RAILWAY INVESTIGATION REPORT
R01H0005

DERAILMENT

OTTAWA VALLEY RAILWAY
TRAIN 301-043
MILE 85.0, NORTH BAY SUBDIVISION
BONFIELD, ONTARIO
12 MARCH 2001

Railway Investigation Report

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Ottawa Valley Railway
Train 301-043
Mile 85.0, North Bay Subdivision
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Report Number R01H0005

Summary

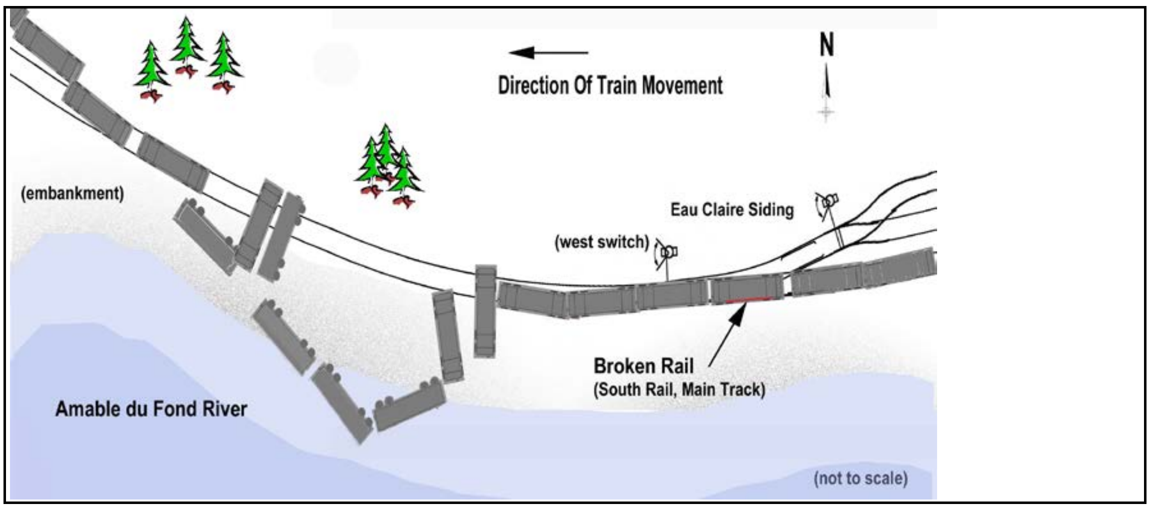
On 12 March 2001, at approximately 0230 eastern standard time, Canadian Pacific Railway train No. 301-043, proceeding westward at about 40 mph, derailed 14 cars near Bonfield, Ontario, Mile 85.0 of the Ottawa Valley Railway North Bay Subdivision. The derailed cars included three methanol residue tank cars and one empty hopper car, which rolled down the embankment into the Amable du Fond River. There was no loss of product and no injuries.

Ce rapport est également disponible en français.

Other Factual Information

The Accident

On 11 March 2001, train No. 301-043 (the train) departed Canadian Pacific Railway (CPR) Saint-Luc Yard (Montréal, Quebec) for Coniston, Ontario. At Smiths Falls, Ontario, the train was transferred to the Ottawa Valley Railway (OVR) and proceeded westward on the OVR North Bay Subdivision. At Mile 85.0, near Bonfield, Ontario, the train experienced a train-initiated emergency brake application. After conducting the necessary emergency procedures, the crew members determined that 14 cars (68th to 70th and 72nd to 82nd) had derailed. The derailed cars included one empty hopper car and three residue Class 111A tank cars (methanol, UN 1230) which rolled into the Amable du Fond River (see Figure 1). None of the cars was breached and no product was lost.



Methanol (also known as wood alcohol) is a colourless flammable liquid with potentially adverse health effects. It can cause increased sensitivity to light, blurred vision and possible blindness when inhaled, absorbed through the skin or ingested.

Damage

Approximately 500 feet (152 m) of track and a switch were destroyed. Two cars were destroyed and 11 cars sustained damage.

Personnel Information

The crew consisted of a locomotive engineer and a conductor. They were familiar with the subdivision, met fitness and rest standards and were qualified for their respective positions.

Train Information

The train, powered by 2 locomotives, was hauling 3 loaded cars, 6 residue cars and 80 empty cars. The train was approximately 5650 feet long and weighed about 3500 tons.

