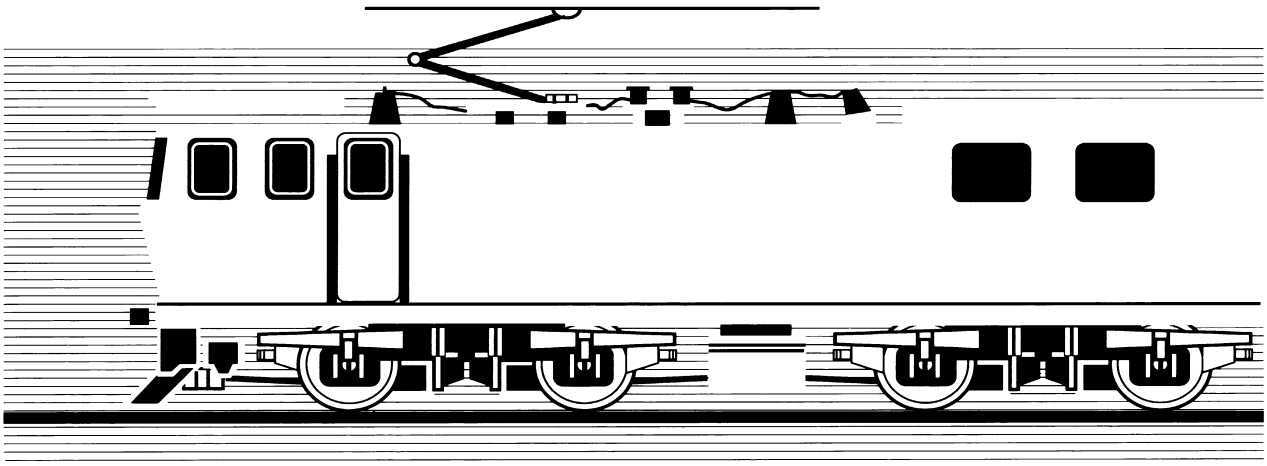
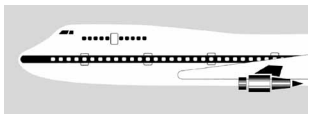
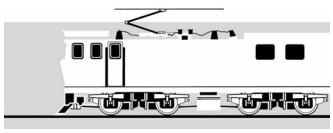


# RAILWAY OCCURRENCE REPORT

**03-114 Express freight Train 220, derailment, Shannon 21 November 2003**


**TRANSPORT ACCIDENT INVESTIGATION COMMISSION**
**NEW ZEALAND**

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

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

# Report 03-114

# express freight Train 220

# derailment

# Shannon

# 21 November 2003

## Abstract

On Friday, 21 November 2003, at about 1300, 10 wagons on northbound express freight Train 220 derailed as the train passed through Shannon.

There were no injuries.

The probable cause of the derailment was a combination of track and a wagon at the limit of their respective working tolerances.

The safety issue identified was the compatibility of current track and mechanical tolerances and their potential to cause derailments.

Safety recommendations were made to the Chief Executive of New Zealand Railways Corporation and the Chief Executive of Toll NZ Consolidated Limited to address these issues.

# Contents



# Figures

## Abbreviations

| | |
|---|---|
| km | kilometre (s) |
| km/h | kilometres per hour |
| m | metre (s) |
| NIMT | North Island Main Trunk |
| POD | point of derailment |
| Tranz Rail | Tranz Rail Limited |
| UTC | coordinated universal time |

## Data Summary

| | |
|---|---|
| **Train type and number:** | express freight Train 220 |
| **Date and time:** | 21 November 2003 at about 1300[1] |
| **Location:** | Shannon |
| **Persons on board:** | crew: 1 |
| **Injuries:** | nil |
| **Damage:** | extensive damage to infrastructure and rolling stock |
| **Operator:** | Tranz Rail Limited (Tranz Rail) |
| **Investigator-in-charge:** | D L Bevin |

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

# 1 Factual Information

## 1.1 Narrative

1.1.1 On Friday, 21 November 2003, Train 220 was a scheduled northbound express freight service from Wellington to Auckland on the North Island Main Trunk (NIMT). The train consisted of a DX and a DC class locomotive in multiple and 41 wagons, with a gross weight of 1441 tonnes and length of 703 m.

