



**RAILWAY INVESTIGATION REPORT**  
**R05C0116**



**DERAILMENT AND COLLISION**

**CANADIAN NATIONAL**  
**FREIGHT TRAIN A443-51-06**

**AND**

**0700 LCS (BELTPACK) YARD ASSIGNMENT**  
**MILE 0.30, GTP INDUSTRIAL BRANCH**  
**HEAD BLOCK MILEAGE 125.69**  
**THREE HILLS SUBDIVISION**  
**SARCEE YARD**  
**CALGARY, ALBERTA**  
**13 JULY 2005**

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

# Railway Investigation Report

## Derailment and Collision

Canadian National

Freight Train A443-51-06

and

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Mile 0.30, GTP Industrial Branch

Head Block Mileage 125.69

Three Hills Subdivision

Sarcee Yard

Calgary, Alberta

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### *Summary*

While shoving eastward at 1045 mountain daylight time, Canadian National freight train A443-51-06 derailed two cars. The derailment destroyed a crossover switch stand and opened the switch points, allowing a following loaded tank car to enter the crossover track and foul the west yard lead. There, the tank car was struck by two locomotives of a westbound yard movement. The collision punctured the tank car, releasing about 106 800 litres of aviation fuel onto the ground. Railway employees acted quickly to shut down all the locomotives involved or near the derailment. Calgary police and fire services controlled the site and protected against a potential fire hazard. There were no injuries. Four businesses in the immediate area were evacuated as a precaution. There was extensive locomotive, car, and track damage.

*Ce rapport est également disponible en français.*

## *Other Factual Information*

### *The Accident*

On 13 July 2005 at 1045 mountain daylight time,<sup>1</sup> Canadian National (CN) freight train A443-51-06 (train 443) was making a reverse switching movement with 2 locomotives pushing 141 cars eastward in CN's Calgary Sarcee Yard. While pushing at about 5 mph, the lead wheels of the trailing truck of the 11th car (empty gondola car ICG 246601) climbed onto the guard rail and the frog of the switch at Mile 0.30 of the GTP Industrial Branch. The car's trailing truck derailed to the north side of the track at the beginning of a long right-hand curve. The train continued pushing eastward until the derailed car's wheels contacted a storage spur switch point, derailing the leading truck of the 10th car (empty centre beam flatcar TTZX 844201) on the turnout frog.

Continuing eastward, the two derailed cars destroyed the "A" crossover switch stand, causing the switch points to float open, lining the 10th and 9th cars for the crossover. The trailing wheels of the 10th car and the leading wheels of the 9th car (loaded non-pressure tank car PROX 41530) entered the opened crossover switch and fouled the yard lead track where they collided with two locomotives of a westward LCS<sup>2</sup> (Locomotive Control System) yard assignment. The collision punctured the tank head of tank car PROX 41530, resulting in about 106 800 litres of aviation fuel spilling onto the ground. A small amount of diesel fuel leaked from the lead yard locomotive's punctured fuel tank. The collision derailed and severely damaged the two LCS locomotives, the tank car, and the flatcar. It also destroyed the crossover switches, track, and about 300 feet of the yard lead track. The empty gondola car was only slightly damaged.

### *Weather*

The weather was clear, with good visibility and gentle winds from the south to the northwest. The temperature was 21°C.

### *Method of Train Control*

In Sarcee Yard, movements are governed by Rule 105 of the *Canadian Rail Operating Rules* (CROR).

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<sup>1</sup> All times are mountain daylight time (Coordinated Universal Time minus six hours) unless otherwise stated.

<sup>2</sup> The Locomotive Control System allows an employee on the ground to remotely control locomotives.

## Site Information

The CN Sarcee Yard is in an industrial area of southeast Calgary (see Figure 1). Orientated in an east-west direction, it is bordered by Barlow Trail to the west and 52nd Street SE to the east. Both are busy roads with a majority of traffic being tractor-trailers (see Figure 2). To the north, 50th Avenue SE runs parallel to the yard. Yard assignments serve the industrial areas around the yard and throughout Calgary. Sarcee Yard serves traffic between Calgary and Edmonton, Alberta, and Calgary and Saskatoon, Saskatchewan. Traffic between Canadian Pacific Railway (CPR) and CN is interchanged at the CPR Alyth Yard. There are commercial and industrial properties adjacent to the yard with residential property to the north.

