Transportation Safety Board
of Canada

Bureau de la sécurité des transports
du Canada

RAILWAY INVESTIGATION REPORT
R00W0253

DERAILMENT

CANADIAN NATIONAL
TRAIN M336-41-10
MILE 50.3, KASHABOWIE SUBDIVISION
SHABAQUA, ONTARIO
11 DECEMBER 2000

Railway Investigation Report

Derailment

Canadian National
Train M336-41-10
Mile 50.3, Kashabowie Subdivision
Shabaqua, Ontario
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Report Number R00W0253

Summary

At 0745 Central standard time on 11 December 2000, eastward Canadian National freight train M336-41-10, proceeding toward Thunder Bay, Ontario, at 34 mph, derailed 17 cars at Mile 50.3 of the Kashabowie Subdivision. The derailed cars included two loaded tank cars containing methanol, one that was breached, spilling about 100 000 litres of product, most of which entered the Shebandowan River. The derailment occurred in an unpopulated, forested area. Persons living close to the river, downstream, were cautioned not to consume water drawn from wells near the river. There were no injuries and no one was affected by the dangerous good. Environmental damage was minimal.

Ce rapport est également disponible en français.

Other Factual Information

The train was en route from Winnipeg, Manitoba, to Thunder Bay, Ontario, and included 3 locomotives, 59 loaded cars and 27 empty cars. It was about 5400 feet long and weighed approximately 8500 tons. The crew, a locomotive engineer and a conductor, had taken control of the train at Fort Frances, Ontario, a crew change location.

In the week before this accident, the average daytime high temperature had been -13.5°C and the daily average nighttime low temperature had been -24.1°C. At the time of the derailment, the temperature was -26.6°C, the skies were clear with a light wind from the west at 9 km/h. The low temperature had exacerbated brake pipe leakage and the crew noted that the end-of-train unit (ETU) was indicating a difference of approximately 10 pounds per square inch (psi) between the brake pipe pressure at the locomotive and the end of the train. The locomotive engineer had avoided using the train air brakes to conserve brake pipe pressure. The incoming crew members at Fort Frances also had indicated that they had experienced an undesired emergency brake application (UDE) on the trip from Winnipeg and had attributed the problem to a car with a defective brake valve. UDEs are attributable to defective brake valves and short-duration brake pipe pressure drops, caused by slack action.

Movements on the Kashabowie Subdivision are governed by the Centralized Traffic Control System as authorized by the Canadian Rail Operating Rules and supervised by a rail traffic controller (RTC) located in Edmonton, Alberta. An average of five freight trains per day traverse this area. The maximum speed permitted is 30 mph.

Event recorder data indicate that the train approached the derailment area at about 0702 Central standard time,[1] at a speed of 34 mph, with the train air brake pressure at the controlling locomotive indicating 82 psi. The throttle was in the idle position. At about this time, the train crew received an audible “low air pressure” alarm from the ETU and a zero air pressure reading. The train crew noted that, although the train was rapidly reducing speed, an emergency application of the train brakes did not occur at the locomotives. The train air brake pressure on the locomotive maintained at 78 psi throughout this deceleration.

The train crew notified the RTC that their train was stopped at Mile 50.0 and that an inspection of the train was being initiated. Walking toward the rear of train, the conductor found a heavy escape of air from the air brake line on covered hopper car CNWX 100671, the 24th car behind the locomotives. Unable to stop the air flow by isolating the brake system on the car, the conductor closed the angle cock on the 23rd car and uncoupled the 24th car from the rear of the train. The crew then proceeded eastward and placed the defective car onto the Anita siding track at Mile 46.0. The front portion of the train was then returned to re-couple with the rear portion of the train. After reconnecting the brake pipe, the crew members were still unable to recover train air brake pressure. Another inspection to the rear revealed derailed equipment beginning at the 62nd car. Aware that tank cars containing dangerous goods were in this area of the consist, the conductor uncoupled the train from the derailed cars, moved the front of the train away from the area, and notified the RTC at approximately 0845.

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[1] All times are Central standard time (Coordinated Universal Time minus six hours) unless otherwise stated.

