Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

# RAILWAY INVESTIGATION REPORT R06Q0046

## MAIN-TRACK TRAIN DERAILMENT

## CANADIAN NATIONAL
## FREIGHT TRAIN M-36921-15
## MILE 137.68, LAC SAINT-JEAN SUBDIVISION
## LAC BOUCHETTE, QUEBEC
## 15 MAY 2006

Canada

# Railway Investigation Report

# Main-Track Train Derailment

# Canadian National
# Freight Train M-36921-15
# Mile 137.68, Lac-Saint-Jean Subdivision
# Lac Bouchette, Quebec
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# Report Number R06Q0046

## *Summary*

On 15 May 2006, at 1545 eastern daylight time, Canadian National freight train M-36921-15 derailed 18 cars at Mile 137.68 of the Lac-Saint-Jean Subdivision, near Lac Bouchette, Quebec. There were no injuries and no dangerous goods involved.

*Ce rapport est également disponible en français.*

# *Other Factual Information*

## *The Accident*

On 15 May 2006, at 1458 eastern daylight time,[1] Canadian National (CN) freight train M-36921-15 (the train) departed Chambord, Quebec, and proceeded southward on the Lac-Saint-Jean Subdivision destined for Garneau Yard near Shawinigan, Quebec. The crew consisted of a locomotive engineer and a conductor. Both were qualified for their respective positions, and met established fitness and rest standards. The train consisted of 3 locomotives and 75 cars (72 loads, 3 empties), weighed 8780 tons and was 4750 feet long.

Near Lac Bouchette (see Figure 1), while the train was travelling at 30 mph with the throttle in position 8, a train-initiated emergency brake application occurred. The lead locomotive came to rest at Mile 136.95. The train crew followed emergency procedures, inspected the train and found that 16 loaded and 2 empty cars, the 39th, 46th, and 50th to 65th cars from the head end, had derailed.

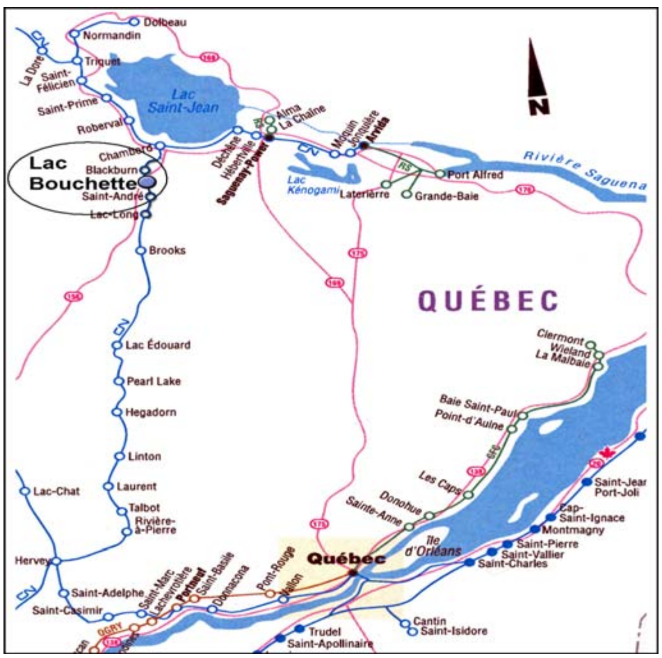


**Figure 1.** Lac Bouchette, Quebec (Source: *Canadian Atlas Railway)*

At the time of the accident, the temperature was approximately 23°C and the wind was from the northeast at 9 km/h.

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

A review of environmental data dating back to 2000 was conducted for the area. It revealed that the temperature, the snowfall and snow cover on the ground were higher than average through the winter of 2005/2006.

## *Site Examination*

At the north end of the derailment site, three wheel flange marks were observed on the head of the west (high) rail. They were located at the entry of the exit spiral[2] of a left-hand curve, in the direction of train travel, at Mile 137.68. The marks extended southward diagonally from the gauge side over a distance of 18 inches. Three feet away, the field side spike heads and tie ends were damaged. The tie end damage extended southward for about 20 feet. Wheel marks and tie damage were observed on the gauge side of the east rail. Track damage extended 1900 feet to the south, ending at the trailing truck of the first derailed car, CNA 405536 (the 39th car from the head end). The next cars to derail were CNA 406497 (the 46th car), CNA 406135 (the 50th car) and the following 15 cars (51st to 65th).

