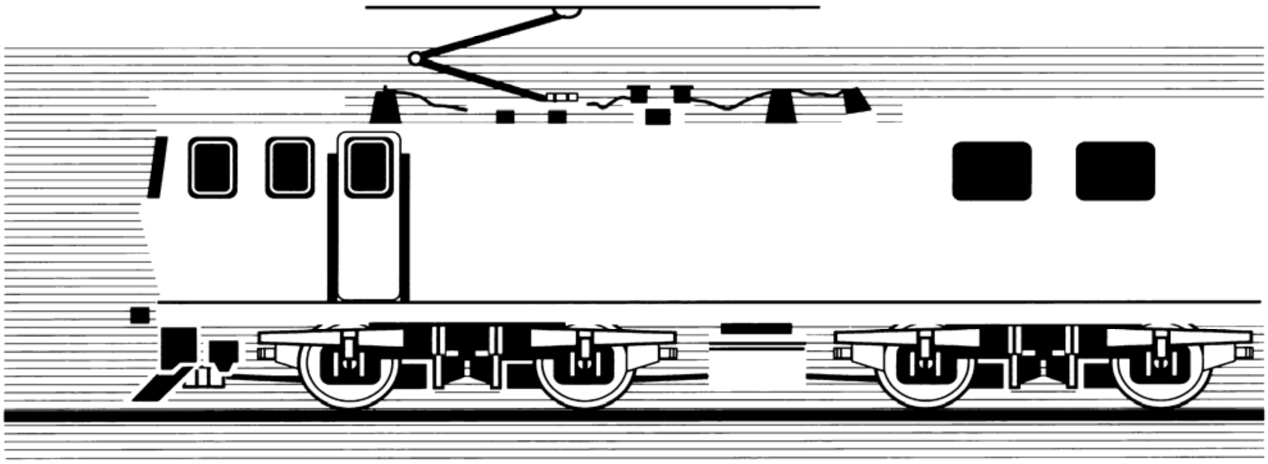
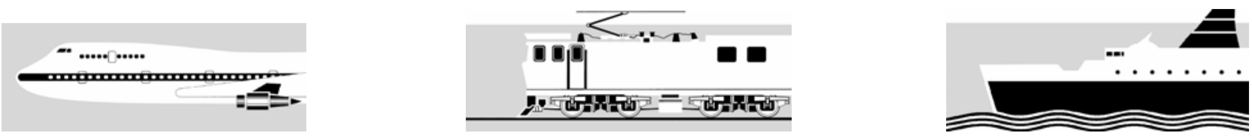


R A I L W A Y   O C C U R R E N C E   R E P O R T

05-125 **Taieri Gorge Railway passenger Train 1910, train parting, Dunedin** **28 October 2005**



TRANSPORT ACCIDENT INVESTIGATION COMMISSION
NEW ZEALAND

Report 05-125

Taieri Gorge Railway passenger Train 1910

train parting

Dunedin

28 October 2005

Abstract

On Friday 28 October 2005, at about 1547, Taieri Gorge Railway passenger Train 1910, travelling from Middlemarch to Dunedin with a crew of 4 and 21 passengers, parted between the leading passenger car XPC412 and passenger car XPC562 as the train approached Dunedin Station.

After the train parted, the brakes applied automatically and the 2 sections of the train stopped about 40 metres (m) apart.

The train parting resulted from the catastrophic failure of the buffer at a flash butt weld that connected the cast coupler head and forged tail.

There were no injuries to passengers or crew.

The safety issues included:

- the identification and tracking of buffer components
- the non-visual inspection of buffer components.

In view of the safety actions taken by Taieri Gorge Railway Limited, no safety recommendations have been made to the operator. One safety recommendation has been made to the Director, Land Transport New Zealand to distribute this report to all heritage operators with gangway-connected rolling stock, and direct all mainline heritage operators to crack test non-alliance buffers on all their operational passenger carriages and guards' vans.

Contents

Figures

Abbreviations

km	kilometre(s)
m	metre(s)
mm	millimetre(s)
MSL	Main South Line
OETT	Otago Excursion Train Trust
TGR	Taieri Gorge Railway Limited
UTC	coordinated universal time

Data Summary

Train type and number:	Taieri Gorge Railway passenger Train 1910
Year of manufacture:	passenger car XPC412 under frame constructed in 1907
Date and time:	28 October 2005, at about 1547[1]
Location:	Dunedin
Persons on board:	crew: 4 passengers: 21
Injuries:	nil
Damage:	extensive damage to one end of both passenger cars XPC412 and XPC562
Operator:	Taieri Gorge Railway Limited (TGR)
Investigator-in-charge:	P G Miskell

[1] Times in this report are New Zealand Daylight Times (UTC + 13) and are expressed in the 24-hour mode.

1 Factual Information

1.1 Narrative

1.1.1 On Friday 28 October 2005, Train 1910 was the TGR Middlemarch to Dunedin passenger service. The train consisted of locomotive DJ3107, 4 XPC passenger cars and a Z class generator car at the rear.

