RAILWAY INVESTIGATION REPORT
R02W0060

MAIN-TRACK DERAILMENT

CANADIAN NATIONAL
FREIGHT TRAIN E-201-31-24
MILE 251.3, REDDITT SUBDIVISION
WINNIPEG, MANITOBA
26 APRIL 2002

Railway Investigation Report

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Summary

At approximately 0100 central daylight time, on 26 April 2002, westward Canadian National freight train E-201-31-24 was departing Winnipeg, Manitoba, along the north main track of the Redditt Subdivision. As the train traversed a crossover from the north to the south main tracks, eight cars derailed at Mile 251.3. The derailed equipment included three loaded box cars identified as containing dangerous goods. Approximately 300 feet of track, a roadway underpass, and the line-side fibre-optic system buried in the grade were damaged. As a precaution, six homes from a residential area adjacent to the main track were evacuated. No injuries or release of product occurred.

Ce rapport est également disponible en français.

Other Factual Information

At approximately 0045 central daylight time,[1] Canadian National (CN) freight train E-201-31-24 departed the Winnipeg, Manitoba, Transcona fuel station, located on the main track. The train proceeded westward on the north main track of the Redditt Subdivision, destined for Vancouver, British Columbia. The train consisted of 3 locomotives and 85 cars (76 loaded and 9 empty), was 5412 feet long, and weighed 9363 tons. The train crew consisted of a locomotive engineer and a conductor. They were familiar with the territory, qualified for their positions, and met fitness and rest requirements.

Train movements on the Redditt Subdivision are governed by the Centralized Traffic Control System of the *Canadian Rail Operating Rules* (CROR) and are supervised by a rail traffic controller in Edmonton, Alberta. The track in the area of the derailment consists of double main Class 3 track, with a maximum operating speed of 40 mph. The track is oriented east-west on raised fill that elevates the track approximately 24 feet above the surrounding landscape. A No. 10 main-track crossover connects the north track to the south track between Mile 251.1 and Mile 251.2. This crossover is used primarily for yard transfers between CN's Symington and Fort Rouge yards in Winnipeg.

The crossover structure contains two switches, each positioned within CN No. 10 power turnout assemblies that are equipped with long straight switch points 16 feet 6 inches long. The power turnout assemblies are at either end of the crossover, on the north and south tracks, respectively, and facilitate the movement of trains from one track to the other. The location of the turnout assemblies creates the equivalent of a 7°44' curve at each end of the crossover for trains moving through the crossover. CN No. 10 turnouts have a maximum design speed of 20 mph, as outlined by the American Railway Engineering Association. CROR Rule 98.1 indicates that speed through a turnout must not exceed 15 mph unless otherwise provided by a signal indication or a special instruction.

In the westward direction of travel, the track profile leading to the crossover consists of a 0.6 per cent ascending grade, beginning at Mile 249.3. At approximately Mile 250.0, the ascending grade decreases to 0.4 per cent, leading to the crest of the elevation at Mile 250.33. After the crest, the grade reverts to a 0.5 per cent descending grade to Mile 251.0, where a No. 10 crossover from the north track to south track is encountered. From that point, the track profile is level for the next 1½ miles.

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[1] All times are central daylight time (Coordinated Universal Time minus five hours).

