Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT
R10T0056

MAIN-TRACK DERAILMENT

CANADIAN NATIONAL
TRAIN M37631-30
MILE 1.40, YORK SUBDIVISION
PICKERING, ONTARIO
30 MARCH 2010

Canada

Railway Investigation Report

Main-Track Derailment

Canadian National
Train M37631-30
Mile 1.40 York Subdivision
Pickering, Ontario
30 March 2010

Report Number R10T0056

Summary

At approximately 1500 Eastern Daylight Time on 30 March 2010,Canadian National freight train M37631-30 was proceeding eastward from Toronto to Montreal, when 4 of its locomotives and 11 of its cars derailed near the GO Train station at Mile 1.40 of Canadian National's York Subdivision in Pickering, Ontario. The fuel tank on one of the locomotives was punctured and released approximately 50 litres of diesel fuel which caught fire. The fire was quickly extinguished by the local fire department. There were no dangerous goods involved and no injuries.

Ce rapport est également disponible en français.

Other Factual Information

At approximately 1000[1] on 30 March 2010, westward VIA Rail Canada Incorporated (VIA) passenger train 57 (VIA 57) departed from Montreal, Quebec, destined for Toronto, Ontario. The train was composed of 1 locomotive and 5 coaches. VIA 57 carried 114 passengers and 5 crew members which included 3 on-board service personnel and 2 locomotive engineers; 1 engineer was in charge of the train and the other operated the locomotive. Both locomotive engineers were qualified for their respective positions, and familiar with the territory.

At approximately 1245 on 30 March 2010, eastward Canadian National (CN) freight train M37631-30 (CN 376) departed from CN MacMillan Yard in Toronto, destined for Montreal. The train consisted of 149 cars, weighed 12 166 tons and was 9383 feet long. The crew consisted of a locomotive engineer and a conductor; both were familiar with the territory, met fitness and rest standards, and were qualified for their respective positions.

CN 376 was powered by three, 6-axle, direct current (DC) General Motors (GM) locomotives, all located at the head-end of the train. Two were SD70M-2 locomotives, each capable of generating 4300 hp, and the third was a SD70I that can generate 4000 hp. All 3 were equipped with extended range dynamic brakes (DB)[2] capable of generating nearly 90 000 pounds of DB braking effort, or 270 000 pounds total. The 3 lead locomotives were immediately followed by 4 isolated[3] GM F59 (Type F) locomotives. The GM F59 locomotives were previously used in GO Transit passenger service and were being transferred from Toronto to Montreal.

The locomotive event recorder (LER) data revealed that CN 376 stopped at Mile 12.63 for a short time, then continued eastward at 1430:59. Its speed was primarily controlled by a combination of throttle modulation and DB application. The throttle was changed one notch at a time and DB adjustments were made in a smooth and steady manner as it descended the grade towards the Kingston Subdivision.

By 1439:14, CN 376 had proceeded to Mile 9.64 and was travelling at 39 mph with the throttle in idle and the DB in position 5. Over the next 14 minutes, the throttle remained in idle and DB was manipulated between positions 5 and 8 to control train speed. As the train approached Pickering, CN signal 014 displayed a "clear to stop" signal for CN 376 indicating that it should be prepared to stop, prior to Pickering Junction, for approaching VIA 57. CN 376 was subsequently advised that VIA 57 had cleared Pickering Junction. This would have allowed the Rail Traffic Controller (RTC) to permit CN 376 to access switch No. 1, which was protected by a 25 mph temporary slow order, thus enabling the train to cross over onto the Kingston Subdivision.

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[1] All times are Eastern Daylight Time (Coordinated Universal Time minus 4 hours).

[2] The dynamic brake is a locomotive electrical braking system that converts the locomotive traction motors into generators to provide resistance against the rotation of the locomotive axles. Energy is produced in the form of electricity and is dissipated as heat through the dynamic brake grids. This brake can be used alone or in conjunction with the train air brake system.

[3] "Isolated" locomotives are not powered and, when isolated, react as a freight car in the train.

By 1453:25, CN 376 had reached Mile 1.54 and was travelling at 29 mph with the throttle in idle and the DB in position 8 (maximum). CN 376 continued with these settings and slowly decelerated to a speed of 23 mph by 1454:42. At 1454:44, the DB was placed into position 5 for 2 seconds then moved back into position 8 when CN 376 experienced a train-initiated emergency brake application at 1454:47. CN 376 came to a stop at 1455:00 near Pickering, Ontario (see Figure 1), after which the crew immediately made an emergency radio broadcast and initiated emergency procedures.

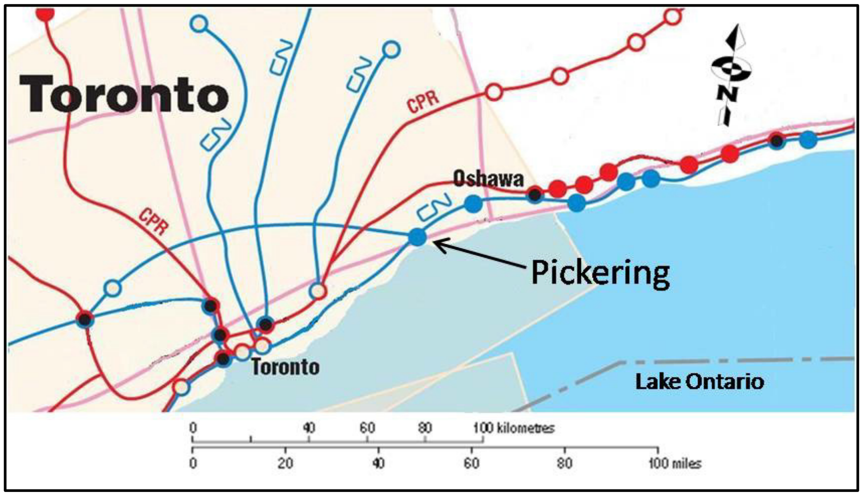

Figure 1 - Derailment Location (Source: Railway Association of Canada, *Canadian Railway Atlas*)

