Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT
R03T0158

MAIN-TRACK DERAILMENT

CANADIAN PACIFIC RAILWAY
TRAIN CP 121-21
MILE 48.30, WINCHESTER SUBDIVISION
GREEN VALLEY, ONTARIO
21 MAY 2003

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 Occurrence Report

Main-Track Derailment

Canadian Pacific Railway
Train CP 121-21
Mile 48.30, Winchester Subdivision
Green Valley, Ontario
21 May 2003

Report Number R03T0158

Summary

On 21 May 2003, at 1325 eastern daylight time, Canadian Pacific Railway freight train 121-21, proceeding westward at approximately 53 mph, derailed at Mile 48.3 of Canadian Pacific Railway's Winchester Subdivision, near Green Valley, Ontario. Five multi-platform rail cars were involved in the derailment. No dangerous commodities were involved and there were no injuries.

Ce rapport est également disponible en français.

Other Factual Information

On 21 May 2003, Canadian Pacific Railway (CPR) freight train 121-21 (the train) departed Montréal, Quebec and proceeded westward on the north main track of the Winchester Subdivision, destined to Toronto, Ontario (see Figure 1). At approximately 1224 eastern daylight time,[1] as the train travelled over a hot box detector (HBD) at Mile 30.0, an alarm tone was generated, followed by an automated voice message to the train crew transmitted from the scanner. The locomotive engineer immediately began braking, stopping the train at approximately Mile 32.0. The HBD message indicated that there was a possible overheated journal bearing on the north side of the train at axle 133. The conductor exited the train to the south side and instructed the locomotive engineer to pull ahead. The train pulled ahead approximately 2138 feet and stopped, which put the conductor in the vicinity of the 133rd axle.

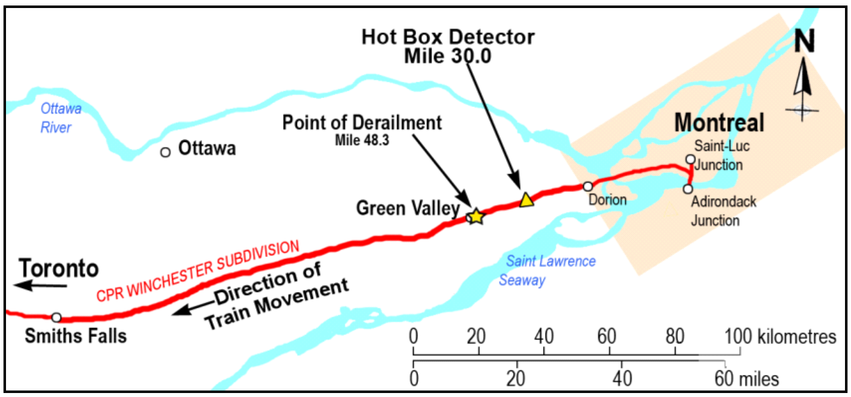

Figure 1. Derailment location map (Source: Railway Association of Canada, *Canadian Railway Atlas*)

After crossing over to the south side, the conductor then performed a train inspection looking for an overheated axle component. Because he had misplaced his temperature-indicating crayon, the conductor used the back of his hand to assess whether the roller bearings were overheated. The conductor observed that the roller bearing temperature on the 133rd axle was slightly elevated. He assumed that the slightly elevated bearing temperature was caused by the heavy load of steel that was being carried by this rail car. Since the conductor did not observe any other signs of an overheated bearing, the decision was made to allow the train to continue in service. Studies by Transport Canada in the mid 1990's indicate that some 45 per cent and 59 per cent of HBD warnings at Canadian National (CN) and CPR respectively were found to be false alarms.[2] According to CPR, this figure has now declined to around 40 per cent.

The conductor then walked to the head end of the train and re-entered the locomotive cab. Twenty-seven minutes had elapsed from the time the train stopped for the inspection to the time the train continued on its route. At 1259, after travelling approximately seven miles further west, the train was required to stop for seven minutes to allow another train to pass, departing this location at 1306.

---

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

2 TP 12691-E, Hot Bearing Detector Study, Railway Safety Directorate, 1996.

At 1325, having travelled almost 18 miles from the inspection point, the train experienced a train-initiated emergency brake application (UDE) and it came to a stop. After performing the necessary emergency procedures, the train crew determined that five multi-platform rail cars, 8th to 12th in the consist, had derailed in the vicinity of the crossing at Highway 34 in the Town of Green Valley (see Photo 1). Numerous grass fires were observed adjacent to the track leading to the derailment site. These grass fires were subsequently extinguished by the local fire department. No dangerous commodities were involved and there were no injuries.

