Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT R06T0153

MAIN-TRACK DERAILMENT

CANADIAN NATIONAL
FREIGHT TRAIN A-435-31-14
MILE 6.0, OAKVILLE SUBDIVISION
MIMICO, ONTARIO
14 JULY 2006

Canada

Railway Investigation Report

Main-Track Derailment

Canadian National
Freight Train A-435-31-14
Mile 6.0, Oakville Subdivision
Mimico, Ontario
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Report Number R06T0153

Summary

On 14 July 2006, at approximately 1348 eastern daylight time, Canadian National westward freight train A-435-31-14, travelling from Toronto, Ontario, derailed seven cars at Mile 6.0 of the Oakville Subdivision near Mimico, Ontario. The derailment occurred while the train was passing over a switch. Derailed equipment fouled the three main tracks. There were no dangerous goods involved and no injuries.

Ce rapport est également disponible en français.

Other Factual Information

On 14 July 2006, at approximately 1330 eastern daylight time,[1] Canadian National (CN) freight train A-435-31-14 departed CN MacMillan Yard, Toronto, Ontario, travelling westward destined for Windsor, Ontario. 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.

At approximately 1348, at Mile 6.0 of the CN Oakville Subdivision, near Mimico, Ontario, the train passed over a recently installed turnout. As the train travelled over the switch at a speed of 27 mph, an in-train emergency brake application occurred. The crew detected no abnormalities as their locomotive passed over the switch. After coming to a stop and conducting the required emergency procedures, the crew inspected the train and discovered that 7 non-regulated cars had derailed (72nd car to 78th car) from their 129-car train. The derailed cars were fouling all main tracks adjacent to the GO Transit passenger loading platform at Mimico Station (see Photo 1).