1.1.2 Train 1910 was crewed by a locomotive engineer, a train operator, a train manager and a guard. There were 21 passengers on board.

1.1.3 At about 1547, shortly after Train 1910 entered Dunedin Station limits on the Main South Line (MSL), the locomotive engineer saw the brake pipe pressure reduce. Thinking that either the train had suffered a burst hose or someone had activated the emergency stop, he bled off the locomotive brake to ensure that there was no severe run-in.

1.1.4 The guard inspected the train, then radioed the locomotive engineer to inform him that the train had parted between the first and second passenger cars, because of a broken buffer (see Figure 1). The 2 sections of the train were about 40 m apart.

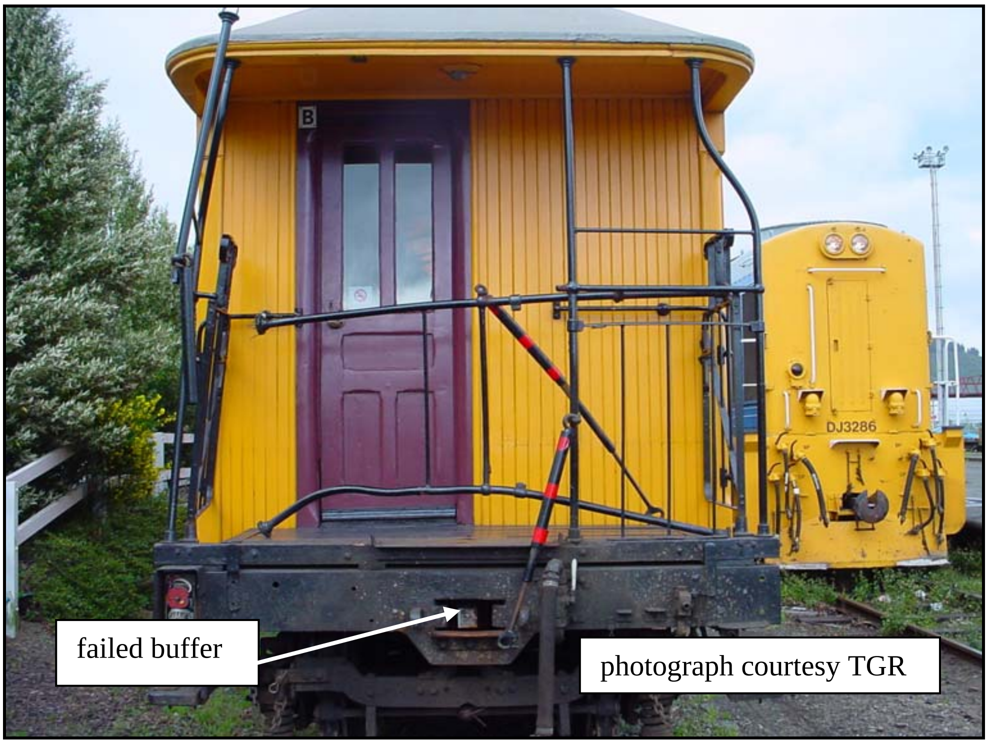


Figure 1
Passenger car XPC412

1.1.5 There were no passengers on the open platform or the walkway between passenger cars XPC412 and XPC562 when the train parted. Passengers had been requested to return to their seats before the train entered ONTRACK's[2] controlled network at 3.5 kilometres (km) on the Taieri Branch because the train passed through 2 one kilometre long tunnels before arriving at Dunedin Station (see Figure 2).

[2] ONTRACK authorised track occupations, and the movement of rail vehicles on the controlled network.

