



RAILWAY INVESTIGATION REPORT
R06V0119



TRAIN DERAILMENT

ROCKY MOUNTAINEER VACATIONS INC.
PASSENGER TRAIN RMV 1-28
MILE 68.3, CANADIAN PACIFIC RAILWAY
MOUNTAIN SUBDIVISION
FRAINE, BRITISH COLUMBIA
28 MAY 2006

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

Train Derailment

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Passenger Train RMV 1-28
Mile 68.3, Canadian Pacific Railway
Mountain Subdivision
Fraine, British Columbia
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Report Number R06V0119

Summary

At approximately 1215 Pacific daylight time on 28 May 2006, Rocky Mountaineer Vacations passenger train RMV 1-28 en route from Calgary, Alberta, to Vancouver, British Columbia, derailed five passenger cars and two staff cars while proceeding westward through the crossover from the south Macdonald track to the north Connaught track at Fraine, British Columbia, Mile 68.3 of the Canadian Pacific Railway's Mountain Subdivision. There were no serious injuries.

Ce rapport est également disponible en français.

Other Factual Information

The Accident

On 28 May 2006, Rocky Mountaineer Vacations Inc. (RMV) passenger train number 1-28 (RMR 8015 West¹) departed Calgary, Alberta, on the Canadian Pacific Railway (CPR) Laggan Subdivision destined for Vancouver, British Columbia.² The train was approximately 1200 feet long, weighed 1100 tons and consisted of two locomotives, one generator car, two staff cars and ten passenger cars. The crew consisted of 2 locomotive engineers and 45 onboard service and culinary staff. Both locomotive engineers were familiar with the territory, were qualified for their positions, and met fitness and rest standards. In addition to the crew, 518 passengers were aboard. The method of train control was Centralized Traffic Control System (CTC), authorized by the *Canadian Rail Operating Rules* (CROR) and supervised by a CPR rail traffic controller (RTC) located in Calgary.

The trip was uneventful until the train proceeded through the Fraine crossover switch at Mile 68.3 of the Mountain Subdivision near Rogers Pass west of Golden at approximately 1215 Pacific daylight time.³ It is standard operating practice for passenger trains, which are usually lighter than freight trains, to be routed to the Connaught track either at Rogers or through the west crossovers at Fraine (see Figure 1). The locomotives, the generator car, and the first two passenger cars had successfully traversed the Macdonald crossover switch when the following seven cars derailed. Four cars jackknifed across both tracks, two cars derailed in the crossover, and one derailed on the Macdonald track, all in an upright position. The last three passenger cars did not derail. There were no serious injuries.

The weather was clear, and the temperature was 15°C.

¹ Canadian Pacific Railway (CPR) designation

² All locations are in British Columbia unless otherwise specified.

³ All times are Pacific daylight time (Coordinated Universal Time minus seven hours) unless otherwise noted.

