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

TRANSPORTATION SAFETY

# REFLEXIONS

Issue 17 – Winter 2001

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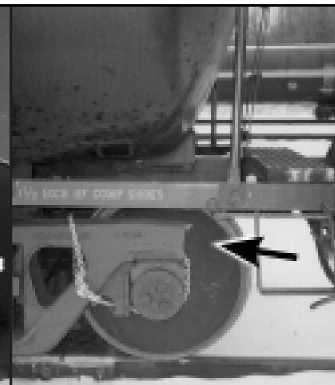

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## Acknowledgements

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Wayne Regaudie

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**The switch stand for the siding at Mile 225.8 had been struck by an unidentified vehicle. The collision uprooted the stand and dislodged the anchoring ties.**

# Passenger Safety Derailed?

A highway vehicle struck and damaged a main-track switch. The person responsible failed to report the incident, which ultimately resulted in a serious accident. – Report No. R96T0111

On 31 March 1996, at 1414 eastern standard time, Ontario Northland Railway (ONR) passenger train 698 was travelling southward at 44 mph on the Canadian National (CN) Newmarket Subdivision. Approaching Mile 225.8, just south of North Bay, Ontario, the locomotive engineer observed that the siding switch stand at Mile 225.8 was canted off-centre. Concerned that the switch might be damaged, he immediately initiated an emergency brake application. The locomotive engineer estimated that the train contacted the switch area at 20 mph. Three coaches, the locomotive, and the electrical power unit derailed.

Passengers believed that steam coming from the first car and entering the coach through the opening in the side wall was smoke from a fire. The leading-end side vestibule door was jammed, and the emergency windows would not open. The passengers exited the coach through the rear vestibule side door, which the operating crew had opened from the outside. Eight passengers and two railway employees sustained minor injuries.

On 29 March 1996, two days earlier, ONR train 697 had passed over the area in the opposite direction, and no problems were noted. It was the last train to pass over the switch before the arrival of train 698. There were no ONR or CN employees working in the area over the weekend.

At the derailment site, a gravel CN service road runs parallel to the track, providing access to a track material storage yard. There is a single sign advising those approaching the roadway from a public thoroughfare, "Danger, Do Not Trespass"; however, access is not restricted.

The switch was canted over at 20 degrees from vertical. Tire tracks from the gravel road and white paint scuff marks on the switch stand, approximately 14 inches (about 36 cm) from the base of the stand, were evident. The switch stand securing spikes were loose, and the anchoring ties were dislodged. The switch was lined for the normal position, and the switch target was in place and properly indicated that the switch was lined for the main track. The components were in good condition, properly adjusted, and well maintained. The force required to dislodge the switch stand would have been considerable, and the person(s) responsible should have been aware of the impact.

**The proximity of the seat back hampered the removal of the emergency exit windows, which are designed to swing inward as though hinged at the top.**

## The Coaches

The ONR coaches are refurbished unilevel, lightweight commuter cars originally built for GO Transit service in Toronto. Large, comfortable, upholstered seats that rotate in pairs were installed. New heating, air conditioning, and electrical systems were added, and baggage storage areas were installed. The coaches were also equipped with manually operated doors and steps.

General lighting, heating, air conditioning, and the public address system are powered by the auxiliary power unit (APU). The emergency backup lighting system is powered by batteries and activated automatically whenever power from the APU is cut off. The emergency lights are located under aisle seats on one side of the coach and overhead in the galleys, vestibules, and washrooms. There are no emergency exterior lights to illuminate the exterior of the coaches for passengers detraining in the dark, nor are the coaches equipped with portable lights such as flashlights.

The ends of each coach contain a vestibule area. Each vestibule is equipped with a manually operated hinged side door and a hinged end door. The side doors in the respective vestibules are installed on opposite sides of the cars. All doors swing inward.

The vestibule side doors are secured with three latches, with large handles to rotate and lift the latches. No written instructions were posted to advise passengers how the door securement system operates.

**The passengers had tried to open the emergency windows but could not in five out of five attempts.**

From the interior of the coach, the mechanism on the top and bottom latches is visible, and the operation of these latches is obvious. The mechanism for the middle latch is hidden, but its operation would, no doubt, be thought to be consistent with the others. On the exterior, the operation of the latches is not apparent, and there are no pictograms or written instructions to indicate the method of operation.

A panel covers the vestibule steps. The stairs are exposed by stepping on a release latch and manually lifting the panel, which then automatically exposes and lowers the steps. No written instructions were posted on the interior or exterior to advise passengers or rescue personnel of the operation of the release latch and its location, neither of which is obvious. During an emergency evacuation, deployment of the stairs would help passengers exit the train and would lessen the risk of injury.

The end doors are secured in place with three latches in a similar fashion to the side doors. As with the side doors, there are no written instructions to provide passengers with information on how to operate the latches; however, as with the side doors, the latch operation is obvious from the interior and not as obvious from the exterior. The upper halves of both the end doors and the side doors contain large safety glass windows measuring approximately 31 inches by 12 inches (about 79 cm by 30 cm).

The coaches are equipped with 12 emergency escape windows located every second window. (The kitchen car is slightly different with only eight emergency windows.) A non-illuminated three-part pictogram on the window, above the handle, illustrates its operation. Each emergency window is identified by a large red handle with the words "Emergency Exit / Pull Handle – Remove Rubber". The gasket is to be removed by pulling on the handle. A second handle, fixed to the window and exposed by pulling the first handle away, is to be pulled, and the window is designed to swing inward as though on hinges at the top (according to the pictogram), toward the interior of the coach.

A safety information plaque measuring 9 3/4 inches by 5 3/4 inches (about 25 cm by 15 cm) is affixed to the corridor wall of each vestibule. The written information advises that each car is furnished with emergency exit windows and emergency equipment and exhorts passengers to become familiar with where these are located. A pictogram of the floor plan of the coach indicates the emergency exit locations as the emergency exit windows and the end doors. Attached to the exterior coach walls, below the emergency windows, are red decals with the words "Emergency Window". From the outside, however, there is no method—other than breaking the glass—to gain entry through the emergency windows.

Individual passenger seating areas are not supplied with safety instructions and procedures. It was not the practice to make announcements to the passengers regarding the location of emergency equipment or emergency evacuation procedures. Emergency equipment in each car includes a basic first-aid kit, fire extinguishers, axe, sledgehammer, and hand saw. These articles are stored in prominently marked and accessible bins in various locations in the coaches.

## Emergency Escape

The passengers had tried to open the emergency windows but could not in five out of five attempts. Tests were conducted to evaluate the operation of these windows as depicted on the pictogram and to understand the difficulties passengers may have encountered.

The TSB conducted an examination of the emergency window operation, coach structural integrity, side- and end-door operation, and emergency escape signage and found the following:

- The emergency windows were not subject to scheduled removal; if in place for a very long time, the seals become stiffer.
- Structural deformation of the coach would make the emergency window removal more difficult.
- The force required to remove the emergency window gasket varied considerably and in some cases was beyond the capabilities of passengers of average strength.
- The little metal handle on the emergency exit windows limits the force that can be applied to it and causes the windows to jam on the window frame.
- The weight of the window makes it difficult to manoeuvre.
- The lack of instructional signs on the exterior of the coach doors could hinder rescue efforts.

Communication between passengers and the crew members was difficult because there were no portable megaphones available. The public address system only functioned within the coaches and relied on auxiliary power. There were difficulties in informing passengers of a gathering point and in providing them with information pertaining to their return to North Bay.

At the time of this occurrence, there were no standards providing minimum safety criteria for the design, retrofit, or refurbishing of railway passenger rolling stock. Furthermore, there were no standards providing for emergency exit design or the size, content, and visibility (including visibility in darkness or smoke) of emergency signage. No requirement existed to provide emergency information to passengers on boarding, including oral, written, or pictorial information. Emergency voice broadcast capability on emergency power, both inside and outside the cars, emergency exterior lighting, and adequate portable lighting (flashlights) were not requisites.

## Previous Passenger Evacuations

On 20 November 1994, a VIA Rail Canada Inc. (VIA) train with light, rapid, comfortable (LRC) equipment struck a piece of rail placed on the tracks near Brighton, Ontario. The piece of rail damaged the locomotive fuel tanks and severed electrical cables. The leaking fuel ignited, and the ensuing fire placed many passengers in a life-threatening situation (TSB Report No. R94T0357, see *Rail Safety REFLEXIONS*, issue 9). The TSB investigation exposed deficiencies in LRC passenger car safety design and evacuation standards. As a consequence, VIA, in concert with Transport Canada, rectified or initiated steps to rectify the identified safety deficiencies.

**The TSB investigation exposed deficiencies in evacuation standards.**

On 22 April 1995, VIA train 1 derailed near Blue River, British Columbia (TSB Report No. R95V0089, see *Rail Safety REFLEXIONS*, issue 15). Many of the shortcomings in passenger coach safety design identified in the TSB report of the accident at Brighton were also evident in this occurrence.

**The size of the little metal handle on the emergency exit windows limits the force that can be applied to it. The handle also causes the windows to jam on the window frame.**

The damaged switch caused the locomotive, the electrical power unit, and three of the four coaches to derail.

