RAILWAY INVESTIGATION REPORT
R98T0042

MAIN TRACK DERAILMENT

CANADIAN NATIONAL
FREIGHT TRAIN NO. Q-107-11-28
MILE 127.54, KINGSTON SUBDIVISION
LYN, ONTARIO
01 MARCH 1998

Transportation Safety Board
of Canada

Bureau de la scurit des transports

du Canada

Railway Investigation Report

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Canadian National
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Mile 127.54, Kingston Subdivision
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Synopsis

On 01 March 1998, at approximately 2359 eastern standard time, Canadian National westward freight train No. Q-107-11-28, travelling from Montreal to Toronto, derailed eight cars at Mile 127.54 of the Kingston Subdivision near Lyn, Ontario. Two of the derailed cars contained dangerous goods; however, no product was lost. The derailment occurred while the train was passing through a crossover. Derailed equipment fouled the two main tracks.

The Board determined that the derailment occurred when a car wheel climbed over a defective switch point. 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 application of existing maintenance and inspection practices did not prompt the required remedial action.

Ce rapport est également disponible en français.

1.0 Factual Information

1.1 The Accident

On 01 March 1998 at approximately 2100 eastern standard time (EST)[1], Canadian National (CN) freight train No. Q-107-11-28 departed Montreal, travelling westward on the Kingston Subdivision destined for Toronto.

At Mile 127.54 of the Kingston Subdivision, near Lyn, Ontario, the train passed through a crossover from the south main track to the north main track. The crew members stated that they detected no abnormalities as their locomotive passed through the crossover. At approximately 2359, the train was stopped near Mile 133.04 by an emergency brake application brought on by a loss of brake pipe air pressure. After conducting the required emergency procedures, the crew members discovered that their train had derailed and that cars were fouling both main tracks in the vicinity of Mile 133.0. Until the train went into emergency, the crew was unaware that a derailment had occurred.

Two dangerous goods containers were among the cars which derailed. These included containers DTTX 27015, transporting ethylene refrigerated liquid, UN 1038, and DTTX 427073, carrying alkylamines, UN 2735. No product was lost as a result of the derailment.

1.2 Train Information

The train was 7,482 feet long, weighed about 5,866 tons and was powered by two locomotives. The train consist comprised 38 loaded container cars, each of which consisted of one, three or five platforms, amounting to 107 platforms in total.

1.3 Personnel Information

The crew consisted of a locomotive engineer and a conductor. Both were familiar with the territory, were qualified for their positions and met fitness and rest standards.

1.4 Method of Train Control

Movements on the Kingston Subdivision are governed by the Centralized Traffic Control System (CTC) of the Canadian Rail Operating Rules (CROR) and supervised by a rail traffic controller (RTC) located in Toronto.

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[1] All times are EST (Coordinated Universal Time (UTC) minus five hours) unless otherwise indicated.

1.5 Particulars of the Track

The authorized maximum speed on the section of the subdivision where the accident occurred is 100 mph for passenger trains and 60 mph for freight trains. The double main track in the area consisted of 132-pound continuous welded rail. The rail was laid on hardwood ties with double-shouldered tie plates and was box-anchored every second tie. The ballast was slag.

1.6 Traffic Density on the Kingston Subdivision

As many as 128 VIA Rail Canada Inc. (VIA) trains and up to 203 freight trains travel over the Kingston Subdivision on a weekly basis.[2]

The tonnage shipped over this subdivision in 1997 totalled 51.34 million gross tonne-miles per mile.[3]

1.7 Occurrence Site Information

A wheel flange mark was observed on the stock rail of the crossover at Mile 127.54, approximately eight feet west of the point of the switch. Marks were also found on the rail anchors on the field side of the south rail of the north main track. From approximately Mile 132.6 westward, about 1,000 feet of the south main track sustained substantial damage, to the extent that it became impassable. Tie and rail damage on the north track extended from Mile 127.54 to Mile 133.0. Eight cars (from the 23rd to the 30th inclusive), including 26 platforms, were derailed. Derailment debris fouled both main tracks. All eight derailed cars remained upright during the occurrence and sustained minimal damage.

