Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

# RAILWAY INVESTIGATION REPORT

# R03T0064

## DERAILMENT

## CANADIAN PACIFIC RAILWAY
## FREIGHT TRAIN NO. 938–12
## MILE 39.5, PARRY SOUND SUBDIVISION
## NOBEL, ONTARIO
## 13 FEBRUARY 2003

Canada

# Railway Investigation Report

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# Canadian Pacific Railway
# Freight Train No. 938–12
# Mile 39.5, Parry Sound Subdivision
# Nobel, Ontario
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## *Summary*

At approximately 0830 eastern standard time on 13 February 2003, Canadian Pacific Railway freight train 938–12, proceeding southward at 42.5 mph, derailed 21 cars at Mile 39.5 of the Parry Sound Subdivision near Nobel, Ontario. The derailed cars included 10 loaded tank cars. Two of the derailed tank cars contained methanol (UN 1230); five contained styrene monomer, inhibited (UN 2055); and three contained non-regulated ethylene glycol. Three tank cars were breached, resulting in the release of approximately 100 tons of ethylene glycol and 130 tons of styrene monomer. A total of 180 people living within 1.5 miles (2.5 km) of the site were evacuated. Two people sustained minor injuries. Minor amounts of released product migrated to Rainy Lake, approximately 450 metres east of the derailment.

# Other Factual Information

## The Accident

On 13 February 2003, at approximately 0830 eastern standard time,[1] Canadian Pacific Railway (CPR) freight train 938–12 (the train), en route from Winnipeg, Manitoba, to Toronto, Ontario, was proceeding southward at 42.5 mph on CPR's Parry Sound Subdivision when it experienced an undesired emergency brake application (UDE). The head end of the train came to a stop at Mile 39.0, which is approximately 2.5 km southeast of the village of Shawanaga and 16 km north of Nobel, Ontario (see Figure 1). Weather conditions were -27°C with calm winds. There was no cold weather slow order in effect, restricting train speed in the area.

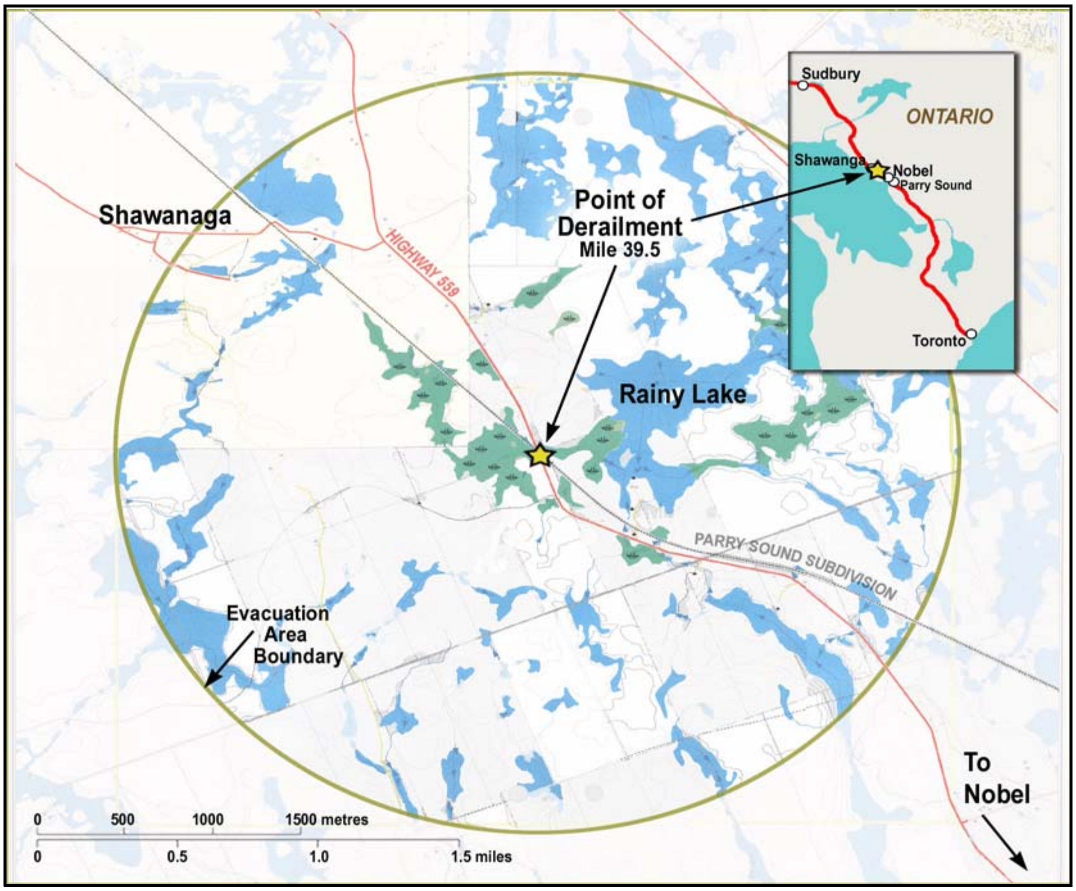


**Figure 1.** Map of derailment area

After notifying the rail traffic controller (RTC) that the train had stopped, the conductor initiated an inspection of the train. While walking towards the rear of the train, the conductor heard hissing sounds originating in the area of several derailed tank cars. Being familiar with the train journal, he suspected that dangerous goods (DGs) may be leaking from the tank cars and