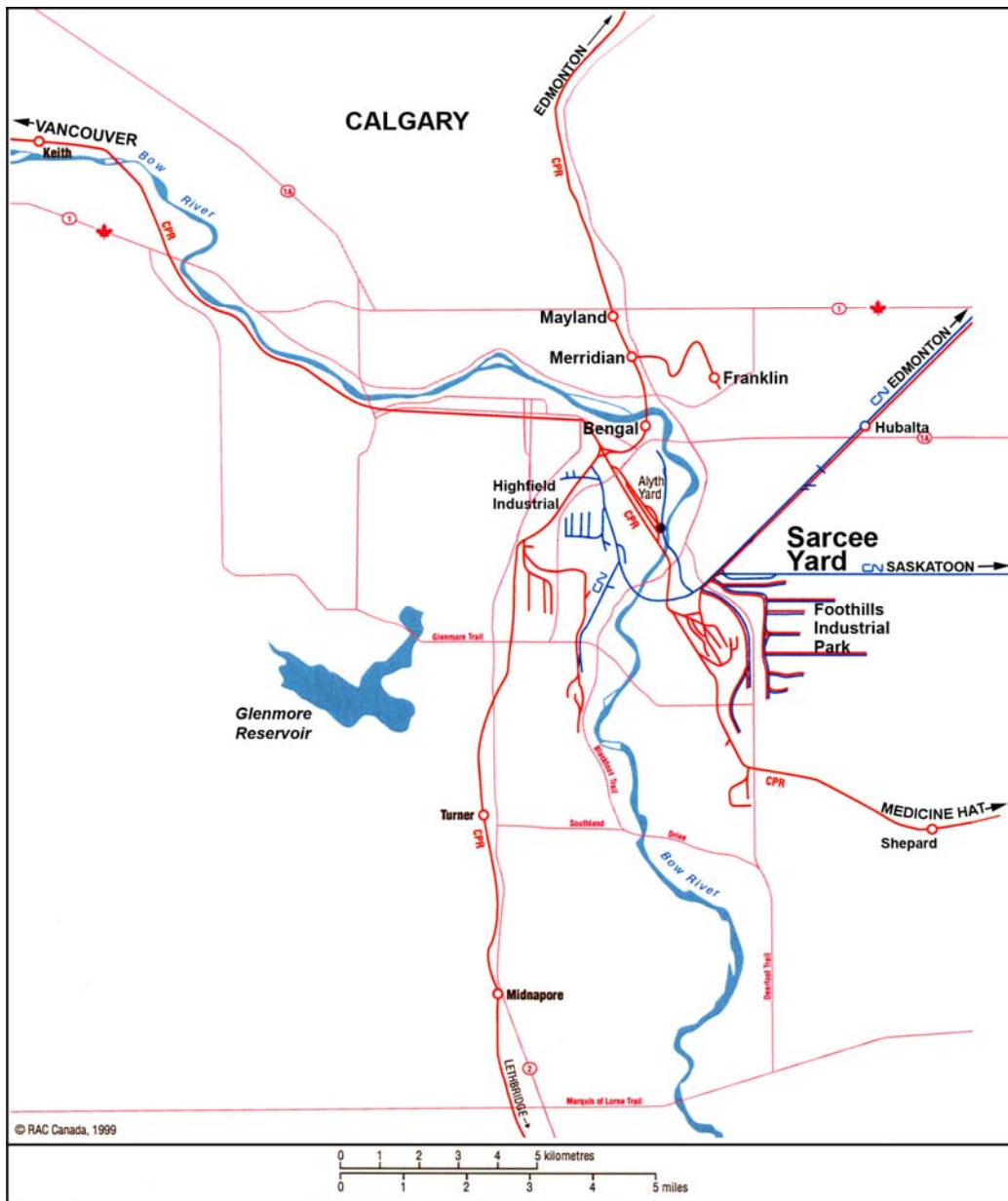


Figure 1. Location of Sarcee Yard in Calgary

The yard consists of nine tracks, south of and parallel to the Drumheller Subdivision main track, which are used to switch cars and make up trains. Tracks N001 and N002 are located north of and parallel to the main track. These tracks were added to Sarcee Yard to facilitate building longer trains. At the west end of the yard, an east wye track connects Mile 125.93 of the Three Hills Subdivision to Mile 131.88 of the Drumheller Subdivision. A north wye switch connects the Three Hills Subdivision with the GTP Industrial Branch. Between the two legs of the wye, the Calgary Industrial Branch extends from Mile 131.88 of the Drumheller Subdivision to the switch at Mile 0.30 of the GTP Industrial Branch. Midway between these two switches on the curve is a westward-facing storage spur track switch. Most of the yard tracks are level and tangent. At the west end of the yard, the Calgary Industrial Branch and switching lead tracks curve south to join the GTP Industrial Branch. These tracks are on a westward descending grade of about 0.6 per cent to the Barlow Trail public level crossing.

