Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT
R09W0033

MAIN TRACK TRAIN DERAILMENT

CANADIAN NATIONAL RAILWAY
MILE 108.23, ALLANWATER SUBDIVISION
ROBINSON, ONTARIO
13 FEBRUARY 2009

Canada

Railway Investigation Report

Main Track Train Derailment

Canadian National Railway
Mile 108.23, Allanwater Subdivision
Robinson, Ontario
13 February 2009

Report Number R09W0033

Summary

At approximately 0435 central standard time on 13 February 2009 while proceeding eastward on the Allanwater Subdivision, Canadian National Freight train M30451-09 derailed 2 locomotives and 29 cars just east of the east siding switch at Robinson, Ontario, approximately 20 miles east of Sioux Lookout, Ontario. The derailed cars included a load of sodium chlorate (UN 1495) and two loads of propane (UN 1075). The derailed cars struck a wayside propane tank that fuelled a switch heater, igniting a fire and causing an explosion. There were no injuries.

Ce rapport est également disponible en français.

Other Factual Information

Canadian National (CN) freight train M30451-09 (the train) consisted of two head-end locomotives and 94 cars. It weighed 10 386 tons and was 6061 feet in length. The train received a mechanical inspection and an air brake test at Symington Yard in Winnipeg, Manitoba before departing, destined for MacMillan Yard in Toronto, Ontario. No defects were noted during these inspections.

On 13 February 2009, the train was proceeding eastward on the Allanwater Subdivision. The crew, consisting of a locomotive engineer and a conductor, were qualified for their positions, met current fitness and rest standards, and were familiar with the territory. At approximately 0435 [1] while travelling at approximately 40 mph on the main track, both locomotives and 29 head-end cars derailed just beyond the east siding switch at Robinson, Ontario (see Figure 1). Neither the train crew nor the crews of the preceding two trains that day noticed anything unusual while travelling over the east switch at Robinson. However, among train operating crews, this location was known as having a rough spot.

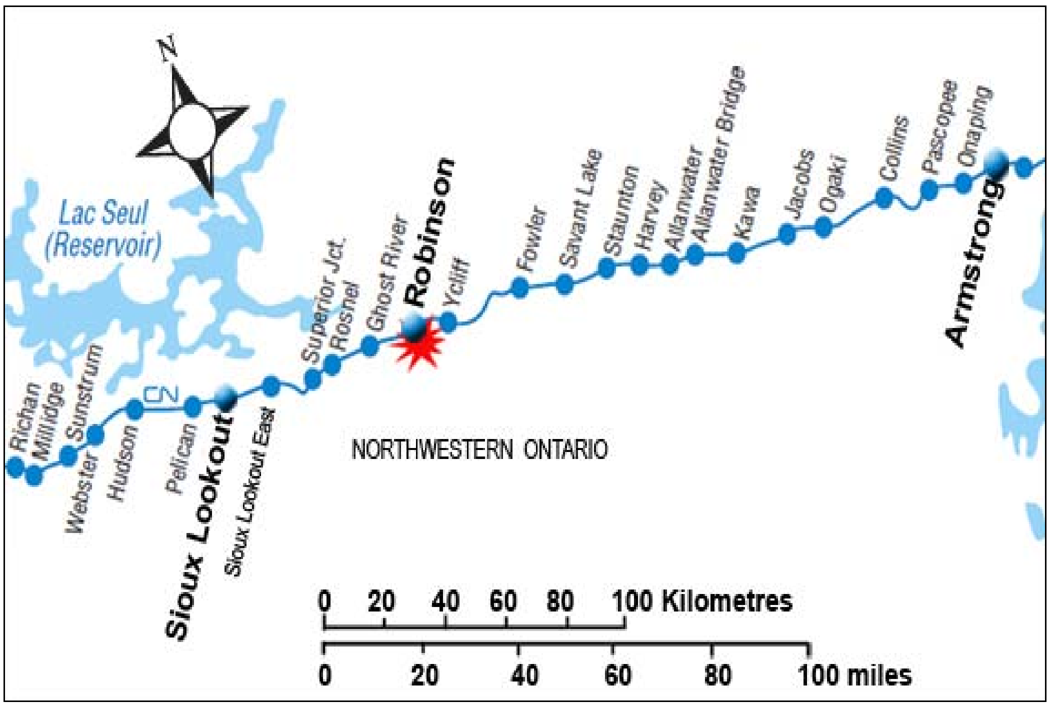

Figure 1. Map of derailment location (Source: Railway Association of Canada).

