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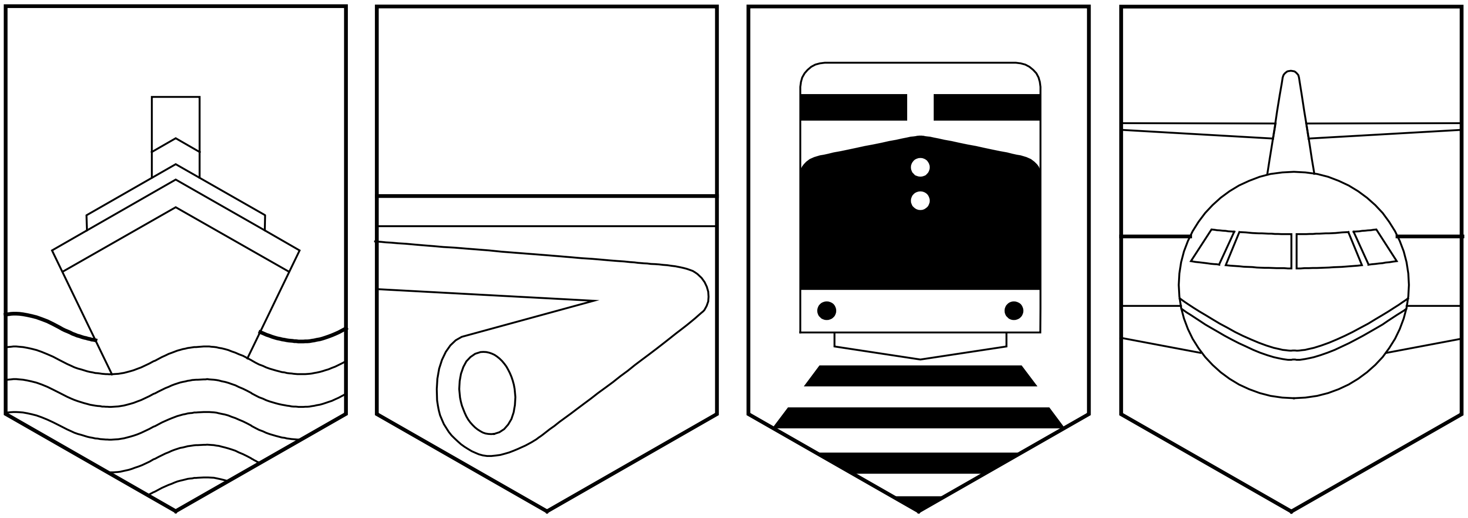

RAILWAY OCCURRENCE REPORT

DERAILMENT

VIA RAIL CANADA INC.
VIA PASSENGER TRAIN NO. 1
MILE 11.12, CANADIAN NATIONAL CLEARWATER SUBDIVISION
BLUE RIVER, BRITISH COLUMBIA
22 APRIL 1995

REPORT NUMBER R95V0089

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Railway Occurrence Report

Derailment

Via Rail Canada Inc.
Via Passenger Train No. 1
Mile 11.12
Canadian National Clearwater Subdivision
Blue River, British Columbia
22 April 1995

Report Number R95V0089

Synopsis

On 22 April 1995, at approximately 1910, VIA Rail Canada Inc. train No. 1, travelling westward at 17 mph, derailed at Mile 11.12 of the Canadian National Clearwater Subdivision. All 13 coaches and one of the two locomotives derailed. Nine of the 172 passengers and 3 of the 15 on train service personnel sustained minor injuries. Approximately 5,700 feet of main track was destroyed.

The Board determined that the L-3 wheel of the second locomotive experienced a catastrophic fracture, and then struck, broke and displaced the rail. The fracture origin was traced to an area of internal overstress cracking.

Ce rapport est également disponible en français.

1.0 *Factual Information*

1.1 *The Accident*

Westward VIA Rail Canada Inc. (VIA) train No. 1 (VIA 1), en route from Toronto, Ontario, to Vancouver, British Columbia, was proceeding from Jasper, Alberta, to Kamloops, British Columbia, with 172 passengers. At approximately 1910, while the train was moving in the vicinity of Mile 11.0 of the Canadian National (CN) Clearwater Subdivision, the first locomotive engineer applied the train brakes to reduce speed for an approaching slow order. Suddenly, at a speed of approximately 17 mph, a rapid deceleration occurred, stopping the train at Mile 11.12. The first locomotive engineer looked back at the train and observed that the second locomotive and all the cars had derailed.

