Report 99-115

vintage train

derailment

Kawakawa

26 June 1999

Abstract

At about 1345 hours on Saturday, 26 June 1999, a vintage steam train operated by the Bay of Islands Vintage Railway was on a scheduled passenger trip from Opua to Kawakawa when the track spread and the locomotive and the following two carriages derailed at low speed. No injuries to the crew or passengers resulted. Safety issues identified included the standard of track maintenance and the adequacy of the track inspection. Two safety recommendations were made to the operator, and two to the Director of the Land Transport Safety Authority to address the safety issues.

The Transport Accident Investigation Commission is an independent Crown entity established to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. Accordingly it is inappropriate that reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

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List of Abbreviations

BVR	Bay of Islands Vintage Railway
km	kilometre(s)
km/h	kilometres per hour
m	metre(s)
mm	millimetre(s)
t	tonne(s)
LTSA	Land Transport Safety Authority

Data Summary

Train type:	steam-hauled vintage passenger	
Date and time:	Saturday 26 June 1999, 1345 hours	
Location:	near Opua (Bay of Islands)	
Type of occurrence:	derailment	
Persons on board:	crew:	3
	passengers:	11 (6 adults, 5 children)
Injuries:	nil	
Damage:	50 track sleepers	
Operator:	Bay of Islands Vintage Railway	
Investigator-in-Charge:	R E Howe	

1. Factual Information

1.1 Narrative

1.1.1 On Saturday 26 June 1999, the Bay of Islands Vintage Railway (BVR) was operating a scheduled scenic train trip between Kawakawa and Opua. The train consisted of a vintage Peckett steam locomotive *Gabriel* (travelling cab first), an A class open club carriage and an AL class passenger carriage.

1.1.2 At about 1345 hours the train was negotiating a right-hand curve at about 8.85 km on the return trip to Kawakawa when the track gauge[1] spread, allowing the leading right-hand driving pair of wheels on the steam locomotive to drop inside the track. The leading left-hand wheel on the trailing bogie of the locomotive then rode up and across the rail head causing all wheels on that bogie to derail to the left (outside) of the curve.

1.1.3 The train was brought to a halt approximately 30 m from the original point of derailment, during which time all 4 wheels on the right-hand side of the following A carriage dropped inside the track together with the right-hand wheels of the leading bogie of the AL carriage.

1.1.4 Following the derailment the 11 passengers were escorted by the guard approximately 1 km on foot to a level crossing where they were forwarded on by minibus. There were no injuries.

1.2 Track

1.2.1 The derailment occurred in the body of a 200 m radius right-hand curve (in the direction of travel) and on a nominally flat gradient.

1.2.2 New sleepers had been spotted into the track over the derailment area giving a gauge of approximately 1092 mm and a cant[2] of between 54 and 64 mm. There was evidence of up to 5 mm gauge push under load and 15 mm voiding[3] under the low leg side of the curve.

1.2.3 The track consisted of 70 lb rail fixed by screw spike and bed plate onto weathered hardwood sleepers. A visual inspection of the sleeper condition in the area 8.5 km to 9.0 km showed that 46 sleepers (approximately 8%) were not holding gauge and required replacement.

1.2.4 The ballast foundation was fouled with mud, poorly drained and choked with weed. Heavy rain for 12 hours prior to the derailment had resulted in the track becoming saturated and spongy.

1.3 The locomotive

1.3.1 The Peckett steam locomotive *Gabriel* was one of about ten Peckett locomotives introduced in the early part of the century for working collieries. *Gabriel* was the only one with a 4-4-0[4] configuration; the others were either 4-6-0 or 4-4-2. The total working weight was 25 t, with the load distributed evenly between the two driving axles and the front bogie.

