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

RAILWAY INVESTIGATION REPORT
R10C0016

NON-MAIN-TRACK DERAILMENT

CANADIAN PACIFIC RAILWAY
FREIGHT TRAIN 292-02
MILE 0.0, BROOKS SUBDIVISION
MEDICINE HAT, ALBERTA
03 FEBRUARY 2010

Canada

Railway Investigation Report

Non-Main-Track Derailment
Canadian Pacific Railway
Freight Train 292-02
Mile 0.0, Brooks Subdivision
Medicine Hat, Alberta
03 February 2010

Report Number R10C0016

Summary

On 03 February 2010, at 1720 Mountain Standard Time, Canadian Pacific Railway freight train 292-02 was proceeding eastward on track 2 through Medicine Hat Yard in Medicine Hat, Alberta, when 7 empty auto carrier cars derailed. Derailed cars contacted equipment on adjacent tracks to the north and south, derailing 2 locomotives and an additional auto carrier car. Fuel tanks from the 2 derailed locomotives were punctured, releasing 9100 litres of diesel fuel (UN1202). There were no injuries. No other dangerous goods were involved.

Ce rapport est également disponible en français.

Other Factual Information

The Accident

On 03 February 2010, eastbound Canadian Pacific Railway (CP) freight train 292-02 (train 292) operated on the Brooks Subdivision (see Figure 1) from Calgary, Alberta (Mile 175.8) to Suffield, Alberta (Mile 26.5) where it picked up 27 empty auto carrier cars and placed them on the head end directly behind the locomotives. After the cars were added, the train consisted of 2 locomotives, 53 loads and 49 empties; it weighed 8983 tons and was 7298 feet long. The train then proceeded to Medicine Hat, Alberta (Mile 0.0) for a scheduled crew change.

Upon arrival in Medicine Hat Yard, train 292 stopped on the west shop track lead to change crews. When changing crews at Medicine Hat, through-trains normally stop on the main track or on track 1. However, in this occurrence, the main track was occupied by stationary westbound CP train 103-31 (train 103) which was waiting for the arrival and departure of train 292. Track 1 was occupied by another train movement.

