Report 99-120

express freight Train 474
and
express freight Train 227

collision

Te Rapa

24 August 1999

Abstract

At approximately 2215 hours on Tuesday 24 August 1999, northbound Train 474 struck a derailed wagon while passing southbound Train 227 between Te Rapa and Horotiu on the North Island Main Trunk line. The incident occurred when a UK wagon conveying a 40-foot container on Train 227 became derailed shortly after passing through Horotiu as a result of a tyre working loose on a wheel. The wagon continued in a derailed state, obstructing the parallel up main line as Train 474 approached. The derailed wagon and container struck the locomotive of Train 474 as it passed, damaging the front side of the locomotive and the cab side window. No injuries were sustained.

The safety issues identified were the susceptibility of tyred wheels to loosening due to excessive heat, and the potential consequences of derailed wagons on double line track.

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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

km	kilometre(s)
km/h	kilometres per hour
LE	locomotive engineer
m	metre(s)
mm	millimetre(s)
TCO	train control officer

Data Summary

Train type and number:	express freight Train 474 express freight Train 227
Date and time:	24 August 1999, approximately 2215 hours
Location:	548.02 km North Island Main Trunk between Te Rapa and Horotiu
Type of occurrence:	collision
Persons on board:	crew: Train 474 1 Train 227 1
Injuries:	nil
Damage:	superficial damage to locomotive of Train 474 and 2 UK wagons damaged.
Operator:	Tranz Rail Limited (Tranz Rail)
Investigator-in-Charge:	R E Howe

1. Factual Information

1.1 Narrative

1.1.1 At about 2215 hours on Tuesday 24 November 1999,Train 474, a Kinleith to Westfield freight service, departed Te Rapa enroute to Westfield after having stopped at Te Rapa for operational purposes. The train consist was DC4801 and 14 wagons, and it was crewed by a locomotive engineer (LE).

1.1.2 Once Train 474 was clear of the Te Rapa yard the LE began to increase train speed. As the train passed the Apple and Pear Board siding, the LE saw Train 227 approaching on the down main line ahead of him, and heard the LE of that train calling the operations controller in Te Rapa, advising of the approach of Train 227.

1.1.3 After looking back to make a normal check of his train the LE of Train 474 looked to the front and noticed in the locomotive headlight that a 40-foot container being conveyed on one of the wagons towards the rear of Train 227 was at an unusual angle. His initial thought was that it must have worked loose because of a faulty twist lock, but as his train got closer he realised that the angle of the container was greater than he had originally thought and that the wagon was derailed with the container obstructing the up main line.

1.1.4 Realising that a collision was inevitable the LE applied the train brake before turning his face away from the locomotive cab window. As the container passed it struck the side of the locomotive cab and window. The LE was still in his seat and was showered with glass, but uninjured. Figure 1 shows the site layout.

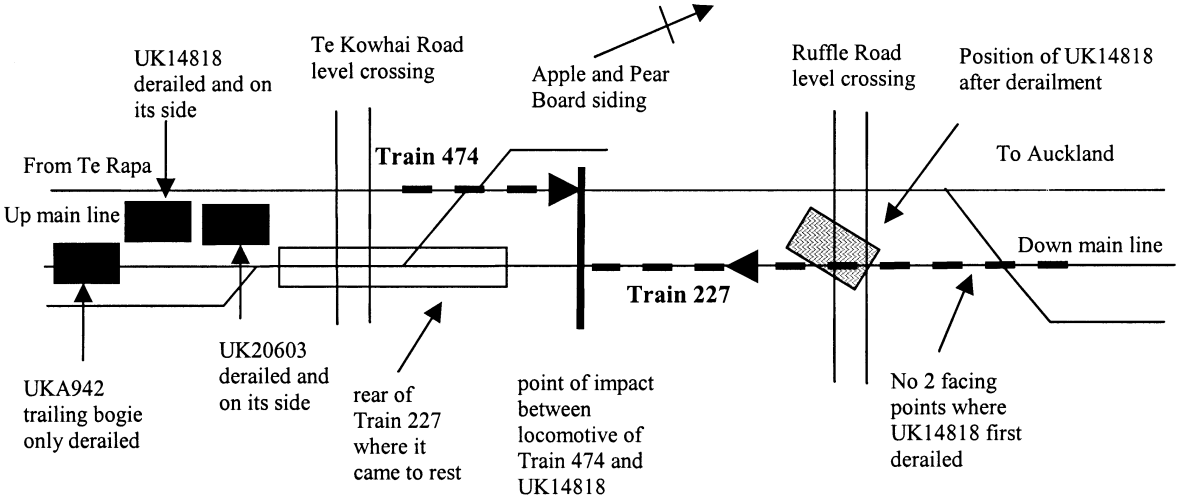

Figure 1
Site layout – not to scale

1.1.5 As soon as he could, the LE of Train 474 called the LE of Train 227 by radio, advising him that some of the wagons on Train 227 were derailed and that one of the derailed wagons had struck the side of his locomotive cab.