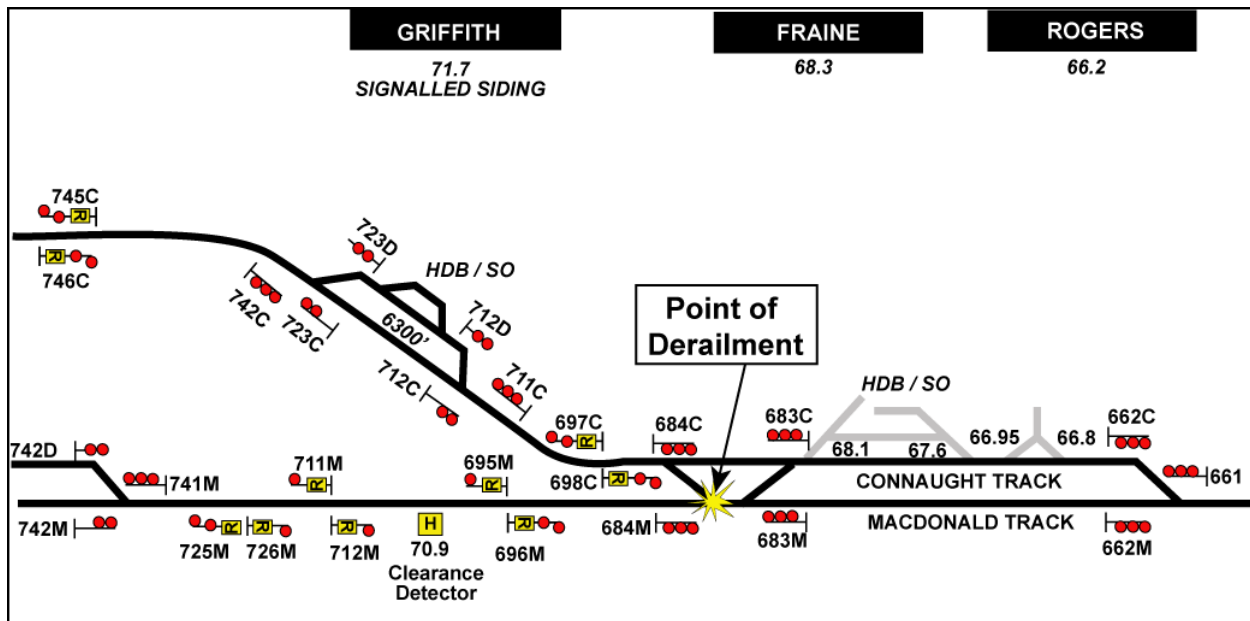


Figure 1. Derailment location

Train Information

Armstrong Hospitality Group owns and operates RMV, which operates the western Canada tourist trains Rocky Mountaineer and Whistler Mountaineer. The Rocky Mountaineer operates the Kicking Horse Route westbound from Calgary–Banff, Alberta, through the Rocky Mountains to Vancouver on Sundays, Tuesdays, and Thursdays, from mid-April to mid-October. RMR train 1-28 had a scheduled departure time from Calgary of 0620 mountain daylight time⁴ with a scheduled arrival in Vancouver of 1710 the following day. There was a scheduled overnight stay in Kamloops. There are no sleeping cars on the RMV because it travels only during daylight hours so passengers can view the mountain scenery.

Equipment

The train consisted of two locomotives, a generator car, ten passenger cars, and two staff cars. The post-derailment condition of the train was as follows (from front to back, west to east):

- RMR 8015 Locomotive
- RMR 8016 Locomotive
- RMR 9632 Generator car
- RMR 5718 Passenger car
- RMR 3219 Passenger car

⁴ Coordinated Universal Time minus six hours

RMR 5558	Passenger car, trailing truck and trailing wheels of lead truck derailed, jackknifed across both tracks
RMR 3237	Passenger car, all wheels derailed, jackknifed across both tracks
RMR 3220	Passenger car, all wheels derailed, jackknifed across both tracks
RMR 5703	Passenger car, all wheels derailed, jackknifed across both tracks
RMR 5449	Staff car, all wheels derailed in crossover
RMR 5721	Staff car, leading truck derailed in crossover
RMR 9504	Passenger car, one wheel derailed
RMR 9505	Passenger car
RMR 9521	Passenger car
RMR 9525	Passenger car

Cars RMR 5718, 3219, 5558, 3237, 3220, and 5703, and the two staff cars were built in 1953 and have all been refurbished. These cars have vestibules on the B-end only. Cars RMR 9504, 9505, 9521, and 9525 are bi-level dome cars custom-built for RMV in 1995 and 2007.

Emergency Response

Immediately following the derailment, train managers determined that all passengers in all cars were accounted for and that there were no apparent injuries. Passengers were evacuated from the derailed cars into the other upright cars, which were located in front of and behind the derailed cars. Where possible, the passengers moved through the cars and from car to car using the vestibules. Where this was not possible, passengers moved from car to car by walking along the tracks. Onboard attendants facilitated passenger movement by directing passengers, moving luggage, and propping vestibule doors open.

At approximately 1240, the train operations coordinator contacted the RMV operations centre in Kamloops via satellite telephone, and a train manager contacted the Vancouver RMV office using a cellular telephone. These communications were sporadic and intermittent due to poor signal quality in this remote location. At times, communications were relayed through CPR via railway radio.