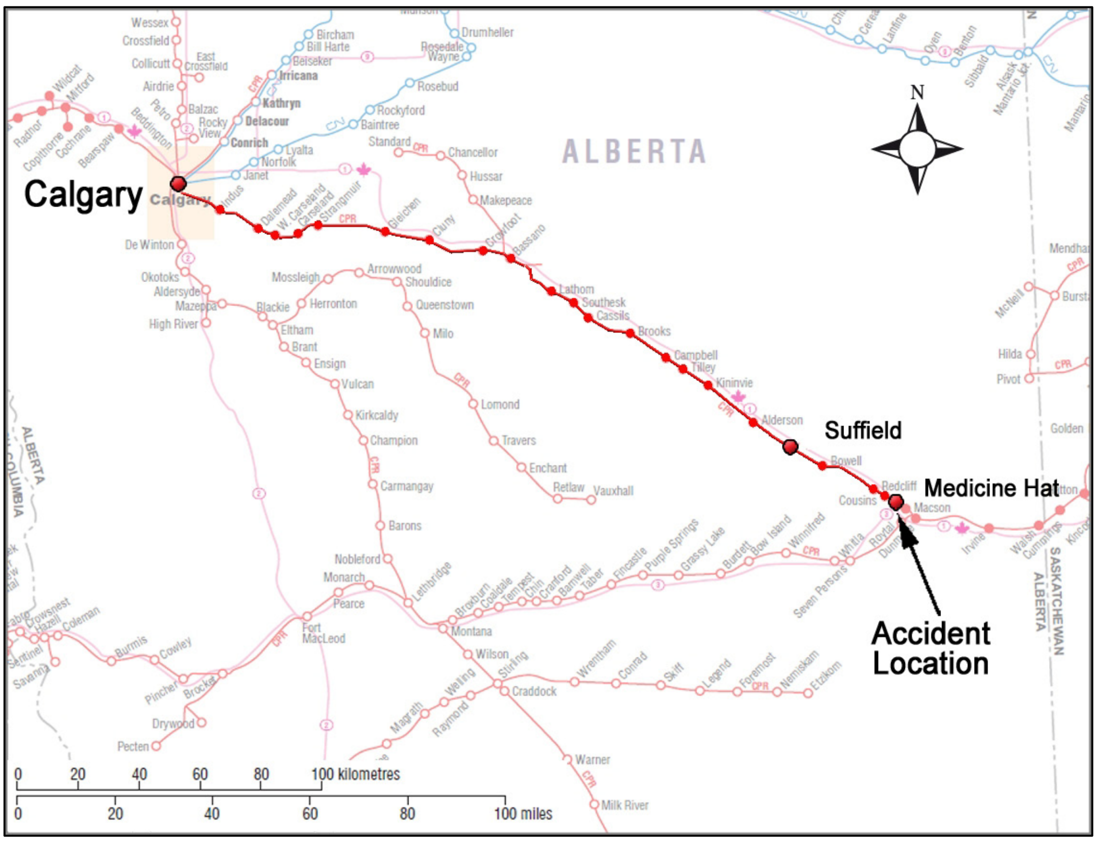

Figure 1. Train journey and accident location

The inbound crew left train 292 in a stretched position [1] with the train air brakes and locomotive independent brake fully applied. The head-end 2800 feet of train 292 came to rest on track that ranged from level to 0.3% descending grade while the tail-end 4500 feet stopped on a 1.3% descending grade. Prior to taking control of the train, the outbound crew discussed the status of the train with the inbound crew, including how it had been left.

The locomotive engineer and conductor of the outbound crew met fitness and rest standards and were familiar with Medicine Hat Yard and the Brooks Subdivision.

At 1717, [2] train 292 released its brakes to depart Medicine Hat and head for Swift Current, Saskatchewan. As the train was departing, it was inspected on both sides. Recorded information shows that the train started to move within 1 minute of the release of the fully-applied train brake just before the locomotive independent brake was fully released. Brake pipe pressure was 86 psi [3] at the head end and 69 psi at the tail end of the train.

At 1719:02, as the train reached a speed of 8 mph, the dynamic brake (DB) [4] was placed in the set-up position (see Table 1). Starting at 1719:08, and over the next 54 seconds, the DB was increased progressively from position No. 1 to position No. 6. The maximum speed reached was 12 mph and the maximum DB effort obtained was 83 000 lbs.

At 1720:12, with speed decreased to 7 mph and dynamic brake fully applied in position No. 8, a train-initiated emergency brake application occurred with head-end brake pipe pressure of 87 psi and 72 psi at the tail end of the train. Seven empty cars on train 292, the 13th to 19th behind the head-end locomotives, derailed (see Figure 2).

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1 A train is in a stretched position when the draft gear between the cars is extended and there is maximum distance between each car. This occurs when the cars are pulled to a stop with the air brakes applied.

2 All times are Mountain Standard Time (Coordinated Universal Time minus 7 hours).

3 CP standard brake pipe pressure for freight service is 90 psi. (CP GOI Section 13, 4.0)

4 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.

Time	Event	Speed (mph)
1717:19	Train Brakes Released	0
1718:14	Train Begins to Move	1
1718:17	Engine Brake Released	1
1719:02	DB Set Up	8
1719:08	DB1	9
1719:10	DB1 – 4 000lbs	10
1719:20	DB2 – 15 000lbs	11
1719:29	DB3 – 30 000lbs	12
1719:38	DB4 – 49 000lbs	12
1719:46	DB4 – 61 000lbs	12
1719:52	DB5 – 71 000lbs	12
1719:58	DB6 – 80 000lbs	12
1720:02	DB6 – 83 000lbs	12
1720:12	DB8 - Emergency	7

Table 1. Locomotive Event Recorder (LER) information from the lead locomotive on train 292, CP 8831

At the time of the derailment, the weather was mainly clear and the temperature was -10°C.

Site Examination

The first car, TTGX 978119, had its rear truck derailed; the following 6 cars had all of their trucks derailed. The 16th car, TTGX 963657, derailed southward from track 2, striking and derailing yard service locomotive CP 3039 which was stationary on shop track 1. As a result, the fuel tank of CP 3039 punctured and diesel fuel spilled onto the ground. The yard assignment locomotive engineer, who was in the cab, was not injured.

