Transportation Safety Board of Canada

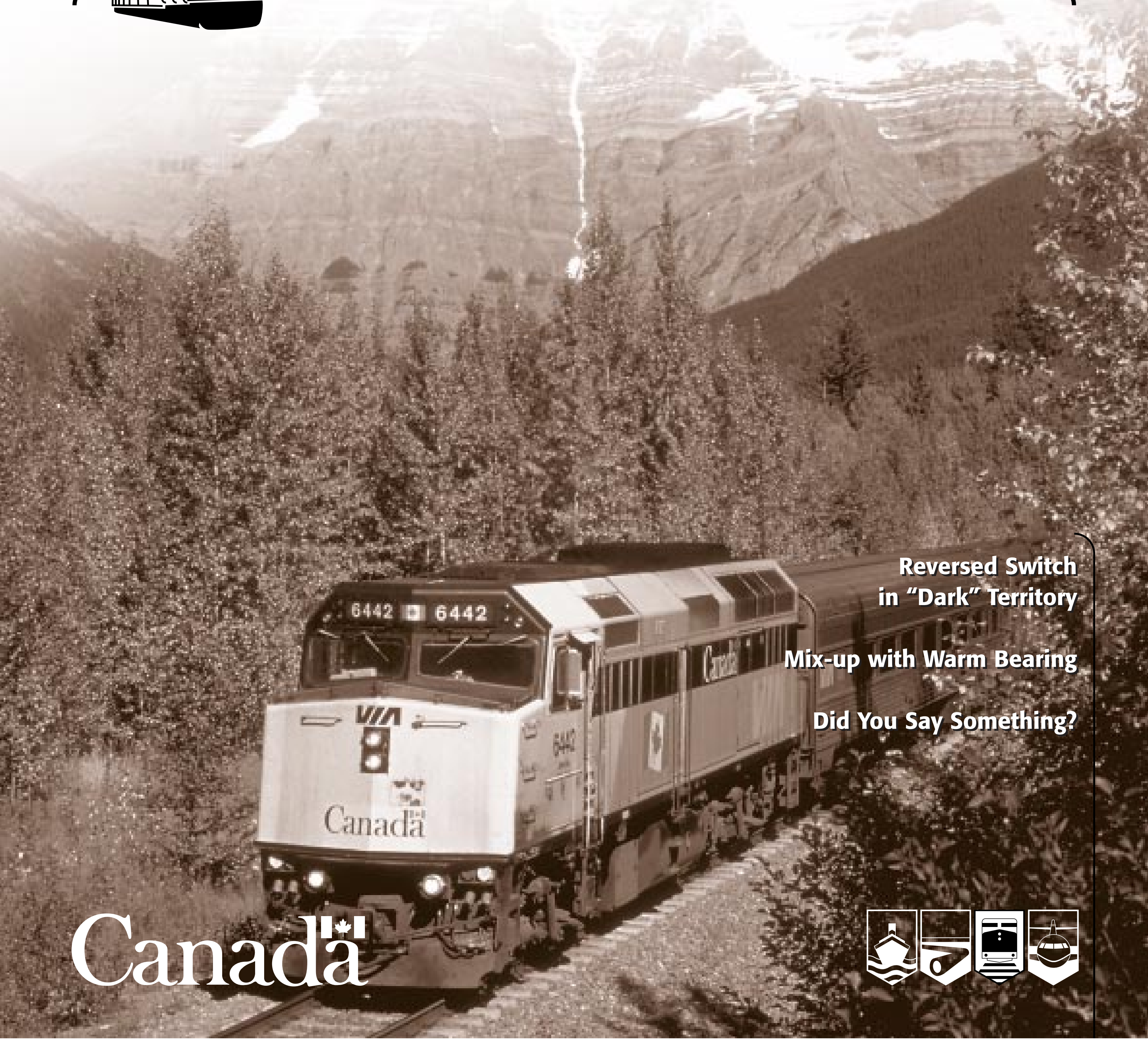
Bureau de la sécurité des transports du Canada

TRANSPORTATION SAFETY

REFLEXIONS

Issue 18 – September 2002

RAIL



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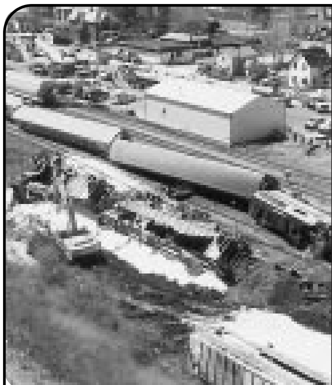

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REFLEXIONS is a safety digest providing feedback to the transportation community on safety lessons learned, based on the circumstances of occurrences and the results of TSB investigations.

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Overhead photograph of accident site looking northwest.

Reversed Switch in "Dark" Territory

A Via Rail Canada Inc. (Via) passenger train, travelling eastward on the north main track of the Canadian National (CN) Chatham Subdivision, at Thamesville, Ontario, encountered a reversed switch, crossed over to the south main track and derailed around noon eastern daylight time on 23 April 1999. The derailed train collided with stationary rail cars on an adjacent yard track. The three stationary cars that were struck were loaded with ammonium nitrate. All four passenger cars and the locomotive of the passenger train derailed, as well as four of the stationary cars on the adjacent yard track. The two crew members in the locomotive cab were fatally injured. However, just before the collision with the stationary rail cars, the locomotive crew transmitted a distress call to an opposing train and shut down the diesel engine, eliminating a potential source of ignition and reducing the risk of fire and/or explosion of the spilled ammonium nitrate. — Report No. R99H0007

Seventy-seven of the 186 passengers and crew on board were treated at hospital. Approximately 50 m of main track and 100 m of the adjacent yard track were destroyed. The locomotive was damaged beyond repair and the leading two passenger cars sustained substantial damage. The on-board Via employees performed their emergency procedures duties in an effective and efficient manner, contributing to the success of the evacuation. The thorough, well-prepared emergency response capability in the community of Chatham-Kent and the immediate notification, through 911, of emergency services resulted

The derailment and collision resulted from a misaligned crossover switch.

in the timely arrival of first responders. The emergency response personnel (firefighters, police, and ambulance staff) coordinated and facilitated an effective evacuation and mitigated the hazards from the spilled dangerous goods.

In its final report on the investigation into this accident, the Board identified safety deficiencies relating to the level of defences associated with the Occupancy Control System (OCS) method of train control, particularly in "dark" territory, where trains are not always provided with sufficient advance warning of reversed main-track switches, and to the storage of dangerous goods in rail cars for prolonged periods of time at locations adjacent to main tracks.

It was readily apparent that the derailment and collision resulted from a misaligned crossover switch. The crew and passengers on the Via train encountered an "unsafe condition"—a situation or condition that has the potential to initiate, exacerbate, or otherwise facilitate an undesirable event. The TSB's investigation examined the circumstances that led to the existence of that unsafe condition, the reasons why it remained undetected and uncorrected, and methods of reducing the associated risks of accidents and their consequences.

There was no information to suggest that vandalism had occurred or that a disgruntled railway employee or former railway employee had acted out of malice. It is most likely that the crossover switches were left reversed by a work train crew (working earlier in the day with a track maintenance gang to dump ballast from hopper cars) and that the actions that resulted in the crossover switches being left reversed were inadvertent.

Train control in areas like Thamesville is such that, once a work train receives authority to operate in a designated area, it is the crew's task to restore switches to normal and to permit the passing of any through traffic, sometimes with certain restrictions. This system is generally effective, but it depends on human memory, training, and procedures.

The safety defences associated with the OCS method of train control were insufficient to provide the crew members on the Via train with adequate advance warning of the reversed main-track crossover switches to enable them to slow their train to a safe speed or stop. In response to past occurrences where trains encountered switches left in the reversed position, the industry and the regulator had taken some safety action. However, these actions focused primarily on increasing the conspicuity of the switch targets and improving compliance with procedural requirements to leave switches properly lined. These actions did not effectively address the absence of adequate advance warning to train crews in OCS dark territory.

Initial Follow-up Action

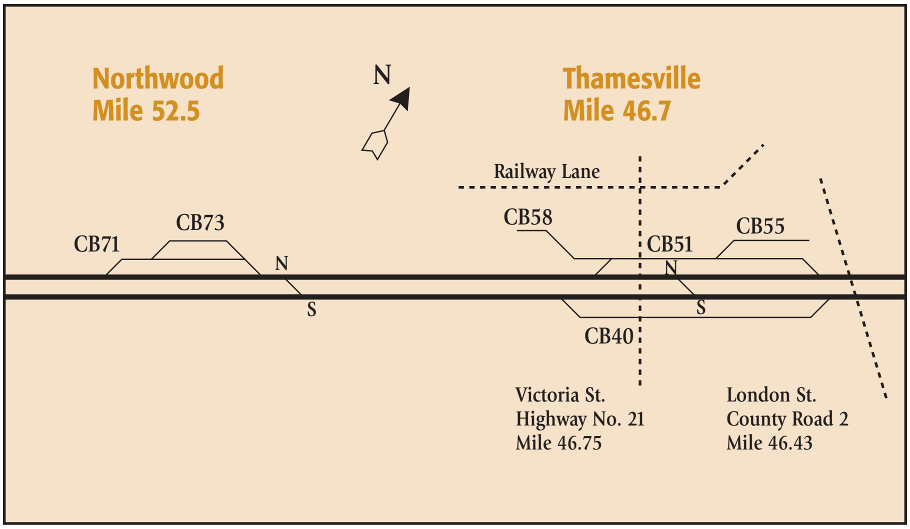
Canadian National

Following the accident, CN undertook several safety initiatives. An upgrade of all remaining OCS outside Automatic Block Signal System (ABS) (dark territory) to Centralized Traffic Control System (CTC), where passenger trains operate on CN trackage in the Québec-to-Windsor corridor, was completed by the end of 2000.