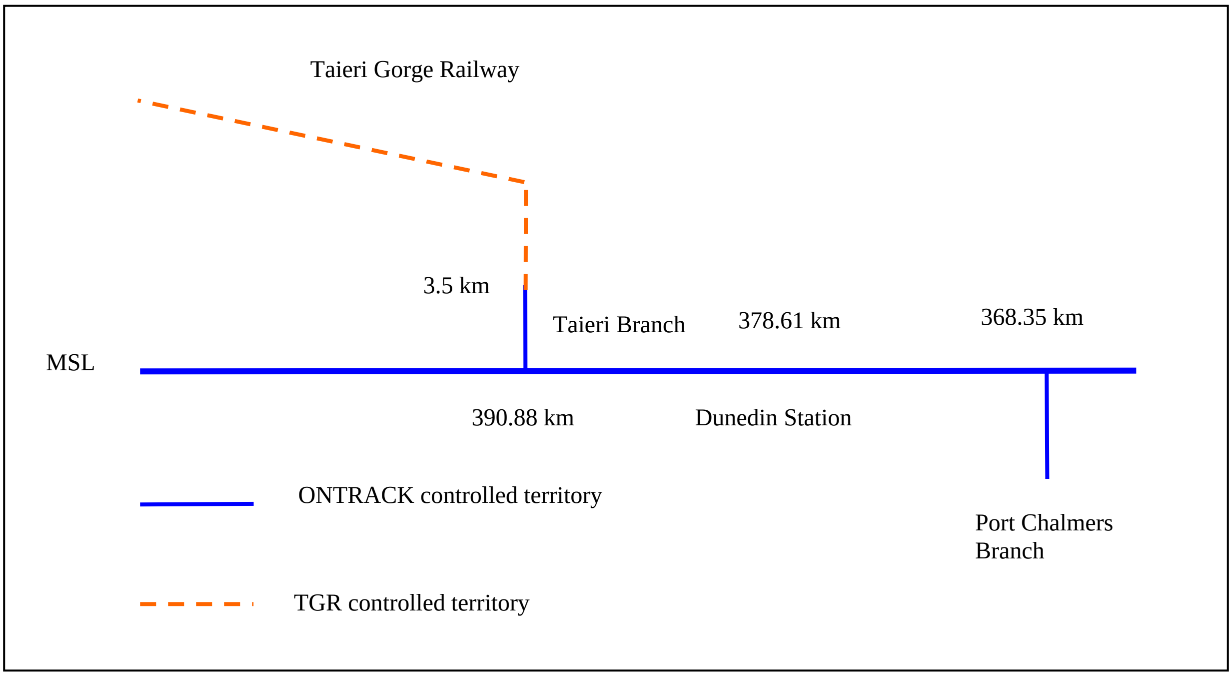


Figure 2
Controlled networks

1.2 Operating information

1.2.1 TGR owned and maintained the track from the termination of the Taieri Branch at 3.5 km through to Middlemarch, a track section of about 60 km.

1.2.2 The "ALL TRAINS STOP" board erected at 3.50 km on the Taieri Branch defined the boundary between TGR territory and the ONTRACK controlled network. The locomotive engineer was required to call train control for permission to pass the "ALL TRAINS STOP" board.

1.2.3 TGR rolling stock, with current fitness certificates, had authority to operate on ONTRACK's lines between Port Chalmers/Old Mosgiel Station (between Mosgiel and Henley Siding) and 3.5 km Taieri Branch. TGR passenger trains were restricted to a maximum speed of 70 kilometres per hour (km)on these lines.

1.3 Site information

1.3.1 Train 1910 parted when the locomotive was at about 379.5 km on the MSL. The brakes applied automatically and the locomotive stopped, with the lead passenger car still attached, at about 379.1 km MSL. The rear of the train stopped under the Cumberland Street road-over-rail bridge, about 200 m further back (see Figure 3).

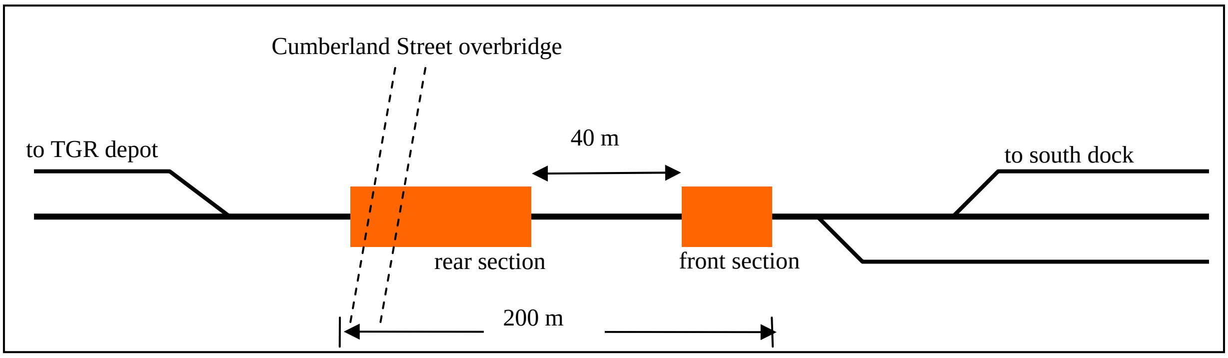


Figure 3
Site plan showing where Train 1910 stopped (not to scale)

1.3.2 Trains entering the south dock at Dunedin Station descended on a constant 1 in 100 gradient from 380.2 km to the mainline points that gave access to the TGR maintenance depot at 379.60 km.

1.3.3 The track at the location of the train parting consisted of 50 kilograms per metre rail on ribbed bedplates fastened to treated pinus radiata sleepers with screw spikes. The track geometry at this location was within acceptable maintenance limits.

1.4 Personnel

The locomotive engineer

1.4.1 The locomotive engineer was an employee of TGR and held current certification for the duties being undertaken.

1.4.2 At about 1546, the locomotive engineer radioed train control to cancel his track warrant[3], and about a minute later the train lost brake pipe pressure when it passed the mainline points leading to TGR's maintenance depot.