**There were no standards for emergency exit design or emergency signage.**

On 16 February 1996, a Maryland Rail Commuter (MARC) train collided with a National Railroad Passenger Corporation (Amtrak) train near Silver Springs, Maryland. The fuel tank of the Amtrak locomotive ruptured on impact. Fire engulfed the locomotive, and burning fuel spilled onto the first MARC car (a cab car). As a result of the ensuing investigation, the National Transportation Safety Board (NTSB) recommended that the Federal Railroad Administration inspect all commuter rail equipment to determine whether it has

(1) easily accessible interior emergency quick-release mechanisms adjacent to exterior passageway doors;

(2) removable windows or kick panels in interior and exterior passageway doors; and

(3) prominently displayed retro-reflective signage marking all interior and exterior emergency exits.

The NTSB also made the same recommendations to the Mass Transit Administration of the Maryland Department of Transportation.

Passenger coach design and fit-out has been largely left to the discretion of the builder. There are, however, no applicable standards, with the exception of Association of American Railroads structural standards (which do not address safety features) and various codes requiring first-aid supplies and firefighting equipment.

## TSB Recommendations and Responses

On 07 July 1996, the Board issued four interim safety recommendations concerning the ONR occurrence. Safety deficiencies with respect to the functionality of the emergency exit windows, the absence of explicit instructions to open the windows, and interference with their operation by coach seats and baggage racks were addressed. The Board recommended that:

*The Ministry of Northern Development and Mines of Ontario ensure that:*

*a) an immediate, one-time, functional test on all emergency window exits on ONR passenger coaches is conducted; and*

*b) a program for regular functional verification of emergency window exits on ONR passenger coaches is established.*
***R96-01***

*The Ministry of Northern Development and Mines of Ontario ensure that explicit instructions for use of the emergency window exits on ONR passenger coaches are readily available;*
***R96-02***

*The Ministry of Northern Development and Mines of Ontario ensure that seats and luggage racks do not interfere with the use of the emergency window exits in the passenger coaches; and*
***R96-03***

*The Ontario Northland Transportation Commission undertake research with an aim to installing, in ONR passenger coaches, emergency exit windows that can be readily removed by able-bodied passengers.*
***R96-04***

In response, the ONR indicated that several measures were being implemented to facilitate passenger egress in an emergency situation:

- A functional test had been performed on all emergency windows on all Ontario Northland Northlander coach equipment. Each window was removed, cleaned, and re-applied.

- A regular functional verification of emergency window exits will be scheduled annually as part of the regular coach maintenance program.

- A placard, outlining schematically and in writing the emergency features of the car, will be placed on each seat.

- The training program for on-board service personnel and operating crews was reviewed, and a retraining program was put in place. The program will include a physical review of the safety equipment on the car, and every trainee will be required to physically remove one of the emergency windows. ONR will also undertake to provide the same training to regular CN crews on layover in North Bay.

- The turnable seats have been secured in a position to ensure unobstructed access to three emergency exit windows on each side of the coaches.

In addition, the Board, concerned with the broad issue of railway passenger safety, recommended that:

*The Department of Transport, in consultation with the railway industry, establish standards governing all emergency aspects of railway passenger safety; and*
***R96-10***

*The Department of Transport review its procedures regarding regulatory oversight of railways to ensure that the required level of railway passenger safety is maintained.*
***R96-11***

## Follow-Up

Shortly after the fatal VIA accident at Biggar, Saskatchewan (TSB Report No. R97H0009, see *Rail Safety REFLEXIONS*, issue 13), the federal Minister of Transport announced a delay in the re-introduction of the proposed amendments to the *Railway Safety Act* to determine whether further adjustments to the legislation were required. The modifications to the Act include provisions for passenger safety and the implementation of a regulatory regime to enforce these provisions.

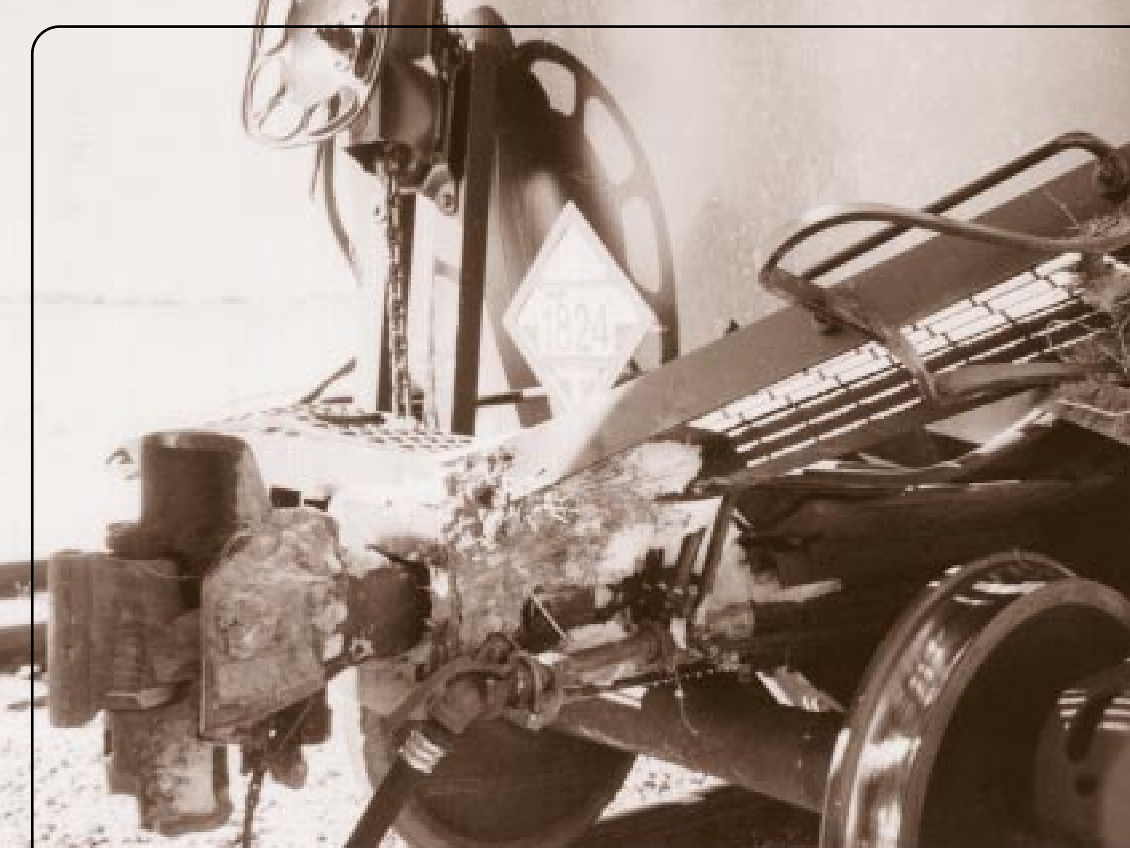
Transport Canada (TC) approved the *Railway Passenger Car Inspection and Safety Rules*, with an effective date of 01 February 1998. The rules contain provisions on emergency exits, trauma kits (including megaphones), instructions, signage, securement of baggage, and emergency lighting and prescribe fail-safe design of electrical and mechanical circuits and systems.

On 31 March 2000, TC approved the *Passenger Handling Safety Rules.* Their rules contain provisions for passenger handling safety plans, training passenger safety inspections, and filing requirements.

TC verified that ONR had completed the actions required to address the Board's recommendations and outlined that TC will continue to monitor the ONR for compliance with passenger train safety requirements. TC also indicated that a switch point lock has been installed to prevent a similar occurrence at this location.

## REFLEXION

Considering the events in recent years in the railway industry, how does railway passenger safety look today?




**The collision knocked two tank cars containing a residue of caustic soda on their sides. Seven other tank cars containing a residue of caustic soda and two containing a residue of chlorine derailed but remained upright.**


# Undesired Quick Release

On 27 February 1996, the crew of a Canadian National (CN) train left 59 cars, secured with air brakes, standing on the main track at Mile 14.6 of the Bécancour Subdivision near Saint-Grégoire, Quebec. The cars rolled northward and struck the locomotive consist at 1300 eastern standard time. – Report No. R96D0029

At 1240, the train was stopped clear of the level crossing at Mile 13.58, and all 59 cars were uncoupled and left standing on the main track. The locomotive consist was then taken northward to perform switching at the Lama Spur. Shortly after they were uncoupled from the locomotives, the 59 rail cars began to move northward. They rolled unnoticed approximately 4,000 feet and at about 1300 entered the spur and collided with the locomotives, which had just been coupled to six cars in the spur. The collision knocked the trailing locomotive and two tank cars containing a residue of caustic soda onto their sides. Seven other tank cars containing a residue of caustic soda and two containing a residue of chlorine derailed but remained upright. Two box cars also derailed. At the time of the impact, the trainman was working between the second and third cars and was seriously injured.

