Report 07-101	**express freight Train 736, derailment, 309.643 km, near Vernon**	**5 January 2007**

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express freight Train 736

derailment

309.643 km, near Vernon

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Abstract

On Friday 5 January 2007, at about 2200, the leading bogie of UK6765, the rear wagon on Christchurch to Picton express freight Train 736, derailed at 309.643 kilometres (km) on the Main North Line. The derailed wagon was dragged a further 3.5 km until it struck the south end main line points at Vernon, derailing the wagon immediately in front.

The derailed wagons were pulled another kilometre before the locomotive engineer became aware of the derailed wagons and brought the train to a stop.

There were no injuries.

A safety issue identified was the current track and mechanical tolerance standards.

In view of the safety actions since taken by Toll NZ Consolidated Limited and Ontrack in response to safety recommendations made following similar investigations by the Commission, no further safety recommendations were made.

Contents

Figures

Abbreviations

EM80	EM80 track evaluation car
km	kilometre(s)
km/h	kilometres per hour
m	metre(s)
mm	millimetres
MNL	Main North Line
NIMT	North Island Main Trunk
POD	point of derailment
ROCOCD	Rate of Change of Cant Deficiency
t	tonne(s)
Toll Rail	Toll NZ Consolidated Limited

Data Summary

Train type and number:	express freight Train 736	
Date and time:	5 January 2007 at about 2200[1]	
Location:	309.643 km, near Vernon	
Persons on board:	crew:	one
Injuries:	crew:	nil
Damage:	extensive to track infrastructure and rolling stock	
Operator:	Toll NZ Consolidated Limited (Toll Rail)	
Investigator-in-charge	D L Bevin	

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

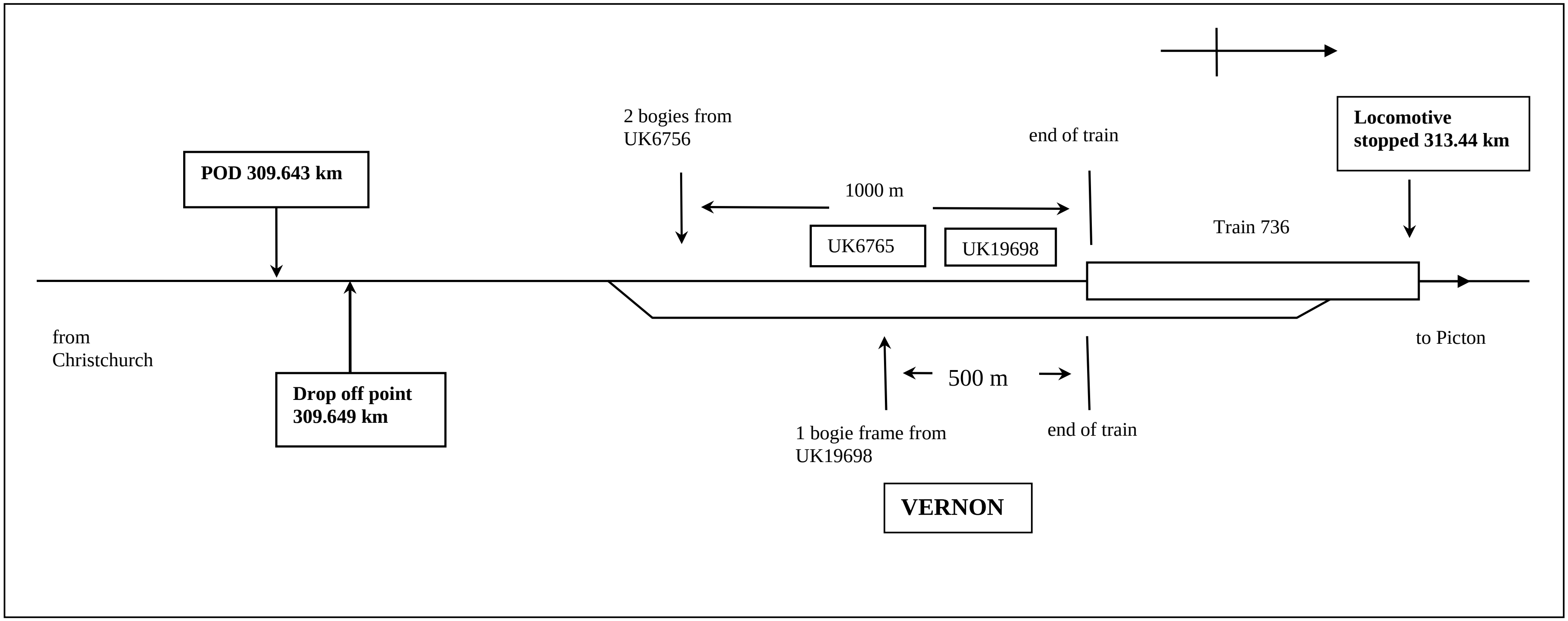

Figure 1
Diagram of derailment site (not to scale)