At about the same time, VIA 57 was approaching from the east on the Kingston Subdivision north track at 60 mph. The normal speed for VIA 57 in this area is 100 mph but a “clear to limited” signal on the approach (signal 3129N) required the train to reduce its speed in preparation for a crossover to the south track, further west at Durham Junction. The VIA 57 crew observed CN 376 derailed ahead of them on the York Subdivision with cars across both Kingston Subdivision tracks and initiated emergency braking just as the emergency radio broadcast was made. VIA 57 came to a stop approximately 1500 feet east of the derailment area and was later permitted to reverse to Oshawa to facilitate passenger transfer. There were no injuries.

After emergency procedures were initiated, it was determined that the 4 isolated locomotives and the first 11 cars had derailed with several of the cars foul of both the north and south tracks of the Kingston Subdivision. The fuel tank on the fourth isolated locomotive, RBRX 18540, was punctured and approximately 50 litres of fuel was lost and ignited. The fire was quickly extinguished by the responding fire department and the remaining leaked fuel was contained and captured. There were no injuries.

At the time of the occurrence, it was 11°C, the sky was cloudy and there was a light wind from the north.

Site Examination

Approximately 125 feet east of the Liverpool Road overpass, the York Subdivision track had shifted about 8 inches to the south. The track shift extended for 150 feet up to Mile 1.40. Within this area, the south rail had lifted out of the tie plates, was canted and rolled. Wheel flange marks were observed on the ties extending eastward from Mile 1.40 for a further 550 feet up to the trailing truck of the first isolated locomotive, RBRX 18536. About 700 feet of track on the York Subdivision and 180 feet of parallel track on the Kingston Subdivision north track were damaged.

All locomotives and the first freight car (loaded covered hopper) had separated from the remainder of CN 376. The lead locomotive came to rest approximately 1000 feet east of the Liverpool Road overpass. The trailing truck of the first isolated locomotive, RBRX 18536, and all wheels of the following 3 isolated locomotives and the freight car were derailed. There was a short separation followed by the 2nd to the 11th cars which had also derailed. Five of the cars had jackknifed and were foul of both Kingston Subdivision tracks. A centre beam flat car, loaded with lumber, came to rest in the Pickering GO station parking lot (see Figure 2).