As the train ascended the grade, it passed lead signal 2499A at Mile 249.9. This signal displayed a "Clear to Stop" indication requiring that the train proceed and prepare to stop at the next signal. The train crested the top of the grade, proceeded around a left-hand curve, and descended toward the crossover. The next signal encountered, 2511A, governed movement through the crossover and displayed a "Slow to Clear" indication for the train, requiring a maximum speed of 15 mph through the crossover. The locomotive event recorder (LER) download revealed that, in the two miles approaching the crossover, the train was primarily controlled through a combination of throttle modulation and dynamic brake (DB).[2] At 0054:26, with the throttle in idle and the train travelling at 20 mph in a descending grade, the locomotive engineer made a fast, hard application of DB in an effort to control the speed of the train as it approached the crossover. Best practices are to move the DB controller through the operating[3] range slowly and smoothly, to prevent high compression or buff forces through the train. At 0055:03, with the throttle in the same position and the DB applied, the train proceeded through the crossover at 19 mph. At 0055:39, during deceleration and at 17 mph, the train experienced a train-initiated emergency brake application. The lead locomotive came to rest on the south track at 0055:53, approximately 1200 feet from the entry to the crossover from the north track. The independent brake on the lead locomotive was not released after the emergency brake application initiated. CN has no written instructions requiring locomotive engineers to bail off the locomotive independent brake during an emergency brake application. The LER's digital channels containing references indicating the level of DB applied are not presently recorded by CN.

After emergency procedures were performed, the crew determined that eight cars (the 4th to the 11th cars, inclusive, behind the locomotives) had derailed at Mile 251.3, blocking both north and south main tracks. Further inspection revealed that the first five derailed cars had slid down the south side of the raised embankment and came to rest in varying positions along the right-of-way. At the west end of a railway bridge spanning St. Joseph Street, several cars came to rest within 150 feet of a house adjacent to the derailment area. The last three derailed cars remained upright along the south track on top of the bridge. Approximately 300 feet of the south track and 13 feet of the north track were damaged. Debris fell to the sidewalk below, damaging a conduit carrying phone and fibre-optic lines and disrupting services.

The first two derailed cars, CBRY 1538 and CRLE 21006 (the 4th and 5th cars behind the locomotives) were empty, 80-foot-long, bulkhead, centre-beam flat cars. These were followed by a flat car loaded with steel plate and five loaded box cars. Extensive wheel tread damage was observed on the lead wheel of the leading truck from car CRLE 21006. Ground surface marks were observed along the south track structure, at the east end of the derailment area.

These marks were followed back to a guard rail in the crossover at approximately Mile 251.15. A gouge mark was observed on top of the guard rail, located on the gauge side of the crossover's south rail, approximately 79 feet from the crossover entrance on the north track. A single set of ground surface marks continued westward from the guard rail gouge mark along the south track for 450 feet, leading up to the derailed cars at the east end

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[2] Dynamic brake is a locomotive electrical braking system that converts locomotive traction motors into generators to provide resistance against the rotation of the locomotive axles. DB is a supplementary system that can be used alone or in conjunction with the train's air brake system. High-capacity extended-range DB on newer locomotives is most effective between 5 mph and 30 mph.

[3] Canadian National, *Locomotive Engineers' Operating Manual*, April 2002.

of the site. An inspection of all derailed cars did not reveal any mechanical deficiencies that might have contributed to the derailment.

Three of the loaded box cars displayed placards identifying them as containing dangerous goods (DGs): two cars were mixed loads of various household cleaners; the third car contained a 78-pound automotive battery. As a precaution, six homes from a residential area adjacent to the main track were evacuated at approximately 0130. The residents were allowed to return home at 0430 the same morning. No injuries or release of DGs occurred.

The weather at the time of the occurrence was clear, -4°C, with moderate winds from the northwest.

The double main track, in the area of the derailment between Mile 250 and Mile 252, consisted of 132-pound continuous welded rail. The rail was laid on 14-inch double-shouldered tie plates on a mix of treated softwood and hardwood ties, with an average of 55 ties per 100 feet of track. The rail and tie plates were fastened to the ties with three spikes per plate and box anchored every tie. The ballast consisted of 2½ inches of crushed rock with 12-inch shoulders with good drainage. All cribs were full. Wear on the rails of the north and south tracks was well within the limits established by CN Standard Practice Circular 1303, which governs the classification of rail. Inspection of the track structure determined that it was generally in good condition; no track defects or conditions were observed that were considered causal to the occurrence.

