Transportation Safety Board
of Canada

Bureau de la sécurité des transports
du Canada

RAILWAY INVESTIGATION REPORT
R02D0069

MAIN TRACK DERAILMENT

CANADIAN NATIONAL
FREIGHT TRAIN M-353-21-02
MILE 117.68, JOLIETTE SUBDIVISION
L'ASSOMPTION, QUEBEC
03 JULY 2002

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

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Freight Train —353-21-02
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Summary

On 03 July 2002, at approximately 1210 eastern daylight time, Canadian National freight train No. 353 derailed 14 cars at Mile 117.68 of the Joliette Subdivision, while travelling southward through the town of L'Assomption, Quebec. Approximately 1830 feet of main track, 660 feet of siding track and a private crossing were destroyed. A four-inch irrigation water main was severed, and approximately 150 trees and seedlings were damaged in an adjacent nursery. There were no injuries and no dangerous goods involved.

Ce rapport est également disponible en français.

Other Factual Information

On 03 July 2002, at approximately 0910 eastern daylight time (EDT)[1], southward Canadian National (CN) freight train No. 353 (the train) departed Garneau Yard, near Grand-Mère, Quebec, destined for Montréal. The train consisted of 2 locomotives, 82 loads, and 9 empty and 2 residue cars. It was about 5570 feet long and weighed approximately 10 390 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 subdivision. The trip from Garneau Yard to L'Assomption was without incident; the train passed by two wayside inspection system sites and no anomalies were reported. At Mile 117.68, as the train was passing the siding at L'Assomption, it experienced a train-initiated emergency brake application.

Information from the locomotive event recorder indicated that the train was travelling at a speed of 41 miles per hour (mph) with the throttle in the No. 8 position. Subsequent inspection of the train revealed no pre-derailment defects that would compromise its safe operation.

After conducting the necessary emergency procedures, the crew determined that the 74th car to the 87th car from the head-end were derailed. Five of the cars were upright, while the other nine cars were overturned, fouling both sides of the main track and siding. Softwood lumber products were strewn over the right-of-way and the adjacent private property.

The Joliette Subdivision extends from Garneau, Quebec, Mile 40.1, to Pointe-aux-Trembles, Quebec, Mile 127.8. Train operations are controlled by the Occupancy Control System, authorized by the *Canadian Rail Operating Rules*, and supervised by a rail traffic controller located in Montréal. In the area of the derailment, the authorized timetable speed for freight trains was 50 mph.

The track was classified as Class 4 track according to Transport Canada's *Track Safety Rules*. The track structure consisted of 115-pound continuous welded rail (CWR) manufactured in 1994 and laid in 1995 on hardwood ties. The rail was secured with 4 spikes per tie on 11-inch double-shouldered tie plates and anchored every third tie. The ties were in good condition, and spaced at approximately 20 inches. The crushed rock ballast was in good condition and had approximately 18-inch shoulders at the end of the ties.

The derailment occurred in a 2-degree right-hand curve, on a 0.1 per cent descending grade in the direction of travel (see Figure 1). Approximately 100 feet north of the private crossing, located at Mile 117.69, wheel marks were visible on the track structure (ties and ballast). Over a distance of 600 feet north of the wheel marks, on the west side of the track, the ties were skewed and the south rail anchors had moved up to two inches from the ties. There were no signs of rail creep on the east side.

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[1] All times are EDT (Coordinated Universal Time [UTC] minus four hours), unless otherwise indicated.