1.4.3 After being informed by the guard that the train had parted, the locomotive engineer radioed the train manager to confirm that all passengers remained safely on board the train. He then informed train control of the situation, secured the train and walked back to inspect the damaged equipment.

1.4.4 When he met the guard at the head of the rear portion of the train, the guard had already removed the broken buffer.

1.4.5 After he confirmed that all passenger cars and the generator car remained on track and that there was no damage to the track, points or interlocking equipment, the locomotive engineer radioed train control and was given authority to proceed, at slow speed, with the front portion of the train to the south dock of Dunedin Station. He also made arrangements for a relief locomotive from the TGR maintenance depot to propel the rear portion of the train into the south dock.

The guard

1.4.6 The guard on Train 1910 held current TGR certification for the duties being performed. His duties and responsibilities included:

- the safe operation of the passenger cars
- passenger safety
- advising the locomotive engineer when the train was ready to depart from stations
- requirements of the train with regards to speed of travel, especially when meals were being served
- setting back, when authorised to by train control
- stops that were made en route.

1.4.7 The guard said that he was travelling in the rear passenger car, XPC590, when he felt the train come to a gentle stop. He thought that the train had stopped for a signal, and was somewhat surprised when he received a radio call from the locomotive engineer enquiring whether the train had a burst hose or the emergency stop had been activated.

---

[3] A track warrant was an authority issued by a train controller to define the limits of a track occupation.

1.4.8 After he alighted from the rear passenger car and saw that the train had parted, he informed the locomotive engineer of the situation. He then radioed the train manager and advised him to keep all passengers safely on board the train.

1.4.9 The guard stayed with the rear portion of the train until it was propelled to the south dock.

1.5 Locomotive event recorder

1.5.1 The event recorder data was not downloaded because train handling was not considered to have contributed to the buffer failure.

1.6 Passenger car inspection requirements

1.6.1 The TGR inspection code required all passenger cars to undergo a pre-departure check and an annual inspection. The annual inspection checklist was compiled from a document produced by the Federation of Railway Operators New Zealand that in turn was taken from Toll Rail's Mechanical Code M2000. The inspection findings were recorded on a TGR 655 form, "Inspection of Carriages".

1.6.2 Any work required as a result of the inspection was identified on TGR 684 form, "Work Required from Inspection of Rail Vehicles". In addition, an annual visual inspection of all rail vehicles and a random audit of other elements such as brake tests and wheel profile measurements were carried out by a suitably qualified independent person.

1.6.3 The TGR pre-departure check for passenger trains included the following passenger car coupling items:

- couplings secure and where necessary slot protectors placed on drawpins
- air hoses connected and taps turned down
- power cables connected, lock rings locked and switches on
- gangways between passenger cars correctly fitted
- telescopic arms placed between passenger cars and tested for security
- spare kidney links, draw pins and brake hoses on board
- complete repair/faults form where necessary
- repair fault if possible before trip departs otherwise remove vehicle if unsafe to run.

For the trip on 28 October 2005, the train preparation/examination certificate was completed and signed by both the train examiner and locomotive engineer before Train 1910 departed. No defects were identified.

1.6.4 TGR's annual inspection of passenger car drawgear included:

- drawbar height, measured from rail level to the drawbar centre
- wear limits on the couplers defined
- cracks on the couplers must not exceed limits defined in Toll Rail Standard M9200/25
- bridle must be serviceable and prevent the corresponding hook lifting
- draft lugs to be intact, and free of debris between draft lugs and sole bars
- wear plates to be secure and not worn through
- Janney yokes to be free of cracks or any other damage

- drawbar packing to be a minimum of 3 mm thick
- drawhooks to be free of cracks, and the hole not exceeding 48 mm in any direction
- drawbar coupling pins must have a diameter greater than 36 mm
- drawbars must not be bent more than 25 mm from the centreline measured at the buffer face
- all operating gear and safety devices must be serviceable
- drawbar side play must be less than 100 mm from one side to the other measured at the headstock
- no appreciable drawbar endplay.

1.7 Passenger car XPC412

1.7.1 Records provided by TGR showed that the end section of XPC412 was built for New Zealand Government Railways at its Addington workshop in 1907. The Otago Excursion Train Trust (OETT) purchased the passenger car in the mid 1970s and converted the drag rod drawgear to its current Janney yoke system.

1.7.2 During the mid-1970s, the OETT also purchased the car body, constructed at Addington workshops in 1924, and fitted it to the frame some time before commencing passenger services in October 1980. Other modifications to the passenger car included:

- converting the bogies with plain bearings to roller bearings
- replacing the tongue and groove cladding with plywood
- fibre glassing the roof
- replacing the original window glass with laminated glass
- upgrading the interior
- fitting holding tanks
- fitting chemical toilets.

1.7.3 In August 1995, TGR purchased the passenger fleet from OETT.

1.7.4 The latest annual inspection of XPC412 was carried out on 22 April 2005. The TGR inspection form indicated that there were a total of 20 items arising from the inspection that required remedial work. None of those items was a defect on the drawgear.