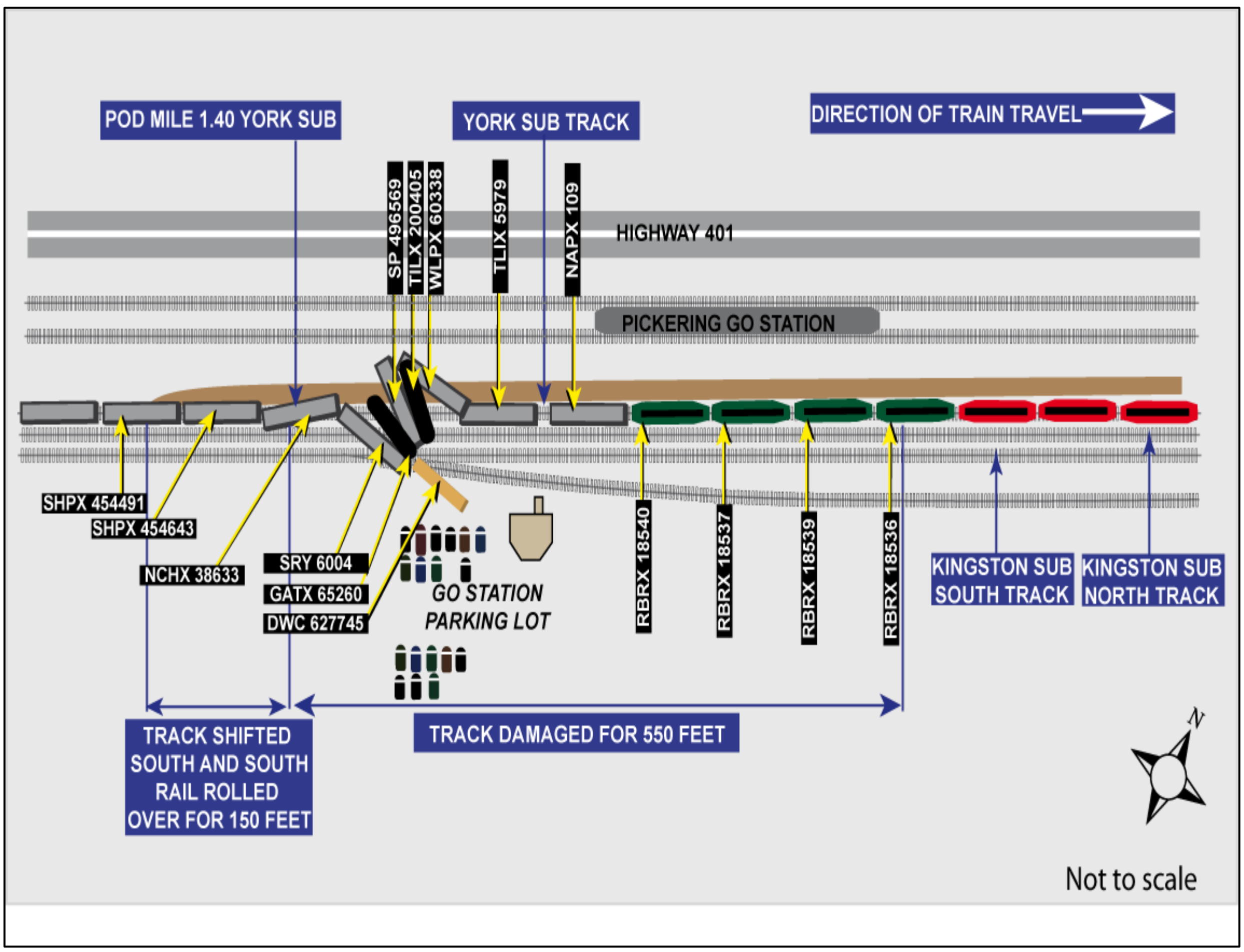

Figure 2 – Site Diagram

Initial visual inspection of the derailed equipment revealed that all 4 of the isolated locomotives were equipped with pin type couplers with no alignment control features (see Figure 4). The sill housings and the coupler shanks of the couplers which connected the second and third isolated locomotives displayed significant damage as a result of contact. There were no other pre-existing conditions or defects observed on any other of the derailed rolling stock that could be considered as causal.

Subdivision Information

The York Subdivision extends from MacMillan Yard (Mile 25.0) east to Pickering Junction (Mile 0.0) where it joins the Kingston Subdivision. From about McCowans (Mile 12.20) to Pickering Junction, the track is on a long descending grade varying between 0.0% and 0.81% with several curves prior to the accident area.

Maximum permissible speed for freight trains is 50 mph; however, the speed had been reduced to 30 mph through the derailment area. In this same area, the York Subdivision runs parallel and adjacent to the Kingston Subdivision. Trains on the York Subdivision can enter the Kingston Subdivision via crossover No. 3 at Mile 1.52 on the York Subdivision or further east at switch No. 1 at Pickering Junction.

The Kingston Subdivision consists of double main track, extending from Mile 10.3, Dorval, Quebec, to Mile 333.8, Toronto. It is a main corridor for passenger and freight traffic. The maximum permissible track speed is 100 mph for passenger trains and 65 mph for freight trains. Train movements on both the York and Kingston Subdivisions are controlled by the Centralized Traffic Control System (CTC), authorized by the *Canadian Rail Operating Rules* and supervised by an RTC located in Toronto.

The track throughout the derailment area consists of 136 lb rail laid on 14 inch double shoulder tie plates fastened on hardwood ties with spikes and anchored every second tie. The cribs were full, the ties and ballast were in good condition. The track was inspected in accordance with company and regulatory requirements with no defects noted.

Industry Locomotive Marshalling Practices

The Association of American Railroads (AAR) states in part, in Section 8.2 of its report R-802 (January 1992) entitled *Train Make-up Manual*, that locomotives that are not equipped with coupler alignment control can be a problem because of their tendency to jackknife when placed behind other locomotives that can generate large dynamic brake forces. Many railroads maintain a list of affected locomotives and limit the number that may be used to 1 or 2 locomotives without the alignment control feature.

Most freight locomotives are equipped with alignment control couplers (see Figures 3 and 4) and bolster stops that limit coupler swing. Alignment control couplers limit the coupler angle under buff conditions, to within 8° from centreline. This limits the lateral force imparted on the track due to high in-train longitudinal compressive buff force and reduces the risk of derailment. In contrast, some older locomotives, yard switchers and locomotives in passenger service, such as the 4 isolated locomotives on CN 376, are not always equipped with alignment control couplers. The absence of these features provides locomotives with a greater range of coupler movement (i.e. larger coupler angle) for negotiating tighter curves that are commonly found in train yards, passenger and/or transit service. In these operations, train weights and lengths are relatively low with similarly reduced buff and draft forces that act upon the train.