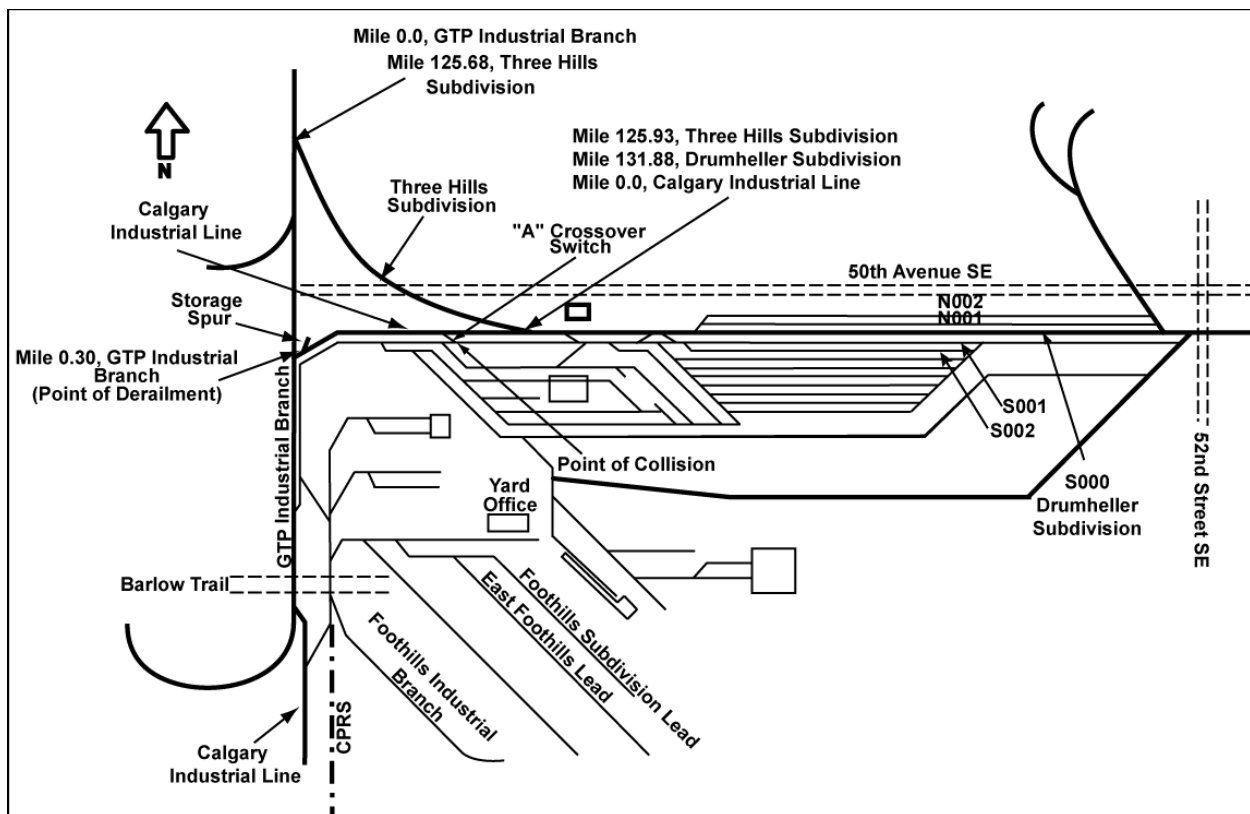


Figure 2. Sarcee Yard

### Train 443

Train 443 consisted of 2 locomotives, 99 loads, 41 empties and 1 residue car, weighed 7684 tons, and was 8931 feet long. Train 443 is operated daily between Calgary and Edmonton.

### *The Train Crew – Train 443*

The train crew for train 443 consisted of a locomotive engineer and a conductor who were qualified for their respective positions, and met fitness and rest standards.

### *The Yard Crew – 0700 LCS Yard Assignment*

The 0700 LCS yard crew consisted of a yard foreman and a helper who were qualified for their respective positions, and met fitness and rest standards.

### *Train 443 – Switching for Departure from Sarcee Yard*

The train's length was limited to the 9100-foot distance between the track circuits used to activate the level crossing signals for Barlow Trail and 52nd Street SE. Train 443 usually departed Sarcee Yard between 1100 and 1300, a peak roadway traffic time. During this time, train 443 can occupy the crossings at Barlow Trail or 52nd Street SE or 50th Avenue SE while being made up.

CROR Rule 103(c) establishes parameters under which it is acceptable for railways to occupy crossings. While the rule limits the amount of time a train can remain standing on a crossing, it does not limit the overall time that vehicular traffic may be obstructed, that is, by switching or by slowly moving trains.

On the day of the occurrence, there was sufficient railway traffic available to fill out the train to close to the maximum 9100 feet. To accommodate Edmonton's Walker Yard switching of train 443, CN Sarcee Yard was required to marshall train 443 with the empty cars on the head end and the loaded intermodal traffic at the rear.

