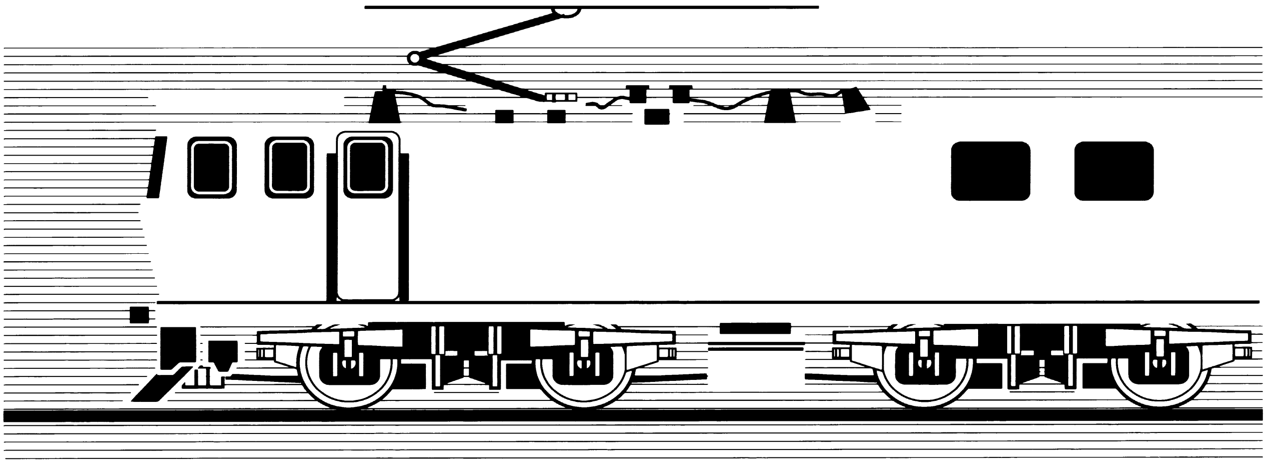
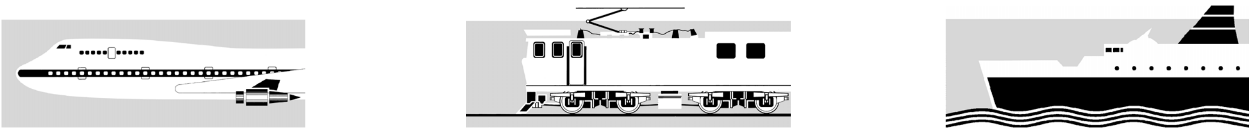


RAILWAY OCCURRENCE REPORT

04-130	express freight train derailments due to axle bearing failures, various locations	5 November 2004- 21 March 2005



TRANSPORT ACCIDENT INVESTIGATION COMMISSION
NEW ZEALAND

Report 04-130

express freight train derailments

due to axle bearing failures

various locations

5 November 2004 - 21 March 2005

Abstract

Between Friday 5 November 2004 and Monday 21 March 2005, there were 4 freight train derailments at various locations as a result of failures of roller bearing units. These failures occurred on varying wagon classes and bogie types.

There were no injuries in any of the incidents.

Because of the similarities arising from each derailment, the investigations into all 4 incidents have been combined into one report.

Safety issues identified included:

- the reporting and tracking of component replacement
- the abnormally high incidence of fused brake blocks on the derailed wagons.

Two safety recommendations were made to the Chief Executive, Toll NZ Consolidated Limited to address these issues.

Contents

Figures

Abbreviations

AAR	Association of American Railroads
ATSB	Australian Transport Safety Bureau
DED	dragging equipment detector
hr	hour(s)
kg/m	kilograms per metre
km/h	kilometres per hour
m	metre(s)
ML	Midland Line
NIMT	North Island Main Trunk
POD	point of derailment
RBU	roller bearing unit
t	tonne(s)
Toll Rail	Toll NZ Consolidated Limited
UTC	coordinated universal time
VDU	visual display unit

Data Summary

Rail Occurrence Number	Train Number	Date	Time	Location
04-130	Train 237	5 November 2004	0410[1]	Owhango
05-106	Train 221	4 February 2005	1630[1]	Kaiwharawhara
05-110	Train 247	21 February 2005	0220[1]	Te Kauwhata
05-114	Train 842	21 March 2005	1038[2]	Jackson

Type of occurrences: derailments

Injuries: nil

Damage: extensive damage to infrastructure and rolling stock

Operator: Toll NZ Consolidated Limited (Toll Rail)

Investigator-in-charge: P G Miskell

[1] Times are New Zealand Daylight Time (UTC + 13 hours) and are expressed in the 24-hour mode.
[2] Time is New Zealand Standard Time (UTC + 12 hours) and expressed in the 24-hour mode.

1 Introduction

Between 5 November 2004 and 21 March 2005 there were 4 express freight train derailments where the cause was attributed to a bearing failure. Because of the similarities of the incidents, investigations into them have been combined into one report, although each incident is dealt with separately. The incidents are summarised below:

- **Occurrence 04-130**: on Friday 5 November 2004, wagon ZH1812 on express freight Train 237 travelling from Auckland to Wellington derailed between Kakahi and Owhango. The derailed wagon activated a dragging equipment detector[3] (DED) unit that sent an alert to train control. The train controller contacted the locomotive engineer and the train was stopped about 4 km past the point of derailment.
- **Occurrence 05-106:** on Friday 4 February 2005, wagon UKR137 on express freight Train 221 travelling from Auckland to Wellington derailed at Kaiwharawhara. A shunter saw the derailed wagons as the train was berthing at Wellington freight yard.
- **Occurrence 05-110:** on Monday 21 February 2005, wagon UK18837 on express freight Train 247 travelling from Auckland to Wellington derailed about 20 m before the north end main line points at Te Kauwhata. The derailed wagon caused significant damage to the main line points and associated signalling equipment.
- **Occurrence 05-114:** on Monday 21 March 2005, loaded coal wagon CB10558 on unit freight Train 842 travelling from Ngakawau to Lyttelton derailed at Jackson on the Midland Line. Six other loaded coal wagons derailed as a consequence of derailment damage to the track. There was significant damage to both track and rolling stock.