1.7.5 The latest inspection of XPC412 by an independent person was carried out on 22 September 2005. The inspection sheet confirmed that all items inspected were code compliant and that no remedial work was required.

1.8 Examination of the failed buffer

1.8.1 The buffer was manufactured by flash butt welding a cast section and a forged section (see Figure 4). The age of the buffer was not known. However, the supplier of the buffers confirmed that the process of butt welding the cast and forged sections had ceased more than 30 years ago. Currently, all new buffers are fully cast, thus eliminating the need to butt weld a cast section to a forged section.

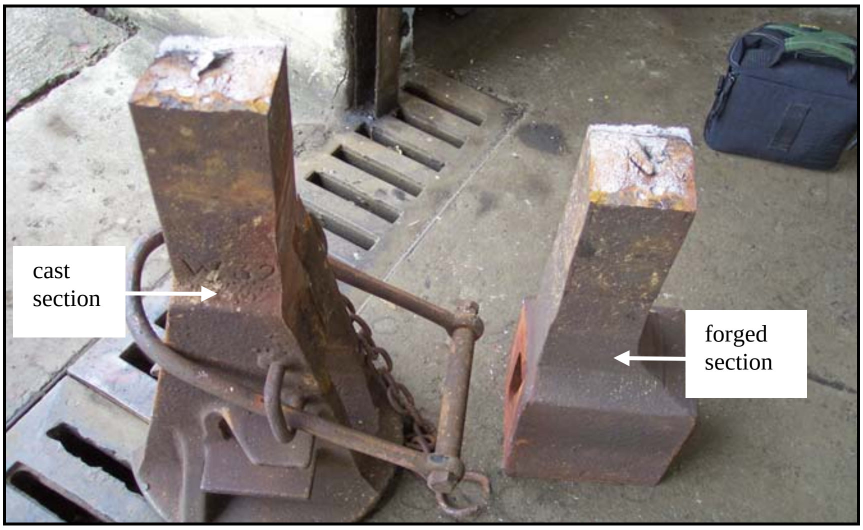


Figure 4
Fractured buffer

1.8.2 The failed buffer was sent to a metallurgy laboratory for examination.

Visual examination

1.8.3 The forged end of the buffer had a 100 mm long section inserted to achieve the required buffer length (see Figure 5).