The track in the area of the derailment was last inspected by CN's track geometry test car on 26 July 2001; a rail flaw detection car tested the rail for internal defects on 04 February 2002. CN's assistant track maintenance supervisor performed biweekly visual inspections of the track structure from a hi-rail vehicle; the most recent inspection occurred on 25 April 2002. Walking detailed inspections of turnout assemblies were performed monthly as required; the most recent walking inspection of both No. 10 power turnout assemblies was conducted on 22 April 2002. In all cases, no defects or track irregularities were detected in the area of the derailment.

CN freight trains are made up using a destination block marshalling method. Blocks of freight cars are placed in the train, in a manner most convenient for their set-out or pick-up, in the order of destinations along the train's route. CN train service plans are developed to assist in the planning of train make-up in conjunction with Transport Canada's (TC) *Transportation of Dangerous Goods Regulations* (TDG regulations) and CN's destination block marshalling requirements. Train journals, tonnage profiles, and DG information for the cars on each train, as well as delivery and pick-up work orders for train crews, are developed based on the train service plan requirements. The TDG regulations contain marshalling restrictions governing the placement of DG cars within trains and do not permit loaded flat cars to be marshalled next to loaded DG cars or residue tank cars. CN's General Operating Instructions (GOI) have placement and trailing tonnage restrictions for certain types of cars, including dimensional loads. However, CN has no operational restrictions for the marshalling of most empty freight cars in trains.

The train was mostly made up of loaded cars. The initial block of six cars behind the locomotives consisted of a loaded box car, a 93-foot flat car with a dimensional load, a loaded box car, two empty bulkhead centre-beam flat cars, and a loaded flat car, respectively. All except seven of the cars trailing the first block were loads; over 90 per cent of the train's weight (8455 tons) trailed the two empty centre-beam flat cars. The train service plan outlined that the first six cars would normally have been at the rear. The 93-foot flat car with a dimensional load prone to load shifting was marshalled, with the two box cars as appropriate buffer cars, close to the locomotive, in compliance with CN's dimensional load handling instructions. The two empty bulkhead centre-beam flat cars were within this block and subsequently moved to the head end of the train. Figure 1 below illustrates the tonnage (weight) distribution of the train.

CN's GOI, section 6.4, discusses the risks of jackknifing locomotives and cars near the locomotives. The GOI indicates that, to reduce the risk of rail rollover or jackknifing, extreme caution must be exercised when making bunched stops or decreasing speed with a locomotive consist. Due consideration should be given to track gradient, curvature, and weight distribution of the train consist, particularly when the cars next to or near the locomotives are empty.

Section 6.8 of CN's GOI covers DB in three short paragraphs. This section outlines that, during planned braking operation, if one (or more) operable DB is available, every effort must be taken to use DB to control train speed. Locomotive engineers are reminded that, when using DB with three or more locomotives, extremely high braking forces can be produced, and caution must be exercised in negotiating descending grades, turnouts, crossovers, and sharp curves. Other railways' GOI contain much more detailed instruction in the operation and use of DB as a method of train control, in particular for newer, high-horsepower locomotives.

The Association of American Railroads (AAR) Research and Test Department Report R-802, *Train Make-Up Manual*, identifies that long empty flat cars are known to be problematic when placed in a train with significant trailing tonnage behind them or when two are placed together in combination in a train, especially when moving through crossovers, curves, or switches. Long/short car combinations may present similar problems, irrespective of their location in a train.[4]

AAR Report R-185, *Track Train Dynamics to Improve Freight Train Performance,* describes the best practices concerning train handling.[5] The reports cover all aspects of freight train handling, including the use of the locomotive DB, locomotive independent brake, train air brakes, and train-handling strategies for different train configurations and track gradients. Report R-185 notes that, when an undesired emergency brake application occurs, some railways prefer to prevent the locomotive brakes from applying to reduce run-in forces at the head end of the train.