An 800-gallon wayside propane tank, which was used to fuel the Robinson east power switch heater, was located on the railway right of way about 50 feet north of the switch (see Figure 2). During the derailment, rolling stock struck and breached the tank, which resulted in an explosion and a fire. The fire engulfed most of the derailment site, including approximately

1 All times are central standard time (Coordinated Universal Time minus six hours).

15 of the 29 derailed cars. Two tank cars of lard and a carload of lumber were consumed in the fire (see Photo 1). Several bulldozers and large backhoes were brought to the accident site to contain the fire and to work on restoring the rail line. The heavy equipment spread the damaged rolling stock about the site and covered it in snow in an effort to extinguish the fire, which burned for about 24 hours. Once the fire was under control, site remediation continued.

Photo 1. Derailment site and fire

A search of the TSB database for the previous 10 years for main track collisions and derailments involving wayside propane tanks revealed three other incidents where tanks or lines were breached, none of which resulted in explosions or fires.

In the area of the derailment, Environment Canada records for February 2009 showed cold, winter weather typical for Northern Ontario. However, a warming trend had occurred between February 05 and February 12, during which approximately 15 millimeters (mm) of rain/snow had fallen. The maximum daily temperature was above 0°C on February 09, 10, and 11.

Site Examination

CN notified the TSB of the accident approximately two hours after it occurred. Rail investigators were deployed from the TSB Regional Office in Winnipeg, Manitoba, and arrived at the CN Incident Command Centre (Command Centre) in Sioux Lookout, Ontario, later that day. Shortly thereafter, an aerial examination of the accident site was conducted. It was determined that due to the size of the fire and the containment efforts, a ground site inspection was not possible that day. It was agreed with the CN Command Centre Officer that a ground inspection would be conducted the next morning. TSB contact information was left with the officer along with instructions to contact the TSB if circumstances changed and prior to any wrecking or restoration work. These instructions were not passed on to the wrecking crew at the accident site.

Upon arrival at the Command Centre the next morning, TSB Investigators learned that the fire had been successfully extinguished during the night and that wrecking operations and track restoration had already commenced. With these activities already underway, a post-fire accident site examination, including an accurate determination of a suspected point of derailment (POD), could not be conducted. However, CN recovered a number of rail pieces during the subsequent site clean-up. The rail was sent to the Sioux Lookout Yard where it was examined by the TSB several months later. At that time, pieces of interest were selected and forwarded to the TSB Laboratory for further examination.

Track Information

The Allanwater Subdivision extends from Armstrong, Ontario (Mile 0.00), westward to Sioux Lookout, Ontario (Mile 138.90). Train movements are governed by the Centralized Traffic Control System in accordance with the *Canadian Railway Operating Rules* and are supervised by a CN rail traffic controller located in Toronto, Ontario. The single main track is classified as Class 4 according to Railway Track Safety Rules (TSR), with a maximum authorized speed of 50 mph for freight trains. Traffic through the area consists of about 16 freight trains per day.

In the vicinity of the derailment, the track was tangent and oriented in an east-west direction with a 0.10 per cent eastward ascending grade. Just south of the main track, a 6450-foot long siding runs parallel, between Mile 108.26 and Mile 109.56 (See Figure 2). A temporary slow order (TSO), which restricted speed to 40mph, was placed in the area of the Robinson east switch on 10 February 2009. Maintenance surfacing of the track at this location was planned for 13 February 2009, the day of the derailment.