1.8 Recorded Information

Event recorder data indicated that, at 2359, the train was travelling at a speed of 45 mph over the crossover at Mile 127.54. When the train cleared the crossover, the throttle lever was moved to its maximum position. After passing through the crossover, the train travelled for approximately eight minutes and stopped after approximately 5.5 miles as a result of the emergency brake application.

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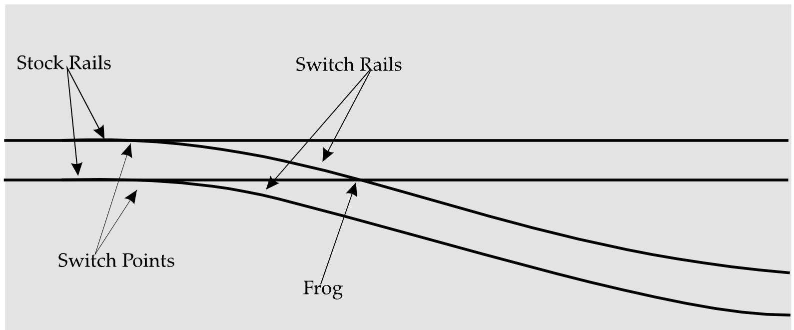
2 VIA Timetable and *CN/VIA Capacity Study*, April 1996.

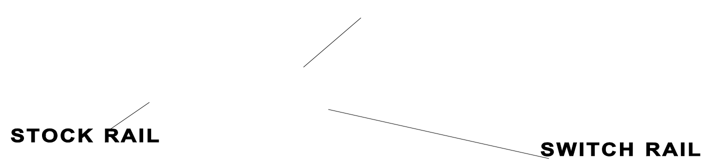
3 Data from Transport Canada, Economic Analysis Directorate, September 1998.

1.9 Turnout Information

The crossover at Mile 127.54 was designed to permit a maximum speed of 45 mph for diverging movements. It was built with No. 20 turnouts equipped with Samson switches. Figure 1 illustrates a turnout and some of its major components.



In a Samson switch point, the lower corner of the head on the gauge side of the stock rail is machined at an angle to house the point on the stock rail. This machining on the stock rail is referred to as an "undercut." The undercut serves to protect the switch point from direct impact with oncoming wheel flanges and the angled fit resists scissor action between the switch point and stock rails under traffic. Samson point stock rails are supplied from the manufacturer with an undercut in either end for installation on either side of the track. Figure 2 shows a cross section of a Samson switch point.



Thirty-eight inches of the running surface on the left-hand switch point of the leading turnout of the crossover was chipped out and missing. The switch point end was chipped such that the thickness of the remaining section was approximately ½ inch.

1.10 Engineering Analysis

The switch point from Mile 127.54 was removed from service and sent to the TSB Engineering Branch for analysis. Engineering Branch Report No. LP 53/98, concluded that:

- the chipping of the switch point was a result of progressive fatigue cracking;
- the cracking propagated from the field side of the switch point through its thickness, resulting in the separation of large sections of the running surface;
- fatigue cracking initiated as a result of continuous service with an improper fit between the switch point and the stock rail;
- the improper fit between the switch rail and the stock rail resulted from the loss of the required undercut in the stock rail; and
- there are no precise inspection criteria in CN's Standard Practice Circulars (SPCs) to assess the loss of the undercut.

1.11 Canadian National Inspection and Maintenance Program

1.11.1 Supervision

For track maintenance programs, the Kingston Subdivision is divided into territories. The territory where the accident occurred runs between Mile 118.3 and Mile 218.5. Each territory is under the responsibility of a track supervisor who reports to an assistant district engineer. The track supervisor is assisted by an assistant track supervisor who has the primary function of performing track inspections. On this particular territory, the organizational structure was unique in that the assistant track supervisor reported to the assistant district engineer. Daily operating activities, however, followed the usual convention with the assistant track supervisor taking direction from the track supervisor. All were qualified track inspectors pursuant to the Track Safety Rules and possessed the necessary experience and knowledge for their duties.