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1 All times are eastern standard time (Coordinated Universal Time minus five hours).

remained upwind on the west side of the track to complete his inspection. After completing his inspection, the conductor notified the locomotive engineer who then informed the RTC of the suspected leak.

The first derailed car was CP 419525, a flat car loaded with freight car wheel sets. This car, still attached to the front portion of the train, was upright with all wheels derailed. The following 20 derailed cars were separated from the front portion of the train by a gap of approximately 500 feet (150 m). Eighteen of these cars came to rest in various positions east of the track and immediately south of the Highway 559 public crossing at Mile 39.5 (see Figure 2). Approximately 430 feet (130 m) of track was damaged.

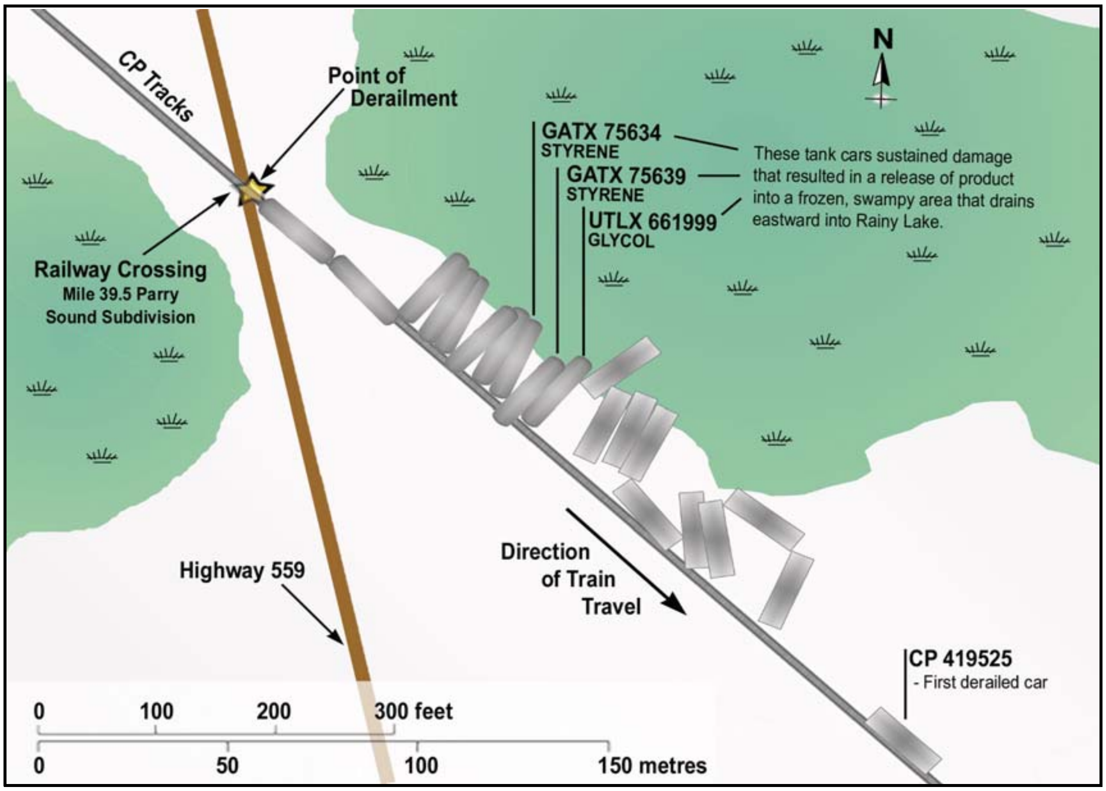


**Figure 2.** Derailment site sketch

A school bus driver travelling near the site reported the derailment to the Ontario Provincial Police (OPP) Communications Centre in North Bay, Ontario. A radio broadcast was then made to police agencies in the area. A constable with the Anishinabek Police Services, who had DG awareness training, responded to the accident. Upon his arrival, he began inspecting the site and noted a pungent odour along with several heavily damaged derailed cars. While inspecting, the constable met the train conductor who advised him that DGs were leaking and he should leave the area. The constable then retreated approximately 800 m to the northeast, downwind of the accident where the odour was still noticeable.