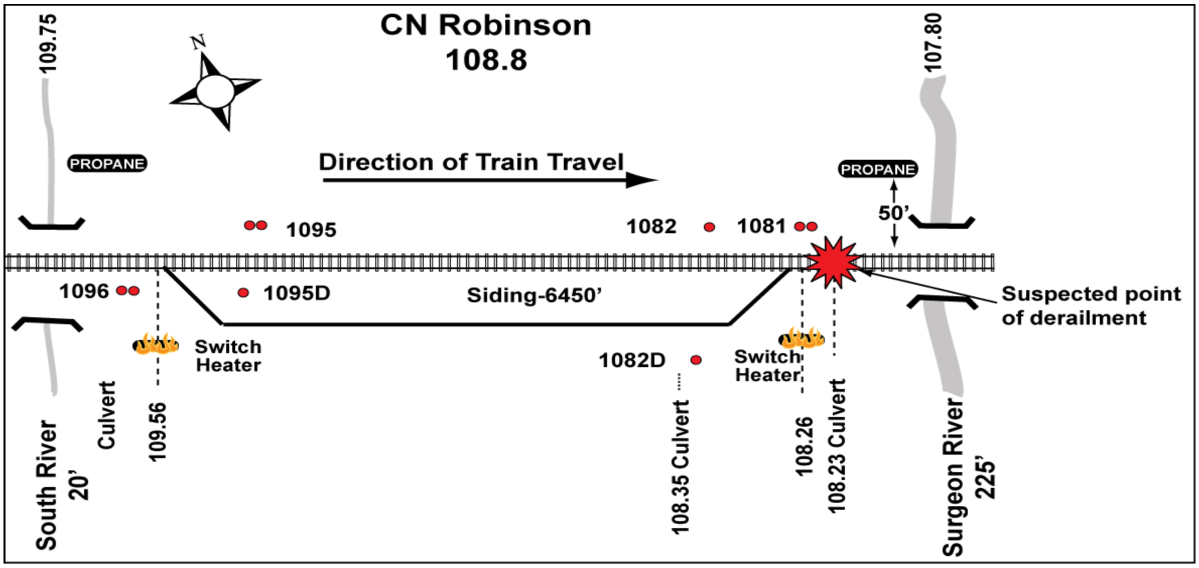

Figure 2. Track layout in area of the accident.

East of the Robinson East switch point, the rail was 136-pound 3 HB [2] continuous welded rail (CWR) manufactured in 1995. The rail in the all-welded No. 12 spring frog turnout was also 3 HB manufactured by Sydney Steel in 1994. Immediately east of the turnout switch on the south rail were two standard joints and a Portec [3] insulated joint. On the north rail opposite the Portec joint, there was an Allegheny insulated joint. Treated wood switch ties and mainline concrete ties were considered to be generally in good condition. The turnout contained four 9-foot, four 10-foot, and four 11-foot ties that transitioned between the wood switch ties and the main track concrete ties. In the switch area, the rail was secured to the ties using flat bottom plates with four lag screws per plate. Mainline rail was fastened to the concrete ties with pandrol clips. The ballast was crushed stone, the cribs were full, and the shoulders were 12 to 18 inches wide.

CN records indicate that there were two culverts in the vicinity of the east switch. The first was a 1′ X 21′ steel culvert with four feet of cover located at mile 108.23, which also corresponded to the approximate location of the joints just east of the switch. The second was a 2′ X 3′ X 72′ stone box culvert located at mile 108.35. During post-accident site examination, the steel culvert could not be located. Inspection records from July 2008 indicate that the left side of the stone box culvert had collapsed and that the right side had heavy displacement of stones. Despite the problems with the two culverts, CN reported drainage around the east switch to be good.

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2 HB refers to a scale used to measure the hardness of the steel. In this case, 3 HB means a minimum hardness of 300 on the Brinell Hardness scale.

