Mile 65.02, Joliette Subdivision Charette, Quebec 04 June 2006

Report Number R06Q0054

Summary

On 04 June 2006, at 1237 eastern daylight time, Canadian National freight train M-36831-03 derailed 14 cars (10 loads and 4 empties), including 7 cars loaded with dangerous goods, while exiting a bridge at Mile 65.1 on the Joliette Subdivision near the town of Charette, Quebec. The dangerous goods cars included 2 cars loaded with gasoline, 3 cars loaded with fuel oil and 2 cars loaded with sulphuric acid. Approximately 233 000 litres of hydrocarbons leaked from 3 tank cars and some flowed into the nearby Rivière du Loup. There were no injuries.

Ce rapport est également disponible en français.

Other Factual Information

The Derailment

On 04 June 2006, at 0819 eastern daylight time,[1] eastward Canadian National (CN) freight train M-36831-03 (the train) departed Rivière-des-Prairies, Mile 132.8 on the Saint-Laurent Subdivision, destined for Garneau, Quebec, Mile 40.1 on the Joliette Subdivision (see Figure 1). The train consisted of 3 locomotives and 142 cars; it was about 6760 feet long and weighed approximately 12 290 tons. The operating crew, a locomotive engineer and a conductor, met fitness and rest standards, were qualified for their respective positions and were familiar with the territory.

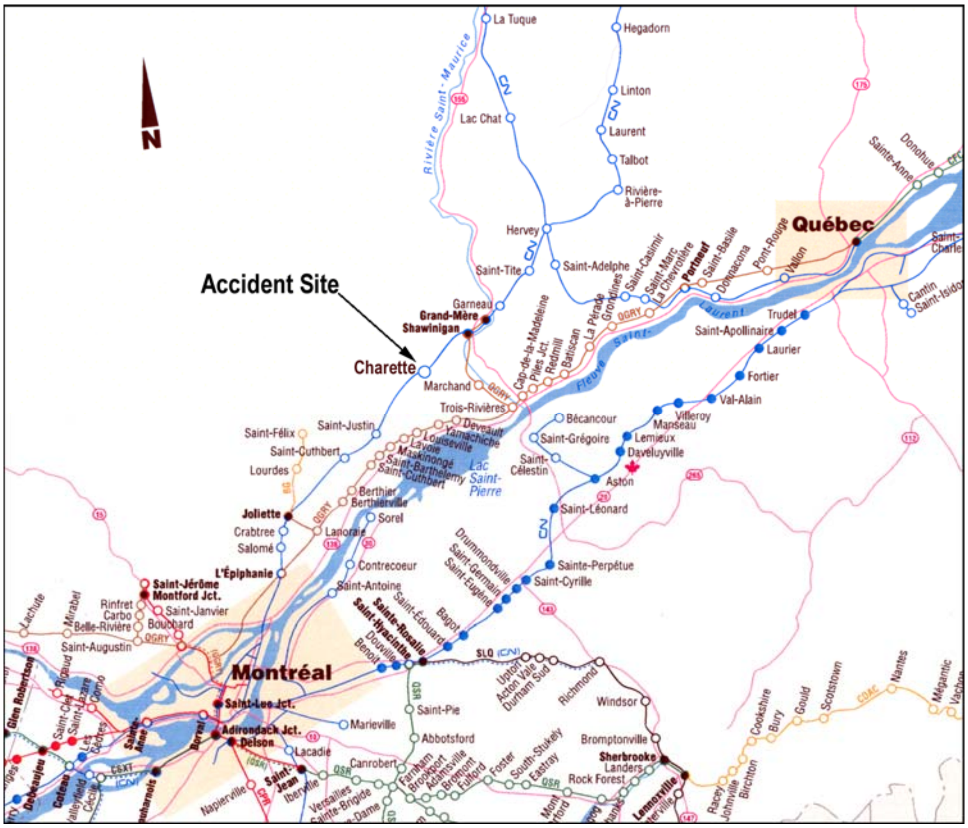

Figure 1. Location diagram of accident site (Source: Railway Association of Canada, *Canadian Railway Atlas*)