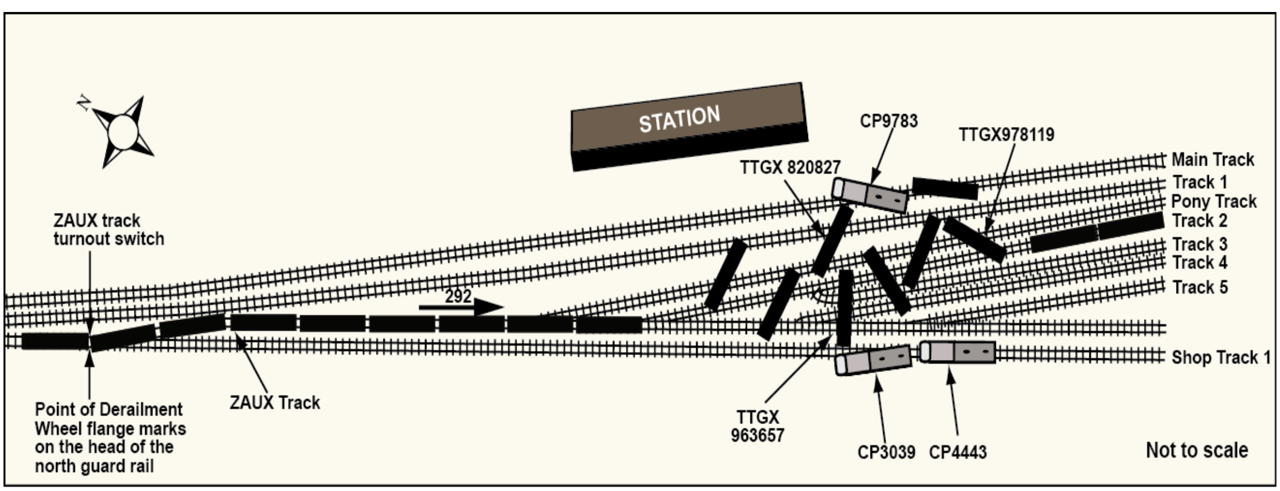

Figure 2. Medicine Hat Yard accident site diagram

The 17th car on train 292, TTGX 820827, derailed northward from track 2 and struck the head-end of train 103 on the main track. The impact caused lead locomotive CP 9783 and the first car, an empty auto carrier, to derail. The fuel tank on CP 9783 punctured and diesel fuel spilled onto the ground. The conductor, who was in the cab of the locomotive, was not injured.

During site examination, the first wheel flange marks in the vicinity of the derailment were found on the head of the north guard rail of the frog in the Number 11 – 100 lb left-hand turnout between the west shop track 1 and the ZAUX track.

Mechanical Inspection of Derailed Cars

Mechanical teardown inspections were performed on 3 of the derailed cars from train 292, the 14th, 15th and 16th cars behind the head-end locomotives. Due to derailment damage, only a limited teardown was performed on the 15th car. Minor side bearing clearance exceptions were noted on the 14th and 16th cars and no exceptions were noted on the 15th car.

Emergency Response

About 1800 litres of fuel was released from locomotive CP 3039 with an additional 7300 litres released from locomotive CP 9783. The fuel mainly pooled on top of the frozen soil, contaminating the ice and snow with some moving into the underlying ballast. A vacuum truck was mobilized to the site to recover pooled liquids and absorbent material was used to prevent further migration of the released fuel. During initial efforts to remove the contaminated material on top of the frozen soil, a standard procedure pressure release of about 1050 litres of coolant from the locomotive's cooling system occurred, further contaminating the snow and ice.

Another vacuum truck arrived on site the next morning but due to freezing liquids, was replaced by a hydrovac unit the following day to remove all surface fluids. An estimated total of 14 275 litres of diesel fuel and coolant were recovered, including about 8500 litres of fuel remaining in the punctured tanks of the 2 locomotives. Approximately 18 cubic meters of ice, snow and soil were removed from the affected area. The remaining 4375 litres of fuel and coolant were to be managed with other similar contaminants in the yard. No fuel entered either the South Saskatchewan River or the municipal storm sewer drain.