1.11.2 Inspection Policy and Procedures

CN's track inspection program is undertaken to identify areas that can jeopardize safe train operations and to plan maintenance. SPCs outline standards and procedures which include the inspection and minimum acceptable maintenance conditions of turnouts, specifically under sections 3100 and 3500. SPC 3500 identifies three classes of turnout inspection and the required inspection frequency. These inspections are described as Routine, Walking and Detailed:

- **Routine:** Every time the turnout is crossed, it shall be visually inspected for defects.

- **Walking:** Turnouts shall be inspected at least monthly on foot, measuring gauge and observing overall condition.

- **Detailed:** Turnouts shall be inspected annually (unless otherwise directed by the district engineer) with a close examination of all components.

According to SPC 3100, a record must be prepared and signed for each inspection on the day the inspection is made. The record must be retained for at least one year after the date of inspection.[4] Routine inspections of turnouts are carried out by an assistant track supervisor at least twice per week as required by SPC 3100 and SPC 3500. A track supervisor may accompany the assistant track supervisor. The assistant district engineer also covers the territory periodically. Inspections and any defects found are noted on forms which are inserted in a single binder referred to as the "logbook."

1.11.3 Inspection and Maintenance Criteria for Switch Points

The switch point inspection and maintenance instructions in SPC 3500 are qualitative and quantitative assessments. Those pertinent to the occurrence include:

- at least the first half of planed portion of switch points fits tight against stock rails;[5] and

- point ends chipped or broken so that the thickness does not exceed: (i) 5 mm (3/16 inch) on both points of switches 39 feet or longer.[6]

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4 SPC 3100, p. 2, Item 12(a), January 1998

5 SPC 3500, Appendix A, Section B, Switches, Item (f)

6 SPC 3500, Appendix A, Section B, Switches, Item (l)

Maintenance guidelines contained in the CN *Track Welder Manual*[7] state that:

> Metal flow along gauge side of the stock rail shall be removed and top radius restored well beyond the switch point contact area. Special attention in this regard must be observed when grinding Samson points and stock rails, not to alter the mating faces [undercut]. Free hand grinding is forbidden.

1.11.4 Inspection and Maintenance Practices

The logbook and forms used to report inspection findings were not standard across the CN system. Each territory created or adapted existing forms to satisfy reporting requirements. In the subject territory, the logbook included forms entitled:

- Routine Track Inspection Report - used to report exceptions observed during a routine inspection. Exceptions refer to items that do not meet the SPCs;
- Monthly Walking Inspection Report - used to record the date of the walking inspection; and
- Detailed Monthly Turnout Inspection Report - Although it is entitled "Monthly," it is used to record data collected during the annual detailed inspection.

The Routine Track Inspection Report and Monthly Walking Inspection Report forms completed in this territory for the 11 months before the occurrence reflect the date of track patrols, identify exceptions if observed and provide the name of the inspector. The Detailed Monthly Turnout Inspection Report form was not specific to each individual turnout. The condition of the switch point was recorded using ratings of "good," "fair" or "poor." The ratings were not defined by a clear set of standards. Switch point thickness was not recorded.

If the individual performing the track inspection, such as an assistant track supervisor, believes that a track does not meet minimum safety requirements, he/she has authority to order remedies, such as taking a crossover out of service until repairs are made or issuing a slow order on that section of track. Such remedies would have a direct impact on the timely and efficient operation of trains, and the responsibility for correcting any noted deficiencies would lie with the track supervisor. In this instance, the assistant track supervisor would not normally order remedies without the concurrence of the track supervisor.

A review of the logbook for the subject territory revealed that the assistant track supervisor conducted the annual detailed turnout inspection in April 1997, 11 months before the derailment. At the time, he recorded the switch point as being in "poor" condition. There were two inspections per week and a monthly walking inspection over the 11-month period before the occurrence. The assistant track supervisor was aware that the track supervisor had scheduled the switch point for replacement in the spring of 1998, and did not further

[7] CN - September 1996 - Track Welder, pp. 3-40

document the condition of the switch point. A "routine" inspection was made on 27 February 1998, four days before the derailment, by the assistant track supervisor and the track supervisor; however, there is no entry in the logbook indicating the existence of a defect.