2 Roller bearing units

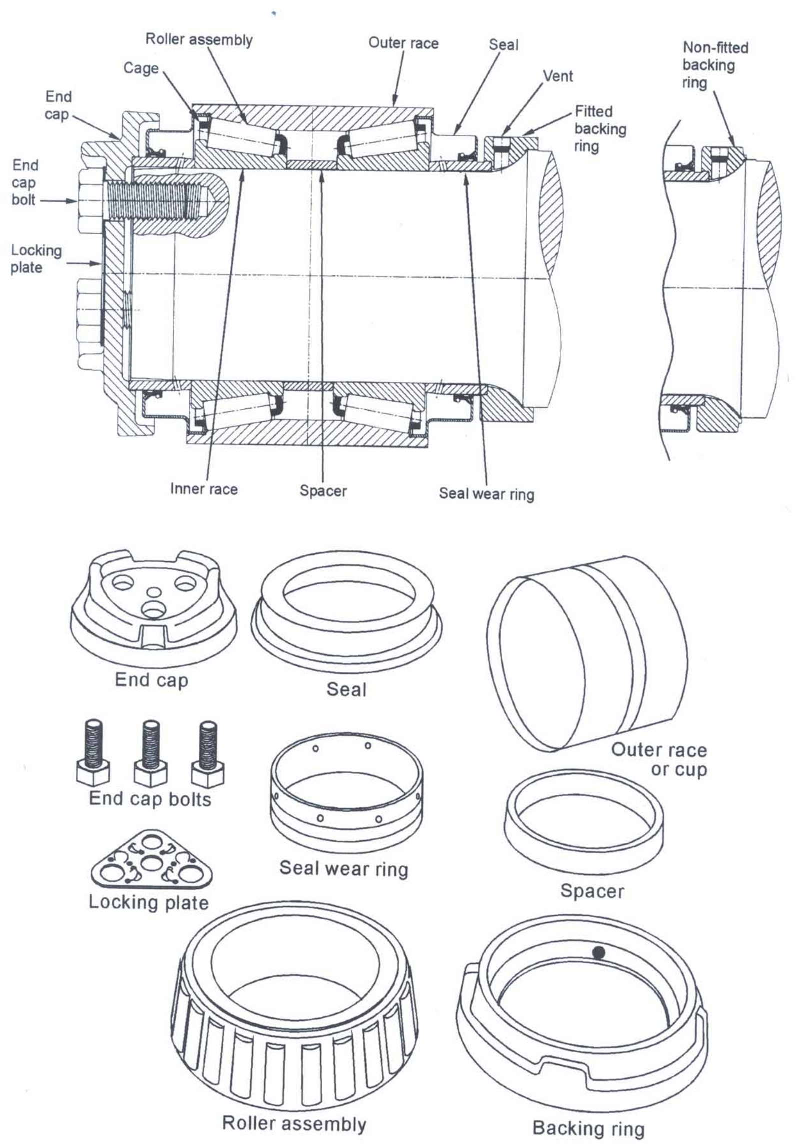
2.1 General

2.1.1 Roller bearing units (RBUs) are fitted to the axle journal ends outside each wheel. Two tapered roller bearings and associated bearing elements are combined into one self-contained assembly and fitted to each axle journal (see Figure 1). The RBU is fitted over the axle journal, the cylindrical portion of the axle, and retained and located by an end cap. The “interference fit” of the inner race on the journal and the lateral clamp provided by the end cap bolts prevent rotational creep between the inner race and the axle. The RBU is then located and retained on the wagon bogie side frame pedestal by a bearing adapter casting.

2.1.2 The advantages of tapered roller bearings included:

- a rolling motion with load bearing contact and positive roller alignment
- low friction from start and at all running speeds
- an ability to sustain large radial and thrust loads
- a high level of reliability
- long intervals between re-lubrication
- ease of installation and removal.

[3] A DED unit detects dragging equipment or a derailed wagon and sends an alert to train control.



courtesy Toll Rail

Figure 1
Package bearing components

2.1.3 The normal running temperature of wheel bearings was 30ºC to 55ºC. If an RBU was too hot to be touched, it was commonly accepted that the bearing was running over temperature and the wagon should be withdrawn from service for a more detailed inspection. Continual running of the bearing at about 40ºC above ambient temperature will eventually lead to a "hot box" condition. A "hot box" is the overheating of the bearing/axle journal assembly. If a hot box was not discovered and the wagon allowed to continue running, it may lead to a bearing seizure, then potentially a "screwed" journal situation where the axle is separated between the wheel and the RBU and subsequently a derailment.

2.2 Bearing overhaul process

2.2.1 Bearings were overhauled in accordance with Toll Rail's Wheelset Manual, M6000, until withdrawn from service because of a condemnable defect. On 12 September 2005, Toll Rail stated in part:

Bearing Overhauls at Alstom Hutt

- C package bearings, as used on most wagon types, are overhauled at Hutt and only those that have passed the internal bore check. All other bearings are sent to an external bearing-overhaul company.
- Bearing overhauls are carried out as per the M6000 wheelset manual.
- To work unsupervised in the overhaul group the staff member must have passed the appropriate skills assessment test.
- Final bearing assembly is by the trades person/leading hand.

Bearing Overhaul Process

- bearing removed from wheelset
- bearings placed into unrefurbished stock
- bearings placed to overhaul gang in batches of 60
- materials supplied to group from stock
- bearing stripped
- seals removed
- 100% replacement items discarded
- heavy grease build-up scraped clear
- hot wash
- hand wash in solvent
- bearing left to drain
- 2-stage hand wash in solvent
- bearing component key measurements recorded (into computer system)
- serial number etched into bearing if not present
- bearing inspected for faults
- bearings rejected on basis of faults or tolerance issues
- if internal bore oversize errors, bearing cone and cups bagged and sent away for overhaul
- bearings that pass inspection tests are assembled > greased > seals installed
- bearing is bagged
- sent to inventory for storage/issue.

Internal audits

- Internal audits of the bearing overhaul process are carried out every eight weeks. As part of the audit one part of the overhaul process is checked for compliance.

2.2.2 Toll Rail advised that during 1997 the type of grease used on bearings of Type 14 bogies was changed from an EP2-based grease to Mobil SHC460. Toll Rail could not confirm the name of the manufacturer of the EP2 grease but advised it had now changed to Timken Premium grease that complies with Association of American Railroads standard (AAR) M-942.

2.2.3 Possible contributing factors for a failed reconditioned RBU would include; insufficient interference fit between the journal diameter and inner ring bore when the RBU was fitted; improper RBU assembly; lubrication problems during overhaul or in service.

3 Bogie inspection requirements

3.1 General

3.1.1 Toll Rail's Mechanical Code M2000 required all freight wagons to undergo at least a pre-departure check, a B-check and a C-check. A B-check covered safety critical items and was performed when 2 or more brake blocks were changed or after an incident. The more detailed C-check was performed generally every 24 months, with an upper limit of 27 months. A C-check could be brought forward if a wagon had been involved in a derailment or collision or had a fault with braking. The code also required CB class wagons to undergo a 6-monthly check. However, Toll Rail advised that these checks have historically been carried out at 12-monthly intervals.

3.1.2 Toll Rail's wagon and container Inspection Manual M9209 required the following bogie/suspension components to be inspected during both a B-check and a C-check.

Springs:	In place, secure and intact.
Bearing keeps:	Held securely in place.
Liners:	Secure. Not broken.
Wedge heights:	Within limits (use Snubber gauge if in doubt).
Bearing adapters:	In place. No visual signs of damage.
Dampers:	Secure. No excessive oil leaks.
Horns:	Not bent or loose.
Bearings:	No sign of overheating. Cap bolts in place and secure. Backing rings secure. No excessive grease leakage.
Brake blocks;	Within wear limits.
VTA valve:	Gap setting correct (W.M.T. only). Plunger and stop in line. Air supply hoses in place.

4 International experience

4.1 An Australian Transportation Safety Bureau (ATSB) report on an investigation[4] into a derailment caused by a failed bearing stated that more than half of the RBU failures on trains operated by National Pacific in 2003 were for undetermined reasons.

[4] ATSB Rail Safety Investigation report into the derailment of Train 6WP2 in Bates, South Australia, 9 November 2003.

Occurrence 04-130

5 Factual Information

5.1 Narrative

5.1.1 On Thursday 4 November 2004, Train 237 was an express freight service travelling from Auckland to Palmerston North. After a locomotive change and an intermediate brake test[5] at Te Rapa, the train departed at about 0024 on Friday 5 November. The train consisted of 2 EF class electric locomotives in multiple[6] hauling 27 wagons, with a gross weight of 978 t and an overall length of 473 m. The train was crewed by a locomotive engineer.

5.1.2 The locomotive engineer said he had an uneventful trip from Te Rapa to Kakahi. At about 0353, Train 237 entered the Kakahi to Owhango track section after being berthed on the main line at Kakahi, 383 km NIMT, for about 21 minutes to cross express freight Train 210 which was already waiting on the loop and express passenger Train 202, the *Northerner.*

5.1.3 A few minutes later, the train controller saw a DED alert flashing on his visual display unit (VDU) that identified the location as being within the Kakahi to Owhango track section. He immediately radioed the locomotive engineer of Train 237 and told him of the alert. The locomotive engineer was instructed to stop and inspect his train.

5.1.4 The locomotive engineer looked back along his train and saw what looked like flames coming from the left side of his train. He was aware that there was an overhead bridge about 500 m ahead, so he slowed his train in order to stop near the bridge to give the Fire Service easy access to the burning wagon.

5.1.5 After he stopped the train, the locomotive engineer notified his location to the train controller and alighted from the locomotive to check his train. Once on the ground, he saw that the wagon was burning out of control (see Figure 2). He asked the train controller to call the Fire Service straight away.

Figure 2
Fire-damaged wagon ZH1812 near Bridge 191 NIMT

[5] An intermediate brake test must be carried out when a locomotive or vehicle(s) is added or detached.
[6] Multiple means that locomotives are coupled and controlled from the lead locomotive.