Particulars of the Track

The North Bay Subdivision is a single main track that extends from Mile 0.0 (Chalk River, Ontario) to Mile 117.3 (North Bay, Ontario). The authorized timetable speed was 50 mph for all trains; there was a permanent speed restriction of 45 mph between Mile 84.5 and Mile 85.5. Train movements are controlled by the Occupancy Control System (OCS) authorized by the Canadian Rail Operating Rules and supervised by a rail traffic controller located in North Bay. The OCS is complemented by an Automatic Block Signal System.

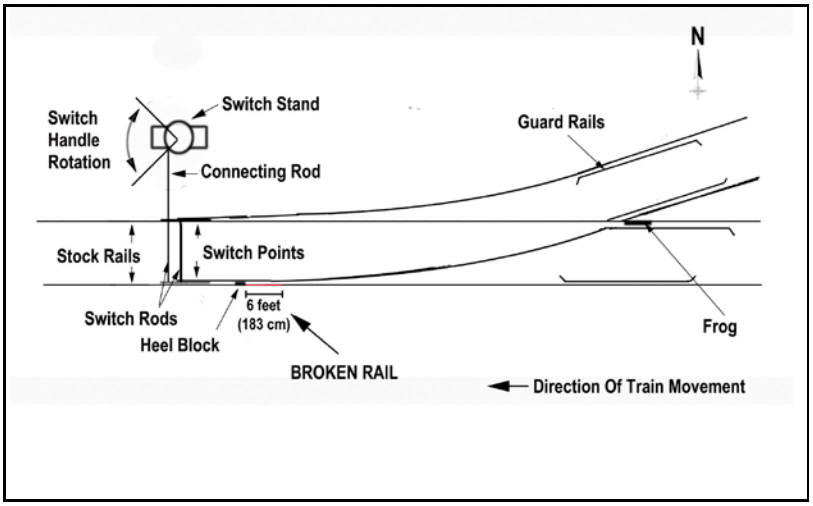
The track consisted of 115-pound continuously welded rail laid in 1982. The rail was laid on double-shouldered tie plates secured to hardwood ties and box-anchored every second tie. The ballast was crushed rock. The roadbed was frozen and the ground surface was snow-covered.

Recorded Information

Event recorder data indicated that the train experienced a train-initiated emergency brake application while proceeding at a speed of 40 mph with the brakes released and the throttle in the No. 8 position.

Occurrence Site Information

In the vicinity of the derailment, the track was adjacent to the Amable du Fond River and was oriented in an east-west direction. The derailment occurred in a 3-degree, 45-minute curve, near the west end switch of the Eau Claire siding (see Figure 2). The tie plates were secured with 8 spikes per tie in the turnout, and 10 spikes per tie in the rest of the curve. Several rail joints, within a short span, were present on the track east of the switch. The main track stock rail, on the west-end switch, was broken into many pieces over a distance of approximately 6 feet (183 cm). The break extended westward, from a bolt hole located 10 inches (25 cm) west of a rail joint, to the switch point heel block. The rail ends at the joint were battered and exhibited material flow.



An examination of the section of train that had not derailed revealed that car CPWX 601303, which was the 63rd car behind the locomotives, and the 5th car ahead of the first derailed car, had two wheels with significant shells, spalls and tread build-up.

The rail joint, 56 pieces of broken rail measuring 114 inches in length (2.9 m), and two wheel sets from car CPWX 601303 were sent to the TSB Engineering Laboratory for analysis.

Track Inspection

The track was inspected twice every week, once by the roadmaster and once by the track maintenance foreman. It was last inspected on 11 March 2001, and no irregularities were noted. A track geometry car inspection was performed on 08 November 2000 with no exceptions noted. The rail was tested by an ultrasonic rail flaw detection car on 14 August 2000 and no internal defects were detected.

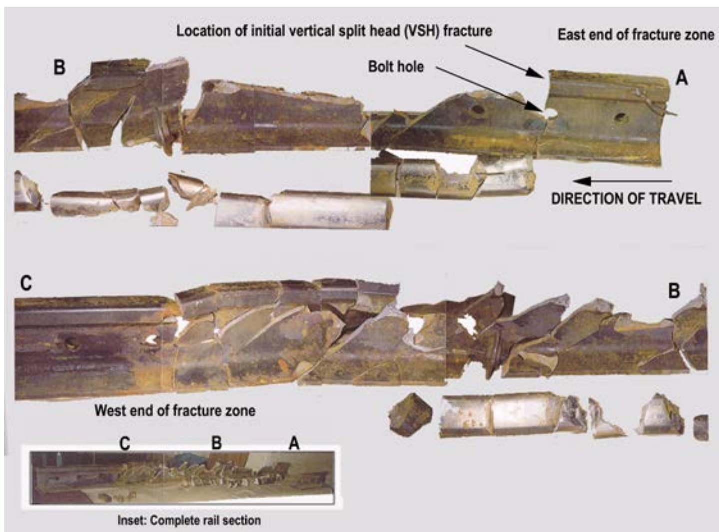
Weather

At the time of the derailment, the temperature was -15°C. The sky was clear and there were 7 km/h winds from the north-northeast.