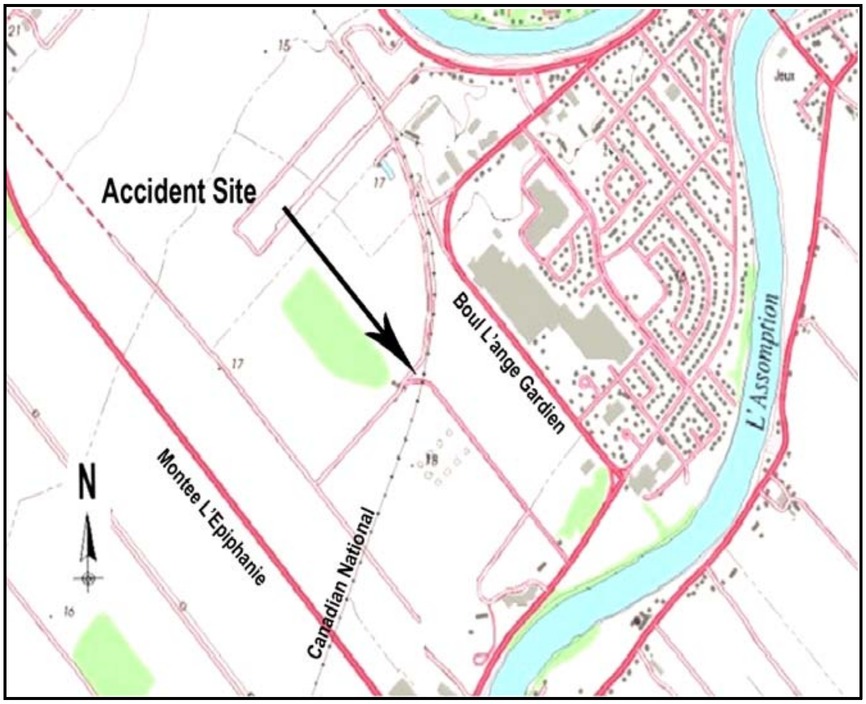

Figure 1. Accident site

The rail was last inspected by a rail-flaw detection car on 29 May 2002, and no rail defects were detected. The track geometry was checked by a Track Evaluation and Service Test (TEST) car on 01 October 2001; a wide gauge condition that was within CN's Standard Practice Circular (SPC) limits was noted.

CN SPC 3700 requires that when the ambient air temperature exceeds the preferred rail laying temperature (PRLT)[2] by 11°C (20°F), or when the rail temperature exceeds the PRLT by the same amount and visible signs of track distress are present, train movements over track with CWR are to be specifically protected against the risks posed by compression stress and track buckling. These protection requirements include slow-order protection and track patrols between 1100 and 2000, or as directed by the district engineer.

In the three days prior to the derailment, Environment Canada records taken from a remote sensing station located near the derailment site showed a sustained period with daily maximum temperatures in excess of 34°C (93°F). On the day of the derailment, the temperature reached 34.3°C (94°F), which was the highest recorded temperature since 1997; the skies were clear, and the wind was from the southwest at 4 km/h.

Because of these warm weather conditions, additional visual inspections were carried out. They were done on each of the two days prior to the derailment by an inspector in a hi-rail vehicle. There were no reports of the rail being out of adjustment and no defects were noted.

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[2] The PRLT for the Joliette Subdivision is 26.6°C (80° F).

A review of the railway records revealed that the west rail was lifted during surfacing work performed on 04 June 2002, to correct excessive superelevation on the curve from Mile 117.50 to Mile 117.65. The work was carried out without disturbing the east side of the track structure. The maximum ambient air temperature was 18.6°C (66°F). Major track work was performed in 1997-1998; however, temperature data pertaining to the period when the work was performed was not available.

CWR is normally installed or adjusted at a temperature close to the PRLT. At that temperature, which constitutes the neutral temperature of the rail, the rail is stress-free, without being subject to either compressive or tensile stresses. Whenever the temperature of the CWR exceeds the neutral temperature, longitudinal compressive forces are created. On a hot summer day with clear skies, rail temperatures can exceed the ambient air temperatures by as much as 16.7°C (30°F). Consequently, when the ambient air temperature is 34.3°C (94°F), the rail temperature can be as high as 51.0°C (124°F), and the compressive force can be up to 86 000 pounds in the case of a 115-pound rail having a neutral temperature close to the PRLT.

The neutral temperature of the rail can change over time; extraordinarily high or low ambient air temperatures, track maintenance and traffic-induced movements can cause a redistribution of the internal stresses in the rail, thus modifying the neutral temperature. When the neutral temperature of the rail is lowered (zones of tight rail), then the temperature at which a track can buckle is lowered. The knowledge of the neutral temperature is critical in the maintenance of CWR; much research has been done, and is ongoing, to develop a non-destructive stress measuring system for CWR to address this issue. Most of these technologies are still largely in a developmental stage and are not yet in widespread use. They are intended to be used in a site-specific manner and are limited in their application, as they require the pre-identification of high-risk locations.

CN has tested and recently adopted a portable non-destructive measurement system that allows the stress conditions in CWR to be evaluated when track work has been performed in an area. At the time of the derailment, the track supervisors had been trained on the new system but the equipment had not yet been introduced in the district.

An examination of TSB data for years 1997-2002 indicated that there were 18 other recorded occurrences where high-compressive stresses in CWR were present.