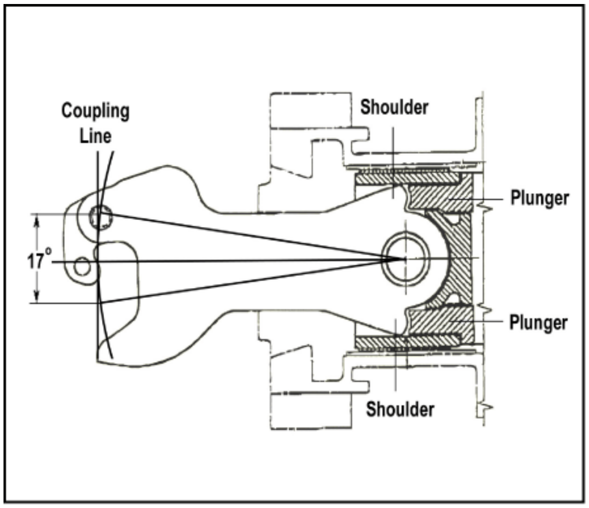

Figure 3 – Alignment control coupler

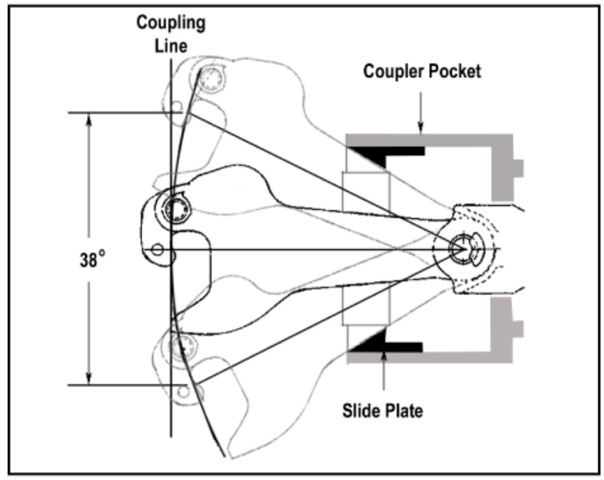

Figure 4 – Coupler without alignment control

GM, the locomotive manufacturer, recommends that locomotives without alignment control features must have bolster stops applied to allow operation in locomotive consists with other locomotives capable of high dynamic braking effort. The recommendations apply whether the locomotives are powered or are isolated in the consist.

Canadian Pacific Railway's (CPR) General Operating Instructions (GOI), Section 15, Item 5.0 entitled "Handling of Locomotives NOT equipped with Coupler Alignment Control" lists CPR locomotives series without coupler alignment control. Item 5.3 states "no more than one of these locomotives are to be moved in a locomotive consist". Section 7.4 (B) states that "no more than two dead or disabled (isolated) locomotives described in Item 5.1 may be marshalled in the train and each locomotive must be marshalled between at least 4 loaded cars (two on each side)".

Other than compliance with the *Transportation of Dangerous Goods (TDG) Act and Regulations*, there are no Transport Canada (TC) regulatory marshalling restrictions for rolling stock that is not equipped with alignment control features.

CN Locomotive Operating Manual and GOI

The CN *Locomotive Engineer Operating Manual* Form 8960 (January 2005) contains the following information, in part:

- Section A1.12.1 contains instructions on marshalling CN yard service locomotives without alignment control couplers but had no reference to foreign (i.e. non CN) locomotives similarly equipped.

- Section A1.12.1 (1) lists CN yard service locomotives by number with instructions that when any of them are "handled in train service behind the working locomotive consist AND trailing tonnage exceeds 4000 tons, it must not have any other locomotive identified in item (1) anywhere in the train behind the controlling locomotive."

- Section F7.1 states that the use of DB is effective in slowing the train for planned stops, speed restrictions and speed control. When DB is available it must be used as the first means of initiating required train braking forces. When DB is in use, the automatic brake may be required to provide additional braking effort. There is no limit on the amount of time spent in DB mode. DB application is to be gradual and incremental, allowing the slack to bunch against the locomotive consist.

- Section F7.3 identifies that the DB controller should be moved through the operating range slowly and smoothly, monitoring the loadmeter to prevent high compression or buff forces throughout the train. Excessive buff forces may result in a derailment or gradual deterioration of the track structure, particularly if the forces occur at a turnout, crossover, point of sharp curvature or other type of track irregularity. To avoid train handling problems, the following DB restrictions must be adhered to:

    - 1 or 2 locomotives in a consist: No DB restrictions.
    - 3 or more locomotives in a consist: DB usage restricted to a maximum of 500 Amps when the head-end is entering a turnout, crossover or curve, until at least half the train has passed through.

- Section F7.7 indicates that the automatic brake can also be used in conjunction with DB at locations where it is desirable to reduce head-end buff forces.

In November 2009, CN published a revised Section G for the *Locomotive Engineer Operating Manual* entitled *Train Handling*. The revisions contained the following more comprehensive instructions:

- Section G1.2 standardized the best practices for train handling throughout CN, the addition of item (iv) is particularly relevant:

    i. Use forward planning for planned stops and speed control;
    ii. Make only incremental/gradual throttle and brake adjustments;
    iii. Control speed using throttle manipulation to the greatest extent possible;
    iv. Select and adjust the throttle, dynamic brake, and air brake in a manner which minimizes in-train and track-train forces; and
    v. Allow slack to gradually adjust within the train before increasing throttle, dynamic brake, or air brake applications.

- Section G2.12 states that DB is an excellent method of speed control, but it is capable of generating high in-train and track-train forces. Because DB concentrates the retarding force at the head-end of the train, there are limits to the amount of braking which should be applied using DB. To avoid excessive force, it may be necessary to use a combination of DB and automatic brake, and/or to implement speed control tactics further in advance. For any given DB handle position, maximum retarding forces occur in the 5 to 30 mph speed range. Extra care must be exercised in this speed range. It further states that adjustments of the DB handle are to be made in a smooth and steady manner.

- Section G2.13 indicates that locomotives can develop very high levels of DB retarding forces capable of damaging the track structure and/or generating excessive buff forces in the train. Either situation can lead to a derailment and therefore, the use of DB must be limited. To respect these limitations, the locomotive engineer must employ speed control strategies farther in advance, and/or use a combination of DB and automatic brake.