1.1.2 At about 1300, shortly after passing over the south end points at Shannon, the leading wheel set of the leading bogie of PK2295 derailed to the right-hand side in the direction of travel. The wagon ran derailed for 600 m to the north end points, where the wheel set struck the spreader bar, derailing the 9 following wagons. PK2295 was running handbrake trailing at the time.

1.1.3 The derailed wagons travelled a further 250 m until the train parted. The locomotives eventually stopped about one kilometre past the original point of derailment (POD), after the train airbrakes applied automatically following the loss of air caused by the parting.

## 1.2 Site information

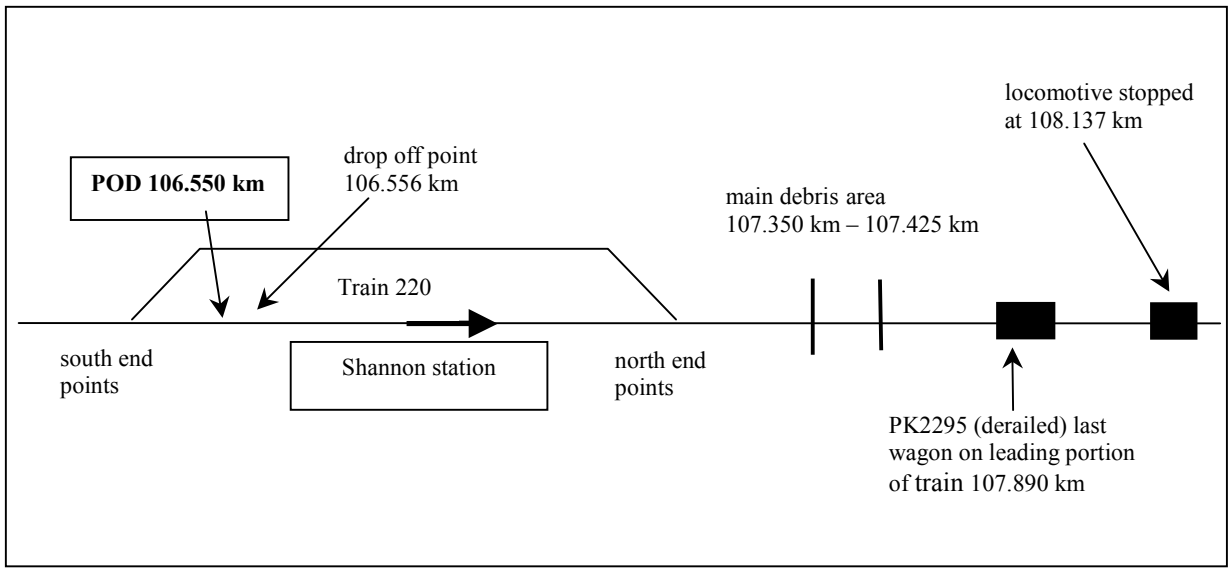



**Figure 1**
**Diagram of derailment site (not to scale)**

1.2.1 Twenty-five wagons remained on the front portion of the train, with all wheels of PK2295, the last wagon of the front portion, derailed to the right-hand side of the track. There was a gap of about 465 m separating the front and rear portions of the train. The first 9 wagons of the rear portion were derailed, but the last 8 wagons remained on the track.

1.2.2 A very light wheel flange mark on the right-hand rail identified the POD at 106.55 km. The marks indicated that the flange travelled along the railhead for a distance of 6 m before dropping off and hitting the rail fastenings (see Figure 2).