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[1] gauge is the distance between the running edges of the two rails.
[2] cant is the height of the outside rail (high leg) on a curve above the inside (low leg) rail.
[3] voiding is the vertical movement of the track under normal train loading.
[4] The numbering sequence depict the standard way of defining the driving and non-driving wheels on a locomotive, for example, a 4-4-0 locomotive has 4 non-driving wheels up front followed by 4 driving wheels followed by zero non-driving wheels.

1.3.2 The back-to-back measurement of the driving wheels was 985 mm, with flange widths of 28 mm and a tread measurement of 100 mm. The driving wheels were spaced at 1670 mm axle centres.

1.4 Train operation

1.4.1 The engine driver estimated that the train speed while travelling through the 80 m long Whangae Tunnel (near Te Ake Ake) some 200 m before the point of derailment was 10 km/h. A 10 km/h speed restriction applied through the tunnel due to clearance restrictions. He stated that having cleared the tunnel he increased the speed to about 15 km/h before he noticed a "bouncing" of the locomotive and immediately applied the train brakes. The locomotive was not fitted with a speedometer and he stated he could only judge the speed "by the pressure on the steam gauge."

1.4.2 The fireman was on the left side of the cab looking in the direction of travel through the open end of the cab. He was first aware of the derailment when he felt rough running – "like running on stones." He estimated the speed through the tunnel was 15 km/h and 20 km/h just prior to the derailment.

1.4.3 The guard stated that after exiting the tunnel she felt the train accelerating and had time to walk from the back to the front of the first carriage (about 5 seconds) before she felt the vibrations of the derailment. She assessed the speed of the train to be 10 km/h through the tunnel and 15 km/h at the time of the derailment. She commented on this particular engine driver's general actions on exiting the tunnel – "opens it up and goes for it."

1.5 Track maintenance standards

1.5.1 BVR's Track and Bridge manual laid down the following criteria for track maintenance:

> 3.1 SLEEPERS
> On main lines and loops used by passenger trains, sleeper centres will be <u>900 mm</u> and must not exceed <u>1100</u>.
> New sleepers will not be less than <u>1.800</u> long, and <u>200 X 150</u> in section.
> They will be Pinus Radiata, treated by soaking for not less than <u>14 days</u> in a mixture of creosote and waste oil.
> Sleepers carry weight and maintain gauge.
> Grades of Sleepers
> 1. First grade 100% New.
> 2. Older sleepers but still near 100%. May have some surface cracks or be bored once.
> 3. Used sleepers, bored twice, but still well able to retain fastenings and carry weight.
> 4. Sleepers with longitudinal cracks or splits, still holding fastenings.
> 5. Worn out, will not hold fastenings, but may carry some weight.
>
> 3.2 AT RAIL JOINTS
> There will not be less than four sleepers, two each side of joint, of grades 1 or 2. Along straight rail there will be not more than five consecutive sleepers of grade 4 or three consecutive sleepers of grade 5. On curved track not more than three consecutive sleepers of grade 4 or two of grade 5.
> Ballast must be packed under sleepers at rail support areas. It must not be packed under ends of sleepers, as this will cause sleepers to break.
> Sleepers must be level and stable on straight track, and packing done so that track is free from humps and hollows. Track tends to dip at joints, so packing must be such as to prevent this.
> On curved track the outer rail must be higher than the inner. This is called super elevation, or cant. This cant must not exceed 50 mm on curves on BVR, and must be arranged so that it starts gradually, builds smoothly to the maximum figure holds it through the curve and then smoothly decreases again.