The track has a maximum descending grade of 0.16 per cent northward from Mile 13.58 but is level at the switch leading into the Lama Spur track. The Lama Spur is a private track connected to the main track in a nine-degree curve branching off to the west.

## How not to Secure the Cars

An inspection of the runaway cars revealed that the angle cock on the lead car was closed, and hand brakes had not been applied to any of the cars. The air brakes were released.

The crew had a pre-job briefing to discuss the work that had to be done on their tour of duty. These briefings do not normally include the method or procedures to use to secure the cars that will be left on the main track, and this briefing was no exception.

The locomotive engineer brought the train to a stop at Mile 13.58 by making a full-service brake application. After being satisfied that the application was complete, the locomotive engineer advised the trainman by radio that he could proceed with uncoupling the train. The trainman then closed the angle cocks between the trailing locomotive and the lead car, uncoupled the train, and rode the trailing locomotive to the spur. Before this movement, the conductor moved into position on the forward platform of the lead locomotive. It was common practice for the trainman to leave the angle cock closed on cars left standing while switching.

**It was railway practice not to apply hand brakes when equipment was left for short periods if the equipment could be seen.**

The train was equipped with a train information and braking system (TIBS), consisting of a sense and brake unit (SBU) mounted on the last car of the equipment left standing on the main track and an input and display unit (IDU) in the locomotive cab. The IDU displays the pressure in the brake pipe, emits an audible alarm when pressure drops below 48 pounds per square inch, and warns of zero brake pipe pressure. The IDU also displays the directional movement of the car on which the IDU is mounted. The TIBS is equipped with an emergency braking feature to remotely trigger an emergency brake application. The locomotive engineer did not notice that the cars were moving.

*Canadian Rail Operating Rules* (CROR) Rule 112 requires that a sufficient number of hand brakes be applied on equipment left at any point, unless special instructions direct otherwise, such as when setting out or picking up cars. At the time of the occurrence, there were no such special instructions. It was, however, railway practice not to apply hand brakes when equipment was left for short periods if the equipment could be seen by the crew (such as when setting out or picking up equipment on spurs and sidings).

## Creating a Pressure Wave

An instruction in force at the time of the occurrence was designed to prevent train crews from closing the angle cocks between the locomotive(s) and the lead car before the brake pipe pressure reduction (used to apply the service brake) was completely exhausted. Another instruction required that the equipment be left with the angle cock fully opened. Closing the angle cock prematurely can cause a pressure wave in the brake pipe, which can activate the quick release feature in the air brake control on individual cars. These valves are designed to sense increases in brake pipe pressure (a brake release) and relay this signal with a burst of air from the auxiliary reservoir to speed up the brake release process. As little as 1.5 pounds of pressure differential can activate the quick release feature; once activated on one car, it will trigger other control valves and propagate an unintended brake release throughout an entire train.

**Closing the angle cock prematurely can activate the quick release feature in the air brake control.**

**CN issued a Safety Flash pertaining to runaway equipment, advising utmost caution.**

Opening the angle cock and exhausting the brake pipe after the brake application is complete will result in a full service brake application if one had not initially been made or will reapply the brakes if they had been unintentionally released. Exhausting the brake pipe will also result in a condition in which a further change to the state of the air brake system is impossible because the brake pipe, or controlling mechanism, has no air pressure.

## Previous Concerns

As a result of the TSB's concern over the frequency of runaways on Canadian railways and the investigation into the runaway occurrence at Minnedosa, Manitoba (TSB Report No. R90H0923), the Board recommended in September 1992 that:

*The Department of Transport conduct a field assessment of the adequacy of training and supervision by Canadian railways to ensure that personnel are correctly applying standard operating procedures when securing standing cars.*
***R92-14***

In response, Transport Canada (TC) acknowledged its concern with respect to runaways and the apparent failure of railway employees to observe existing regulations and rules. TC advised that it had intensified the monitoring of railway performance in the areas of training and supervision to ensure that deficiencies were acted upon.

## CN Safety Initiatives

On 14 August 1995, CN issued Circular L-4797, entitled *Runaway Cars: Unintentional Release*, to all running trades personnel, with specific reference to car securement practices. The circular reinforced compliance with CROR Rule 112, the General Operating Instructions (GOI), and special instructions.

On 23 August 1995, CN issued instructions to train service managers outlining a comprehensive plan to reinforce the GOI requirements. The managers were asked to meet with the train crews under their jurisdiction in order to discuss pertinent rules and instructions. They were also to explain the proper work methods to train crews and determine whether these methods were indeed being applied. To this end, they were asked to check the condition of the braking system of cars left on the track. It was also suggested that the managers discuss the problem of runaway cars at their next Safety and Health Committee meeting and look at various ways of making employees aware of the issue and ways of preventing the problem.

On 21 September 1995, CN issued a Safety Flash pertaining to runaway equipment, advising that there had been several runaway incidents during the preceding weeks and that utmost caution had to be exercised to eliminate accident risks. Common sense and adherence to rules and instructions had to be the guiding principles at all times. CN management conducted impromptu spot checks among train/yard crews at 26 locations in the Champlain District in February 1996 to determine work practices for compliance with operating rules and GOI as directed by the 23 August 1995 plan. The locomotive engineer involved in this occurrence recalled having been checked with regard to this initiative. The crew was conversant with the GOI item as conveyed by company publications.

## Post-Edson Procedure

Following the main-track collision near Edson, Alberta (12 August 1996, TSB Report No. R96C0172), CN issued a special instruction pertaining to the securement of equipment (the Minimum Handbrake Application Chart) and guideline points. The Minimum Handbrake Application Chart removed the vagueness of "sufficient number of hand brakes" in CROR Rule 112 by specifying the number of hand brakes in relation to the number of cars to be secured. One of the guideline points related to the interpretation of what "equipment left" meant, which also made the rule more specific. This guideline essentially exempts employees from having to apply hand brakes on equipment left under CROR Rule 112 and the associated Minimum Handbrake Application Chart if

- the cars are being set out or picked up,
- the cars are left with an emergency or full service brake application with angle cocks operated in accordance with the provisions of GOI items 7.2(k), and
- the equipment can be seen by the crew so that the crew can initiate an emergency brake application on the equipment through the use of the TIBS.

This new procedure is in recognition of the efficiency of such a system (with no need to apply and release a number of hand brakes) and the realization that the application of hand brakes does not always guarantee that cars will not run away. Cars left with air brakes in a full service application or in emergency will not move until the brakes are released or pressure in the brake cylinders leaks off, a process that takes hours if not days. Therefore, it would be important to identify a means of ensuring the fail-safe use of air brakes under such circumstances.

Information gathered during this investigation indicates that TC does not agree with leaving cars standing under any circumstances without an appropriate number of hand brakes applied.

## Unsafe Operating Practices?

CN's attempts to educate its operating crews on the appropriate securement of equipment with air brakes have been extensive but have not had the desired result. Similarly, TC's monitoring has not had an apparent impact. It would appear that the ease with which a train can be left with a fully charged brake pipe and then recoupled in an almost ready-to-go state, combined with most crews' experience that such a procedure is safe, may have led to a widespread acceptance of an unsafe operating practice.

Canadian Pacific Railway (CPR) also has a procedure for leaving cars standing for short periods of time, but it specifies that such cars must be left in an emergency brake application. This procedure precludes the need to be careful in handling the angle cocks and ensures that the standing cars are left with maximum braking effort and a fully exhausted brake pipe to prevent any unintended signal propagation. From a procedural viewpoint, CPR has seemingly overcome the propensity for train crews to leave cars standing with a charged brake pipe for the sake of efficiency (even though it can be time-consuming to recover train air pressure after an emergency brake application).

The strict application of CROR Rule 112 would have provided yet another means of securing the cars. However, for operational reasons, the industry has moved away from requiring the application of hand brakes when trains stop to pick up or set out cars.

While the application of hand brakes may not be the only means of ensuring that cars do not move in these circumstances, this occurrence demonstrates the need to develop effective operating practices that are more resistant to normal human error.

Subsequent to this occurrence, CN reissued the Job Aid / Special Instruction pertaining to CROR Rule 112 (Securing Equipment) for en route switching at main-track or siding locations. CN has mandated that a portion of a train may be left on the main track or siding without hand brakes applied, providing that the standing portion left is 10 cars or more and has air brakes applied in full service or emergency, and the angle cock is left fully open. The grade must not be more than 1.5 per cent, and the cars cannot be left more than two hours. If the above conditions cannot be met, hand brakes must be applied as per the Minimum Handbrake Application Chart during the switching process.

## REFLEXION

In attempting to achieve economies in operating practices, do we sometimes forget that safety goes to the bottom line?


The subject side frame with the outer pedestal leg missing (arrow), as found by the investigator.