The North American *Emergency Response Guidebook* suggests that, for a large spill involving these commodities, a downwind evacuation of 300 m (1000 feet) should be considered. Following discussions between the police constable and the Shawanaga First Nations Chief, a decision was made to evacuate the area within 2.5 km of the site. The evacuation, which affected 180 people and included the village of Shawanaga, started at 1030 on 13 February 2003 and remained in effect for 54 hours. During this period, concern was raised by the evacuees regarding the lack of communications from railway officials. The local fire department, OPP, and other provincial and federal regulatory agencies attended the scene during the course of the incident.

## *Site Inspection of Derailed Cars*

Of the 21 derailed cars, 10 were loaded tank cars with 7 containing DGs. Two of the derailed tank cars remained upright, intact, and attached to the separated rear portion of the train. The remaining eight derailed tank cars were lying side by side, at approximately 90 degrees to the track, on the east side of the track. Three of these tank cars, the 58th to 60th from the head end, sustained significant damage resulting in the release of product. These low-pressure tank cars were jacketed, insulated, and had been built under tank car construction specification DOT 111A100W1. Tank car UTLX 661999 (58th car) contained ethylene glycol and the following tank car, GATX 75639, contained styrene monomer, inhibited (UN 2055). Both cars were punctured and lost most of their content. Tank car GATX 75634 (60th car) was damaged in the top manway area and came to rest on its side, releasing approximately 30 per cent of its load (styrene monomer, inhibited). The post-accident examination of the derailed cars determined that there were no significant pre-existing mechanical defects or deficiencies that may have contributed to the accident.

## *Dangerous Goods and Environmental Impact*

Approximately 100 tons of ethylene glycol and 130 tons of styrene monomer were released. Ethylene glycol is a non-regulated commodity, heavier than and soluble in water, and used as an ingredient in anti-freeze and de-icing solutions. Styrene monomer, stabilized, a Class 3 flammable liquid, is clear and colourless with an aromatic odour. Its vapours are lighter than air, it has a flash point of 90° Fahrenheit and may cause irritation to the eyes and mucous membranes. Styrene monomer, stabilized is insoluble in water and may polymerize if contaminated or subjected to heat. It is used to make plastics, paints, synthetic rubber, and styrofoam products.[2]

Some of the released product entered the swampy area that drains into Rainy Lake, approximately 450 m southeast of the track. A large amount of the spilled product was absorbed by vegetation in the area. Test wells dug throughout this area revealed that the styrene had polymerized and turned into a semi-solid state. Water monitoring stations, installed by environmental agencies, determined that only a minor amount of spilled product had entered the lake.

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[2] *Emergency Handling of Hazardous Materials in Surface Transportation*. Association of American Railroads.

## *Injuries*

The conductor and the police constable sustained minor injuries after inhaling fumes from the released DG product. There have been several rail occurrences (R99T0256, R01E0009 and R01M0061) where first responders had approached the accident site without appropriate protective equipment and were exposed to DGs. In TSB report R99T0256, the Board raised the safety concern that emergency response personnel in small communities may not be provided with the necessary tools, protective equipment, and training to be fully aware of and prepared for the risks associated with DGs being transported through their communities by rail.

## *Site Examination of Broken Rail*

The east rail broke at a rail joint, approximately three feet south of the highway crossing at Mile 39.5. Wheel marks observed on the rail head, 17 inches south of the east rail end, identified this as the point of derailment (POD). Rail wear was within established limits. The gauge side rail joint bar had broken in half, with the north end remaining bolted to the rail. The exposed gauge side joint bar fracture surfaces revealed a small pre-existing fatigue crack, near the middle of the bar in the radius of the bottom reinforcing rib, which extended to a depth of 3/16 inch. The remainder of the joint bar’s cross-section failed in a brittle mode from the tip of the crack. The field side joint bar remained intact. The rail had sustained a diagonal fracture, originating from the third bolt hole of the rail end, down through the base of the rail. At the bottom of the bolt hole, a small dark oxidized area was noted. The rail beyond the joint had broken into numerous pieces and displayed fracture surfaces consistent with progressive catastrophic failures sustained during the derailment.

## *Detailed Examination of Broken Rail*

The broken rail pieces were forwarded to CPR’s Test Department in Winnipeg for failure analysis. TSB investigators were present during the tests. The rail material met CPR’s specification for 115-pound carbon steel rails. Rail pieces containing the third bolt hole pre-crack and suspected POD from the east rail were reconstructed (see Photo 1).

**Photo 1.** Reconstructed rail from suspected POD

1. The first rail piece contained the rail end, two complete bolt holes, and a portion of the third in its web. It measured 17 inches along the head and 14 inches along the base.

2. The second rail piece contained the remaining portion of the third bolt hole, measured 17 inches along the base, and was missing its rail head. The rail web fracture surface was damaged from wheel impacts resulting from wheel drop off.

3. The third piece was a seven-inch section of rail head that had separated from the web of the second piece and mated perfectly to the south-end rail head of the first piece. The third piece displayed fracture surfaces with brittle characteristics typical of catastrophic failure.