Photo 1. Derailed rolling stock west of crossing with Highway 34, Mile 48.3 of the Winchester Subdivision

The stub of a burnt-off roller bearing was found approximately 800 feet east of the crossing on the north side of the track.

The operating crew of train 121 consisted of one locomotive engineer and one conductor. Both crew members were qualified for their respective positions and met company and regulatory fitness and rest standards.

The train was 5566 feet long and weighed approximately 4110 tons. It was powered by 3 locomotives and was hauling 16 multi-platform cars. This type of train is referred to as the "expressway"; it is designed to transport highway trailers. Each rail car on expressway trains can have three to five platforms. A single truck will normally connect adjacent platforms on this type of rail car. The expressway train is designated as a non-restricted expedited freight movement, which means that it normally has priority over freight traffic and it can operate at express freight speed.

The Winchester Subdivision is comprised of double main track extending from Dorion, Quebec, to Smiths Falls, Ontario. The permissible track speed is 60 mph for non-restricted expedited freight equipment. Train movements are controlled by the Occupancy Control System (OCS)/ Automatic Block System (ABS) as authorized by the *Canadian Rail Operating Rules* (CROR). Train movements are supervised by a rail traffic controller (RTC) located in Montréal.

On CPR main lines, wayside inspection systems (scanners) are placed at regularly spaced intervals, approximately 20 to 30 miles apart, to detect overheated roller bearings and dragging equipment and to alert train crews to these problems. The scanner at Mile 30.0 was a SERVO System 9000. The 9000 system processes input from heat-sensing scanners, wheel-sensing transducers and other sensors such as the dragging equipment sensor. Scanner data are stored in computer memory and can be recalled, repeated and transmitted in voice, visual or hard copy format. If an alarm is triggered when a train passes over the scanner, a one-second alert tone is initially broadcast. Only after the entire train passes over the scanner will additional information be provided regarding the nature of the problem. This additional information consists of a two-second alert tone followed by an automated voice message providing details of the problem.

The CROR are operating rules designed for the safe movement of trains. They do not contain specific instructions governing the use, installation and operation of HBDs or other wayside detections systems. With respect to HBD operations, train crews refer to the railway's General Operating Instructions (GOIs) that provide instructions for approaching a scanner, passing through a scanner and responding to scanner alarms.

CPR's GOIs require the locomotive engineer to stop the train immediately if practical (or at a designated location) upon receiving an alarm at a scanner. During the train inspection, it is normally acceptable for a crew member to detrain and have the train pull ahead at a slow speed to the first identified defect and then to subsequent defects to assist with the inspection. There are a number of conditions when the train is not permitted to pull ahead (for example, when the defect is visible to the crew, when the HBD transmits an alarm for dragging equipment, when the train is carrying one or more loads of special dangerous commodities, when the detector broadcasts more than six alarms, or when the cause of the alarm is not heard or is in doubt).

Section 5.11.0 of CPR's GOIs outlines the procedure for inspecting suspected overheated bearings. The GOIs state that a temperature-indicating crayon with a melting point of 200°F should be used on the face or side of the outer ring of the roller bearing to determine whether it is overheated. The GOIs state that unless temperatures are below freezing, at least one member of the train crew must be in possession of a temperature-indicating crayon. If a temperature-indicating crayon is not available, the roller bearing should be tested for heat by feeling the bearing housing using the back of the hand. In this occurrence, the crew members had misplaced their temperature-indicating crayon and had to perform the test using the back of the hand.

Section 5.3 of CPR's GOIs states that the location within the train of the reported defect must be determined by counting the actual axles from the front of the train. Care must be taken to ensure that rail cars and locomotives with more than four axles are accurately counted. The GOIs state that scanner alarms can only indicate the general vicinity of the suspected problem, rather than an exact location. Given this uncertainty, the GOIs require that if the defect is not found at the indicated location, the train must be further inspected over a distance of 16 axles in each direction from the indicated location on both sides of the train.

