Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT
R01W0182

MAIN-TRACK DERAILMENT

CANADIAN PACIFIC RAILWAY
TRAIN 218-29
MILE 8.15, BROADVIEW SUBDIVISION
KEMNAY, MANITOBA
01 OCTOBER 2001

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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Canadian Pacific Railway
Train 218-29
Mile 8.15, Broadview Subdivision
Kemnay, Manitoba
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Report Number R01W0182

Summary

At approximately 1900 central daylight time on 01 October 2001, eastward Canadian Pacific Railway freight train 218-29 was proceeding toward Brandon, Manitoba, through a siding at Kemnay, Mile 8.15 of the Broadview Subdivision. As the train exited the east end of the siding, nine cars derailed, including two loaded tank cars of methanol and one loaded tank car of vinyl acetate. As a precaution, 69 people were evacuated from Kemnay because of the hazardous goods in the three derailed tank cars. No injuries or release of product occurred.

Ce rapport est également disponible en français.

Other Factual Information

On 01 October 2001, Canadian Pacific Railway (CPR) freight train 218-29 departed Broadview, Saskatchewan, at about 1620[1] and proceeded eastward on the main track of the Broadview Subdivision, destined for Brandon, Manitoba. The train consisted of 3 locomotives and 118 cars (77 loaded cars and 41 empty cars), was 7494 feet long, and weighed 11 496 tons. The locomotive engineer and the conductor were familiar with the territory, were qualified for their positions, and met fitness and rest requirements.

At the time of the occurrence, the temperature was 16°C, with scattered clouds and good visibility. The wind was out of the east at 16 km/h, and the overall conditions were dry.

Train movements on the Broadview Subdivision are governed by the Centralized Traffic Control system of the *Canadian Rail Operating Rules* (CROR) and are supervised by a rail traffic controller in Calgary, Alberta. The track in the area of the derailment consists of a single main-track with a 7430-foot-long parallel siding south of the main line. The Estevan Subdivision connects to the Kemnay siding at a junction switch at the east end of the siding, about 285 feet west of the main-track siding switch. Both switches are positioned within No. 13 power turnout assemblies. The track is on a 0.25 per cent grade, descending in an eastward direction.

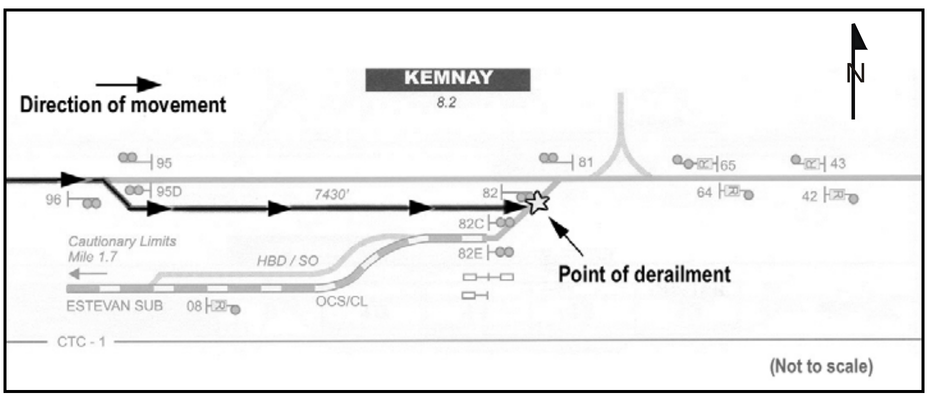

Figure 1. Point of derailment

The train entered the west end of the siding at Mile 9.55 of the Broadview Subdivision. Event recorder data revealed that at approximately 1858 the lead locomotive approached the east end of the siding, travelling at 14 mph with the throttle in the idle position. Once the lead locomotive cleared the east-end junction switch, the train accelerated to 22 mph with the throttle in position 5. While travelling at 25 mph with all brakes released and the throttle in idle, the train experienced a train-initiated emergency brake application and came to a stop at approximately 1901.