The observed dark oxidized area in the third bolt hole was determined to be a pre-crack (see Photo 2). It originated from the middle of the web in the hole's bore and extended through the entire thickness of the web downwards towards the base for 3/4 inch. From there, a secondary brittle fracture propagated down through the remainder of the rail base cross-section. Examination of a metallographic sample removed from near the pre-crack fracture origin revealed several corrosion pits and a secondary branch crack full of oxides extending from the surface of the hole bore. Two corrosion pits displayed microscopic cracks extending from their root. The examination determined that the pre-crack had been present for some time prior to the rail failure. Characteristics displayed by the pre-crack fracture surface were typical of brittle fracture with no evidence of fatigue.

**Photo 2.** Pre-crack in third bolt hole. Exploded view is a close-up of the full pre-crack fracture surface with the mating surface removed.

A corrosion test was performed by CPR using a broken rail from the site to determine the amount of time required to achieve the oxidized appearance observed on the pre-crack fracture surface. The test indicated that it would take longer than a month.

## *Train Information*

The train, comprised of 2 locomotives and 75 cars (71 loaded and 4 empty), was approximately 5000 feet long and weighed 9112 tons. The train crew, consisting of a locomotive engineer and a conductor, had taken control of the train at Cartier, Ontario. The crew was familiar with the territory and met fitness and rest requirements.

Movements on CPR's Parry Sound Subdivision are governed by the Automatic Block Signal System and Occupancy Control System, as authorized by the Canadian Rail Operating Rules and supervised by a rail traffic controller located in Calgary, Alberta. An average of 16 freight trains per day traverse this area. The authorized track speed was 60 mph for expedited freight trains and 45 mph for non-expedited freight trains. The train in this occurrence was a non-expedited freight car. The signal governing movements over the POD and derailment location was "clear," indicating that the track was unoccupied and safe to traverse.

## *Train Handling Information*

The track has a descending grade of 0.3 per cent from Mile 41.1 to Mile 39.6, leading to generally level track at the Highway 559 crossing. Locomotive event recorder data indicated that the train had been in throttle position 8 between Mile 44.0 and Mile 40.0, and that train speed had increased to 43.6 mph. At Mile 40.0, the throttle was placed in the idle position and the dynamic brake[3] was slowly increased to level 8. Shortly thereafter, the train experienced the UDE.

## *Track Information and Rail Testing*

The Parry Sound Subdivision is a single main track consisting of 115-pound continuous welded rail laid on hardwood ties. The rail south of the crossing was manufactured by Algoma Steel in January 1984. In the derailment area, the track is tangent and constructed on four feet of raised subgrade traversing a wetland area. The ballast was a mixture of crushed rock and slag. The cribs were full and the shoulders extended 12 inches beyond the tie ends. A drainage culvert is located north of the Highway 559 crossing.

CPR's track evaluation car passed over this location on 16 October 2002, and again on 30 January 2003. On both inspections, track evaluation measurements indicated track surface irregularities on both sides of the road crossing. The measurements were within the tolerances for urgent defects and priority defects established in CPR's Standard Practice Circulars. A Hi-rail inspection by a track maintenance supervisor had been conducted on 12 February 2003. No track defects were noted during this inspection. Subsequent to the occurrence, TSB investigators observed deteriorated ties and poorly drained track conditions on both sides of the crossing.

Rail testing had been performed by Sperry Rail Service on 13 January 2003. This test, involving both ultrasonic testing and magnetic induction testing, was conducted using a 100 series car that produces results in graph format on paper tape. Under limits established for current ultrasonic

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3 Dynamic brake is a locomotive electrical braking system that converts locomotive traction motors into generators to provide resistance against the rotation of the locomotive axles.

rail testing technology, a pre-crack that is ½ inch long and extends more than halfway through the web is only required to be detectable 75 per cent of the time. Magnetic induction is a complementary testing system that analyzes the rail head for defects. The 13 January 2003 test results were reviewed. There were no recorded indications identifying rail defects in the vicinity of the east rail joint, south of the public crossing at Mile 39.5.

### *Wayside Inspection and Wheel Impact Load Detectors*

Visual inspections of trains are routinely performed by railway personnel. These include pull-by inspections at crew change locations; track-side, pass-by inspections at meeting points; and mechanical inspections at designated terminals. To complement these train inspections, CPR has equipped its rail network with electronic wayside inspection systems (WIS) that check the condition of rolling stock while en route. The scanners, which are spaced approximately 25 miles apart along main track, normally include a hot box detector for overheated bearings, a hot wheel detector, and a dragging equipment detector.