Although the practices in reports R-802 and R-185 are recommended to the railways, individual railway practices may differ. Canadian Pacific Railway (CPR) and the Burlington Northern and Santa Fe have included many of these recommended practices in their GOI and training programs. During initial training, CN trains its locomotive engineers to bail off the locomotive independent brake during an undesired emergency brake application, depending on the situation. However, CN's GOI, the *Locomotive Engineers' Operating Manual* used for qualification standards for operating crews (QSOC) requalification, and the *Best Practices Train-handling Guide* for the Redditt Subdivision make no reference to the procedure. In addition, CN has no requirement for freight trains to be made up in a fashion that minimizes the potential for excessive in-train forces.

In 1997, a *Best Practices Train-handling Guide* for the Redditt Subdivision was developed and made available to all locomotive engineers. Similar guides were implemented district by district over most of the CN main-line corridors. The guide was developed to introduce a new train-handling policy and to assist operating crews in choosing the most economic train-handling methods for this subdivision. Locomotive engineers are to "utilize forward planning in consideration of territory profiles, planned stops, required speed adjustments and slack control, avoiding aggressive use of the throttle and train braking systems." It further states that "throttle manipulation must be utilized as the primary means of controlling train speed and that DB must be fully utilized as the initial braking force."

In April 2002, CN developed a *Locomotive Engineers' Operating Manual* as a reference guide to assist engineers in the proper operation of trains. The manual includes some new material as an update to the existing manual. It also incorporates operating bulletins, divisional data, and other instructions/rules previously contained in the GOI, in an effort to put relevant information into one source document. The manual is used as the "instruction and study" portion for the examination of locomotive engineers during their QSOC requalification on motive power and on train handling.

The manual includes a section describing the preferred use of the DB to help reduce or prevent high buff forces and also emphasizes that the DB must be fully used as the initial braking force. Excessive buff forces may result in a derailment or gradual deterioration of the track structure, particularly if the forces occur at a turnout,

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[4] Association of American Railroads Research and Test Department Report No. R-802, *Train Make-Up Manual*, section 4, "Excessive Train Forces," pp. 10–11 and section 6.0, "Special Car Cases," pp. 37–39.

[5] Association of American Railroads Report No. R-185, *Track Train Dynamics to Improve Freight Train Performance*, second edition.

crossover, or curve. High-capacity DB locomotives in consists of three or more should be limited to a maximum of 500 amps when entering a turnout, crossover, or curve until at least half the train has passed. No correlation is made between the maximum amperage and the amount of DB force applied, nor is there any restriction on the maximum combined DB force used for a locomotive consist.

The train crew members were unaware that the *Best Practices Train-handling Guide* and the *Locomotive Engineers' Operating Manual* were available. The locomotive engineer was first trained in 1976 and most recently requalified in January 2002. He had never received any practical instruction on the proper use of locomotive DB on newer locomotives or on the risks that are associated with the use of these locomotives equipped with extended-range high-capacity DB in train-handling operations.

On 26 November 1977, the derailment of 5 locomotives and 78 loaded coal cars near Flat Creek, British Columbia, prompted an inquiry by the Canadian Transport Commission (CTC). The CTC report of the inquiry (File No. 31385.3845), issued on 22 January 1980, concluded that locomotive engineer's training in air brake instruction and train operation was inadequate. The report recommended that a regulation outlining standards for train crews be drafted by a committee of representatives from the railways, labour, and the regulator. After several accidents under similar conditions and industry consultations, Regulation CTC-1987-3 Rail, *Minimum Qualification Standards for Locomotive Engineers, Transfer Hostlers, Conductors and Yard Foremen*, was promulgated on 12 March 1987. The regulation was assumed by TC and is still in force.