1.1.6 Once his train had come to a stop the LE of Train 474 contacted the Train Control Officer (TCO) by radio and advised him of what had happened, then left the cab to check the outside of the locomotive for any further damage.

1.1.7 Returning to the cab he again contacted the TCO and advised him that the locomotive had not sustained significant damage and was in good enough condition to continue. He also spoke to the Network Control Manager who offered to provide a relief for the remainder of the journey to Westfield, but the LE declined on the grounds that he was not injured and felt able to continue his shift.

1.1.8 Train 227, a Westfield to Wellington express freight service, had departed Westfield at the start of its journey.

1.1.9 Train 227 consisted of train locomotive DX5097, assisting locomotive DX5016 and 29 wagons, and was crewed by an LE.

1.1.10 The LE stated that he had an uneventful trip south. After passing through Horotiu, he heard the LE of Train 474 talking over the radio as he departed Te Rapa.

1.1.11 Between Ruffle Road level crossing and Te Kowhai Road level crossing he passed the head of Train 474 travelling in the opposite direction on the up main line. At almost the same time, he noticed a significant speed reduction on his locomotive speedometer and, sensing something may be wrong with his train, immediately made a service brake application.

1.1.12 Immediately after the LE of Train 227 had made the brake application the LE of Train 474 called him on the radio, telling him that some of Train 227 "was off the road" and that one of the derailed wagons and its container load had side swiped the locomotive cab of Train 474 as the trains passed.

1.1.13 The LE of Train 227 continued with the brake application, bringing his train to a stop at 548.02 km, approximately 100 m south of Te Kowhai Road level crossing.

1.1.14 On going back to check his train the LE found 3 wagons derailed in the vicinity of the Te Rapa public siding turnout. Two had tipped on their sides between the down and up main lines while the third had derailed trailing bogie only, and was still upright. The train had parted with the back portion of the train stopped across Te Kowhai Road level crossing.

1.2 Site details

1.2.1 The first sign of track damage prior to the derailment site was at the south end of Horotiu. Two parallel lines of indentations on the down main line concrete sleepers, one 190 mm to the right of the left-hand rail, and the other 300 mm to the right of the right-hand rail, were visible from immediately south of No 2 turnout. No 2 points were facing points that allowed the train 2 optional routes, depending on their setting.

1.2.2 Several parallel gouge marks were present in the road seal at Ruffle Road level crossing between the rails and to a distance of 660 mm beyond the inside edge of the right-hand rail in the direction of travel.

1.2.3 The leading wheel set of the trailing bogie UK14818 broke up following the derailment with components spread over 10 m between the turnout off the down main line to the Te Rapa Public Siding and Te Kowhai Road level crossing. UK14818 was the 20th wagon of the 29 wagons on Train 227 and conveyed a 40-foot container with a weight of 11.3 tonnes. The gross weight of the wagon was 26.3 tonnes.

1.2.4 The wheel and tyre from the leading right-hand wheel on the trailing bogie were found separated in this area, but there was no sign of the Gibson retaining ring (refer to 1.5). The wheel set components showed no evidence of discolouration due to overheating.

1.3 Operating details

1.3.1 The rail corridor between Horotiu and Te Rapa consisted of a down main line for trains running to Te Rapa and an up main line for trains running from Te Rapa. This was defined as double line running.

1.3.2 A rule of left-hand running applied, which meant that LEs, positioned as they were on the right-hand side of the locomotive, travelled next to the opposing line and passing trains.

1.3.3 All train movements were appropriate for the Double Line Automatic control system.

1.4 Wagon history

1.4.1 No defects had been detected on UK14818 by Tranz Rail's inspection procedures[1] prior to the departure of Train 227 from Westfield.

1.4.2 The last wagon inspection was a B check[2] in October 1998. The next C check[3] was due in April 2001. These inspections were to code requirement. No defects were reported on the last B inspection.