By 1300, Canadian National (CN) had conducted an aerial survey of the site and determined that a total of 17 cars, the 62nd to 78th inclusive, had derailed, including two loaded tanks cars of methanol. An immediate alert was communicated to the local police, health and environmental agencies. The other derailed cars included five loaded cars of grain, seven empty flat cars and three empty box cars in various orientations.

The 9th derailed car, loaded tank car CELX 23478 (manufactured in 1982) containing methanol, had come to rest inverted and at a right angle to the track in the south ditch. The following car, PROX 41223, also with a load of methanol, came to rest south of the track against the side of car CELX 23478, upright with the bottom outlet mechanism sheared off. Tank car PROX 41223 had heavily struck the midpoint of car CELX 23478 and caused a fracture about 12 feet in length, extending from the manway attachment area to about one-half the diameter of the tank and falling within five inches of a vertical weld line. The fracture surface was shiny and displayed chevrons, indicative of a brittle fracture. The breach resulted in all but a small residue of methanol being released to the environment. The drawbars between the two tank cars had broken, rendering the double-shelf couplers—designed to keep tank cars carrying dangerous goods from uncoupling and striking each other—ineffective.

Car PROX 41223 was equipped with level A low-profile skid protection. Product was leaking from a partially open bottom unloading valve, which was subsequently stopped by first responders manipulating the valve handle. A total of approximately 100 000 litres of product was lost from the two cars. The released product had flowed over the frozen ground easterly in the south ditch, then moved through a culvert at the east end of the derailed cars and drained into the Shebandowan River that ran adjacent to and north of the tracks.

The 111A tank car fleet in North America is built for general service, meaning that the tank cars may be loaded with a wide variety of dangerous or non-dangerous goods. There are approximately 189 000 specification 111A tank cars in service in North America with about 64 000 used to transport dangerous goods.

Careful examination of the derailed cars at the derailment site did not reveal any indication that an equipment deficiency in these cars had caused or contributed to the derailment. Set-off car CNWX 100671 was determined to have a leaking brake pipe connection that was corrected by tightening.

The subdivision in the derailment area is a single main track consisting of 136-pound continuous welded rail laid on concrete ties. Ballast was a mixture of crushed rock and slag. The cribs were full and shoulders were 16 inches wide. The track in the immediate area of the derailment is located on a raised berm along the river. The water level of the river is about 30 feet lower than the top of the rail. The ditch on the south side of the track, adjacent to the derailed cars, was about five feet deep.

The last visual Hi-rail inspection was on 08 December 2000 and no irregularities had been noted. The rail in this area was last ultrasonically tested on 11 November 2000, with no deficiencies recorded. The testing frequency varies from one region to another, depending on such factors as tonnage, traffic type and density, rail age and previous defect rate. This subdivision is ultrasonically tested twice per year. A CN geometry test car inspected the area on 17 November 2000. No abnormalities were recorded.

From Mile 51.00 to Mile 50.35, the track is substantially straight and level. From Mile 50.35 to Mile 49.9, it descends at 0.6 per cent. From Mile 49.9 to Mile 49.2, it is again substantially level. At Mile 50.35, the track enters a 4.15-degree curve with a 2.5-inch superelevation. The first markings on the ballast from the derailed equipment were evident approximately 100 feet into the curve.

Methanol (methyl alcohol), Class 3.2, UN 1230, is a colourless, flammable and poisonous liquid. The flash point is 11°C. It is a fire hazard and its vapours present the risk of an explosion. The lower explosive limit of methanol is 6.0 per cent and the upper explosive limit is 36.5 per cent by volume. Vapours are heavier than air and will spread along the ground and collect in low and confined areas, such as sewers and basements. It is considered to be a human poison by ingestion and skin contact, in that it affects the nervous system.

Upon being notified of the spill, the police contacted local residents regarding potential heath risks, advising residents to refrain from drinking river and well water until testing had been completed. Environmental consultants were immediately contracted by CN and conducted water testing over an extended period. River water samples were taken at six different locations—three in the immediate area of the derailment and three downstream. Wells of the nearest residences, 20 km downstream, were also tested for infiltration. All testing determined that the risks to public health were minimal. The local health authority issued notices to local residents regarding health risks and provided regular updates on water testing. The responsible authorities, upon completion of site surveys, determined that there was minimal impact to the river's ecosystem. On 04 January 2001, the local health authority declared the water from all tested areas to be free of spilled product.