- Section G2.13 (1) restricts a head-end locomotive consist to 18 axles with operative DB. In comparison, when operating one or more alternating current (AC) locomotives, the maximum number of operative DB axles in the consist must not exceed 12 axles. High horsepower (4400) AC locomotives are capable of generating up to 98,000 pounds of DB braking effort per locomotive.

- Section G3.3 discusses jackknifing, and operators are instructed to exercise extreme caution when making bunched stops or decreasing speed giving due consideration to grade, curvature and weight distribution of the train consist and to exercise care when using DB without the train air brakes to effect a slowdown or stop, particularly with three or more locomotives in the consist.

Prior to 2003, CN GOI contained special instructions on identifying, marshalling and handling locomotives that are not equipped with alignment coupler control. They stated:

> Extreme caution must be exercised when making bunched stops or decreasing speed, with locomotive consists, giving due consideration to grade, curvature and weight distribution of the train consist. The cautions highlighted in the foregoing are particularly important when:
>
> *(a)* *Any locomotives which are not equipped with alignment control draft gear are in the consist.* [emphasis added]

At some point, these instructions were removed from CN's GOI.

Other Related Occurrences

The TSB has conducted 11 other derailment investigations that involved high in-train forces in long trains (see Appendix A for a summary of TSB investigations R09T0092, R07D0009, R07T0110, R07T0323, R05C0082, R05V0141, R02C0050, R02W0060, R01M0061, R01T0006, and R00W0106). In each case, the Board determined that train marshalling and the management of in-train forces were contributing factors. While most trains were marshalled in accordance with railway and regulatory requirements in place at the time, they were not configured in a way that allowed for the effective management of in-train forces.

Due to the number of occurrences that involve longer, heavier trains, and the inability to safely manage in-train forces, the Board included a systemic safety issue associated with the operation of longer, heavier trains on its Watchlist issued in March 2010. The Watchlist states that "inappropriate handling and marshalling can compromise the safe operation of longer, heavier trains" and calls on railways to "take further steps to ensure the appropriate handling and marshalling of longer, heavier trains."

The TSB has examined 5 CN occurrences involving high in-train buff force on long heavy trains and rolling stock marshalled at the head of the train that was not equipped with couplers with alignment control features - R02C0050, R05D0039, R06W0085, R07T0110 and R07T0323 (see Appendices A and B). In each case, there were no marshalling restrictions for the equipment and high buff forces resulted in excessive coupler angularity which imparted high lateral forces to the track structure and resulted in rail rollover and derailment.

TSB Laboratory Report

The TSB Laboratory conducted several dynamic simulations for this derailment using the most recent track geometry inputs and LER data from CN 376 (report LP 045/2010). The following observations, in part, were made:

- The alignment control couplers on the 3 operating locomotives limited the coupler angle within 8°.
    - The maximum axle lateral force transformed from the in-train buff force at the third operating CN locomotive was about 16 kips, less than the track panel shift resistance of 41 kips.
    - The maximum transformed truck-side lateral/vertical (L/V) ratio on the operating locomotives was about 0.23, well below the rail roll over resistance of 0.63 if the fastening withdrawal resistance of the spikes were ignored.
- The couplers on the isolated passenger locomotives with no alignment control had coupler angles up to 21° in jackknifed positions as measured on the derailed equipment.
    - CN 376 produced the maximum in-train buff forces of 219 kips at the third operating locomotive, CN 8846, and approximately 214 to 218 kips between the second and third isolated passenger locomotives.
    - The maximum axle lateral force transformed from the in-train buff force at the isolated passenger locomotives was 68 kips, far exceeding the track panel shift resistance of 38.5 kips.
    - The maximum transformed truck side L/V ratio occurred between the second and third isolated passenger locomotive and ranged between 1.59 – 1.62, which far exceeded the rail roll over resistance of 0.63.

- The derailment likely would not have occurred had the isolated locomotives been equipped with alignment control couplers or equivalent equipment to limit drawbar angles below 8°.

Analysis

There were no track or rolling stock defects that were causal to the accident. CN 376 was marshalled with 4 isolated passenger locomotives that were not equipped with alignment control couplers, placed behind a locomotive consist equipped with 3 high horsepower locomotives capable of producing up to 270 000 pounds of DB force, with significant trailing tonnage. Each of these factors played a role in the accident. The analysis will focus on alignment control couplers, train marshalling, and dynamic braking.

The Accident

Shortly after CN 376 passed Mile 12.20, the throttle was placed in idle and DB was applied. The train speed was controlled using DB adjustments made in a smooth and steady manner as it descended the grade and negotiated the curves towards Pickering. This eliminated the slack between the cars and produced high in-train buff forces at the head-end of the train. CN 376 approached Pickering travelling at 23 mph with the throttle in idle and the maximum DB applied. Under these conditions, high in-train buff forces generated excessive lateral force between the second and third isolated passenger locomotives, resulting in track panel shift, rail rollover and derailment.

Alignment Control Couplers

Alignment control couplers limit the lateral force imparted on the track due to high in-train longitudinal compressive buff force and reduce the risk of derailment. Locomotives that are not equipped with alignment control features have a tendency to jackknife when placed behind other locomotives that generate high DB forces, particularly when exposed to significant trailing tonnage and subjected to high in-train buff forces. All of these features were present on CN 376.

The alignment control couplers on the operating locomotives limited the coupler angle to 8°, but the non-alignment control couplers on the isolated passenger locomotives had coupler angles of up to 21°. In the presence of high in-train buff forces exceeding 200 kips, the large coupler angle of the isolated locomotives with no coupler alignment control magnified the lateral drawbar force and produced a high L/V ratio that exceeded derailment criterion. Isolated locomotives not equipped with either alignment blocks or alignment control couplers present a higher risk of derailment.