5.1.6 Three fire appliances and crews attended, but the crews were instructed not to fight the fire until traction earth straps were in place and the overhead power was confirmed as being isolated.

5.2 Site information

Derailment

5.2.1 The exact location where wagon ZH1812 derailed could not be determined. However, there was evidence of fresh scrape marks on the left-hand railhead at 379.290 km North Island Main Trunk (NIMT) and signs of intermittent ballast disturbance on a private level crossing at 378.834 km. The location where the first wheel dropped off the running rail, the drop-off point, was established as 378.127 km, some 1163 m past the scrape marks, where the opposite wheel dropped inside the right rail and ran derailed until the train was stopped some 4.315 km further south.

5.2.2 Train 237 stopped when wagon ZH1812, the 16th wagon in the consist, was at 373.812 km about 2 wagon lengths from Bridge 191, the State Highway 4 road over rail bridge. The leading axle of the trailing bogie had derailed to the left.

Track information

5.2.3 The track section from Kakahi to Owhango was referred to as the Kakahi Bank because it was on a rising gradient of about 1 in 50 throughout the section.

5.2.4 The drop-off point was at the exit from a 275 m long, 275 m radius left-hand curve.

5.2.5 The curve was laid with 50 kg/m rail secured to concrete sleepers with Pandrol fastenings. All track materials were in good condition. The ballast cribs were full and the width of the ballast shoulders complied with maintenance standards.

5.2.6 The day before the derailment, the EM 80 track evaluation car had measured and recorded the track geometry from Taihape to Hamilton. The EM80 compared the recorded data to defined maintenance parameters and produced a computer-generated printout that identified the location and nature of all exceedances. There were no track geometry issues identified near the drop-off point.

5.3 Operating information

5.3.1 The rail corridor between Kakahi and Owhango was single line. The signals and motor-driven points machines at these stations were operated from Centralised Traffic Control located at the national train control centre in Wellington.

5.3.2 The maximum authorised line speed between Kakahi and Owhango was 70 km/h. However, the drop-off point was on a tight-radius curve, the speed of which was restricted to a maximum of 60 km/h. The curve speed boards were displayed in accordance with code requirements.

Dragging equipment detectors

5.3.3 ONTRACK Rail Operating Code Section 6, Clause 19.0 stated in part:

> **DRAGGING EQUIPMENT (On Wagons)**
>
> Immediate action is required if dragging gear or bond chains are suspected as the cause of any trackside problems or loss of points detection. At selected sites, Dragging Equipment Detectors are provided. These send an automated message to Train Control and at some locations all radio users in the immediate vicinity of the detector when activated. These sites are listed in Working Timetable Section G1.

When a Dragging Equipment alarm is activated or dragging equipment is suspected:

- The train must be stopped immediately.
- The train consist must be held outside the station in advance until it is checked (to protect points).

5.3.4 Between Taumarunui and Owhango there were 8 DED units, of which 2 were located at 377.97 km and 374.47 km, between Kakahi and Owhango. The DED units were similar to that in Figure 3. When a DED activated, a flashing light appeared on the train controller's VDU. However, the alert indicated the track section concerned but was not capable of identifying whether either or both of the DED units between Kakahi and Owhango had activated.

Figure 3
Combined heat/dragging equipment detection unit

5.4 Traction control

5.4.1 An extract from the traction control room data log was provided for analysis.

5.4.2 The data log confirmed that:

- at 0409:52, Mananui circuit breaker 13 tripped
- at 0409:58, Mananui circuit breaker 13 tripped again
- at 0410:00, Mananui circuit breaker 13 re-closed and locked out automatically
- at 0422:45, train controller activated the emergency catenary cut-off
- at 0422:53, emergency catenary cut-off reset automatically
- at 0431:01,traction control operator isolated and tagged the Owhango to Mananui section.

5.4.3 The after-hours duty traction controller had arrived at the control room within 16 minutes of the initial trip and set tags to prevent the inadvertent livening of the Owhano-Mananui section.

5.5 Locomotive event recorder

5.5.1 Data from the locomotive event recorder was not available for analysis. Toll Rail advised the download had been completed but the data had been misplaced.

5.6 Wagon ZH1812

5.6.1 Wagon ZH1812 contained mixed freight. The wagon had a tare weight of 20 t and was designed to carry a maximum load of 36.8 t, giving a maximum gross weight of 56.8 t. The actual gross weight of the wagon had not been measured by weighbridge. However, a gross weight of 39 t was declared on the consignment documentation.

5.6.2 The inspection and maintenance records for wagon ZH 1812 showed that the most recent C-check was carried out on 2 March 2004, and the 3 most recent B-checks were carried out on 8, 15 and 29 October 2004. The work undertaken during these checks included:

Date	Check	Work carried out
2 March 2004	C	Replaced 8 brake blocks Repaired doors
8 October 2004	B	Replaced 4 brake blocks Repaired doors
15 October 2004	B	Replaced 2 brake blocks
22 October 2004		Repaired doors
29 October 2004	B	Replaced 4 brake blocks

The maintenance orders made no reference to work being carried out on axle bearings.

5.7 Examination of derailed wagon ZH1812

5.7.1 At some point, the left-hand RBU on the leading axle of the trailing bogie seized on the journal to a point where it twisted or screwed and separated from the axle (see Figure 4). The RBU was not recovered after failure, despite an extensive search of the rail corridor from Kakahi to the DED site near 378 km.

Figure 4
Recovered wheelset with failed journal

5.7.2 As the train continued, the leading end of the bogie side frame dropped and bounced, causing minor damage to the railhead and the tops of some sleepers (see Figure 5). At the same time, the left-hand wheel was in a raised attitude off the rail and lodged under the wagon floor. The left-hand wheel eventually penetrated the steel wagon deck.

Figure 5
Bogie side frame of the derailed bogie

5.7.3 Toll Rail advised that the failed bearing met the requirement of AAR for a C class package bearing but there was no record of the name of supplier of the bearing or the date it was fitted. Similarly, they had no records of the service history of the failed bearing. Previous overhaul identification was marked on the RBU, but because it had not been recovered the tracking maintenance history could not be traced. However, Toll Rail estimated the derailed wheel set to be half-worn so it was likely to have been in service for about 350,000 km.

5.8 Defects detected on trains

5.8.1 Toll Rail's Rule 6, Special Precautions for Safe Operations stated in part:

(a) Staff Must Watch for Defects on Trains
If in a position to do so, staff must watch for defects on trains. Advise the Locomotive Engineer of what you observe.

Defects can include:

- Overheated axle boxes (hot boxes)
- Sticking brakes
- Sliding/skidding wheels
- Wheels not properly positioned on the rails (derailed)
- Dragging equipment (brake rodding, bond chains etc)
- Insecure loads
- Signs of smoke or fire
- Headlight or end of train signal improperly or not displayed
- Damaged pantograph
- Any other dangerous condition

If *a* defect is observed:

- Advise Train Control immediately
- Advise the train crew immediately
- Stop the train
- Investigate and rectify the defect.

5.8.2 Neither of the locomotive engineers on Trains 210 and 202 radioed the locomotive engineer on Train 237 to advise of any defect on Train 237 when the trains crossed at Kakahi.

5.9 Personnel

Locomotive engineer

5.9.1 The Te Rapa-based locomotive engineer held current certification for the work being undertaken. He had worked for Toll Rail and its predecessors for 28 years and had held Grade 1 locomotive engineer certification for 16 years.

5.9.2 The locomotive engineer was unaware that anything was amiss with his train until he was instructed by the train controller to stop and check his train following the DED activation. When he received the call, his train was climbing the Kakahi Bank and travelling at about 55 to 60 km/h. The train was stopped when wagon ZH1812 was about 2 wagons length from Bridge 191.

5.9.3 He felt a slight jolt just before the train stopped, as if the train had parted. A later inspection of the train confirmed that there was a gap of about 500 mm between derailed wagon ZH1812 and the trailing wagon DD88, which remained on the track.

5.9.4 When the locomotive engineer was near Bridge 191 on his way to first inspect the wagon damage, he heard a snapping sound. He said he realised that the sound was the overhead contact wire falling across the burning wagon, so he scrambled up the bank away from the overhead line.