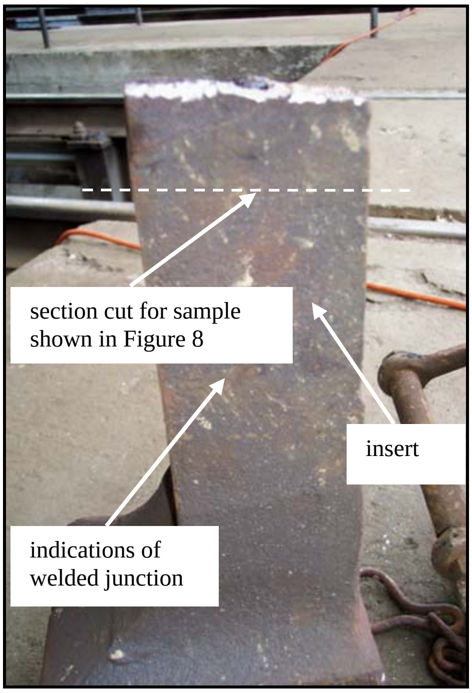


Figure 5
Forged end of buffer

1.8.4 The fracture initiation positions are marked in Figure 7.

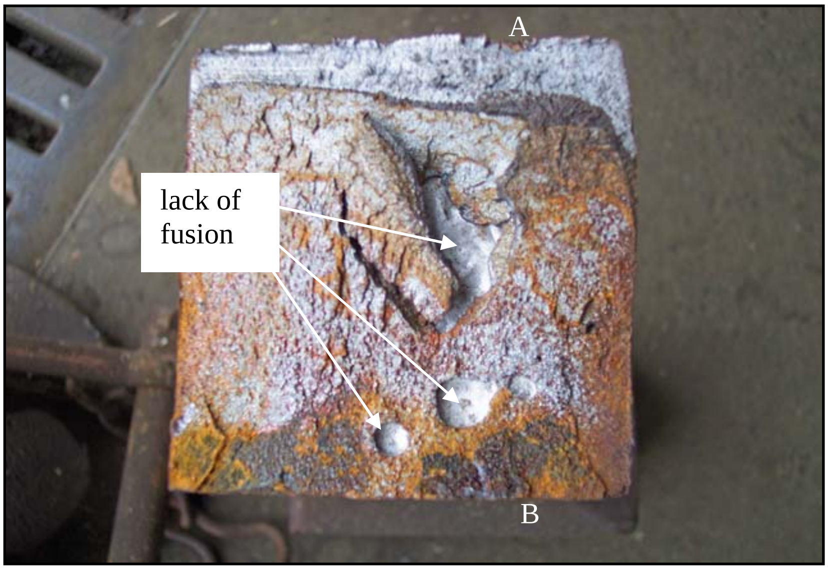


Figure 6
Fracture face of forged section

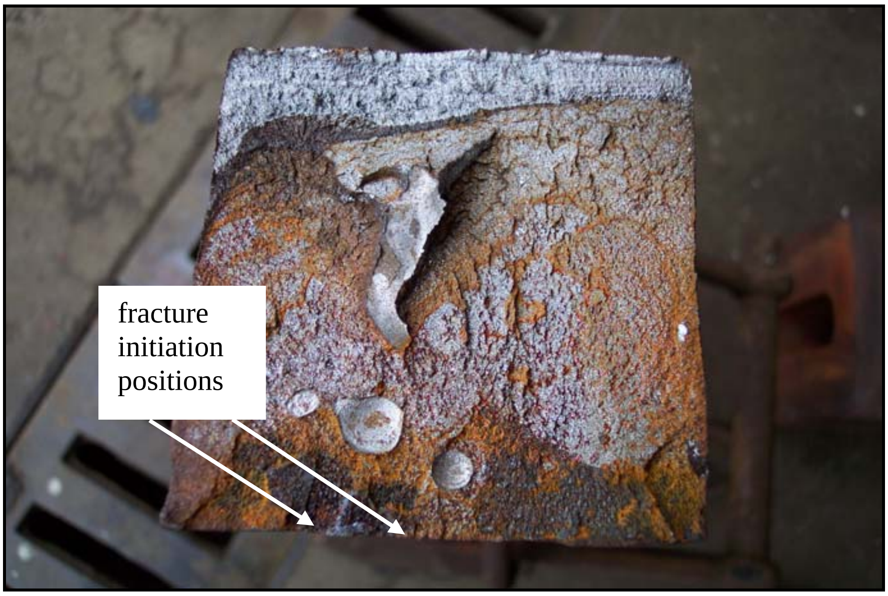


Figure 7
Fracture face of cast section

Spectrographic analysis

1.8.5 Samples were cut from the fractured end to determine the material types from which the cast section, forged section and insert were made. The surface of the forged end was fine ground and etched to reveal the position of the flash butt weld and the fusion zone. This macro-etched surface revealed what appeared to be a surface weld over the junction of the flash butt weld shown in Figure 8.

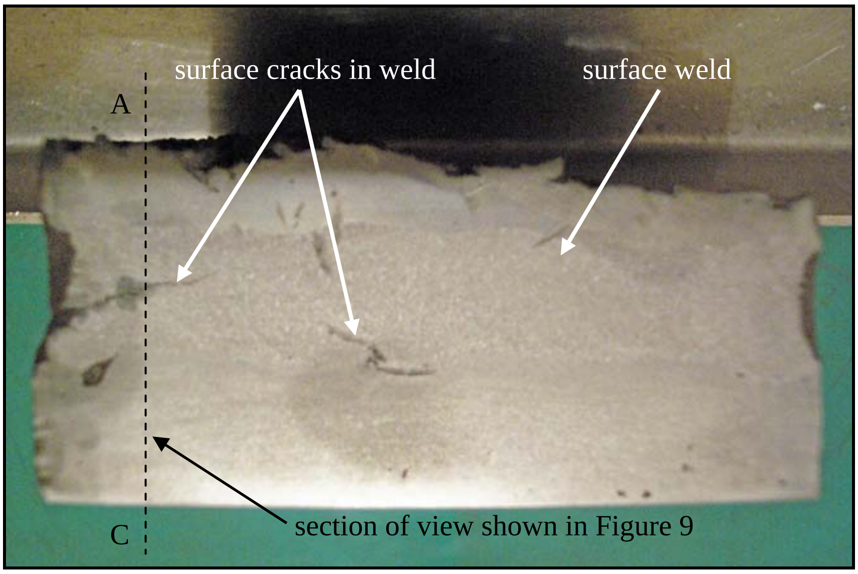


Figure 8
Surface macro of forged end

1.8.6 The percentages of carbon, manganese, phosphorous, sulphur, silicon, nickel, chromium, molybdenum, copper and aluminium in the sections were:

	%C	%Mn	%P	%S	%Si	%Ni	%Cr	%Mo	%Cu	%Al
Casting	0.25	0.73	0.04	0.03	0.38	0.08	0.06	0.018	0.11	0.053
Forging	0.18	0.69	0.027	0.055	0.08	0.11	0.06	0.009	0.14	0.005
Insert	0.30	0.70	0.026	0.035	0.20	0.13	0.09	0.030	0.14	0.006

1.8.7 The surface weld, shown in Figure 8, contained some cracks. One such crack originated at the edge where there was an undercut, resulting in a small void in the weld deposit. This crack had propagated from the root of the weld deposit and followed the fusion zone for about 15 mm (see Figure 9).