1.4.3 In May 1999, records indicated a missing brake block had been replaced, with the annotation "burn out".

1.5 Axle manufacture details

1.5.1 The failed axle was stamped as follows (with Tranz Rail's explanations):

End with tyre off	**72T**	Force (tons) to press wheel hub on axle
	DSB 8981	Original axle order number
	K M	Inspectors stamp
	14389	Numbering for Otahuhu workshops
Opposite end	**66T**	Force (tons) to press wheel hub on axle
	814	Unknown
	672	Unknown

1.5.2 Although Tranz Rail records did not show the exact date the axle was manufactured, Rolling Stock Division Railfreight Systems Code M12.1, Axles, clause 6.3, which was in effect at the time the wheel set was assembled, stated that:

> All new axles produced after 1/7/91 are to have a unique six digit serial number (from a group allocated by the Manager Rolling Stock) stamped on one end only. This will be the only stamping on the axle ends. The stamped

[1] Referred to as an A check
[2] An inspection required when a wagon requires 2 or more new brake blocks or is involved in an incident
[3] A full inspection required every 2 years

number is to be located midway between one roller bearing cap retaining bolthole and the bearing journal edge.

Axles produced after 1/7/91 are to have all the information as detailed in clause 6.2. recorded in book form by the officer in charge so the axle can have all its parameters readily accessible from its serial number. A complete and accurate record of this information is to be sent to the National manager Rolling Stock following each and every assembly of wheel sets.

Clause 6.2. required that:

All existing axles are to have the following particulars branded on the ends within the 63 mm diameter circle as shown on drawing 12050469 [refer Appendix 1]:

One end

a) Makers name or initials
b) Cast number
c) Letters WR or DSB or B followed by the number of the contract or purchase order
d) Grade of steel and heat treatment
e) Inspectors stamp
f) Pressure in tonnes (or tons)

Opposite end

a) Shop symbol
b) Year fitted
c) Serial number
d) Pressure in tonnes (or tons)
e) Size of journal in mm (or inches)

An accurate record of all of these particulars is to be kept by the officer in charge of this work. Details of all axle brandings must be forwarded to the National Manager Rolling Stock for inclusion in a master data file.

The amount of information stamped on the ends of the axle involved in this incident did not meet the requirements of clause 6.2.

1.5.3 There was no record of when the axle was fitted to UK14818.

1.5.4 Much of the information required in accordance with Rolling Stock Division Railfreight Systems Code M12.1, relating to this wheel set was unavailable due to the loss of records following the closing of the Otahuhu Workshops, where this wheel set was assembled. The facility was closed completely and the site decommissioned in 1993 with all equipment and records being disposed of at that time.

1.5.5 Tranz Rail's policy was to not hold wheel and tyre records for longer than 7 years; therefore, it was unlikely that the information would have been available, even if the Otahuhu Workshops had remained open. Tranz Rail stated that the reason they did not hold wheel and tyre records for longer than 7 years was, if an assembled tyre or wheel lasted this long in service there could be no doubt as to the integrity of its original assembly tolerances. Tranz Rail considered that a failure of a wheel or tyre fit after a prolonged period in service would more likely be due to environmental factors such as excessive wear or overheating, rather than the original fit.

1.5.6 Tranz Rail advised that there were no records detailing the wheel and flange thickness for UK14818 because under their new system that data was only recorded after turning on a wheel lathe or when a bogie was changed. This wagon had not had either done to it since the introduction of the new asset management computer system in October 1998. Historical data for wheel readings had not been transferred from the old system.

1.5.7 Following the derailment the tyre thickness of the loose tyre was measured and found to be 30 mm generally, with isolated readings down to 26 mm minimum. The condemning limit for Type 14 bogies as used on UK14818 was specified in Tranz Rail Mechanical Code M2000 dated 1 June 1999 as no less than 29 mm.

1.6 Personnel

1.6.1 The LE of Train 227 was certified for the duties he was undertaking.

1.6.2 The LE of Train 474 was certified for the duties he was undertaking.

1.7 Principle of tyred wheels

1.7.1 Tyred wheels have been traditionally used in New Zealand. They are currently being phased out in favour of solid, one-piece wheels, for economic reasons, and due to a known tendency for tyred wheels to come loose in service.

1.7.2 The method of fitting and retaining tyres involved shrink-fitting at a high temperature. As the temperature cooled a shrink-fit on the wheel resulted and the tyre lip was then rolled until the Gibson retaining ring was tightly gripped. Figure 2 shows the tyred wheel assembly.