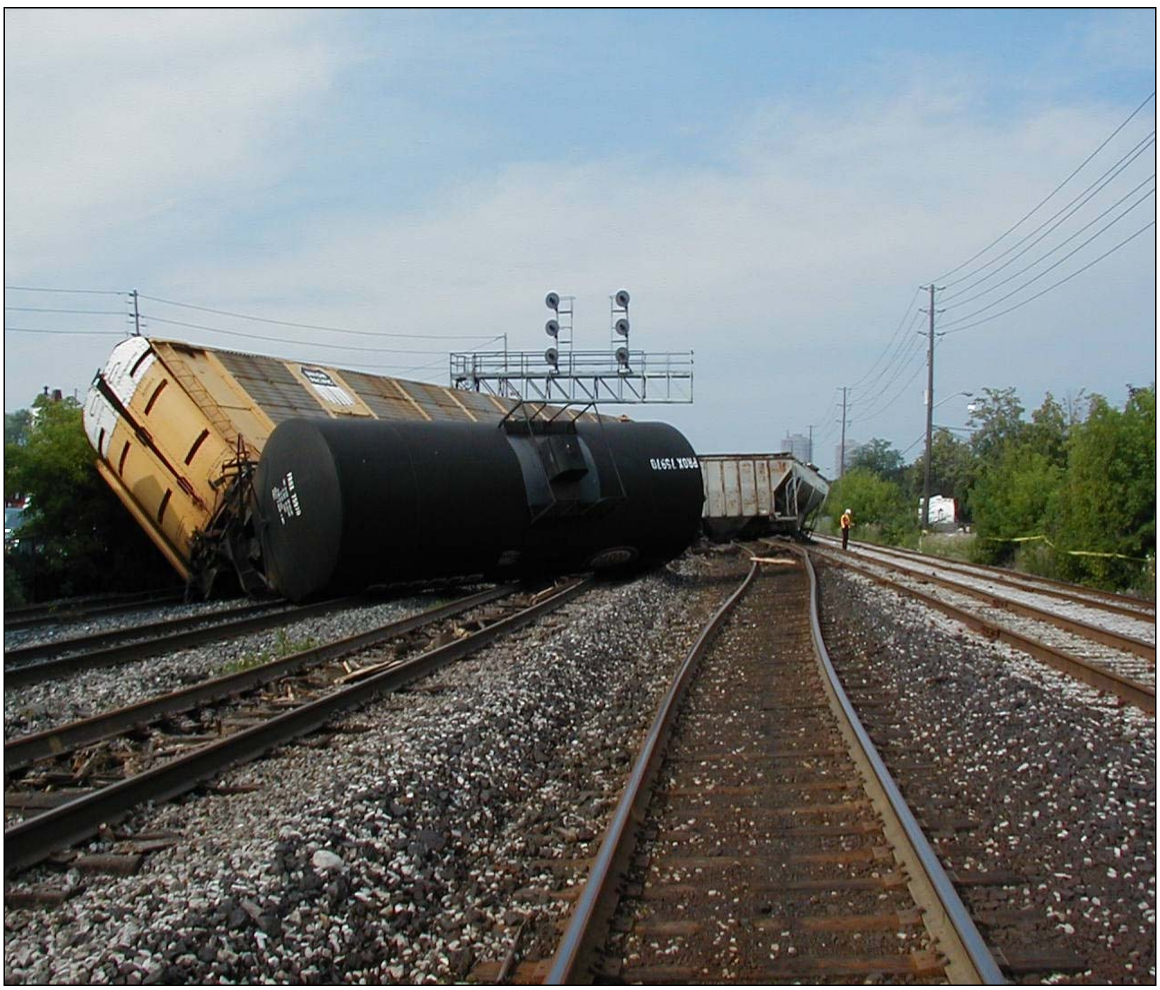

Photo 1. Derailed cars blocking main-line tracks

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1 All times are eastern daylight time (Coordinated Universal Time minus four hours).

The train had derailed at a track buckle in an area of track that had undergone recent upgrades in the form of a new turnout installation and track resurfacing.

At the time of the occurrence, the weather was clear and the temperature was 29°C.

Train Information

The train was 8351 feet long, weighed approximately 10636 tons and was powered by three locomotives. The train consisted of 68 loaded and 61 empty rail cars.

Method of Train Control

On the Oakville Subdivision, train movements are governed by the Centralized Traffic Control System (CTC) of the *Canadian Rail Operating Rules* (CROR) and are supervised by a rail traffic controller (RTC) located in Toronto.

Locomotive Event Recorder Information

At 1345:13, the train was proceeding at approximately 38 mph with the brakes fully released. Over the next 2 minutes and 10 seconds, the throttle was reduced from position 8 to the idle position. At approximately 1348:08, while travelling at a speed of 27 mph with brakes fully released, the train experienced a train-initiated emergency brake application. The head end of the train came to a stop at 1348:33.

Particulars of the Track

The Oakville Subdivision is Class 4 track. The authorized maximum speed on the Oakville Subdivision is 80 mph for passenger trains and 60 mph for freight trains. In the vicinity of the derailment, the main tracks consisted of 136-pound continuous welded rail (CWR). The rail was laid on hardwood ties with double-shouldered tie plates and was box-anchored every second tie. The ballast was a mixture of slag and crushed rock.

Site Inspection Following the Derailment

In the vicinity of the derailment, recent track surfacing had occurred. The track was covered with crushed ballast that partially obscured the view of the ties, tie plates and rail anchors.[2]

The turnout at Mile 6.0 had been recently installed. However, the switch had been clamped and spiked to allow through traffic only. In the vicinity of the switch, box-anchoring on every tie (that is, four rail anchors per tie with two anchors on each side) extended 50 feet in each direction from the switch. Beyond 50 feet, the ties were box-anchored every second tie.

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2 Rail anchors are devices applied onto the base of the rail adjacent to the sides of the tie to help restrain longitudinal movement of the rail.

East of the switch, the track structure had shifted laterally (approximately 12 inches), forming an "S" shape (see Photo 2). In addition to the buckled track and damaged turnout, approximately 650 feet of the three main-line tracks was damaged during the derailment.