Track Information

Most of the rail on the west shop track lead was 60-foot reclaimed jointed rail which had been installed in 2004. All joints were six-hole, fully bolted joints in excellent condition. The rail was box-anchored every second tie and laid on single shoulder tie plates fastened with 2 spikes per tie. The ties were a mix of hardwood and softwood and were in good condition. The ballast was mostly a pit run/walking[5] ballast blend with fair to poor drainage. There is a long, eastward descending grade from approximately Mile 5.5 to Medicine Hat Yard.

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[5] A grade of aggregate suitable for walking on.

During the post-accident site examination, no pre-existing defects were observed and no exceptions were noted in the vicinity of the turnout.

During the previous 3 years, no significant track maintenance, aside from bolt maintenance, had occurred. At the time of the accident, no track maintenance work was planned at this location.

The ZAUX track turnout was in good condition. The frog was in new condition and had not been welded. The north rail in the turnout was 100-pound RE HF rail manufactured in 1943 and the south rail was 100-pound CP RE rail manufactured in 1995. The wear on both rails was within the allowable limits outlined in the CP *Red Book of Track Requirements*. The turnout was inspected in accordance with regulatory requirements.

Train Operations on the Brooks Subdivision

Train movements on the Brooks subdivision are governed by the Centralized Traffic Control System (CTC) authorized by the *Canadian Rail Operating Rules* (CROR) and supervised by a Rail Traffic Controller located in Calgary, Alberta. Train crews are required to be in possession of a Daily Operating Bulletin (DOB) starting at Mile 8 on the Brooks Subdivision and continuing through the yard to Mile 135 on the Maple Creek Subdivision. Traffic through Medicine Hat Yard [6] is governed by CROR Rule 105, “Speed on Non-Main Track” and has a maximum speed of 10 mph.

Freight Car Information

The 8 rail cars involved in the derailment, 7 from train 292 and 1 from train 103 were 94-foot long empty auto carrier cars with end-of-car cushioning devices (EOCCD). The EOCCD provide 10 inches of longitudinal travel at each end of the car. Normal draft gear provide about 3-1/4 inches of longitudinal travel at each end. EOCCD equipped cars are designed to dampen in-train forces by using hydraulic-style car impact cushioning. This coupling system can reduce the effect of buff (compression) and draft (tension) forces, provide a smoother ride and reduce lading and equipment damage.

The 8 derailed cars were also equipped with long shank couplers that can swing laterally up to 13 degrees from centre while regular couplers swing laterally up to a maximum of 7 degrees from centre. The long shank couplers with higher angularity are necessary with these longer cars for proper curving performance.

Train Marshalling

The occurrence train was marshalled with 27 empty auto carrier cars at the head end, each equipped with EOCCD, followed by a block of 15 loads and 19 empties, and then by a block of 38 loads and 3 empties at the tail-end (see Figure 3). In addition to the 27 auto carrier cars, 2 other cars were also equipped with EOCCD.

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[6] That portion of a main track designated by yard limit signs and timetable special instructions or a track bulletin.

The Association of American Railroads (AAR) *Train Make-Up Manual* [7] indicates that cars equipped with EOCCD add to train slack and can greatly increase dynamic in-train forces. Specifically, Section 6.6 states: "large blocks of EOCCD equipped cars should not be entrained ahead of large blocks of loaded cars with conventional draft gears". However, the 27 empty auto carrier cars on train 292 were equipped with pre-loaded EOCCD that only compress when buff force greater than 50 kips is applied.

Canadian Pacific Railway has developed and implemented a proprietary Train Area Marshalling system (TrAM) which is used to plan train marshalling to minimize the effect of in-train forces. TrAM is computer-supported and includes instructions regarding marshalling and trailing tonnage limits for specific types of car equipment. The limits vary depending on the car type, length, and weight, as well as the length of the adjacent car. TrAM also considers the placement of remote locomotives within the train and the placement of cars equipped with EOCCD. Other operating factors considered include the curvature and grade of the track over which the train will operate. TrAM applies to mainline operations only, not in yards.

CP's General Operating Instructions (GOI) Section 7, Item 6.1 requires that mixed conventional freight trains be made up, to the maximum extent practicable, with the loads located closest to the locomotives, subject to destination blocking. In addition, Note 1 of CP GOI Section 7, Item 6.1 (Marshalling Heavy and Light Cars or Blocks) states that: "The Train Area Marshalling Messages do not indicate whether train marshalling fulfills the intent of this item."