The second locomotive engineer immediately made an emergency radio broadcast to alert other trains in the area of their situation. He then radioed the rail traffic controller (RTC) and received

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[1] All times are Pacific daylight time (PDT) (Coordinated Universal Time (UTC) minus seven hours) unless otherwise stated.

protection for their train. Fearing injuries, he also requested emergency assistance. The first locomotive engineer, concerned that the electrical power to the coaches might cause a fire, shut down the locomotive power source.

Before inspecting the train, the second locomotive engineer detrained and placed torpedoes on the track as an additional precaution against oncoming traffic. The first locomotive engineer remained in the lead locomotive, accessible to the locomotive radio.

The RTC immediately contacted the Blue River ambulance service, who, in turn, alerted the local police force and activated the Clearwater and District Disaster Plan. The RTC then dispatched a work train crew, just off-duty at Blue River, to the derailment with a locomotive and two cabooses to evacuate the passengers and railway employees.

The train came to a stop with the second (trailing) locomotive and all cars derailed. The baggage car, situated immediately behind the locomotives, and the second to sixth cars were leaning at various angles toward the North Thompson River, situated approximately 30 m (99 feet) to the east, and about 10 m (33 feet) below the tracks. The remaining cars (7th to 13th) were derailed and upright on the roadbed. Detraining in the direction of the river was impractical due to the steepness of the embankment.

As the train decelerated, the coaches bounced about and passengers observed dust and gravel flying by the windows. The bouncing of the coaches threw some passengers from their seats.

Once the train stopped, passengers and on train service (OTS) personnel in the second to sixth cars immediately opened most west-facing vestibule doors and a west-facing baggage car door and began detraining. The conductor and assistant conductor assisted passengers in exiting the train. The angle of the coaches made deploying the west vestibule doors and detraining the passengers very difficult.

There was no need to immediately evacuate the last seven cars as they had remained upright and stable. The OTS employees in these cars advised the passengers that their safety was not compromised and to remain in their seats.

With daylight all but gone and the temperature falling, the passengers who had been evacuated from the second to sixth cars were issued blankets and escorted in groups by OTS employees to the tail end of the train.

Although the emergency lighting functioned on all cars, there was no exterior emergency lighting. Railway employees used flashlights and lanterns to provide guidance. Evacuated passengers milled about, confused, scared, and disoriented. Disturbed ballast and rails and ties strewn about the roadbed made walking difficult. Communication with the evacuees proved difficult as no means of enhanced communication, such as a loud hailer, was available. The train public address system did not have external speakers nor did it operate on other than the locomotive power source.

Emergency personnel arriving by road were not able to access the site and had to set up a staging area approximately 5 km north of the derailment, where they waited for the arrival of a work train.

When the work train arrived at the staging area, shoving two cabooses, the emergency response personnel boarded. The work train continued on to the derailment site. As the work train neared the site, the track was heard to break under it.

While the emergency responders administered comfort and first aid, the crew of the work train determined that the track north of their train had abrasions on the ball of the east rail every 10 to 11 feet and that the rail under their train had broken at one of these abrasions.

Once passengers were loaded into the cabooses, the work train returned to the staging area where a bus, vans, and ambulances were waiting. Two trips were required to complete the evacuation. On the second trip, only those passengers in discomfort were detrained at the staging area. The train then continued into Blue River.

Nine passengers were taken by ambulance to the hospital in Clearwater, approximately 88 km south of the derailment site. The physical injuries were all minor in nature, but two passengers experienced extreme stress, and were removed from the train and the site on a spinal board. All other passengers and OTS personnel were taken to the town of Blue River, approximately 18 km north of the derailment site.

Once the uninjured evacuees arrived at Blue River, most of the passengers and all the OTS employees boarded buses, arranged by VIA, to take them to Vancouver. The operating crew members were transported by taxi to Kamloops. Approximately 50 passengers were left in Blue River without VIA personnel in attendance. There was no VIA representative at Clearwater.

1.2 Injuries

Three OTS personnel and nine passengers sustained minor injuries.

1.3 Damage to Equipment

The baggage car and the second to sixth coaches initially sustained minimal damage, but they sustained additional damage when shoved onto their sides to accommodate the track repair. The 7th to 13th coaches and the second locomotive remained upright and sustained only minor damage to the running gear. The lead locomotive was not affected.

1.4 Damage to the Track

Approximately 5,700 feet of track was destroyed.

1.5 Personnel Information

The operating crew consisted of two locomotive engineers, positioned in the lead locomotive, and a conductor and an assistant conductor, positioned in the passenger coaches.

The operating crew members were qualified for their respective positions and met fitness and rest standards established to ensure the safe operation of trains.