1. Factual Information

1.1 Narrative

1.1.1 On Thursday 28 December 2006 the track inspector identified track geometry exceedances at a termination[2] joint at 309.642 km during a routine track inspection from 260.70 km to Picton on the Main North Line (MNL).

1.1.2 He recorded the exceedances, which included Class 2 top and line through the termination joint, and gauge, in his M125 book[3] and, once back in his office at Kaikoura, faxed a copy of the M125 to his Area Manager's office in Christchurch and to the track maintenance ganger in Blenheim, who was responsible for the section.

1.1.3 Each track exceedance at the site was classified as Priority 2 or Priority 3. However, because of their close proximity, number and nature, the track inspector assigned them a Priority 1[4] on the M125 reporting sheet.

1.1.4 On Friday 5 January 2007, Train 736 was a scheduled northbound express service from Christchurch to Picton. The train consisted of a DFT and a DQ class locomotive in multiple and 31 wagons, with a gross weight of 1029 tonnes (t) and a total length of 542 metres (m).

1.1.5 The locomotive engineer had brought Train 736 through the 40 kilometres per hour (km/h) reverse curves off the Dashwood Pass and had increased speed towards the next 50 km/h curve where the derailment occurred. He estimated he was travelling about 50 km/h at the time of the derailment, which was later confirmed from analysis of the locomotive event recorder.

1.1.6 The locomotive engineer said his usual practice was to drift the train as he approached Vernon, having come out of dynamic braking.[5] Once the locomotive was on the straight approaching Vernon he would select notch 1 and by the time the train reached the authorised line speed of 65 km/h the rear of the train had cleared the 50 km/h curve.

1.1.7 He said he was following this practice when he noticed the train end monitor[6] giving inconsistent brake pipe pressure readings, ranging between 240 and 500 kilopascals before registering zero.

1.1.8 When the locomotive reached Vernon about 5 minutes later he increased power but the train did not increase speed, so he applied more power but the speed still did not increase. He suspected something was wrong and reduced power, and felt minor surges as the speed decreased.

1.1.9 He crossed over to the left side of the locomotive cab to see the rear of the train as he was on a slight left-hand curve. He saw large amounts of sparks so he returned to the driver's seat immediately. The train then surged violently 2 or 3 times and he knew something serious had happened, so he brought the train to a stop.

1.2 Site information

1.2.1 The track from Christchurch to Picton was single line with the movement of trains controlled by track warrants issued from the train control centre in Wellington.

[2] A bolted rail joint at the end of a length of continuous welded rail.
[3] A book in which track faults were recorded in triplicate.
[4] See 1.4.2 for information on priorities.
[5] The locomotive traction motors were used as generators to create a braking force.
[6] The train end monitor was mounted on the rear buffer of the last wagon on the train to monitor brake pipe pressure. A short-range radio transmitter relayed this information to a head end display unit located in the locomotive cab.

1.2.2 The point of derailment (POD) was 309.643 km, near Vernon on the MNL. The northbound approach to the POD was a 500 m long descending grade of 1 in 60, preceded by a 7 km long descending grade of 1 in 53 from the Dashwood Pass.

1.2.3 A wheel flange mark on the left-hand rail identified the POD at 309.643 km. The marks indicated that the flange travelled along the railhead for a distance of 6 m before dropping off.