Main-track switch targets were upgraded to larger standard size and 3M "diamond"-grade retroreflective material was applied at 3700 locations across Canada. In addition, CN commissioned a switch target recognition study, the conclusions of which generally indicate improved performance characteristics of targets with retro-reflective material and of larger size.

In May 1999, CN implemented expanded requirements for railway employees regarding confirmation of the position of main-track switches. The information took the form of a Special Instruction to *Canadian Rail Operating Rules* (CROR) Rule 104 and is applicable to all rules-qualified employees on the CN Great Lakes District. Then, in November 2000, CN adopted a system-wide Special Instruction to CROR Rule 104. The Special Instruction formally established communication requirements for employees handling hand-operated switches in all OCS territory.

In October 2000, CN began field-testing a switch point indicator signal system. The purpose of the system is to indicate the status of switch point positions in dark territory. The system



Schematic of Northwood and Thamesville.

transmits switch position to a signal installed beyond the maximum braking distance of a train. It is expected that the test will provide information on crew acceptance and system reliability in various weather conditions. The test was completed and was successful; however, there are currently no plans to implement the system.

CN also indicated that it has been removing redundant or infrequently used switches. The crossover switches at Thamesville were removed when the track was reconstructed after the accident.

The Minister of Transport issued an Emergency Directive regarding the use of main-track switches in non-signalled territory.

Transport Canada

On 14 November 2000, the Minister of Transport issued an Emergency Directive regarding the use of main-track switches in non-signalled territory to Via, CN, Canadian Pacific Railway (CPR), and RailAmerica Inc. pursuant to section 33 of the *Railway Safety Act*. The more salient measures ordered by the Directive included speed limitations for passenger trains and other track movements when encountering a facing-point switch in non-signalled territory and a requirement for all employees using main-track switches in non-signalled or ABS territory to immediately confirm to another employee by personal contact, radio, or other communication that they have fulfilled the requirements of CROR Rule 104.

Via Rail Canada Inc.

The investigation found that the existence of some previously identified passenger safety hazards exposed passengers and crew to unnecessary risk. Consequently, following this occurrence, Via amended company radio procedures to ensure constant monitoring of the train standby channel from the locomotive of all passenger trains. Furthermore, to address the problem of unrestrained baggage in the end baggage compartments of its cars, Via has decided to install a net in front of every shelf. (As of April 2002, 80 per cent of the Light, Rapid, Comfortable (LRC) fleet was so equipped.) Since August 2000, Via has required that the tool boxes be attached to the back of the frame of the seat closest to the bulkhead, using elastic straps. The tool boxes have been permanently relocated to the locomotives, where they are installed securely.

Via has designed a prototype pull-handle for the manual operation of LRC side doors from the interior. The prototype handle, tested in the summer of 2000, demonstrated that the principle works. Implementation commenced in December 2000. Also, with regards to the Via-owned section of the Chatham Subdivision, Via has removed four main-track hand-operated switches.

More Action Taken

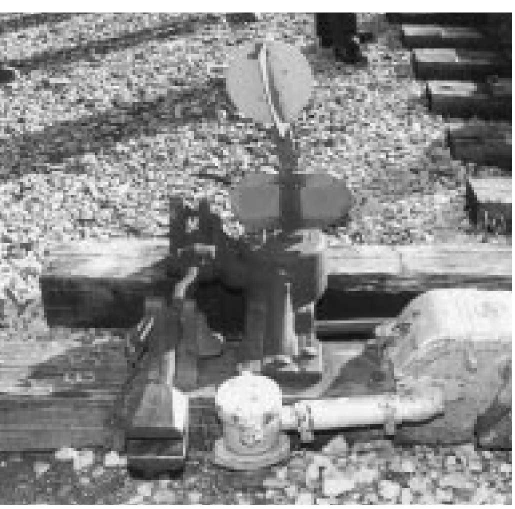
In the 20 months after the accident at Thamesville (to December 2000), 14 occurrences where trains unexpectedly encountered reversed main-track switches in OCS dark territory were reported to the TSB; 4 of those involved passenger trains. The overall occurrence data indicate that, despite the ongoing safety action by the regulator and the industry, in

Although significant safety action has been taken, additional improvements are not a certainty.

all types of territory, reportable occurrences of this nature have continued to average around 10 annually. Further, some of these occurrences continue to involve passenger trains, where the potential for loss of life is much greater.

Although significant safety action has been taken, additional improvements are not a certainty. The initiatives of Transport Canada (TC) and the railway industry should result in significant safety improvements, but the long-term continuation of some of these improvements is uncertain.

The Board noted that the conditions of TC's Emergency Directive, for operations in OCS



West crossover switch, Mile 46.72, lined and locked in 1`the reverse position.

territory, may not continue beyond the six-month period dictated in the directive. The Board believed that a serious situation still exists, with a continuing probability of passenger trains encountering unanticipated reversed main-track switches, albeit at lower speeds. The Board therefore recommended that:

The Department of Transport require the development of additional permanent system defences that permit a means to help ensure safety when trains approach main track switches in Occupancy Control System outside Automatic Block Signal System territory.
R01-01

On 14 May 2001, TC renewed the Emergency Directive for another six months, because TC was of the opinion that there were no long-term mitigation measures proposed by the railways. On the same day, all federally regulated railways were ordered to revise CROR Rule 104 and to file the revised rule submission with TC within 150 days. Rule 104 has been modified accordingly.

Further in reply to recommendation R01-01, TC stated that it was funding a research project consisting of a study of systems that will indicate the position of a hand-operated switch on non-signalled rail lines. The study will identify technology currently available across North America and abroad.

This investigation determined that, in OCS outside ABS, the existing safeguards were inadequate to prevent the unauthorized reversed main-track switches from leading to the occurrence. The Board believes that, when the effect of a single error on a safety-critical system can lead to the derailment of a passenger train at high speed, the error tolerance of that system is inadequate.

Past safety actions relating to unauthorized reversed main-track switches have focused primarily on eliminating errors through improved procedural compliance. The speed restrictions imposed through TC's Emergency Directive, although temporary, indicate an acknowledgement of the inevitability of some level of human error with respect to the handling of main-track switches. The Board believes that this is a necessary first step toward understanding the effects of errors on a safety-critical system and toward developing mitigating strategies and has recommended that:

The Department of Transport, the Railway Association of Canada and provincial authorities responsible for train operations review the system design specifications for computer-assisted and non-computer-assisted Occupancy Control System in Canada to ensure all components of these systems are designed with sufficient regard to human error.
R01-02

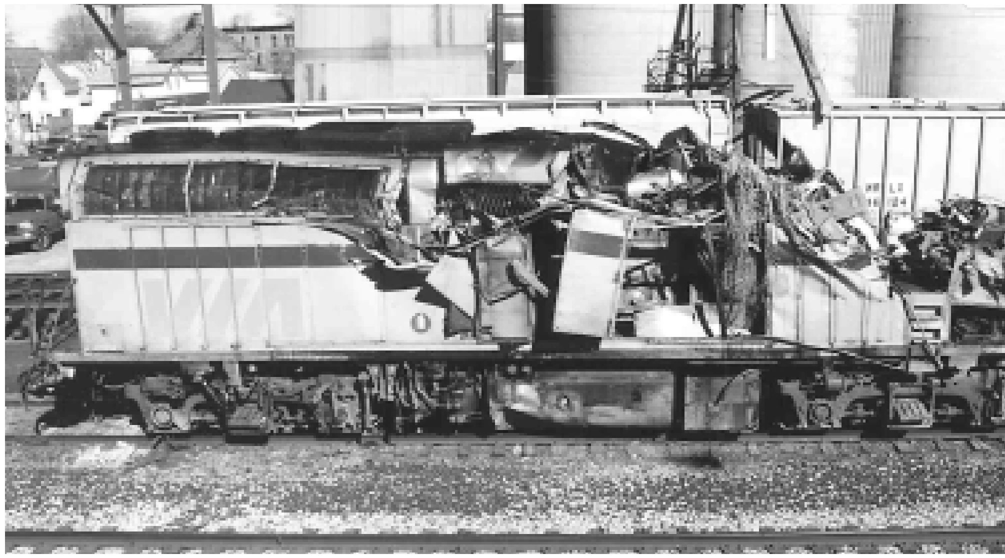
The storage of certain dangerous goods in rail cars created an unacceptable level of risk.

TC supported the intent of this recommendation. It proposes to develop, jointly with the Railway Association of Canada, an instrument such as a questionnaire for the railways to use that will allow them to analyze the system design specifications, including the consequence of human error on OCS operations. It is anticipated that, if any inadequacies in system defence are identified, corrective action will be initiated by the railways. TC is reviewing the railways' self-analysis and will initiate whatever action is deemed necessary.

At Thamesville, the storage of certain dangerous goods in rail cars created an unacceptable level of risk for persons, property and the environment. Although it is rare that a derailed train would come into contact with stored dangerous goods, the Board believes that the risks posed, particularly within municipal areas and when passenger trains are involved, are unacceptable.

The Board has recommended that:

The Department of Transport review the current regulatory framework and industry policy to help ensure that an adequate level of safety is maintained regarding the storage of dangerous goods within the rail transportation system and during the transition of shipments of dangerous goods to or from the rail transportation system.
R01-03



Right side shown after locomotive was righted. Damage is more extensive at the front right and along the right side of the locomotive.