Fifteen OTS personnel were positioned throughout the train.

1.6 Train Information

The train was comprised of refurbished stainless steel conventional equipment, marshalled from front to rear as follows:

Locomotive 6439 - Leading
Locomotive 6414 - Trailing

Car	8607 - Baggage
Coach	8122 - Vestibule doors trailing
Coach	8118 - Vestibule doors trailing
Coach	8111 - Vestibule doors trailing
Observation	8510 - Vestibule doors trailing
Coach	8104 - Vestibule doors trailing
Observation	8512 - Vestibule doors trailing
Sleeper	8303 - Vestibule doors trailing
Diner	8415 - No vestibule
Sleeper	8331 - Vestibule doors trailing
Sleeper	8317 - Vestibule doors trailing
Sleeper	8308 - Vestibule doors trailing
Observation	8706 - Vestibule doors leading

At Jasper, the arrival of VIA 1 is coordinated with the arrival of VIA train No. 6 from Prince Rupert, British Columbia. VIA 1 sets off a block of cars destined for Prince Rupert and lifts a block of cars from Prince Rupert destined for Vancouver. On 22 April 1995, a No. 1 air brake test and a mechanical inspection were performed on all cars and locomotives before departing Jasper and no exceptions were noted.

1.7 Train Inspection

While VIA 1 travelled over the Albreda Subdivision between Jasper and Blue River, a distance of 132.5 miles, it passed another westward train and was met and inspected by six eastward trains with no exceptions noted. In addition, the train passed over six hot box and dragging equipment detectors on the Albreda Subdivision with no exceptions noted. At Mile 23.8 on the Edson Subdivision (east of Jasper), the locomotive consist and the cars destined for Vancouver passed over a wheel impact detector without evidence of excessive impact.

1.8 Particulars of the Track

The Clearwater Subdivision is an east/west subdivision, but geographically runs north and south, stretching from Blue River (Mile 0.0) to Kamloops (Mile 139.4). At the occurrence location, the subdivision is a single main track on a two-degree six-minute curve on 0.2 per cent grade.

The track consists of 136-pound continuous welded rail manufactured in 1993, and placed in service in 1994. The concrete ties were installed on crushed rock ballast. The track condition in the derailment area was good.

On 10 April 1995, a rail flaw detection car tested the track and found no defects. On 21 April 1995, a track supervisor patrolled this area by Hi-rail and found no track defects.

1.9 Method of Train Control

The Clearwater Subdivision is governed by the Centralized Traffic Control (CTC) system authorized by the Canadian Rail Operating Rules (CROR). Train movements on the Clearwater Subdivision are supervised by an RTC located in Kamloops.

The authorized maximum train speed in the area of the accident was 45 mph for passenger trains and 35 mph for freight trains.

1.10 Weather

At the time of the occurrence, the weather was clear, winds were calm, and the temperature was 12 degrees Celsius.

1.11 Recorded Information

Event recorder data indicate that, at a recorded time of 2111:24 (eastern standard time), the locomotive was moving forward at a speed of 46 mph with the throttle in idle and brakes released. Locomotive brake pipe pressure was recorded at 87 pounds per square inch (psi). At a recorded time of 2111:26, brake pipe pressure decreased by 6 psi to 81 psi, indicating a minimum application of the train brakes. At a recorded time of 2111:51 and a recorded speed of 42 mph, brake pipe pressure increased to 86 psi, indicating that the train brakes had been released. Speed continued to decrease until, at a recorded time of 2112:07 and a recorded speed of 17 mph, brake cylinder pressure increased from 0 to 20 psi while train brake pipe pressure remained constant, indicating an application of the independent locomotive brakes. The recorded speed reached 0 mph at a recorded time of 2112:11.

1.12 Occurrence Site Information

1.12.1 General

At the derailment site, the subdivision traverses mountainous territory and runs along the west bank of the North Thompson River. On the west side of the roadbed, the terrain is heavily treed with an almost vertical slope. The east side of the roadbed has a near vertical drop toward the North Thompson River.

Small wheel rim fragments were located along the right-of-way, beginning approximately 2,500 feet north of the last derailed car. Beginning about 400 feet further southward, abrasions on the ball of the east rail were observed every 10 to 11 feet. Closer to the derailment site, the severity of the abrasions increased and breaks in the rail could be seen. Two large pieces of wheel tread were discovered on the roadbed near the location of the first abrasions. Some ties were cracked and some tie plates and rail anchors were observed to have metal abrasions. The ballast remained relatively undisturbed.