> It is far more important that the cant is constant, once achieved, than held to a particular dimension.
> To prevent heat buckle fish plates must not be bolted up solid, but must be greased when first fitted and spring washers under nuts not completely flattened.
> Bed plates must be fitted under rails on four sleepers, two each side of joints, on all sleepers on points, and on all sleepers on curved track.
> When using screw fittings, there must be a spring washer on top of either a square plate washer or a long sleeper spring grip plate.
> Ballast must not be placed on top of sleepers, and any ballast found on top must be cleared. Ballast on top of sleepers harbours moisture and will considerably shorten sleeper life.
> The gauge of the track is 3ft 6 inches [1067 mm]. On curves this is increased to 3 ft 6 ½inches [1080 mm]. Some tolerance is permitted but track gauge must never be less than 3' 6" [1067 mm] and must never exceed 3' 7" [1092 mm]
> It is important to ascertain <u>why</u> gauge has increased, and take steps to ensure that it does not increase further.
> Fish plates must have 4 bolts in each pair. If during inspection 1 is found to be missing it must be brought to the attention of the person responsible. If 1 bolt each side of the fishplate is missing, trains may continue to run but at a severely reduced speeds and repairs must be attended to urgently.
> Trains **must not** run, under any circumstances, if 2 bolts, on the same side of the joint, are missing.

1.6 Rail service licence

1.6.1 Section 6A of the Transport Services Licensing Act 1989 required that applications for a rail service licence had to be accompanied by a description of the proposed safety system which was to include matters relating to maintenance standards, procedures for ensuring compliance, and auditing procedures.

1.6.2 BVR was licenced under the act and were operating to a safety system approved by the Land Transport Safety Authority (LTSA) on 26 March 1997.

1.7 Track inspections

1.7.1 Details of the rail safety system supplied by BVR included the following with regard to track inspections:

> **1.53 INFRASTRUCTURE…**
> BVR's Chief Engineer or his deputy will examine the track and bridges twice yearly, as detailed in the Track and Bridge manual.
> Once a year a suitably qualified, non member of the Preservation Society, engineer will inspect the track and bridges and report his findings to the GM.

1.7.2 Section 3.2 of the Track and Bridge manual supplied by BVR required the following track inspections:

> Track inspections must be done on foot by BVR engineer or by someone authorised by the GM at intervals not exceeding 26 weeks. Defects must be noted for each half km and recorded and compared with previous inspection sheets and large increases noted (see sample report sheet) and investigated.

1.7.3 The management structure of BVR named the general manager and the chief engineer as the same person.

1.7.4 The copy of the BVR Track and Bridge manual held by LTSA stated that the track inspections were to be made every 13 weeks, half the period stated in BVR's manual. The general manager was of the view that this had been changed to a 26-week interval and that this change had been approved by the LTSA but was unable to find any documentation to support his view.

1.7.5 The last track inspection to meet the requirements quoted in 1.7.2 was carried out on 4 November 1998, some 33 weeks before the derailment. For the section of track between 8.5 km and 9.0 km, 28 defective sleepers were noted on the report sheet requiring 26 to be replaced. Fishplates, bolts, packing and super elevation were all noted with a tick.

1.7.6 The last track inspection by a non-member of the Preservation Society was in September 1998, 9 months before the derailment. The inspection report included comments that defective sleepers previously identified in independent inspections had been replaced or were in the process of being replaced.

1.8 Rail safety audits

1.8.1 Section 39F of the Transport Services Licensing Act 1989 stipulated that a rail service operator was required to have a regular audit of their safety system as specified in their approved safety system.

1.8.2 The BVR Rail Safety System manual stipulated the following in relation to safety audits:

> 1.26 SAFETY AUDIT ARRANGEMENTS
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> The approved safety auditor shall complete an audit of the safety systems once per year in compliance with the Transport Services Licensing Amendment (No 3)
>
> 1.27 AUDIT COVERAGE
>
> Records of the operations and maintenance of BVR's Safety Operation Manual.
> Inspect any operations and/or items of equipment as required.
> Report any non-compliance of Safety Operations Manual to the GM
> Make recommendations for alterations to the Safety Operations Manual should any become apparent.