# Broken Truck Side

A tank car, containing a load of regulated product, probably moved from Alberta to eastern Ontario with a nearly severed pedestal jaw. The loss of truck side integrity meant that there was the potential for a derailment at track speed. – Report No. R97T0075

On 30 January 1997, at Mile 117.9 of the Kingston Subdivision, a trainman on a Canadian National (CN) freight train, while switching at Maitland, Ontario, observed that the pedestal leg on the "A" end of the truck side frame (R-4 position) was missing on tank car PROX 88181. The conductor instructed the locomotive engineer to return the train to Brockville Yard at a reduced speed of 20 mph. At Brockville Yard, the axle was chained to the truck side frame by a carman to allow the car to be switched through the yard and into the repair track. Despite a search for the missing piece of the truck side frame on the track and right-of-way between Mile 117.9 (DuPont Chemical) and Mile 125.6 (Brockville Yard), nothing was found.

The tank car contained a residue of anhydrous ammonia, a clear, colourless, corrosive gas with a characteristic odour that is toxic if inhaled. It is used as a fertilizer, as a refrigerant, and in the manufacture of other chemicals and is shipped as a liquid under pressure. Contact with the product can cause frostbite as well as first- and second-degree burns, which are often severe and may be fatal with extensive exposure.

## Thirty Years on the Road

The tank car was constructed by Union Tank Car Company, East Chicago, Indiana, in March 1967. It was designed in accordance with the Association of American Railroads (AAR) specifications. Repair records indicate that only routine running repairs had been performed on the tank car since construction.

**The fracture surface as found. The small shiny areas (arrow) and the light orange colour indicate that the fracture is relatively fresh.**

The truck side frame is a Barber S-2 type, manufactured in December 1966. In Canada, all truck side frames must meet the requirements of the AAR Operations and Maintenance Department, Mechanical Division.

A roof liner is applied to the pedestal roof of the truck side frame when the bearing adapter wears the pedestal roof beyond acceptable limits. Procor Limited applied a roof liner to the pedestal roof of the failed truck side frame. Repair records indicate that the roof liner may have been applied in February 1987. The application involved four plug welds and an application of weld bead running in both transverse and longitudinal directions around the roof liner. This application method was accepted and applied in all Procor Limited's repair plants. A roof liner had also been installed in the comparison truck side frame using this same application procedure. However, transverse welding creates an undesirable residual stress in the radius between the pedestal roof and jaw, which could contribute to fracture initiation. Approximately 20,000 truck side frames had roof liners applied using a similar application procedure. Many of these truck side frames are still in service.

## Multiple Failure Factors

Between 15 and 22 January 1997, the car was operated while loaded in very cold temperatures. Considering the brittleness of the truck side frame steel in low temperatures, it is believed that the truck side frame failed during this time. The nature of the fracture surface indicated that the outer pedestal jaw was not completely severed in the first fracture episode and may have remained attached for some time.

The car did not display any obvious signs of impact. Because the circumstances of the failure were unknown, the broken truck side frame and the truck side frame from the "B" end (comparison truck side frame) were sent to the TSB for examination and analysis.

The TSB report indicated that catastrophic failures in steel casting result from four concurrent conditions—sufficiently low temperature, residual stress, sufficient load, and the presence of a stress riser. After examining the truck side frame, the TSB concluded the following:

- The truck side frame failed as a result of overstress.
- The overstress resulted in brittle fracture of the truck side frame casting.
- The overstress initiated in the radius between the pedestal roof and the outer pedestal jaw.
- Factors likely contributing to the overstress initiation include the presence of casting defects, the proximity to the transverse weld of the roof liner, and the substandard fracture toughness of the truck side frame material.
- Material deficiencies and repair methods were observed that may have contributed to the failure.

Canadian Pacific Railway indicated that, before this occurrence, there had been five similar failures since 1994. These all occurred to truck side frames where roof liners were applied at Procor Limited. The ambient temperatures at the time of all five truck side frame failures were recorded to be below -20°C. All five truck side frames met Grade B steel specifications and were manufactured between 1965 and 1975. Four of the failures resulted in derailments.

CN records indicate that, since 1994, five truck side frame failures occurred. The records do not indicate further details as to where and why these failures occurred.

A casting defect observed in the radius between the pedestal roof and the outer pedestal jaw.

The casting defect after some exploratory work with a die grinder exposing a possible crack (arrow).

## AAR Specifications

The failed truck side frame would have met the AAR specification for casting defects since the current specifications do not require the area in question to be inspected. It was determined that a casting defect had served as the initiation point of the crack that propagated through the truck side frame. Consequently, a review of the casting defect inspection criteria may be in order.

The material from the truck side frame did not meet all the requirements in the AAR specifications for truck side frames. Although the material was cast as Grade B steel, as required, the hardness and fracture toughness of the material were both below the minimum acceptable range. Furthermore, the minimum acceptable range is considered to be unsatisfactory given the low ambient temperature experienced in the Canadian climate in the winter months and the susceptibility of such metal to brittle fracture at low temperatures.

Although roof liner application procedures are detailed in the AAR specifications, Procor Limited did not adhere to them; it added an application of weld bead running in both transverse and longitudinal directions around the roof liner. This additional application of weld increased the residual stress in the radius and thus created a weakened area. Many of the other similar failures were noted as having had roof liners applied by Procor Limited, using the additional weld. It is reasonable to expect that the truck side frames repaired in this manner are potential safety hazards.

Although truck side frame failures were reportable to the AAR before 1990, they are no longer. As a result, it is difficult to quantify this type of failure beyond those instances noted by the railways themselves. Given the information that the railways were able to supply, we can conclude that this type of failure usually occurs during the winter months when the ambient temperature is low. It is thus critical, for the safe operation of tank cars, to ensure that all of the conditions for catastrophic failures in truck side frames do not exist concurrently.

## Follow-Up Action

Procor Limited revised its methods and modified the weld configuration of the wear liner. It has also initiated a program to inspect the transverse welds when the trucks are dismantled.

## Safety Concern

The brittle fracture that caused the failure of the side frame developed as a result of four factors: the presence of a casting defect, the proximity of the transverse weld, the low fracture toughness, and the cold weather. There are several documented incidents of failure of side frames under similar circumstances. The Board recognizes that Procor Limited's measures should reduce the risk of this type of occurrence in the long run. However, the investigation clearly disclosed that the contributing factors identified in this occurrence might be present on many tank and freight cars of the existing fleet. The Board is concerned that there is no initiative from the industry or the regulator to alleviate the risk of further side frame failures in the short term.

## REFLEXION

What might the consequences have been, if not for the actions of an alert train crew?

What does this occurrence tell us about the previous inspections across the country that did not detect the crack?

The subgrade was soft, with water standing on both sides of the track. The derailment occurred on a section of continuous welded rail with newly installed ties. The jointed rail shown in the photo is a component of the track panels, laid subsequent to the derailment.

# Tamper-Proof?

On 14 June 1996, near Nicholson, British Columbia, at Mile 138.4 of Canadian Pacific Railway's (CPR) Windermere Subdivision, a CPR freight train derailed 13 loaded cars of coal. There were no injuries. Eleven freight coal cars were destroyed. – Report No. R96C0135

The train had departed Fort Steel, British Columbia, at 1245 Pacific daylight time, destined for Golden, British Columbia. At 1607, as the train approached Mile 138.4, the 75th to the 87th cars, inclusive, derailed. Recorded train speed was 24.2 mph in a 25 mph slow order.

## Unfinished Track Work

The derailment occurred in an area where ballast was disturbed as a result of tie renewal work the previous day.

The track is a single main track located on a level grade and a four-degree curve. Track structure consisted of 136-pound continuous welded rail (CWR). The CWR was laid at the desired rail temperature of 85°F (about 29°C). The rail temperature at Mile 119.8, shortly after the derailment location, was 105°F (about 41°C). The ambient temperature at the time of the derailment was about 79°F ( 26°C ).

The subgrade was soft, with water standing on both sides of the track. Ballast was slag, heavily fouled, with fine materials. There was approximately 12 inches of ballast under the ties, with shoulders varying between 6 and 12 inches. The standard ballast section requires 12 inches of ballast under the ties and 12 inches of ballast on the shoulders. Cribs

**The track program supervisor raised the track speed in the belief that the ballast section had been restored to standard.**

were filled, and ballast was loose. Additional ballast had not been added to cribs and shoulders, and the ballast had not been tamped by a tamping machine. Ties were installed in clusters of three to six ties adjacent to one another; that is, up to three ties on curves and six ties on tangent track.

The assistant track supervisor performed the last track inspection in a hi-rail vehicle about three hours before the derailment. No defects were noted.

## Tie Gang Activities

The tie gang was scheduled to install 20,000 ties between Mile 39.0 and Mile 138.5. The track program supervisor was advised by the track programs and equipment manager to tie up his crew and ship his equipment to another location as of 13 June 1996.

Work blocks were arranged on a daily basis, with the crew starting work between 0430 and 0500. The start time was scheduled to avoid disturbing the track in the heat of the day. In an effort to complete the project on schedule, the gang started at 2230 on June 12 and continued through the night until 0900 on the morning of June 13. The crew installed 671 ties over that period. The track program supervisor raised the track speed from 10 mph to 25 mph at 0745 on June 13 in the belief that the ballast section had been restored to standard by filling the cribs and that the requirement of the passage of a minimum of 50,000 gross tons had been met. This procedure had been a practice on this project and on previous tie programs on which the track program supervisor had worked.