During the night, train 443 was marshalled on tracks N001 and N002 located north of the Drumheller Subdivision main track (S000). Intermodal traffic, consisting of loaded multi-platform container and trailer flatcars, was switched onto track N002. The balance of the train was switched onto track N001 and consisted of mostly empty cars. During the early morning of 13 July 2005, a carman inspected the mechanical condition of the cars and pre-tested them with yard air to ensure that the air brakes were working properly and that the train's air brake system was fully charged.

The train crew reported for duty at 0830 on 13 July 2005. The locomotive engineer was operating the two locomotives (CN 2670 and WC 6939) and the conductor was at the west N001 switch waiting to couple the eastward movement of the cars from track N001 onto the cars in track N002. The yardmaster was at the east end of track N001 waiting to line the N001 switch for the eastward movement onto the Drumheller Subdivision and over the 52nd Street SE crossing.

After the locomotives had been coupled to the cars in track N001, the locomotive engineer and the carman performed an air brake test to establish continuity and test emergency braking from the tail end. Once continuity was established, the locomotives and the first portion of the train pulled westward out of track N001.

When the westward movement of the locomotives and cars from N001 came to a stop clear of the switch to track N002, the locomotives were west of the Barlow Trail public level crossing. The crossing was blocked and traffic quickly backed up. The locomotive engineer was instructed by the conductor to back the movement eastward to couple the cars from track N001 onto the cars in track N002. According to event recorder data, the eastward movement started at 1041:57 and the movement was stopped at 1043:19 when the coupling was made, followed by the connection of the train air brake system.