1.7.3 Tyre loosening on the wheel centre was not unknown. The purpose of the Gibson retaining ring was to restrain any such loose tyres for a short period. If a tyre had become overheated, perhaps due to heavy brake action, and thus lost its shrink-fit on the wheel, the outer lip of the tyre and the Gibson retaining ring were intended to retain the tyre in place until it cooled and regained its shrink-fit.

1.7.4 If this overheating continued, for example through dragging brakes, the tyre could start to revolve and wear away the interface fit so that when the tyre cooled down it could still be loose on the wheel. This would accentuate the wear between the original interface fit surfaces and also gradually erode the Gibson retaining ring.

1.7.5 If the Gibson retaining ring failed, there would be nothing to stop the tyre from moving to the outside of the wheel.

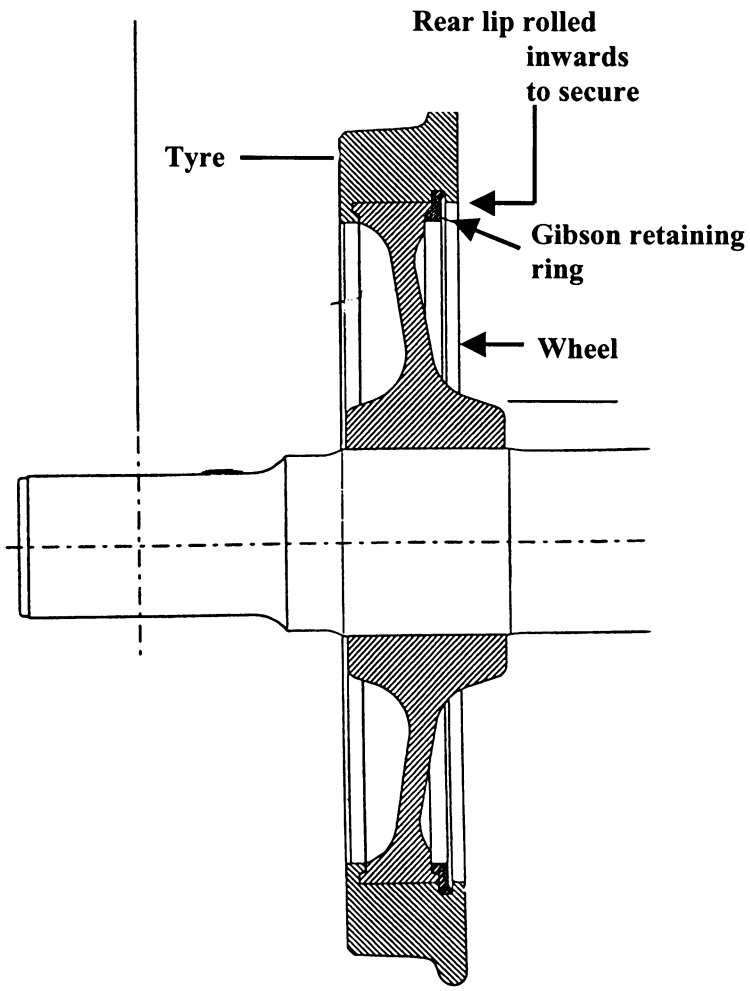

Figure 2
Diagram showing tyred wheel assembly

1.8 Solid wheel policy

1.8.1 Tranz Rail advised that there were good engineering reasons for the use of tyres and that they are used internationally but, given sufficient wear and / or sufficient heat, tyres will move, regardless of the quality of manufacture. The Gibson retaining ring was intended to limit the consequences of the movement, but eventually these could fail and the tyre would separate from the wheel. They commented that this in itself does not make tyres inherently unsafe or an unwise choice; it was simply a characteristic of the design.

1.8.2 Tranz Rail policy since the early 1990s had been to move away from tyres to solid wheels where there were no clear economic or technical benefit for using tyres. Solid wheels are now standard for Tranz Rail freight wagons and tyres are being eliminated from this fleet as remaining tyred wheel sets are worn to limits. The programme allowed, in time, for only locomotives and electric multiple units to retain tyred wheels.

2. Analysis

2.1 UK14818

2.1.1 The tyre found at the derailment site, the missing Gibson retaining ring and the track markings south of No 2 points at Horotiu indicated that the tyre on the leading right-hand wheel of the trailing bogie of UK14818 had moved out laterally prior to reaching No 2 points.

2.1.2 The movement of the tyre was the likely result of overheating, causing the tyre to loosen and abrade the Gibson retaining ring until it failed.