1 All times are central daylight time (Coordinated Universal Time minus five hours).

After emergency procedures were performed, the crew determined that nine cars had derailed (the 93rd to the 101st car behind the locomotives) at Mile 8.15. Further inspection revealed that, over a distance of approximately 741 feet (228 m), four derailed cars remained upright, three were leaning, and two were on their side to the south of the main-line track. The first four cars (the 93rd to the 96th from the head end) derailed at the east end of the site. The remaining five cars derailed at the west end. A gap of approximately 178 feet (55 m) separated the two derailment areas. The track structure within the gap was destroyed. Approximately 865 feet (266 m) of track was damaged. Three derailed cars (the 97th to the 99th cars from the head end) were tank cars containing dangerous goods (two loads of methanol [UN 1230] and one load of vinyl acetate [UN 1301]). No injuries or apparent release of product occurred.

Representatives from the Rural Municipality (RM) of Whitehead (in which the town of Kemnay is situated), CPR, the Brandon Fire Department, the Royal Canadian Mounted Police, and Manitoba Emergency Management Organization responded to the site. The RM had representatives present, but not all responsible local officials could be contacted in the initial stages of the occurrence. A joint agency discussion ensued. As a precaution, a voluntary evacuation of the surrounding area was implemented. Sixty-nine people were evacuated because of the hazardous goods to be transferred during the clean-up. After the dangerous goods were offloaded and transferred, the area was declared safe. The evacuees returned at 1330, 03 October 2001.

The Manitoba *Emergency Measures Act* (1987), which established the Manitoba Emergency Management Organization, states: "every local authority shall prepare, approve and adopt emergency preparedness plans and programs." Emergency plans generally include a contact list identifying local officials responsible for enacting the plan and other resources available in the event of an emergency. It was determined that the RM had no emergency plan, either drawn up or in place, outlining procedures to deal with local emergencies, such as this train derailment. The RM was dependent on Brandon to provide fire and ambulance service. Because the RM had no first responders of its own, it felt that an emergency plan was unnecessary.

The tank cars loaded with methanol—PROX 41238 (the 97th car behind the locomotives) and CGTX 30093 (the 98th car)—remained coupled on their sides to the south of the track. PROX 41073 (the 99th car), loaded with vinyl acetate, had separated from CGTX 30093 and was leaning at approximately 30° to the south. During the derailment, the A-end coupler of CGTX 30093 had separated from the B-end coupler of PROX 41073 and impacted the B-end of the PROX 41073 tank, severely denting the head. Each tank car was equipped with double-shelf (top and bottom) couplers. These couplers are mandatory for all tank cars. Double-shelf couplers are to prevent tank cars from separating during a derailment, reducing the risk of a tank head puncture from couplers. Subsequent inspection determined that the top shelf of the B-end coupler from PROX 41073 had broken away, allowing the cars to separate. The exposed fracture surfaces revealed porosity throughout approximately 20 per cent of the cross-sectional area. The broken coupler was sent to the TSB Engineering Laboratory for examination.

The TSB examination (Engineering Report LP 100/01) determined that the coupler (serial number 1053) was an SE60DE type, manufactured in September 1990 by McConway and Torley Corporation at its Kutztown, Pennsylvania, plant. The top shelf of the coupler had broken in the transition radius between the shelf and the coupler head in the horn area. Visual examination of the fracture surfaces revealed fresh fracture characteristics typical of a brittle failure. A large region of shrinkage porosity approximately 0.75 inch by 1 inch (19 mm x 25 mm) was observed within the fracture boundaries. The porosity was not visible at the surface of the casting.

The coupler head was sectioned through the fracture surface. Further examination revealed two regions of shrinkage porosity within the coupler. The larger region extended from the fracture surface and measured approximately 3.5 inches deep by 2.6 inches wide (90 mm by 65 mm). The second region measured approximately 2.6 inches deep by 1.4 inches wide (65 mm by 36 mm). Coupler manufacturing is governed by specifications M-201-92 and M-211 as outlined in the Association of American Railroads (AAR) *Manual of Standards and Recommended Practices*. These specifications also apply to other castings, such as yokes, bolsters, and side frames.