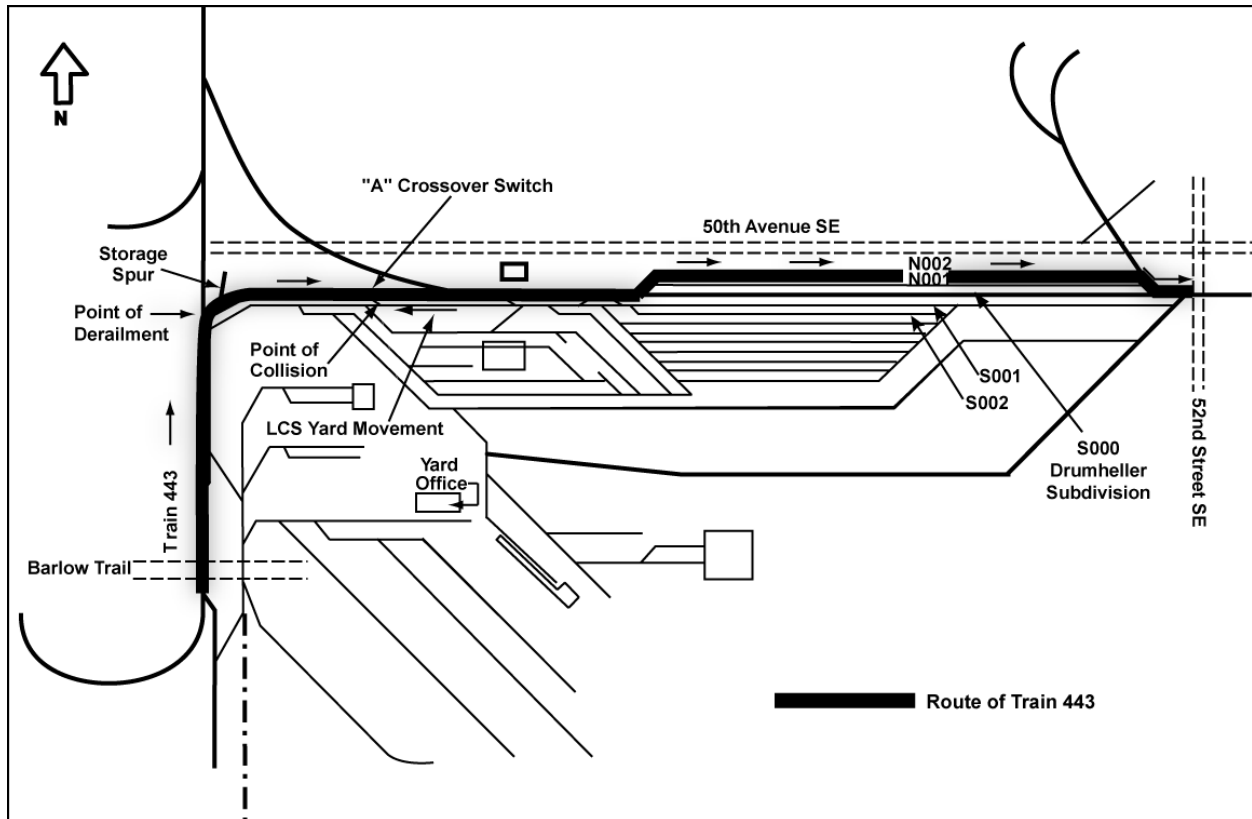


Figure 3. Route of train 443 in Sarcee Yard

The locomotive independent air brake was applied to hold the train on the eastward ascending grade. At 1044:18, the selector lever was placed in reverse, independent brake pressure reduced and the throttle opened to gather the slack. The independent brake was released at 1044:25 and at 1044:28 the speed registered 1 mph. The throttle was increased to position No. 4 at 1044:47 and speed increased to 3 mph at 1044:49. When the speed dropped to 1 mph at 1044:51, the throttle was rapidly increased to position No. 7 then reduced to position No. 5 at 1044:52. Between 1044:52 and 1045:31, when the speed increased to 5 mph, the throttle was manipulated between positions 6, 5, 3, and 4. Between 1045:45 and 1046:18, the throttle was manipulated between positions 3, 2, and 1. The speed dropped to 4 mph at 1046:31 and to 3 mph at 1047:03. At this time, there was a train-initiated emergency brake application. The movement came to a stop at 1047:06.