3 A Portec insulated joint is bolted together, while an Allegheny insulated joint is glued and bolted.

Track Inspection

The Allanwater Subdivision rail was ultrasonically tested on 16 December 2008 and 08 January 2009; no defects were recorded in the vicinity of the derailment. The subdivision was inspected by CN's track geometry car (TEST) on 10 April 2008, 01 June 2008, 11 July 2008, 15 September 2008, and 28 October 2008 (siding test). All five geometry tests indicated that there were superelevation, wide gauge, alignment, and surface anomalies at or close to the Robinson east switch. Specifically:

- The "roughest" surface (i.e., that had the most numerous and severe surface defects) as well as Urgent [4] and Near Urgent WRP62 [5] and WDGA (wide gauge) defects were recorded on the April test. There was no record of any activity to repair the urgent condition.

- A Near Urgent WRP62 defect was recorded on the June test.

- Priority surface profile and WRP62 defects were recorded on the April, June, July, and September tests.

- While no Urgent or Near Urgent surface defects were recorded after the June 01 geometry test, these anomalies could still be seen on the geometry test brush charts.

- The geometry conditions were very close to a mud hole that was reported to be 10 ties east of the switch, which is an area that also contained a number of joints.

In compliance with the TSR, the Class 4 track was visually inspected at least twice weekly, with an interval of at least two calendar days between inspections. In addition, mainline turnouts were inspected monthly. On 10 February 2009, main line track and detailed turnout inspections were conducted in the area of the accident. The detailed turnout inspection for the Robinson east turnout noted a "mud hole east of points" in the approximate location of the insulated joints. Static measurements taken during the track inspection noted a 1½-inch, low-surface profile defect and a 5/8-inch cross level [6] defect in the area of the mud hole. There was no record of any significant repairs or maintenance activity performed in the area of the east switch in the previous year.

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4 Urgent defect is a track geometry deviation exceeding minimum safety requirements as specified in the railway *Track Safety Rules* or the United States Federal Railroad Administration (FRA) Track Safety Standards. Near Urgent defect is a track geometry deviation approaching 90 per cent of the Urgent value. Priority defect is a track geometry deviation that exceeds CN's allowable maintenance tolerance.

5 Warp 62′ in tangent track is the difference in cross-level between any two points less than 62′ apart.

6 Cross level is the difference in height between the running surface of one rail to the running surface of the opposite rail at the same point in the track. On tangent track, both rails by design should be at the same height, or have zero cross level.

CN Engineering Track Geometry Standard TS 7.1 (5) states that when unloaded (static) track is measured to determine compliance with the standard, the amount of rail movement, if any, that occurs when the track is loaded must be added to the measurement of the unloaded track. In this occurrence, the static surface profile measurement of 1½ inches was considered a Priority defect but less than the two-inch Urgent value for Class 4 track and no speed reduction was required. However, under dynamic loading conditions, the 1½ inch deviation was likely higher considering the history of geometry anomalies and defects at the location. To protect the defect, a 10 mph temporary slow order was placed, which reduced track speed to 40 mph, the maximum speed for the next lowest class of track (Class 3).

Similarly, the static cross level measurement of 5/8 inch was considered a Priority defect but less than the 1 ¼ inch Urgent value for Class 4 track. However, dynamic measurements could exceed 1¼ inches, which also requires that the track speed be reduced to the maximum for Class 3 track, or 40 mph.

Track Safety Rules

Part 1, Section 3, Item 3.1 of the TSR states, in part, that the requirements prescribed in this part apply to specific track conditions existing in isolation. Therefore, a combination of track conditions, none of which individually amounts to a deviation from the requirements in this part, may require remedial action to provide for safe operations over that track. Nothing in the rules prevents a railway company from prescribing a higher level of maintenance.

Part II, Subpart C, Item VI of the TSR states, in part, that each track owner shall maintain the surface of its track within the limits prescribed. The deviation from uniform surface profile on rail at the mid-ordinate of a 62-foot chord may not be more than two inches for Class 4 track. The deviation from zero cross level at any point on tangent track may not be more than 1¼ inches. The TSR notes that if a track geometry-related defect is detected during a track inspection, the railways must impose a temporary slow order on the track to protect the defect. After a 72-hour period, if the track defect has not been repaired, the slow order speed must be revised to the next lower track class.