While the train was exiting the north end of the bridge at Mile 65.10, it experienced a train-initiated emergency brake application. After initiating emergency procedures, the crew determined that 14 cars (the 49th to 62nd cars) had derailed. The derailed cars included 3 loaded gondola cars, 4 empty flat cars, and 7 tank cars loaded with dangerous goods. Two tank cars were loaded with gasoline (UN 1203), three were loaded with fuel oil (UN 1202) and the other two were loaded with sulphuric acid (UN 1830).

---

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

The locomotive event recorder data indicated that, from Mile 66.43, the train was proceeding at a steady speed of 30 mph with the throttle in idle and the dynamic brake engaged. The locomotives came to rest at approximately Mile 64.13.

Local fire and police departments, Environment Canada, ministère du Développement durable, de l'Environnement et des Parcs (Ministry of Sustainable Development, Environment and Parks) and the Canadian Forest Service responded to the accident.

At the time of the derailment, the temperature was approximately 20°C. The relative humidity was 48 per cent and the wind was from the north at 13 km/h.

Site Examination

The first derailed car, a gondola car, came to rest at Mile 64.78 with its trailing wheel set pulled to the west. The 50th and 51st cars, also gondola cars, came to rest in the ditch along the west side of the track 915 feet south of the first derailed car. The following 9 cars, which included 5 dangerous goods tank cars loaded with gasoline or fuel oil, piled up north of the bridge (see Photo 1). One of the derailed cars contacted electrical power lines, resulting in a power outage in the area. Three tank cars (one gasoline and two fuel oil cars) were punctured and released product, some of which flowed down the embankment and into the Rivière du Loup. The last two derailed cars (PROX 13521 and PROX 13516), loaded with sulphuric acid, remained upright on the north end of the bridge. The leading truck of car PROX 13516 (the last derailed car) fell between the rails and the trailing truck derailed to the gauge side of the east rail.

An inspection of the derailed equipment did not reveal any pre-derailment mechanical defects, although a broken knuckle was recovered during the inspection of the derailed cars.

Immediately south of the last derailed car, the spikes were lifted on the gauge side of the west rail while the east rail had shifted to the field side and was sitting on top of the spikes. Near the abutment, both rails were spread. The west rail had been pulled to the field side and displayed heavy rubbing marks along its gauge side face and numerous wheel flange markings along its gauge side base.

Photo 1. Accident site (Source: Newspaper *Le Nouvelliste*)

No wheel flange markings were found on top of the rail. However, starting approximately 25 feet from the north bridge abutment, wheel flange markings and bridge tie damage was observed between the rails. Approximately 12 feet from the abutment, the bridge tie damage increased significantly and progressed northward onto the track approach ties towards the pile-up of derailed cars.

Bridge ties 1, 3 and 6, counted from the north end of the bridge, had several vertical splits. Ties 4 and 5, which supported a joint on the east rail, were broken; tie 4 was sheared horizontally and tie 5 was broken vertically. An inspection of the bridge deck south of the derailment zone revealed abrasion marks along the toe of the rail base extending up to four inches on either side of the spike heads.

The north bridge approach, which comprises six approach ties, was heavily damaged by the derailment. The ties were dislocated and the wood fibres on their top surface had been shredded by the derailed wheels. The remaining portions of the ties displayed extensive old splits and decay (see Photo 2). The ties were double-spiked (that is, four spikes per tie plate).

Photo 2. Track tie from the north approach

Seventeen bridge ties and the broken knuckle were sent to the TSB Engineering Laboratory (LP 045/2006 and LP 108/2006) for examination. The following observations were made:

- The knuckle failed in tension as a result of overstress. Chevron markings pointed back to and identified a shallow pre-existing fatigue crack in the pulling face of the failed knuckle as the initiating point for the overstress fracture.
- Bridge ties 1, 3, 5, 6, and 9 displayed pre-existing full depth splits, while tie 4 had pre-existing horizontal shear fracture and vertical splits through the tie plate areas. These ties had reduced lateral holding capacity as a result of wood splits intersecting at the tie plate spike holes.