CP's network of track is divided into 6 TrAM areas with each area having its own marshalling restrictions. TrAM Area 1 is the least restrictive. The route from Calgary to North Portal, Saskatchewan is classed as TrAM Area 1. TrAM considers cars that weigh more than 45 tons as loads. Although empty, the auto carrier cars have a tare weight of approximately 50 tons due to the weight of the rack. In this occurrence, upon departing Calgary, there were no TrAM messages for train 292 indicating a TrAM rules violation.

After adding the 27 empty auto carrier cars to the head-end of the train at Suffield, a TrAM check was received over the radio from the rail traffic controller indicating that there were no marshalling violations.

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7 Association of American Railroads, Research and Test Department, Report No. R-802, *Train Make-Up Manual*, January 1992.

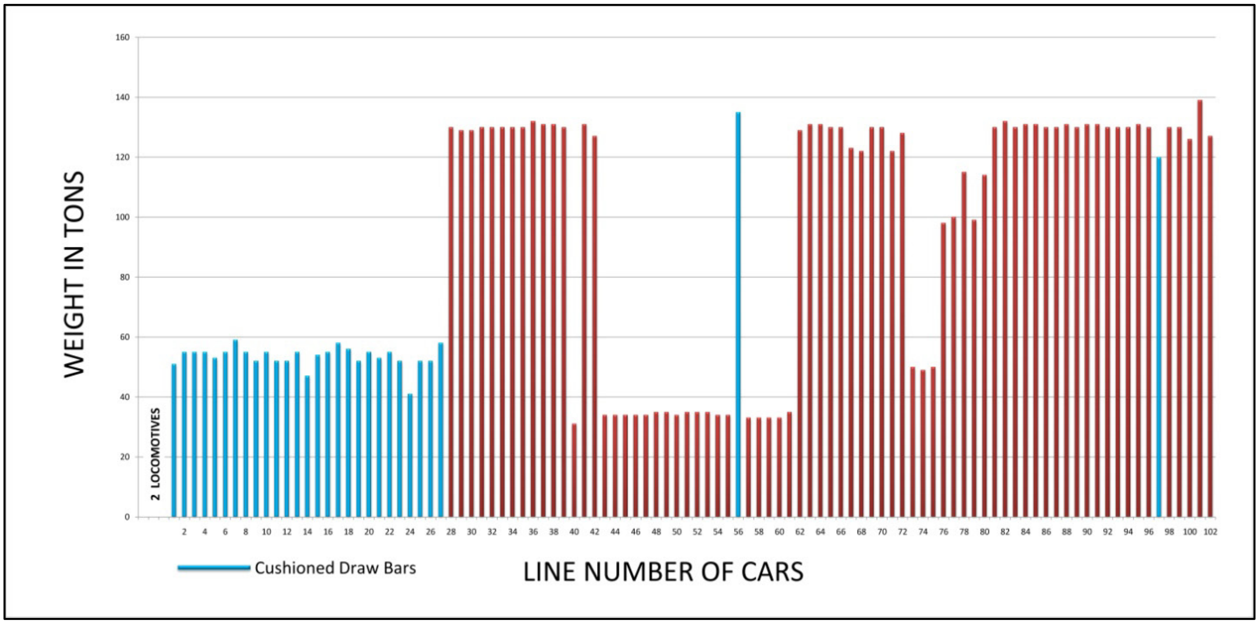

Figure 3. Tonnage Profile for Train 292 (Note: The locomotives weigh 210 tons each)

Use of Dynamic Braking

The 2 locomotives powering train 292 were high horsepower AC locomotives with high capacity, extended range [8] dynamic brakes. The locomotives had a combined DB factor of 20 and were capable of generating a total of 196 000 pounds of retarding force. CP's DB factor of 20 refers to a maximum of 98 000 pounds of force times 2 for a total of 196 000 pounds of force, rounded up to 200 000 pounds of force.