The first derailed car, CGLX 10481 (the 93rd car behind the locomotives) was a covered hopper loaded with plastic pellets. Covered hopper cars have a high centre of gravity. The trailing truck of CGLX 10481 was derailed. Recent heavy gouging was observed on the rim face of the R-1 wheel. No rim face damage was noted on any other wheels. All wheels appeared to be in good condition and displayed a near-new tread profile. A mechanical inspection of the car was performed. No pre-derailment defects were noted. The car was scaled to evaluate the load's weight distribution; the car was determined to be evenly loaded.

Marks observed on the south rail head identified the point of derailment (POD) at approximately 10 feet 4 inches (3.15 m) east of the Estevan Subdivision junction switch point. The marks extended diagonally, from gauge to field side, along the top of the rail head for an additional 8 feet 6 inches (2.59 m) before marks on the ballast and tie ends appeared to the field side. Gouge marks were observed extending along the south rail gauge face, east of the POD. Wheel marks and tie damage continued eastward to the derailed cars at the west end of the site.

CROR Rule 98.1 indicates that speed through a turnout must not exceed 15 mph unless otherwise provided by special instruction. CPR's *General Operating Instructions* (GOI), Special Instructions for CROR Rule 105, indicate that a speed of 15 mph applies for sidings unless otherwise provided by a subdivision footnote. Broadview Subdivision footnote 4.2 of CPR's *Manitoba Service Area Time Table* designates a maximum of 25 mph on sidings.

The track structure in the area consists of 136-pound jointed rail. The rail was laid on double shouldered tie plates on treated softwood ties, with an average of 60 ties per 100 feet of track. The rail and tie plates were fastened to the ties with 5 spikes per plate and box-anchored every second tie. The ballast was crushed rock with 12-inch shoulders, and all cribs were full. The wear on the south rail at the POD was 5/32-inch vertical wear and 7/32-inch gauge face wear. The north rail exhibited 9/32-inch vertical wear and no gauge face wear. A section of rail from the south rail, containing the POD, was removed from the track and sent to the TSB Engineering Laboratory for examination. The examination determined that the rail was within CPR Standard Practice Circular (SPC) 09 for rail wear limits.

CPR's track evaluation car (TEC) last inspected the siding on 07 May 2001. The TEC is able to identify 23 separate types of track-related defects. Recorded defects are classified as either "Urgent " or "Priority". An "Urgent" defect requires a mandatory train speed restriction for the track and immediate attention. A "Priority" defect , which may not necessarily require a speed restriction, must be inspected and corrected as soon as possible. The CPR standards for these defects are generally more stringent than Transport Canada's (TC) *Track Safety Rules* (TSR). The graphs from the 07 May 2001 TEC inspection revealed cross-level variations in the east end of the siding for several hundred feet in advance of the POD. These cross-level variations appeared to coincide with staggered rail joints. A rail joint between the junction switch point and the POD on the south rail was observed to be suspended approximately ½ inch above the top surface of the tie plate with the track in the unloaded condition. The spikes securing the joint were high, indicating that the joint was "pumping" while under load.

Unloaded and static-loaded track cross-level profile measurements were taken at the site. The maximum recorded static cross-level loaded deviation occurred in the area of the POD , where the south rail dropped 1¼ inches. The variations in cross-level measured by the TEC and on site were both within the limit of 2 inches for Class 2 track specified in the TSR, section C, part VI.

SPC 34 for track, section 7.0, and the accompanying *Track Evaluation Car Guidelines for Defects & Reports* identify a rock-and-roll cross-level variation "Urgent" defect for Class 2 track as "3 consecutive alternating changes in the cross-level measurement that are more than 1⅛ inches between a distance of 45 feet to 65 feet." There is no equivalent "Priority" defect. In addition, the TSR do not identify consecutive multiple cross-level variations as a track defect. The TEC measured three consecutive alternating cross-level variations near the POD during the 07 May 2001 inspection. The recorded values were close to the specified limits for an "Urgent" defect. However, under current CPR specifications, these recorded values did not require attention.