Technical Examination of the Rail

The examination of the broken rail revealed the following.

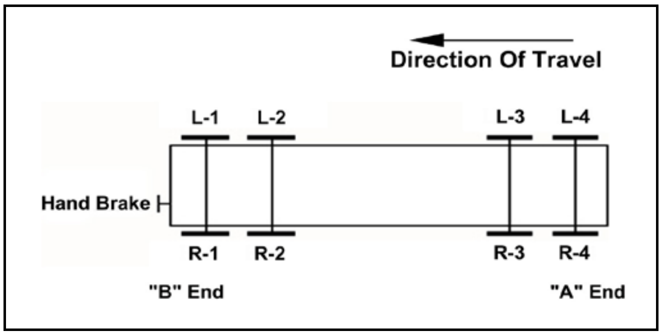
- The rail was made of chromium alloy.[1]
- The ultimate tensile strength (UTS) of the rail averaged 165 000 psi, while its elongation was 9.0 per cent. The minimum rail properties specified by CPR are 155 000 psi for UTS and 9.0 per cent for elongation.
- The resistance of the rail to breakage, measured using Charpy impact testing, was 2 to 3 foot-pounds.
- The break occurred 10 inches (25 cm) from the rail joint, through a bolt hole (see Figure 3). The rail head had broken along the centre line consistent with a vertical split head (VSH) fracture.
- Chevron markings indicated that the fractures initiated from the top of the rail surface.
- No long-term cracking was observed, indicating that the VSH fracture was recent.



[1] "In the past, several railways had used chromium rail because of its good wear properties, but discontinued its use due to problems from welding, mainly, embrittlement." (TSB Engineering Laboratory report LP 18/01, section 4.2)

Technical Examination of the Wheels

The wheels (see Figure 4) of the leading truck of car CPWX 601303 were examined and the following observations were made.



- All wheels exhibited built-up tread.
- The shells on wheel R-1 spread over a length of 5.75 inches (146 mm), a width of 1.6 inches (40 mm) and a depth of between 0.06 and 0.18 inches (1.6 and 4.5 mm). The shells on wheel L-2 spread over a length of 12 inches (300 mm), a width of 1.6 inches (40 mm) and a depth of between 0.056 and 0.16 inches (1.4 and 4.1 mm).
- The height of the wheel flange on wheels R-2 and L-2 was 1 $^{15}/_{16}$ inch (49.2 mm).
- Both wheel R-1 and wheel L-2 contained a flat spot 2½ inches (63 mm) long.
- The maximum out-of-round measurements were 0.115 inches (2.9 mm) for wheel R-1, 0.013 inches (0.51 mm) for wheel R-2, and 0.185 inches (4.7 mm) for wheel L-2.

Out-of-round and flat spot measurements for wheels R-1 and L-2 reached or exceeded Association of American Railroads (AAR) limits.[2] The flange height on wheels R-2 and L-2 exceeded both Transport Canada (TC) and AAR limits. Relevant AAR and TC allowable limits for freight car wheels are contained in Appendix A.

Wheel Impact

The railway industry recognizes the relationship between wheel impact loading, out-of-round, and rail breaks, and has installed wheel impact load detector (WILD) systems to identify and remove high impact wheels before they can cause damage to rolling stock or track infrastructure.

A 1994-1995 study established a correlation between WILD data and out-of-round wheel measurements. The impact loads generated by the wheels of car CPWX 601303 were interpolated using data from this study (see Figure 5). The interpolation shows that, when a 95 per cent confidence interval was used, the impact loads