The train consist document given to the train crew on the day of the accident indicated that the axle count for their train was 230. However, the actual axle count for the train should have been recorded as 234. This discrepancy of 4 axles occurred due to the presence of a modified rail car (referred to as a Meyler car). The Meyler car is a multi-platform rail car with a total of 40 axles rather than the 36 axles normally found on a multi-platform rail car of this length. On train 121-21, the Meyler car was the first car behind the locomotives. The computer program used by CPR to prepare train consist documentation treats the Meyler car as a rail car with 36 axles. This computer coding problem has existed for a period of time and had been previously reported to CPR Operations personnel by their train crews.

Based on the locomotive event recorder (LER) data, a total of 27 minutes elapsed from the time the conductor detrained to when the train continued down the track. Approximately 10 of the 27 minutes elapsed when the train pulled ahead to allow the conductor to reach the suspect location. The conductor therefore took approximately 17 minutes to perform the inspection and to return to the head end of the train. A post-accident simulation was conducted by TSB investigators to determine the approximate time that would be required to conduct a thorough train inspection and then return to the locomotive from a location approximately 133 axles away. During the simulation, it took 11 minutes to inspect 16 axles in each direction from the suspected location on both sides of the train. It took an additional 14 minutes to return to the head end of the train after the inspection, giving a total elapsed time of 25 minutes.

The data for train 121-21 were downloaded from the scanner at Mile 30.0 of the Winchester Subdivision along with the data from the previous scanner, located at Mile 12.4 of the Vaudreuil Subdivision. The scanners had recorded the following temperatures for the roller bearings in the vicinity of the 133rd axle:

Axle	Bearing Temperature (°F, above ambient air temperature) from Scanner at Mile 12.4 (Vaudreuil Subdivision)	Bearing Temperature (°F, above ambient air temperature) from Scanner at Mile 30.0 (Winchester Subdivision)
131	102.9	139.4
132	101.8	134.8
133	140.3	307.4
134	107.3	145.8

A post-accident review of the inspection and maintenance records for wayside inspection system (WIS) equipment near the accident site determined that there were no deviations from the required procedures.

Following the occurrence, CPR requested Brenco Inc., a bearing manufacturer, to conduct a failure analysis on a similar roller bearing by overheating the component. A summary of Brenco's findings is provided as follows:

- Based on Brenco's analytical model for roller bearing cooling rates, the bearing on axle 133 would have been around 270°F after the train had been stopped for 24 minutes.

- At a temperature of 270°F, an open hand could not be brought within one inch of the roller bearing without significant discomfort.

- Given the fact that bearings have been shown to fail at different rates in the laboratory, it was not possible to determine how long the bearing would have continued prior to failure from a temperature of 307°F. The train had travelled an additional 18 miles. However, during the 60 minutes between the scanner alarm and the burn off, the train had stopped twice. The slowing, stopping and ramp up during these two stops delayed the burn off of the roller bearing.

- It is not possible to exactly determine what external visual symptoms would be displayed by a bearing in the early stages of failure. Given that failures can occur internally to the bearing, symptoms such as a misplaced adapter, displaced seal, purging grease or a burnt grease odour may not always be evident.

Analysis

The derailment occurred when an overheated roller bearing seized, resulting in a burnt-off journal (BOJ) occurring on the 133rd axle of the train (see Photo 2). As the roller bearing overheated and seized, the axle extruded, causing a reduction in cross-sectional thickness. After sufficient thinning occurred, the overheated axle could no longer support the weight of the loaded car, resulting in a complete axle fracture. The exact cause of the roller bearing failure could not be determined due to the amount of damage sustained to the axle journal and the roller bearing. The analysis will focus on the warning systems and inspections used by railways, such as CPR, to detect roller bearing failures before a derailment occurs.

Photo 2. Photos of L3 wheel and burnt-off journal stub from car XPWX 2007 showing damage resulting from an overheated roller bearing.

Roller bearings that are failing but not detected and remain in service present a serious hazard to the safety of railway operations. CPR relies on a combination of wayside detection equipment and train crew inspections to identify potential defective bearings and to ensure that defective equipment is removed from service. In this occurrence, the 133rd axle had been identified by an HBD scanner as a location with a possible overheated roller bearing. However, during the resulting manual inspection, no defective axle components were detected. The suspect rail car was allowed to continue in service, resulting in a derailment, after travelling approximately 18 miles from the inspection location. The system of detection and inspection therefore failed as a safety defence for this defective roller bearing.