Restrictions on the Marshalling of Specialized Equipment

Inappropriate train handling and marshalling has been flagged on the TSB's Watchlist as one of the safety issues posing the greatest risk to Canadians. Train marshalling and length both affect the magnitude of in-train forces. These forces are increased when locomotives not equipped with alignment control couplers are marshalled at the head end behind locomotives generating high DB forces. For conventional trains the risk increases further where there is significant trailing tonnage. The TSB has investigated at least 3 other similar CN accidents in which these were causal elements. As in this case, there were no company or regulatory marshalling restrictions for foreign rolling stock that were not equipped with alignment control couplers. While CN 376 was marshalled in accordance with CN and regulatory requirements, the placement of the 4 locomotives without alignment control couplers, between the operating locomotives and heavy trailing tonnage, resulted in a configuration highly vulnerable to in-train forces.

It is not unusual for a foreign yard, freight or passenger locomotive to be placed in a train in order to be moved from one location to another. In these situations, the locomotives are not always equipped with alignment control couplers. The CN *Locomotive Engineer Operating Manual* contains instructions for handling the CN yard locomotives without alignment control couplers but has no reference to foreign (i.e. non CN) locomotives similarly equipped. Prior to 2003, CN GOI had special instructions for identifying, marshalling and handling such equipment. However, those instructions were removed sometime later. Consequently, CN had no instructions or bulletins in place for transporting the 4 GO Transit locomotives. The absence of special instructions for identifying, marshalling and handling rolling stock without alignment control features compromised safe railway operations.

Dynamic Brake

From Mile 9.64 until the derailment at Mile 1.40, CN 376 descended a long grade with a series of curves with the throttle in idle and its speed controlled solely by the use of DB. This essentially concentrated longitudinal and braking forces on the isolated locomotives at the head-end and was consistent with past CN operating practice. Prior to the accident, CN's *Locomotive Engineer Operating Manual* was revised and provided locomotive engineers with more discretionary train handling options. In particular, Section F7.7 and revised G2.12 of the manual indicate that it may be necessary to use a combination of DB and automatic (train) brake to avoid excessive force or to provide additional braking effort. However, due to past company operating practices and instructions which promoted the use of DB as the primary method of train control, train crews may have been conditioned to use DB increasing the risk that optimal train handling may not be achieved in all situations.

For conventional trains equipped with head-end power, CN restricts DC locomotive consists with operative DB to 18 axles. Under the same conditions, CN limits high horsepower AC locomotives to 12 axles due to the higher DB braking force generated with AC power. Each 6-axle AC locomotive can generate a DB retarding force of about 98 000 pounds which equates to 196 000 pounds of DB retarding force for 2 AC locomotives. In comparison, the 3 head-end operating SD70 locomotives on CN 376 each had 6 axles and generated a DB retarding force of about 90 000 pounds which equates to 18 driving axles and 270 000 pounds of DB retarding force for the 3 DC locomotives. In this occurrence, the use of dynamic brake contributed to the development of high in-train buff forces which imparted lateral forces on the track that exceeded derailment criterion. Therefore, CN's operative restriction of 18 axles for DC locomotive consists with operative DB may not be adequate to protect against excessive DB retarding forces in all cases.

Findings as to Causes and Contributing Factors

1. High in-train buff forces generated excessive lateral forces between the second and third isolated locomotives resulting in track panel shift, rail roll over and derailment.

2. In the presence of high in-train buff forces, the large coupler angle of the isolated locomotives with no coupler alignment control magnified the lateral drawbar force and produced a high lateral/vertical ratio that exceeded derailment criterion.

3. While CN 376 was marshalled in accordance with CN and regulatory requirements, the placement of the 4 locomotives without alignment control couplers, between the operating locomotives and heavy trailing tonnage, resulted in a configuration highly vulnerable to in-train forces.

4. The absence of special instructions for identifying, marshalling and handling rolling stock without alignment control features compromised safe railway operations.

Findings as to Risk

1. Due to past company operating practices and instructions that promoted the use of dynamic brakes (DB) as the primary method of train control, train crews may have been conditioned to use DB increasing the risk that optimal train handling may not be achieved in all situations.

2. Isolated locomotives not equipped with either alignment blocks or alignment control couplers present a higher risk of derailment.

Other Finding

1. CN's operative restriction of 18 axles for direct current (DC) locomotive consists with operative DB may not be adequate to protect against excessive DB retarding forces in all cases.

Safety Action

Action Taken by Transport Canada

On April 7, 2010, a TC Rail Safety Inspector (RSI) issued a Notice under Section 31 of the Railway Safety Act (RSA) to CN concerning failure to effectively manage in-train forces on freight trains operating on the Kingston Subdivision. CN was requested to advise the TC Surface Ontario regional office by April 22, 2010 on how it intends to resolve these hazards or conditions identified in the Notice.

On April 16, 2010, CN replied to the Notice indicating that it had limited train size on operations between Mile 39.8 (Coteau, Quebec) and Mile 301.6 (Oshawa, Ontario) of the Kingston Subdivision. Furthermore, CN has committed to a progressive implementation of Distributed Power (DP) on the Kingston Subdivision, with the intention that in the future, all trains operating in this area will be equipped with DP.