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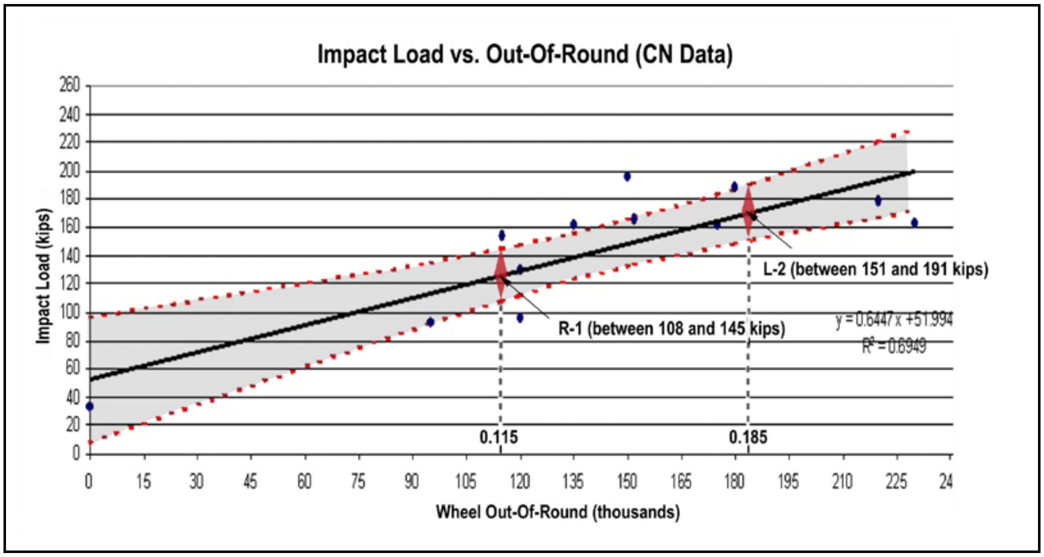
[2] Although wheels R-1 and L-2 exceed AAR limits for out-of-round measurement, they were not condemnable because wheels needed to be both detected to have a wheel impact load detector (WILD) reading exceeding 90 000 pounds (90 kips), and verified to exceed 0.070 inches out-of-round using an approved gauge or other suitable device. In July 2002, AAR rule 41.A.1.s was modified so that either condition, by itself, is condemnable.

would have been between 108 and 145 kips (108 000 and 145 000 pounds) for wheel R-1 (out-of-round value



0.115), and between 151 and 191 kips (151 000 and 191 000 pounds) for wheel L-2 (out-of-round value 0.185).

Railway Car Inspection

Railway cars are inspected according to TC's Railway Freight Car Inspection and Safety Rules. Safety inspections must be performed by a certified car inspector when a train is made up, cars are added to trains or interchanged. In addition to TC inspection rules, the AAR requires all freight railroads and interchange freight car owners to subscribe to the AAR Interchange Rules.

The purpose of safety inspections, performed by a certified car inspector, is to ensure that cars are deemed reasonably safe prior to allowing them to proceed down the track. During a safety inspection, each component of a car is examined and checked with measuring devices and gauges, when required. Defects such as shells or spalls can be identified visually; however, when they are healed (when metal flows into the spall cavities), they can only be identified by WILD systems. The detection of out-of-round wheels requires precise measurement at three locations using an out-of-round gauge (see Photo 1), or the use of WILD systems.

For CPR trains originating in Montréal and routed through the OVR west to Winnipeg, Manitoba, wheel impacts are not measured by any WILD system before reaching Thunder Bay, Ontario. In eastern Canada, CPR has WILD systems installed on the Lacolle Subdivision, southeast of Montréal, and on the MacTier Subdivision between Toronto and Sudbury, Ontario.

At Saint-Luc Yard, a safety inspection was performed by a certified car inspector. The inspector noted defects such as open doors and worn brake shoes, but none were related to wheel condition. All noted defects were corrected prior to departure.

At Smiths Falls, Ontario, the train did not receive a safety inspection; however, a pull-by inspection was performed by the CPR crew after the transfer of the train to the OVR crew and no defects were noted.

Historically, safety inspections were not performed in Smiths Falls as CPR owned and operated the track between Smiths Falls and Coniston. After the transfer of the track to the OVR, in October 1996, this practice (not perform inspections in Smith Falls) continued.

Analysis

Introduction

The train operation met company and regulatory requirements and no train handling irregularities were evident. There were no marks on the track or roadbed east of the location of the broken rail indicating wheel climb or equipment failure (i.e. broken wheel or axle). Defects were observed on the wheels of car CPWX 601303. Therefore, the analysis will focus on the fracture of the rail, and the wheel inspection.

Broken Rail

The rail head broke along the centre line, consistent with a VSH fracture initiated from the top of the rail surface. As the fracture was recent, it was not detected by the ultrasonic rail flaw detection test performed seven months prior to the derailment.

All examined wheels from car CPWX 601303 had built-up tread; moreover, wheel R-1 had a flat spot and an out-of-round condition exceeding AAR measurement limits. Such conditions would have resulted in high impact loads adversely affecting the rail and equipment. Furthermore, the frozen ground and the presence of several joints within a short span of track increased the stiffness of the track structure and reduced its damping effect, causing the rail to absorb the full wheel impact loading.