1.2.3 The maximum authorised line speed for express freight trains in the area of the derailment was 80 km/h.

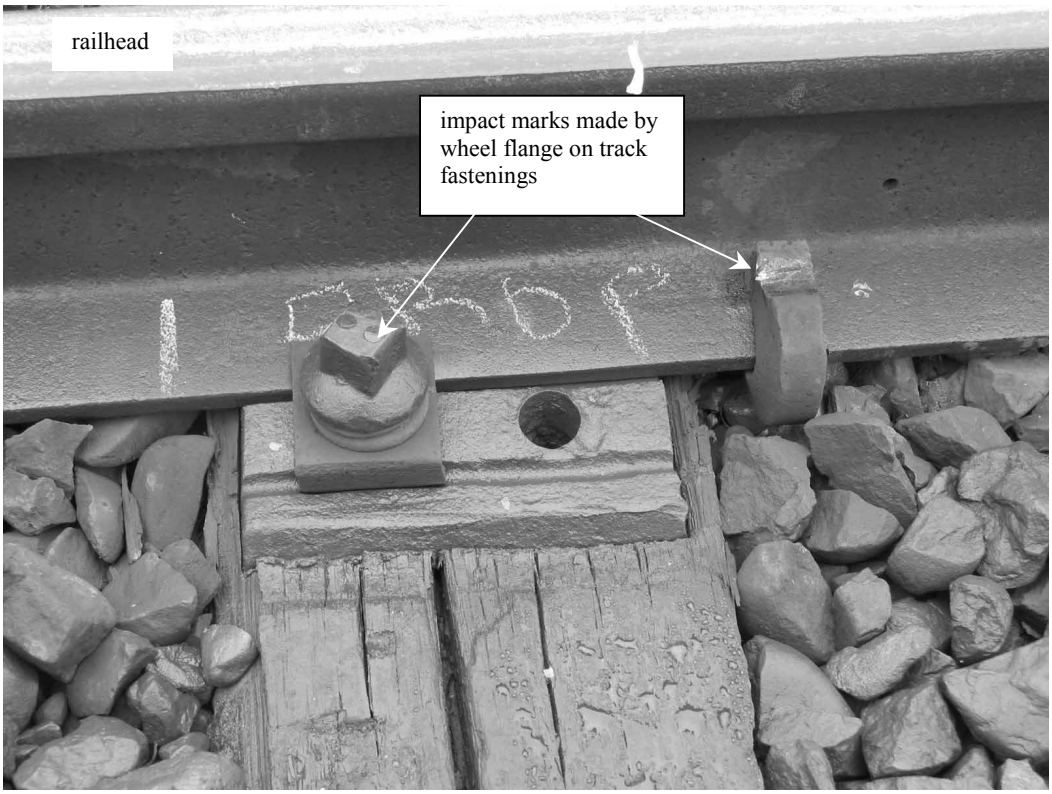



**Figure 2**
**The point at which the wheel dropped from the railhead**

## 1.3 Locomotive event recorder

1.3.1 The locomotive event recorder data was downloaded and made available for analysis.

## 1.4 Wagon PK2295

1.4.1 Wagon PK2295 had a standard 3 piece bogie as used on most freight wagons worldwide. The 3 main pieces were one bolster and 2 side frames. The bolster was supported by 2 sets of coil springs. The larger diameter coil springs, known as primary suspension, provided vertical support. The smaller diameter coil springs, known as wedge springs, applied pressure to the friction wedge to control wagon damping[2].

1.4.2 Following the derailment, examination of the bogies of PK2295 identified that the friction wedges were significantly worn although still within code as specified in Tranz Rail's Mechanical Code M2000 (the Code). The combined float[3] clearance was 7 mm at the handbrake end of the wagon and 10 mm at the non-handbrake end of the wagon.

1.4.3 The Code stipulated that the float limit at the handbrake end of the wagon was between 6 mm and 10 mm and between 12 mm and 16 mm at the non-handbrake end.

1.4.4 Tranz Rail considered that although the wagon was 2 mm outside the float limits at the non-handbrake end of the wagon it was not sufficient on its own to cause the derailment.

[2] Damping reduced oscillation of wagons while in motion.
[3] Float is the clearance between the float block on the bogie bolster and the corresponding block on the wagon underframe.

## 1.5 Track information

1.5.1 The track at the POD was 91lb continuous welded rail secured to pine sleepers with N type[4] fastenings laid in 1972.

1.5.2 The measure-up of the track following the derailment identified two opposing priority 2, 18 mm cyclic twists[5] about 12 m (106.538 km) and 2 m (106.548 km) respectively before the POD (see Figure 3). Tranz Rail's Track Code T003 defined priority 2 twists as those between 16 mm and 18 mm and required them to be programmed for maintenance. Both of these twists had been identified during the EM80 track evaluation car[6] run over the section on 3 November 2003.