The first three derailed cars remained upright. Their trailing trucks were skewed with their leading wheel set derailed to the field side of the west rail. The trailing wheel set of the third car had fallen between the rails. The 51st to 65th cars came to rest in various positions along the right-of-way (see Figure 2).

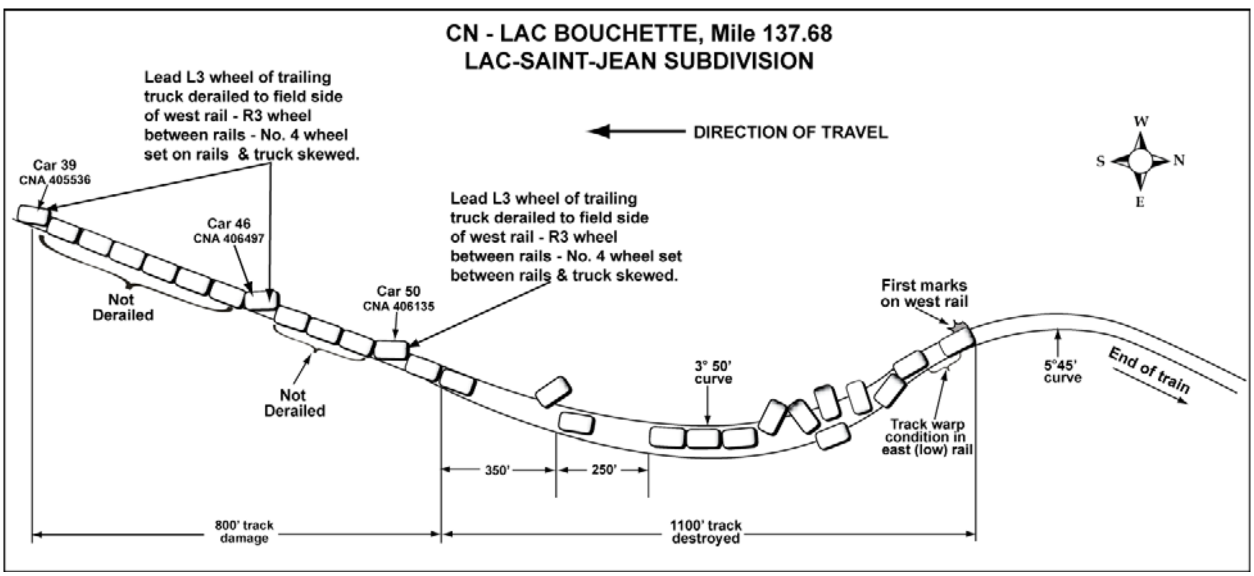


**Figure 2.** Accident site diagram

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2 Spirals are located at entries and exits of curves. They are used to transition from zero curvature and superelevation to full curvature and superelevation. The curvature and superelevation in a spiral change at a uniform rate to permit trains to negotiate a curve.

Cars CNA 405536, CNA 406497 and CNA 406135 were the same type of "high cube " box car.[3] They have, by design, a high centre of gravity. Each had a maximum gross weight of 286 000 pounds and was loaded with paper. They had a truck centre spacing of 40 feet 10 inches and were equipped with Stucki constant contact side bearings. The cars were forwarded to Chambord for a detailed teardown truck inspection.

Nine cars between the 39th and 50th cars (40th to 45th cars and 47th to 49th) did not derail. Seven of them were standard height cars, equipped with roller side bearings and had various truck centre spacings. The other two cars (42nd and 49th) were loaded "high cube" box cars that were the same type as the first three derailed cars. The preliminary inspection of all cars did not reveal any visible pre-derailment mechanical defects.

## *Track Information*

The Lac-Saint-Jean Subdivision consists of a single main track that extends northward from Garneau Yard (Mile 0.0) to Arvida, Quebec (Mile 203.5). Train movements are governed by the Occupancy Control System as authorized by the *Canadian Rail Operating Rules* and are supervised by a rail traffic controller located in Montréal, Quebec. The track is Class 3 according to Transport Canada–approved *Railway Track Safety Rules* (TSR). The maximum speed permitted is 30 mph for freight trains and 40 mph for passenger trains. Rail traffic consists of 24 freight and 6 passenger trains per week with an annual tonnage of about 8 million tons.