Broken ties, a broken rail, and part of a wheel set lie on the shoulder of the track.

## Track Standards

Standard Practice Circular (SPC) No. 8, paragraph 27, details certain precautions that must be taken when renewing ties in CWR territory, including the following:

- The ballast section must be immediately restored to the required standard after completion of tie renewals each day.
- If the rail temperature is, or is expected to be, more than 10°F (about 12°C) above the rail-laying or adjusted temperature, then the following slow orders must be imposed before allowing traffic to operate:

i) During the course of the work, 10 mph until ballast section is restored to standard.

**Track disturbed by heavy tie renewals can lose 80 per cent of its resistance to buckling.**

ii) After the ballast section has been restored to standard, 25 mph until the passage of 50,000 gross tons of traffic, ensuring that speed is not raised while rail temperature is above the preferred rail-laying temperature.

CPR management notes that the SPC No. 8 requirement to "restore the ballast section to standard" also includes ensuring that the track is tamped. Management goes on to state that if the track is not tamped and regulated, it is not restored to standard, and a 10 mph restriction must remain in place until those actions are completed.

The untamped track was weakened to a condition where the integrity of the track structure was unable to withstand the compressive forces brought on by the rail expansion and the passing of the train. It is likely that, as the train passed over the rail at approximately 24 mph, the rail began to shift until it completely misaligned and caused the train to derail. The following track conditions contributed to the overall weakness of the track structure:

- The ballast section was less than standard for CWR.
- The ballast was in poor condition and fouled with fine materials.
- The ballast was loose, and newly installed ties were not tamped.
- The ties were installed in clusters.
- The subgrade was soft.

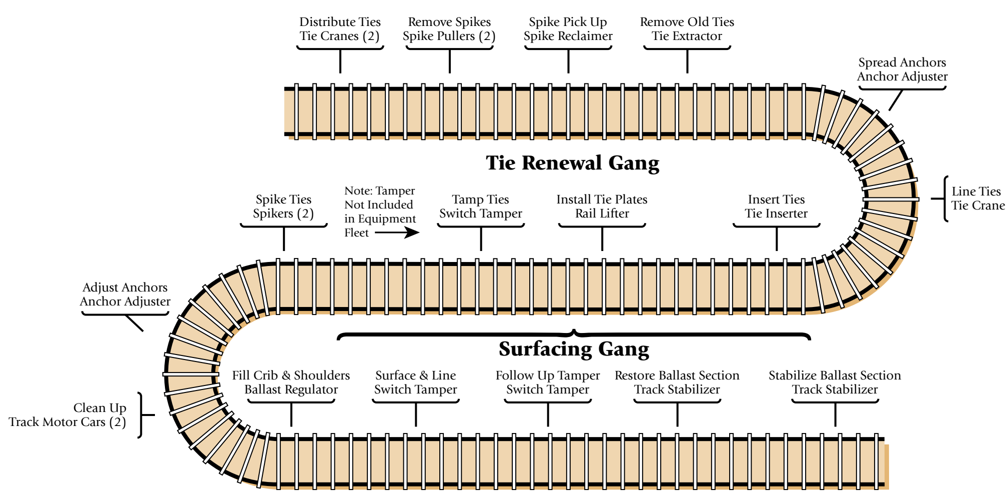
The new ties were installed in clusters and not immediately tamped because of malfunctioning equipment and an eventual reassignment of the required tamper out of the tie renewal gang's equipment consist.

## Track Buckle Characteristics

A track buckle is a large misalignment of track. Most buckles occur on curves and are usually caused by one or more of the following factors:

- weakened track conditions,
- high compressive rail forces, or
- train vehicle forces.

A weakened track condition will prevail if ballast is missing from the cribs or ends of ties, if ballast is disturbed, or if ties are installed in clusters and not properly tamped. Track disturbed by heavy tie renewals can lose as much as 80 per cent of its resistance to buckling. The action of the train, particularly the use of dynamic braking on downgrades, can increase the amount of compressive rail forces. Train vehicle forces can contribute to track buckling by exerting lateral wheel forces on a curve.




**Schematic showing sequence of events for tie renewal and follow-up surfacing gang.**

**Transport Canada railway safety officers have initiated spot checks.**

Minor track buckles had occurred at Mile 136.0 and Mile 114.3 on 12 June 1996. The CWR was distressed by cutting out a section of rail to relieve the compressive forces. The tamper from the tie renewal gang was diverted to correct the alignment. On June 14, a track misalignment was found at Mile 134.0 and was corrected by the local track maintenance forces.

## Communication Gap

There was limited communication between the track maintenance supervisor and the track program supervisor, who was responsible for quality control, daily work activities, and placement of slow orders. The judgement that the track condition was satisfactory for 25 mph was solely the decision of the track program supervisor, who knew that the job was not complete. A subsequent track patrol by the track maintenance supervisor was ineffective in identifying the track hazard, even though the track maintenance supervisor was aware that the tie renewal crew did not have a tamper in their consist. Track maintenance supervisors rely heavily on the judgement of track program supervisors, whose judgement would be overruled only under extenuating circumstances.

## Preventing a Recurrence

The TSB forwarded a Rail Safety Advisory to CPR relating the circumstances of this occurrence. The advisory stated that a misinterpretation of standing instructions, SPC No. 8, may have occurred and had not been detected by program management. It further suggested that the railway bring the circumstances to the attention of those involved in tie renewal programs to reduce the likelihood of recurrence.

In response, CPR extended the annual review/training period for track program supervisors to 15 days in 1997 from the 9 days held in 1996. The 1997 program included a review of SPCs and a thorough review and discussion of occurrences. All track program supervisors were given instructions on track safety rules and were retested and qualified as licensed track supervisors. In addition, training and certification as track supervisors was given to all extra gang foremen who were assigned to district gangs. Furthermore, CPR is considering rewriting SPC No. 8 to clarify the terms “ballast section restored to standard”.

Transport Canada railway safety officers have initiated spot checks in the course of their annual track monitoring program to ensure that track maintenance personnel adhere to all current railway policies and instructions concerning track buckling.

## REFLEXION

An article in *Rail Safety REFLEXIONS*, issue 2, describes an occurrence on Canadian National with some similar elements (TSB Report No. R91W0189). In that occurrence, as a result of a communication gap, a requested 15 mph slow order was not issued, and a train entered the work area at 38 mph with unfortunate results.

# Meeting in the Dark

On 01 July 1996, an assigned Canadian National (CN) crew consisting of a conductor and a locomotive engineer (both qualified engineers) operated westward freight train 359 from Humboldt, Saskatchewan, to North Battleford, Saskatchewan, arriving at 2100 central daylight time and going off duty at 2205. – Report No. R96W0171

Because there was no connection for the train at North Battleford, it was backed into spur track NB-36 at Mile 145.4 of the Aberdeen Subdivision and secured, and the engine was shut down. During this manoeuvre, the conductor was operating the locomotive, and the locomotive engineer was performing the conductor's duties, unlocking and lining the switch and placing the derail in the non-derailing position.

The same crew was called for eastward train 358 at 0245 on 02 July 1996, after being off duty 4 hours 40 minutes. The train departed North Battleford at 0340. At 0351, the train was diverted onto spur track NB-36 and collided with unattended train 359. Recorded speed at impact was 22 mph, reduced from 38 mph when the emergency brake application was made. Zone speed was 45 mph; however, caution speed was in

**The proper procedure when leaving switches temporarily in the reverse position is to secure the switch with the padlock and remove the key.**

effect between miles 143.7 and 147.7. Within these limits, a train or engine must be prepared to stop short of a switch not properly lined.

The locomotives of both trains were extensively damaged, and 10 cars derailed. The locomotive engineer sustained minor injuries when he jumped from the train.

## The Switch and Switch Lock

The hand-operated switch at Mile 145.4 consists of a No. 10 turnout and a standard switch stand. The switch stand mast is approximately seven feet above the rail head and is equipped with reflective targets conforming to Canadian government standards of reflectivity (maximum). An eight-inch square green target (to indicate through movement) and a small red circular target (to indicate a reversed switch) top the mast. A red oblong target, measuring approximately 18 inches by 15 inches, also indicating that the switch is reversed, is mounted approximately 15 inches below the top targets.

Switch NB-42 is located approximately nine feet west of switch NB-36. The targets and mast for switch NB-42 are located lower than those for switch NB-36 and in such a way that the respective targets do not overlap. However, train crews approaching the area from either direction with one switch lined in the reverse position can see both a green square target and a red oblong target.

Manually operated main-track switches are equipped with high-security padlocks, the keys to which are only issued to employees qualified in the Canadian Rail Operating Rules (CROR). After opening the padlock, the key can only be removed if the padlock is relocked. The proper procedure when leaving switches temporarily in the reverse position is to secure the switch in this position with the padlock and remove the key. It is common practice, however, to leave the key in the open lock until the switch is restored to normal.

After the accident, a key ring and padlock key belonging to the locomotive engineer was retrieved from the open lock of the NB-36 switch stand. The derail was not in the derailing position.