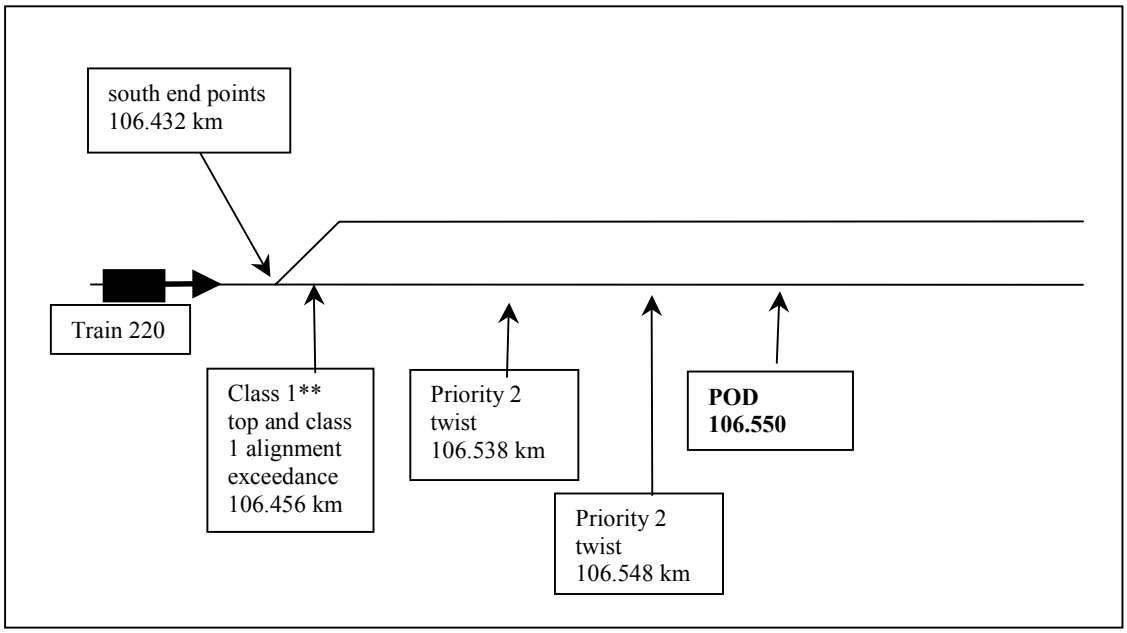



**Figure 3**
**Diagram showing location of identified track faults (not to scale)**

1.5.3 The EM80 track evaluation car had also identified a Class 1** (beyond Priority 1[7]) top exceedance and a Class 1 alignment exceedance about 100 metres before the point of derailment (see Figure 3). Tranz Rail's Track Code T003 required that a Class 1** exceedance was to be fixed within 24 hours if critical and, if necessary, a temporary speed restriction be imposed. Until the Class 1 has been corrected, competent track staff must check the condition of Class 1** exceedances during inspections.

1.5.4 The top exceedance had not been repaired, nor was there a speed restriction in place at the time of the derailment. New Zealand Railways Corporation[8] advised that not all Class 1** exceedances required a temporary speed restriction until fixed, and the decision was based on material type and condition, other track geometry issues and the size of the exceedances. In this case the Class 1** alignment exceedance was not considered critical, so repair was programmed for some later date and no speed restriction was imposed. However, specific checks were initiated.

1.5.5 The 2 twists were within acceptable maintenance tolerances at the time of the derailment, and Tranz Rail considered that on their own they would not have caused the derailment.

[4] N type fastenings consisted of screw spikes, bedplate and spring washers.
[5] The difference in cant measured at 4 metre spacing.
[6] The track evaluation car measured and recorded track geometry and identified track beyond tolerance.
[7] Beyond acceptable maintenance levels.
[8] Access provider since 1 September 2004.

### 1.6 The locomotive engineer

1.6.1 The locomotive engineer was a certified Grade 1 locomotive engineer and held a current operating certificate. He had held Grade 1 certification for 19 years.

1.6.2 He estimated Train 220 was travelling between 70 and 80 km/h at the time of the derailment.

## 2 Analysis

2.1 Analysis of the locomotive event recorder data confirmed the locomotive engineer's estimated train speed at the time of the derailment of about 70 km/h, which was less than the maximum authorised line speed for express freight services.