In 1998, CPR installed a network of wheel impact load detectors (WILD) adjacent to a number of its WIS sites. CPR located its WILD sites based primarily on traffic patterns, interchange points, and the availability of mechanical staff to respond. At the time of the occurrence, CPR had nine WILD sites in Canada. The development and installation of WILD technology is an industry initiative that has enhanced rail safety by proactively identifying high impact wheels so that they can be removed before they cause damage to rolling stock or track infrastructure. Currently, there are no regulatory requirements in Canada on the use of WILD technology.

### *Wheel Impact Load Detector Alarm Thresholds*

A WILD installation consists of a network of strain gauges placed on the web of the rail to measure rail deformation under traffic. The gauges measure the impact load generated by each wheel tread. Additional devices record the impact load and identify the respective car and wheel position. Wheels that exceed impact thresholds are removed from service before they cause damage to rolling stock or track infrastructure. As outlined in CPR's WILD policy (Maintenance Regulation RSC 50–50), four WILD alarm levels have been established, with each threshold triggering a specific maintenance response.

In addition to the maintenance response to recorded actual impacts, CPR also developed a speed-corrected algorithm. The algorithm is a proactive measure that takes an actual impact level at a slower speed and corrects it using linear progression to impact at 50 mph. This correction allows CPR to evaluate wheel impacts to a normalized speed of 50 mph. However, the algorithm is sensitive to wheel defect type, low speed conversion, and assumed linearity. As such, the management of wheel removals using the algorithm is somewhat arbitrary.

CPR's WILD policy is in line with industry norms based on an impact threshold of 140 kips for actual readings and exceeds (i.e., is more restrictive) industry norms for the speed-corrected threshold of 170 kips. The policy indicates that immediate attention (i.e. stop train, setout car, and remove wheel set) is not required until the actual wheel impact is 140 kips[4] or greater, or the corrected-for-speed value is 170 kips or greater. Using these WILD thresholds, CPR removes an average of 400 wheel sets per month due to high wheel impacts.

CPR may, however, alter its policy for wheel removal thresholds at any time. In 2003, CPR reduced the algorithm calculation by 10 kips in an effort to minimize the number of wheel set changeouts required. With the 10-kip reduction in the algorithm, CPR estimated that there would be a 50 per cent reduction in the number of wheel sets removed due to estimated impacts in excess of 170 kips. In addition, for the winter of 2003–2004, CPR increased the wheel removal threshold for actual impacts from 140 kips to 145 kips. With this 5-kip difference, CPR estimated that there would be a 25 per cent reduction in the number of wheel sets removed.

In 2002, CPR implemented an Accelerated Wheel Removal Program (AWRP) for its intermodal (IM) car fleet. Under the AWRP, a wheel set is monitored once it reaches the AAR 90-kip WILD threshold and, if the car is loaded, a message is sent to a CPR facility near the destination point. Once unloaded at the facility, the car is inspected and the wheel set is changed if material and staff are available. Since implementing the AWRP, IM car availability has improved and IM en route car setouts have been reduced.

From its inception, CPR's WILD thresholds were determined primarily by industry practice. CPR had no record of engineering analysis for WILD data to support the thresholds contained in its policy. In comparison, Rule 41, Section 1, Subsection r(1) of the *Field Manual of the AAR Interchange Rules* (2003 edition) indicates that an actual wheel impact reading of 90 kips or greater is condemnable at any time. The AAR Wheel, Axle, Bearing and Lubricant Committee was responsible for the development and implementation of Rule 41. Its decision to use 90 kips as the condemning limit was based on a number of technical studies conducted during the early 1990s. Engineering analysis from these studies supports 90 kips as a reasonable wheel removal threshold to limit the damage to equipment and track infrastructure.[5]

## *Recorded Wheel Impact Loads*

On 02 February 2003, while travelling at 37.5 mph, the train was inspected at a WILD site near Raith, Ontario, approximately 59 miles (95 km) west of Thunder Bay, Ontario. Although there were no wheel impacts greater than 140 kips, four of the recorded impacts were between 90 kips

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4 A kip is a load of 1000 pounds dead weight.

5 R–754. "Condemning Wheels Due to Impact Loads." Semih Kalay and Ali Tajaddini. February 1990.
R–810. "Vehicle/Track System Response Due to Condemnable Wheel Tread Defects." Ali Tajaddini and Semih Kalay. April 1992.
R–829. "Wheel Impact Load Detector Tests and Development of Wheel Flat Specification." Semih Kalay. May 1993.
R–851. "Evaluation of Railroad Wheel Impact Load Damage Factors." D.R. Ahlbeck. October 1993.
R–855. "Economic Analysis of High Impact Load Wheels." Dharma R. Acharya, Thomas S. Guins, Semih Kalay and Ali Tajaddini. December 1993.

and 116 kips. The next WILD facility on the train's route is located at Bolton, Ontario, just north of Toronto, approximately 850 miles (1300 km) southeast of Raith and 150 miles (225 km) south of the derailment site.