5.9.5 The locomotive engineer said he met the fire chief on the roadside to advise him of the product mix being conveyed in the burning wagon and to confirm that there were no known hazardous products on the train. The fire crew were instructed to delay fighting the fire until confirmation had been received from traction field staff that the overhead power had been isolated.

Train controller

5.9.6 The train controller held current certification for the tasks he was carrying out. At the time of the incident he was authorising train movements between Marton and Hamilton on the NIMT, and between Waitakare and Otiria on the North Auckland Line.

5.9.7 The train controller saw the DED alert flashing on his VDU. Immediately, he radioed the locomotive engineer on Train 237 and waited what he thought was a minute or so before the locomotive engineer responded. Once the train controller acknowledged the DED alert, the light reverted to steady instead of flashing.

5.9.8 At about 0422, the train controller activated the Taumarunui overhead power emergency cut-off switch after being told by the locomotive engineer that the Owhango volunteer fire crew had arrived on site.

6 Analysis

6.1 Because both the journal end and the failed RBU were not recovered, it was not possible to determine the cause of the bearing failure. The bearing components probably rolled down the steep embankment and away from the track towards the Whakapapa River somewhere between Kakahi and where scrape marks on the railhead were first observed

6.2 The wagon had been inspected to code requirements, the last B-check being 7 days before the derailment. Such inspections would not necessarily detect the defects that lead to failure.

6.3 The absence of records showing when the RBU was fitted or whether it was new or reconditioned, added to the difficulty in determining a probable cause for the failure. A safety recommendation to address this issue has been made to the Chief Executive of Toll NZ Consolidated Limited.

6.4 Toll Rail's code required staff to report all potential defects observed on a train promptly to the train crew or to Train Control. Train 210 was already berthed on the loop and stationary at Kakahi when Train 237 berthed on the mainline and came to a stop. The RBU that failed on wagon ZH1812 was on the loop side when Train 237 berthed but the locomotive engineer of Train 210 had not seen anything unusual as Train 237 approached and rolled by. Whether the locomotive engineer of Train 210 had missed any obvious sign at that time, or the damage had yet to reach the catastrophic stage, could not be determined. However, it was unlikely that the condition of the RBU would have deteriorated to total failure in less than 3 km without showing some indication of degradation at Kakahi.

6.5 Train 237 had remained stationary on the mainline for nearly 20 minutes before opposing Train 202 crossed at Kakahi. During this time any indication of overheating, such as a glowing axle journal, would have faded with cooling and that, together with Train 200 passing through at up to 50 km/h, would have meant that the locomotive engineer would not have seen any evidence of potential defects.

6.6 After Train 202 had cleared Kakahi, Train 237 departed. Although the RBU would have cooled during the 21 minutes the train was stationary at Kakahi, it would have heated up rapidly once the train started to move. As a result the RBU failed and the axle journal was screwed from the axle within 3 km of Kakahi, suggesting that it had probably collapsed or was in a near collapsed state when Train 237 arrived at Kakahi.

6.7 The impending RBU failure made the derailment inevitable. The condition of the RBU had progressively deteriorated to a point where friction-induced heat caused the portion of the axle between the RBU and the wheel to become plastic, where upon the axle separated or "screwed off" as the axle turned. Once the axle failed, the vertically unrestrained wheel would have lifted, until it rubbed on the underside of the steel wagon deck.

6.8 The train controller acknowledged the alert from the DED and radioed the locomotive engineer of Train 237. The train had probably travelled another 2 km by the time the locomotive engineer responded to the train controller and stopped the train. During that time the unrestrained vertical movement of the turning wheel would have penetrated the wagon deck, rubbed against a pallet and provided an ignition source for the fire. When the locomotive engineer looked back to check his train the wagon was already ablaze. His decision to continue for about another 400 m before stopping the train near Bridge 191 improved the access for the fire service.

6.9 The speed of Train 237 at the time of the derailment was unknown because the data from the locomotive event recorder was not available for analysis. However, as the train had been waiting on the main line at Kakahi for some time and, when it departed, almost immediately started to climb the Kakahi Bank it was unlikely that the train was exceeding the authorised maximum line speed.

6.10 After the train stopped, the intensity of the fire was such that the overhead contact wire melted and fell across several wagons. When the contact wire failed, it tripped out Mananui 13 sub-feeder. The traction control computer recognised the trip out, then automatically closed again 5 seconds later. Why a further 12 minutes elapsed before the train controller operated the catenary emergency shutoff could not be determined.

6.11 The locomotive engineer acted appropriately by ensuring fire service personnel did not start to fight the fire until earth straps had been erected and confirmation received that the electrified area had been secured. As a consequence, there was no risk to them from the overhead power supply.

7 Findings

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

7.1 The cause of the RBU failure could not be determined.

7.2 Scheduled inspections and workshop maintenance were carried out on wagon ZH1812 in accordance with Mechanical Code M2000.

7.3 The condition of the bogie and wheelsets was considered unlikely to have contributed to the RBU failure.

7.4 No records were available to confirm the manufacturer and age of the RBU or its service life.

7.5 The pre-departure inspection and en-route brake test at Te Rapa was carried out appropriately. Although the failed RBU developed its fault over a period of time, no signs of imminent failure were apparent to those undertaking the inspections.

7.6 The track geometry did not contribute to the derailment.

7.7 The train controller responded appropriately to the DED alert by contacting the locomotive engineer and instructing him to stop and inspect his train.

Occurrence 05-106

8 Factual Information

8.1 Narrative

8.1.1 On Friday 4 February 2005, Train 221 was an express freight service travelling from Auckland to Wellington. Departing Paekakariki, the train consisted of 2 DBR locomotives and a DX locomotive in multiple hauling 36 wagons, with a gross weight of 1601 t and an overall length of 653 m. The train was crewed by a locomotive engineer.

8.1.2 At about 1630, the locomotive engineer slowed his train and was berthing on Wellington freight arrival road when he received a radio transmission from a shunter instructing him to stop his train because wagons at the rear of the train had derailed. The locomotive engineer looked back along his train and saw a cloud of dust.

8.1.3 The train stopped inside the limits of Wellington Freight Yard. The last 3 wagons on the train had derailed but there was evidence that the trailing bogie of the fourth wagon from the rear of the train had run derailed and then rerailed itself, possibly at a turnout. Wagon UKR137, the third last wagon had a screwed axle journal on the A2 wheel position, the right-hand side of the trailing wheelset on the leading bogie (see Figure 6). The derailed wagons were conveying refrigerated containers.

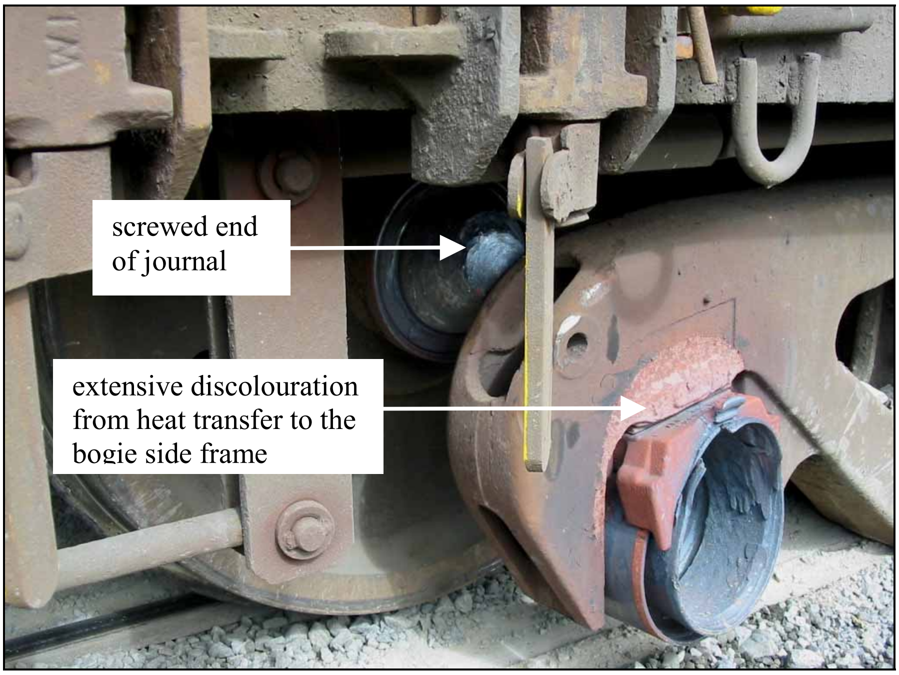


Figure 6
Screwed axle journal at A2 wheel position on wagon UKR137

8.2 Site information

Derailment

8.2.1 The exact location where A2 wheel on UKR137 started to climb the right rail, the point of derailment (POD) could not be determined. However, the drop-off point for B2 wheel, the opposite wheel on the same axle, was established as 2.534 km on the Down main of the NIMT at Kaiwharawhara Station (see Figure 7).