In the area of the derailment, the track consists of 136-pound continuous welded rail. On curves, the rail is secured to the ties with four spikes and box-anchored every second tie. On tangents, the rail is secured to the ties with two spikes and box-anchored every third tie. There are approximately 3200 ties per mile. They are in fair condition with a new tie installed about every 5th tie. The ballast consists primarily of crushed rock ranging in diameter from 1 to 2 ¼ inches. It is in good condition, with no signs of fouling. The cribs are full and the shoulders are 24 inches wide.

The track has a reverse curve configuration with an ascending gradient to the south that varies from 0.6 to 1.0 per cent. The reverse curve consists of a 5-degree 45-minute left-hand curve followed by a 3-degree 50-minute right-hand curve. The left-hand curve begins with a 200-foot-long entry spiral followed by a 260-foot-long curve body and a 250-foot-long exit spiral. The reverse curve is followed by about 800 feet of tangent track.

Unloaded track gauge and cross-level measurements were taken in the curve body and the entry spiral starting at Mile 137.68 and extending northward over a 400-foot section of track (the south section of the left-hand curve including the exit spiral being destroyed). The following observations were made:

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[3] High cube is an industry term that identifies excess height cars that meet Plate F dimensional criteria. The words "EXCESS HEIGHT" are stencilled on the ends of the 39th, 42nd, 46th, 49th and 50th cars.

- The superelevation in the body of the curve varied between 3 9/16 inches and 3 7/8 inches, which is within the allowable limits for the operating track speed.

- The difference in cross-level at the exit of the entry spiral was 1 5/16 inches over a distance of 56 feet. For Class 3 track, CN's Standard Practice Circular (SPC) 3101 considers a difference of 1 ½ inches in cross-level between any two points less than 62 feet apart as a priority Warp 62 spiral defect. A priority defect must be monitored until repaired.

In the area of the derailment, track inspections were performed regularly in accordance with the TSR. The latest track inspection was performed by hi-rail on 14 May 2006; no exceptions were noted. A track geometry inspection was performed on 09 June 2005 by a hi-rail track geometry vehicle; no defects were identified. A second track geometry inspection was performed by the geometry TEST car on 03 August 2005; two priority defects were detected—a Warp 62 in the entry spiral and a wide gauge in the exit spiral of the left-hand curve. On 20 September 2005, the track was undercut and surfaced. According to CN, the work was performed in accordance with the SPCs.

## *Car Information*

A detailed truck teardown inspection was conducted on the trailing trucks of the first three derailed cars. The truck components exhibited various stages of wear.

- The truck from the 39th car (CNA 405536) was in good condition and the lead wheel had a new profile.
- The truck from the 46th car (CNA 406497) had a dry bolster bowl that displayed evidence of binding and two inner bolster gibs that exceeded the wear limits set forth in Rule 47[4] of the *Field Manual of the AAR Interchange Rules*. One constant contact side bearing was crushed while the other had excessive clearance. Its lead wheel exhibited a heavily worn profile but was within allowable limits. The worn truck bolster and crushed side bearing were replaced before the car returned to service.
- The truck from the 50th car (CNA 406135) was worn but within condemning limits; the lead wheel had a moderately worn profile.

The first three derailed cars (39th, 46th and 50th) and the two other "high cube" cars that did not derail (42nd and 49th) were loaded in accordance with established practices. The loading diagrams indicated that the loads in the 39th, 46th, 49th and 50th cars were equally distributed. In the 42nd car, the exact placement of the loading is unknown because it contained several

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4 Rule 47.A.4 of the *Field Manual of the AAR Interchange Rules* states that, when wheels are changed or trucks dismantled, wear on truck side frame columns and bolster gibs must be measured before disassembly and, when wear exceeds 1 ½ ", same must be repaired.

different roll sizes. The 39th car weighed 107 tons, the 46th car weighed 125 tons and the 50th car weighed 126 tons. The 42nd and 49th cars weighed 110 tons and 132 tons respectively. The 49th car had a lower loaded centre of gravity than the first three derailed cars.

## *Analysis*

The train was operated in compliance with railway and regulatory requirements. There were no operating conditions that could be considered causal in this occurrence. The truck from the second derailed "high cube" car (46th) exhibited worn components. However, it is unlikely that this condition played a role as it was not present in the other derailed "high cube" cars. Therefore, the analysis will focus on the geometry of the left-hand curve and its effect on the "high cube" box car response.