The assistant district engineer undertook 17 inspections over the territory (Mile 118.3 to Mile 218.5) in 1997 and an additional inspection was completed on 14 January 1998.

Several other switch points in this territory were observed to be worn, chipped and did not meet CN's 3/16 inch criterion for the maximum allowable thickness of switch points as specified in the SPCs. In comparison, the switch points in the two adjacent territories were well within the limits defined in CN's SPCs.

1.12 Transport Canada Inspection Audits

Transport Canada (TC) is responsible for administering and enforcing provisions of the *Railway Safety Act*, which has, as an underlying philosophy, the following definitions of the role for regulation and railway management:

- railway management must be responsible and accountable for the safety of operations; and
- the regulator must have the power to protect the public and employee safety.

TC's approach to monitoring the safety of a railway's infrastructure is to review or audit the records of the railway's own compliance monitoring program and then examine the end result by site inspections to focus on safety systems and patterns of compliance and to determine systemic safety problems. TC has regional rail safety offices located in Moncton, Montreal, Toronto, Winnipeg, Calgary and Vancouver. Apart from the Central Region, which has two inspectors, each of these offices has one infrastructure inspector who operates over regions which have different trackage sizes:

Atlantic	1,070 miles
Quebec	3,100 miles
Ontario	8,000 miles
Central	15,800 miles (shared between two inspectors)
Pacific	3,100 miles

Because of the size of some regions, it is impossible for an infrastructure inspector to review all trackage in a given region every year. Therefore, a method based on stratified sampling is used. The population (railway subdivisions) is divided into relatively homogeneous or similar strata (groups). Every region is divided into 5 to 10 groups. Subdivisions having similar characteristics are grouped together. Subdivisions or sections of subdivisions are selected from each group, and then, within those sections of subdivisions, random samples for inspection are chosen from the following five data sources:

- logbooks;
- rail defect data;
- track geometry car data;
- turnout condition data; and
- bridge condition data.

Sample sizes are based on the extent of trackage in each region, risk assessment and historical data on the subdivisions. The distribution of samples is biased toward track groups presenting higher risks. For example, high-speed main tracks will receive more attention than secondary tracks.

For the Ontario Region, sampling over at least 1,000 miles (approximately 14 per cent of the territory) must be completed to obtain a minimum confidence level of 95 per cent. This means that the probability is 0.95 that the condition of track assessed from the sample actually reflects the condition of the entire trackage. The Ontario inspector must also carry out additional special inspections triggered by accidents, incidents or high rates of defects found in previous inspections.

In 1997-1998, the Ontario inspector covered 2,067.6 miles of track or 29.5 per cent of the territory, but due to the random nature of the sampling process, the track in the area of Mile 127.54 was not inspected. Records of inspections performed by the Ontario Region indicate that safety monitoring and inspections of track structure in the area of the accident were last conducted in 1995 during a special program initiated to examine the condition of frogs in turnouts in service between Montreal and Toronto. In addition, all other turnout components were inspected on both main tracks between Brockville (Mile 118.3) and Toronto (Mile 332.6).

Of the 218 turnouts inspected in 1995, 5 had defective frogs. The track supervisor immediately imposed a 10 mph slow order until the frogs were changed. The other turnouts in the Kingston Subdivision were reportedly in good condition and the track structure was found to be in good condition. As part of the 1997-1998 Ontario infrastructure audit and monitoring program, 17 turnouts were inspected from Mile 218.18 to Mile 264.51 and from Mile 299.5 to Mile 332.4. Some deficiencies were found and were immediately corrected by CN. None were related to chipped or worn switch points.

1.13 Track Safety Rules

The Track Safety Rules, approved by the Minister of Transport in March 1992, prescribe minimum safety requirements for railway track that is part of the general railway system of transportation. Track Safety Rules criteria relating to switch point chipping state in part that “Unusually chipped or worn switch points must be repaired or replaced. Metal flow must be removed to insure proper closure."[8] The Track Safety Rules also specify that "each switch point must fit its stock rail properly."