CTC-1987-3 Rail states that a railway company shall establish and provide training necessary to satisfy the purposes of the regulation. To be certified, locomotive engineers must successfully complete eight core subjects, including locomotive operation and train-handling components. Railways must requalify locomotive engineers every three years and are responsible for record keeping. Within 90 days of the regulation coming into force, a railway company shall file a description of all employee training material relating to each occupational category. Similarly, a railway company must file a description of any changes made to the training material. TC is the regulatory authority that oversees the regulation and ensures that all core training subjects are represented in the material. There is no requirement for a practical component to be completed for a locomotive engineer to requalify. The regulation does not require the regulator to review the specific content of the training material, nor does it outline a mechanism for the regulator to recommend additions or improvements to the training criteria as operations in the rail industry change.

The use of locomotive DB as one of the primary means of train control has evolved in Canada over the last 16 years, coinciding with the renewal of both CN and CPR locomotive fleets. In the 1970s, CN operated many of its locomotives within the Prairie Division with no DB feature. The trains were controlled by throttle modulation, locomotive independent brake, and train automatic air brakes. By the mid 1980s, CN and CPR had some of the oldest Class 1 locomotive fleets in North America. At that time, the locomotives that were equipped with DB were capable of generating up to 48 000 pounds of DB force per locomotive, providing that the DB was fully operative.

The introduction of new high-horsepower locomotives, from the late 1980s to the present, introduced much more effective DB systems capable of generating up to 98 000 pounds of DB force per locomotive. As the railways recognized significant fuel savings and operating efficiencies with the use of DB incorporated as a train-handling method, its use has evolved into one of the primary means of controlling a train. In this occurrence, the locomotives were all constructed between 1987 and 1998. The train had a combined total of 12 200 horsepower with a maximum combined DB force of approximately 194 000 pounds at 20 mph.

The *Railway Locomotive Inspection and Safety Rules* are industry rules, submitted by the Railway Association of Canada and approved by the Minister of Transport. Included in the rules are mandatory requirements for LERs. Section 12.1 of the rules states:

> Controlling locomotives other than in designated and/or yard service, shall be equipped with an event recorder meeting the following minimum design criteria:
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> (a) the event recorder shall record the time, the speed, the brake pipe pressure, the throttle position, the emergency brake application, the independent brake cylinder pressure, the horn signal and Reset Safety Control function;
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> (b) the event recorder shall retain a minimum of five minutes of data preceding a collision or derailment;
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> (c) the event recorder shall have a suitable means to transfer the stored data to an external device for processing and analysis.

A similar derailment occurred at this same location in October 1998, when a CN train derailed two empty flat cars while proceeding westward at about 12 mph (TSB occurrence R98W0207). The derailed cars, located 38 and 39 from the locomotives and marshalled ahead of a block of loaded cars, were compressed by the slack run-in of the train as it traversed the No. 10 crossover. In addition to this investigation, the TSB has either investigated or is currently investigating occurrences R01T0006, R01W0007, and R02C0050. Either train make-up (marshalling) and/or the inappropriate use of locomotive DB have been identified as factors contributing to these accidents.

Analysis

There were no equipment or track defects observed that were considered as factors contributing to the occurrence. Literature on track/train dynamics for freight trains indicates that the use of locomotive DB can generate high buff forces. Derailments can occur in switches, curves, turnouts, and crossovers as a result of wheel lift or climb, especially if the cars involved are light loads, empty, or problematic car combinations in trains where a significant amount of the train tonnage is behind the cars in question. This combination existed on CN freight train E-201-31-24. The analysis will focus on train handling, train make-up (marshalling), locomotive engineer training, and awareness issues relating to the derailment.

The first two derailed cars, CBRY 1538 and CRLE 21006 (the 4th and 5th cars behind the locomotives), were empty 80-foot-long bulkhead centre-beam flat cars. The industry has identified this combination of long car/long car as problematic, particularly when the cars involved are empty, placed in a train with the bulk of the tonnage trailing, and negotiating sharp turnouts (No. 10 or less). The lead wheel set of the leading truck from car CRLE 21006 displayed the most significant tread damage from among all derailed wheel sets, indicating that it had travelled the furthest on the ground and was likely the first wheel set to derail. Ground surface marks from the derailment site, identified as originating from a wheel flange, were traced back to and identified the initial point of derailment as a gouge mark on top of a guard rail. The guard rail was on the gauge side of the crossover's south rail, approximately 79 feet from the crossover entrance on the north track. The lack of markings on the gauge side of the south rail head at that location precludes wheel climb from being a factor in the accident. The gouge mark on the guard rail at the initial point of derailment indicates that wheel lift was one of the primary mechanisms involved in initiating the derailment.