The Charpy impact test values and elongation results for the broken rail indicated a low fracture toughness and rail ductility. These results are consistent with other chromium alloy rail properties, and indicate that the ability of the rail to withstand high transient loads, particularly in cold weather, was limited. Therefore, it is likely that the stresses generated by the wheel R-1 impact load, combined with the tensile thermal stresses due to the low temperature, initiated the break in the main track rail.

As subsequent wheels struck the broken rail head, the fracture propagated over a distance of 6 feet (183 cm) to the heel block of the switch, and led to the derailment of the train.

Safety Inspection of the Train

Wheel shells, flat spots and spalls can develop rapidly during winter time and might not have been condemnable at the time of the safety inspection at Saint-Luc Yard or the pull-by inspection in Smiths Falls. Out-of-round wheels are not likely to be detected unless every wheel in a consist is measured with a gauge; therefore, if they were present on car CPWX 601303, it is unlikely they would have been detected when the train was inspected by a certified car inspector at Saint-Luc Yard.

Manually measuring out-of-round anomalies is a lengthy process that can negatively affect railway operations. Moreover, wheels with healed cavities can only be identified through the measurement of the impact load they generate. As a consequence, railway companies rely more and more on systems that can identify wheel defects while the wheel is in motion. Therefore, WILD systems complement the safety inspections performed by certified car inspectors and have become a vital tool in the inspection of wheels.

For CPR trains originating in Montréal and routed through the OVR west to Winnipeg, wheel impacts are not measured by any WILD system before reaching Thunder Bay. In this circumstance, there is an increased risk that shells, spalls or other wheel defects that are missed or not sufficiently developed at the time of a safety inspection, remain undetected and generate high impact loads that can be detrimental to the rail or equipment.

Findings as to Causes and Contributing Factors

1. The train derailed when the main track stock rail fractured as a result of a vertical split head fracture.

2. The frozen ground and the presence of several joints within a short span of track increased the stiffness of the track structure and reduced its damping effect, causing the rail to absorb the full wheel impact loading.

3. Low ductility and poor fracture toughness of the rail reduced the ability of the rail to withstand high transient loads.

4. Stresses generated by the impact loading from wheel R-1 of car CPWX 601303, combined with tensile thermal stresses due to the low temperature, initiated the failure of the main track stock rail.

Findings as to Risks

1. The absence of WILD systems along some routes increases the risk that wheel defects not identified during safety inspections remain undetected and generate high impact loads that can be detrimental to the rail or equipment.

Safety Action Taken

The OVR relocated the Eau Claire turnout from its location in curved track onto tangent track.

The frequency of rail flaw detection on all main track rail has been increased to three times per year.

CPR and the North American railway industry are continuing to add to and improve wheel impact technology.

TC is developing an audit/monitoring program for train traffic control signals that will include all forms of wayside detector systems, including WILDs.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 17 December 2002.

*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.*

Appendix A— Relevant Portions of 2001 Transport Canada and Association of American Railroads Standards

Transport Canada's Railway Freight Car Inspection and Safety Rules state that cars cannot be placed or continue in service if, among other conditions:

- a wheel has a shelled spot that is more than 1¼ inches (31.75 mm) in width and 1½ inches (38.10 mm) in length;
- a wheel has a slid flat spot that is more than 2½ inches (63.50 mm) in length or two adjoining flat spots each of which is more than 2 inches (50.80 mm).

Association of American Railroads Rule 41–Section A

- Shelled tread: When the shell or spall is ¾ inch in diameter or larger and the shells or spalls are more or less continuous around the periphery of the wheel or whenever any shell or spall is 1 inch or more in diameter, the wheel must be removed from service. "Islands" or original tread surface metal contained in the shell or spall will not be considered as part of the area of the shell or spall.
- Built-up tread: A wheel is condemnable whenever the tread has built-up metal ⅛ inch or higher than the wheel tread.
- Wheel Out-of-Round[3]: Detected by a wheel impact load detector reading greater than 90,000 pounds for a single wheel and verified by an AAR approved gage or other suitable device. The detector used must reliably measure peak impacts and provide a printed record of such measurements. The verified out-of-round "runout" must exceed 0.070 inches. Wheels with condemnable slid flat spots are a handling line responsibility and must not be billed as out-of-round.
- Slid Flat:
  a. Two inches or over in length.
  b. Two or more adjoining spots each 1½ inch or over in length.
  c. Mate wheel is automatically condemnable regardless of length of flat spot.

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[3] Transport Canada has no specification for out-of-round or tread build-up limits.