## *0700 LCS (Beltpack) Yard Assignment*

The 0700 yard assignment was making up train 115 in track S001 south of the main track. The yard crew consisted of a yard foreman and helper who were located at or near the S001 switch. Also on board was a diesel mechanic investigating a reported power loss on locomotive CN 7078. Two locomotives, CN 7078 and CN 1405, were coupled to 29 cars, pulling the movement westward at about 8 mph on the yard lead track. The yard helper was controlling the LCS movement using the beltpack<sup>3</sup> remote control method of operation. The movement was slowing down to about 4 mph as there were only about four cars to clear the S001 switch. The locomotives were observed to suddenly jump to the side and a cloud of dust was observed. The yard helper stopped the yard movement using the beltpack controls.

## *Locomotive Damage*

The two LCS yard locomotives were derailed and damaged from the impact with the flatcar and the tank car. Locomotive CN 7078 derailed, sustaining damage to the front right corner steps, side sill, and pilot. The leading and trailing trucks had air brake cylinder damage and the fuel tank's top corner was dented and punctured. A small amount of diesel fuel leaked onto the ground. Locomotive CN 1405 had the leading truck derailed and its right side pilot and stair casing was damaged and fuel tank dented.

## *Damage to Rolling Stock*

Bulkhead flatcar TTZX 84420 was derailed, sustaining damage to the A-end right side truck and bulkhead.

The B-end of tank car PROX 41530, a non-pressure 111A100W1 tank car built in 1989, derailed. The B-end left corner of the tank head was punctured at about the 8 o'clock position and the body bolster was bent and torn from the tank shell plate. The puncture measured 15 inches longitudinally and 15 inches vertically.

## *Other Damage*

The derailment destroyed the crossover switches, connecting track and about 300 feet of the yard lead track.

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<sup>3</sup> Beltpack is a remote control method of operating a locomotive. In this occurrence, the helper performed the switching operation while the foreman provided the point protection and operated the switches. The helper used an operator control unit to transmit commands to remotely activate the locomotive controls through an onboard computer.



## *Dangerous Goods*

Aviation fuel, Class 3, UN 1863, is a highly flammable liquid that can form an explosive mixture with air. Most vapours are heavier than air and will spread along the ground and collect in low or confined areas.

Diesel fuel, Class 3, UN 1993, is a flammable liquid that can form an explosive mixture with air. Its potential hazards are similar to those of aviation fuel.

## *Particulars of the Track*

The Mile 0.30 GTP Industrial Branch turnout had a No. 10 100-pound switch with a Racor 17D semi-automatic switch stand. It was in good condition.

The storage spur turnout had its switch points spiked for through movement on the curved track. The storage spur track had been destroyed in a derailment on 06 November 2004.

The "A" crossover turnouts were No. 10 100-pound switches with Racor 17D semi-automatic switch stands. The switches were in good condition before the occurrence.

The rail consisted of 100-pound (four-hole) jointed rail manufactured by Dominion Steel Company in 1957. Approaching the switch and on the curve, the rail was secured by four spikes per plate and a hold-down spike. The rail was anchored at every tie approaching the curve and every third tie around the curve. On the tangent, the rail was secured by two spikes per plate on softwood ties. The tie condition was fair. Ballast was pit run fouled by soil. There was no elevation on the 18-degree curve beyond the Mile 0.30 GTP Industrial Branch turnout.

The grade approaching the switch was 0.6 per cent ascending eastward from Barlow Trail.

The Sarcee Yard track was inspected and maintained by a track supervisor and maintenance crew who were located in the yard.

## *Emergency Response*

After liquid was observed spreading out under the LCS locomotives, all locomotives on the LCS yard assignment, train 443, and the nearby shop track were quickly shut down. When the conductor from train 443 arrived at the derailment site, he advised everyone that the liquid leaking from the tank car was aviation fuel.

With the fuel spreading, six CN employees evacuated the yard office and one truck driver was told to leave the area. All employees evacuated to the south into the wind. A 911 call was made and CN management were called to request emergency assistance. The fuel was observed flowing toward the storm sewer outlet; therefore, an attempt was made to seal it off with a reflective vest. Another storm sewer was covered with a blanket to stop the flow of liquid into the sewer. Those remaining on site then headed south towards the yard office and, subsequently, left the yard.