Instructions on DB usage are contained in CP GOI Section 16, which states (in part):

> *Item 7.1* – Full DB may be used with up to a maximum of 200 000 pounds (referred to as DB factor of 20).
> *Item 7.6 C* - When operating on any yard track, if the DB factor of the lead locomotive consist is 14 or greater, than the DB effort MUST NOT exceed 60 000 pounds.
> *Item 7.7 A* – The train air brakes and DB may be used in conjunction with each other.
> *Item 7.7 B* - When the release of an automatic (train) brake application is to be followed by a DB application or an increase in DB, the DB should be applied before releasing the automatic brakes. However the DB should be reduced for at least two minutes after releasing the automatic brakes to prevent a run-in of slack of jackknifing proportions.

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8 There are 2 types of dynamic brake, the standard and extended range. The extended range DB develops its maximum retarding force between 6 and 23 mph, while the standard DB is largely ineffective below 10 mph and develops its maximum retarding force at 23 mph. Once the maximum DB is reached, the retarding force decreases gradually as the speed increases.

Train Forces and Wheel-Rail Interface

All railcar draft gears have some longitudinal travel or "slack" designed into them which can be a significant factor in a long train with many cars. When head-end braking occurs, the train becomes bunched. The draft gear and cushioning devices become compressed and compression or "buff" forces result. The buff force generated can be high, especially during the transition from a stretched to a bunched state when the trailing cars impact against the cars ahead. When high buff forces act on cars on curved track, where the drawbars have taken an angle to each other, high lateral forces can be generated that come to bear through the wheel flange against the gauge side of the rail. The run-in of slack and the continued build-up of buff force during braking events must be properly managed to avoid elevated lateral versus vertical force (L/V) ratios (see figure 4).

L/V ratios quantify the relationship between the weight of the locomotive or railcar bearing down on the rail through the wheel interface (i.e., vertical force) and the force of the wheel flange pushing out on the rail (i.e., lateral force). The single wheel L/V ratio can be used to predict the risk of the wheel climbing the gauge face of the rail or lifting off the rail. Circumstances in which a car is operating with high lateral force and low vertical force can result in a wheel climb event and derailment. For normal flange/rail contact conditions, a wheel L/V ratio of 1.5 can cause wheel climb.

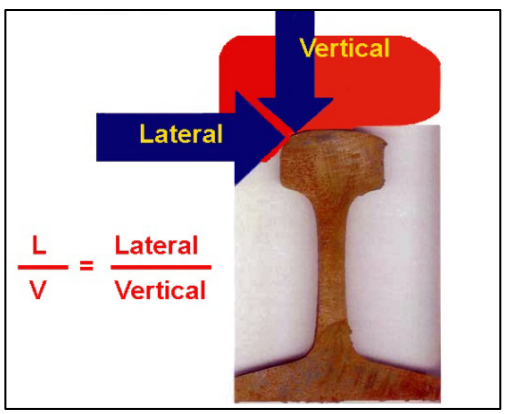

Figure 4. L/V Forces

Train Handling Guidelines

CP GOI Section 16 contains guidelines on train handling to avoid elevated L/V ratios and derailments due to high buff forces. CP GOI Section 16, Item 10.1 – Introduction to Train Handling Guidelines, states (in part):

> Knowledge of the road and train make-up are the most important factors the locomotive engineer must take into account when developing a train handling plan to operate safely, efficiently and with competence. The particular care and attention required when starting or stopping a train must also be exercised when the train is undergoing a transition from bunched to stretched or vice versa. Changes in slack due to grade changes

and/or train make-up, as well as those initiated by the locomotive engineer must be handled in such a way as to maintain the in-train forces within acceptable levels.

CP GOI Section 16 Item 12.0 states (in part):

- "…during planned stopping, slowing or controlling train speed, if dynamic brakes are available, the power (use of train air brakes) method should be avoided."
- "In many of the train handling methods, a final reduction is made approximately 200 feet from stop. This reduction is to keep the train bunched".