On the day after the derailment, the 2 locomotives and 47 cars at the head end of the train that were unaffected by the accident were taken south to Toronto. While en route, the train traversed CPR's WILD site at Bolton. While travelling over this site at 35 mph, the WILD identified six wheels on the east rail with actual impacts ranging from 106 kips to 119 kips. These wheels included the four that had been identified at the Raith site on 02 February 2003. The six recorded impacts were above AAR's condemning limit of 90 kips but below CPR's WILD removal threshold. When adjusted for the derailment speed (42.5 mph), three of these wheel impacts were calculated to be between 120 kips and 130 kips, and the other three impacts were between 130 kips and 140 kips.

## *Previous Derailments Related to Wheel Impacts*

Rail steel is known to have reduced fracture toughness and ductility at low temperatures, particularly if a rail defect acting as a stress raiser is present. A previous TSB investigation report, R99H0010, identified that an existing pre-crack was sufficient to initiate rail failure under the effect of stresses induced on the rail by the combination of low ambient temperatures and wheel impact loads below WILD threshold limits established by the railway for car set-off.

In addition, a derailment on CPR's White River Subdivision on 23 January 2003 was related to a wheel exhibiting high impacts. While travelling at 34 mph, CPR train 213–22, handling 92 cars (23 loads, 69 empties), derailed 29 cars at Mile 78.2. The temperature was -20°C. CPR identified the derailment cause as a broken wheel. Impacts from this broken wheel caused the south rail to fail, resulting in the derailment. Two days previously, the same wheel had recorded an impact of 99 kips while travelling at a speed of 30 mph. This impact force is above AAR's condemning limit of 90 kips, but below CPR's removal thresholds. Consequently, no maintenance action was initiated for this wheel set after the impact measurement.

## *Cold Weather Slow Orders*

At the time of this occurrence, CPR had no formalized system-wide process in place to define when a cold weather slow order should be placed on a specific track area. On 20 December 2002, track maintenance supervisors in Southern Ontario were instructed to adhere to CPR's new Draft/Proposed Cold Weather Slow Order Policy. Based on the criteria outlined in the proposed policy, the area of the derailment would be subject to a cold weather slow order once temperatures reached -35°C. Because this area was not identified as a high-risk location, it was not necessary to implement a -25°C slow order. However, the proposed policy was not fully implemented until after the derailment. At the time of the derailment, the decision to place cold weather slow orders was left to the discretion of the local track maintenance supervisor. In comparison, Canadian National has had formalized system-wide, cold weather slow order guidelines incorporated into its winter plans for its Eastern Canada Region for several years. Depending on track conditions, cold weather slow orders may require trains to reduce speed once the ambient temperature reaches -25°C.

# Analysis

The operation of CPR freight train 938–12 met company and regulatory requirements. No train handling irregularities were evident and an examination of the derailed rolling stock did not reveal any pre-existing equipment defects that were considered causal in the accident. The analysis will focus on the effects of corrosion, cold ambient temperature, ultrasonic rail testing, wheel impacts on track infrastructure, and the lack of regulatory overview for wheel impact load detector (WILD) systems. The actions of emergency responders will also be discussed.

## The Derailment

The train derailed just south of a public crossing when the east rail of the main track failed catastrophically in the location of a pre-existing rail joint bolt hole crack (pre-crack). A metallographic sample removed from near the pre-crack fracture origin revealed several corrosion pits and a secondary branch crack full of oxides extending from the surface of the hole bore. This suggests that at some time prior to the occurrence, a corrosion pit in the third bolt hole from the east rail end likely acted as a stress raiser and facilitated the development of the pre-crack. The lack of fatigue features on the pre-crack fracture surface suggests that it was generated by a single load some time prior to this occurrence. The amount of oxidation observed on the pre-crack, along with testing performed by CPR, confirmed that the pre-crack was likely present at the time of the ultrasonic inspection, one month prior to the accident, and had remained dormant until this occurrence.

When exposed to cold ambient temperature, the fracture toughness and ductility of rail steel are reduced, rendering it more susceptible to brittle failure, particularly if a stress raiser (e.g. pre-crack) is present. In this occurrence, a rail joint bolt hole crack was present and the temperature was -27°C. At this temperature, the rail contracted, inducing high tensile forces into the continuous welded rail. In addition, the east rail was subjected to six wheel impacts from the head-end 47 cars of the train, which were recorded to be in excess of AAR’s condemning limit of 90 kips, but below CPR’s removal threshold. Under these conditions, it is likely that the wheel impacts initiated a brittle downward fracture through the base of the east rail from the root of the pre-crack.

The failure of the rail’s bottom cross-section and the subsequent loss of load-bearing ability facilitated the development of another brittle fracture from the top portion of the bolt hole, resulting in the separation of a seven-inch rail head section. The lack of rail end batter at the joint and lack of polishing on the fracture surface of the seven-inch section indicate that the rail failed catastrophically beneath the train. The void created by the rail head separation allowed the wheels of the 47th car to drop off. As subsequent wheels struck the broken rail head, additional rail fractures developed, leading to the derailment of the following 20 cars. The gauge side joint bar failure occurred as a result of the derailment and was not considered causal to the accident.