TSB Laboratory Analysis

Four rail pieces and three broken joint bars, including a 132-pound/136-pound compromise bar, were sent to the TSBs Laboratory for further analysis. The analysis revealed that although pre-existing fatigue defects were noted on the fracture faces of the three joint bars, the poor condition of the rail suggested that the rail was not from the main track, but likely from the siding track, which was not involved in the accident. The rail from the suspected POD had not been recovered and therefore could not be analyzed.

The following TSB Laboratory report was completed:

LP 087/2009 – Examination of Rail

This report is available from the Transportation Safety Board of Canada upon request.

Transportation Safety Board Act and Regulations

Subsection 9 (1) of the Transportation Safety Board Regulations (the Regulations) sets out the requirements for the "Preservation of Evidence Respecting Reportable Accidents and Incidents." It states where a reportable accident or incident takes place, the owner, operator, master and any crew member shall, to the extent possible, and until otherwise instructed by the Board or except as otherwise required by law, preserve and protect any evidence relevant to the reportable accident or incident, including evidence contained in documents as defined in subsection 19(16) of the Act. Paragraph (2) indicates that that Subsection (1) shall not be construed as preventing any person from taking necessary measures to ensure the safety of any person, property, or the environment. Paragraph (3) notes that where evidence relevant to a reportable accident or incident has to be interfered with pursuant to subsection (2), the person directing, supervising, or arranging the interference shall, to the extent possible in the circumstances, and prior to the interference, record the evidence by the best means available.

The penalty for not complying with the requirements in Section 9 of the Regulations is found in subsection 35 (2) of the *Canadian Accident Investigation and Safety Board Act* (the Act) and it states that "every person who contravenes a provision of this Act or the Regulations for which no punishment is specified is guilty of an offence punishable on summary conviction."

Analysis

The train was operated in compliance with company and regulatory rules and instructions and there were no identified equipment or rail material deficiencies that could be considered causal. This is the only rail accident in 10 years that resulted in a breached propane tank and subsequent fire. The propane tank involved was 50 feet north of the track, near the edge of the railway right of way. Given the scope of the accident, it is unlikely that additional tank protection would have altered the outcome. The analysis will focus on the condition of the track sub-grade and on the geometry defects in the vicinity of the accident.

The Accident

The train was travelling at 40 mph when both head-end locomotives and the following 29 cars at the head end of the train derailed. The cars piled up near Mile 108.23, in the vicinity of the Robinson east switch. These factors are consistent with a sudden catastrophic event and were indicative of a sudden loss of wheel-rail contact.

Due to the extensive damage sustained by firefighting efforts and track restoration, the exact point of derailment could not be determined. However, all five of the 2008 track geometry tests identified a number of track geometry anomalies in an area that also contained several joints, was missing a culvert, and had a known mud hole. This suggests that a persistent area of instability was located near the area where the accident occurred. Based on the observed conditions, it is likely that the train derailed just east of the Robinson east switch when it struck the mud hole and the sub-grade and/or rail failed catastrophically.

Effect of Temperature Variations on Track

Temperature variations such as occurred in the area in early February 2009 resulted in a freeze-thaw cycle, which likely had the effect of degrading track surface. Warm-weather thawing in the track structure produces excess free water that decreases normal internal soil friction, leading to reduced cohesion, stability, and bearing support. Water pockets can form under the track structure causing soft, sinking spots. A mud or slurry can form that works upward, fouling the ballast and destroying its drainage properties. [7] Under these conditions, combination surface defects located in curves and near changes in track modulus such as bridge, crossing and turnout locations may deteriorate more quickly during freeze-thaw periods, increasing the risk of derailment.

The 10 February 2009 turnout inspection noted a "mud hole east of points" in the approximate location of the insulated joints, while the static measurements taken during the track inspection identified a 1½ inch low-surface profile defect and a 5/8 inch cross level defect in the area of the mud hole. Although it cannot be verified, given the volume of train traffic through the area, the absence of any significant repairs or maintenance activities, and the existence of the mud hole, it is reasonable to conclude that the track geometry defects at this location likely increased in severity since the last geometry test and the mud hole probably deteriorated in the days prior to the derailment due to the recent warmer temperatures.