Approaching the last car, approximately 200 feet of the east rail had been ripped from the ties and displaced to the east. The west rail had remained secured to the ties at several locations through the derailment area, but had similarly been torn free and displaced to the east. Rail displacement was evident up to the trailing locomotive.

1.12.2 Equipment

Two of the derailed cars (third and fourth) were tipped nearly 45 degrees and were under the wayside signal wires and touching the trees about 30 feet from the roadbed. The other derailed cars were leaning at lesser angles away from the tracks.

The second locomotive (6414) stopped with the trailing truck derailed. Approximately 26 inches of wheel tread, four inches into the wheel plate, was missing from the L-3 wheel. Some fracture surfaces were noted to be heavily oxidized.

A torch was used to cut a hole in the L-3 wheel and the wheel was chained to allow movement along the tracks after derailment. The use of a torch prohibited a full metallurgical laboratory examination of the wheel.

The damaged wheel and five pieces of rim, together with the mating wheel and the brake shoes of both wheels, were forwarded to the TSB Engineering Branch for examination.

1.13 VIA 1 Equipment

1.13.1 Locomotive 6414

1.13.1.1 Inspections and Maintenance

Locomotives, subject to regulatory requirements and company policy, are required to have periodic inspections and maintenance. This includes trip inspections documented as "Trip Inspection 'C' or 'B'" and shop inspections denoted as "E6" inspections and quarterly "AB" inspections.

Between January 1995 and the time of the derailment, locomotive 6414 received eight "C" trip inspections and two "B" trip inspections. In addition, one "E6" inspection and one quarterly "AB" inspection were performed.

Maintenance records indicate that the slack adjuster was repaired on 14 February 1995. On 05 March 1995, during a quarterly "AB" inspection, wheel re-profiling was performed because of worn wheels.

Locomotive 6414 had been maintained in accordance with VIA's standards and the records did not contain information of mechanical problems affecting its safe operation.

1.13.1.2 Wheels

Locomotive 6414 was equipped with 40-inch diameter class-B steel wheels (E40), manufactured by Canadian Steel Wheel (CSW) of Montreal, Quebec. The wheel set was assembled by CN shops in Pointe-Saint-Charles, Quebec, in November 1993. Class B wheels are designed for high-speed service. The E40 designation denotes multi-wear design for use on locomotives. The multi-wear design permits the machining of worn wheel treads and flanges.

The design of the high-speed locomotive wheels requires the inclusion of compressive residual stress in the wheel rim. Such a stress is produced by quenching the rim with a water spray at the cooling stage of manufacture. To date, no non-destructive system exists to measure the amount of compressive residual stress built into a wheel. Quality control at fabrication is essential.

1.13.2 Conventional Equipment

1.13.2.1 Day Coaches, Sleepers, Observation Cars and Diners

Each car is equipped with two electrical power supply systems. Lighting, heating, air conditioning, and a public address system are supplied from power generated by the locomotive consist.

When the locomotive-generated electrical current is discontinued, a secondary electrical supply source is activated. The secondary electrical supply source is supplied by batteries under the coach deck. Emergency power is distributed to emergency lights located under aisle seats on one side of the car and to overhead lights located in the galleys, vestibules, and washrooms.

There are no exterior lights to provide illumination for passengers detraining from the equipment into darkness. No emergency portable lighting is stored on the passenger equipment.

1.13.2.2 Doors, Steps and Windows

The vestibule end of each car was equipped with two manually operated exterior doors and stairs with four retractable steps allowing access or egress from either side of the car.

The vestibule doors were manually operated and, under normal car positioning, easily opened. No written instructions were posted to advise passengers how the doors operate. The platform, covering the steps exiting the vestibule, operated in conjunction with the vestibule door. To open the stairwell platform, the vestibule door must be opened. No instructions were posted to instruct the user of the proper operating method.

Emergency exit windows consisted of two 1/4-inch (6 mm) panes of tempered glass separated by air space. They measured 26 inches (0.66 m) high by 42 inches (1.07 m) wide. Coaches, sleeping cars, observation cars, and diners have four emergency exit windows, two on either side of each car. Each emergency exit window had a non-illuminated pictogram of a hand holding a mallet-like hammer and the words "Emergency Exit." A small pointed hammer to break the emergency exit windows was stored near each emergency exit window in a glass-covered box.

Although the doors operated easily, the angle of the coaches and weight of the doors were such that two persons were required to hold them in the open position. The crew noted that the installation of a device to hold the door in the open position would facilitate an emergency exit.