As action to address this recommendation, TC was consulting with municipal, industry, and railway company representatives to review the full range of safety issues affecting storage of dangerous goods on railway property. The results of these consultations may lead to amendments to the *Transportation of Dangerous Goods Regulations*.

Furthermore, TC indicated that the upcoming clear language version of the *Transportation of Dangerous Goods Regulations* will address who has possession of the dangerous goods at destination. Amendments will reduce the likelihood that there could be any confusion as to when a dangerous good car is delivered and who has possession of it.

The TSB investigation found that recent improvements in passenger safety and emergency preparedness had reduced the risks to which passengers were exposed and contributed to a safe and efficient evacuation of the train. However, a number of passenger safety-related hazards, identified and reported on in previous investigations, were also found; that is, an unsecured metal tool box and unrestrained baggage in end baggage compartments. The Board recognizes that legitimate safety priorities of the railway industry and regulator may preclude the prompt mitigation of all known risks; however, the Board is concerned that, in some circumstances, industry and regulatory safety programs have not resulted in the elimination of some passenger safety hazards in a timely fashion.

Aerial photograph of accident site.

Mix-up with Warm Bearing

Canadian National (CN) freight train 304 was proceeding eastward from Hornepayne to Toronto, Ontario, on 06 February 1999, at approximately 1615 eastern standard time. As the train passed by the Wayside Inspection System (WIS) site at Mile 255.1 of the Ruel Subdivision near Oba, Ontario, the WIS detected several abnormal conditions around the 95th and 96th axles on the train, including hot bearings, hot wheels, and dragging equipment. The dragging equipment detector (DED) feature of the WIS had been declared out of service more than 12 hours before. (Three trains had been stopped for dragging equipment indications, and after being inspected by the crews, no dragging equipment was found. One of these trains was staffed by the same crew operating train 304.) — Report No. R99T0031

A radio message was transmitted directly to the train crew from the WIS site ("talker"), verbally advising the crew of "dragging equipment", followed by radio messages of "multiple alarms". The crew members radioed the rail traffic controller (RTC) in Toronto to advise of their situation and also to make the RTC aware that they had been stopped by an alarm at the same site during their previous trip. They requested direction from the RTC as to what they should do. The RTC stated that he would consult with the hot box operator (HBO) in Edmonton, Alberta.

Once contacted by the RTC, the HBO in Edmonton consulted with the rail traffic control mechanical service representative (RTC Mech), who worked in the same office, about the conditions on the tape at Oba. The RTC Mech concluded that

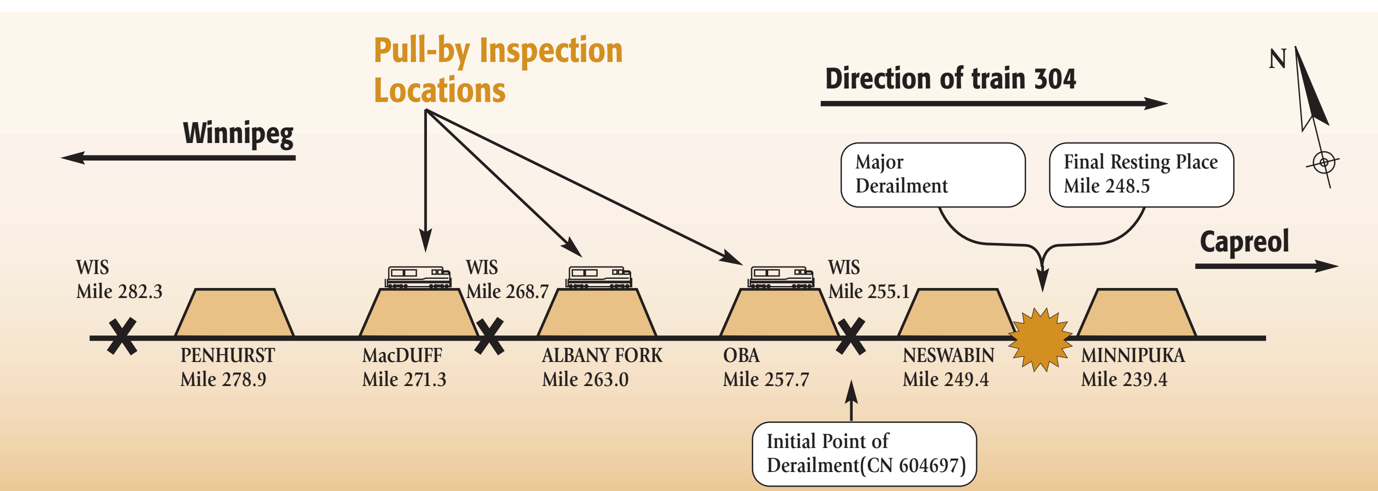
The inspection of the derailed rolling stock revealed a burnt-off journal.

the tape produced from the scan at Oba was "faulty". The RTC subsequently instructed the train to proceed. No restrictions were issued to the crew.

At approximately 1628, when the train was passing the east switch at Neswabin, at Mile 248.5, the crew experienced a train-initiated emergency brake application. After the train stopped, the crew heard a loud noise and saw, about 20 car-lengths away, a cloud of smoke. The train was carrying 20 tank cars of seven different dangerous goods intermixed through the consist. The crew immediately advised the RTC, disconnected the two locomotives from the rest of the train, and proceeded to a safe location. The emergency response, including police, fire, railway, shipper, and private contractor emergency response teams, as well as various provincial and federal regulatory agencies, was carried out in a timely and effective manner. There were no injuries as a result of this derailment. Sixteen of the twenty derailed cars from train 304 were destroyed, including three tank cars that were involved in the post-derailment fire. Four cars experienced minor damage and were repaired and returned to service.

The inspection of the derailed rolling stock revealed a burnt-off journal (BOJ) at the No. 3 wheel on the 21st car. The mode of failure of BOJs is well known throughout the railway industry. 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, and complete axle fracture ensued. The marks on the track indicate that the truck side of the car dropped to the track approximately 200 feet before the WIS at Mile 255.1 as a result of the axle fracture. The train continued in a derailed state until it reached the east switch at Neswabin, approximately seven miles later, where the main derailment occurred.

The nature of the failure that led to the overheating of the roller bearing could not be determined due to the amount of damage. The weight of the loaded car was within allowable limits, and the load was equally distributed over the length of the car body. Therefore, the axle load is not considered to have contributed to the overheat condition. Moreover, the wheel had travelled less than half the number of miles expected before requiring replacement.



Simplified sketch (not to scale) showing pull-by inspection and WIS locations relative to the accident location.

En Route Inspections

Between the initial terminal of Hornepayne and the point of derailment, a distance of approximately 41 miles, train 304 had been inspected by the crew members of three other trains. However, train 304 was inspected on the north side only. No defects were noted during these inspections.

Before the WIS at Oba, the train had passed over two other WIS sites (Shekak, Mile 282.3, and MacDuff, Mile 268.7). No alarms were communicated to the crew by the advance warning alarm (AWA) system (the talker). However, the HBO display screen at Edmonton was showing a warm bearing (yellow) indication at Mile 268.7.

CN had developed an operating manual titled *Hot Wheel, Hot Box & Dragging Equipment Systems, Operating Guidelines* commonly referred to as TP-105. CN's use of TP-105 criteria predates its use of AWAs using a talker system. TP-105 criteria incorporate a more restrictive threshold than that used by the AWA system. Operators use these more restrictive criteria to help them identify bearings as potentially being in the early signs of distress.

When a WIS-scanned bearing meets TP-105 criteria for a warm bearing, the HBO is presented with an electronic tape, and a yellow message is placed on a status window on a computer monitor at the HBO workstation. The HBO was required to compare this tape with the tape of the same train obtained at the previous detector site. The HBO was then required to pay close attention to the suspected car, as it moved over subsequent detectors, to determine if the bearing was overheating, maintaining its temperature, or cooling down.

Specifically relating to this occurrence, when the train went over the MacDuff WIS, a warm bearing differential alarm for the 95th axle was generated. The HBO did not examine the previous site the train had passed over, nor did he flag the next site (Oba) so that a comparison could be made between the two readings to determine if the bearing was becoming progressively warmer. When the train passed over the WIS at Oba, it generated an electronic tape that depicted a multiple alarm tape, including hot wheel, dragging equipment, and hot bearing at or near the 95th axle.

The HBO initially thought that this looked like a faulty tape.

According to the HBO, he initially thought that this looked like a faulty tape. Then, as a result of the hot wheel indication, he requested clarification from the RTC Mech regarding the hot wheel tape. The RTC Mech was aware that the DED at this site had previously been taken out of service and, based on his observation of the hot wheel and hot bearing tape, interpreted the results to be a "faulty tape". The RTC Mech's decision was accepted because of the perceived line of authority between the RTC Mech and the HBO.

WIS Improvements

Since the accident, CN has issued *Wayside Inspection Systems Chart Handling Procedures*, a supplement to TP-105, to provide definite processes for chart reading and understanding roles and responsibilities of the RTC Mech and HBO. The document contains descriptions of faulty tapes, including signs of possible derailment, and the actions that should be taken by specific parties. CN also indicates that, when a WIS issues an alarm directly to a train, this alarm takes precedence. No amount of experience, judgment, or feeling on the part of the HBO or the RTC Mech can override such an alarm.

In addition, CN took the following action:

- The RTC Mech is no longer allowed to override the HBO's decision regarding TP-105 decisions.

- The faulty tape criterion has been tightened up.

- System maps have been put on the HBOs' desks to help them conceptualize the various subdivisions.