After the train crested the top of the grade, the front portion slowly accelerated away from the rear, pulled by the weight of the locomotives. The train approached the crossover at approximately 19 mph, a speed higher than the "Slow to Clear" signal indication that dictated 15 mph for the movement through the crossover. As recommended by most of CN's train-handling literature, the locomotive engineer used locomotive DB as the initial braking force in an attempt to slow the train. The use of DB as the train entered the crossover bunched the locomotives and the cars on the front portion of the train and allowed the train's trailing tonnage to run in as the rear of the train crested the grade.

The speed at which the train decelerated before the emergency brake application indicates that DB was sustained. The run-in of slack, combined with sustained DB, generated buff forces severe enough to initiate wheel lift, derailing the lead wheel of the leading truck from car CRLE 21006 (an empty 80-foot-long bulkhead centre-beam flat car) as it travelled through the crossover. The single wheel set travelled approximately 450 feet on the ground before additional cars derailed, resulting in a train-initiated undesired emergency brake application.

Given the location of two empty 80-foot-long bulkhead centre-beam flat cars near the head end of the train, the locomotive engineer misjudged how the train was going to react to a speed reduction at this location; this was the first major train-handling decision of his trip. A locomotive engineer's ability to get a "feel" for how efficiently the DB is working is an essential element of train handling and, since the train had just departed, there had not been sufficient time to make that determination. The train's approach to the crossover at a speed higher than the signal indication necessitated a choice of speed reduction methodologies. The locomotive engineer selected locomotive DB as the initial braking force, a technique emphasized by the railway, in an attempt to slow the train. The choice of train-handling methods respected the principles of train handling emphasized by the railway; however, the train speed approaching the crossover did not comply with the operating requirements dictated by the signal indication.

Alternative train-handling methods were available to the locomotive engineer. If selected, they would have ensured safe operation of the train at this location. The train speed could have been reduced earlier, permitting a reduction in DB level as the head end of the train traversed the crossover, as suggested by known industry best practices. Train automatic air brakes could have been used alone, without DB; this method is also an accepted industry practice in slowing trains in cresting grade situations but was not encouraged by the railway's train-handling instructions to use DB as the initial braking force. A heavy application of DB made in an attempt to control the train's speed as it traversed a crossover—when there were long-wheelbase, empty cars close to the locomotives, with 90 per cent of the train's tonnage trailing on a descending grade—was inappropriate for the conditions and operating requirements of that location.

Destination block marshalling of trains is an accepted practice that increases operational efficiencies and simplifies service delivery for the carrier. Although this type of marshalling is not inherently unsafe, it does not take into account the train-handling difficulties that can arise from problematic combinations, such as long car/long car, placed in a train. Other Class 1 railways recognize the risk of undesirable train configurations: their GOI contain specific instructions precluding empty cars from being placed at the head end of trains unless most trailing cars are empty or light loads. CN's GOI contain no such instruction, and the train, as marshalled before departure from MacMillan Yard in Toronto, met CN's marshalling requirements and those of the TDG regulations.

CN requires that the dimensional load be placed at the head end of the train. Subsequently, the cars within that block were also moved to the head end of the train. This placed two long, empty bulkhead centre-beam flat cars near the head end of the train, with 90 per cent of the train's tonnage (8455 tons) trailing the empty cars. Previous TSB accident assessments and investigations have identified similar train configurations as factors contributing to several accidents. The train configuration of empties ahead and loads behind, combined with the presence of three locomotives equipped with high-capacity extended-range DB and a train-handling policy emphasizing the use of DB as the initial braking force, increased the risk for a derailment initiated by track/train dynamics to occur.