8 Transport Canada, Railway Track Safety Rules, p. 32, Item XII, part (h)

2.0 Analysis

The method of train operation played no role in this occurrence. The analysis in this report focuses on the condition of the switch point that led to this derailment and related inspection and maintenance practices. Although the switch point was chipped beyond the condemnable limit and was inspected regularly by the track supervisor and the assistant track supervisor, no immediate remedial action was taken.

2.1 The Derailment

Wheel flange marks on the left-hand switch rail and marks on the wheel of the 23rd car were consistent with the 23rd car in the consist climbing the chipped switch point and derailing. The next seven cars then derailed as the train proceeded, leading to a train-initiated emergency brake application and stoppage near Mile 133.04. The switch point at Mile 127.54 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. This excessive chipping was exacerbated by an improper fit between the switch rail and the stock rail due to the loss of the required undercut in the stock rail.

2.2 Track Inspection Process

Inspections are typically a two-step process: the first step requires inspection of an item and the second step, a decision regarding whether the item meets specifications. In order to successfully inspect an item, the inspector must have the ability to detect and measure the appropriate component, and have a standard against which to compare it. At the time of this occurrence, the SPCs provided a 3/16 inch condemnable limit on the switch point end thickness; however, ratings such as "good," "fair" and "poor" were used. This type of assessment removed from the process the comparison with the specified condemnable limit of 3/16 inch and hence, a clear pass/fail mechanism. Because "good," "fair" and "poor" were subjective criteria, inspectors were exposed to sources of errors such as "overconfidence bias" or "risk desensitization." The track supervisor's assessment of the track condition was not based on the SPC criteria, but rather on his experience. This behaviour is consistent with an overconfidence bias, characterized by the tendency to overestimate the correctness of one's own knowledge of a given situation and its outcome. One result is that attention is placed only on information that supports one's choice, with contradictory evidence being ignored.

Repeated exposure to a perceived risk without any resulting adverse consequences can result in a gradual shift from a heightened state of alertness and readiness to respond to a risk to a relaxed or normal state. Each successive harmless exposure reduces an individual's attention to the source of risk, particularly when cues used to assess the presence of risk change in a very gradual manner.[9] Since the deterioration of turnouts typically occurs very gradually, both the track supervisor and the assistant track supervisor may have become

[9] G.A. Peters (1998). "Liability prevention techniques for a world marketplace." in the *International Journal of Fatigue*, vol. 20, pp. 99-105.

desensitized to the risk that this deteriorated turnout posed and did not take action even though the turnout was assessed as "poor" 11 months before the accident.

Social pressures have also been clearly identified as contributing to the quality of inspections.[10] Pressure from peers or supervisors for "acceptance" or "rejection" of components can influence the decision-making aspect of inspection processes. The assistant track supervisor, whose task was to inspect the track, took direction from the track supervisor, whose task was to maintain the track. This reporting relationship increased the risk of social pressures adversely affecting the inspection process. Furthermore, it probably led to the assistant track supervisor ceasing to record the unsafe condition in records available for review by railway managers and TC or take remedial action that would impair train operations over the territory for which the track supervisor was responsible. Many industries have recognized the need to separate the role of inspection from that of maintenance, and have developed organizational structures and policies to assure this independence.

The ratings "good," "fair" and "poor" used in the Detailed Monthly Turnout Inspection Report 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 may 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.

The Detailed Monthly Turnout Inspection Report was not specific to each individual turnout, and it did not show previous conditions of the turnout. The design of this reporting form did not promote a review mechanism and did not facilitate the different levels of supervision in monitoring deteriorating track conditions. For example, the assistant district engineer covered this territory 17 times before the occurrence and was not made aware of the defective turnout condition.

Without a comprehensive and formalized review mechanism, the railway's ability to detect any unsafe condition and identify maintenance discrepancies between territories is compromised.