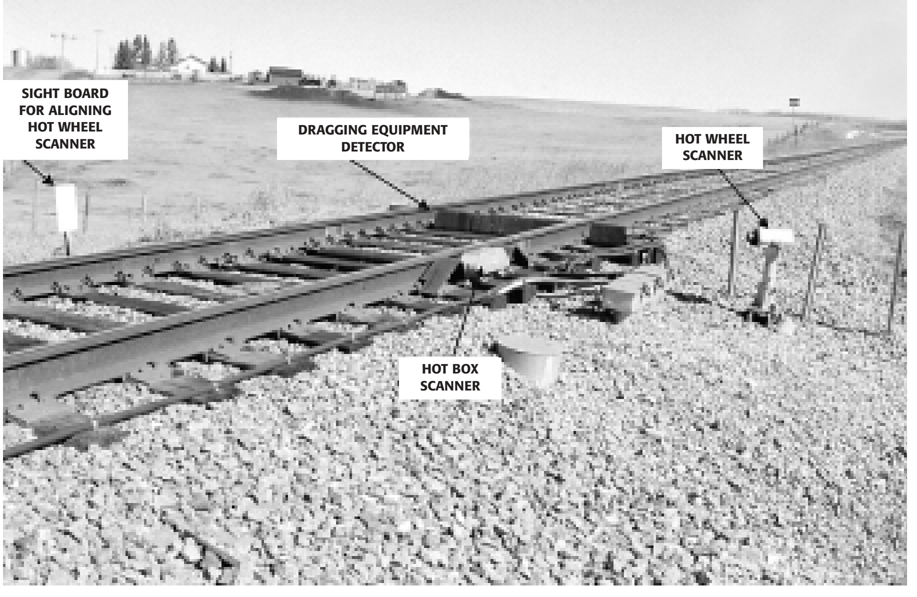
- Team-building sessions were provided to all RTC Mechs and HBOs, including the spares who normally work the HBO job, and CN's supervisory program will include the HBOs.

- Main-route hot box detector (HBD) spacings continue to be reduced. In April 2000, CN lowered the "alarm" threshold for TP-105 hot alarms on 20 branchline subdivisions that have HBDs spaced 40 miles apart or more.

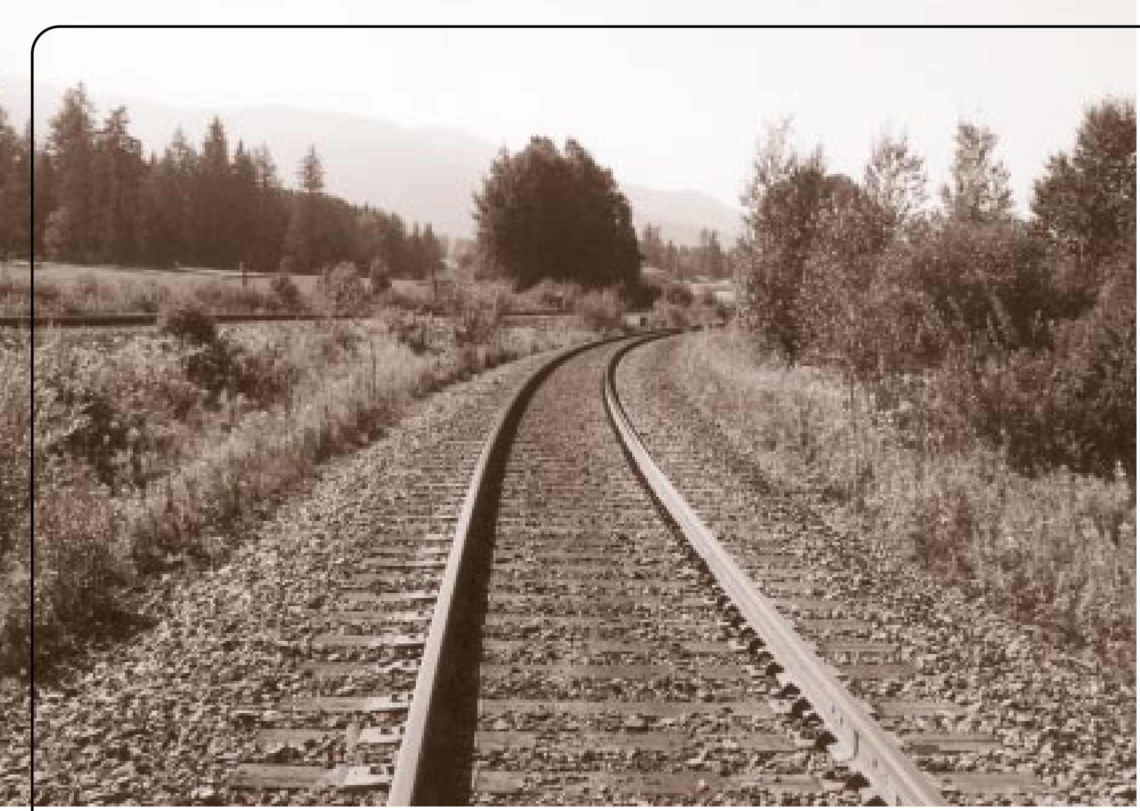
Additional Safety Issues

During this investigation, a number of issues emerged that, if addressed, may enhance both the efficiency and the safety afforded by the existing system. In its final report, the Board indicated that CN may wish to consider employee understanding of the complete system and employee workload, dynamic testing of WIS systems, and field detection of emerging bearing failures.

The Board also expressed concern that, without an industry standard that will detail the frequency and adequacy of roller bearing inspections, there may be less-than-adequate protection against the catastrophic failure of railway axles in some operational settings.



WIS site equipped with dragging equipment detector and hot wheel detector.



Reduced sight distance approaching accident site.

Did You Say Something?

The Board has identified two safety deficiencies related to the backup safety defences for signal communication and the impact of noise on the communication of safety-critical information between crew members on locomotive cabs. These deficiencies were highlighted in the Board's final report on its investigation into an accident where Canadian Pacific Railway (CPR) train 463 collided with the rear-end of CPR train 839 at Mile 78.0 of the CPR Shuswap Subdivision, near Notch Hill, British Columbia, on 11 August 1998. Due to the track layout and the reduced sight distance, this location is particularly vulnerable to collisions because it is a regular meet location where trains are often stationary and are difficult to see. — Report No. R98V0148

Calling of Signals

The Board found that a signal had been misinterpreted as a "Clear to Stop" signal indication; consequently, the train crew did not reduce the train's speed and was unable to avert the collision. The crew members on train 463 stated that they communicated the indication of the signal with each other. The conductor observed and called a "Restricting Signal" indication and noticed that the locomotive engineer was looking in the direction of the signal. The conductor did not hear the locomotive engineer call the signal indication he observed. The locomotive engineer observed and called a "Clear to Stop" indication but did not hear the conductor acknowledge this indication. Neither the conductor nor the locomotive engineer requested clarification of the signal indication observed nor did they challenge each other's identification of the signal. An authority gradient between the two crew members probably prevented the conductor from challenging the locomotive engineer and

The widespread practice of not calling signals effectively removes the backup safety defence.

expressing his concerns. (The conductor was relatively inexperienced, with only seven trips on this subdivision compared to the locomotive engineer who had 25 years' service, the last 10 years of which had been on this subdivision.)

The Shuswap Subdivision is controlled by the Centralized Traffic Control System (CTC), a system of block signals where train movements are supervised from a central office by a rail traffic controller (RTC). Train movements are governed by the signal indications. Under normal operating conditions, there is no requirement for the RTC or for the train crews to communicate a train's location to other trains. The system relies on the identification and calling of the signals by the crew per *Canadian Rail Operating Rules* (CROR) Rule 34, which states:

> Crew members within physical hearing range must communicate to each other, in a clear and audible manner, the indication by name, of each fixed signal they are required to identify. Each signal affecting their train or engine must be called out as soon as it is positively identified, but crew members must watch for and promptly communicate and act on any change of indication which may occur.

In the calling of signals, the conductor acts as a second line of defence by independently identifying and interpreting the signals and communicating this to the locomotive engineer. By communicating the signal to each other, the crew members have an opportunity to reassess a potentially misidentified signal.

A TSB survey conducted as part of the investigation identified that many crews do not call "Clear Signal" indications, presumably because of the redundant nature of clear signals (most signals are clear) and the fact that a clear signal identifies a situation not requiring any immediate action. This inconsistency in calling signals defeats the basic premise of redundancy, the double check by the second crew member, built into the protection of train movements. The widespread practice of not calling signals effectively removes the backup safety defence available from the second crew member in ensuring accurate signal interpretation, thus increasing the risk of accidents.

Transport Canada (TC) is aware of possible non-compliance to Rule 34(b) by railway employees and has initiated a concentrated effort across Canada to assess compliance with the rule. Depending on the results of this assessment, TC will take remedial action as necessary.

The Board recognizes this concerted effort by the railway company and the regulatory body to address the communication of signals between crew members.

However, the Board is concerned that the effectiveness of the program will likely be both temporary and incomplete.

The Board believes that, for the long term, various measures could be considered to address this safety deficiency. One option would involve a shift to a non-verbal recordable electronic means of communicating signals. This means would also provide a record of crew actions, thereby facilitating company or regulatory monitoring. An additional option would involve replacement of the current rule with another more suitable backup defence that could alert crew members if their actions are not consistent with the signal indication. A wide-ranging review of both the extent of the problem and various potential solutions could achieve a significant improvement in rail transportation safety. Therefore, the Board recommended that:

The Department of Transport and the railway industry implement additional backup safety defences to help ensure that signal indications are consistently recognized and followed.
R00-04

In reply, TC indicated support for the intent of this recommendation. TC is monitoring studies being undertaken by CPR on improved radio and cab communications using headsets. In addition, TC is monitoring technologies such as the Communications-Based Train Control, also referred to as Positive Train Control System, which enables communications between trains.