1.13.2.3 Emergency Equipment Information

The safety information was contained on a non-illuminated stainless steel plaque measuring 9 3/4 inches (25 cm) by 5 3/4 inches (14.5 cm) on the corridor wall of the vestibule of each car. The plaques provided instructions on the location of emergency exit windows and the use of the emergency hammer, and information as to the location of the first-aid kit. The instructions were both in written form and in pictogram form. Individual passenger compartments were not supplied with safety instructions and procedures. It was not the practice to make announcements to the passengers regarding evacuation procedures and the location of emergency tools, first-aid kits, and trauma kits. First-aid equipment is required on all trains for medical emergencies, fires, and rescue situations in accordance with the On Board Trains Occupational Safety and Health Regulations ancillary to Part II of the *Canada Labour Code*, dated 26 March 1987.

Emergency equipment in each car included a first-aid kit, fire extinguisher, axe, sledge hammer, and hand saw. In addition to the basic first-aid kit in each car, there were two trauma kits in the dining car. A stretcher was located in the baggage car, and the coaches were equipped with wheel chairs. Oxygen equipment was stored in the meal service cars.

The train was equipped with a public address system to provide communication throughout the train, or within each individual car powered by the locomotive electrical supply.

1.14 Tests and Research

1.14.1 TSB Engineering Branch

The TSB Engineering Branch analyses (Engineering Report LP 94/95) of the broken wheel, wheel pieces, mating wheel, and brake components revealed the following:

1. Wheel tread thickness on the broken wheel was measured at 1 15/16 inches (condemning mit is 1 inch and new condition is 2 1/2 inches).

2. There was normal wear on the brake shoes except for the damage consistent with contacting a roken wheel.

3. The intact wheel showed no signs of overheating at the tread.

4. The fracture features on four of the wheel pieces were consistent with overload rupture.

5. The fifth piece of wheel showed evidence of having a fatigue pre-crack on a transverse racture before it failed in overstress rupture.

6. The fracture details on both the wheel and mating pieces show internal overstress cracking nd suggest that internal overstress cracking was the initiating event.

7. Observed shelling of the wheel tread was believed to be secondary in nature to the primary ailure, although a large piece approximately 1/2 inch thick had begun to separate from the wheel as a result of eep shelling.

Energy dispersive X-rays and metallurgical analysis determined that no heat distress or obvious flaws were present in the wheel material and that manufacturing quality was consistent with the requirements of the Association of American Railroads (AAR).

The TSB investigated another VIA locomotive wheel failure early in 1995 (Engineering Report LP 9/95) involving the same wheel manufacturer—CSW. In that case, the wheel also failed as a result of internal cracking that was most likely initiated by the combined action of applied and

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se reports are available upon request from the Transportation Safety Board of Canada.

residual stresses. No material deficiencies were observed. The TSB concluded that, because of the sudden nature of the failure, ultrasonic inspection to monitor wheel condition is not sufficient. A wheel may pass an ultrasonic inspection and develop a severe internal crack soon thereafter.

1.14.2 CANAC International Inc. Railroad Technologies

After the accident, three locomotive wheels manufactured by CSW in Montreal, and removed from service by VIA after an ultrasonic inspection detected internal defects, were examined by CANAC International Inc. Railroad Technologies (CANAC) in Saint-Laurent, Quebec. To complete the study, VIA supplied a CSW locomotive wheel worn to condemning wear limits and a new wheel manufactured by Standard Wheel of Bornham, Pennsylvania, U.S.A. CANAC's examination showed that the identified internal defects consisted of (a) occasional large inclusions, and (b) unacceptable amounts of microscopic non-metallic particulate, as judged by the CN Clean Steel Standard, used in the assessment of rails. The wheel worn to condemning limits was found to contain the highest percentage of total particle area.

Although one defective wheel did not meet AAR requirements for rim hardness and the carbon content of the worn wheel exceeded the AAR specifications, most of the chemical and mechanical properties conformed to AAR specifications. The sizeable discontinuities were regarded, however, as a significant factor in increasing the susceptibility of the wheels to fracture in service.

CANAC suggests that the noted irregularities were the result of a breakdown in quality assurance and inspection procedures at the wheel manufacturing plant.

The new locomotive wheel made by Standard Wheel, manufactured in April 1995 and examined for comparison purposes, was found to contain acceptably low levels of non-metallic inclusions as judged by the CN Clean Steel Standard for rails.

The CANAC report indicates that wheel suppliers cannot be relied upon to provide clean steel in the absence of a Clean Steel Standard. CANAC points out that the corresponding situation for rails is already being addressed by companies such as CN through its internal standard for clean steel. The report also indicates that steel producers are able to produce clean steel by taking measures such as implementing degassing procedures, paying attention to the regular repair of furnace and ladle linings, and regularly replacing worn nozzles and shrouds. It suggests that there is a real need for wheel producers and wheel customers to co-operate, through writing a standard, to ensure wheels of good quality at an acceptable cost.