A CPR supervisor and a team of four paramedics from Golden, approximately 30 miles east of Fraine, attended at the scene. While the CPR supervisor evaluated the situation, the paramedics assessed all passengers and crew members, and confirmed that there were no injuries. This information was communicated to the RMV operations centre and to rail traffic control.

Inspection of the derailed equipment determined that the tenth car, RMR 9504, was only partially derailed and could be readily re-railed. All passengers were removed from this car before re-railing was done by a locomotive that had arrived from Golden. The re-railed car and three tail-end cars were pulled back to Golden, arriving at approximately 1615 with 394 passengers and 40 crew members.

En route to Golden, some passengers required medical attention for relief from the stress associated with the occurrence that had exacerbated pre-existing medical conditions. Treatment included supplying oxygen. All RMV oxygen supplies were depleted by the time the rear portion of the train arrived in Golden. Two ambulances were called to meet the train in Golden. Nine passengers were transported to hospital for medical attention. Buses transported the remaining passengers and crew to Kamloops.

The front of the train, consisting of the two locomotives, the generator car, and passenger cars RMR 5718 and RMR 3219, carrying 124 passengers and 5 onboard crew, continued to Revelstoke, Mile 125.7, arriving at 1600. Upon arrival, passengers and onboard staff were transported to Kamloops by motor coaches.

At about 2145, the first motor coaches began to arrive in Kamloops. By 0200, all passengers and crew had arrived in Kamloops.

Recorded Information

Locomotive event recorder information indicates that, at 1216:40, the train was travelling at 24 mph in throttle position 3 as it proceeded through the crossovers when a train-initiated emergency brake application occurred.

The CTC field logs indicate that the Fraine On Sheet (OS) track⁵ was occupied at 1216:19 by RMR 8015 West. At 1216:32, the Macdonald switch reversed. At 1216:37, the Macdonald switch was registered as out of correspondence (not communicating).

No alarms were recorded for the train when it passed hot box detectors at Mile 39.3 and Mile 54.5.

Crossover Details

The west crossover from the Macdonald to Connaught track at Fraine consisted of two No. 13, 136-pound, power-operated dual control switches. The track and switches were in good condition. The switch points were AREMA⁶ standard knife-point switches.

⁵ The OS time refers to the time when the track circuit at Fraine between signals 683 and 684 was occupied.

⁶ American Railway Engineering and Maintenance of Way Association

The CPR standard for mainline switches has been non-Samson switch points. CPR began phasing in Samson switch points for mainline applications in 1996. As of 2007, Samson switch points became the standard for all main-track switches.

In a Samson switch point, the lower corner of the head on the gauge side of the stock rail is machined at an angle to house the point on the stock rail. This machining on the stock rail is referred to as an undercut. The undercut protects the switch point from direct impact with oncoming wheel flanges, and the angled fit resists scissor action between the switch point and stock rails under traffic. Samson switch point stock rails are supplied from the manufacturer with an undercut in either end for installation on either side of the track. Figure 2 compares cross sections of the Samson and standard switch point designs.

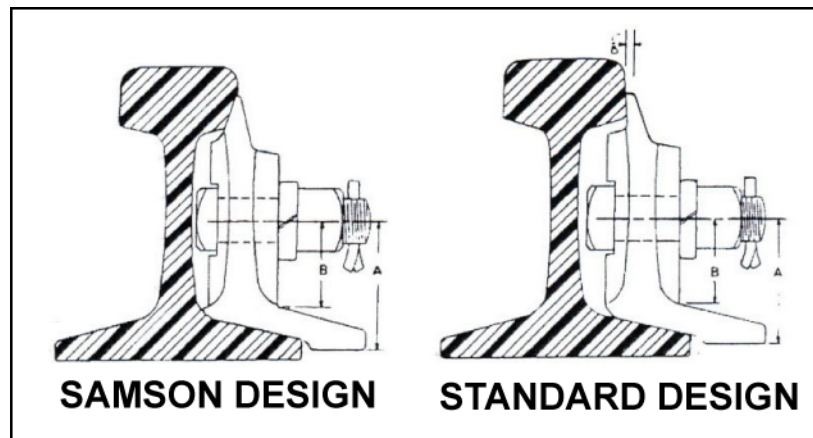


Figure 2. Samson and standard switch points

Track

The Connaught track and tunnel route through Rogers Pass was constructed in 1916. CPR has had double track through Rogers Pass since the construction of the Macdonald track and tunnel in 1988. Westward freight trains, which are usually heavier than passenger trains, are routed on the Macdonald track, which has an ascending grade of 1 per cent, while the Rocky Mountaineer passenger train is usually routed on the Connaught track, which has a steeper ascending grade of 2.4 per cent.