The resulting noise made it impractical to verbally communicate effectively.

Locomotive Cab Noise

The locomotive engineer and the conductor on train 463 were qualified for their respective positions and met fitness and rest standards. This was the locomotive engineer's fourth trip since returning from vacation. He obtained, on average, seven hours of sleep on each of the three nights preceding the occurrence. The conductor had been on leave for four days before the occurrence and obtained approximately eight hours of sleep each of those nights. The crew was exposed to a high noise environment as the train was proceeding up Notch Hill at throttle eight, the maximum throttle position; both the conductor and the locomotive engineer were wearing ear plugs. Because it was an exceptionally hot day, and the locomotive was not equipped with air conditioning, the crew had opened the windows. The resulting noise made it impractical for the locomotive engineer and conductor to verbally communicate effectively from their respective seating positions.

The effective and safe operation of a railway is largely dependent upon accurate and timely communications. Noise in the locomotive cab, particularly in older locomotives, impedes the exchange of safety-critical information through voice communication between the crew members. Therefore, the Board recommended that:

The Department of Transport assess the impact of noise on voice communication in locomotive cabs and ensure that crew members can effectively communicate safety-critical information.
R00-05

TC accepted this recommendation and, in its reply, indicated that it had participated in an assessment of noise levels in locomotive cabs in conjunction with Human Resources Development Canada in November 1999. The results, presented in January 2001, indicate that noise levels meet the *Canada Labour Code* requirements with respect to hearing loss.

Rear-end car of train 839 at accident site.

Other Findings

In its final report on this occurrence, the Board noted that the informal nature of train line-ups may lead train crews to develop incorrect mental models of their position relative to other trains and that the monitoring method used presently by TC and by the railway for assessing the level of compliance to Rule 34 is ineffective. The Board also noted that the current railway practice of crew pairing from the spare board will pair senior and junior crew members at random, and therefore, the importance of crew resource management (CRM) training within the railway industry should be developed as a safety initiative to eliminate the "authority gradient" factor.

CPR has now developed a CRM training program that is being delivered to new-hire running trade employees. Work is ongoing to deliver this program to existing employees.

REFLEXION

Achieving safety results from CRM requires a total team effort. Management provides the needed training and a conducive work environment; employees put the training into practice and base their day-to-day routines on CRM principles. As part of the team, how are you doing?

View of the missing section of the running surface of the switch point. The arrow points to a crack in the rail adjacent to missing head fragments.

The Good, the Fair, and the Poor

On 02 May 2000, the TSB recommended that:

A system-wide assessment of Canadian National's track and turnout inspection reporting and supervisory review procedures be conducted by either Transport Canada or the railway.
R00-01

The recommendation resulted from the TSB's investigation into a derailment that happened on 01 March 1998 just before midnight eastern standard time when a Canadian National (CN) freight train, travelling from Montréal to Toronto, derailed eight cars in the CN Kingston Subdivision near Lyn, Ontario. The derailment occurred while the train was passing through a crossover. Two of the derailed cars contained dangerous goods; however, no product was lost.
— Report No. R98T0042

The derailment occurred when a car wheel climbed over a defective switch point at the crossover. This switch point became defective due to the separation or chipping of large sections of the running surface along the point of the switch. The switch point was noted as being in poor condition 11 months before the derailment and, although subsequently inspected numerous times, no remedial action had been taken.

The ratings were not defined with a clear set of standards.

The switch point became defective when progressive chipping resulted in the separation of large sections of the running surface. This process eliminated the sharp taper of the upper portion of the point and resulted in a point thickness three times wider than the specified limit. At the time of the occurrence, the Standard Practice Circulars provided a 3/16-inch condemnable limit on the switch point end thickness; however, ratings such as "good", "fair", and "poor" were being used in the Detailed Monthly Turnout Inspection Report in this territory of the Kingston Subdivision.

These ratings were not defined with a clear set of standards. Therefore, consistency between different inspector ratings could not be ensured nor could comparisons across territories be meaningful. The track condition conveyed through the supervisory system might not have reflected the actual condition. As a result, the control mechanisms in place (review of logbook and on-site track inspection by supervisors) were rendered ineffective, and the system did not identify a relatively lower level of maintenance for switch points in this territory, including the defective turnout.

Moreover, the Board found that the lack of quantifiable pass or fail standards in Transport Canada's (TC) *Railway Track Safety Rules* does not permit TC track inspectors to assess with consistency and accuracy the condition of the switch point and take the appropriate safety action. Even though the TC program puts more emphasis on high-traffic corridors, the random nature of auditing by sample means that some sections of this trackage may not be sampled for several years, leading to situations where unsafe practices remain undetected.

Subsequent to the derailment, TC railway safety officers inspected the turnouts between Mile 118.3 and Mile 162.1 of the Kingston Subdivision. This inspection identified four defective switch points. In March 1998, a Track Inspection Defect Report was issued to the CN track supervisor, followed by a Notice and Order a few days later. CN repaired these switch points, and the Notice and Order was removed on 27 April 1998.

CN's senior engineering officers performed a detailed inspection of the entire Kingston Subdivision between 04 March 1998 and 06 March 1998. CN also carried out a follow-up review of inspection practices with all inspection personnel on the area of southern Ontario previously known as the Great Lakes District South. The related forms and logs for the inspections were standardized in the District. Furthermore, CN indicated that it will add quantitative measurements for the assessment of switch points.

To enhance its inspection and auditing program, TC decided to hire an additional rail safety officer in the Ontario Region.

The Board recognized these efforts by CN and TC to mitigate the risks associated with inadequacies in inspections for turnouts. However, the Board noted that the actions, such as the standardization of inspection forms and logs, are limited to an area of southern Ontario. Apparently, neither CN nor TC had assessed whether the weaknesses in safety defences that contributed to this accident exist elsewhere in the national system. Therefore, in its final report on the investigation into this accident, the Board made recommendation R00-01.

In its July 2000 reply to this recommendation, TC stated that, following the accident, all its regional infrastructure inspectors had been requested to pay particular attention to switches. The regional offices reported that no similar situations were observed where railway supervisors had not taken appropriate action to ensure safe switch conditions.

TC officials discussed the inspection of turnouts with CN to ensure that the railway's inspection staff across the CN system understand and take action to guarantee safe turnout conditions.

Furthermore, TC advised that CN had issued instructions in May 2000 to its track inspectors to avoid using subjective terms like poor, fair, good. When possible, quantitative terms should be used and correct inspection processes are to be constantly monitored.

REFLEXION

Are terms like good, fair, poor or phrases such as "Looks good" and "Checked OK" creeping into your work instead of exact measurements/readings? If so, are they hiding indications of existing or potentially unsafe conditions?

Risks on "Other than Main Tracks"

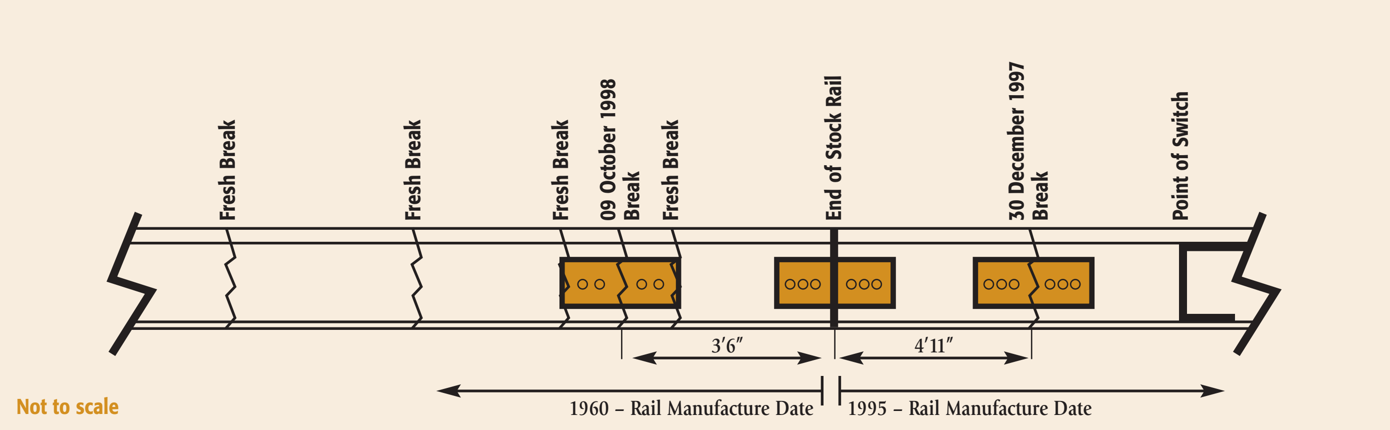
A Canadian National (CN) train, departing MacMillan Yard in Concord, Ontario, experienced a train-initiated emergency brake application on 26 November 1998, at approximately 0645 eastern standard time. Once the train came to a stop, the conductor detrained and observed that three tank cars had derailed: one tank car had rolled down a 20-foot embankment to the west of the tracks, another was lying on its side, and the third had remained upright. The derailed tank cars were loaded with anhydrous ammonia; the protective housing and valving on one of the cars were damaged, resulting in a minor leak. The yard was evacuated, and the public roadways in the area were closed for approximately five hours. There were no injuries. — Report No. R98T0292

The train consisted of 4 locomotives, 81 loaded cars, 13 residue cars, and 35 empty cars. It was approximately 8400 feet long and weighed about 12 000 tons. The temperature at the time of the derailment was approximately -10°. The skies were cloudy and the winds light.