The TEC graphs from the 07 May 2001 inspection also identified a track alignment deviation of 1 7/16 inches at the south side bent stock rail of the junction switch's No. 13 turnout at the east end of the siding, approximately 20 feet before the POD. The measured deviation was within the three-inch limit for Class 2 track specified in SPC 34 and TSR and did not require attention.

Canadian National (CN) has established limits for combination sub-urgent track defects as part of its track maintenance practice. CPR identifies individual priority defects that are within ⅛ inch of being urgent. However, neither TC nor CPR have specifications that establish limits that identify the combination of sub-urgent track cross-level and alignment irregularities as a defect requiring corrective action. The TSR notes that the rules "apply to specific track conditions existing in isolation. Therefore, a combination of track conditions, none of which individually amounts to a deviation from the requirements in this part, may require remedial action to provide for safe operations over that track. Nothing in the TSR prevents a railway company from prescribing a higher level of maintenance."[2]

CPR's track maintenance supervisor last inspected the track in the area of the derailment on 28 September 2001. The No. 13 power turnouts at the east end of the Kemnay siding were last inspected on 14 September 2001. A rail flaw detection car tested the rail for internal defects on 01 October 2001. No defects were detected in the area of the derailment.

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[2] Transport Canada, *Railway Track Safety Rules*, Part 1—General, Clause 3—Scope.

The New and Untried Car Analytic Regime Simulation (NUCARS) computer program determines a theoretical lateral/vertical (L/V) ratio of wheel-load force based on track information and freight-car dimensional data. An L/V ratio of 0.80 to 0.90 is generally considered a minimum for a wheel climb to be likely.[3] The tendency toward derailment increases as the ratio increases. Different ratios offer different degrees of hazard:

- A ratio of 0.68 indicates initial instability, and an unrestrained rail may overturn.
- At a ratio of 0.75, a worn wheel flange may climb a worn rail.
- At a ratio of 0.82, the wheel flange may disengage from the rail and an outside wheel may lift from the rail on curves.[4]
- A ratio of 1.00 is the criterion established as indicative of a wheel-climb derailment occurring under AAR Chapter XI testing for service worthiness of new freight cars.[5]

CPR performed a NUCARS simulation of the loaded hopper car (CGLX 10481) going through the Kemnay siding at 24 mph. The track was modelled using data from the 07 May 2001 TEC inspection of the siding. The TEC data compared closely to the hand measurements recorded at the site. The simulation determined that the existing track and equipment conditions resulted in a single wheel (R-2) L/V ratio of 0.98. CPR identified that the combination of track cross-level and alignment deviations at the east end of the Kemnay siding, near the POD, were likely the primary factors contributing to this derailment.

In 1999, the TSB conducted an investigation into occurrence R99T0256 in which track cross-level and alignment deviations were present near the POD. Individually, the anomalies did not require corrective action under track geometry specifications in effect at that time. However, collectively, these track anomalies were found to be among the primary factors contributing to the derailment. As a result of this investigation, CN, CPR, and TC are collaborating on a joint research study targeted at characterizing the effect of combination track geometry defects.

Analysis

CPR freight train 218-29 was operated in compliance with government and company operating practices. The track infrastructure near the derailment was maintained in accordance with the TSR and SPCs for a Class 2 track. The analysis will focus on operating speed through the siding, freight car conditions, and track conditions. The top shelf failure of the B-end coupler from PROX 41073 and the lack of an emergency plan for the RM of Whitehead will also be discussed.

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3 Association of American Railroads, Research Reference R-185, *Track Train Dynamics Report: TTD Guidelines for Optimum Train Handling, Train Makeup and Track Considerations*, section 4, item 4.7.1 L/V Ratio, November 1979.