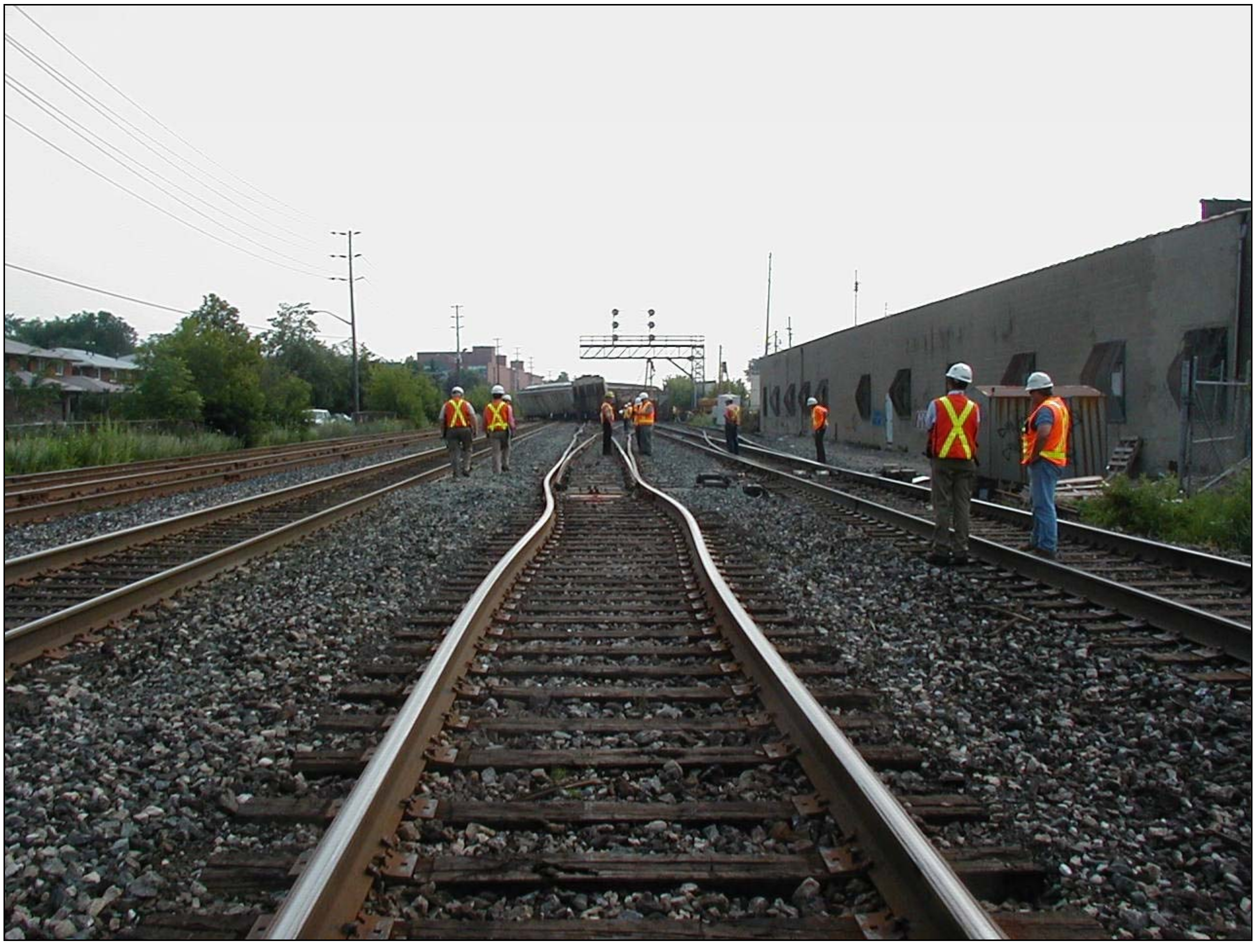

Photo 2. Track buckle at turnout (Mile 6.0)

Canadian National's Box-Anchoring Requirements at Turnouts

Continuous welded rail expands when it is heated and contracts in cooler temperatures, generating longitudinal compressive forces and longitudinal tensile forces respectively. These forces can be considerable and must be restrained to prevent track buckles in the summer and pull-aparts in the winter. Rail anchors and embedded track ties work together to minimize the effects of these internal longitudinal rail forces. In areas where the rail comes up against a rigid structure (for example, a road crossing or turnout), sufficient rail anchors are installed to ensure that the rail longitudinal forces are appropriately distributed in the track and are not concentrated against these rigid structures.

CN's Standard Practice Circular (SPC) 3500 specifies the rail anchoring requirements for ensuring adequate longitudinal restraint of rail at turnouts. The specific instructions include

- On main track or in CWR territory:
  - Fully anchored on both tracks through turnouts (except where anchors will interfere with switch points).
  - Fully anchor for 200 ft (60 m) in both directions beyond the turnout.
- On other tracks, sufficient number of rail anchors to restrain rail movement affecting switch points and frogs.