Track Particulars

Through the derailment area, on track designated as "other than main track", the track structure consisted of 115-pound rail, laid on double-shouldered tie plates on softwood ties and fastened with four spikes per tie. Ties were 15 per cent defective. The ballast was crushed rock. It was contaminated with dirt and mud, and a soft spot was noted. The minimum annual tonnage over this track is around 17 million gross tons.

The rail had broken at four locations. The fractures were on two adjacent rails, joined together with a four-bolt joint bar. One rail length was manufactured in 1960 and was relaid in 1989, having been moved from another location. The second one was manufactured and laid in 1995.



Layout of rail fractures.

An analysis of the rail concluded that

- The four recent rail fractures were mostly overstress in nature. A subsurface fatigue crack extending across approximately five per cent of the cross-section was observed on two fractures.

- Subsurface fatigue cracks were associated with shelling damage. Subsurface cracking of this type tends to progress internally in directions transverse and longitudinal to the rail axis, making it undetectable by external visual inspection.

- Shelling damage was due to excessive wear.

Track Inspection and Maintenance

The railway's track inspection and maintenance program segregates "main track" and "other than main track". The existing division between the two categories evolved from train operation requirements. Factors such as tonnage and speed were not taken into consideration even though they are the main factors affecting the rate of track infrastructure deterioration.

The broken rail had experienced a subsurface fatigue crack.

The fact that heavy tonnage tracks deteriorate faster and require more frequent inspections and remedial action is well recognized within the industry. Both Transport Canada's (TC) *Railway Track Safety Rules* and CN's Standard Practice Circulars require additional inspections for tracks carrying heavier tonnage. However, this requirement applies only to main tracks.

The rail was tested by a rail flaw detection car on 05 June 1998 and no defects were noted in the derailment area. A walking inspection was performed by the assistant track supervisor 17 days before the derailment, noting "replace rail south/west leg". Although no timeframe was specified for the work, it was scheduled to be carried out sometime in December, after the next rail flaw detection car inspection.

The investigation determined that the broken rail had experienced a subsurface fatigue crack. It is not known whether the subsurface fatigue crack existed when the rail flaw detection car passed over the rail approximately six months before the derailment. A walking inspection of the track had identified that the rail should be replaced. Due to the lack of clear maintenance criteria for "other than main tracks", the priority of the corrective action was not assessed adequately and no action was taken immediately. Had this section of track been classified as a main track or given a special status different from that of other lightly used yard tracks, the worn section of rail would have been removed immediately because the rail wear exceeded CN's allowable limits. Moreover, although CN prohibits closure rails shorter than 3.66 m (12 feet), previous rail breaks were repaired using joint bars installed within that distance. Since the installation was on a yard track, the risk was perceived as being low.

Accident Follow-up

TC and CN had several meetings concerning the application of rules governing the inspection of "other than main tracks and sidings". Both organizations agreed that trackage in yards may have different usage and that the current rules concerning inspection frequency requirements need to be amended to better reflect this situation. In May 2000, TC granted to CN, on a one-year basis, an exemption to the *Railway Track Safety Rules* to permit CN to evaluate a new inspection regime in MacMillan Yard based on track usage.

The Board recognizes that the initiatives taken by TC and CN are a positive step to correct discrepancies in inspection frequencies between different trackage located in same yards and will ensure that heavy tonnage tracks are inspected more frequently. However, shortcomings in track maintenance practices become evident when heavy tonnage yard tracks, such as inbound or outbound tracks, are considered. The existing discrepancies between "main tracks" and "other than main tracks" jeopardize safety: the discrepancies do not permit railway personnel to assess with consistency and accuracy the track condition and determine the appropriate safety action. Therefore, the Board recommended that:

The Department of Transport and the Railway Association of Canada ensure that maintenance standards and practices address the level of risks in heavy tonnage "other than main tracks."
R01-04

In supporting the intent of the recommendation, TC replied that, following the accident, CN had been exempted for one year from the *Railway Track Safety Rules* at MacMillan Yard to implement and evaluate an inspection regime specifically tailored for that yard. In May 2001, TC granted CN a three-year extension to the exemption. The extension will allow sufficient time for TC and the railway industry to work towards developing a uniform set of rules that could apply to all railway yards.

TC and the railway industry have agreed to form a working group to recommend amendments to the *Railway Track Safety Rules* and railway industry practices, taking into consideration the TSB recommendation and CN's revised inspection and maintenance practices at MacMillan Yard.

Faulty Mental Picture

The frequency of rear-end collisions and the circumstances surrounding them continue to be problematic, as are the decisions made by crew members regarding the application of a restricted speed rule. — Report No. R98C0022

Canadian National (CN) train 447 collided, at about 8 mph, with the rear end of stationary CN train 771 near Obed, Alberta, on 01 March 1998. The two crew members in the lead locomotive on train 447 were seriously injured. The last car from train 771 and the lead locomotive from train 447 derailed; both sustained extensive damage. Injuries sustained by the two crew members from secondary impact in the lead locomotive were consistent with unrestrained occupants striking objects in the cab after an initial low-speed impact.

The Board determined that the rear-end collision occurred when the crew of train 447, which was being operated under the assumption that train 771 was at least 1.5 miles farther ahead, did not maintain adequate vigilance. The assumption was based on the interpretation of an automated voice transmission provided by a Wayside Inspection System (WIS). Contributing to this accident were a lack of accurate information regarding the location of train 771, an inadequate dissemination of information regarding the nature of WIS broadcasts to operating crews, and poor visual conspicuity of the rear of train 771.

Before the collision, the crew of train 447 had reduced speed to 15 mph upon reaching a restricting signal but did not maintain vigilance. Because of an inaccurate mental model of

The effective and safe operation of a railway is largely dependent upon accurate and timely communications.

the location of train 771, they were not prepared to stop within one-half the range of vision of the preceding train. A "no alarm" broadcast from a WIS prompted the crew to believe that train 771 had completely passed the WIS, which was 1.5 miles ahead. The "no alarm" message is ambiguous because it does not distinguish whether an entire train or a portion of a train has passed over the WIS.

Although the railways must be responsible for ensuring the safe operation of trains, it is the Board's view that Transport Canada's (TC) regulatory responsibilities include ensuring that the railways have effective systems in place to prevent train collisions. The Board has observed the growth of rail industry technology and is aware that there are numerous new technologies that are intended to ensure the safe separation of trains. The Board is concerned that the risk of train collisions due to inadequate safe distances between railway rolling stock remains and therefore recommended that:

The Department of Transport ensure that an assessment is made of the technologies designed for the safe separation of railway rolling stock movements, with the intent of establishing a minimum safety standard.
R00-02

In reply, TC indicated that it is conducting a research project/program on new train technologies in three phases. The first phase, completed in March 1998, provided a comprehensive review and analysis of current technology and implementation. The second phase focuses on assessing the effect of the identified technologies on safety in railway operations. The third phase will establish a minimum safety standard for the new technology.

In its final report on the investigation into this accident, the Board noted that the effective and safe operation of a railway is largely dependent upon accurate and timely communications between the rail traffic controller (RTC) and others whose work may affect or be affected by train operation. The interpretation of "prompt advising", per existing rules, does not always promote timely notification to the RTC, trains, and others in the vicinity when a train is being delayed and poses a safety risk. Immediate communication of the potential for train delays promotes timely adjustment by others affected. Therefore, the Board recommended that:

The Department of Transport ensure that an assessment is made of the suitability of current Canadian Rail Operating Rules and railway instructions concerning the immediate reporting of operating delays to all concerned when there is a safety risk.
R00-03

TC will ensure that the Railway Association of Canada (RAC) is aware of the Board's recommendation and will correspond with the RAC requesting a review of Rule 85 (on reporting delays).

The primary concerns in the design of current locomotive cabs are cab crashworthiness and crew injury prevention in collisions and derailments. However, train action, such as slack in the train running in or out, unexpected emergency stopping, or sudden lurching of the train, often results in a person in a locomotive cab losing his or her balance, falling, and, in the process, striking any of the sharp metal objects permanently fixed in the cab.

The Board is concerned that, without ergonomically modifying the interior of the locomotive cab to provide protection against secondary impact, the risk of the inherent hazards within the locomotive cab will continue to contribute to severe injuries.

In replying to the Board's concern, TC stated that it had little evidence from accident statistics that the lack of devices, such as personal restraints, in locomotive cabs has increased the severity of employee injuries during accidents. However, the Railroad Safety Advisory Committee Working Group has been working on revising standards and practices to enhance the level of crashworthiness protection, including the interior configuration of locomotives.