With train 443 blocking the two southbound lanes of the 52nd Street SE crossing at the east end of the yard, police assistance was requested to direct traffic over the crossing in either direction in the northbound lanes. To clear the crossing, a front-end loader made a cut behind five cars and pushed them east. While this was occurring, the fire department arrived at 1123 at the north side of the tracks off 50th Avenue SE and was directed to the spill site.

The emergency responders decided to not activate the emergency evacuation procedures because the fuel was not pooling, and no vapour cloud was forming. Four businesses in the immediate area were evacuated as a precaution. The fire department monitored the vapour with air sensors throughout the day. A storm sewer holding pond and the irrigation canal showed traces of aviation fuel, which was controlled by river booms and recovered by vacuum trucks. Contaminated soil in the yard was excavated and removed to a landfill. There were no injuries as a result of the spill.

### *Previous Accidents Involving Destination Marshalling*

On 06 November 2004, train 443 was being pushed eastward when two empty bulkhead flatcars jackknifed and derailed on the switch at Mile 0.30 of the GTP Industrial Branch. The two derailed cars were pushed eastward until the cars damaged the storage spur switch and destroyed the track. At the time, CN decided not to remove the storage spur switch and track even though it was surplus. The 06 November 2004 accident was not reported to the TSB (see Appendix A).

The consequences of destination marshalling have been a contributing factor in a number of CN derailments in recent years (TSB reports R02C0050, R01M0061, and R01T0006). This matter has been identified as a safety concern by the Board and has been the subject of a recent Rail Safety Advisory issued to Transport Canada (RSA 02/06). While many long trains have been successfully operated across the CN system, reverse switching movements through curvature and over public crossings with long trains, particularly when empties are marshalled ahead of heavy blocks of cars, represents risk to persons, property, and the environment.

When marshalling trains as long as 9100 feet, the yardmaster must be out of the yard office to protect the rear of the train over the 52nd Street SE crossing. If there is an accident or occurrence, the yardmaster is not in a position to respond because he is at the far east end of the yard.

### *Analysis*

Neither the condition of the track or rolling stock nor the handling of the train were considered contributory to this accident. The investigation will therefore focus on train length and marshalling practices in Sarcee Yard. Reporting accidents to the TSB and emergency response will also be discussed.

Up until two years ago, CN operated train 443 no longer than 7000 feet so that it would fit between the 52nd Street SE crossing and the east leg of the wye switch (50th Avenue SE crossing) at Mile 131.88 of the Drumheller Subdivision. As business increased, CN increased the length of train 443 up to a maximum of 9100 feet, the distance between the crossing circuits at

Barlow Trail and 52nd Street SE. The operation of longer trains is consistent with CN's system-wide operating philosophy. Train 443 was 8931-feet long and was marshalled with the empty cars on the head end and loaded cars at the rear of the train. Making up train 443 with this configuration required pushing empty cars up a grade and around a curve against loaded cars.

CN recognized that trains of this configuration are subject to undesirable track-train dynamics. As a result, the CN *Locomotive Engineer Operating Manual*, Form 8960, Section G1.2.1, contained guidelines to reduce the possibility of jackknifing cars during pushing movements. The lowest tractive effort possible was to be used and extreme caution exercised, giving due consideration to the grade and curvature of the track, and the weight distribution of the train. While the locomotive event recorder shows a momentary increase in throttle position from position 4 to position 7 to position 5 over two seconds, there would not have been a significant build-up of horsepower with diesel-electric locomotives to have adversely affected the movement.

As train 443 reversed, the loaded tank car pushed against the empty flatcar and the empty gondola car. The longitudinal or buff force required to reverse the train was increased by the ascending grade and the track curvature. The concentration of longitudinal force at the empty gondola car resulted in sufficient transformed lateral force to overcome the relatively light vertical force exerted by the empty gondola car, resulting in a wheel-climb derailment. The leading wheels of the trailing truck of the empty gondola car climbed the guard rail and derailed at the frog. As the movement continued eastward, the car jackknifed outward at the frog, derailing the truck to the north.