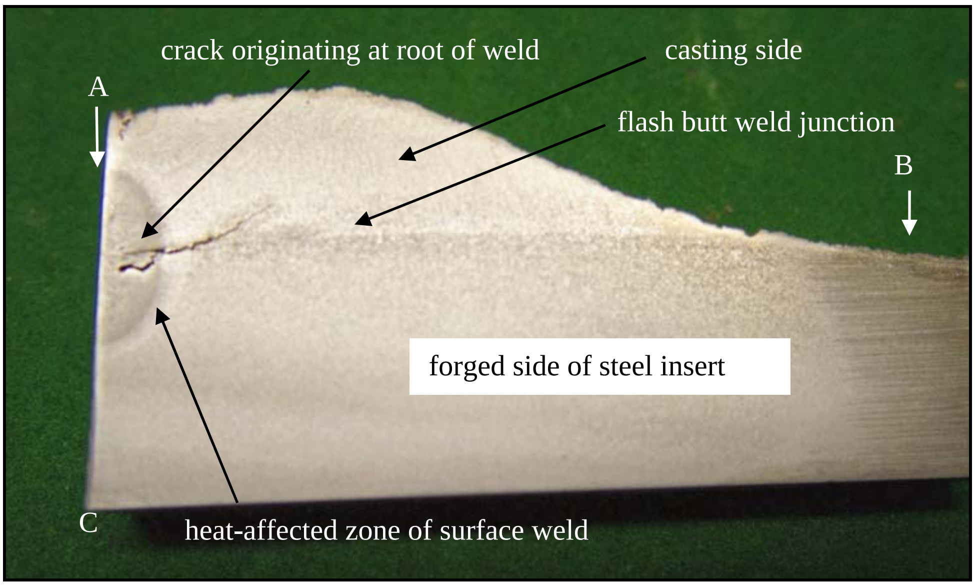


Figure 9
Micro of the section through the dotted line in Figure 8

2 Analysis

2.1 The buffer failed due to fatigue followed by tensile failure. The fatigue crack, which originated at the root of a weld deposit, followed the fusion zone through the section until there was no longer enough sectional strength remaining to sustain the stress, resulting in a catastrophic failure.

2.2 The initial flash butt weld had large areas of no or poor fusion and the surface weld deposit may have been an attempt to repair the initial lack of fusion.

2.3 Surface cracks and areas of lack of fusion acted as stress concentrators, resulting in slow initial crack propagation. The rate of crack propagation would have accelerated as the effective cross-section of the buffer was reduced, with the catastrophic failure occurring when there was less than 15% of the original cross-sectional area remaining.

2.4 Neither the age of the buffer nor its operational and maintenance history could be determined. However, given that the practice of flash butt welding cast and forged sections had ceased more than 30 years ago, it was likely that the buffer had been in service for at least that time. In this case, the buffer would have had several thousand trips with a range of loading conditions.

2.5 TGR advised that, since the failure, each buffer had been given a unique identifier that is recorded on the passenger car inspection form to enable its maintenance and operational history to be recorded and traced. Because of this, no safety recommendation covering this issue has been made.

2.6 Although the pre-departure checks, including a general visual inspection of the drawgear, had been carried out, the visual check primarily confirmed that the passenger cars were coupled correctly and was not specifically to look for fatigue cracks on the drawgear. Even if a cursory check for cracks had been made, the examination would not have detected the fatigue cracks because they were behind the headstock.

2.7 The annual inspection of the buffers, before this incident, was visual only, and unless the crack was obvious, that it could be missed and a potentially defective passenger car returned to service. Because of the safety actions taken by TGR that included crack testing all buffers, including spare stock, no safety recommendation has been made to TGR. However, to ensure that the lessons from this incident are understood by other heritage operators, a safety recommendation has been made to the Director, Land Transport New Zealand.

2.8 Given the extent of corrosion at the failure surface, the main fatigue crack had been propagating for a considerable period of time, and it was possible that similar fatigue cracks had developed on other buffers. However, because TGR has implemented a crack testing programme, no safety recommendation covering this issue has been made.

2.9 Once Train 1910 parted, the safety systems operated as designed in that the brakes applied automatically, bringing both sections of the train to a stop without further incident or discomfort to the passengers and crew.

3 Findings

Findings are listed in order of development, not in order of priority.

3.1 The train parting resulted from the tensile failure of the buffer connecting the leading 2 passenger cars.

3.2 The origin of the fatigue cracking was associated with a non-compliant flash butt weld between the cast and forged sections of the buffer.

3.3 Some of the fatigue cracks in the failure zone were probably present soon after the buffer was put into service.

3.4 Although the buffer was estimated to be more than 30 years old, the absence of a unique identification number on the buffer prevented confirmation of its age and tracking of its operational and maintenance history.