Locomotive DB has existed for some time. It was primarily developed as a secondary means of train handling because of the limited amount of DB force available on earlier locomotive fleets in Canada. With locomotive fleet renewal in Canada over the last 16 years, the use of locomotive DB has evolved into one of the primary means of train control. CN's current GOI, *Best Practices Train-handling Guide,* and the *Locomotive Engineers' Operating Manual* all emphasize that "DB must be fully utilized as the initial braking force." This emphasis may generate an over-reliance on DB as the primary braking force in conditions where it may be inappropriate, increasing the risk of adverse consequences. It may further create an expectation that train automatic air brakes should be used to supplement DB rather than the opposite.

Regulation CTC-1987-3 Rail outlines minimum QSOC. TC is the regulatory authority overseeing the regulation and ensuring that core training subjects are represented in the material. CN's current QSOC training of locomotive engineers meets the requirements of the regulation. However, when compared to other Class 1 railways, CN's material contains limited information on DB and train-handling strategies for its use. With the use of locomotive DB evolving into one of the primary means of train control and most of CN's literature emphasizing that it be used as the initial braking force, it appears that little has been provided in the way of practical instruction on these changes. In this case, the locomotive engineer was first trained in 1976 and had never received any subsequent practical instruction on the use of locomotive high-capacity extended-range DB or the risks associated with its use in train-handling operations. Previous TSB accident assessments and investigations have also identified the inappropriate use of locomotive DB as a contributing factor in the accidents. This suggests that training for locomotive engineers has not kept pace with improvements in DB technology and train-handling methodologies; it further raises a question as to the adequacy of current locomotive engineer training as overseen by TC under the existing regulation.

CTC-1987-3 Rail contains no requirement for a practical component of training to be completed for a locomotive engineer to requalify and misses an opportunity to familiarize locomotive engineers with new equipment and train-handling techniques. The regulation, as written, further fails to provide TC with either a mandate to review specific content of training material for train crews at regular intervals or a mechanism that requires that changes to the training criteria be made as changes occur in the rail industry. The lack of a requirement for practical locomotive engineer training, when requalifying under the current CTC-1987-3 Rail regulation, increases the risk of locomotive engineers making inappropriate train-handling decisions, particularly as equipment, train configurations, and operations in the rail industry evolve.

CN's train-handling literature contains no written instructions requiring locomotive engineers to bail off the locomotive independent brake during an emergency brake application. In this derailment, the locomotive independent brakes remained applied during the emergency brake application. The loss of dynamic braking force, which diminishes with the reduction in speed as the train comes to a stop, was offset by full application of the locomotive independent brakes during the emergency brake application. This situation maintained a high buff force level, aggravating the consequences of the derailment. Accepted industry practice, when any emergency brake application is initiated, requires the locomotive engineer to partially release the independent brake to prevent a run-in of train slack. Had the locomotive independent brake been partially or completely bailed off during the emergency, the buff force levels would have been reduced. The forward inertia of the locomotives might have kept the front portion of the train stretched, lessening the risk and consequences of the derailment.

The LER download provided limited train-handling information for this occurrence. CN meets TC's current requirement for LERs as set forth in section 12 of TC's *Railway Locomotive Inspection and Safety Rules*. However, CN does not use all the relevant digital channels from the LER download that would provide a more complete picture of the events leading to and during an accident. The LER for this occurrence provided by CN did not reference DB current, DB control position, end-of-train air brake pressure, acceleration, or the low-pressure alarm from the end-of-train sensory braking unit. Other Class 1 railways go beyond the scope of the rules and record this information on the LER. The absence of mandatory requirements to include additional operating parameters for LERs in TC's *Railway Locomotive Inspection and Safety Rules* imposes limitations on the identification of safety deficiencies in train operations.