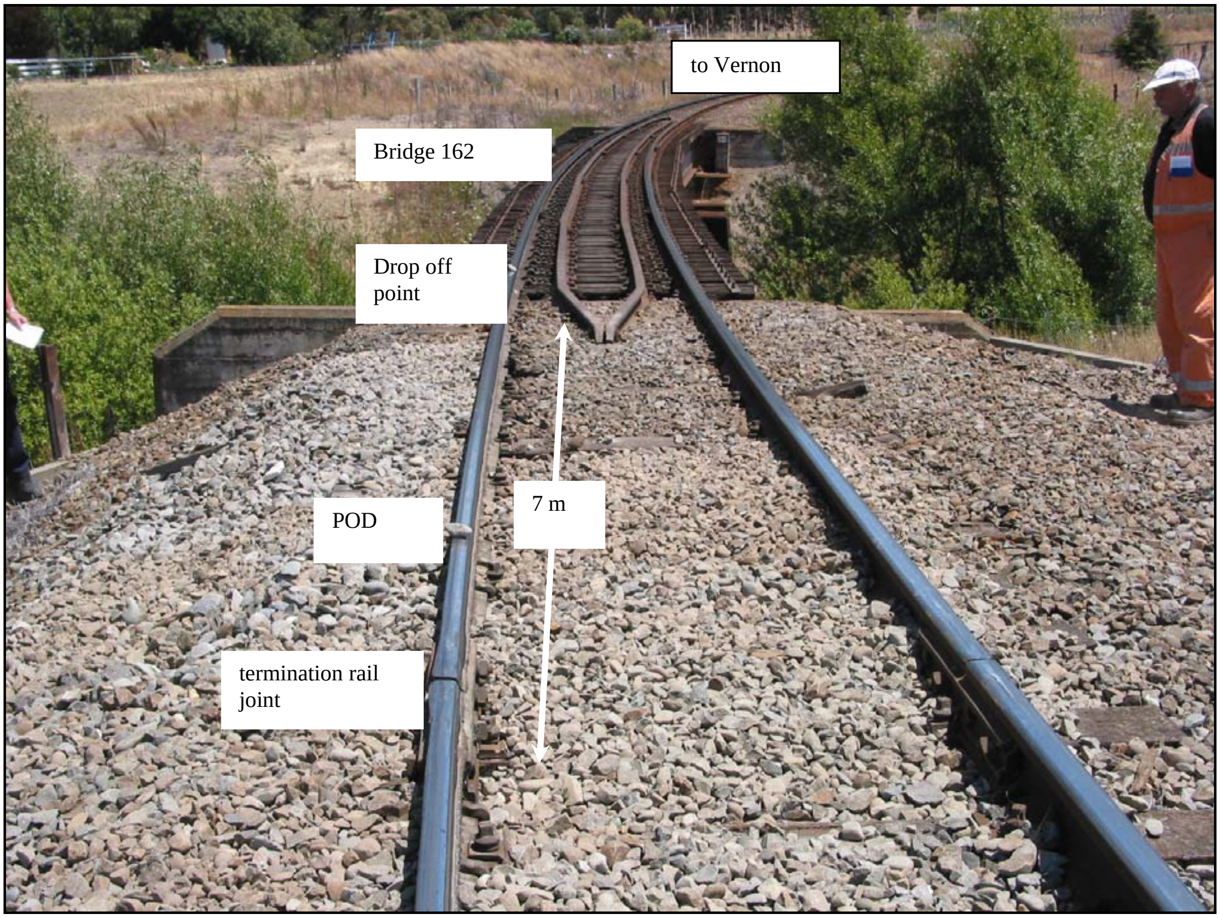

Figure 2
Track formation at the POD

1.2.4 The POD was on a 500 m long, 200 m radius right-hand curve. The maximum authorised speed for the curve was 50 km/h.

1.2.5 The 2 bogie frames from UK6765, the rear wagon, were found about 1000 m from the rear of where the train stopped. UK6765 had been dragged from there to where the train eventually stopped without the bogies attached. The leading bogie of UK19698, the second wagon from the rear of the train, was found about 500 m from the rear of the train.

1.3 Track information

1.3.1 The track leading up to the termination joint, one metre before the POD, consisted of 50 kilograms per metre continuous welded rail on concrete sleepers.

1.3.2 The rail from the termination joint across Bridge 162 was laid in 12.8 m lengths fastened to timber sleepers.

1.3.3 The cribs and ballast shoulders were full, with the depth of ballast under the sleepers exceeding the minimum standard of 300 millimetres (mm).

1.3.4 Rail wear at the POD measured 11 points of side wear on the high leg rail. The maximum side wear tolerance was 16 points.

1.3.5 The track on the derailment curve was last machine-tamped in June 2003.

Bolted rail joints

1.3.6 A rail joint served the following functions:

- provided a connection between the rails, acting as a continuous girder to provide a uniform running surface and alignment
- provided a resistance to deflection, similar to that of the adjacent rail
- prevented vertical and lateral movement of the rail ends relative to each other.

1.3.7 Ontrack's T200 Infrastructure Engineering Handbook stated in part that:

> - for rails longer than 10 m, an expansion gap of 5 mm between the rail ends is to be allowed for when the rail temperature is between 21°C and 25°C
> - for laying bolted rail when rail temperature greater than 30°C the expansion gap is to be 3 mm
> - combined batter and dip at a bolted joint must be less than 6 mm.