1.8.3 The last rail safety audit carried out in April 1999 by a licenced rail safety auditor in regard to the civil engineering structures made the following comments:

> The inspection reports for all bridges, the tunnel and track were sighted. There was good correlation between the inspection records and the physical condition. An inspection of the Te Ake Ake Tunnel after the substantial recent rainfall showed good drainage and track condition. I have a concern about the amount of vegetation at the tunnel entrance on the Opua end of the track that could cause a hazard...
> The new Civil Engineer for the BOIVR has made his detailed inspection in September 1998 and his recommendations are being acted on by the railways. There is evidence of work being done on the rails and sleepers all along the track in order to maintain a safe standard for operation.

1.8.4 Following this audit a letter was sent from the LTSA to BVR on 17 June 1999, some 9 days prior to the derailment, which included the following comment on track:

> Track and Bridge Report September 1998
> The Track and Bridge Report of 19 September 1998 contained two recommendations:
>
> 1. Track and culvert repairs to be attended to as a matter of urgency.
> Please advise what action you have taken in this regard and when this work will be completed . . .

1.8.5 Track upgrading work had commenced at Kawakawa and was proceeding towards Opua but had not reached the derailment area by June 1999.

1.9 Personnel

1.9.1 The general manager at the time of the derailment had a mechanical engineering degree and had previous experience with New Zealand Railways. He left BVR in January 2000.

1.9.2 The engine driver held a diesel driver licence issued on 1 June 1995, and reissued on dates 2 June 1995, 14 July 1997 and 12 July 1998. He had a current steam ticket (issued by the Secretary of Transport on 14 March 1998). He left BVR on 23 July 1999.

1.9.3 The fireman was certified as a guard class 3 on 14 March 1997, after a familiarisation run and a week’s operation under supervision. On 31 March 1997, he was certified as a diesel driver class 3 and had been recertified annually since then, the last being on 2 June 1999.

1.9.4 The guard was certified as a guard class 3 on 2 January 1996, and a guard class 2 on 1 June 1996, and had been recertified annually since then, the last being on 2 June 1999.

2. Analysis

2.1 The track gauge in the derailment area as measured after sleeper spotting had been carried out was 1092 mm, which was at the outer limits allowed by the BVR Track and Bridge manual. It is likely that the rails had been fixed at the gauge that they sprang back to once the derailment had been cleared.

2.2 The gauge dimensions of the driving wheels meant that the track gauge had to spread to 1141 mm, to allow a wheel to drop down inside the track. At a static track gauge of 1092 mm (and probably more prior to the track repairs), this required a maximum further widening of 49 mm. With defective sleepers giving weak screw spike holding, it would have required relatively little lateral force for the rails to be either pushed bodily out or rotated about their base to attain this gauge. It is unlikely that the sleepers met the requirements of clause 3.2 of the BVR Track and Bridge code (refer 1.5.1.).

2.3 The locomotive was travelling in the reverse direction, that is, with the driving wheels leading. With normal forward travel, the leading bogie provided guidance for the driving wheels so that they would better align to the track. In reverse, and without this guidance, the 4-4-0 driving arrangement of *Gabriel* meant that the driving wheels could attain a significant angle of attack on the rails as the locomotive negotiated a curve. The measurement over the driving wheel flanges of 1041 mm allowed 51 mm float on the 1092 mm track gauge. With the relatively short wheel base of the driving wheels (1670 mm), the float would have allowed them to become angled to the track and apply lateral loadings to the high leg rail in excess of the normal centrifugal loadings.

2.4 The track was last inspected on 4 November 1998, over 33 weeks prior to the derailment. This was in excess of both the 26-week interval as required by clause 1.53 of BVR's safety Operating Manual and the 13 weeks required in section 3.2 of the approved version Track and Bridge manual held by LTSA. Because the general manager was carrying out all internal inspections, it is not clear which inspection was carried out on 4 November 1998, although the report indicates an inspection to clause 3.2 of the Track and Bridge manual. Clause 1.53 and clause 3.2 inspections are distinct and it is important that they do not get confused and integrated. As worded in the manual they were capable of variable interpretation as to who was to inspect and when. A recommendation has been made to the Director of LTSA to address this issue.