Railway Occurrence Statistics

	2002 (Jan.–July)	2001	2000	1996–2000 Average
Accidents	**593**	**1063**	**1065**	**1137**
Main-track train collisions	5	7	9	12
Main-track train derailments	72	128	120	141
Crossings	149	279	264	298
Non-main-track train collisions	70	89	113	112
Non-main-track train derailments	217	385	388	373
Collisions/Derailments involving track units	3	16	16	19
Employee/Passenger	6	8	13	10
Trespassers	43	79	79	95
Fires/Explosions	13	37	32	48
Other	15	35	31	29
Incidents	**171**	**322**	**330**	**401**
Dangerous goods leaker	100	194	188	248
Main-track switch in abnormal position	6	9	17	13
Movement exceeds limits of authority	51	95	102	100
Runaway rolling stock	8	9	9	16
Other	6	15	14	24
Million train-miles*	**55**	**83**	**80**	**79**
Accidents/million train-miles	**11**	**13**	**13**	**14**
Accidents Involving Dangerous Goods	**142**	**207**	**249**	**273**
Main-track train derailments	13	18	30	31
Crossings	3	8	12	8
Non-main-track train collisions	32	39	50	60
Non-main-track train derailments	85	129	149	156
Other	9	13	8	18

	2002 (Jan.–July)	2001	2000	1996–2000 Average
Accidents with a Dangerous Goods Release	**1**	**6**	**6**	**9**
Accidents Involving Passenger Trains	**41**	**76**	**61**	**71**
Fatalities	**50**	**98**	**87**	**103**
Crossings	22	41	33	37
Trespassers	28	55	53	62
Other	0	2	1	4
Serious Injuries	**45**	**91**	**67**	**95**
Crossings	25	47	33	50
Trespassers	12	22	23	30
Other	8	22	11	15

* Source: Transport Canada. Train-miles estimated.

Figures are preliminary as of 05 August 2002.

RAILWAY Occurrence *Summaries*

The following summaries highlight pertinent safety information from TSB reports on these investigations.

DETERIORATED PEDESTRIAN CROSSING

A Via Rail Canada Inc. train, travelling westward at approximately 50 mph on the Canadian National Chatham Subdivision, struck two wheelchairs and their occupants at a pedestrian level crossing on 06 August 1999, at approximately 1315 eastern daylight time. Both persons received only minor injuries and were taken to the local hospital. — Report No. R99S0071

The two locomotive engineers in the locomotive cab initially observed what they thought was someone "playing chicken" with the train. About one-half mile west of the Penang Lane crossing, they realized that there were persons in wheelchairs in difficulty on the crossing. They immediately made an emergency application of the train brakes. The train entered the crossing at a recorded speed of 3 mph and the locomotive stopped approximately 30 feet west of the crossing.

Wheelchair of the same type as one of those involved in the accident, but not with identical specifications, with a castor wheel in the field side of the rail.

Penang Lane is a 3.8-m–wide paved laneway south of the railway tracks and provides access to private residences. It ends at the tracks at a locked single-arm swing gate that prevents motorized vehicle traffic access over the tracks. A 2.4-m–wide paved nature trail, the Ganatchio Trail, in the park immediately to the north of the tracks is used by the public for recreational purposes. The trail and the public park lands are accessible 24 hours a day.

While crossing over the single-track level crossing, the person in the leading wheelchair became immobilized just beside the south rail, when one of the front wheels fell into the field side of the flangeway.

The person in the second wheelchair became immobilized in a similar fashion in the field side of the flangeway of the north rail. It is probable that the roughness of the poorly maintained approaches and planking affected the control of the wheelchairs to the extent that the front castors were oscillating, or bouncing, and they easily fell into the flangeways. Because of their disabilities, the persons were unable to extricate themselves from their wheelchairs. Both wheelchairs were then struck by the train: one person was dragged under the locomotive and the other was thrown to the south, clear of the track. The wheelchair of the person who was dragged under the locomotive was destroyed.

The pedestrian crossing intersected the single main track at 71° and was protected on both sides with standard reflectorized crossing signboards (crossbucks) and a stop sign. The asphalt approach, north of Penang Lane, was uneven next to the planking. The crossing planking was in very poor condition; missing pieces of splintered wood having created an uneven surface. This accident was the first recorded at this crossing.

The crossing planking was in a very poor condition.

In its investigation into this occurrence, the Board found that there was no regulatory or industry mechanism in place for quantitatively defining or identifying hazardous or deteriorated surfaces of pedestrian level crossings, that the existing regulations pertaining to railway-highway crossings do not include any design or construction standards for the safe movement of wheelchair traffic over level crossings, and that there are no design standards for wheelchairs to address outside transportation environments, such as railway crossings.

Action Taken

Subsequent to the accident, railway officers from Transport Canada (TC), along with supervisors from Canadian National (CN) and the city of Windsor, inspected the crossing. As a result, the crossing planks were immediately replaced.

Another CN inspection determined that safety could be further enhanced by paving the crossing surface. The planking was removed and replaced by an asphalt surface, with flange and mud rails on either side of the rails. Underbrush and vegetation growth along the right-of-way were also cleared within two weeks of the accident.

The city of Windsor arranged for the repair of the deteriorated asphalt surface near the crossing and enhanced the sightlines on the north side of the crossing by removing trees and underbrush on city-controlled property.

Within four weeks of the accident, an automated warning system (flashing light signals and a bell) was installed at the crossing.

Further, the city of Windsor, in collaboration with the railway companies operating within the city boundaries, with input from the local association for persons with disabilities and from TC, carried out a study to identify the crossings used by wheelchair occupants. Preferred wheelchair routes were identified, and the crossing surfaces of these preferred crossings were improved to facilitate safe passage of persons in wheelchairs.

TC has drafted grade crossing regulations and accompanying standards. These are intended to be published in the *Canada Gazette* in the near future and include requirements to facilitate passage of assistive devices across grade crossings.

REFLEXION

Are the safety surveys at your workplace looking for the potentially unsafe conditions from everyone's perspective?

COMBINATION OF FACTORS LEADS TO SPILL

> *While a Canadian National (CN) crew was performing switching operations on the Wesco spur in Cornwall, Ontario, in daylight on 27 August 1999, six tank cars ran away and struck the stop block at the end of the track. One car, a Class 111A tank car, derailed and was punctured. Approximately 5000 gallons of product, a Class 3 combustible liquid, was released but was almost all recovered. There were no injuries. — Report No. R99D0159*

The crew members were to push a draft of eight cars onto the switching lead, place the two leading cars in the draft just ahead of the locomotive, then couple to a second draft of six tank cars that had been parked in two separate cuts. However, the handbrake had been applied on only one car despite CN instructions that two handbrakes must be applied on each cut of cars. During the switching, the crew members were in positions from which they could see neither the end of the draft they were pushing nor the cars that were already standing. As such, it was very difficult to avoid contact between the drafts. Under normal conditions, contact between the drafts would have triggered the coupling mechanism and coupled the two drafts together. However, since wrong coupling equipment had been installed on the end car, coupling did not occur. The first three cars, which were not secured by handbrakes, started to roll and struck the rest of the draft. On impact, the other three cars started to run away because the one handbrake that was applied was insufficient to hold them.

In addition to car securement and coupling guidelines not being followed, and the coupling equipment not meeting specifications, the Board found that there was no monitoring and control program to prevent employees from using procedures that were inconsistent with company instructions, that the end stop blocks were deteriorated to the point where they could not perform their designed function, and that Class 111A tank cars do not have sufficient protection against punctures, even in a low-speed impact.

Trailing truck of the leading car at the damaged stop block.

CN subsequently issued new instructions for the Wesco spur requiring that rolling stock be grouped and secured with the appropriate number of handbrakes and that cars must rest against the stop blocks on tracks so equipped. CN also retrofitted the stop blocks and modified the track layout at Cornwall.

However, in its final report on the investigation into this occurrence, the Board noted that neither CN nor Transport Canada has assessed whether the weaknesses in safety defences that contributed to this accident exist elsewhere. The Board is concerned that the risks associated with rolling stock securement and switching practices have not been fully assessed. Likewise, the Board is concerned that the absence of railway or regulatory standards governing the inspection and maintenance of stop blocks can lead to inadequate inspection and maintenance programs. Without maintenance, the equipment that plays a key role in the safety of operations cannot perform the function properly, thereby increasing the risk to the public.

MISSED STOP SIGNAL

A main-track collision occurred when crew members operated their train past a stop signal indication. The crew members had become impaired by fatigue—due to excessive waking hours without a restorative rest period—and succumbed to fatigue. A microsleep might have caused them to miss the stop signal indication. Contributing to this occurrence was the railway industry's difficulty scheduling work in consideration of sleep/wake cycles to facilitate rest needs for employees in train service.— Report No. R98V0183

The left front of train 792 (lead locomotive CN 2548).

Two Canadian National (CN) freight trains collided on the Ashcroft Subdivision at Basque, British Columbia, on 01 October 1998. The eastward freight train (train 792) proceeded on the main track past a stop signal and collided with the side of the westward freight train (train 415). Three cars on the westward train and the lead locomotive of the eastward train were damaged and derailed. There were no injuries and no release of dangerous goods.

The crews of both trains were qualified for their respective positions and were in compliance with regulatory requirements for mandatory time off-duty and maximum hours of service. The crew members of train 792 reported that, in an effort to remain alert, they had opened windows, stood up, and drunk tea. Both crew members recall seeing an "advance clear to stop" signal at the advance signal to the west end of the Basque Siding. They stated that they communicated the signal name and indication between themselves and that the conductor broadcast the name of the signal, as well as their location, over the standby radio channel. They recognized that they might be meeting another train at Basque but did not recollect hearing any radio communications from the crew of the opposing train.

The sleep/wake pattern that both crew members experienced on the day they reported for work resulted in fatigue. The conductor had been awake for almost 21 continuous hours before the occurrence, and the locomotive engineer had been awake for more than 21 hours with only one hour of sleep. The locomotive engineer and the conductor had a sleep/wake pattern established in their biological clocks for sleep during this working shift. The unexpected change of duty for the locomotive engineer did not allow him to obtain restorative rest, compromised his ability to be rested, and resulted in his fatigued condition. The conductor's biological clock had not adjusted to night working hours. The current regulatory requirements for mandatory time off-duty and maximum hours of service can result in train crews complying with regulatory requirements but not being sufficiently rested. Loss of income from missing a trip will motivate an employee to report for duty with insufficient rest.