Track Information

The Joliette Subdivision extends from Garneau (Mile 40.1) to Pointe-aux-Trembles, Quebec (Mile 127.8). In the area of the derailment, train movements are governed by the Occupancy Control System as authorized by the *Canadian Rail Operating Rules* and supervised by a rail traffic controller located in Montréal, Quebec. The track is classified as Class 3 track according to Transport Canada–approved *Railway Track Safety Rules* (TSR). The maximum authorized timetable speed is 35 mph for freight trains and 45 mph for passenger trains. Rail traffic consists of about 28 freight and 6 passenger trains per week with an annual tonnage of about 13 million tons.

The track through the derailment area consisted of a tangent single main track oriented in a north-south direction and descending northward at a one per cent grade. North of the bridge, the rail was 115-pound continuous welded rail manufactured by Algoma in 1955. From the north end of the bridge to the crossing at Mile 64.52, ties were changed and new rail was laid in 2005. However, the north approach track ties were not renewed.

Rivière du Loup Bridge

The track crosses over the Rivière du Loup at Mile 65.1 on an open-deck steel bridge comprised of 20 steel spans seated on steel towers and 2 concrete end abutments. The bridge is 1070 feet long and 130 feet high. The deck consists of timber ties measuring 12 inches by 12 inches by 13 feet long spaced 4 inches apart. The running rails were 115-pound jointed rail manufactured in 1962. The rail was laid on 14-inch double-shouldered bridge tie plates fastened to the ties with two spikes per tie plate.

On the north abutment, the rails spanned the top of the backwall and were not secured to the two abutment ties with spikes and tie plates. There were no rail anchors on the bridge. According to CN's Standard Practice Circular (SPC) 3601 in force in 1987, when the ties were renewed on the north end of the bridge, the installation of rail anchors was optional. In 2003, the SPC was amended and did not differentiate between jointed rail on bridges and jointed rail on track. Item 17 in SPC 3601 stated that 8 anchored ties per 39 feet for Class 3 track were required. Because the bridge deck had performed adequately since installation without anchors, the installation of anchors was not deemed necessary.

Track Inspection

As prescribed by the TSR, the track was visually inspected twice weekly with at least two calendar days between inspections, and inspected annually by a track geometry car. These former inspections were usually performed by hi-rail. The inspector would disembark to conduct more detailed checks of areas that were known to be problematic (that is, check gauge in curves, inspect switches or monitor known near urgent defects). The most recent visual track inspection of the derailment area was conducted on 02 June 2006 by hi-rail; no defects were noted. The area was not checked in detail because it was not considered to be problematic.

The last track geometry car inspection was carried out on 02 June 2006. Deviations of about ½ inch in alignment, surface and gauge were recorded in the vicinity of the north abutment of the bridge. These deviations were within the prescribed limits of the TSR and SPC. Similar deviations were also recorded previously on the geometry car inspection performed on 08 November 2005. The rail was tested by a rail flaw detection vehicle on 23 May 2006; no defects were found in the vicinity of the derailment.

Bridge Inspection

Bridge decks receive a visual inspection annually and a detailed inspection as required. During the inspections, inspectors walk the length of the bridge to verify the condition of the ties in order to assess their structural and gauge holding capacity. The inspectors are instructed to measure the track gauge on the bridge and record signs of decay such as loose spikes and crushing under the tie plates. In addition, splits and checks are also recorded because they are areas prone to the development of decay and may also affect the structural capacity of the ties. Drill tests are carried out to further assess the condition of the ties.