Findings as to Causes and Contributing Factors

1. The run-in of slack, combined with a sustained high dynamic brake (DB) level, generated buff forces severe enough to initiate wheel lift. Consequently, the lead wheel of the leading truck from car CRLE 21006 (an empty 80-foot-long bulkhead centre-beam flat car) derailed as it travelled through the crossover.

2. The choice of train-handling methods respected the principles of train handling emphasized by the railway. However, the train speed approaching the crossover did not comply with the railway's operating requirements dictated by the signal indication.

3. An application of DB made in an attempt to control the train's speed as it traversed a crossover—when there were long-wheelbase, empty cars close to the locomotives, with 90 per cent of the train's tonnage trailing on a descending grade—was inappropriate for the conditions and operating requirements of that location.

Findings as to Risk

1. The emphasis that DB be used as the initial braking force may generate an over-reliance on DB as the primary braking force in conditions where it is inappropriate (such as the configuration of empties ahead and loads behind), increasing the risk of adverse consequences. Such use may further create an expectation in train operations that train automatic air brakes be used to supplement DB rather than the opposite.

2. The lack of a requirement for practical locomotive engineer training when requalifying under the current CTC-1987-3 Rail regulations increases the risk of locomotive engineers making inappropriate train-handling decisions, particularly as equipment, train configurations, and operations in the rail industry evolve.

3. Had the locomotive independent brake been partially or completely bailed off during the emergency brake application, the buff force levels would have been reduced. The forward inertia of the locomotives might have kept the front portion of the train stretched and lessened the risk and consequences of the derailment.

Other Findings

1. The absence of regulatory requirements to include additional operating parameters for locomotive event recorders imposes limitations on the identification of safety deficiencies in train operations when investigating accidents.

Safety Action

As a result of this investigation, the TSB issued Rail Safety Information Letter 08/02 to Transport Canada (TC) concerning two derailments at the same location.

TC has distributed this information to all TC regional offices to assess whether issues related to the use of locomotive DB could be national in scope. TC will review and contemplate further action based on comments received.

On 27 May 2003, TC wrote to the Railway Association of Canada to discuss the development and implementation of a train design system that takes train tonnage and length into consideration. In addition, TC suggests that train-handling instructions (with regard to weight distribution in a train) should be written as an aid to locomotive engineers so that excessive braking can be avoided whenever possible.

In autumn 2003, TC will commence a review of Regulation CTC-1987-3 Rail, which governs the minimum qualifications for locomotive engineers. Based on the results of the review, TC will make recommendations to the industry concerning locomotive engineer training and dynamic testing.

TC is monitoring compliance with applicable rules and regulations, particularly at the location of the occurrence.

TC and Canadian National (CN) will discuss, as part of regular meetings, the issue of including a "DB Factor" table on the train journal as a job aid for DB usage.

In May 2002, CN issued a bulletin advising locomotive engineers of the new *Locomotive Engineers' Operating Manual* and to have it accessible while on duty.

CN is currently in the midst of an Advanced Locomotive Engineer Refresher Training program for all of its locomotive engineers. The one-day course includes a review of the *Best Practices Train-handling Guide* for the applicable region and instructions on the proper use of DB and throttle manipulation. Some of the training occurs on a locomotive simulator to reinforce proper train-handling techniques.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 09 July 2003.

Appendix A – Glossary

AAR	Association of American Railroads
C	Celsius
CN	Canadian National
CPR	Canadian Pacific Railway
CROR	*Canadian Rail Operating Rules*
CTC	Canadian Transport Commission
DB	dynamic brake
DG	dangerous goods
GOI	General Operating Instructions
LER	locomotive event recorder
mph	miles per hour
QSOC	qualification standards for operating crews
TC	Transport Canada
TDG	transportation of dangerous goods
TSB	Transportation Safety Board of Canada
°	degree
‘	minute