The derailed empty gondola car was pushed further eastward toward the storage spur switch that was spiked for through movements eastward on the track. At this time, the south wheels of the derailed gondola truck were on the ground close to the gauge side of the south running rail. The derailed wheels struck the open south storage spur switch point, driving the derailed truck further northward and derailing the lead truck of the following flatcar. The derailed trailing wheels of the gondola car and leading wheels of the flatcar then climbed the frog of the storage spur, falling to the ground close to the gauge side of the north rail.

Continuing eastward, the derailed cars destroyed the "A" crossover switch stand, opening the points for the trailing truck of the flatcar and the tank car to proceed through the crossover where they fouled the yard lead track and collided with the LCS movement. Had the storage spur switch been removed after the 06 November 2004 occurrence, the derailed wheels would not have struck the open switch point and been diverted further northward. The derailed wheels would have likely travelled around the curve close to the running rails without destroying the "A" crossover switch stand. This would have reduced the severity of this occurrence because the tank car would not have diverted onto the crossover and into the path of the LCS movement.

Although CN recognized that destination marshalling may increase the risk of undesirable track-train dynamics, train 443 was marshalled with empty cars close to the head end and loaded cars behind.

## *Reportable Accidents*

At the time of the 06 November 2004 accident, some officials within CN were erroneously of the view that it was not necessary to report it to the TSB, and it was not reported.

The 06 November 2004 accident could have been an opportunity for the railway to review its marshalling and operating practices for train building at Sarcee Yard.

## *Emergency Response*

The damage to the tank car and the resulting spill of aviation fuel created a potentially serious fire hazard. The well-coordinated emergency response measures were executed quickly and professionally so that the risk to employees and local residents was reduced.

## *Findings as to Causes and Contributing Factors*

1. The concentration of longitudinal force at the empty gondola car resulted in sufficient transformed lateral force to overcome the relatively light vertical force exerted by the empty car, resulting in a wheel-climb derailment.
2. Although Canadian National (CN) recognized that destination marshalling may increase the risk of undesirable track-train dynamics, train 443 was marshalled with empty cars close to the head end and loaded cars behind.

## *Other Findings*

1. Because CN did not investigate nor report to the TSB a prior, similar derailment at the same location, an opportunity was lost to review and identify safety deficiencies.
2. While recorded information indicates that there were momentary throttle manipulations, these throttle changes were not of sufficient duration to be considered safety-significant events.

## *Safety Action Taken*

The Canadian National (CN) loaded intermodal equipment is now handled on the head end of train 443.

The CN yardmasters are instructed to keep heavy cars on the head end when possible.

Transport Canada will work with its Transportation Development Centre to further explore train length and train handling for the development of possible safety guidelines or standards.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 08 December 2006.*

*Visit the Transportation Safety Board's Web site ([www.tsb.gc.ca](http://www.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 – Previous Accident*

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<b>Date</b>	06 November 2004
<b>Time</b>	1700 mountain standard time
<b>Day</b>	Saturday
<b>Railway</b>	Canadian National
<b>Location</b>	Mile 0.30 of the GTP Industrial Branch off Mile 131.88
<b>Subdivision</b>	Drumheller
<b>Yard</b>	Sarcee
<b>Train</b>	A443-51-06
<b>Consist</b>	CN 5666, CN 2685, CN 5536
<b>Loads</b>	46
<b>Empties</b>	92
<b>Tons</b>	6400
<b>Length</b>	7981 feet
<b>Derailed</b>	Two bulkhead flatcars
<b>Location in the Train</b>	11th and 12th from the head end
<b>Weather</b>	0°C, freezing rain, snow, cold

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On 06 November 2004 at about 1700 mountain standard time, while train 443 was pushing eastward, two bulkhead flatcars derailed at Mile 0.30 of the GTP Industrial Branch switch. The two bulkhead flatcars jackknifed on the switch frog, derailling the two cars to the north. The derailed cars were pushed eastward until the cars contacted and damaged the storage spur switch. The cars jackknifed onto an equipment and vehicle parking area. The spur track was destroyed. It was decided to not remove the track even though it was surplus.