The results of inspections are noted on an inspection report in which the inspector rates the general condition of the bridge components as good, fair, poor or bad. A "poor" rating initiates various levels of monitoring and a "bad" rating requires that action be taken to correct the condition. Additional comments are added each year to the detailed report to provide a historical record of the condition of the bridge.

The last detailed inspection of the bridge deck was performed on 26 October 1998. The inspection report indicated that the north approach was low and two approach track ties were defective. Many of the bridge ties were shown as having loose spikes. For instance, near the north abutment, the number of loose spikes per tie was as follows (ties are counted from the north end of the bridge):

Tie Number	Number of Loose Spikes
1	4
3	3
5	2
7	1
9	1
10	4

On the north end of the bridge, the gauge was 56 7/8 inches, which is within the limits outlined in the TSR. No ties were marked as having splits or checks.

The last visual inspection of the bridge deck was performed on 02 November 2005. Between 1998 and 2005, visual inspections were performed on 05 October 1999, 02 November 2000, 09 June 2001, 19 November 2002, and 10 September 2003. The bridge deck was snow-covered in December 2004 and could not be performed. The deck condition (including loose spike count) and track gauge were not shown to have changed since the last detailed inspection in 1998.

Site Remediation

Environment Canada partnered with the ministère du Développement durable, de l'Environnement et des Parcs and the Canadian Forest Service to form a Regional Environment Emergency Team (REET) to manage the environmental response effort. The team quickly determined that approximately 233 000 litres of hydrocarbons had leaked from 3 tank cars, a large portion of which had already flowed into nearby Rivière du Loup.

Containment barriers were constructed to slow the flow of the remaining hydrocarbons into the river. Skimmers and booms were installed on the Rivière du Loup to collect the hydrocarbons near the derailment site and downstream near the St. Lawrence River. Sixteen wells and nine exploration trenches were dug to recover the hydrocarbons. Initially, they were being recovered at a rate of 40 litres per hour; however, as of 27 September 2006, the rate had dropped to 2 litres per hour and none were entering the Rivière du Loup. In total, approximately 73 000 litres of hydrocarbons had been recovered.

An assessment of the water and the soil in the surrounding area was performed. Environment Canada assessed the impact of the spill on the bird and fish life along the Rivière du Loup as low and assessed CN's response as good. Hydrocarbons continued to be recovered through the winter months.

Analysis

As the train was travelling at a constant speed with the dynamic brake engaged, and there was no pre-derailment mechanical defect, the operation of the train and condition of the rolling stock are not considered contributory to this accident. The analysis will focus on the condition of the track, the track inspection procedures, and the site remediation efforts.

The Derailment

There were no wheel flange markings on top of the rail to point to wheel climb as a derailment mechanism. Rather, the position of the last derailed car and the wheel flange markings on the base of the rail and gauge side surface of the ties indicate that the train derailed when the rails spread and the wheels fell between the rails. The extent of damage on the surface of the bridge deck ties and north approach track ties close to the abutment indicate that the ties nearest the abutment had the largest number of derailed wheels travel over them. Therefore, it is likely that the train derailed in the vicinity of the abutment.

The review of the inspection records and the examination of the ties in the field and of the bridge ties in the laboratory suggest that a cluster of ties in the area of the north abutment had reduced lateral strength. The approach track ties were deteriorated and were not renewed in 2005 when substantial work was carried out north of the bridge. Even though they were double-spiked, their holding capacity was not restored. Furthermore, some bridge ties were split and had loose spikes. These ties, with the two abutment ties (where no ties plates were installed) and the track approach ties, formed a section of track at the north end of the bridge of at least 12 feet where the lateral strength had been lowered.

The abrasion marks observed on the base of the rail south of the derailment area were indicative of rail creep across the bridge. Because the track has a descending grade towards the bridge, trains travel over the bridge northward in dynamic braking and apply longitudinal forces to the track structure. In the absence of rail anchors on the bridge, the rail was being pushed northward and compressed at the end of the bridge. The rail became more susceptible to lateral instability as its internal stresses were increased. As the train passed over the north end of the bridge, where surface and alignment geometry deviations were present, its wheels exerted lateral forces on the rails. These forces exceeded the lateral restraint capacity of the rail, which had been lowered due to the tie condition near the north abutment, causing the rails to shift and the train to derail.