Given the incidence of false alarms generated by WIS equipment (currently around 40 per cent at CPR), railways must still make extensive use of train crew inspections to decide the course of action in response to an alarm. These inspections require the train crew to locate the axle in question, verify the temperature of the roller bearing at the suspect location and surrounding axles (where necessary), and then make a decision on what action to take.

During post-accident examination, TSB investigators were unable to verify whether the train crew had performed the inspection at the right location. While the use of a temperature-indicating crayon will leave a temporary tell-tale mark on the roller bearing to indicate that the bearing was inspected, there are no such markings if the inspection is performed with the back of the hand, which was the inspection approach taken by the crew.

Standard rail cars are normally designed with four axles. When an HBD alarm is triggered, the train crew can normally determine the location of the suspect axle relatively easily based on the knowledge that there are four axles on a rail car. However, when there are multi-platform rail cars on the train, the train crew must know where these rail cars are located within the train and how many axles there are on these rail cars. The equipment on the expressway train are multi-platform rail cars where adjacent platforms share a common truck. In this occurrence, determining the location of the 133rd axle was further complicated by the presence of a modified Meyler rail car. Train crews who operate expressway trains must be aware that there will be a four-axle discrepancy between the actual and reported axle count whenever the Meyler car is on their train. With incorrect axle count information being supplied to train crews, there is a potential for confusion when locating suspect axle locations, increasing the risk that defective roller bearings will not be identified

As specified in CPR's GOIs, train crews are required to perform an actual axle count from the head end of the train when conducting a hot box inspection to overcome any inconsistency in train consist documentation. While this provides an additional manual check, the potential to lose count of axles while walking alongside the train is quite high. There are many distractions such as passing trains and radio communication that may disturb the person performing the count.

Scanner alarms can only indicate the general vicinity of the suspected problem. As such, when a defect is not found during the initial inspection, crews are required to continue inspecting both sides of the train for 16 axles in each direction from the suspected location. The TSB simulation indicated that it would take approximately 25 minutes to inspect the required 32 axles (on both sides of the train) and then walk back to the head end of a train from the vicinity of the 133rd axle. Given that the train had only stopped for approximately 17 minutes from the time the train had pulled ahead until the train was underway, it would have been difficult for the train crew to perform a thorough inspection of all of these axles.

If the rail car with the suspect axle is not set off, the conductor can decide to proceed to the next scanner at a slower-than-normal track speed. Despite the significant investment railways have made in HBD technology, the train crew's inspection is the ultimate arbiter of whether a potentially defective rail car will continue in service. If the decision is to continue, no other defence barrier is available to protect the train until it reaches the next HBD, increasing the risk that defective bearings will remain in service and result in derailments.

Findings as to Causes and Contributing Factors

1. The derailment occurred when an overheated roller bearing seized, resulting in a burnt-off journal on the 133rd axle of the train.

2. Although the hot box detector (HBD) scanner had identified the 133rd axle as a potential problem, the train crew's inspection did not detect any overheated axle components. The train crew allowed the identified car to continue in service.

Findings as to Risk

1. Despite the significant investment railways have made in HBD technology, there are still a large number of false alarms. The train crew's inspection is the ultimate arbiter of whether a potentially defective rail car remains in service. If the decision is to continue, no additional defence barrier is available to protect the train until it reaches the next HBD, increasing the risk that defective bearings will remain in service and result in derailments.

2. When the modified Meyler rail car is present on a Canadian Pacific Railway (CPR) train, the axle count information supplied by the computer to train crews is incorrect, which may lead to confusion when identifying overheated bearing locations, increasing the risk that defective roller bearings will not be identified.

Safety Action

Canadian Pacific Railway (CPR) has updated its computer system to provide the correct axle count information for Meyler cars in expressway service.

In September 2003, CPR implemented a bearing temperature trending process on its coal loop in British Columbia. By connecting the hot box detectors (HBDs) to a central system, CPR performs trending analysis to proactively set out cars with suspect bearings. CPR is reviewing the option of extending this bearing trending process to other locations.

CPR has installed and is testing a track-side acoustic detector system near Vancouver, British Columbia, which is the first such installation in Canada. This device evaluates acoustic signatures of bearings to identify bearing flaws before they reach a critical state.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 12 October 2004.