4 William Hay, *Railroad Engineering*, 2nd ed., section 4, L/V Ratios, Track Train Dynamics, p. 658.

5 Association of American Railroads, *Manual of Standards and Recommended Practices*, C-II Freight Car Design and Construction, chapter XI, Service-Worthiness Tests and Analyses For New Freight Cars, p. 397.

As the lead locomotive cleared the east-end switch, the train slowly accelerated from 14 mph to 25 mph, at which point it experienced a train-initiated emergency brake application and came to a stop as a result of the derailment. The first derailed car (CGLX 10481) remained upright on the track with the trailing truck derailed. The investigation determined that the lead wheel of the trailing truck (R-2) was the first wheel derailed to the field side of the south rail, approximately 10 feet 4 inches east of the Estevan Subdivision junction switch point.

CGLX 10481 was a loaded covered hopper car. This type of car has a higher centre of gravity, rendering it susceptible to car body oscillation when exposed to multiple alternating track cross-level variations while operating between 15 mph and 25 mph. Car body oscillation can contribute to wheel climb/lift derailments, which occur primarily when negotiating curves and turnouts.

The NUCARS computer simulation produced an L/V ratio of 0.98 based on the combination of track cross-level and alignment deviations, car type, and speed in the siding. An L/V ratio of 0.82 is considered sufficient for a wheel flange to disengage from the rail and for an outside wheel to lift from the rail on curves. CPR's analysis indicated that the track cross-level conditions and alignment deviations near the POD were the primary factors contributing to this derailment. Another major factor was the loaded covered hopper car travelling within a speed range (15 mph to 25 mph) that causes car body oscillation in high-centre-of-gravity cars when alternating track cross-level variations exist.

CROR Rule 98.1 and CPR's GOI identify 15 mph as the speed for sidings and through turnouts unless otherwise provided by a subdivision footnote. Broadview Subdivision footnote 4.2 in CPR's *Manitoba Service Area Time Table* designates a maximum speed of 25 mph on sidings. The train speed of 25 mph for sidings in the Broadview Subdivision, although within current CROR and CPR operational requirements, increased the risk of a wheel lift derailment. Given the known cross-level and alignment track irregularities near the POD, the likelihood of a derailment would have been reduced had the train remained at 15 mph until clear of the siding as indicated by CPR's GOI, rather than accelerating to 25 mph as allowed by the subdivision footnote.

Individually, the track cross-level and alignment deviations near the POD did not require corrective action under current TC and CPR specifications. The TSB had investigated similar track geometry conditions that contributed to a derailment in 1999 (R99T0256). As a result of that investigation, CN established limits for combination track defects as part of its track maintenance practice. In addition, a joint research study was initiated by CN, CPR, and TC to identify the effect of combination track geometry defects. To date, none of the study's results have been released. The TSR notes that the rules "apply to specific track conditions existing in isolation. Therefore, a combination of track conditions, none of which individually amounts to a deviation from the requirements in this part, may require remedial action to provide for safe operations over that track". Presently, there are no TC or CPR specifications that establish limits identifying the combination of sub-urgent track cross-level and alignment irregularities as a defect requiring corrective action. Without specifications in place to protect against combination sub-urgent track defects, in particular within areas containing turnouts, the risk of derailments under similar conditions continues.

During the derailment, the A-end coupler of CGTX 30093 impacted the B-end tank head of PROX 41073, severely denting the head. Examination of the coupler by the TSB Engineering Laboratory (Engineering Report LP 100/01) determined that the coupler failed instantaneously during the derailment as a result of forces caused by the derailment sequence. Contributing to the coupler failure was the substantial size of the pre-existing shrinkage porosity defects located at a critical transition radius, which joined the coupler head and the top shelf.