2.2 The float and friction wedge condition on wagon PK2295 was probably not enough on its own to cause the derailment. However, when combined with the track alignment top exceedance and twists, it contributed to the sequence of events leading to the derailment. A safety recommendation covering these issues has been made to the Chief Executives of New Zealand Railways Corporation and Toll NZ Consolidated Limited.

2.3 Whilst the float clearance at the non-handbrake end of PK2295 was outside the code it was marginally below the lower limit and on its own would not have contributed to the excessive unrestrained rolling of the wagon.

2.4 The track condition on its own would probably not have caused the derailment but, in combination with the condition of wagon PK2295, became a contributing factor. This was evident from the fact that the 25 wagons in front of PK2295 had successfully negotiated the track.

2.5 Although the twists, at 18 mm, were within maintenance tolerance limits, they were both at the upper limit for priority 2 tolerances. The twists may have progressed beyond priority 2 when the effect of the axle loading of PK2295 was taken into account.

2.6 The train crossing the south end points and the top and alignment exceedances would have initiated rolling oscillations within the wagons, which would have been further amplified as the train passed over the 2 twists just before the POD. However, the under-tolerance at the non-handbrake end of PK2295 may have prevented that wagon from rolling freely.

2.7 If over-tolerance produced excessive, unrestrained rolling then under-tolerance would probably make the wagon stiff. What precise impact this stiffness has is not clear but when coupled with track which was close to limits it may have contributed to the derailment.

2.8 The twists were about 10 metres apart and, with a length of 9.5 metres between bogie centres on a PK class wagon, it is probable that the bogies on PK2295 were negotiating the cyclic twists simultaneously.

2.9 The distance between the initial track exceedance and the POD was about 100 metres. With the train travelling at 70 km/h, PK2295 would have taken about 5 seconds to cover the distance. This was not sufficient time for the rolling wagon to stabilise after each impacting influence before experiencing the next.

2.10 Even if the Class 1** top exceedance had been repaired the out-of-code condition of PK2295 might have still have made it unstable when crossing the south end points as it approached the 2 twists and the derailment might have still happened. Had a temporary speed restriction been in place the reduced speed of Train 220 might have been sufficient to enable PK2295 to safely negotiate the twists.

2.11 The Class 1** top exceedance was not critical and did not meet the requirement for either repairing in 24 hours or the imposing of a temporary speed restriction. However, had the twists been closer to the top exceedance, the combination may have necessitated a temporary speed restriction.

# 3 Findings

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

3.1 Train 220 was operated correctly, and the actions of the locomotive engineer did not contribute to the derailment.

3.2 The derailment was probably caused by dynamic interaction between wagon PK2295 and the track.

3.3 The dynamic interaction was caused by a combination of track and wagon conditions, each of which in isolation would not have been sufficient to cause the derailment.

3.4 The twists were at the upper limit for priority 2 tolerance limits.

3.5 Although outside limits the top exceedance was being managed within code and no speed restriction was required.

# 4 Safety Recommendations

4.1 On 23 March 2005, it was recommended to the Chief Executive of New Zealand Railways Corporation that he:

4.1.1 in conjunction with Toll NZ Consolidated Limited critically review current track and mechanical code standards and maintenance tolerances to ensure they are compatible and minimise the potential for derailments caused by dynamic interaction (009/5).

4.2 On 1 April 2005, the Chief Executive of New Zealand Railways Corporation replied in part:

> New Zealand Railways Corporation (NZRC) intend to implement this recommendation.
>
> As this recommendation involves working in conjunction with another party, this may take some time before being fully implemented.

4.3 On 4 April 2005, it was recommended to the Chief Executive of Toll NZ Consolidated Limited that he:

4.3.1 in conjunction with New Zealand Railways Corporation critically review current track and mechanical code standards and maintenance tolerances to ensure they are compatible and minimise the potential for derailments caused by dynamic interaction (010/5).

4.4 On 11 April 2005, the Chief Executive of Toll NZ Consolidated Limited replied in part:

> We accept this recommendation. A similar recommendation has been raised during the joint internal investigation into a similar incident and has been accepted by Ontrack[9] and Toll Rail management.

Approved for Publication 28 April 2005

Hon W P Jeffries
Chief Commissioner

[9] Trading name of New Zealand Railways Corporation.

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