Loss of income from missing a trip will motivate an employee to report for duty with insufficient rest.

The investigation determined that, before the collision, there was periodic movement of the throttle control on train 792 approximately every 108 seconds, which corresponds closely with the reset time permitted by the reset safety control (RSC) vigilance feature. This timing suggests that the locomotive engineer was using the throttle control to reset the RSC. However, given the locomotive engineer's state of fatigue, this action was probably done unconsciously, thereby reducing the effectiveness of the RSC as a safety device. The Board found that the RSC device is not sufficiently demanding or aggressive to negate an automatic behaviour response and may not serve its intended purpose in all circumstances.

The Railway Association of Canada (RAC), working with its member railways, labour unions, and Transport Canada, is developing new work/rest rules for operating employees to replace the current *Maximum Hours of Work Order* and *Mandatory Off Duty Time Rules.* The RAC has expressed that "while good scheduling mechanisms and strategies can improve employee alertness, there is no scheduling system in the world that will guarantee that employees will always report to work fully alert for their entire tour of duty."

SHELLY DAMAGE

A Canadian National (CN) freight train, proceeding through Bedford, Nova Scotia, at about 30 mph, derailed the leading truck of the second locomotive and the first eight cars on 09 October 1999. There were no injuries and no dangerous goods were involved. — Report No. R99M0046

The track was inspected visually twice per week and by a track geometry car four times per year. The last visual track inspection in the Bedford area was conducted by a track inspector in a hi-rail vehicle on 08 October 1999. No reportable defects were noted in the occurrence area. The last track geometry car inspection was carried out on 12 July 1999, and several wide-gauge defects were found in the area. These problems were repaired on 12 and 13 July 1999. Surface roughness, cross-level, and alignment were found to be within prescribed limits. The last ultrasonic test was conducted on 23 June 1999, and no defects in the area were noted.

There is no information to indicate that train handling, rolling stock integrity, rail metallurgy, or track geometry contributed to this accident. The slight overspeed (up to 8 mph) that occurred westward from the derailment area had no bearing on events. A rusted and battered piece of the recovered north rail indicates that a rail failure derailed the train.

Although the mode of failure could not be precisely identified, the TSB suggested that the origin of the initial fracture and the initiation of the downward progression was in the area of microcracks emanating from shelly damage on the rail head. The investigation provides one indication that shelly damage can result in subsurface microcracks and rapid crack growth leading to partial or complete rail failure. Neither the *Railway Track Safety Rules* nor CN's Standard Practice Circulars fully address this issue.

The recommended remedial action for shelly damage is rail grinding. Grinding effectively removes surface and gauge corner irregularities by re-profiling the rail head. An active rail grinding program has now been initiated on the Bedford Subdivision, and identified sections of rail will be ground twice per year.

HIGH WINDS LEAD TO COLLISION

Canadian Pacific Railway (CPR) intermodal freight train 471, largely made up of well-type container flat cars loaded with double-stacked containers, was operating westward on the north main track of the Carberry Subdivision en route from Winnipeg to Brandon, Manitoba, on 01 November 1999. At the same time, CPR intermodal freight train 472, similarly configured, was operating eastward on the south main track. — Report No. R99W0231

When the two trains met and the locomotive consists of the two trains had passed each other by approximately 20 car lengths, the crew on train 472 observed that train 471 had derailed cars mid-train and that containers on the derailed cars were leaning towards the track on which train 472 was operating.

The locomotive engineer on train 472 applied the train brakes in emergency as the conductor made a radio call to advise the crew of train 471. The crew of train 472 took cover on the locomotive floor. While stopping in emergency, the three locomotives on train 472 struck the top containers loaded on a derailed car. The three locomotives and a container on train 472 were damaged. Six of eight containers that were loaded on the two derailed cars from train 471 were also damaged. No one was seriously injured and no dangerous goods were involved.

The conductor and the locomotive engineer on train 471 had experienced nothing unusual in the operation or handling of their train before the accident. The weather was a mix of rain and snow with high winds. Environment Canada had recorded wind speeds between 67 and 83 km/h from the northwest, with gusts up to 107 km/h.

The high crosswinds exaggerated the natural oscillation of the well cars loaded with empty double-stacked containers, causing wheel lift and the subsequent derailment of the cars. The risk of high crosswinds affecting double-stacked intermodal cars was considered low, and no procedures were in place to govern operations in these conditions.

Following the occurrence, CPR undertook a detailed study of available wind monitoring and assessment systems, reviewed internal accident records (which indicated very few instances where high winds contributed to an accident), and analyzed 50 years of wind data gathered near derailment locations. CPR concluded that the installation of wind monitoring equipment at any given location on the CPR system would not be cost effective.

As of April 2000, CPR added high winds as an alert condition to its regular monitoring of weather advisories. When the railway's Network Management Centre receives such an alert, the possible local effects and action required are discussed with the service area managers.

Wreckage of container from train 471 embedded in cab of lead locomotive of train 472.

Investigations

The following is *preliminary* information on all occurrences under investigation by the TSB that were reported between 01 January 2001 and 31 July 2002. Final determination of events is subject to the TSB's full investigation of these occurrences.

DATE	LOCATION	COMPANY	EVENT	OCCURRENCE NO.
JANUARY 2001 08	Bowker, Ont.	Canadian Pacific Railway	Main-track derailment	R01W0007
16	Mallorytown, Ont.	Canadian National	Main-track derailment	R01T0006
FEBRUARY 02	Red Deer, Alta.	Canadian Pacific Railway	Non-main-track derailment	R01E0009
15	Trudel, Que.	Canadian National	Main-track derailment	R01Q0010
MARCH 12	Mattawa, Ont.	Ottawa Valley Railway	Main-track derailment	R01H0005
APRIL 12	Stewiacke, N.S.	Via Rail Canada	Main-track derailment	R01M0024
MAY 09	Burlington, Ont.	Canadian National	Pedestrian fatality	R01T0129
AUGUST 29	Montréal, Que.	Canadian National	Non-main-track derailment	R01D0097
SEPTEMBER 24	Richmond Hill, Ont.	Canadian National	Main-track collision	R01T0255
OCTOBER 01	Brandon, Man.	Canadian Pacific Railway	Main-track derailment	R01W0182
06	Drummond, N.B.	Canadian National	Crossing collision	R01M0061

DATE	LOCATION	COMPANY	EVENT	OCCURRENCE NO.
JANUARY 2002 12	Whitby, Ont.	Via Rail Canada	Collision with object	R02T0008
FEBRUARY 15	Dartmouth, N.S.	Canadian National	Non-main-track derailment	R02M0007
22	Port Hope, Ont.	Canadian Pacific Railway	Main-track collision	R02T0047
MARCH 03	Carmangay, Alta.	Canadian Pacific Railway	Main-track derailment	R02C0013
18	Éric, Que.	Quebec North Shore & Labrador Railway	Main-track derailment	R02Q0021
24	Glenogle, B.C.	Canadian Pacific Railway	Mian-track collision	R02C0022
APRIL 26	Winnipeg, Man.	Canadaian National Railway	Main-track collision	R02W0060
28	Natal, B.C.	Canadian Pacific Railway	Main-track collision	R02V0057
MAY 02	Firdale, Man.	Canadian National	Crossing	R02W0063
13	Kingston, Ont.	Via Rail Canada	Crossing	R02T0149
JULY 03	L'Assomption, Que.	Canadian National	Main-track derailment	R02D0069
08	Camrose, Alta.	Canadian National	Main-track derailment	R02C0050
22	Joffre, Que.	Canadian National	Main-track derailment	R02Q0041
23	Carstairs, Alta.	Canadian Pacific Railway	Main-track derailment	R02C0054

Final Reports

The following investigation reports were approved between 01 January 2001 and 31 July 2002.
*See article or summary in this issue.

DATE	LOCATION	EVENT	REPORT NO.
98-11-26	Concord, Ont.	Yard derailment	R98T0292*
99-01-31	Jasper, Alta.	Main-track collision	R99E0023
99-02-06	Neswabin, Ont.	Derailment	R99T0031*
99-04-13	Bégin, Que.	Main-track derailment	R99Q0019
99-04-23	Thamesville, Ont.	Derailment/collision	R99H0007*
99-06-05	Bellamy, Ont.	Crossing accident	R99T0147
99-07-14	Hornepayne, Ont.	Collision at crossing	R99H0009
99-08-06	Windsor, Ont.	Crossing accident	R99S0071*
99-08-15	Messiter, B.C.	Derailment	R99V0141
99-08-27	Cornwall, Ont.	Runaway cars	R99D0159*
99-09-23	Near Britt, Ont.	Derailment	R99T0256
99-10-09	Bedford, N.S.	Derailment	R99M0046*
99-11-01	Poplar Point, Man.	Derailment and collision	R99W0231*
99-11-23	Bowmanville, Ont.	Crossing accident and derailment	R99T0298
99-12-30	Mont-Saint-Hilaire, Que.	Derailment and collision	R99H0010
00-03-10	Brossard, Que.	Derailment	R00D0026
00-03-14	Temagami, Ont.	Main-track derailment	R00T0067
00-05-16	White, Ont.	Main-track derailment	R00W0106
00-07-09	Rockwood, Ont.	Derailment	R00T0179
00-08-30	La Tuque, Que.	Collision and derailment	R00D0098
00-12-19	Imperial Mills, Alta.	Crossing accidents	R00C0159
01-05-09	Burlington, Ont.	Pedestrian fatality	R01T0129

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