1.15 Other Information

1.15.1 First Responders

The first responders included the local police and ambulance service, a volunteer provincial highway emergency rescue team, and CN employees both on duty and off duty. The highway emergency rescue team comprised local citizens trained in first aid and rescue operations, and equipped with emergency response vehicles, equipment, and supplies.

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[3] CN Specification 12-16 effective in July 1993 invoked stringent microcleanliness limits for new rail.

[4] CSW was forced into bankruptcy and ceased operation in December 1994.

1.15.2 The Evacuation

The efforts of the first responders brought into the site by the work train were coordinated by the VIA operating crew. Injuries had been assessed and prioritized before the first responders arrived.

The initial evacuation efforts by the VIA operating crew and OTS personnel were met with relative calm, although there were a few distraught and panicked passengers. All passengers but two detrained with little or no help.

1.15.3 VIA Communications

VIA locomotives are equipped with 25-watt radios and a toning feature that the locomotive engineers use to converse with the RTC at all times.

Handheld three-watt radios without a toning feature were supplied to the other crew members. The three-watt radios could not be used to contact or communicate with the RTC, and were intended to keep the members of the operating crew in communication with each other.

During the emergency situation, communication between the members of the operating crew was essential to the conduct of a safe and efficient evacuation. Transmission between the three-watt radios was garbled, and at times cut out entirely, such that the crew had to designate an employee with a radio midway in the train to relay communication to the locomotive engineer. The 25-watt locomotive radio was then used to relay communications between the crew members and the RTC.

On 09 April 1993, a VIA train derailed at a washout at Mile 17.53 of the CN Saint-Maurice Subdivision near Rapide Blanc, Quebec. The crew was unable to contact the RTC using their three-watt radios to obtain emergency medical assistance for injured crew members and passengers. The RTC was contacted using the 25-watt locomotive radio from the damaged locomotive.

1.15.4 Passenger Car Safety Standards

On 20 November 1994, a VIA train with Light, Rapid, Comfortable (LRC) equipment struck a piece of rail deliberately placed on the tracks near Brighton, Ontario. The piece of rail damaged the locomotive fuel tanks and severed electrical cables. The leaking fuel ignited and the ensuing fire placed many passengers in a life-threatening situation. Forty-six passengers were injured (TSB report No. R94T0357).

The TSB investigation into the Brighton accident exposed deficiencies in passenger car safety and evacuation standards. The standards deemed wanting included emergency exit design; the size, content, and visibility (including visibility in darkness or smoke) of emergency signage; the dearth of emergency information provided to passengers on boarding, including both oral and written or pictorial information; the lack of emergency voice broadcast capability to the exterior of the cars; the lack of emergency outside lighting; and inadequate portable lighting, i.e., flashlights (see Section 4.0 for the safety action taken).

2.0 Analysis

2.1 Introduction

VIA 1 was operated in accordance with company operating instructions and government safety standards. The train derailed after the L-3 wheel of the trailing locomotive fragmented and broke the rail. The trailing locomotive had been maintained in accordance with VIA's maintenance standards. The flawed and weakening wheel was not detectable by routine inspections, maintenance, and electronic wayside devices. The track damage and derailment resulting from the fragmented wheel were nearly instantaneous, providing no opportunity for the operating crew to bring the train to a controlled stop.

The analysis will address the factors related to the cause of the broken wheel and discuss aspects of the emergency situation after the derailment.

2.2 Consideration of the Facts

2.2.1 Wheel Failure

2.2.1.1 Detection

The external crack in the wheel existed for an unquantifiable period of time as indicated by the presence of oxidation of the fracture surfaces at failure. It would not have been visible to train crews and car inspectors during routine running inspections. It can be said, however, that at the time the wheel was re-profiled on 05 March 1995, the crack had not yet reached the surface of the wheel, although an internal crack may have existed at that time. It would seem, therefore, that such cracks propagate slowly but continuously under operating conditions and that in-service detection would require measures other than routine train or locomotive inspections. The TSB Engineering Branch report indicates that ultrasonic wheel testing while the train is in service would not prove effective due to the rapid and unpredictable nature of the crack initiation.