Termination joint at 309.642 km

Figure 3
Termination joint at 309.642 km

A 25 mm expansion gap and a combined batter and dip of 8 mm were measured at the termination joint.

Figure 4
Batter and dip at termination joint; left-hand rail in direction of travel

1.4 Code requirements for track inspections

1.4.1 Ontrack's Track Code (the Code) required that the MNL be inspected twice per week. There was no amended inspection regime in place over holiday periods as existing procedures allowed for a maximum gap of 5 days between inspections.

1.4.2 Track conditions found during a static measure-up were prioritised and were to be actioned as follows:

Priority	Action required
Priority 1	Consider the need for a temporary speed restriction and fix within 30 days
Priority 2	Programme for maintenance
Priority 3	Note and review for action

1.4.3 Track and engineering inspections were supplemented by an EM80 track evaluation car (EM80) run that measured track geometry such as gauge, cant and line and compared the actual readings against predetermined Priority 1, 2 and 3 tolerance limits. An exception report was printed with details of the location, type and priority of the particular exceedance. When measuring gauge the EM80 applied one tonne of side pressure to simulate dynamic train forces.

1.4.4 The Code required the EM80 to run twice a year over all main lines and loops.

1.4.5 EM80 track geometry exceedances were classified and were to be actioned as follows:

Priority	Description	Action to be taken
Class 1**	Beyond maximum	To fix immediately. If not fixed within 24 hours impose temporary speed restriction – if considered necessary
Class 1	Beyond acceptable limits but below maximum	To be fixed within 4 weeks. If not fixed within 4 weeks impose temporary speed restriction – if considered necessary
Class 2	Marginally beyond acceptable limit	Infrastructure maintenance service provider to evaluate and forward supplementary list to Ganger at a later stage, directing action to be taken

1.4.6 The track geometry maintenance tolerances for a static inspection differed from those of the dynamic inspection by the EM80, and so too did the priority rating system. The reason for this was that the EM80 applied lateral loading as well as vertical loading to the rail as it was measuring, to simulate the loads created by a passing train. The Rate of Change of Cant Deficiency (ROCOCD) was a formula-based calculation that could only be determined by the EM80's on-board computer.

1.5 Track inspections

1.5.1 On 23 January 2006, the track inspector reported the following track geometry exceedances 7 m south of Bridge 162 (309.642 km):

- top down, mainly left-hand high leg through and south of joint
- line peaked
- off cant.

1.5.2 On 15 March 2006, the EM80 identified the following track geometry exceedances 7 m south of Bridge 162:

- Class 1** line
- Class 1 ROCOCD
- Class 2 gauge.

1.5.3 ONTRACK advised that, although these track geometry exceedances at 309.642 km had not been permanently repaired at the time of the derailment, they had been attended to by the track ganger on a number of occasions to undertake temporary repairs. Permanent repairs were scheduled as part of the 2007 – 2008 Renewals Programme.

1.5.4 On 27 September 2006, the EM80 identified the following track geometry exceedances 7 m south of Bridge 162:

- Class 1 top and line
- Class 2 ROCOCD of 215 mm, which did not require the imposition of a temporary speed restriction.
- Class 2 gauge.

1.5.5 On 28 December 2006, the track inspector reported the following track geometry exceedances 7 m south of Bridge 162:

- top down, mainly left-hand high leg through joint
- line peaked
- 15 – 18 mm off cant
- gauge 1090 mm.

1.5.6 The track inspector undertook an inspection run through the site on 4 January 2007. This was 6 days after the last inspection and one day before the derailment. At that time the track geometry exceedances reported on 28 December 2006 had not been corrected.

Post-derailment track measure-up 6 January 2007

1.5.7 The track measure-up following the derailment identified a 17 mm twist at the bolted rail joint at 309.643 km. This was between Priority 2 and Priority 3 tolerances specified in the T200 Infrastructure Engineering Handbook.

1.5.8 The gauge at the POD was recorded as 1085 mm. A 10 mm void[7] was recorded under the left-hand rail and 8 mm under the right-hand rail.

1.5.9 The track measure-up and subsequent analysis identified a ROCOCD measurement of about 174 mm at the POD. This was between Class 2 and Class 3 and would not have required the imposing of a temporary speed restriction.

1.5.10 The expansion gap was measured during the day when the rail temperature would have exceeded 30 degrees, but the gap may have been wider at the time of the derailment, which happened at night.