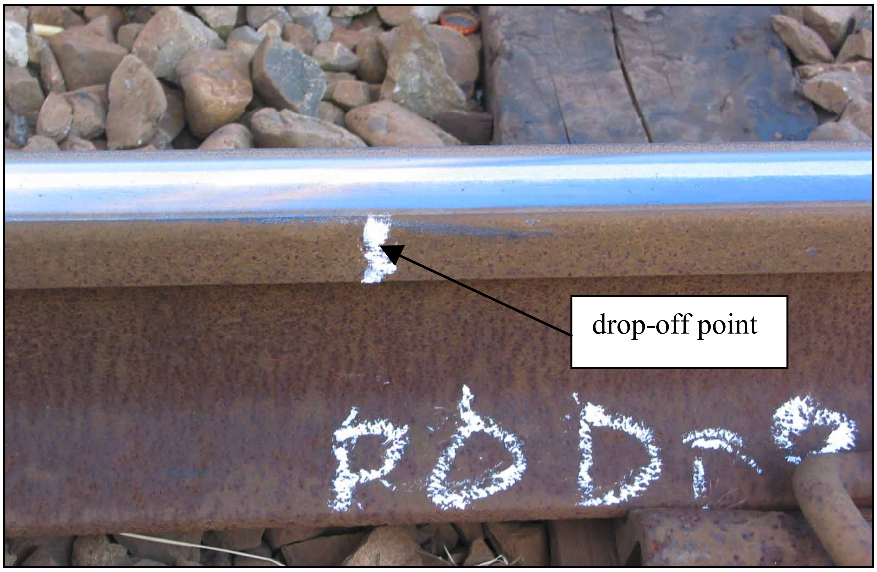


Figure 7
Drop-off point

8.2.2 Bearing fragments from UKR137 were found at the south portal of Tunnel 1 at about 3.95 km. The bearing outer seal was on the safety wire mesh net on Bridge 3, about 30 m from the tunnel portal and the screwed off end of the journal, complete with the bearing cap, was found under the bridge.

8.2.3 When the train stopped in the freight yard the following was noted:

- marks on the wheel tread indicated that the trailing bogie of the fourth wagon from the rear UKR152 had been dragged off track and rerailed itself
- both bogies of the third wagon from the rear,UKR137, were derailed to the right
- the trailing bogie of the second to last wagon from the rear, UKR124, was derailed to the left
- both bogies of the rear wagon, UKR111, were derailed to the left.

Track information

8.2.4 The straight track at the drop-off point consisted of 50 kg/m continuous welded rail secured to treated pinus radiata sleepers with Pandrol fastenings. The track materials were in sound condition and no track geometry issues were present that could have contributed to the derailment.

8.3 Operating information

8.3.1 The section of track where the bearing failure occurred was double line, with both Up and Down main lines. Express freight trains were restricted to a maximum authorised speed of 80 km/h.

8.4 Locomotive event recorder

8.4.1 Data from the event recorder on DBR1200 was downloaded and provided for analysis.

8.5 Wagon UKR137

8.5.1 Wagon UKR137 was conveying a refrigerated container. The wagon had a tare weight of 14.3 t and was designed to carry a maximum load of 43 t, giving a maximum gross weight of 57.3 t. The actual gross weight of wagon UKR137 had not been measured by weighbridge. However, an estimated gross weight of 33.5 t was declared on the consignment advice documentation.

8.5.2 The inspection records indicated the last C-check before the bearing failure was carried out by Alstom staff, at Westfield Depot, on 13 October 2003. Work included repairs to brakes, drawgear, twistlocks and crack repairs to the wagon underframe.

8.5.3 A wheelset change occurred on 13 March 2003. Wheel profile readings indicated that it was likely that it was the replacement wheelset that had derailed.

8.5.4 The 3 most recent B-checks before 4 February 2005 were:

Date	Work carried out
21 – 26 January 2005	Repair air brake equipment Replace VTA valve Repair brake rigging Replace brake blocks
23 September 2004	8 slipper blocks replaced
28 May 2004	Replace brake blocks

8.5.5 In addition to the B-checks, maintenance records confirmed fused or missing brake blocks were replaced on wagon UKR137 during 2004 on 14 and 3 December, 25 and 19 November, 29,14 and 12 October, 26 August, 30 and 21 June, 10 May, 3 April and 16 February.

8.6 Examination of derailed wagon UKR137

8.6.1 Clean bolts in the brake rigging were consistent with repairs having been completed a few days earlier. The end cap bolts were present on the failed wheelset. However, extensive heat damage had promulgated from the screwed-off axle journal into the bearing adapter and the bogie sideframe. The bearing end caps on the failed axle were not date-stamped as required by code.

8.6.2 No records were available to confirm the supplier of the failed bearing or the date that it was fitted.

8.6.3 The tread on the failed wheelset had multiple areas of shelling (see Figure 8).

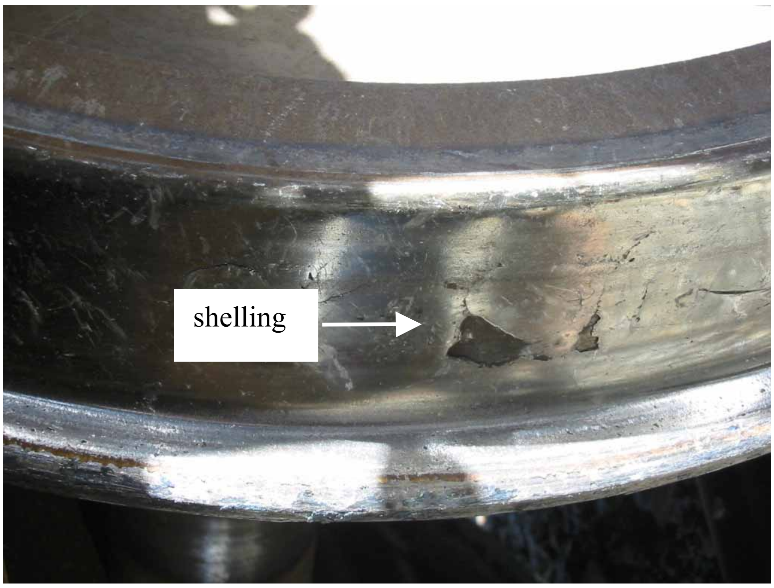


Figure 8
Shelling on the wheel tread

9 Analysis

9.1 The wagon had been inspected to code requirements with the last B-check completed 9 days before the RBU overheated and failed. However, such inspections would not necessarily detect a defect that led to the RBU failure.

9.2 Wagon UKR137 had a history of fused[7] brake blocks before the RBU failure and derailment. However, the cause of the fused brake blocks was not addressed. The fused brake blocks were replaced and the wagon was returned to service but continued to have an abnormally high number of replacements of fused brake blocks. A recommendation to address this issue has been made to the Chief Executive of Toll NZ Consolidated Limited.

9.3 The failed wheelset showed multiple areas of shelling on the wheel treads, probably the result of skids that could be attributed to issues with the braking system. The hammering action caused by flat spots on the wheel tread, such as a skid or shelling, would have generated extreme shock loads into the bearing that eventually resulted in the catastrophic failure of the RBU and the subsequent derailment.

9.4 Extensive heat damage had been transferred to the RBU, the wear adapter and the bogie side frame. The condition of the RBU had deteriorated to a point where friction induced heat reached such a level that the bearing seized and the axle journal screwed off as the axle rotated. Once the axle failed the wheel was unrestrained and lifted. UKR137 was the first wagon to derail and the trailing 2 wagons were pulled off when they were passing over turnouts entering Wellington Yard.