Combination Surface Defects

Track surface defects that occur within a close proximity of each other can have a cumulative adverse effect on wheel/rail interaction. CN's Track Geometry Standard TS 7.1 requires that action be taken to address combinations of Priority defects within 100 feet of each other in curves and near changes in track modulus such as bridge, crossing, and turnout locations.

The observed surface and cross-level defects prompted the Track Maintenance Supervisor to apply a TSO of 40 mph, a 10 mph speed reduction, to the area in the vicinity of the accident. A static surface profile measurement of 1½ inches was recorded but under dynamic loading conditions the defect could exceed the two-inch maximum for Class 4 track. In isolation, this would be considered an Urgent defect requiring that a TSO be applied in accordance with the TSR. Similarly, a static cross level measurement of 5/8 inch was recorded, but under dynamic

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[7] W.W. Hay, Effects of Excess Moisture in subgrade soils, Section 12, page 288, *Railroad Engineering*

loading this could exceed the 1¼ inch maximum for Class 4 track, which on its own would also be considered an Urgent defect requiring a TSO. Depending on the defect and measurement, the most restrictive speed reduction would be applied. In this case, the 10 mph reduction TSO was considered to be sufficient for the conditions.

TSR requirements apply to specific track conditions existing in isolation. However, when combinations of track conditions are observed, additional remedial action may be required to provide for safe operations. The CN Track Inspector complied with CN's Engineering Track Geometry Standard by issuing a TSO to protect the surface defect, restricting track speed to the maximum for the next lowest class of track (Class 3), or 40 mph. However, the 10 mph speed reduction may have been insufficient to protect against the combination of track surface defects, under dynamic loading conditions.

Investigation for Causes and Contributing Factors

Due to the scope of the accident and extensive fire containment efforts, a ground inspection was not possible when TSB Investigators first arrived at the site. It was agreed with CN that a ground inspection would be conducted the following morning. TSB contact information was left with the CN Officer in charge along with instructions to contact the TSB if circumstances changed and prior to any wrecking or restoration work. These instructions were not passed on to the wrecking crew at the accident site. Fire containment was completed during the night and wrecking operations and track restoration had immediately commenced without TSB consent.

It is recognized that there are times when emergency response and firefighting activities need to take place immediately and that sometimes wreckage will need to be moved. However, when this happens, the wreckage and its movement should be documented. Then, once the emergency is under control, the TSB must have access to all of the evidence and that evidence must be preserved for the TSB's full and independent investigation.

In this occurrence, the evidence was disturbed initially by the firefighting efforts and this evidence was not documented. The evidence was further disturbed in the wrecking and track restoration work. It is unclear how much damage was due to fire containment and how much was due to CN's track restoration activities, but what is significant is that the rail from the suspected POD was lost in the process. Consequently, the TSB was unable to examine the undisturbed derailment site and those portions of the track key in determining the cause of the derailment.

Findings as to Causes and Contributing Factors

1. The train derailed just east of the Robinson east switch, likely due to the collapse of the sub-grade and/or rail failure in the vicinity of a mud hole.

2. While the precise cause of the collapse cannot be confirmed, it is likely that the track geometry defects at this location had increased in severity since the last geometry test (October 2008) and the mud hole had deteriorated in the days prior to the derailment due to the recent warmer temperatures.

3. While a temporary slow order (TSO) was issued restricting track speed to 40 mph, the 10 mph speed reduction may have been insufficient to protect against the combination of track surface defects, in the presence of a mud hole, under dynamic loading conditions.

Findings as to Risk

1. Combination surface defects located in curves and near changes in track modulus such as bridge, crossing and turnout locations may deteriorate more quickly during freeze-thaw periods, increasing the risk of derailment.

2. When evidence from accident sites is not preserved, the Transportation Safety Board may be hindered in determining the causes and contributing factors and in identifying safety deficiencies in the transportation system. Unidentified safety deficiencies can result in subsequent, otherwise preventable, accidents.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 26 March 2010.

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