The north rail was standard carbon steel, manufactured in 1988. This rail, on the low side or inside of the curve, displayed negligible head and flange wear and remained intact and in place. The south rail, on the high side or outside of the curve, was high chromium rail manufactured in 1981. Head wear on this rail was measured to be 11 mm and flange wear, 7 mm, both well within allowable limits. Approximately 100 feet into the curve, the south rail was found broken at a field weld. Beyond this location, the south rail was fractured in several places and bent under and about the derailed cars. Eight pieces of rail taken from the high rail were forwarded to the TSB Engineering Laboratory for examination and analysis.

The TSB Engineering Laboratory (report LP 134/00) concluded the following:

- The fractured high rail section at the derailment site showed fracture features consistent with a crack having been present before the derailment. The length of the pre-crack was 27 cm (10.5 inches) in length, and could have played a role in the derailment.

- The failed rail was a high-strength chromium rail that was confirmed by the material and hardness analyses. The microstructure showed a relatively clean material and a medium grain size at American Society for Testing and Materials (ASTM) 6.

- Typical rail material has an elongation in the range of 6 to 12 per cent. Elongation values for the failed rail were 8.5, 5.5 and 6.0 per cent, using ASTM standard round specimens. Only one met CN's specification of 8 per cent minimum. Resistance to impact was also very low, as indicated by the 2 to 3 foot-pounds (3 to 4 joules) Charpy impact values, although these values were characteristic of most rail material. Both these mechanical properties significantly limited the ability of the rail to withstand high load transients. The marginal ductility in itself could have led to the initiation of progressive cracking observed in the web.

- The Canadian railway industry has discontinued the purchase of chromium rail mostly because of welding problems. It had been introduced because of its good wear properties.

- The derailment occurred during the colder winter months, at which time rail contracts, thereby increasing the internal tensile stresses, and facilitating crack initiation.

Analysis

The train experienced a UDE as the 62nd to 78th cars were negotiating the curve at Mile 50.3. The defective brake pipe line on car CNWX 100671 and extreme cold resulted in the problematic brake pipe pressure loss, but the source of the UDE is not known. The incoming crew at Fort Frances had also experienced a UDE. Such events are not uncommon and company policy is to continue train operations. The emergency brake application had not propagated to the head of the train and may be attributable to a small blockage in the brake pipe in the head end of the train. This allowed for an effective service brake from the front of the train, but not the quick pressure release necessary to trigger the emergency brake emanating from the rear portion of the train.

The forces generated by the emergency brake application on a piece of rail exhibiting marginal ductility and high internal tensile stresses and a pre-existing crack led to rail failure and the subsequent derailment. The 4 mph overspeed may have increased the lateral forces on the rail, but the magnitude of the effect is not known.

The section of track involved had been inspected by the rail flaw detection car one month before the derailment and no rail defects had been detected in the derailment area. The marginal ductility of the chromium alloy rail and the low temperatures experienced in the area allowed for the rapid propagation of the crack that would not typically have been revealed by a twice-yearly ultrasonic testing program. The presence of this type of rail on a subdivision that will typically experience extreme low temperatures during winter calls into question the ability of widely spaced ultrasonic testing to ensure a safe operating environment.

The railway immediately recognized the risk to employees, first responders, the local population and the environment associated with the release of such a large quantity of a dangerous good. Their response, and that of agencies charged with public and environmental safety, was timely, effective and comprehensive.

Findings as to Causes and Contributing Factors

1. The forces generated by the emergency brake application on a piece of rail exhibiting marginal ductility high internal tensile stresses and a pre-existing crack led to rail failure and the derailment.

Findings as to Risk

1. The rapid propagation of cracks in rail during times of low temperatures calls into question the ability of widely spaced (twice-yearly) ultrasonic testing regimes to ensure a safe operating environment in areas that experience severe winter conditions.

Other Findings

1. The railway response, and that of agencies charged with public and environmental safety, was timely, effective and comprehensive.

Safety Action Taken

Transport Canada (TC) will be contacting CN representatives in the near future to determine if problems related to chromium rail have been experienced before and obtain information as to the extent of its use. Based on the response, TC will decide upon any safety action to be taken, if required.

CN has increased and continues to increase its rail testing frequency on core and secondary lines where warranted, especially in winter months.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 27 January 2003.

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