## *Rail Joint Corrosion*

Metallographic examination determined that the pre-crack likely developed from the root of a corrosion pit. The location of the failed rail joint, three feet south of the crossing, made it more susceptible to snow, salt, and debris from the road. The location of the rail joint in such close proximity to the road increased the risk of corrosion developing in joint components.

## *Cold Weather Slow Orders*

The rail industry recognizes the negative effect that exceptionally cold weather has on track infrastructure and rolling stock. Most railways will take measures to minimize these adverse effects. However, at the time of this occurrence, CPR had no system-wide formalized process defining when a cold weather slow order should be issued for a specific area of track. In most cases, that decision was left to local track maintenance supervisors based on their experience, knowledge of the territory, and the weather conditions.

Prior to the occurrence, track maintenance supervisors in Southern Ontario were instructed to adhere to CPR's new Draft/Proposed Cold Weather Slow Order Policy. Based on the risk criteria outlined in the proposed policy, at the temperature of -27°C on the day of the occurrence, there was no requirement to implement a cold weather slow order. Had a cold weather slow order been implemented, train speed and wheel impacts would have been lower, likely reducing the severity of the derailment.

## *Ultrasonic Rail Testing*

Ultrasonic testing has become a valuable tool to assist with rail maintenance plans and to identify rail defects. The accuracy of the testing equipment is essential for effective rail maintenance programs. Ultrasonic rail testing normally detects bolt hole cracks that are at least ½ inch long and extend completely across the rail web. In this occurrence, the pre-crack was of a detectable size, extending across the entire web thickness downwards towards the base of the rail to a depth of 3/4 inch. However, such cracks may not be detectable up to 25 per cent of the time with current ultrasonic testing technology. In addition, the pre-crack location, wholly contained within the joint bars, made it undetectable by visual inspection. The rail was ultrasonically tested for defects approximately one month prior to the accident. The test did not identify any rail defects in the vicinity of the rail joint. However, the amount of oxidation observed on the pre-crack fracture surface, in conjunction with CPR's corrosion test, confirmed that the pre-crack was present at the time of the test. It is likely that the irregular shape of the pre-crack, along with its orientation and location at the bottom of the bolt hole, made it unresponsive to ultrasonic detection.

## *Regulatory Overview of WILD Systems*

WILD systems are an enhancement to safety, which complement the visual inspection of trains performed by railway personnel. The rail industry has installed WILD systems as a preventative tool to identify high impact wheels so they can be removed before they cause damage to rolling stock or track infrastructure. Through regulatory monitoring, Transport Canada seeks to ensure railways have adequate tools and systems in place to facilitate safe operations. However, there are no regulatory requirements to monitor WIS technology, including WILDs. In the absence of regulations, railways operate WIS systems as they see fit. Consequently, the location of WILD sites, the distance between them, and WILD maintenance standards and intervention thresholds differ for each railway. In addition, railways can alter WILD thresholds to satisfy operational needs without being required to conduct a risk assessment.

CPR increased the wheel removal threshold for actual readings from 140 kips to 145 kips for the winter of 2003–2004, without performing a formal risk assessment. In 2003, CPR also lowered the corrected-for-speed algorithm by 10 kips in an effort to reduce the number of wheel changeouts required under its existing WILD policy. Therefore, wheel impacts recorded at 140 kips or calculated for speed adjustment at 170 kips no longer required immediate attention. Common engineering practice would dictate that measures be taken to reduce the level of impact inflicted on track infrastructure during winter, when components are more susceptible to brittle failure. Although links have been established between high wheel impact loads and rail failures, the absence of a regulatory overview for WILD technology increases the risk that wheels producing high impact readings will not be identified and removed from service in a timely manner.

## *CPR's Wheel Removal Thresholds*

There is no doubt that CPR's WILD network and policy have contributed to improvements in rail safety. However, because the interaction between high wheel impacts, rail material characteristics, temperature, and track structure rigidity is not fully understood, it has been difficult for the industry to establish optimal wheel removal thresholds that take both operating and safety criteria into account. For example, the AAR condemning limit of 90 kips, based on several engineering studies, may be prohibitive to rail operations in Canada during winter months, due to the large number of wheel sets that would require removal at that threshold. CPR's wheel removal threshold of 140 kips is more manageable from an operations perspective, but is based primarily on industry practice with no engineering analysis to support it. In contrast, the success of its AWRP indicates that there are other ways to manage wheel set removal using the AAR condemning limit of 90 kips.