The CROR pertaining to main-track hand-operated switches and derails provide that "main track switches must be lined and locked for the main track when not in use." Also, "after a derail has been placed in the non-derailing position and the track is no longer in use, such derail must be restored to the derailing position and secured with a lock whether or not there is equipment on the track."

## Crew Rest

The locomotive engineer had last worked on 29 June 1996 and had gone off duty at about 2030 that day. He did not work on 30 June 1996. He indicated that he had had normal rest from his arrival home on 29 June 1996, until he was called to work on the afternoon of 01 July 1996, to take train 359 to North Battleford. He indicated that he had slept until approximately 0800 on 01 July 1996.

The conductor had last worked 30 June 1996. He indicated that he had had sufficient rest before being called for duty on 01 July 1996, having slept through the night and woken up in the morning.

Neither crew member had requested rest at North Battleford on arrival. Both were called for train 358 at 0245, after having been off duty for 4 hours 40 minutes. They indicated that they had slept for approximately 2 hours in the rest quarters used by CN for crew layovers at North Battleford.

The crew's maximum on-duty time was 18 hours in any 24-hour period, with no more than 12 hours in one tour of duty. Employees who go off duty at their objective terminal after working less than 10 hours are not further restricted, other than the requirement to work not more than 18 hours in any 24-hour period. Employees who are off duty for 8 hours are considered fit for 12 hours of work. Employees are expected to report for duty fit and rested.

**Employees are expected to report for duty fit and rested.**

The crew met the mandatory rest requirements. While no case can be made to indicate that fatigue played a direct role in the failure of the crew to reline switch NB-36 or operate their train in a more cautious manner when leaving North Battleford, identifiable fatigue issues, including sleep needs, sleep deprivation, and working through a period or circadian rhythm most likely to induce sleep, were present.

## Simulation

At about 0200, 03 July 1996, a simulation of an eastward train approaching the switch for track NB-36 was performed to determine the effective switch target recognition distance. The locomotive used in the simulation was similar to the leading locomotive on train 358 and equipped with double headlights and ditch lights.

The switch was lined for track NB-36, and a track unit was placed on the main track just beyond the switch. The movement proceeded eastward from the station until either the track unit or the switch target could be visually verified. The switch target and the track unit could not be visually verified until the engine reached Mile 145.6, approximately 1,000 feet from the switch to track NB-36.

The distance required to stop a 10,000-ton train, such as train 358, operating at 45 mph (the maximum speed within cautionary limits at North Battleford), is around 2,750 feet. Since the simulation revealed that equipment on the track could be first seen from approximately 1,000 feet, caution speed for train 359 would have been a speed at which the train could have been stopped in 500 feet. Such

**The caution speed was much slower than the allowable maximum speed under night-time conditions.**

a speed would be around 20 mph. The caution speed was therefore much slower than the allowable maximum speed under night-time conditions. It is also evident that, in daylight conditions, at 45 mph, caution speed requirements would involve seeing and identifying a hazard from over a mile away. The caution speed limit for this size of train in daylight conditions may therefore also be much less than the authorized maximum.

Misaligned switches are a threat to safe train operation. For heavy trains operating above 15 mph, switch targets cannot be considered as a means for train crews to identify and react to misaligned switches.

In occupancy control system territory, railway operating practices rely solely on employees complying with CROR requirements to ensure that switches are left lined for the main track after use. There are no electronic or procedural means to ensure or verify compliance.

## Safety Initiatives

CN installed a high-reflectivity switch target at NB-36; however, in July 1997, the spur was removed from service.

CN developed a job aid called "Trip Safety Check List". The list requires that listed crew duties and responsibilities be checked off at pre-departure, departure, en route, arrival, and tie-up times. Crews are required to verify their possession of switch keys in the "Personal Equipment" section of the list.

The Railway Association of Canada is drafting a new rule to regulate both the minimum hours off duty and the maximum hours on duty. The new rule will address the fatigue-related issues raised in this report. The new rule is expected to be approved by Transport Canada in 2001.

## Safety Concern

The Board recognizes the concerted effort by the railways and the regulatory body to resolve fatigue and alertness issues. The new rule will undoubtedly assist in reducing the frequency of occurrences involving fatigue-induced crew performance degradation. The Board, however, believes that implementation of initiatives such as CANALERT, coupled with a comprehensive hours-of-work rule, is necessary to alleviate the problem of fatigue in the railway operating environment. The Board is concerned that although certain elements of CANALERT have been implemented, there has not been widespread application of the CANALERT concepts.

The Board appreciates that removing the previous 15 mph maximum speed limit within cautionary limits improved operating efficiency. However, the Board is concerned that current operating speeds within cautionary limits have significantly reduced the margin of safety.

## REFLEXION

Does an experienced crew working on familiar territory sometimes become less vigilant and overlook some of the basic concepts of safe railroading?


Lead locomotive of train 45 plowed into the rear of train 475, resulting in substantial equipment damage. Both trains were handling loaded iron ore cars.

# The Lone Engineer

Two days after implementation of one-person train operation, a train crewed by a single locomotive engineer collided with the rear of another train while proceeding on a restricting signal indication. The locomotive engineer of the moving train was injured, and equipment was substantially damaged. – Report No. R96Q0050

The Quebec North Shore and Labrador Railway (QNS&L) developed a business plan to change to one-person train operation, citing other one-person operations such as Amtrak and New Zealand Rail. In the instance of Amtrak, the railway has limited the run to four hours when a train has one person in the operating cab. New Zealand Rail operates with one person in the operating cab; however, all its trains are scheduled. Employees know as much as a year in advance when they will be working.

Before the implementation of one-person train operation, railway representatives gave presentations to the Railway Association of Canada (RAC) and the regulator, Transport Canada (TC). In these presentations, they specified their plans to negotiate for one-person operation and the particulars of how they intended to operate in a one-person environment. They also reported having advised TC that they intended to begin one-person crew operations at the successful completion of contract negotiations with their

**The collective agreement included provisions to operate selected trains with one-person crews.**

operating union, the United Transportation Union (UTU). The railway reports to have solicited comment from both organizations and that TC responded with an indication that the railway's proposal was sound. TC, however, maintains that it was not advised of the railway's intention to commence one-person crew operations at the successful completion of contract negotiations. TC indicates that it assessed the proposal as sound and that it advised the railway that it would need to see a much more thorough proposal before giving a conclusive opinion. TC reports that it did not see an issue with respect to rules compliance. TC maintains that it advised the railway that any proposed operation was expected to be as safe as the existing operation. In addition, TC recalls that it raised concerns with respect to pre-departure job briefings, rear-view mirrors on locomotives, reset safety control operation, and pull-by train inspections.

Correspondence from the UTU to TC expressed concerns about the safety of the operations of trains with one person in the operating cab. The official reply conveyed TC's position at the time: "there are no federal regulations designating the number of persons to be employed on a train. Crew size is a matter to be negotiated between the railway company and the unions." TC also advised the union: "regardless of the crew size, railway companies must comply with all operating rules or seek exemptions from such rules by explaining how they can do so in a safe manner."

On 11 July 1996, the QNS&L and the UTU signed a collective agreement that included provisions to operate selected trains with one-person crews. The following day, the railway began operating trains as per the new agreement.

## The Accident

On 14 July 1996 at 1045 eastern daylight time, in clear daylight, southward train No. 45, operated by a single locomotive engineer in the operating cab, collided with the rear of train No. 475 at Mile 131.68 of the Wacouna Subdivision, near Mai, Quebec. Recorded speed was 30.1 mph when an operator-initiated emergency brake application occurred. The train travelled a recorded distance of 486 feet between the emergency brake application and the recorded speed of 0 mph.

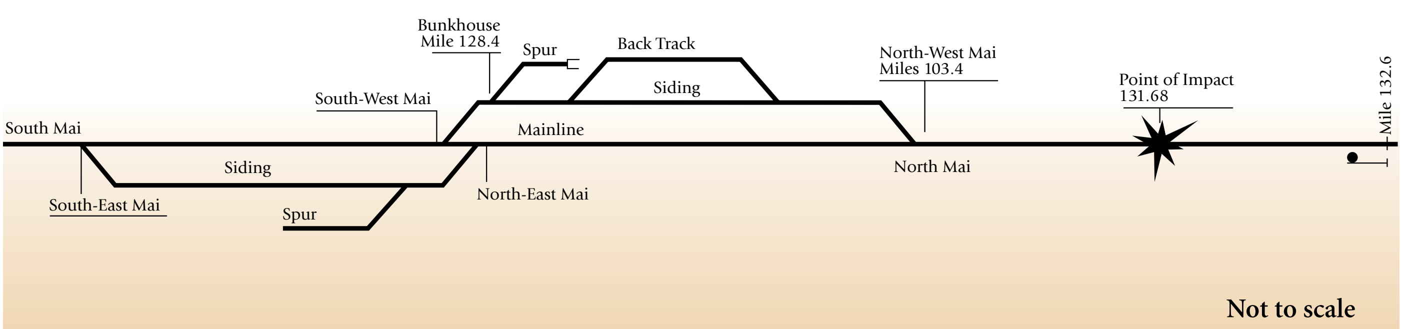



**Diagram shows track layout at the occurrence site. Point of impact was one mile past the point where train 45 accepted a restricting signal indication.**

**Approaching the point of impact from the north, there is a three-degree curve to the left and a slight ascending grade of 0.2 per cent. Sight lines were limited by forest and track curvature.**

At 1030, the rail traffic controller (RTC) had contacted the locomotive engineer of train 45 as the train passed Mile 137.3, approximately 5.6 miles behind the rear of train 475, and advised him that train 475 was stopped in emergency just before Mai. This was acknowledged. At signal 132.6, train 45 encountered a restricting signal (indicating proceed at restricted speed). Restricted speed is defined as "a speed that will permit stopping within one-half the range of vision of equipment, also prepared to stop short of a switch not properly lined and in no case exceeding SLOW SPEED." Slow speed is defined as "a speed not exceeding fifteen miles per hour."