Railway Track Safety Rules

The *Railway Track Safety Rules*, approved by the Minister of Transport in March 1992, prescribe the minimum safety requirements for railway track that is part of the general railway system of transportation. *Railway Track Safety Rules* criteria relating to the adequate longitudinal restraint of rail at turnouts and track crossings are listed below:

- Rail Anchoring – A sufficient number of anchoring devices will be applied to provide adequate longitudinal restraint (refer to *Railway Track Safety Rules*, Part II, Subpart D (VII)).

- Turnouts and Track Crossings Generally – In turnouts and track crossings, the fastenings must be intact and maintained so as to keep the components securely in place. Also, each switch, frog, and guard rail must be kept free of obstructions that may interfere with the passage of wheels (refer to *Railway Track Safety Rules*, Part II, Subpart D (XI (a)).

- Turnouts and Track Crossings Generally - Classes 4 through 6 track must be equipped with rail anchors through and on each side of track crossings and turnouts, to restrain rail movements affecting switch points and frogs (refer to *Railway Track Safety Rules*, Part II, Subpart D (XI (b)).

Turnout Installation

At the time of the derailment, there was an ongoing work program to upgrade the track infrastructure in the area to facilitate the movement of GO Transit trains. This work included the installation of a new turnout in the vicinity of the derailment. Although the turnout was requested and paid for by GO Transit, CN was responsible for the design, installation and commissioning of the turnout.

The turnout at Mile 6.0 was installed between 18 February and 21 February 2006. This installation was conducted over four consecutive nights due to limited track time in this busy corridor and due to the logistical challenges associated with moving the pre-fabricated track panels into position. At the end of the fourth night, the switch was clamped and spiked out of service because the switch was not immediately required and the appropriate signal upgrades were still to be completed.

Although the work gang had not completed box-anchoring the rail (every tie) for 200 feet before and after the switch as required by SPC 3500, they assumed that a second work gang would be arriving shortly to clean up the area around the turnout and to complete the box-anchoring of the rails. The second work gang visited the site several days after the completion of the turnout installation. However, this work gang did not complete the box-anchoring of the rails.

The documentation provided to these work gangs for the purpose of the turnout installation consisted of an approved engineering drawing of the turnout and CN's SPCs involving turnout installation. Communication between the two gangs with respect to which aspects of the job were completed or remained to be completed was verbal. No written documentation was required upon completion of a job or upon handing a job over to the other work gang.

At the end of February 2006, CN's Production Supervisor, who had overall responsibility for the turnout installation, conducted an inspection of the work. During this inspection, with the ties and anchors partially obscured by excess ballast, the Production Supervisor did not note the unfinished box-anchoring. The Production Supervisor believed that the installation had been completed with the exception of some welding left to be done and did not inspect further.

Between 21 February 2006 (when the first work gang completed the installation of the turnout) and up to the date of the derailment, the track in the area of the turnout was repeatedly inspected. These inspections included the twice weekly inspections by the Assistant Track Supervisor, monthly inspections by the Acting Track Supervisor, and a hi-rail inspection by the Transport Canada Rail Safety Inspector. Despite these repeated inspections, the unfinished box-anchoring was not identified.

Resurfacing Turnouts on the Oakville Subdivision

Another work program that took place on the Oakville Subdivision around the time of the derailment involved resurfacing the turnouts. This resurfacing work at the turnout (Mile 6.0) was conducted on July 10 at night due to traffic considerations and to provide cooler working temperatures for a maintenance activity that disturbs the track bed.

Some time before the arrival of the resurfacing gang, the track bed had been flooded with additional ballast. Before commencing the work on the track, the foreman inspected the track geometry in the vicinity of the turnout. The unfinished box-anchoring was not noted during this inspection or during the work.

Upon completion of the resurfacing work, a slow order of 10 mph was placed on the track (as required by SPC 3705). After the appropriate amount of traffic (tonnage) had passed over the track, the 10 mph slow order was removed and a second slow order (25 mph) was put in place. The 25 mph slow order was removed on the morning of the derailment at approximately 1000. With respect to the removal of slow orders, Section 23 (f) of SPC 3705 states that

> Prior to increasing or removing a speed restriction, the track must be inspected to ensure appropriate anchorage exists and that there are no signs of tight rail as per SPC 3205, clause 42. Verification must also be made that the required tonnage actually passed over the track being restricted. Speed restrictions should not be removed in the heat of the day.