2.2.1.2 Metallurgical Considerations

The TSB Engineering Branch examination attributes the initial fracture in this little-worn wheel to internal overstress cracking from a combined action of applied and residual stresses, and suggests that either a localized stress reversal or less-than-desired overall compressive stresses were built into the wheel at manufacture. In either scenario, the cracking could be attributable to a quality control lapse at the quenching stage of production leaving the wheel without the necessary compressive residual stress to perform as designed.

The CANAC report outlines that the CSW wheels that were examined, although meeting most AAR standards for metallurgical composition, exhibited high levels of non-metallic inclusions (as judged by the CN Clean Steel Standard for rail steel) and that some large inclusions were potential sites for crack initiation during service. The CANAC hypothesis—that CSW failure to detect defects as large as those observed was suggestive of a quality assurance and inspection procedure breakdown at the manufacturing plant—has merit.

The CSW wheels examined by both laboratories were manufactured between August 1993 and December

1993, which would seem to indicate that perhaps wheels manufactured in this time frame are prone to failure and that perhaps the failure can be traced to a manufacturing quality control problem during this period.

2.2.1.3 General

The separate laboratory observations and conclusions are of particular note. It would seem that non-condemnable rim thickness plays no role in the crack initiation because the wheel in the subject accident was little worn and one of the CSW wheels examined had performed satisfactorily until removed from service after reaching maximum wear limits. Similarly, non-metallic inclusions were not seen to be the source of crack initiation, although such an eventuality existed. It would seem, therefore, that the largely unmeasurable (at least by non-destructive means) feature of residual tensile stress could be the single most important aspect of satisfactory wheel performance after appropriate metallurgy and design are formulated.

2.2.2 Passenger Car Safety Standards

The design and fit-out of the various passenger cars in the train did not present undue obstacles to the safe and timely evacuation of the train, although many of the shortcomings identified in the TSB report on the 20 November 1994 accident at Brighton were evident, i.e., no external emergency lighting, minimal posted emergency procedure information, no external public address system, emergency exit difficulties, etc. It is believed that an emergency evacuation of this train under life-threatening circumstances may have resulted in many of the same problems as were experienced at Brighton. Therefore, standards governing all emergency aspects of railway safety ought to be developed with regulatory audit to ensure that these standards are maintained.

2.2.3 Communications

The train was powered by two locomotives and therefore equipped with two 25-watt radios. The train was also equipped with three-watt portable radios, but these functioned poorly. Under certain circumstances, however, particularly in the event of fire, locomotive radios might be destroyed, leaving a crew dependent on the portable radios. Therefore, portable radios should not only be capable of contact with the RTC, but should also permit inter-crew communication within reasonable range. The ongoing review of VIA radio capability should ultimately address the communication shortcomings demonstrated by this accident.

2.2.4 Emergency Response

The train crew and OTS personnel carried out their duties in a professional manner. The actions of the emergency response team, including the volunteer highway rescue team and the off-duty work train crew, were timely, well organized, and effective. The highway rescue team is considered to have played a significant role in this highly successful rescue mission.

3.0 Conclusions

3.1 Findings

1. The train was being operated in compliance with government safety standards and VIA Rail Canada Inc. operating instructions.

2. The L-3 wheel of the trailing locomotive broke, fracturing and displacing the rail and erailing the train.

3. The broken wheel fractured due to internal overstress cracking initiated by the combined ction of applied and residual stresses.

4. The wheel may not have been manufactured with sufficient residual compressive stresses to ustain service loading.

5. Quality control at manufacture may not have been adequate during the time period that the wheel was produced.

6. Residual compressive stress, essential to successful high-speed wheel performance, is not measurable by non-destructive testing.

7. Aspects of VIA's conventional car design and fit-out do not adequately meet emergency afety standards.

8. The VIA portable train radios did not function as would have been expected.

9. The emergency response and rescue were conducted in a timely, efficient, and professional ashion.

3.2 Cause

The L-3 wheel of the second locomotive experienced a catastrophic fracture of the wheel, and then struck, broke and displaced the rail. The fracture origin was traced to an area of internal overstress cracking.

4.0 Safety Action

4.1 Action Taken

4.1.1 Communications

VIA Rail Canada Inc. (VIA) has replaced the three-watt radios, which were reported as being insufficient during the emergency situation, with five-watt portable radios. VIA will be using 30-watt radios on trains serving remote locations, and the Western and Eastern transcontinental trains will be equipped with both cellular and satellite cellular telephones.

4.1.2 Wheel Failure

The TSB investigation determined that the quality of the wheel manufacturing process may not have been adequate during the time period in which the wheel was produced. VIA has indicated that it does not use Canadian Steel Wheel (CSW), the supplier of the wheel involved in the occurrence, anymore and is now purchasing from overseas new forged steel wheels that are designed specifically for high-speed passenger train operations.