Track Lateral Strength

The track and bridge received regular inspections. The track gauge was measured during bridge inspections to assess the holding capacity of the ties; however, the inspections were unable to detect the reduced lateral strength of the track. The deterioration of the approach track ties was acknowledged and the ties were double-spiked. This corrective measure would have been sufficient to maintain gauge in most instances; however, the rail was not anchored on the bridge and was being pushed northward and compressed at the end of the bridge.

While measurements of gauge widening or signs showing that the rail has shifted are reliable indicators of the track's ability to retain gauge in curved track, they can be misleading on tangent track because they do not reflect the behaviour of the track under load. In curved track, trains exert steering forces on the rail. Thus, track lateral strength degradation is easily identified as signs of gauge widening will appear when the lateral strength of the track decreases. In tangent track, however, this phenomenon is less likely to occur and the inspection process must rely more heavily on detecting indirect indicators of track lateral strength degradation such as loose spikes, wood checks or splits and visibly decayed ties.

The extent to which these characteristics affect a tie's spike holding capacity and therefore the lateral strength of the track is not quantifiable but rather is based on a subjective evaluation of the tie condition. Since visual signs of tie decay are not always fully assessed and the inspection for decay is a subjective process, there is an increased risk that the weakened condition of some sections of ties on tangent track such as the bridge approach will remain undetected. Assessing the track lateral strength using a system such as the Gauge Restraint Measuring System (GRMS), which applies lateral loads to the rails, would have been more beneficial.

Broken Knuckle

As the train had been operating in dynamic braking at the time of the derailment, the draft components, including the knuckle, were in compression. The knuckle failed in tension as a result of overstress; therefore, the failure occurred as a result of the derailment.

Site Remediation

Although the first responders arrived after a large portion of the hydrocarbons had entered into the Rivière du Loup, their efforts to contain the spill and recover the released hydrocarbons were successful in limiting the amount that entered the waterways. As a result, the environmental impact of the spill was low. Approximately one-third of the released product was recovered.

Findings as to Causes and Contributing Factors

1. As the train passed over the north end of the bridge, where surface and alignment geometry deviations were present, its wheels exerted lateral forces on the rails. These forces exceeded the lateral restraint of the rail, which had been lowered due to the tie condition near the north abutment, causing the rails to shift and the train to derail.

2. The deteriorated track ties on the north approach and the bridge ties near the north abutment, including the two abutment ties where no tie plates were installed, formed a section of track at least 12 feet long where the lateral strength had been lowered.

3. The lack of rail anchors on the bridge allowed the rail to creep northward, becoming more susceptible to lateral instability as its internal stresses were increased in the vicinity of the bridge north abutment.

4. The track and bridge received regular inspections; however, the inspections were unable to detect the reduced lateral strength of the track.

Findings as to Risk

1. Since visual signs of tie decay are not always easily recognizable and the inspection for decay is a subjective process, there is an increased risk that the weakened condition of some sections of ties on tangent track will remain undetected.

2. Assessing the track lateral strength using a system such as the Gauge Restraint Measuring System (GRMS), which applies lateral loads to the rails, would have been more beneficial.

Other Finding

1. The environmental impact of the released hydrocarbons was low. Approximately one-third of the product did not reach the waterways and was contained and recovered.

Safety Action Taken

Canadian National (CN) installed rail anchors on several bridges in Ontario and Quebec including the bridge at Mile 65.1 on the Joliette Subdivision.

Transport Canada has initiated a process to modernize the *Railway Track Safety Rules*. The assessment of track lateral strength is one of the issues being considered.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 18 July 2007.

*Visit the Transportation Safety Board's Web site (**www.tsb.gc.ca**) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.*