A small piece of the Macdonald track left-hand switch point was found lodged between the switch point and stock rail (see Photos 1a and 1b). The fragment measured 9.4 cm long with a maximum width of 1.5 cm. The piece had chipped out a distance of approximately 11.5 cm to 21.5 cm from the point end. Wheel marks on the switch point indicated that a wheel travelled about 18½ feet along the top of the switch point before dropping in between the stock rail and switch point. Although a piece of the switch point had broken out, the actual tip of the switch point was not hit.

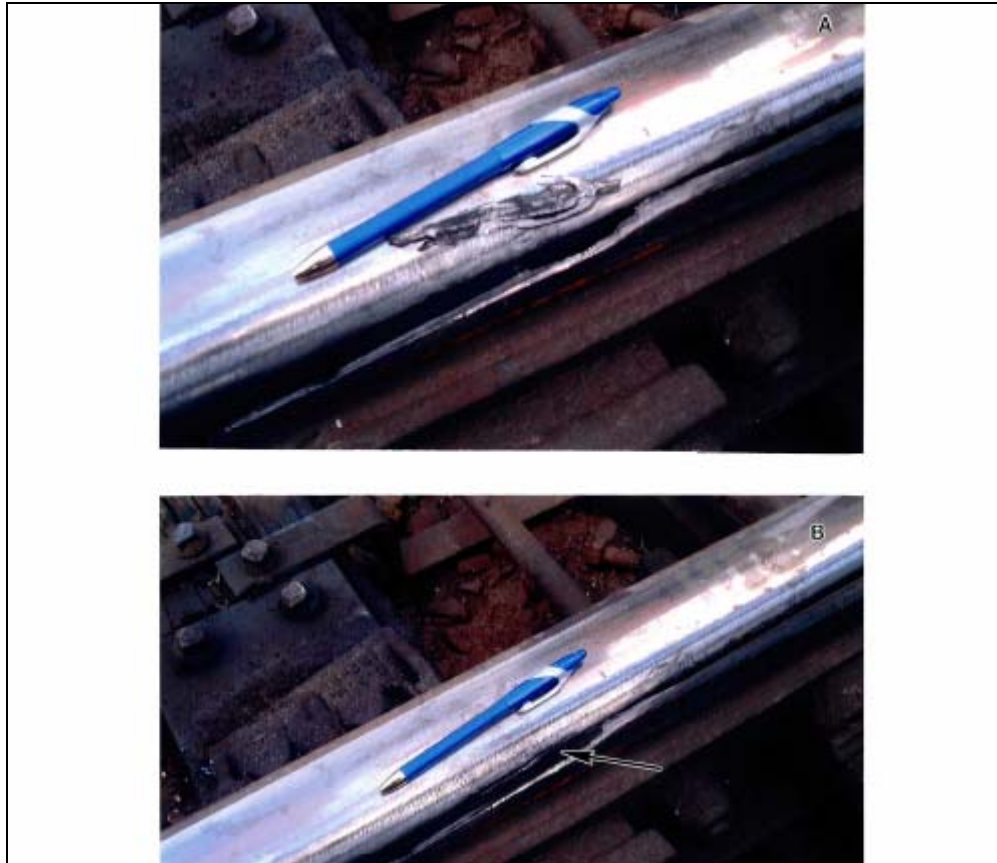


Photo 1a. Separated piece of switch point

Photo 1b. Original position of the fragment between the switch point and stock rail (arrow)

After the occurrence, the chipped switch point was ground to restore profile and the switch rods were adjusted. The switch point remained in service until both switch points and frog were replaced on the Macdonald track crossover switch, along with the switch point area of the No. 13, 136-pound, Connaught track crossover switch. Track damage through and east of the crossover was minimal, but 400 feet of track panel, 1400 feet of new rail, and four cars of ballast were required to repair the track west of the crossover.