4.1.3 Passenger Safety

During the investigation into this occurrence and the one involving a VIA train at Brighton in November 1994 (TSB report No. R94T0357), several safety deficiencies with respect to passenger safety were identified. As a result, in December 1994, the Board made specific recommendations regarding the emergency egress hammers, and other recommendations in July 1996 regarding the overall standard and regulatory oversight of passenger safety in the railway industry. With respect to several of the other identified deficiencies, the TSB forwarded five Rail Safety Advisories to Transport Canada (TC) and VIA in February 1995.

Following the recommendations and advisories, VIA and TC undertook several initiatives to address many of the deficiencies.

VIA began installing emergency signage on the interior and exterior of its cars; adding emergency windows in the dome cars; placing emergency procedure pamphlets, trauma kits, and flashlights in the passenger cars; and replacing break-out hammers for emergency exit windows. Also, VIA standardized its procedures for the use of emergency oxygen, and conducted a comprehensive emergency response training program for on train service (OTS) employees (this program was delivered to over 90 per cent of the OTS personnel). In addition, VIA has included its equipment configurations in the North America database of the Operation Respond Institute, enabling emergency response organizations to have quick access to accurate safety and evacuation information on VIA cars.

TC approved the Railway Passenger Car Inspection and Safety Rules submitted by the Railway Association of Canada (RAC); the Rules came into effect on 01 February 1998. The Railway Passenger Car Inspection and Safety Rules contain provisions on emergency exits, signage, instructions, securement of baggage, and provide for “fail-safe” design of public address systems and emergency lighting. TC has also indicated that “Emergency Preparedness and Passenger Evacuation Rules” are being developed.

By late summer 1997, however, some of the proposed measures had not been fully implemented. Consequently, in the fatal VIA accident near Biggar, Saskatchewan, on 03 September 1997, many of the previously identified passenger safety deficiencies had put the safety of the passengers and railway employees at risk. From the TSB's examination of the occurrence wreckage, post-accident interviews, and a survey of the passenger safety features of other VIA train operations, it was confirmed that a number of significant shortcomings persisted in current passenger safety practices.

Shortly after the accident at Biggar, the Minister of Transport announced a delay in the re-introduction of the proposed amendments to the *Railway Safety Act* to determine whether further adjustments to the legislation were required. It was also indicated that changes to the Act could include provisions for passenger car design; minimum emergency equipment standards; standard operating procedures for emergency situations, including the provision of passenger safety information and the associated crew training; and the implementation of an effective regulatory regime to enforce these provisions.

TC also took regulatory action under the *Railway Safety Act*, and issued notices to VIA regarding:

- Emergency exit information for passengers on VIA trains
- Number and accessibility of trauma kits on VIA trains
- Passenger safety cards for VIA transcontinental fleet
- Emergency signage for emergency exits.

An industry rule respecting emergency evacuation and response is also being considered. The RAC has put together a working group that will develop "Passenger Safety Rules" for final consideration before the end of March 1998.

Notwithstanding these measures, and recognizing that the effective implementation of comprehensive standards for rail passenger safety would take time, the Board believed that many other safety measures could be implemented immediately. Collectively, the following measures would have the potential to reduce significantly the risks to rail passengers involved in an accident:

- Standardized passenger safety briefings prior to departure
- Passenger safety cards demonstrating emergency procedures

- Conveniently located emergency window exit hammers, with unequivocal signage and instructions for effective use
- Sufficient numbers of appropriately equipped and readily accessible trauma kits
- Readily accessible flashlights
- Emergency signage for all emergency exit routes, and equipment which is both understandable and legible under emergency conditions
- Exterior emergency signage to assist first responders
- Effective emergency public announcement systems
- Effective emergency lighting systems
- More secure stowage of, or restrictions on, carry-on baggage
- Completion of standardized training for all train crew and on train service (OTS) personnel on emergency procedures.

Therefore, the Board recommended, as a matter of urgency, that:

> The Minister of Transport require that VIA Rail complete its implementation of those short-term measures necessary to improve rail passenger safety (as outlined above) within 30 days.
>
> (R97-07, issued October 1997)

The Board is pleased to note that immediately following the release of this recommendation, VIA announced that, in light of the Board's interim recommendation, VIA was committed to completing, within the next 30 days, the initiatives commenced as a result of the Board's recommendations stemming from the Brighton accident. The Board believes that this commitment could go a long way to improve rail passenger safety in the short term, and as such, the Board will be following the developments in this area with continued interest.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 16 December 1997.