On May 25, 2010, TC reviewed the corrective measures outlined in CN's response to the TC Notice. TC was satisfied that the hazard and condition posing the threat to safe railway operations had been addressed.

CN is currently operating manifest trains to a maximum of 10 000 feet on the Kingston Subdivision and trains over 8500 feet are DP equipped.

CN will notify TC before implementing any changes to current operating plans on the Kingston Subdivision.

Action Taken by CN

CN issued Great Lakes District Operating Bulletin No. GLD 1043, Handling Locomotives with Non-Alignment Control Couplers (NACC), was issued April 20, 2010:

1. Trailing Tonnage Does Not Exceed 4,000 tons – a maximum of two (2) NACC locomotives may be operated or moved on a train, and must be marshalled immediately behind head-end locomotive consist.

2. Trailing Tonnage Exceeds 4,000 tons – a maximum of one (1) NACC locomotive may be operated or moved on a train, and must be marshalled immediately behind head-end locomotive consist.

In both cases:

a) Dynamic brake is limited to position 5 or less;
b) Independent brake can only be used at speeds below 10 mph.

CN Mechanical Department issued on March 31, 2010 Technical Bulletin 2010-M-07, *Locomotives With Non Alignment Control Couplers*, and subsequently revised it on April 18, 2010. This bulletin calls for a detailed visual inspection of the draft gear and couplers on all non-CN locomotives.

Any non-CN locomotives without alignment control couplers must be retrofitted with coupler alignment blocks, and for GP trucks, the bolster stop must be used to permit movement.

CN initiated a “Process for Assuring Safety of Locomotives with Non-Alignment Control Couplers” effective April 9, 2010. The process is designed to identify foreign locomotives with NACC and to ensure they are properly secured and handled in train service according to company general operating instructions, bulletins and manuals.

This report concludes the Transportation Safety Board’s investigation into this occurrence. Consequently, the Board authorized the release of this report on 24 February 2011.

Visit the Transportation Safety Board’s website (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.

Appendix A – Other Related TSB Investigations Involving In-Train Forces

The TSB has conducted investigations into the following derailments:

1. **R09T0092** - On 21 March 2009, Canadian National freight train M36231-20, proceeding eastward at about 50 mph, derailed 6 cars at Mile 247.20 of the Kingston Subdivision, near Brighton, Ontario. The train was powered by 3 head-end locomotives hauling 137 cars (75 loads and 62 empties). It was approximately 8850 feet long and weighed about 11 845 tons. The train was proceeding east at about 50 mph when a moderate run-out of train slack resulted in a broken knuckle on the 107th car. The train separated into a head-end portion of 107 cars and a tail-end portion of 30 heavily loaded cars. The heavier tail-end subsequently collided with head-end and caused the derailment. The investigation determined that the train was operated in accordance with company and regulatory requirements but weight distribution was not considered and the train was not configured in a way that effectively managed in-train forces.

2. **R07D0009** – On 12 February 2007, Canadian National (CN) freight train M31031-10 derailed eight cars near Drummondville, Quebec. A broken knuckle on the 75th car caused an emergency brake application to propagate to the head-end of the train. The train consisted of 5 head-end locomotives and 105 cars (80 loads and 25 empties), was approximately 7006 feet long and weighed about 10 815 tons. The investigation determined that the marshalling of the train (that is, empties ahead and loads behind) was a contributing factor.

3. **R07T0110** – On 28 April 2007, CN freight train M36321-26 derailed a Herzog track maintenance machine and 21 empty multi-level cars at Cobourg, Ontario. The train consisted of 3 head-end locomotives and a mix of 84 empty and loaded cars. It was 9602 feet long and weighed about 9000 tons. The investigation determined that the marshalling of the train, with placement of a car equipped with non-standard couplers at the head-end of a train with significant trailing tonnage, was a contributing factor.

4. **R07T0323** – On 30 October 2007, CN freight train M38461-29 derailed while stopping to set off a block of intermodal cars at Malport, Ontario. The train consisted of 4 head-end locomotives and 131 cars (59 loads and 72 empties), was approximately 7839 feet long and weighed about 7810 tons. The investigation determined that the marshalling of the train, with placement of equipment with non-standard couplers at the head-end of a train with significant trailing tonnage, was a contributing factor.

5. **R05C0082** – On 27 May 2005, Canadian Pacific Railway (CPR) freight train 277-26 derailed 2 locomotives and 24 cars, including 3 pressure tank cars last containing anhydrous ammonia (UN 1005), near Bowden, Alberta. The train consisted of 2 head-end General Electric AC4400 operating locomotives followed by 2 isolated rear-facing General Motors GP 9 locomotives, 77 cars (22 loads and 55 empties), was 5050 feet long and weighed 4512 tons. The investigation determined that high buff force caused by the abrupt dynamic brake (DB) application and the marshalling of the train, with placement of a locomotive equipped with non-alignment control couplers at the head-end of a train, was a contributing factor. The magnitude of the buff force application was exacerbated by the

marshalling of 18 cars with cushion drawbars immediately behind the locomotive consist. The train was not marshalled in accordance with CPR General Operating Instructions (GOIs).