2.5 While there was a speed restriction of 10 km/h in force through the tunnel, there was no restriction in force outside the tunnel. A 10 km/hour speed restriction would have been appropriate in view of the poor sleeper condition.

2.6 Based on the various reports, and the engine driver's reported driving traits, it is likely the train exited the tunnel at a speed in excess of 10 km/h and was travelling at about 20 km/h at the time of the derailment. Although this was below the maximum allowable line speed of 40 km/h it would have been an excessive speed for the track condition.

2.7 The logic of the approved inspection system for BVR was based around 4 track inspections per year by an "authorised person" to ascertain and direct maintenance, 2 inspections per year by the chief engineer or his deputy to ensure proper maintenance levels, a yearly independent inspection, and a yearly audit of the safety system to satisfy LTSA that the operating licence requirements were being met. This tiered inspection and audit system should have been sufficient to identify the weak track condition that had developed, and initiate appropriate action to protect rail traffic.

2.8 There was a possible conflict within the BVR Rail Safety System manual whereby Section 1.53 required a twice-yearly inspection of the infrastructure by the chief engineer or his deputy as detailed in the Track and Bridge manual, which in turn required inspections at intervals not exceeding 13 weeks by a BRV engineer or someone authorised by the general manager. This could be interpreted as a total of 6 inspections per year maximum, or 4 inspections per year minimum. The frequency of inspections and the staff authorised to carry out such inspections should be clarified. The BVR erroneous interpretation resulted in the general manager doing 2 inspections per year to meet all inspection requirements. Regardless of interpretation, the track had not been inspected to the standard required by the approved safety system.

2.9 It was disappointing that the safety system audit did not identify the difference between the approved safety system inspection requirements and actual inspection frequency. This is a key part of any safety system and should be a priority check for any audit.

2.10 Inspection in itself will not ensure a safe track standard. It needs to be coupled with an assessment and action programme taking account of available resources and other defences such as temporary speed restrictions.

3. Findings

Findings and safety recommendations are listed in order of development and not in order of priority.

3.1 The likely cause of the derailment was gauge spread due to inadequately fixed rail on failed sleepers.

3.2 The condition of the track was not suitable for the permitted speed of operation.

3.3 Track weakening had been detected but the extent had not been fully appreciated and appropriate action to protect rail traffic had not been implemented.

3.4 The track was not being inspected at the frequency required by the LTSA-approved safety system.

3.5 The inspection requirements were not clearly defined.

3.6 The audit had failed to identify deficiencies in this safety critical area.

4. Safety Actions

4.1 The General Manager of BVR advised on 23 July 1999 that following the temporary repairs at the derailment site, a strict speed restriction had been enforced.

5. Safety Recommendations

5.1 On 20 July 2000 it was recommended to the General Manager of BVR that he:

5.1.1 clarify the skill level and frequency of inspections required as part of the BVR approved safety system and ensure that the individuals approved within the Preservation Society to carry out each level of inspection are defined (039/00)

5.1.2 initiate actions arising from such inspections to ensure safe rail operation. (040/00)

5.2 On 14 August 2000 the BVR confirmed previous advice from the Acting General Manger that the recommendations were accepted and in hand.

5.3 On 25 July 2000 it was recommended to the Director of the LTSA that he:

5.3.1 ensure inspection requirements included in rail service operation safety systems clearly define:

- the type of inspections required
- the frequency of each inspection
- the persons who can carry out each inspection. (041/00)

5.3.2 give increased emphasis to the quality and frequency of inspections as key parameters for auditing the performance of rail operators to their approved safety system. (042/00)

5.4 On 4 August 2000 the Director of the LTSA replied:

5.4.1 I note your safety recommendations 041/00 and 042/00 and confirm these will be adopted as future specific requirements for definition in all rail safety systems and will be subject to appropriate audit requirements.

Approved for publication 2 August 2000

Hon. W P Jeffries
Chief Commissioner