TSB Engineering Laboratory Examination

The broken piece of the switch point was submitted to the TSB Engineering Laboratory to determine the mode of failure and possible cause for the separation. Report LP 059/2006 includes these conclusions:

- The piece separated from the point rail as a result of an applied overstress. The remaining surfaces of the separated piece were too badly damaged to identify the presence or nature of any prior progressive failure.

- The material properties appear consistent with a lightly alloyed high carbon steel in a pearlitic heat treatment condition. No material deficiency is indicated.

Track Maintenance and Inspection

The left switch point of the Macdonald switch was dated either 1988 or 1989 (the last digit was partially obscured). It was partly worn when it was installed in the turnout in 2003.

Maintenance records indicate that welding was performed on the frog and on a broken heel block bolt. Bolts in joints through the turnout were replaced in April 2006, and a cracked joint bar was replaced in the track between the turnouts. Grinding marks on the stock rail show evidence of recent grinding to remove metal flow that could prevent the switch point from fitting tightly against the stock rail.

The last monthly turnout inspection was performed by the assistant track maintenance supervisor (ATMS) on 18 May 2006. "Monitor turnout plates and right hand switch point" and "frog to be welded" were noted on the inspection form.

The last detailed turnout inspection was performed by the ATMS on 21 April 2006. The ATMS noted that there was no lost motion on switch rods 1, 2, or 3; were no worn bolt holes; and all bolts were tight on rods 1, 2, and 3.

On 23 May 2006, the track maintenance supervisor's inspection indicated no exceptions. Furthermore, no exceptions were noted by the ATMS on 26 May 2006, which was the last track inspection before the derailment.

The last westbound train through the crossover before the derailment was a freight train, which went through on 12 May 2006.

Inspection of Car RMR 3237

Based on the layout of the derailed cars, the track damage, and an examination of the damaged left-hand crossover switch point, it was determined that the point of derailment was approximately 18½ feet west of the point of switch. Facing-point derailments at a switch typically occur when the lead wheel of the lead axle of a car strikes and breaks the switch point resulting in a split switch.

The wheels on the first and second derailed cars, RMR 5558 and RMR 3237, were inspected and wheel profiles measured in the field. The wheels on car RMR 5558 did not show any defects.

Post-occurrence inspection of the leading B-end truck wheels and springs of car RMR 3237 was conducted at the RMV maintenance facility in Kamloops on 16 June 2006. Mechanical inspection records for the car were also reviewed. The wheels under the car were Griffin, 36-inch, 100-ton wheels. Evidence of creeping on the tread surface and vertical wear on the flange of the leading R1 wheel was observed. A circumferential band of surface cracking oriented at approximately 55 degrees to the flange was indicative of possible steering issues. These cracks form when the

wheel is frictionally heated or by contact fatigue fractures of a plastically overstrained surface layer of wheel material.⁷ This condition can result in higher lateral forces being exerted by the wheel flange along the rail gauge face and switch point.

The Association of American Railroads (AAR) has published the *Field Manual of Interchange Rules* designed to make car owners responsible for repairs to their cars. All freight railways and interchange freight car owners subscribe to these rules. Although they are not a regulatory instrument, they provide an equitable basis for charging for such repairs and damages.

The *Railway Passenger Car Inspection and Safety Rules* (RPCISR) prescribe the minimum safety standards for passenger cars operated by railway companies in trains at speeds not exceeding 125 mph (200 km/h) subject to the jurisdiction of the *Railway Safety Act* as administered by Transport Canada.

Wheel R1 had a flange height of 1 9/64 inch. Flange height of 1½ inch is cause for removal according to “Why Made Code 64 Rule 41 of the AAR Field Manual.” Part II of the RPCISR, Safety Defects, 9.1 (g) prohibits wheels from continuing in service when the height of the wheel flange from the tread to the top of the flange is more than 1½ inch. The diagonally opposite L2 wheel had a flange height of 1 5/16 inch. The flange on wheel R1 was 13/16 inch vertical, as shown in Photo 2. “Why Made Code 62 Rule 41 of the AAR Field Manual” specifies that a flange with a flat vertical surface extending 1 inch or more from the tread is cause for renewal. The RPCISR has no provisions concerning wheels with vertical flanges.