## Preparation

The railway's preparation for one-person operation included identifying the Canadian Rail Operating Rules (CROR) that normally require more than one crew member to comply with the rules and developing contingency plans to remain in compliance with one person in the locomotive cab. From this information, railway rules instructors developed a short training document and presentation. Locomotive engineers were required to attend an approximately three-hour information session to discuss rules and other operating concerns before operating a train alone. No means of assessment was used to evaluate the employees' knowledge of the information covered in these sessions. The railway did not apply for any exemption to the existing operating rules.

On 12 July 1996, the locomotive engineer of train 45 attended a company training session on one-person crew operations from 1330 until about 1630. He made two trips on 13 July 1996, finally booking off at 2240, and retired at about 2330. The next day, he arose at 0550 and went to work for 0620. The collision occurred at 1045.

## Contributing Factors

In its final report, the Board determined that the collision occurred because the moving train was operated past a governing restricting signal, at a speed at which the locomotive engineer was unable to stop short of the stationary equipment. The implementation of the major operational change to locomotive-engineer-only train operation without a comprehensive analysis of its impact and without the implementation of effective compensatory safety measures contributed to this occurrence.

## The Aftermath

Shortly after this collision, TC restricted the QNS&L from operating any trains with only a locomotive engineer until the QNS&L had received appropriate exemptions from the CROR. The railway requested exemptions from specific operating rules on 26 July 1996 to re-establish locomotive-engineer-only train operations. In its letter of reply on 26 August 1996, TC stipulated 13 specific safety-related conditions that had to be met before the exemptions could

**No means of assessment was used to evaluate the employees' knowledge.**

**A working group was formed comprising headquarters and regional TC staff, and representatives from the QNS&L and the UTU.**

be granted. The railway met the conditions, and the appropriate exemptions were granted on 24 April 1997. Locomotive-engineer-only train operations recommenced on 17 July 1997.

A working group was formed comprising headquarters and regional TC staff, and representatives from the QNS&L and the UTU. As a result of group discussions, consensus was met on proposed changes to the current operating practices that would ensure that locomotive-engineer-only train operations would be as safe as an equivalent multi-employee operation.

More than 65 improvements were outlined by the working group; some of the more significant ones follow.

- A proximity detection device (PDD) will be installed and operational on all lead locomotives, track units, and on-track vehicles operating on the main track between Sept-Îles and Wabush Lake Junction. The only exception will be in large production gangs where only the two machines or pieces of equipment at the extreme ends of the gang need be so equipped.
- The QNS&L must ensure that the passenger train crews are assigned and scheduled and that all through freight trains are scheduled from Sept-Îles.
- No switching is to be carried out unless a second qualified employee assists.
- To facilitate napping, locomotives will be equipped with a napping radio channel, blindfolds, timers for locomotive engineers, and reclining seats.
- Locomotive engineers will receive 120 to 130 hours of simulator training and training in train operations, first aid, fire extinguisher use, proper interpretation and application of the rules affected by locomotive-engineer-only train operation, proper use of the PDD system, and emergency procedures applicable to locomotive-engineer-only operations.
- RTCs will receive training similar to locomotive engineers in locomotive-engineer-only operation. TC has implemented a system to monitor the training program.
- There will be increased supervision of locomotive engineers.

**Control stand in the locomotive engineer's operating compartment of a QNS&L locomotive.**

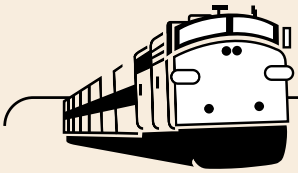
- The QNS&L will implement and maintain a system to record data related to the performance indicators and tracking mechanisms as laid out in the QNS&L (undated) paper presented to TC on 25 November 1996.

On 03 September 1996, TC advised the RAC in writing that the RAC was expected to develop a rule or rules, in consultation with the industry, that would govern one-person train operations. TC has received a submission from the RAC, but the matter is still being reviewed. Meanwhile, TC has not received any further requests for an exemption from the existing rules.

# Railway Occurrence Statistics 2000

| | 2000 | 1999 | 1995-1999 Average |
|---|---|---|---|
| **Accidents** | **1,062** | **1,129** | **1,179** |
| Main-track Train Collisions | 9 | 10 | 13 |
| Main-track Train Derailments | 121 | 119 | 148 |
| Crossings | 261 | 283 | 321 |
| Non-main-track Train Collisions | 112 | 100 | 113 |
| Non-main-track Train Derailments | 387 | 403 | 378 |
| Collisions/Derailments Involving Track Units | 16 | 27 | 19 |
| Employee/Passenger | 13 | 13 | 8 |
| Trespassers | 79 | 95 | 102 |
| Fires/Explosions | 32 | 53 | 49 |
| Other | 32 | 26 | 28 |
| **Incidents** | **329** | **333** | **436** |
| Dangerous Goods Leaker | 188 | 167 | 281 |
| Main-track Switch in Abnormal Position | 17 | 15 | 13 |
| Movement Exceeds Limits of Authority | 101 | 115 | 100 |
| Runaway Rolling Stock | 9 | 15 | 16 |
| Other | 14 | 21 | 26 |
| **Million Train-miles*** | **76.7** | **74.2** | **75.9** |
| **Accidents/Million Train-miles** | **13.8** | **15.2** | **15.5** |
| **Accidents Involving Dangerous Goods** | **249** | **223** | **283** |
| Main-track Train Derailments | 31 | 18 | 32 |
| Crossings | 12 | 8 | 7 |
| Non-main-track Train Collisions | 48 | 48 | 62 |
| Non-main-track Train Derailments | 150 | 133 | 164 |
| Other | 8 | 16 | 18 |
| **Accidents with a Dangerous Goods Release** | **5** | **9** | **8** |
| **Accidents Involving Passenger Trains** | **61** | **71** | **73** |
| **Fatalities** | **87** | **106** | **110** |
| Crossings | 33 | 37 | 41 |
| Trespassers | 53 | 62 | 65 |
| Other | 1 | 7 | 4 |
| **Serious Injuries** | **66** | **96** | **105** |
| Crossings | 33 | 44 | 58 |
| Trespassers | 23 | 34 | 33 |
| Other | 10 | 18 | 14 |

* Source: Transport Canada
Figures are preliminary as of 08 January 2001.



# RAILWAY Occurrence *Summaries*

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

## WHERE'S THE POINT?

*On 06 March 1996, in Canadian National (CN) MacMillan Yard (near Toronto, Ontario), 1500 West Control Yard Assignment shoved through a crossover, collided with train 383, and derailed seven cars, including one load of ethylene oxide, a dangerous commodity. There were no injuries. – Report No. R96T0080*

The yard assignment was being operated by remote control. The yard foreman was in the lead locomotive, and the yard helper was controlling the movement from approximately 36 cars behind the head end. Both crew members were equipped with a locomotive control system (LCS) beltpack.

The movement stopped while the yard foreman detrained and lined the crossover from track C-06 to the track adjacent to the Halton outbound track. He then instructed the helper to begin pulling again and took up a position on the roadway on the west side of the movement. As the movement proceeded southward on a curve, the locomotive consist disappeared from the foreman's view.

The helper, meanwhile, had detrained to be near switches that would be used when moving northward. He could not see the foreman and assumed he was still riding the point. The foreman radioed the helper to determine if he could see the locomotive consist from his position and was informed that he could not. The next communication between the two was garbled and unintelligible. At this time, the yard coordinator interceded and advised the yard crew that the crossover should be lined for their route. The helper responded that he was stopping the movement, but before the brakes were applied, the locomotive entered the crossover and struck train 383, which was standing on the Halton outbound track.

Point protection was lost at a critical time. If the yard foreman had remained on the locomotive, he would have seen the risk of collision and would have had time to stop the movement.

In October 1996, the Board wrote to Transport Canada (TC) addressing safety issues associated with LCS. Copies were sent to CN, Canadian Pacific Railway, and the Railway Association of Canada. The TSB suggested that TC, in conjunction with the railways, may wish to review LCS procedures, with a view to ensuring the adequacy of monitoring movements under LCS control. In response, TC indicated that there are no specific federal regulations or rules governing either the recovery method or other aspects of LCS. TC reiterated that operating employees have to comply with all applicable Canadian Rail Operating Rules and other applicable federal regulations.