9.5 The event recorder data indicated that the train was reducing speed before entering Wellington Yard and was travelling well within the authorised line speed.

9.6 The track geometry near the drop-off point was within acceptable maintenance tolerances and therefore did not contribute to the derailment.

10 Findings

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

10.1 Scheduled inspections and workshop maintenance were carried out on wagon UKR137.

10.2 The abnormally high number of replacement of fused brakeblocks on wagon UKR137 in the period leading up to the derailment indicated a faulty braking system that had not been previously resolved satisfactorily.

10.3 The flat spots and shelling on the failed wheelset were probably caused by the performance of the wagon braking system.

10.4 There were no records available to confirm when the failed RBU was fitted to the wheelset and the wheelset service life.

10.5 Train 221 was being driven correctly and the actions of the locomotive engineer did not contribute to the derailment.

10.6 The track geometry did not contribute to the derailment.

[7] A fused brake block is one that has either worn away the friction material, dropped out or fractured, and the shoe or backing plate has over-heated and become semi-welded to the wheel tread.

Occurrence 05-110

11 Factual Information

11.1 Narrative

11.1.1 On Monday 21 February 2005, Train 247 was an express freight service travelling from Auckland to Wellington. It consisted of locomotives DFT7173 and DXR8007, in multiple, hauling 14 wagons with a gross weight of 456 t and an overall length of 270 m. The train was crewed by a locomotive engineer.

11.1.2 At about 0220, when the train was entering station limits at Te Kauwhata, the locomotive engineer felt the train surge just as the train lost all its air from the air brake system. The emergency brakes applied automatically. The locomotive engineer said he was travelling through a 40 km/h temporary speed restriction at the time, and estimated his speed to be around that mark. He radioed train control before walking back along the train to see what had happened.

11.1.3 Wagon UK18837, the eleventh wagon on the train was on its side, foul of the Up Main line (see Figure 9) and the trailing wagon, UK7349 was derailed, although upright. The locomotive engineer put out a small scrub fire near the derailed wagons.

11.1.4 The journal on the leading axle of the trailing bogie (A3) on wagon UK18837 had "screwed" off the axle (see Figure 10).

Figure 9
Derailed wagon UK18837

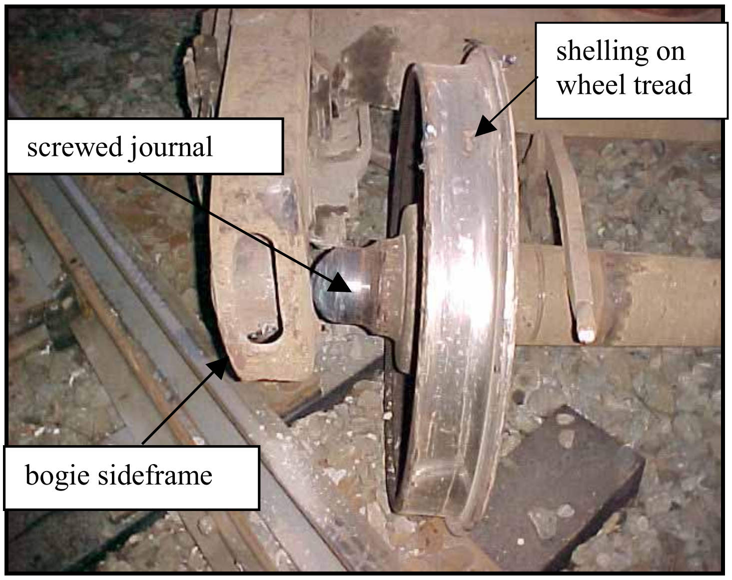


Figure 10
Screwed journal on wagon UK18837

11.2 Site information

Derailment

11.2.1 The POD was determined as 592.420 km NIMT on the single line. The drop-off point was 4 m past the POD. The derailed wagon tipped to the right-hand side after being dragged through the north-end mainline turnout.

11.2.2 The bearing adapter and some failed bearing components from UK18837 were found trackside a few metres before the POD. The "screwed" off journal end with the locking plate was not located.

Track information

11.2.3 The straight track at the POD consisted of 50 kg/m rail secured to concrete sleepers with Pandrol fastenings. The track materials were in sound condition and there were no track geometry issues present that could have caused the derailment.

11.3 Operating information

11.3.1 Trains operating on the 13 km single line track section between Amokura and Te Kauwhata on the NIMT were controlled from the Centralised Traffic Control (CTC) centre in accordance with the CTC regulations. The maximum speed for freight trains in the section was 80 km/h.

11.4 Locomotive event recorder

11.4.1 Data from the locomotive event recorder was not available for analysis. Toll Rail advised the download had been completed but the data had been misplaced.

11.5 Wagon UK18837

11.5.1 UK class wagons have a tare weight of 14.3 t and are designed to carry a 43 t load giving a maximum gross weight of 57.3 t. At the time of the derailment, wagon UK18837 was conveying 2 XBC containers, loaded with grain, from Auckland to Hamilton. A gross weight of 55 t was declared on the consignment documentation.

11.5.2 The inspection and maintenance records indicated that the most recent C-check on wagon UK18837 was completed on 27 January 2004 at Westfield. Work included a brake test, repairs to twistlocks, underframe crack and adjustments to the handbrake, drawgear height and wagon float. A wheelset and 4 bearing adapters were also replaced. Toll Rail could not confirm which wheelset was replaced.

11.5.3 The 4 most recent B-checks were carried out on 7 February 2005, 14 and 7 December and 26 November 2004. During these checks respectively 8, 4, 2 and 4 fused brake blocks were replaced. In addition, maintenance records confirmed that the wagon received attention for fused brake blocks on 4 other occasions between 1 December 2004 and 21 February 2005.

11.6 Examination of derailed wagon UK18837

11.6.1 The tag on the B3 bearing cap was stamped 6.99, indicating that the B3 bearing was overhauled in June 1999.

11.6.2 The A3 wheel tread had multiple areas of shelling.

12 Analysis

12.1 Wagon UK18837 had been inspected to code requirements, with the last B-check being 14 days before the RBU failure. However, such inspections would not necessarily identify a problem with an RBU, resulting in the withdrawal of the wagon from service as a precautionary measure.

12.2 The name of the RBU manufacturer, when it was fitted, or whether a new or reconditioned RBU was fitted to the failed wheelset could not be deterrmined. However, because the bearing cap at the opposite end to the failed RBU was fitted in June 1999, it was likely that the failed bearing was fitted at the same time and had therefore been in service for about 6 years.

12.3 Wagon UK18837 had 3 B-checks in the 10 weeks before the derailment as well as on 4 other occasions programmed through the maintenance depot for replacement of fused brakeblocks. However, without recognising a braking performance issue, the wagon was returned to service after carrying out short-term maintenance such as brakeblock replacement. This is similar to the circumstances of occurrence 05-106, discussed earlier in the report.

12.4 Wagon UK18837 had multiple areas of shelling and flat spots on the wheel treads probably as a result of deficiencies in the braking system. The extreme shock loads impacting on the bearing by a wheel with multiple areas of shelling probably led to the eventual failure of the RBU and subsequent derailment.

12.5 The track geometry near the POD was within acceptable maintenance tolerances and therefore did not contribute to the derailment.

13 Findings

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

13.1 Scheduled inspections and workshop maintenance were carried out on wagon UK18837 in accordance with Mechanical Code M2000.

13.2 The abnormally high number of replacements of fused brakeblocks on wagon UK18837 in the period leading up to the derailment indicated a faulty braking system that had not been previously resolved satisfactorily.

13.3 The flats and multiple areas of shelling on the failed wheelset probably resulted from the condition of the wagon braking system.

13.4 The service life of the wheelsets on wagon UK18837 including when the failed RBU was fitted to the wheelset, could not be determined.