The track damage led back to Mile 137.68, where the three wheel flange marks were observed on the head of the west rail. The orientation of the marks and the position of the derailed leading wheel sets in the trailing trucks of the 39th, 46th and 50th cars suggest that they derailed at that location. The flange marks may have resulted from either wheel climb or wheel lift. The mechanical teardown inspection of the trucks from the first three derailed cars did not reveal any common factor that was conducive to wheel climb because the truck components exhibited different wear patterns. Furthermore, the lack of markings on the gauge face of the rail indicates that the derailment was initiated by wheel lift, which occurred as the first three cars to derail were entering the exit spiral of the left-hand curve.

The lead wheel of each trailing truck unloaded on the high rail, which resulted in wheel lift and the derailment of the wheel set. The trailing truck in each of the cars became skewed, exerting spreading forces on the rails. The trailing wheel set of the 50th car fell between the rails, leading to the derailment of the following 15 cars.

The measurements taken in the entry spiral of the left-hand curve showed that a track warp condition was emerging. There was an increase of 1 5/16 inches in cross-level, over a distance of 56 feet. While this is below CN's priority Warp 62 spiral defect limit, it nevertheless indicates a deterioration of the spiral geometry. It is likely that a similar track warp condition had also developed in the exit spiral because the entire curve was located in similar terrain and was subjected to the same railway traffic and track maintenance. In addition, the measurements were not taken under load; therefore, the magnitude of the warp condition would have been greater under the passage of trains.

The first three derailed cars had similarities in their design and their loading. Each was a "high cube" box car, equipped with constant contact side bearings. Consequently, they had a high centre of gravity and were torsionally rigid, characteristics that are known to affect the car dynamic response and cause wheel lift in the presence of a track warp condition such as the one that was emerging in the entry spiral of the left-hand curve.

Nine cars travelled over the emerging track warp in the exit spiral without derailing. Seven of them were standard height cars, equipped with roller side bearings and various truck centre spacings, which made them less susceptible to track warp. The two other cars (42nd and 49th) were of the same design as the first three derailed cars. However, their loading was different.

The placement of the loading in the 42nd car was unknown; it contained several different paper roll sizes with the potential for uneven load distribution. The 49th car was heavier and had a lower loaded centre of gravity than the first three derailed cars. Therefore, the trailing trucks of these two cars were probably less susceptible to the wheel unloading and less likely to derail.

There were no common mechanical defects observed in the first three derailed cars that could cause wheel lift. Furthermore, the similarity in car design and loading alone were not sufficient to cause the derailment. Therefore, the only plausible explanation as to why these loaded 100-ton cars would derail is that an unusual interaction between the first three derailed cars and the track had occurred. For that to happen, a track warp condition, which affected the response of these particular cars, had to be present.

The track warp condition had emerged in the spirals of the left-hand curve even though the track was undercut and surfaced in September 2005. Given that the restorative work was performed in accordance with CN's SPCs, environmental and local subgrade conditions must have played a role in the emergence of the track warp conditions observed in the entry spiral. It is possible that the higher than usual snowfall and its melting in the spring affected the subgrade and accelerated the deterioration of the geometry in the spirals of the left-hand curve.

The frequency of track geometry inspections met the regulatory requirements; however, no geometry test had been conducted since the track was undercut and surfaced in September 2005. Although track visual inspections play an important role in detecting emerging track surface conditions, they might not be sufficient to detect cross-level deviations such as track warp in a spiral because cross-level variations are already present in a spiral by design.

## *Findings as to Causes and Contributing Factors*

1. The 39th, 46th and 50th cars derailed while entering the exit spiral of the 5-degree 45-minute curve as a result of wheel lift. The trailing wheel set of the 50th car fell between the rails, leading to the derailment of the other cars.

2. Although the design and loading of the first three derailed cars made them potentially more susceptible to wheel lift, a track warp condition had to be present in the spiral of the left-hand curve for the derailment to occur.

3. It is possible that the higher than usual snowfall and its melting in the spring affected the subgrade and accelerated the deterioration of the geometry in the spirals of the left-hand curve.

## *Finding as to Risk*

1. Although track visual inspections play an important role in detecting emerging track surface conditions, they might not be sufficient to detect cross-level deviations such as track warp in a spiral because cross-level variations are already present in a spiral by design.

# *Safety Action Taken*

Canadian National (CN) has enhanced the track inspection on the Lac-Saint-Jean Subdivision by replacing the hi-rail track geometry test with a second track geometry car test and decreasing the interval between the geometry car tests.

CN plans to purchase an additional track geometry test car with the intent of increasing the frequency of geometry testing on its entire system.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 05 February 2007.*

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