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## TANK CARS ON THE LOOSE

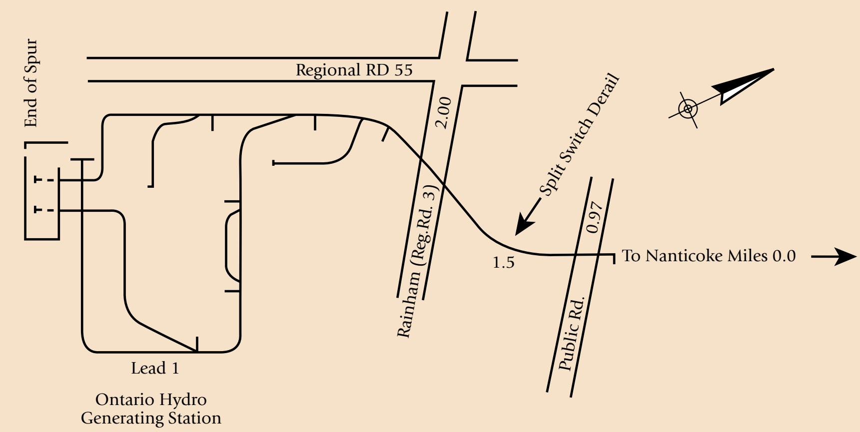
*A failed attempted coupling, with a derail in the non-derailing position, resulted in the runaway of five dangerous-goods tank cars.*
*– Report No. R96T0137*

On 24 April 1996, a Canadian National (CN) train crew was switching at the Esso oil refinery near Nanticoke, Ontario, Mile 0.0 of the CN Hagersville Subdivision. Lacking a run-around track, the crew resorted to a roll-by manoeuvre in order to relocate the engine from the south end to the north end of a cut of 11 cars. The crew pushed five tank cars up a 1% ascending grade, coupled them to six other tank cars, ran the locomotive into another track, then let the cars roll past the locomotive, using hand brakes to stop the movement. When the locomotive was coupled to the north end of the cars and an unsuccessful attempt was made to charge the train line, the crew discovered that the five south cars were missing.

The crew then shoved the six cars southward, looking for the missing cars. They expected to find them at a split-switch derail at Mile 1.5; however, the derail was discovered lined and locked in the non-derailing position. Eventually, the cars were found 600 feet south of the Ontario Hydro fly-ash building at a stop block. Two of the cars had derailed. One contained spent sulphuric acid; the other, residue of sulphuric acid. The runaways had travelled uncontrolled for more than two miles, over two public crossings, and through the Ontario Hydro thermal generating plant building. There were no injuries.

The derail had been left in the non-derailing position by another crew, which had switched the spur two days earlier. Several notices had been posted in the operating crew bulletin book at the Brantford crew office pertaining to the handling of derails in the Brantford area. In the previous 12 months, Transport Canada safety inspectors had issued two notices regarding the mishandling of derails in 13 observed instances in southwestern Ontario.

In 1996, subsequent to the Edson, Alberta, runaway and collision (TSB Report No. R96C0172), CN introduced several safety initiatives on a system-wide basis, including a system review of derail installations. As a result, some 600 additional derails were installed, and 200 were relocated. For this program to be successful, however, derails must be properly used. (See *Rail Safety REFLEXIONS*, issue 13.)




**The split switch derail (arrow) was located at Mile 1.5 to prevent runaway cars on the 1% grade. The derail was unpopular with train crews because of its location.**

## SUBGRADE FAILURE

*On 06 May 1997 at 0040 eastern daylight time, Canadian National (CN) train 283, moving westward at 45 mph, derailed both locomotives and 12 cars at Mile 34.55 of the Kingston Subdivision, near Coteau-du-Lac, Quebec. The train had encountered a depression in the track where the north slope of the embankment and roadbed had slid away, leaving about 20 metres of the north track unsupported. – Report No. R97D0113*

The locomotive engineer and the conductor sustained minor injuries. The fuel tanks on both locomotives were punctured, and approximately 12,000 litres of diesel fuel drained into the nearby Rouge River. Pieces of fibre-optic cable were found in the slide debris.

The TSB investigation concluded that the failure of the embankment was the result of the interaction of a number of factors, including the following:

- meteorological conditions that favoured the creation of saturated soils and high ground-water levels;
- the presence of indigenous, weak subsurface clays in the embankment; (Clays have a low shear-strength and are susceptible to water saturation, which further lessens their shear-strength.)
- the presence of grey clay, the strength of which decreases profoundly when it is water-saturated and disturbed;
- surface and subsurface conditions conducive to significant water migration towards and through the embankment into the river;
- the possibility of a rapid drawdown of an elevated river level and the presence of bank erosion and ice scour;
- the probable presence of desiccation cracks in the clay near the embankment toe due to large tree growth;
- the vibrations and dynamic pumping effects of heavily loaded trains.

## Previous Recommendations

After accidents attributable to roadbed failure at Conrad, British Columbia (TSB Report No. R97V0063), and Pointe au Baril, Ontario (TSB Report No. R97T0097), the Board issued interim recommendations R97-01 and R97-02. (See *Rail Safety REFLEXIONS*, issue 12.) Following these recommendations, meetings were held between CN, Canadian Pacific Railway, the Ontario Ministry of Transportation and Highways, Transport Canada, and the Geological Survey of Canada to address the recommendations. Various measures were undertaken to mitigate the problems in the Thompson/Fraser corridor. CN continues with roadbed and track continuity warning system initiatives consisting of field tests using the technology of time domain reflectometry as well as remote-sensing electrical measurement technique (RADAR).

# Ongoing Investigations

The following is *preliminary* information on all the occurrences under investigation by the TSB that were reported between 01 January and 31 December 2000. Final determination of events is subject to the TSB's full investigation of these occurrences.

| DATE | LOCATION | EVENT | OCCURRENCE NO. |
|---|---|---|---|
| JANUARY | | | |
| 30 | Newcastle, N.B. | Main-track switch in abnormal position | R00M0007 |
| FEBRUARY | NIL | | |
| MARCH | | | |
| 10 | Brossard, Que. | Non-main-track train derailment | R00D0026 |
| 14 | Temagami, Ont. | Main-track train derailment | R00T0067 |
| APRIL | | | |
| 19 | Haney, B.C. | Main-track train derailment | R00V0060 |
| MAY | | | |
| 16 | Malachi, Ont. | Main-track train derailment | R00W0106 |
| 22 | La Tuque, Que. | Main-track train derailment | R00Q0023 |
| JUNE | | | |
| 20 | Chalk River, Ont. | Main-track train derailment | R00H0004 |
| JULY | | | |
| 09 | Rockwood, Ont. | Collision involving track unit | R00T0179 |
| AUGUST | | | |
| 30 | La Tuque, Que. | Crossing accident | R00D0098 |
| SEPTEMBER | | | |
| 29 | Acton, Ont. | Crossing accident | R00T0257 |
| OCTOBER | NIL | | |
| NOVEMBER | | | |
| 30 | Winnipeg, Man. | Main-track train derailment | R00W0246 |
| DECEMBER | | | |
| 09 | Blue Bell, N.B. | Main-track train derailment | R00M0044 |
| 10 | Marysville, Ont. | Main-track train derailment | R00T0324 |
| 11 | Anita, Ont. | Main-track train derailment | R00W0253 |
| 12 | Lloydminster, Sask. | Main-track train derailment | R00E0126 |
| 13 | Martel, B.C. | Collision involving track unit | R00V0206 |
| 20 | Pitlochrie, Alta. | Crossing accident | R00C0159 |

# Released Reports

The following investigation reports were published between 01 January and 31 December 2000.

| DATE | LOCATION | EVENT | REPORT NO. |
|---|---|---|---|
| **97-10-07** | Chatham, Ont. | Dangerous goods leak | R97S0098 |
| A loaded pressure tank car leaked butane through an old crack. | | | |
| **97-11-24** | Carrier, Que. | Tank car failure | R97D0253 |
| A 111A tank car carrying sulphuric acid split open, releasing the entire product. | | | |
| **97-12-02** | Field, B.C. | Runaway, derailment | R97C0147 |
| Sixty-six cars derailed during an uncontrolled high-speed descent on a steep portion of Field Hill. | | | |
| **98-03-01** | Lyn, Ont. | Main-track derailment | R98T0042 |
| Eight cars, including two dangerous goods containers, derailed when a car wheel climbed over a defective switch point. | | | |
| **98-03-01** | Obed, Alta. | Rear-end train collision | R98C0022 |
| Poor visual conspicuity, inadequate vigilance, and inaccurate information resulted in two trains colliding. Recommendations issued. | | | |
| **98-05-31** | Creston, B.C. | Main-track derailment | R98V0100 |
| A freight train encountered a roadbed depression, derailing three locomotives and eight gondola cars. | | | |
| **98-12-15** | Ballantyne, Que. | Signal problem | R98D0184 |
| An incorrect wire installation led to a permissive signal when a train was still in the next block. | | | |

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