Newly manufactured couplers are visually inspected to ensure compliance with AAR specifications M-201-92 and M-211, which govern the manufacturing of the component. A visual inspection alone cannot detect internal defects. However, the use of ultrasonic or radiographic non-destructive testing methods would readily reveal the presence of large cavities in a critical area of a coupler. The AAR manufacturing specifications do not require ultrasonic or radiographic inspection of cast steel couplers. Without adequate non-destructive testing quality-control methods in place, there continues to be a risk of new couplers or other component castings containing subsurface manufacturing defects in critical areas that may lead to premature failure.

As noted earlier, the Manitoba *Emergency Measures Act* (1987) specifies that "every local authority shall prepare, approve and adopt emergency preparedness plans and programs." The RM of Whitehead had no plan. Although no injuries or release of dangerous goods occurred, the lack of an emergency plan could have impaired emergency response and increased the risk of serious harm to people and the environment.

Findings as to Causes and Contributing Factors

1. The derailment occurred because of sub-urgent track cross-level and alignment deviations and because a high-centre-of-gravity loaded covered hopper car was travelling within a speed range known to create wheel unloading conditions due to car body oscillation.

Findings as to Risk

1. The train speed of 25 mph for sidings in the Broadview Subdivision is within current operational requirements of the *Canadian Rail Operating Rules* and Canadian Pacific Railway (CPR). Nevertheless, this speed increases the risk of a wheel lift derailment by allowing trains to travel within a speed range (15 mph to 25 mph) known to be problematic for high-centre-of-gravity loaded covered hopper cars when the combination of known sub-urgent cross-level and alignment track irregularities are present.

2. Neither the *Track Safety Rules* nor CPR have specifications that establish limits that identify the combination of sub-urgent track cross-level and alignment irregularities as a defect requiring corrective action. Without specifications in place to protect against combination track defects, in particular within areas containing turnouts, the risk of derailments occurring under similar conditions continues.

3. The manufacturing specifications of the Association of American Railroads do not require ultrasonic or radiographic inspection of cast steel couplers. Without adequate non-destructive-testing quality-control methods in place, a risk exists that new couplers or other component castings will contain subsurface manufacturing defects in critical areas that may lead to premature failure.

Safety Action Taken

1. As a result of this investigation, the TSB issued Rail Safety Advisory 04/02 to Transport Canada (TC) concerning coupler casting and quality control.

2. TC has advised other regulatory bodies in Canada and the United States of the issue of coupler casting and quality control.

3. The coupler manufacturer has advised TC that it has improved its manufacturing processes over the last 12 years.

4. The issue of combination sub-urgent track defects will be brought to TC's Track Safety Rules Working Group, which will begin meeting in May 2003. Based on the results of testing and discussions from within the working group, the *Track Safety Rules* may be revised to refine the rule for combination track geometry defects.

5. Canadian Pacific Railway (CPR) is rewriting its standard practice circulars (SPCs), including SPC 34 for track. TC anticipates that SPC 34 will be rewritten to reflect combination priority level defects.

6. CPR has tightened its track-evaluation-car thresholds for rock-and-roll surface roughness and cross-level defects in Class 2 track from the original Class 2 levels to Class 3 levels.

7. CPR is participating in a research program with TC and Canadian National relating track geometry characteristics to lateral/vertical ratios for instrumented hopper car wheel sets.

8. The Regional Municipality of Whitehead is developing an emergency plan that will include proper contact lists.

This report concludes the TSB's investigation into this occurrence. Consequently, the Board authorized the release of this report on 06 May 2003.

Appendix A - Glossary

AAR	Association of American Railroads
CN	Canadian National
CPR	Canadian Pacific Railway
CROR	*Canadian Rail Operating Rules*
GOI	*General Operating Instructions*
km/h	kilometres per hour
L/V	lateral/vertical
m	metres
mpg	miles per hour
NUCARS	New and Untried Car Analytic Regime Simulation
POD	point of derailment
SPC	Standard Practice Circular
TC	Transport Canada
TEC	track evaluation car
TSB	Transportation Safety Board of Canada
TSR	*Track Safety Rules*
°	degrees