Despite the requirement to inspect the track to ensure appropriate rail anchoring, the unfinished box-anchoring was still not noted before removing either slow order.

SPC 3705 does not define the term "heat of the day." It was indicated that this term is generally interpreted as the time at which the maximum ambient and rail temperature occurs. However, information gathered during the investigation revealed that different individuals had different ideas of how this phrase should be interpreted. Environment Canada records indicate that, on the day of the occurrence, the temperature in Toronto at 1000, when the slow order was removed, was 27.7°C. On that day, the temperature had risen steadily from an overnight low of 20.5°C at 0500, reaching a high of 30.2°C at 1500.

Inspection and Maintenance Activities on the Oakville Subdivision

Day-to-day inspection and maintenance activities were conducted by local or divisional forces with responsibility for a defined area of track. These individuals worked under the supervision of the Senior Manager of Engineering who reported to the Subregional General Manager, with an additional reporting requirement to the Regional Chief Engineer. Each portion of track was under the direction of a Track Supervisor who oversaw one or more Assistant Track Supervisors.

In the area of the derailment, there had been some turnover in personnel during the time period between the day the switch was installed and when the derailment occurred. During this period, the Track Supervisor responsible for the territory had left the company. In the interim, one of the Assistant Track Supervisors for the Oakville Subdivision was acting in the capacity of Track Supervisor, in addition to performing his normal Assistant Track Supervisor duties. All were qualified track inspectors pursuant to the *Railway Track Safety Rules* and all possessed the necessary experience and knowledge for their duties.

Construction projects (for example, the installation of a new turnout) were performed under the supervision of the Division Engineer. Planning and implementation of these projects were performed by the Program Supervisor. Direct supervision of specific jobs within a project was carried out by a Foreman who reported to the relevant Program Supervisor. In the case of the turnout installation at the occurrence site, the work was conducted by two separate work gangs over multiple nights, which required coordination between the two gangs.

Track rehabilitation projects (for example, track resurfacing) were conducted under the authority of the Manager, Track Services and the Assistant Superintendent, Track Services. Specific projects were planned and organized by Program Supervisors and carried out by assigned Track Services Foremen.

Close coordination between these three groups was often required. For example, with respect to the turnout installation, local forces were required to inspect and maintain the turnout once it was completed. As such, they were required to know, among other things, what work on the turnout had not been finished and when this work was likely to be completed. With respect to the track resurfacing, local forces were involved in placing the required slow orders and in removing the slow orders. Slow order decisions were based on the results of inspections conducted after the work was completed. Day-to-day communication between these three groups for the purpose of coordinating work was mostly verbal and informal.

Canadian National's Turnout Inspection Requirements

CN's SPCs outline the standards and procedures for track construction, maintenance and inspection. SPC 3100 (and the *Railway Track Safety Rules*) require that Class 4 track be inspected twice weekly with a minimum of two track geometry car tests annually. In addition, SPC 3500 identifies three types of turnout inspection and their required inspection frequency. These inspections are defined as Routine, Walking and Detailed:

- Routine: Every time the turnout is crossed, it shall be visually inspected for defects.
- Walking: Turnouts shall be inspected on foot at least monthly, 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.

Factors Contributing to Maintenance Errors

Maintenance activities, by necessity, involve the disruption of system components. Due to these disruptions, they provide significant opportunity to introduce unsafe conditions into the system. Reason and Hobbs (2003)[3] provide a review of the types of errors observed in maintenance activity and examine methods of controlling the probability of a maintenance error.

In this occurrence, the turnout installation had not been completed in accordance with the railway's SPC. Specifically, the rail had not been properly box-anchored (that is, every tie for 200 feet before and after the switch). This type of error is known as an error of omission (that is, an error where something that should have been done was not completed). This form of error is not uncommon in maintenance and installation activities. Studies conducted in both nuclear power plants and aircraft maintenance facilities have consistently determined that errors of omission were the most common types of errors observed. In addition, these studies

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[3] J. Reason and A. Hobbs, *Managing Maintenance Error: A Practical Guide*, Burlington, VT: Ashgate, 2003.

determined that the primary factors contributing to these types of errors include poor documentation, time pressures, bad procedures, fatigue, and lack of coordination/ communication.

The importance of communication and coordination between different groups involved in a maintenance task was also underscored in an Australian survey of problems observed in an aviation maintenance environment. In that study, 12 per cent of the reported occurrences involved coordination problems between individuals or groups. In several cases, it was observed that people made assumptions about a job and then failed to confirm those assumptions with others.