2.1.3 After the Gibson retaining ring had failed and the tyre had moved laterally, the tyre was restrained between the wheel and the bogie. This prevented the loose tyre breaking free from the axle.

2.1.4 As the wagon traversed No 2 turnout immediately south of Horotiu, the rail discontinuity at the frog[4] and displacement of the wheel flange was sufficient to cause the loose tyre to take a diverging route from the rest of the train (refer Figure 3), pulling the wheel at the opposite end of the axle in the same direction until both wheels were derailed. The first flange marks on the sleepers beyond No 2 turnout were 1170 mm apart, confirming that the tyre had moved away from the wheel.

2.1.5 Damage to the concrete sleepers immediately south of No 2 turnout indicated that only one axle was derailed initially. However, damage to the seal at Ruffle Road level crossing, approximately 3 km south of the initial derailment point, indicated the wheels on the leading bogie and the remaining wheels on the trailing bogie had all derailed, probably as a result of the impact of the originally derailed wheels on the road seal.

2.1.6 As Train 227 continued, the right-hand wheels on UK14818 were travelling in the ballast between the down and up main lines, while the left-hand wheels were travelling on the sleepers between the rails on the down main line, with the wagon fouling the adjacent up main line.

2.1.7 This was the position of the wagon when it was struck by the locomotive of Train 474 near the 548 km between Ruffle Road level crossing and Te Kowhai Road level crossing.

2.1.8 After impacting with the locomotive of Train 474 the wagon continued with all wheels off until it reached Te Kowhai Road level crossing. On impacting with the seal at this level crossing, the trailing bogie collapsed and the defective axle was wrenched out, allowing the loose tyre to come free of the axle.

[4] A v-shaped section of rail where two running rails cross.

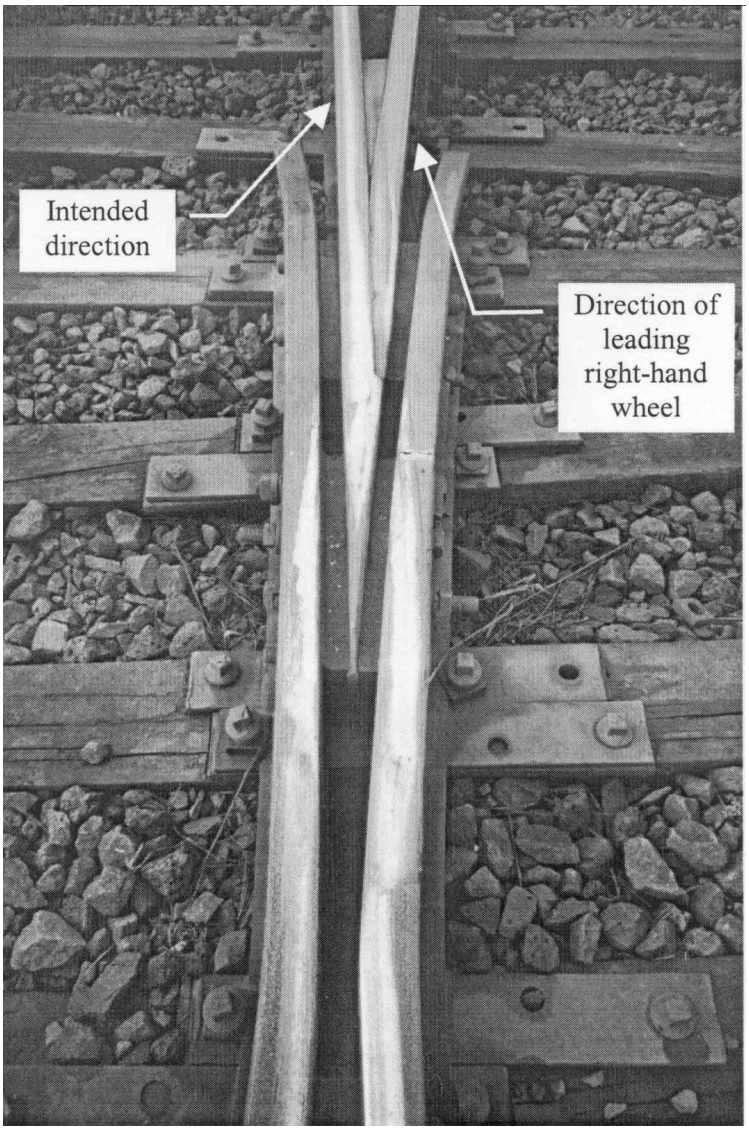

Figure 3
No 2 facing turnout at Horotiu

2.2 The defective wheel set

2.2.1 Axle markings indicate the axle was manufactured in Otahuhu workshops prior to 1 July 1991.

2.2.2 The policy of holding axle assembly records for 7 years appears to be adequate based on the fact that any defects resulting from incorrect assembly should have been identified prior to that time. It is unlikely that the tyre failure resulted from incorrect assembly.