13.5 The track geometry did not contribute to the derailment.

Occurrence 05-114

14 Factual Information

14.1 Narrative

14.1.1 On Monday 21 March 2005, Train 842 was a unit freight service travelling from Ngakawau to Lyttelton. The train consisted of locomotives DXC 5293 leading and DXH 5425 in trail hauling 21 loaded coal wagons with a gross weight of 1470 t and an overall length of 346 m. The train was crewed by a locomotive engineer.

14.1.2 After a crew change at Red Jacks, on the Stillwater-Westport Line, the incoming locomotive engineer travelled to Stillwater, where he received his operating instructions from train control to run Train 842 to Otira, crossing Train 833 at Moana, 174 km Midland Line (ML).

14.1.3 At about 1038, as the train approached Jackson, 147.68 km ML, the locomotive engineer felt the locomotive surge and lose the air from the air brake system. The emergency brakes applied automatically.

14.1.4 After the train stopped, the locomotive engineer called the train controller, who told him that a hot axle stub that may have come from his train had started a small trackside scrub fire near Moana, the last station that the train had passed through.

14.1.5 The locomotive engineer left the locomotive cab to inspect his train. He found only 4 wagons remained coupled to the locomotives. When he reached the parted section of his train he saw that the next 7 wagons had derailed (see Figure 11) while the remaining 10 wagons at the rear remained upright and on the track.

Figure 11
Some of the derailed wagons

14.2 Site information

Derailment

14.2.1 The point of derailment was identified at 147.808 km ML, on a sleepered crossing for rail service vehicles (see Figure 12). The axle journal on the left-hand side of the trailing axle on leading bogie of CB10558, the fifth wagon on the train, had "screwed" off and the axle stub had burnt through the side frame. Strike marks indicated that when the bogie side frame impacted with the sleepered crossing it would have lifted the wheel clear of the rail. The wagon continued a further 400 m until the derailed wheel struck the frog in the south-end main line points at Jackson, forcing the wheel and bogie clear of the track. The following 6 wagons derailed as a result of damage to the turnout.

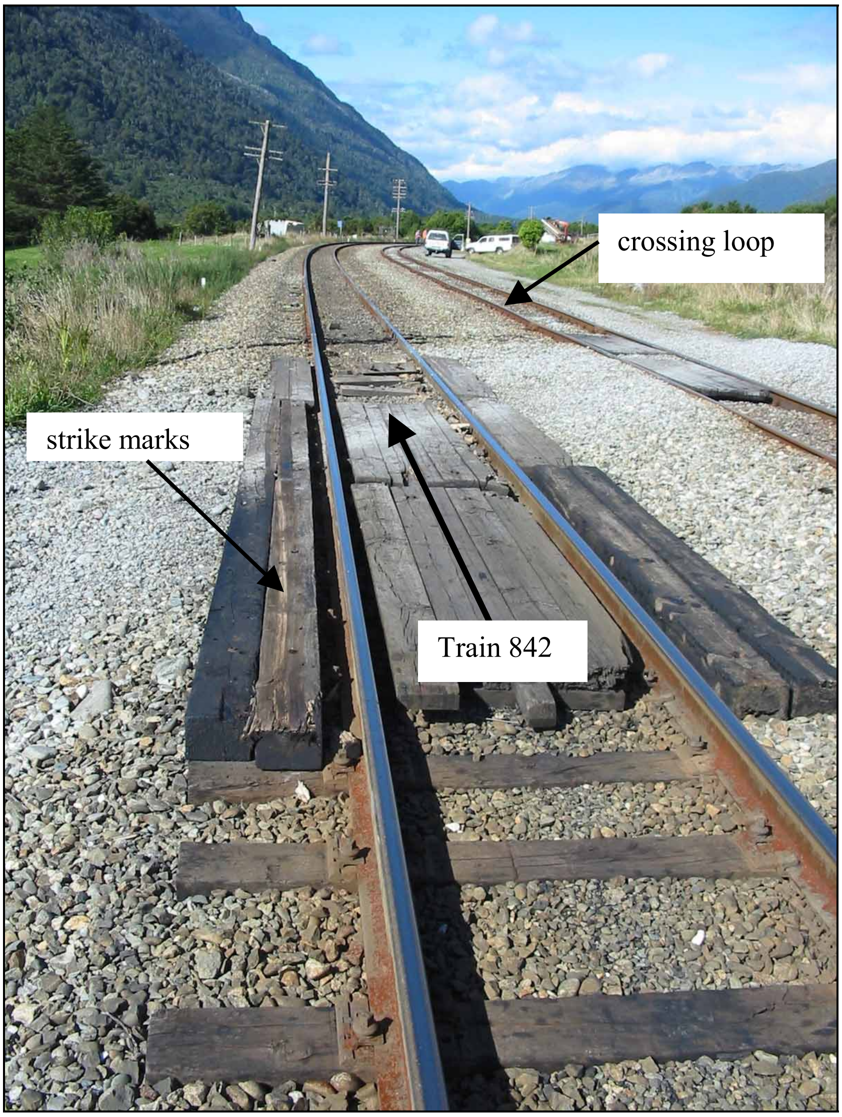


Figure 12
Point of derailment

Track information

14.2.2 The straight track at the POD consisted of 50 kg/m continuous welded rail fastened to treated pinus radiata sleepers RR Type fastenings. The track had been destressed during March 2004. The EM80, track evaluation car, had measured and recorded the track geometry the week before the derailment. There were no track geometry issues identified near the POD.

Operating information

14.2.3 The maximum authorised speed for unit freight trains operating between Otira and Rotamanu, including Jackson, was 80 km/h. However, because Jackson was on a 400 m radius curve the maximum curve speed was restricted to 70 km/h.

14.3 Locomotive event recorder

14.3.1 Data from the event recorder on DX5293 was downloaded for analysis.

14.4 Wagon CB10558

14.4.1 Wagon CB10558 was loaded with coal. The wagon had a tare weight of 16.8 t and was designed to carry 55.2 t of coal, giving a maximum authorised gross weight of 72 t. Although wagon CB10558 had not passed over a weighbridge, the train documentation had a declared weight of 70 t for it, and the other 20 wagons on the train.

14.4.2 The inspection and maintenance records indicated the last C-check was completed on 9 December 2004. Work included replacement of 8 brake blocks, repair to the brake pull rod, adjustments to drawgear height and turning No. 4 wheelset on the lathe to remove skids.

14.4.3 Maintenance records reported that all 8 brake blocks on the wagon were replaced on 3 December 2004, 18 March 2004, 18 October 2003, 2 July 2003 and 12 May 2003. Repairs to the brake beam were also carried out when the brake blocks were replaced in March 2004.

14.4.4 Wagon CB10558 had not had a bogie or wheelset change, and no work on the bearings had been carried out for 2 years before the derailment.

14.5 Examination of derailed wagon CB10558

14.5.1 The roller bearing unit from A2 wheel had failed at least 25 km before the POD. The "screwed" off axle stub was found trackside at 174.55 km, near Moana (see Figure 13). The bearing cap locking tab was stamped "94", indicating that RBU was last overhauled in 1994. There were several other small trackside scrub fires between Moana and Jackson caused by hot debris from the failed RBU.

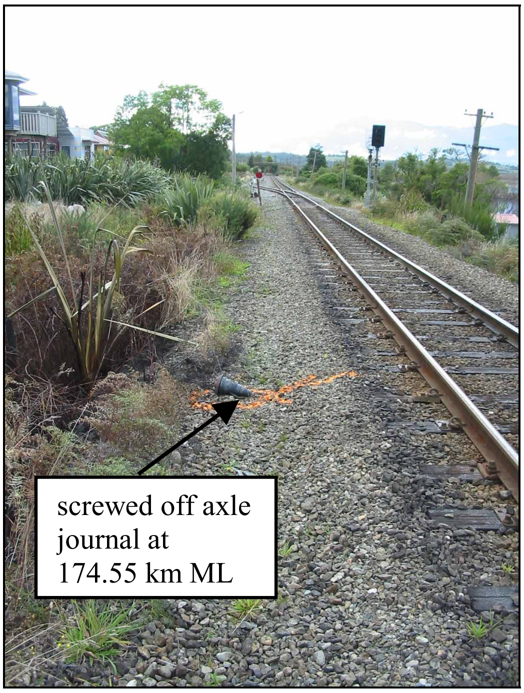


Figure 13
Burnt off axle stub from wagon CB10558

14.5.2 After the derailment, the wagon came to rest about 40 m away from the POD, straddling a creek (see Figure 14).

Figure 14
Derailed wagon CB10558

15 Analysis

15.1 The cause of the RBU failure could not be determined.

15.2 Wagon CB10558 had been inspected to code requirements with the last C-check undertaken about 3 months before the derailment occurred. The last B-check was undertaken before the C-check. A pre-departure check was also carried out in accordance with code requirements.