1.6 Three-piece bogie

1.6.1 Wagon UK6765 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.[8]

1.6.2 The leading bogie of wagon UK6765 derailed at 309.643 km, one metre after the termination joint. UK6765 was conveying a refrigerated 40 foot container weighing 24 t for a gross weight of 39 t.

1.7 Wagon inspection regime

1.7.1 The Toll Rail Mechanical Code M2000 Issue 6 identified that all freight wagons must be inspected at the following frequency:

- a pre-departure check
- a B-Check, carried out when 2 or more brake blocks were changed, or after an incident
- a C-Check, carried out before a depot pass-out but with an upper limit of 27 months
- a Brake Service Check, carried out every 10 years but with an upper limit of 11 years.

1.7.2 A pre-departure check was a thorough walk-around inspection undertaken by yard operating staff immediately before a train departed from a terminal, and included checks on the condition of brake blocks and wheels and correct draw gear connections. The person carrying out the inspection signed a Train Inspection Certificate to confirm that the train was in proper condition for safe running. This certificate was attached to the Train Work Orders and remained in the locomotive cab until the train reached its destination.

1.7.3 The B-Check inspection requirements for the bogie suspension included ensuring that wedge heights were within limits. The most recent B-Check on wagon UK6765 was completed on 28 April 2006. During that check wedge heights were recorded as 41 mm, which was 1 mm within limits. Wheelset measurements were within limits.

1.7.4 The last C-Check, which also included ensuring that the wedge heights were within limits, was completed on 14 March 2005.

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[7] Vertical displacement under load.
[8] Damping reduced oscillation of wagons while in motion.

1.8 Post-derailment inspection of UK6765

1.8.1 On Thursday 25 January, following the derailment, examination of the bogies of UK6765 showed that the friction wedge measurements[9] on the bogies were:

- on the leading bogie – 42 mm, which was on the condemning limit (see Figure 5)
- on the trailing bogie – 41 mm, which was within limit and had one mm of wear remaining.

Figure 5
Wedge measurement leading bogie of UK6765

1.9 Wagon UK19698

1.9.1 UK19698 was the wagon immediately in front of UK6765. The wedge heights and the wheelset measurements were within limits.

1.10 Locomotive event recorder

1.10.1 The locomotive event recorder was downloaded and made available for analysis. This confirmed Train 736 was travelling at 50 km/h at the time it derailed.

[9] All wedge measurements quoted were taken at tare – that is, there was no weight on the wagon.

1.11 Personnel

The locomotive engineer

1.11.1 The locomotive engineer was a certified Grade 1 locomotive engineer and held a current operating certificate. He had 26 years' experience driving trains and had been based in Picton for about 9 years.

The track inspector

1.11.2 The track inspector was based in Kaikoura and was responsible for track inspections from 217.3 km, about 27 km north of Kaikoura, to Picton, a distance of 130 km. He undertook track inspections twice a week through the derailment area, once in each direction. Any track geometry exceedances he identified were notified to the Ontrack Area Manager's office in Christchurch and to the track ganger.

1.11.3 In accordance with the Code he had considered imposing a temporary speed restriction of 60 km/h on the derailment curve because of the track exceedances, but the curve speed was already restricted to 50 km/h.

The track ganger

1.11.4 The track ganger was based in Blenheim and was responsible for track maintenance between 260.7 km and Picton, a distance of 86.9 km. He had been in the role for 15 years.

1.11.5 He confirmed that the POD was 309.643 km and said there had been problems at that particular termination joint before. Track geometry exceedances at that location had been reported by both the track inspector and the EM80.

1.11.6 He said he had received a copy of the M125 from the track inspector advising him of the defects at the bolted joint but could not remember when he had received it. He said that if any Priority 1 geometry exceedances were identified on the M125 he usually waited for a work order, unless he received direct notification from the track inspector that the fault required immediate attention in which case he would undertake repairs straight away. He was not sure if the track inspector had spoken to him about the geometry issues identified on 28 December 2006 but did not think he had.

1.11.7 He could not say how long it would take to repair Priority 1 faults as some jobs had to wait, depending on priority allocation. Also, he couldn't always get out to repair them as other things, such as derailments, often took resources from the work. He allocated work to be done once the work orders were received, and often spoke with the track inspector to determine which jobs were the most important. The last time he could remember the gang working at the bolted joint was when they had done lifting and lining following the EM80 run in September 2006. They had not been back since.