Steps taken to prevent errors of omission include memory aids (for example, checklists), job specifications, independent checks, and sign-offs of maintenance work. Steps that can be taken to prevent coordination problems when multiple individuals or groups are involved in a maintenance task or when a maintenance task is spread out over a period of time include clear documentation and record keeping. These records should indicate who is responsible for specific task elements or which task elements require sign-off as they are completed.

Analysis

The method of train operation was not a contributing factor in this occurrence. The analysis will focus on the turnout installation project, track resurfacing project and related inspection and maintenance practices.

The Derailment

The train derailed as it passed over the turnout at Mile 6.0. This recently installed turnout had been constructed by two work gangs over multiple days in mid-February 2006. In this occurrence, insufficient rail anchors had been applied at the time of installation. Box-anchoring (that is, four rail anchors per tie) extended for only 50 feet in each direction from the switch. To adequately restrain longitudinal expansion and contraction of the rail, the railway's SPC requires that the track be fully anchored for 200 feet in both directions beyond the turnout.

While rail anchors are essential for counteracting longitudinal thermal expansion forces in rail, this condition (that is, insufficient rail anchoring) was not unsafe during the turnout installation period. Due to the cooler temperatures in mid-February, thermal expansion forces in the rail would not have been a problem. However, this condition became unsafe several months later with the warm summer temperatures and with the presence of disturbed track due to a resurfacing project performed at this location the week before the derailment.

With unrestrained, high thermal expansion forces in the rail, the track buckled east of the turnout (Mile 6.0) resulting in the derailment. Specifically, the track buckled under the load of the train as a result of increased longitudinal rail forces, insufficient rail anchoring, and a destabilized track structure.

Turnout Inspection

There were numerous opportunities between February 2006 and the derailment in July 2006 to identify the deficiency. The rail anchors in the vicinity of the turnout may have been obscured by ballast for a short period immediately after the turnout installation and for a short period just before the derailment when track surfacing was being performed. However, frequent inspections (at least twice weekly) were conducted between February and July and these inspections did not identify the unfinished rail anchoring.

Removal of Temporary Slow Orders

Temporary slow orders (TSOs) are placed at track locations where maintenance or construction activities have disturbed the track surface. These TSOs reduce train speed to allow the trains to travel safely over the disturbed track. With sufficient train traffic (that is, tonnage) over the track, the ballast will reconsolidate, thereby restoring track stability.

In this occurrence, track resurfacing had been performed at this turnout on July 10. Following this resurfacing, a TSO for 25 mph was placed on the track at this location. This TSO was removed at 1000 on the morning of the derailment. SPC 3705 states that TSOs are not to be removed "in the heat of the day." However, the SPCs do not define the term "heat of the day." At CN, this term is generally interpreted as the time at which the maximum ambient and rail temperature occurs. Although rail temperature is normally correlated to ambient temperature, rail temperature can also increase further through sustained, direct exposure to the sun.

On July 14, the day of the derailment, the ambient temperature at 1000 had not reached the maximum recorded temperature of the day (that is, a temperature of 30.2°C at 1500). As such, based on CN's general interpretation, the 25 mph slow order had not been removed during "the heat of the day."

Despite following the required procedure for placing and removing slow orders after a maintenance activity, a track buckle occurred. Due to the warm temperatures that day (and in the days leading up to the derailment), the rail had absorbed sufficient thermal energy to destabilize the track structure. Without adequate rail anchoring in place, additional ballast consolidation would not likely have been enough to restrain the thermal expansion forces in the rail. Therefore, even if the slow order had been removed later in the day, the track buckle would still likely have occurred under train loading due to inadequate rail anchoring.

Project Management of Work Programs

When the turnout was installed, it was not box-anchored as required by CN's SPC. This form of error, where a step is missed or left out, is one of the most common forms of error in maintenance activities. Lack of coordination between individuals conducting the maintenance activity is known to be a frequent contributor to this type of error. The most common and effective form of defence for coordination problems during maintenance consists of effective documentation. The documentation should set out the specific task elements to be completed and should require the signature of a qualified person upon task completion. This form of documentation facilitates the handover of a task between different groups and encourages a final inspection upon completion of a task.