Analysis

Given that the operation of the train met all company and regulatory requirements, and no defective equipment was identified, train operation and equipment conditions are considered to have played no significant role in the occurrence. Therefore, the analysis will focus on the build-up of compressive stress in the rail and the inspection of CWR.

Even though the accident happened on the hottest day since major surfacing work was performed in 1997-1998, it is not possible to establish a causal link between the two events, as there is no information to indicate how the work was performed and the level of stress in the rail after that work . The more recent surfacing work was completed when the ambient air temperature was within the "working zone" temperature range, and the lift was minimal with no lateral displacement of the track. Therefore, it is likely that the effects of the surface work on the rail stress level and on the track's lateral strength were marginal.

Rail creep and tie skewing present north of the derailment zone were indicative of rail-stress redistribution and a modification of the rail neutral temperature in the area where the derailment occurred. Moreover, on the day of the derailment, the high ambient air temperature and the direct rays of the sun caused the rail temperature to rise, reaching levels unsurpassed since the major surface work had been performed in 1997-1998. Consequently, the temperature gradient (i.e. the difference between the neutral temperature of the rail and the rail temperature) and the compressive thermal stresses in the rail were abnormally high. It is probable that the additional compressive stresses caused by the rolling friction of the wheels and the loading and unloading of the track by the passing train axles triggered the buckling mechanism. The track then progressively shifted out of alignment under the train. With each passing car, the alignment deviation increased until the track shifted sharply and buckled. The 74th car could not negotiate the misaligned track and derailed.

Hot weather inspections were carried out even though the ambient air temperature was within the limits of 11°C (20°F) above the PRLT, as outlined in SPC 3700. However, these additional inspections were not sufficient to identify the potential for a track buckle. Signs that may indicate a risk of buckling may not always be visible from a hi-rail vehicle moving at the speeds normally used during track inspections. The existing inspection methods used in the railway industry largely rely on employees to inspect the track structure for any physical signs of a degradation in track structure integrity. These inspection methods have been used quite successfully for years, but the track must be inspected at the right time of the day and the employee must identify the physical signs of a tight rail condition. Relying on visual inspections alone to identify the physical signs of potential track buckling does not provide the maximum safety margin, as it does not always allow the harmful levels of compressive stress in a track structure to be identified in advance.

Even though most of the non-destructive technologies to measure the stress level in CWR are still largely in the developmental stage, CN has taken a positive step by testing and adopting a promising non-destructive measurement system that is portable and allows for the stress conditions in CWR to be evaluated when track work has been performed in an area. The introduction of this technology will aid maintenance employees in identifying the level of stress in a rail and reduce the risks of track buckle.

Findings as to Causes and Contributing Factors

1. Thermal stresses due to higher than normal ambient temperatures, combined with the forces exerted by the passing train axles, triggered the track buckling mechanism.
2. The train derailed when the 74th car could not negotiate the misaligned track.

Findings as to Risk

1. Even though hot weather inspections were carried out, they were not sufficient to identify the potential for a track buckle.

2. Relying on visual inspections alone to identify the physical signs of potential track buckling does not provide the maximum safety margin, as it does not always allow for the advance identification of harmful levels of compressive stress in a track structure.

Other Findings

1. It is likely that the effects of the most recent surface work on the rail stress level and on the track lateral strength were marginal.

Safety Action

CN has taken the following corrective actions to address track buckle:

1. CN has purchased three portable rail stress detection units, called VERSE, for undertaking spot checks of rail stress in CWR territories. These have been issued to the CN field forces that are undertaking frequent spot checks targeting suspicious locations. The introduction of these systems will aid maintenance employees in identifying the level of stress in CWR and reduce the risks of track buckle.

2. SPCs were amended so that extreme heat inspections are triggered when the ambient temperature exceeds 30°C (86°F). In addition, hot weather speed restrictions are imposed at known problem areas or where warning signs of track buckling are apparent.

3. CN contracted environmental services from a weather provider. With this new initiative, should the temperature exceed 30°C (86°F), a warning will be issued to the CN Traffic Control Centres, the CN Weather Monitor Web site and the e-mail bulletin board site. This information is then relayed to the appropriate track forces. In addition, the Engineering Network Operation Officers monitor the Weather Monitor Web site and will contact either the General Superintendent of Engineering or the Track Supervisors, to ensure that they are aware of the warning and the need to implement hot weather inspections and possible speed restrictions.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 16 February 2004.