[10] B. Kantowitz and R. Sorkin (1983). *Human Factors: Understanding People-System Relationships.*

2.3 Interpretation of Track Safety Rules

The amount of allowable chipping or wearing of switch points that can occur before remedial action is taken is not specified in the Track Safety Rules. Since the criteria do not offer a quantifiable pass or fail standard, TC track inspectors cannot assess with consistency and accuracy the condition of a switch point and take the appropriate safety action. Therefore, conditions similar to those in this occurrence can remain unidentified.

2.4 Transport Canada Audits

TC measures a region's overall state of compliance with the Track Safety Rules by sampling areas within that region. However, unsafe practices that may be present within a territory are not detected if that territory is not part of the sampling program. When larger samples are used, the confidence level is increased and the margin of error decreased; therefore, the ability to accurately infer the expected state of the turnouts is also improved. 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. Should an unsafe condition be present, it can remain undetected and continue to deteriorate until it manifests itself in an accident. Due to the larger territory size and higher traffic density in Ontario, the potential risk for latent unsafe conditions remaining undetected is higher than in other areas of Canada.

3.0 Conclusions

3.1 Findings

1. The train derailed when a wheel on the 23rd car of the consist climbed a defective switch point of a turnout at Mile 127.54.

2. The switch point thickness was approximately ½ inch, exceeding the prescribed maximum allowable thickness of 3/16 inch.

3. The switch point was noted as being in poor condition 11 months before the derailment and, although subsequently inspected numerous times, no remedial action was taken.

4. Although the SPCs provided a 3/16 inch condemnable limit on the switch point end thickness, ratings such as “good,” “fair” and “poor” were used for inspections. These assessments were not defined with a clear set of standards. Thus, the risk of “overconfidence bias” or “risk desensitization” in the inspection process was increased and the supervisory control mechanism rendered ineffective.

5. The design of the Routine Track Inspection Report, the Monthly Walking Inspection Report, and the Detailed Monthly Turnout Inspection Report did not promote a review mechanism and did not help the different levels of supervision to monitor track conditions. As a result, the review system did not identify the defective turnout, nor the low level of switch point maintenance in this territory relative to other territories.

6. The lack of independence between the assistant track supervisor and the track supervisor increased the risk of social pressures, adversely affecting the inspection process.

7. The lack of quantifiable pass or fail standards in TC’s 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.

8. 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.

3.2 Cause

The derailment occurred when a car wheel climbed over a defective switch point. 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 application of existing maintenance and inspection practices did not prompt the required remedial action.

4.0 Safety Action

4.1 Action Taken

Subsequent to the derailment, railway safety officers from TC's Ontario Region inspected the turnouts between Mile 118.3 and Mile 162.1 of the Kingston Subdivision. This inspection identified four defective switch points. A Track Inspection Defect Report (No. 98-002) was issued to the CN track supervisor on 11 March 1998, followed by a Notice and Order on 16 March 1998. CN completed the repair of these switch points, and the Notice and Order was removed on 27 April 1998.

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

CN's senior engineering officers performed a detailed inspection of the entire Kingston Subdivision between 04 March 1998 and 06 March 1998.

CN 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 have been standardized in the District. Furthermore, CN indicated that it will add quantitative measurements for the assessment of switch points.

4.2 Action Required

The Board recognizes the concerted effort by CN and TC to mitigate the risks associated with inadequacies in inspections and inspection practices for turnouts. It believes that the action taken will reduce the probability of unsafe turnouts being left in service. However, the Board notes that the actions, such as the standardization of inspection forms and logs, are limited to the area of southern Ontario previously known as the Great Lakes District South. Apparently, neither CN nor TC has assessed whether the weaknesses in safety defences that contributed to this accident exist elsewhere in the national system. Therefore, the Board recommends 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

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 14 March 2000.

Appendix A - Glossary

CN	Canadian National
CROR	Canadian Rail Operating Rules
CTC	Centralized Traffic Control System
EST	eastern standard time
mph	mile(s) per hour
RTC	rail traffic controller
SPC	Standard Practice Circular
TC	Transport Canada
TSB	Transportation Safety Board of Canada
UTC	Coordinated Universal Time
VIA	VIA Rail Canada Inc.