6. **R05V0141** – On 05 August 2005, CN freight train A47151-05 derailed nine cars, including one load of sodium hydroxide (UN 1824), also known as caustic soda, and eight empty cars near Garibaldi, British Columbia. Approximately 40 000 litres of the caustic soda spilled into the Cheakamus River, causing extensive environmental damage. The train consisted of 5 head-end locomotives, 144 cars (3 loads and 141 empties), and 2 remote locomotives behind the 101st car. It was about 9340 feet long and weighed 5002 tons. The investigation determined that the combination of excessive locomotive tractive effort and trailing tonnage, along with long–short car coupling, produced high lateral forces and a correspondingly high lateral/vertical ratio and wheel lift, causing the train to stringline the curve.

7. **R02C0050** - On 08 July 2002, CN freight train A44251-08 derailed 2 locomotives and the first 27 car bodies. Under braking, the non-alignment couplers on the derailed locomotives permitted maximum drawbar angles of approximately 19°. Buff forces translated through these couplers generated lateral forces which were sufficient to cause rail roll and wheel lift, leading to the derailment.

8. **R02W0060** – On 26 April 2002, CN freight train E20131-24 was departing Winnipeg, Manitoba, along the north main-line track of the Redditt Subdivision. As the train traversed a crossover with the DB applied, eight cars derailed. The derailed equipment included 3 loaded box cars containing dangerous goods. The train consisted of 3 locomotives and 85 cars (76 loads and 9 empties), was 5412 feet long, and weighed 9363 tons. The investigation determined that the run-in of slack from significant trailing tonnage, combined with a sustained DB level, generated buff forces severe enough to initiate wheel lift derailing an empty 80-foot-long bulkhead centre-beam flat car marshalled near the head-end of the train.

9. **R01M0061** – On 06 October 2001, CN freight train M30631-05 derailed 15 cars after striking an automobile on a farm crossing in the township of Drummond, New Brunswick. Seven of the derailed cars were tank cars carrying liquefied petroleum gas (UN 1075). The train consisted of 3 head-end locomotives, 130 cars (60 loads and 70 empties), was about 8700 feet long and weighed approximately 10 000 tons. The investigation determined that an undesired emergency brake application (UDE) occurred when the train struck the automobile. Due to the track profile and train configuration, there was excessive run-in generating high buff forces, resulting in rail rollover and the derailment.

   The report indicated that "CN has equipped six per cent of their locomotive fleet with an end-of-train system that automatically initiates synchronous braking from both the locomotive and the tail-end during emergency and service applications. However, CN and other Canadian railways have not committed to a program which would accelerate the replacement of existing systems with the newer technology. Therefore, the remaining existing locomotives will continue to use older end-of-train units until they reach the end of their service life. Given that Canadian railways are equipped with a relatively young locomotive fleet, and given the evolution of freight train operations to longer trains, the risks inherent to emergency situations on long freight trains will remain unaddressed." Therefore, the Board recommended that:

> Transport Canada encourage the railway companies to implement technologies and/or methods of train control to assure that in-train forces generated during emergency braking are consistent with safe train operation.
>
> (R04-01, issued April 2004)

TC accepted the Board's recommendation and informed its stakeholders. TC noted that CN has adopted Trainlink-ES technology and that approximately 500 road locomotives were equipped by the end of 2006. CPR has adopted enhanced Train Information Braking System (TIBS) technology that includes an end-of-train auto-emergency feature and equipped 94 per cent of its locomotives. All newly purchased road locomotives are to be equipped with the new technology. The Board assessed the response to Recommendation R04-01 as being Fully Satisfactory.

10. **R01T0006** – On 16 January 2001, CN freight train M31031-15 derailed 26 cars near Mallorytown, Ontario. The derailed cars included 2 tank cars loaded with propane. The train consisted of 2 head-end locomotives, 149 cars (76 loads and 73 empties), was approximately 9450 feet long and weighed about 11 700 tons. The investigation determined that a combination of the geometric alignment of the track, train marshalling and the buff forces generated during the emergency brake application resulted in a wheel lift derailment.

11. **R00W0106** – On 16 May 2000, CN freight train E20531-15 derailed 19 of its 136 cars in the vicinity of Mile 155.0 of the Redditt Subdivision. Four of the derailed cars contained dangerous goods. The train consisted of 2 head-end locomotives, 136 cars (51 loads and 85 empties), was approximately 8800 feet long and weighed about 9440 tons. The investigation determined that, during throttle reduction while in a curve on a descending grade, the train experienced a wheel climb derailment that was a result of high lateral forces created by excessive run-in of the rear portion of the train.

Appendix B – TSB Class 5 Occurrences Involving Non-Standard Couplers and In-Train Forces

R05D0039 - On 02 March 2005, CN freight train M31031-02 (train 310) derailed 16 cars while being brought to a controlled stop on tangent track at Coteau, Quebec. The train consisted of 3 head-end locomotives, 89 loads and 48 empty cars, 8138 feet long and weighed 14712 tons. The derailed cars included 10 BGSX empty air dump cars equipped with non-standard bell mouth swivel butt couplers located in the 4th to 31st positions behind the locomotives with 67 loaded grain cars at the tail-end.

R06W0085 - On 27 May 2006 near Armstrong, Ontario, CN freight train M30041-26 derailed the same first car body (HZGX 1750A) as the train was making a routine stop. The train consisted of 3 head-end locomotives, 65 loads and 21 empty cars, 5479 feet long and weighed 9175 tons. Equipment with non-standard couplers had been marshalled immediately behind the locomotives at the head-end of the train with significant trailing tonnage. The accident occurred in a curve while using dynamic braking.