15.3 The locomotive engineer was about 2 hours into his shift when he took over the driving duties on Train 842. Analysis of the event recorder data indicated that the train was travelling at about 60 km/h when the derailment occurred. The locomotive engineer was alert throughout the journey and had regularly cancelled the vigilance light within 2 to 3 seconds.

15.4 It was unlikely that track condition contributed to the derailment for 2 reasons. Firstly, the RBU on wagon CB10558 failed near Moana some 27 km before Jackson and secondly, the track evaluation car did not identify any out of code track geometry a week before the derailment at the POD.

15.5 Once the RBU had seized, friction-generated heat probably caused the axle journal to become plastic and "screwed" off the axle. How wagon CB10558 managed to stay on track for so long when the first sign of debris from the failed RBU was recovered trackside at Moana, some 27 km earlier, could not be explained.

15.6 The wagon had no history of brake problems that could have contributed to the RBU failure. All brake blocks on the wagon were periodically replaced as a result of what was considered to be normal wear and tear.

16 Findings

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

16.1 The cause of the RBU failure on wagon CB10558 could not be determined.

16.2 Regular inspections were carried out on wagon CB10558.

16.3 Train 247 was being driven correctly and the actions of the locomotive engineer did not contribute to the derailment.

16.4 The track geometry did not contribute to the derailment.

17 Previous rail occurrence investigated by the Commission, involving a bearing failure that led to a derailment

17.1.1 Rail Occurrence Report 01-102 covered the derailment of a PK wagon conveying containers on Train 237 at Paerata as a result of a bearing failure. The locomotive engineer of Train 237 saw sparks coming from the middle of his train and suspected a possible dragging brake rod. He was unaware of the derailment and proceeded slowly from Paerata towards Pukekohe, where he intended to stop and inspect his train. A collision occurred at Pukekohe between Train 144 travelling on the Up Main line and the derailed PK wagon on Train 237 travelling on the adjacent Down Main line.

17.1.2 Following the derailment, Tranz Rail commissioned SKF New Zealand Limited to carry out a specific audit of bearing overhaul practices at Hutt Workshops. The audit objectives were:

- to determine if the practices and procedures currently used by Tranz Rail when refurbishing axle boxes and package bearings result in a reliable product being returned to service
- to recommend any changes to procedures which may improve reliability of products being returned to service.

17.1.3 The audit was carried out on 24 April 2001. The audit found all key processes were carried out competently and stated in part:

> The fitters involved with bearing refurbishment showed a high level of motivation and desire to achieve excellent results. They were familiar with the dimensional requirements of each assembly and showed the necessary skills to be able to accept or reject components based on the references provided.

18 Safety Actions

18.1.1 On 12 September 2005, Toll Rail advised the following safety initiatives had been taken to reduce the number of derailments attributed to bearing failures and stated in part:

> It should be noted that bearing failures are an issue that railways all around the world are facing. Because of the time it will take to cover the entire wagon fleet, any initiatives that we have or will put in place may take years to show any benefit.

> In August 2002, an Australian-based consultant was contracted to complete an external review of bearing failure issues. This review identified a range of corrective actions in relation to:

Bearing Overhaul

- Facility improvement
- Tools and equipment
- Backing rings
- Seals and Seal Rings
- Lubricant

Bearing Mounting

- Facility Improvement
- Tools and Equipment
- Components

Bogie Overhaul

- Bogie and Side Frames
- Adapters

Field Maintenance

- Inventory
- Component Replacement
- Code Checks

Maintenance Manuals

Maintenance Records

Training

Alstom and Toll Rail Engineering have closed out most of the corrective actions. Those remaining are nearing completion.

A subsequent internal review prepared by Alstom for Toll Rail Engineering was completed in June 2004. This review looked at derailment risk reduction options for wheelset bearings. It concluded that loose bearing components were likely a dominant cause of bearing failures. A number of options were identified:

- Retaining the existing maintenance regime for checking quality of clamp forces
- Introduce an "end cap bolt re-torque" procedure
- Accelerate bearing overhaul rates
- Wayside detection

RE-TORQUE

As a result of this review, the 66 OM class (bulk milk) and four UCG class (bulk LPG) wagon fleets are presently undergoing "end cap bolt re-torque" tests. The decision to reduce the derailment risk on these classes of wagons was primarily influenced by the potential environmental impacts should they be involved in a significant derailment.

The work is almost complete. It will include consequential axle replacements.

Toll Rail Engineering is reviewing remaining options. Their initial evaluation shows these options all involve cost increases that outweigh the present cost/risk of wheelset bearing related failures. However, our review will consider if there are lower cost intermediate steps that can be taken to progressively reduce the likelihood of these derailments and at the same time allow funding higher priority safety initiatives.

19 Safety Recommendations

Safety recommendations are listed in order of development, not in order of priority.

19.1 On 7 December 2005 the Commission recommended to the Chief Executive of Toll NZ Consolidated Limited that he:

> withdraw from service and investigate the braking systems of all wagons that exhibit an abnormally high incidence of brake block burn-out. (110/05)

19.2 On 21 November 2005 the Chief Executive of Toll NZ Consolidated Limited replied in part to the preliminary safety recommendation:

> This fits in with our overall strategy to reduce bearing related derailments.

19.3 On 19 December 2005 the Chief Executive of Toll NZ Consolidated Limited replied in part:

> It will take 6 months to develop the system, as described.

19.4 On 7 December 2005 the Commission recommended to the Chief Executive of Toll NZ Consolidated Limited that he:

> develop a system for recording and tracking both new and reconditioned key components used on bogies. (111/05)

19.5 On 19 December 2005 the Chief Executive of Toll NZ Consolidated Limited replied in part:

> It will take 10 years for the implementation to be complete, as bogies can have up to 10 years life between overhauls.

Approved on 16 December 2005 for publication

Hon W P Jeffries
Chief Commissioner

Recent railway occurrence reports published by the Transport Accident Investigation Commission (most recent at top of list)

05-121	Express freight Train 354, near collision with school bus, Caverhill Road level crossing, Awakaponga, 2 Septmeber 2005
05-112	Hi-rail vehicle passenger express Train 200, track occupancy incident, near Taumarunui, 7 March 2005
05-111	Express freight Train 312, school bus struck by descending barrier arm, Norton Road level crossing, Hamilton, 16 February 2005
05-109	Passenger Train "Linx" and "Snake", derailments, Driving Creek Railway, Coromandel, 20 February 2005 - 3 March 2005
05-107	Diesel multiple unit passenger Train 3037, wrong routing, signal passed at danger and unauthorised wrong line travel, Westfield, 14 February 2005
05-105	Express freight Train 829, track occupation irregularity, Kokiri, 3 February 2005
05-102	Track warrant control irregularities, Woodville and Otane, 18 January 2005
04-130	Express freight Train 237, derailment, between Kakahi and Owhango, 5 November 2004
04-103	Shunting service Train P40, derailment, 43.55 km near Oringi, 16 February 2004
04-116	Passenger express Train 1605, fire in generator car, Carterton, 28 June 2004
04-127	Express freight Train 952 and stock truck and trailer, collision, Browns Road level crossing, Dunsandel, 19 October 2004
04-126	Express freight Train 244, derailment inside Tunnel 1, North Island Main Trunk, near Wellington, 11 October 2004
04-125	Collision between an over-dimensioned road load and rail over road bridge No.98 on Opaki-Kaiparoro Road, between Eketahuna and Mangamahoe, 2 October 2004.
04-123	Electric multiple unit traction motor fires, Wellington Suburban Network, 7 May 2004 – 30 September 2004
04-121	Locomotive DBR1199, derailment, Auckland, 24 August 2004

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