In this occurrence, a pre-existing bolt hole crack, cold ambient temperature, and wheel impacts that were greater than AAR's 90-kip condemning limit were all factors contributing to the derailment. Two other recent derailments have occurred under similar circumstances. In these derailments, wheels with measured impacts greater than 90 kips were allowed to continue in service, because they did not exceed the railway's removal criterion of 140 kips. In these cases, railway WILD removal thresholds were inadequate, as they did not consider the level of risk posed by such wheel impacts.

## *Location of WILD Sites*

At the time of the occurrence, CPR had nine WILD sites across Canada. The largest distance between any two adjacent sites was approximately 850 miles, between the WILD installations at Raith and Bolton. Over this distance, a large portion of CPR's Northern Ontario route is not monitored for trains with high impact wheels. The main line through this area traverses difficult terrain and can experience extreme winter conditions. With exceptionally cold winters, the rail is more susceptible to brittle failure initiated by impact loads. Given this link between wheel impact loads and rail failures, long sections of track that are not monitored by WILD systems are susceptible to an increased risk of accidents caused by such failures.

### *Risk to First Responders*

The risk to employees, first responders, the local population, and the environment after the accident was recognized, and measures were taken to mitigate the circumstances. A local police officer, who had DG awareness training but no prior experience with derailments involving DGs, was dispatched to the accident. This first responder approached the site without appropriate protective equipment or information about the products involved, and he exited downwind from the site. Although his injury was minor, this situation is directly related to a safety concern raised by the TSB after an accident near Britt, Ontario (R99T0256). The concern stated that some first responders in small communities may not have adequate training to safely assess the risks associated with a major railway accident involving DGs, due to the low frequency of their involvement with railway accidents. Consequently, in performing their duties, first responders may expose themselves to DGs and increase the risk of serious injuries.

## *Findings as to Causes and Contributing Factors*

1. The train derailed immediately south of the public crossing when the rail failed catastrophically due to a pre-existing rail joint bolt hole crack.

2. Prior to the occurrence, a corrosion pit, which had developed on the bolt hole surface, likely acted as a stress raiser and facilitated the development of a pre-crack. The pre-crack was not detected by ultrasonic testing one month prior to the accident.

3. A cold ambient temperature induced thermal tensile stresses in the continuous welded rail and made the rail more susceptible to brittle failure.

4. Wheel impacts from the head-end portion of the train that were greater than the Association of American Railroads (AAR) condemning limit of 90 kips, but below Canadian Pacific Railway's (CPR's) threshold of 140 kips, likely initiated a brittle fracture from the root of the pre-crack through the base of the rail, facilitating the final catastrophic rail failure.

## *Findings as to Risk*

1. Rail joints in close proximity to a road crossing may lead to the contamination of joint components by corrosive agents and increase the risk of corrosion and pre-cracks developing.

2. The lack of regulatory overview of wheel impact load detector (WILD) technology increases the risk that wheels producing high impact readings will not be identified and removed from service in a timely manner.

3. CPR's current WILD policy does not adequately address the level of risk posed by wheel impacts recorded between AAR's condemning limit of 90 kips and CPR's WILD removal thresholds of 140 kips (actual) and 170 kips (calculated).

4. Given the link between high wheel impact loads and rail failures, long sections of track that are not monitored by WILD systems are susceptible to an increased risk of accidents caused by such failures.

5. First responders may not be provided with sufficient training to be aware of the risks associated with the rail transportation of dangerous goods. Consequently, they may be exposed to dangerous goods during initial response to a derailment, increasing the risk for serious injuries.

## *Safety Action Taken*

In November 2003, after reviewing rail traffic trends on its system, Canadian Pacific Railway (CPR) installed a wheel impact load detector (WILD) site at Mile 88.17 on the Cartier Subdivision, west of Sudbury, Ontario, for a total of 10 in Canada.

Since the derailment, CPR has implemented a formal Cold Weather Slow Order Policy, which is applied system wide. The policy defines when a cold weather slow order should be issued for a specific location. The policy incorporates ambient temperature readings from track side detectors and the level of risk associated with known track defects at that location.

Where the temperature is less than -25°C, a slow order is now a CPR policy for targeted areas where there are known track problems.

## *Safety Concern*

The rail industry uses WILD technology to monitor wheel tread performance under dynamic conditions. This technology allows the industry to proactively identify high impact wheels, many with condemnable tread defects, so they can be removed before they cause damage to rolling stock or track infrastructure. The failure of a specific wheel to meet railway removal thresholds and/or the Association of American Railroads WILD condemning criteria results in a maintenance action to remove the wheel set.

The WILD technology is presently being used as a defect and maintenance tool, but is not currently regulated by Transport Canada's *Railway Freight Car Inspection and Safety Rules*. The Board is concerned that this lack of regulation and overview permits railways to adjust WILD policy wheel removal threshold values to facilitate material management, rather than adjusting the thresholds based on engineering analysis of WILD data or on established safety criteria.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 22 September 2004.*

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