Photo 2. R1 wheel with vertical flange gauge applied

Mechanical records show that on 31 October 2005 the R3 wheel (trailing A-end truck) had a flange thickness of 1 1/32 inch. According to the “Why Made Code 60 Rule 41 of the AAR Field Manual,” 15/16 inch thick or less is cause for removal. Wheel set number 3 on the A-end truck was changed out for thin flange, using the Rule 41 criteria, on 09 May 2006, 20 days before the

⁷ J. Kalousek and E. Magel, *Tribological Interrelationship of Seasonal Fluctuations of Freight Car Wheel Wear, Contact Fatigue Shelling and Composition Brakeshoe Consumption* (Vancouver: National Research Council, 1994).

derailment. On the same day, the car was jacked for lubrication, cleaning, and replacement of the centre pot and pin. In addition, the A/R side bearing was replaced in response to a complaint of a noisy A-end truck.

Rail Passenger Safety

Through a combination of site and post-accident inspections, and interviews, a number of occupant safety issues were identified in this occurrence.

- Cars with vestibules at one end only that were marshalled with cars whose vestibules were at opposite ends of a two-car cut made evacuation more difficult.
- Refrigerator and cabinet doors that came off the hinges and/or opened and storage cabinets with doors intentionally removed spilled their contents into aisle ways blocking exit routes.
- Rotated seats could have impeded passenger and staff movement or injured the occupant.
- Unsecured furniture, garbage bins, coolers, boxes, storage units, cleaning equipment, and luggage were strewn about during the derailment cluttering evacuation routes.
- Communications between crew members and passengers could have been conducted more quickly.
- Secondary impact or post-accident injury was a possibility.

The TSB has previously identified risks to rail passenger safety and has addressed them in two Rail Safety Advisories (RSAs) sent to the regulator and copied to the industry.

- RSA 05/01, Observations of Rail Passenger Safety in Canada; and
- RSA 05/06, Passenger Car Occupant Safety Review.

Although not specifically addressed to the operator of the Rocky Mountaineer, these advisories were made available to them through their affiliation with the Railway Association of Canada.

RSA 05/01 included a comprehensive overview of the rail passenger safety issues identified during the investigation of five VIA accidents that occurred between July 1999 and April 2001. These safety issues fell into four general categories: passenger preparedness, occupant protection, evacuation, and emergency response and rescue.

RSA 05/06 included an Occupant Safety Report related to TSB Investigation R05E0008, the derailment of VIA train No. 1 on 31 January 2005 after being struck by a logging truck at a level crossing near MacKay, Alberta. The report discussed signage, emergency egress, obstructions, secondary impacts, and onboard communications.

Analysis

The operation of the train was not considered contributory to this accident. Therefore, the analysis will focus on the crossover switch, the mechanical condition of the wheels under car RMR 3237, and passenger safety. Although the RMR equipment demonstrated its sturdiness, and the outcome was favourable from a safety perspective in this occurrence, this investigation identified a number of risks to occupant safety specific to this equipment.

Field evidence, wheel measurement data, and laboratory examination of the broken piece of switch point indicate that the B-end of car RMR 3237 derailed first. Wheel measurements and wear profiles of the four R wheels on the leading trucks of the first two derailed cars indicate that wheel R1 on car RMR 3237 was the wheel most likely to exert excessive lateral force on the switch point. The circumferential band of surface cracking on the tread of wheel R1 suggests possible steering issues with the B-end of the car. This condition likely contributed to the vertical flange wear pattern on the leading R1 wheel, indicating that the flange had been crowding the rail gauge face.

Although the condition of the R1 wheel was not cause for removal according to the AAR interchange rules or condemnable under the RPCISR, the vertical flange of wheel R1, unlike the flange of a new wheel profile, was in full contact with the switch point, resulting in overstress, causing a piece to break out. The broken piece of the switch point became wedged between the switch point and stock rail, and wheel R1 rode up on the switch point and fell between the switch point and the stock rail, derailing itself and the car ahead, RMR 5558. The five cars following car RMR 3237 “split the switch” and also derailed.