3.5 The annual inspection procedures required a visual inspection only of the passenger car buffers.

3.6 No track geometry issues were identified that could have contributed to the train parting.

3.7 The actions of the locomotive engineer and train crew did not contribute to the incident.

3.8 Passenger safety was not at risk during the incident.

4 Safety Actions

4.1 On 14 November 2005, TGR advised in part:

> To date we have:
>
> - had a metallurgy report on the broken buffer
> - produced an acceptance criteria for repair and a repair procedure
> - crack tested all our spare buffer stock (mag-particle and ultrasonic) and found more than 50% have surface cracks, usually around the flash butt welds
> - started a programme of crack testing all our current fleet and replacing with repaired buffers if cracks are found
> - called for quotations for replacement buffers, both existing type (JA) with stronger shanks and for bottom-shelf alliance couplers
> - prepared a report for broadcast to the heritage rail operators in New Zealand. It will include a recommendation to normalise old buffers every 5 to 10 years to reduce the likelihood of cracking and extend their life.
>
> Acceptance criteria for repair could be as follows:
>
> 1. If any crack runs the entire width of the section and continues down one or more sides then the buffer is not repairable.
> 2. If any side has 4 or more cracks longer than 30 mm or the total number of cracks longer than 20 mm on all 4 sides exceeds 6 then the buffer is not repairable.
> 3. If any crack longer than 30 mm has opened more than 1 mm between the surface crack faces the buffer is not repairable.
> 4. In all other cases the buffer is repairable.

5. If any crack depth during grinding out penetrates more than 25 mm then the buffer is not repairable.

A repair procedure for coupling buffers to include:

1. Give each buffer a unique identification – record this on the buffer and report form.
2. Identify all crack defects by Magnetic Particle Inspection (MPI) – mark their position and extent on the buffer for crack removal.
3. Record the positions and extents on the report form.
4. Determine if the buffer is within the acceptable criteria for repair. If not, reject the buffer and record that on the report form.
5. Remove the cracks by grinding or arc-air gouging followed by grinding – a minimum root radius of 5 mm should be acceptable.
6. Check by MPI that the cracks are completely removed.
7. Pre-heat the entire buffer or area within 75 mm surrounding the area to be repaired 30 - 80ºC.
8. Weld the required areas using the selected welding method and filler material indicated below.
9. When welding is complete cover the buffer with an insulating blanket to allow slow cooling.
10. MPI the weld repair area for signs of defects after the buffer has cooled below 40ºC.
11. If any cracks or other defects show then repair again as from step 5.
12. When no cracks show on MPI then mark the report form as accepted.

For Manual Metal Arc Welding: use filler to AS/NZS 15553.1: E41XX–2 or E48XX-2 (e.g. CIGWELD Weldcraft or Ferrocraft 21 or 22 or other equivalents) – follow manufacturer’s requirements for power settings.

For Gas Metal Arc Welding (MIG): use filler to AS/NZS 2717.1: ES2-GC/M-W503AH (e.g. CIGWELD Autocraft Super Steel – or equivalents) – follow manufacturer’s requirements for power settings and gas usage.

5 Safety Recommendations

5.1 Because of the safety actions taken by TGR, no safety recommendations have been made to the operator.

5.2 On 25 August 2006, the Commission recommended to the Director, Land Transport New Zealand that he:

(a) distribute the Commission's Report 05-125 to all heritage operators with gangway-connected rolling stock, and

(b) direct mainline heritage operators to crack test the non-alliance buffers on all their operational passenger carriages and guards' vans on an annual basis (037/06).

5.3 On 11 September 2006 the Director, Land Transport New Zealand replied in part:

> Land Transport NZ could require, for instance, all mainline heritage operators to crack test all non-alliance buffers on an annual basis, if the Director of Land Transport considers this action necessary in accordance with the Railways Act 2005 Section 28. This Section states that imposing conditions on the operation of any rail vehicles must be only if the Director believes, on reasonable grounds, that the operation or use of a rail vehicle or class of rail vehicle, etc., may endanger persons or property and that prompt action is necessary to prevent this risk. At this stage Land Transport NZ is unsure if this threshold for intervention has been met.
>
> We considered this potential risk to passengers best addressed by:
>
> 1. Distributing the Commission's Report 05-125 to all operators with operational passenger carriages fitted with non-alliance buffers.
>
> 2. Recommending all above rail operators crack test the non-alliance buffers on all their operational passenger carriages and guards van on a periodic basis. It would be problematical for Land Transport NZ to require the testing on an annual basis without a specific risk analysis to be carried out by each operator concerned.
>
> Land Transport NZ has decided not to implement the above safety recommendation; however on receipt of your final report we will bring this matter to the individual attention of rail operators concerned as detailed in (1) & (2) above.
>
> Land Transport NZ will continue to monitor this issue through the regulatory assessment process on a regular basis.

Approved on 17 August 2006 for publication

Hon W P Jeffries
Chief Commissioner

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04-127	Express freight Train 952 and stock truck and trailer, collision, Browns Road level crossing, Dunsandel, 19 October 2004

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