2.2.3 The tyre had been loosened, probably through overheating as a result of dragging brakes or applied handbrakes, over a period of time.

2.2.4 This wearing away was a slow process until the Gibson retaining ring disintegrated, at which stage the tyre was able to move laterally away from track centre.

2.2.5 There was no evidence to suggest that there were either dragging brakes or a secured handbrake on UK14818 at the time of the derailment.

2.2.6 B inspection requirements included a visual check to detect signs of loose tyres. However, such loosening may well have occurred in the period October 1998 to August 1999, and gone undetected until failure. The brake block replacement in May 1999 is not considered to be related to the failure.

2.2.7 The tyre thickness was generally 30 mm, although at isolated points it was below the minimum (26 mm minimum compared to 29 mm condemning) and the tyre was on its last turn before condemning. The tyre had run on ballast for about 5.5 km following the derailment and this may have contributed to the low tyre thickness points measured. However, tyre thickness can go as low as 19 mm in other circumstances (low speed, light axle 4-wheel wagons) and there is a reasonable tolerance from a wheel-loading viewpoint. The worn wheel was, however, much more susceptible to overheating and the loosening of the tyre is likely to have been a combination of overheating and the decreased ability of the worn tyre to dissipate heat.

2.2.8 The historical method of finding loose tyres on New Zealand Railways had been by tapping the wheel and determining those loose by sound. This was a specific check made prior to train departure. These checks were discontinued many years ago. Current wagon inspection procedures do not require such checks. Although possible to detect a loose tyre visually during a depot inspection (B and C checks), it would not be expected during an A check.

2.2.9 Loose tyres are not common, and derailments due to loose tyres are less common. The phasing out of tyred wheels on wagons commenced in the early 1990s. Wheel wear due to utilisation will govern the final date by which such wheels are eliminated. Tranz Rail estimate that approximately 5% of the wagon fleet still use tyred wheels. Tranz Rail's policy will result in an early elimination of tyred-wheel wagons and no additional recommendations are considered necessary to deal with the safety issues involved.

2.3 Actions of the LE of Train 227

2.3.1 The LE of Train 227 was unaware of the condition of UK14818 at either the initial point of derailment or after passing over Ruffle Road level crossing. As the air hoses had not been broken at any stage there was no loss of air and subsequent applying of brakes to warn him that anything was wrong.

2.3.2 The reduction in speed noticed by the LE of Train 227 was probably as a result of the impact between UK14818 and the locomotive of Train 474 and the LE made an initial brake application sensing that something may be wrong with his train before he received the call from the LE of Train 474. This action was appropriate.

2.4 Actions of the LE of Train 474

2.4.1 Once he was aware of the impending collision, the LE of Train 474 could do nothing but make a brake application before taking evasive action to protect himself. This action was appropriate.

3. Findings

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

3.1 Trains 227 and 474 were being operated normally prior to the incident.

3.2 The LEs were appropriately certified for the duties being carried out.

3.3 The derailment was caused by a loose tyre on the right-hand wheel on the leading axle of the trailing bogie of UK14818 moving laterally on the wheel, resulting in the wheel taking the wrong road at No 2 facing turnout immediately south of Horotiu.

3.4 The tyre was able to move laterally because the relative movement between the wheel centre and the loose tyre over time had resulted in the wearing away and subsequent collapse of the Gibson retaining ring.

3.5 The tyre had been loose for some time prior to the derailment.

3.6 The probable cause of the loose tyre was overheating, either as a result of dragging brakes or a secured handbrake during all or part of an earlier journey.

3.7 The original fitting of the tyre was unlikely to be a factor in this derailment.

3.8 The worn tyre could have accentuated the effect of any overheating.

3.9 Inspection procedures could be expected to find visual evidence of a loose tyre during B and C checks if such a condition existed, but not necessarily during A checks.

3.10 The intervals between B and C checks are such that loose tyres may go undetected between original loosening and retaining ring failure.

3.11 The progressive replacement of tyred wheels is addressing the safety issues identified.

Approved for publication 2 August 2000

Hon. W P Jeffries
Chief Commissioner