1.11.8 The time between receiving the M125 and the work order generated by the M125 varied depending on how busy the Christchurch office was. He had not received any work orders over the Christmas period, but even if he had, no work would have been done as he was the only person on duty between Christmas and New Year.

1.11.9 On 5 January the heat alarms through his area had activated so the track ganger had undertaken a special inspection from Picton to Wharanui (257.86 km). During this inspection he had passed through the derailment site but he had not noticed anything that caused him concern. He said he had been travelling in a hi-rail vehicle, which rode very rough and which would have accentuated any defects as he travelled over them.

1.12 Previous similar rail occurrences investigated by the Commission

Occurrence report 03-114, express freight train derailment, Shannon, 21 November 2003

1.12.1 On Friday 21 November 2003, Train 220 was a scheduled northbound express freight service travelling through Shannon on the North Island Main Trunk (NIMT) line when PK2295 derailed.

1.12.2 Following the derailment, an examination of PK2295 identified that the friction wedges were worn but were within Code. The float limit at the handbrake end of the wagon was 2 mm outside the limit but Tranz Rail (now Toll Rail) considered that this was not enough on its own to cause the derailment.

1.12.3 The measure-up of the track following the derailment identified 2 opposing track twists about 12 m and 2 m respectively before the POD. The twists were within acceptable maintenance tolerances at the time of the derailment and Tranz Rail (now Ontrack) considered that on their own they would not have caused the derailment.

1.12.4 It was concluded that the derailment was probably caused by dynamic interaction between PK2295 and the track.

Occurrence report 04-107, express freight train derailment, Kopaki, 23 March 2004

1.12.5 On Tuesday 23 March 2004, Train 220 was a scheduled southbound express freight service travelling through Kopaki on the NIMT line when USQ7663 derailed.

1.12.6 Following the derailment, an examination of USQ7663 identified that the A2 wheel bearing adaptor was both damaged and distorted and had been running in a displaced position for some time. The locating lug was broken on the adaptor and there was a crack on the inside face. When the adaptor was placed on the bearing, it could be slightly rotated about a vertical axis, and also rocked and slid backwards and forward axially. Although the bearing adaptor was not a secure fit, and appeared to have been running in a displaced manner for some time, the condition of the adaptor on its own was probably not sufficient to cause the bogie to derail.

1.12.7 All bogie adaptor pockets were checked for dimensional compliance but all except that at the A2 wheel were within the acceptable tolerances. The A2 pocket was worn to an extent that it allowed 3 mm more longitudinal movement than the upper tolerance limit.

1.12.8 When the springs supporting the friction wedges were removed from the bogie side frames, it was found that 2 of the inner springs on the B-side were broken at the same position, about one and-a half turns from the bottom. The fractured springs would have prevented the friction wedges being effective in damping out the rolling effect. Rolling oscillations would thus continue for longer durations, increasing the risk of these oscillations compounding should there be any small cyclic changes in track geometry.

1.12.9 From the post-derailment measure-up of the track geometry at one metre intervals for 120 m leading up to the POD and the subsequent derailment analysis, there was no standout track condition which alone would have caused the derailment. The gauge, cant and curvature were reasonably regular within the body of the curve and within the Network Provider's[10] established maintenance tolerance limits. However, there was evidence of some cyclic wavy top leading up to the POD. Although the track geometry at the POD was within maintenance tolerances, the wavy top may have contributed to the derailment when combined with a wagon at the limit of acceptable maintenance tolerances.

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[10] New Zealand Railways Corporation assumed responsibility for the long-term operation and maintenance of the mainline and designated portions of operator-controlled territory on 1 September 2004.

1.12.10 The track geometry at the POD was within Tranz Rail's maintenance standards. However, the cyclic wavy top before the POD, when combined with a wagon with inadequate damping, may have contributed to the derailment.

Occurrence report 05-103, express freight train derailment, Hunterville, 20 January 2005

1.12.11 On Thursday 20 January 2005, Train 237 was a southbound express freight service travelling through Hunterville on the NIMT line when UK3083 derailed.

1.12.12 A post-derailment examination of the bogies on UK3083 found that 2 of the 4 inner wedge springs from each bogie were up to 2 mm less than the minimum length and one outer wedge spring from the leading bogie was on the minimum required length required for reuse, if the bogie was to be overhauled at the time. The combined effect of the springs being below, or right on, the minimum length did not mean either bogie was out of Code, but rather that the springs were out of specification for reuse.