TSB Laboratory Analysis

The TSB Laboratory examined the dynamic forces in this derailment (report LP 020/2010) and determined that:

- The derailment was caused by the extremely high lateral force transformed from the high in-train buff force under the DB application which exceeded the GOI limits.
- The locomotive engineer applied only dynamic braking on Train 292-02 without any air brakes during the time leading up to the derailment.
- The long car length and large drawbar angle of the empty auto carrier cars contributed to the transformation of in-train buff force into high lateral force.
- Train dynamics simulation estimated that the maximum in-train buff forces at the derailed cars (13th to 19th) were in a range of 141 to 147 kips and the transformed lateral force on the left derailed wheel was in a range of 226 to 237 kips, with wheel L/V ratios of 1.22 on the 17th and 18th car to 1.50 on the 14th car which likely derailed first.
- If the train were re-marshalled by exchanging the head-end block of 27 empty auto carrier cars with the tail-end block of heavily loaded cars, the maximum in-train force would be very similar, but the maximum transformed lateral force and L/V ratios would be applied on the heavier cars instead of the lighter, empty auto carrier cars, significantly reducing the risk of derailment.

CP Testing and Simulation

CP conducted a computer simulation of the accident scenario using the Train Operations and Energy Simulator (TOES) program. The simulation used track data based on CP's track evaluation car test data and train 292's consist, tonnage profile and LER download information. The TOES simulation indicated that the 13th through 19th cars (i.e., the 7 car block that derailed) would have experienced an initial run-in when the train brakes were released to start the movement, followed by variable and increasing trailing coupler forces as DB was progressively applied (i.e., ranging from 60 000 to 160 000 pounds of buff force) while they negotiated the west shop lead turnout. The simulation indicated that the 19th car had the highest buff force of the group of 7 derailed cars as they went through the west shop track lead turnout.

CP conducted a TOES simulation with the same train consist but with DB 4 applied prior to releasing the train and independent brakes. For this scenario, DB was supplemented with train brakes to maintain speed below 10 mph as required by CROR Rule 105 (Speed on Other than Main Track). The simulation predicted a lower initial run-in and that the 13th through 19th cars would have experienced steadier and lower maximum trailing coupler buff forces (i.e., ranging from 80 000 to 115 000 pounds of buff force) as the train negotiated the west shop track 1/ZAUX turnout.

Analysis

Track and rolling stock condition were not considered contributory to the derailment. The analysis will focus on train handling, train marshalling and the routing of trains through a yard.

The Accident

The first marks observed on the track were wheel flange marks found on the head of the north guard rail of the frog in the number 11–100 lb left-hand turnout between the west shop track 1 and the ZAUX track, indicating the point of derailment (POD).

Train 292 was stopped on the west shop track lead in front of the Medicine Hat station for a crew change. The train was stopped in a stretched position on a descending grade with the air brakes fully applied. After the automatic and independent brakes were released, train 292's speed increased to 8 mph before the DB was applied. Up to 83 000 pounds of DB effort was applied to control the speed of the train below 10 mph, i.e. 23 000 pounds above the recommended maximum of 60 000 pounds permitted on a yard track when the DB factor of the lead locomotive is 14 or greater. Because of the recent train brake release, the brake system was only partially recharged. Consequently, the train brake was not considered a viable option to help control the train as it began to accelerate about 1 minute after the release. By the time the derailment occurred, about 3 minutes after the release, the train brake system had regained some capacity, but DB was the only brake used to control train speed.

Using DB alone, and with more than the recommended effort, generated high in-train buff forces that were concentrated near the head-end of the train where the empty auto carrier cars were positioned. Although considered loads by TrAM, these relatively lighter cars produced a lower vertical force component for the L/V ratio. Subsequently, as the lighter auto carrier cars negotiated the sharp turnout curve, the elevated in-train buff forces produced high lateral forces at the wheel/rail interface. With an elevated L/V ratio, wheel climb occurred on the 14th car, leading to the derailment of the 13th through 19th cars.

TrAM Loaded Car Criteria

The rear 4500 feet of train was heavier and on a steeper grade than the lighter 2800 foot long head-end portion. Although not a TrAM violation, marshalling of the long and lighter empty multi-level auto carrier cars ahead of the heavier rear portion of the train made it vulnerable to the large in-train buff forces generated when attempting to control train speed using DB only. The buff forces compressed the EOCCD draft gear, producing high transformed lateral forces due to the wide angle couplers. These cars when empty are more than 50% heavier than empty conventional cars and TrAM considers them to be loads. Had they been placed on the tail end of the train behind heavier loaded cars, the risk of derailment would have been reduced. While it may seem appropriate to apply the TrAM load threshold of 45 tons to empty long cars with wide angle couplers and pre-loaded EOCCD draft gear, marshalling them ahead of heavier loaded cars increases the risk of derailment during heavy braking events.