In this occurrence, communication between the three groups involved in the installation of the turnout (that is, local forces, installation gang and clean-up gang) was undocumented and informal. There was no formal handover procedure between the crews conducting the work and there was no formal sign-off procedure when the work was completed. This informal procedure allowed assumptions about which group would complete the box-anchoring to go unchallenged, increasing the risk of an error of omission.

Work Plan Timeline

Although there was an overall project plan for the track and signal modifications, there was no detailed work plan in place for individual tasks within the plan. The documentation provided to the work gangs for the purpose of the turnout installation consisted of an approved engineering drawing and CN 's SPCs related to turnout installation. While the absence of a detailed work plan allowed scheduling flexibility for the work gangs, it also created a situation where the installation task was allowed to be completed over several months. In fact, the turnout installation was still not complete up to the day of the derailment. The lack of a specific completion time led to a situation where no one was alert to those aspects of the job that remained incomplete. The absence of a detailed work plan allowed a lengthy period of time to elapse between the start and completion date, increasing the risk that unfinished work would go undetected.

Findings as to Causes and Contributing Factors

1. The train derailed due to a track buckle in the vicinity of a recently installed turnout.

2. The track buckle occurred as a result of increased longitudinal rail forces, insufficient rail anchoring in the vicinity of the turnout, and a destabilized track structure that was unable to restrain the thermal expansion forces.

3. Multiple turnout inspections in the six months before the derailment failed to identify the unfinished box-anchoring.

Findings as to Risk

1. Informal communication procedures between work gangs allows assumptions about which gang would complete what portions of the work to go unchallenged and unverified, increasing the risk of a maintenance error of omission.

2. The absence of a detailed plan (that is, with timelines) during a major work program may allow a lengthy period of time to elapse between project start and task completion dates, increasing the risk that unfinished work will go undetected.

Other Findings

1. Although Canadian National's (CN) Standard Practice Circulars (SPCs) specify that slow orders should not be removed "in the heat of the day," they do not contain any guidance with respect to what constitutes "heat of the day."

2. Had the slow order been removed later in the day, the track buckle would still likely have occurred under train loading due to inadequate rail anchoring.

Safety Action Taken

On 21 July 2006, Transport Canada issued a Notice and Order specifying that

> In the Province of Ontario, CN Rail ensure that trains are not operated at a speed in excess of 10 MPH for freight and 30 MPH for passenger, in CWR territory on any track that it maintains where construction of a line work is undertaken, or where the following track maintenance activities are undertaken:
>
> - Mechanized tie renewal
> - Panelized turnout replacement
> - Out-of-face surfacing
> - Ballast cleaning
> - Undercutting
> - Shoulder cleaning
> - Lining
>
> Otherwise than under the following terms and conditions;
>
> Such line work has been inspected by a qualified track supervisor, and is deemed by said person to be safe to proceed at a speed greater than above, and CN Rail's Regional Chief Engineer gives written approval for the increase in speed. These written approvals will be maintained by CN Rail, and be made available for review by the department upon request.
>
> Or, until the threat is removed.

Following implementation of the Notice and Order, Transport Canada met with senior managers at Canadian National (CN) to develop an action plan to improve the quality control process for verifying the completeness of maintenance work. The following safety action was implemented by CN, leading to the removal of the Notice and Order on 08 August 2006:

- A temporary slow order (TSO) reduction checklist was developed and circulated to all relevant track maintenance personnel. This checklist will ensure that all aspects of CN's Standard Practice Circulars (SPCs) (including rail anchor requirements) will have been met before any speed increase.

- All turnouts were inspected to ensure that anchors have been properly installed as per the regulations and SPCs.

- A procedure was modified to ensure that no turnouts would be resurfaced unless the rail anchor pattern complies with the SPCs.

- A procedure was modified to ensure maximum compaction of any disturbed ballast (that is, before a TSO is removed). Specifically, the number of passenger trains to be considered equivalent to one loaded freight train was increased from 6 trains to 12 trains.

- CN Track Inspectors were re-qualified to ensure full understanding of regulations and to sensitize the inspectors to the contributing factors that lead to track buckles.

- A joint inspection process was implemented for CN Track Services personnel to ensure that all aspects of a maintenance or construction project are completed according to the SPCs and Transport Canada regulations. This process requires communication and sign-off between the Track Supervisor and the Program Supervisor.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 28 March 2007.