Samson switch points are designed for heavy traffic switches. Their design “shelters” the switch point under the stock rail, protecting the point from excessive wear and wheel impacts as they traverse from the stock rail to the switch point while taking the diverging route. The crossover at Fraine was not heavily used and CPR has only recently made Samson points standard on mainline installations. While AREMA standard knife-point switches are widely used in the industry, Samson switch points reduce the risk of overstress impact from wheels with flat, vertical flanges.

Rail Passenger Safety

RMR cars built in 1953 have vestibules only in the B-end of the car. Although RMV has no instructions regarding marshalling cars with vestibules uniformly situated throughout the train, it is its practice to minimize the circumstances in which cars with vestibules at opposite ends are adjacent to each other in a two-car cut. Should two cars be marshalled together with vestibules at opposite ends, evacuation time and the risk of post-accident injury are increased for occupants further away from the vestibules.

Findings as to Causes and Contributing Factors

1. The train derailed when the leading R1 wheel of car RMR 3237 “split the switch,” causing the wheel to drop between the switch point and the stock rail.
2. The switch point was forced away from the stock rail when a small piece of the point broke off and became wedged between the switch point and stock rail.
3. The piece of switch point broke due to overstress contact when struck by a non-condemnable vertical flange on the leading R1 wheel of car RMR 3237.

Finding as to Risk

1. Marshalling together two cars with vestibules at opposite ends increases evacuation time and the risk of post-accident injury for occupants further away from the vestibules.

Other Finding

1. Samson switch points reduce the risk of overstress impact from wheels with flat, vertical flanges.

Safety Action Taken

Rocky Mountain Vacations Inc. conducted a review of this occurrence to determine how to improve its emergency response. According to the operator, the following changes have been implemented⁸ or are in the process of being implemented:

- Responses to emergencies will employ more resources than previously and will scale back as required rather than build upon smaller scale responses.
- Community resources have been located along the rail route and documented in order to more effectively enlist the aid of the communities in the event of an emergency.
- More radios with well functioning volume controls have been installed in the cars.
- Train management team communication protocols have been revised.
- Communication protocols have been developed with motor coach contractors for the transportation of passengers during emergencies.
- Motor coaches hired to transport passengers during emergencies are to be properly stocked with emergency supplies.

⁸ Only the *actions taken* relevant to the occurrence are listed here.

- Radios are now placed in each coach car and dome car galley, and additional charged spare radio batteries have been added to each supply car to ensure communication among all personnel.
- An internal emergency response plan outlining notification procedures, roles, responsibilities and action items has been developed and annual training sessions held.
- Senior management and staff are to undergo more frequent training in emergency response procedures, including mock emergency drills and evacuation exercises.
- Onboard attendants will be trained on the use of satellite telephones.
- Satellite telephone instructions will be added to the Onboard Safety and Emergency Procedures Handbook.
- An emergency procedures manual and communication protocol will be developed for responding to guest issues (for example, medical concerns, passenger reassurance) during an emergency.
- Emergency requirements for motor coach suppliers will be established.
- Emergency response plans for selected stations along the RMV routes are to be developed.
- Selected stations are to be equipped with a portable satellite phone and emergency response kits for RMV use.
- All cars will be equipped with emergency equipment including megaphones and high-visibility vests.
- Emergency response plan will be practiced with CPR.
- Communication protocols will be established to more effectively respond to client and supplier concerns.
- The Guest Safety Plan will be reviewed annually to include lessons learned during the previous operating season, new regulatory requirements, and safety and emergency equipment.
- The Guest Safety Plan was updated to ensure evacuation procedures are in place for the times when cars with vestibules at opposite ends are marshalled adjacent to each other in a two-car cut.
- A Physician Kit (with on-call medical support available by phone) was added to the safety and emergency equipment on each train. RMV onboard crew will receive training on the use of the Physician Kit.
- Training will be given to all onboard staff on managing critical incident stress following trauma in the workplace. A peer support program will be established in 2008.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 19 March 2008.