1.12.13 An internal report compiled by Alstom Transport New Zealand Limited[11] for Toll Rail concluded that the condition of the bogies and the load configuration of UK3083 could not have caused the derailment on their own.

1.12.14 The site investigation found that the rail joint at 206.266 km, 20 m before the POD, had a battered head of rail, and the fishplate on the field side[12] of the right-hand rail had a developing fracture. The 2 halves of a discarded fishplate that had a fracture in about the same place were laying trackside close to this joint.

1.12.15 The measure-up of the static track geometry following the derailment identified 2 track conditions within 67 m of the POD. Both track condition sites had previously been identified as having exceedances by the EM80 car on 3 November 2004.

1.12.16 On their own, the track conditions would probably have not caused the derailment. The track measure-up after the derailment did not identify any track conditions that required the imposition of a temporary speed restriction on the 100 m of track leading to the POD.

1.12.17 The derailment was probably caused by dynamic interaction due to a combination of track and wagon conditions, either of which on their own were unlikely to have caused the derailment.

1.12.18 In response to this series of investigations it was recommended to the Chief Executives of Ontrack and Toll Rail that together they 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 (009/05 and 010/05). Both parties advised that they accepted the respective recommendations.

[11] Alstom was contracted to supply the inspection and maintenance of rolling stock to standards set by Toll Rail.
[12] Field side referred to the outside face of the rail.

1.12.19 On 26 June 2007 the Risk and Safety Manager of Ontrack advised:

> In relation to the Safety Recommendation 009/05, which recommends a review of current track and mechanical code standards and maintenance tolerances to ensure that they are compatible and minimize the potential for derailment caused by dynamic interaction, I can provide the following update:
>
> In April 2007 Toll Rail and Ontrack jointly engaged Interfleet to perform the following professional services:
>
> 1. Develop guidelines for the measurement of wagon and track suitable for the analysis of VAMPIRE modelling for the Studholme[13] derailment. (Ontrack to then modify existing measurement forms and procedures for track and arrange training for staff for all mainline derailment investigation.) Ontrack and Toll Rail to perform the measure-up to the required standards and formats.
> 2. Model (using VAMPIRE) the Studholme derailment to simulate the circumstances of this derailment and to establish a cause (includes investigating new – worn friction damping and the effects).
> 3. Determine the effect of constant side bearers – investigate if they would have helped in prevention of the derailment.
> 4. Validate the track and wagon data against measured test data on the network.
> 5. Investigate the effect of varying the standards on the track and wagon input and tolerance to avoid derailment.
> 6. Develop the model for mainline track for various speed categories on the New Zealand Network and using typical worst case current rolling stock and maintenance tolerances review the track geometry tolerances in particular for twist, ROCOCD and cyclic fault types.
>
> Stage one is complete for track. The measure-up of the wagon data is still to be completed. It is anticipated that Stage 2 will be completed by August and that Stage 6 will hopefully be completed by the end of the year so the recommended tolerances can be tested, implemented and codified in 2008.

2 Analysis

2.1 Train 736 had all but passed over the termination joint at 309.642 km when the leading left-hand wheel of the leading bogie of the rear wagon of the train, UK6765, derailed and rode up onto the left-hand rail in the direction of travel. The wheel travelled on the top of the rail for another 6 m before it dropped off to the outside of a right-handed curve.

2.2 The train continued for a further 3.5 km until the derailed wheel set struck the south end points mechanism at Vernon. The impact tore the bogie frames from under the wagon and tipped the wagon on its side. The leading bogie on the wagon in front of UK6765 then derailed and was torn from under the wagon, causing that wagon also to fall on its side. The wagons remained coupled to the train while being dragged on their sides.

[13] Derailment of Train 934 between Glenavy and Studholme, 6 March 2007.

2.3 Track inspections were a means of identifying conditions that could lead to service failures of essential components or conditions that could lead to derailments. The track inspection in January 2006 had identified track geometry exceedances at and around the termination joint at 309.642 km, which had also been confirmed during an EM80 run in March. Although the track geometry exceedances at and around the termination joint had not been permanently repaired at that time, records showed that temporary repairs had been undertaken on several occasions between January 2006 and January 2007.

2.4 When the track geometry exceedances at the termination joint were reported on 28 December 2006, the track maintenance ganger had no other staff on duty. Had the track inspector determined that the joint required immediate maintenance, the length ganger could have called upon personnel from the adjacent gang, imposed a temporary speed restriction or closed the line to traffic until such repairs were completed. However, because the track inspector had classified the combined exceedances as Priority 1, the track ganger had 30 days in which to effect repairs or impose a temporary speed restriction if he considered it necessary. The derailment happened 8 days into that 30- day window. Although the track ganger had not called out staff to repair the bolted rail joint, the site was protected by the permanent reduced speed restriction for the curve.