Routing of Through Trains at Medicine Hat Yard

Eastward through-trains are normally routed on the main track or on track 1 when changing crews in Medicine Hat. However, in this occurrence, both the main track and track 1 were occupied. To accommodate the crew change and to expedite the movement, train 292 was routed through the yard and over 3 turnouts, including the No. 11 west shop track 1/ZAUX track turnout, where the derailment occurred. Operating train 292 over yard track 2, rather than the more tangent main track or track 1, increased the risk of derailment by producing excessive lateral forces.

Leaving "Stretched" Trains on a Downgrade

Leaving the train with the slack bunched would have reduced the buff force generated when the train brakes were released. To achieve this, the inbound crew would have had to execute a bunched stop through the yard and over the turnouts. While it is likely that the inbound crew were focused on making a safe stop for the crew change, leaving the train stretched on a downgrade through yard turnouts made a safe re-start difficult.

Train Brakes

Instructions on the use of DB indicate that when the DB is required after a train brake release the DB handle should be moved into a braking position before releasing the train brake. However, CP's simulation showed that when this was done, a reapplication of the train brake would still have been necessary to keep the train speed below 10 mph. After release of the fully applied train brakes, the train accelerated to 8 mph in 1 minute 43 seconds. To effectively maintain the train speed below 10 mph, it would have been necessary to reapply the train brakes very quickly after they were released. While some service brake capacity on this 102 car conventional train was regained before the derailment, there would not have been sufficient recharge time for a service reapplication of the train brakes to be relied upon so soon after the release of the full service brake application. An operator-initiated emergency brake application was always an option, but not one that a locomotive engineer would likely use while traversing numerous yard turnouts unless it were absolutely necessary.

Environmental Response

Despite the release of considerable quantities of both fuel and coolant, much of the spilled material was recovered and did not enter either the South Saskatchewan River or the municipal storm drain system. The environmental response was prompt and effective.

The following TSB Engineering Laboratory report was completed:

LP020/2010 – Train Simulation, CP Freight Train, 292-02

Findings as to Causes and Contributing Factors

1. Once the train had reached a speed of 8 mph, DB was applied above the recommended maximum level to maintain speed below 10 mph, generating high in-train buff forces.

2. As the lighter auto carrier cars that had been marshalled on the head end negotiated the sharp turnout curve, the elevated in-train buff forces produced high lateral forces at the wheel/rail interface.

3. With an elevated L/V ratio, wheel climb occurred, leading to the derailment of the 13^{th} through 19^{th} cars.

4. Operating train 292 over yard track 2, rather than the more tangent main track or track 1, produced significant lateral forces.

5. While it is likely that the inbound crew were focused on making a safe stop for the crew change, leaving the train stretched on a downgrade through yard turnouts made a safe re-start difficult.

6. To effectively maintain the train speed below 10 mph, it would have been necessary to reapply the train brakes very quickly after they were released. However, there was insufficient recharge time for such a service reapplication of the train brakes to be reliable.

Finding as to Risk

1. While it may seem appropriate to apply the TrAM load threshold of 45 tons to empty long cars with wide angle couplers and pre-loaded EOCCD draft gear, marshalling them ahead of heavier loaded cars increases the risk of derailment during heavy braking events.

Other Finding

1. The environmental response was prompt and effective.

Safety Action Taken

Canadian Pacific Railway has undertaken the following safety action:

- The incident was reviewed as part of an Air Brake Refresher/Train Handling course given to each locomotive engineer in the terminal. The course included a review of the proper train handling method for this situation (Note: the method was confirmed on the simulator as well as in the field, and is consistent with CROR rules and GOI Section 16, Appendix 1: Descending Heavy Grade Job Aid).

- Local management also rode with each locomotive engineer to determine their proficiency regarding the principles taught in the course.

- Local supervisors of operations were requested, when circumstances permit, to not route eastbound trains, particularly heavier eastbound trains, through the yard.

- TrAM 3 is being developed and will have a provision to assess the marshalling of lighter cars (i.e., less than 45 tons) versus heavier cars near the head end of a train.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 17 August 2011.

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