2.5 The friction wedge on the leading bogie of UK6765 was right at the condemning limit when measured following the derailment. The wagon was loaded with a 24 t container, which may have closed the friction wedge gap over the condemning limits, but this alone should not have caused the wagon to derail. Dynamic interaction describes a derailment where the track geometry, wagon condition, wagon loading and train speed are individually within tolerance limits, or only marginally in excess, but to the extent that each variation in itself is not sufficient to be a prime cause of derailment. However, in combination these conditions can result in a derailment.

2.6 From the post-derailment measure-up of the track geometry at one metre intervals for 120 m leading up to the POD, and the subsequent derailment analysis, there was no standout track condition which alone would have caused the derailment. The track exceedances leading up to, at and following the termination joint, although individually of a low priority, collectively were serious enough for the track inspector to class them as Priority 1. Priority 1 did not mean that they collectively would cause a derailment, but when combined with a wagon that may have been oscillating, could cause that wagon to derail if the speed of the train was coincidentally just right for it to do so.

2.7 The friction wedge gap being just on or over limits would have placed UK6765 at increased risk of derailment due to dynamic interaction between track and wagon. Such a condition can lead to the wagon oscillating, sometimes referred to as “rocking and rolling” or “harmonic roll” in time with its natural frequency. Any other upsetting force that either interrupted or enhanced this natural oscillation could lead to a derailment.

2.8 With dynamic interaction, speed of the train did not necessarily mean the train was travelling too fast. The publication *Train Derailment Cause Finding* – stemming from an international government/industry research programme on train track dynamics – quoted the usual speed range for a “rock and roll” derailment as being 10 to 25 miles per hour (16 to 40 km/h). Analysis of the locomotive event recorder showed the train was accelerating through about 50 km/h when wagon UK6765 was passing over the termination joint, which was the authorised speed for the curve the wagon was on. While speed is a factor in derailments involving dynamic interaction, this is not necessarily a reflection of driver technique but more an unfortunate culmination of the state of the track, the state of the wagon and the speed at which the wagon is travelling.

3 Findings

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

3.1 The derailment was probably caused by dynamic interaction resulting from a combination of the friction wedges on the leading bogie of UK6765 at condemning limits, the track geometry exceedances at the bolted rail joint and the speed at which the train happened to be travelling, each of which in isolation would probably not have been sufficient to cause the derailment.

3.2 The friction wedges on the leading bogie of UK6765 were on the condemning limit, which would have reduced their effectiveness in damping out the rolling effect following the impact with the bolted rail joint, and would have placed the wagon at an increased level of risk of derailing.

3.3 Train 736 was operated correctly, and the actions of the locomotive engineer did not contribute to the derailment.

3.4 Train 736 was not exceeding the maximum authorised line speed at the time of the derailment.

4 Safety Recommendations

4.1 In view of the previous safety recommendations made to the Chief Executives of Ontrack and Toll Rail, which were equally applicable to this report, no further safety actions have been made at this time.

Approved on 21 February 2008 for publication

Hon W P Jeffries
Chief Commissioner

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06-102	SA/SD passenger Train 4306, braking irregularity, between Westfield and Otahuhu, 31 March 2006
06-101	diesel multiple unit passenger Train 3163, fire in diesel auxiliary engine, Manurewa, 15 March 2006
05-127	Mainline shunting service M52, track occupation irregularity, Te Rapa, 27 October 2005
05-120	Express freight Train 142, runaway wagons, Mercer, 1 September 2005
05-128	Diesel multiple unit Train 3056, passenger injury, Papatoetoe, 31 October 2005.
05-125	Taieri Gorge Railway passenger Train 1910, train parting, Dunedin, 28 October 2005
05-118	Express freight Train 245, derailment, Ohingaiti, 27 July 2005
05-115	Empty passenger Train 2100, train parting and improper door opening, Ranui, 1 April 2005
05-108	Diesel multiple unit passenger Train 3334, fire, Auckland, 23 February 2005
05-126	Express freight Train 246, derailment, South Junction, 30 October 2005
05-103	Express freight Train 237, derailment, 206.246km Hunterville, 20 January 2005
05-121	Express freight Train 354, near collision with school bus, Caverhill Road level crossing, Awakaponga, 2 September 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

Price $22.00 ISSN 1178-4164