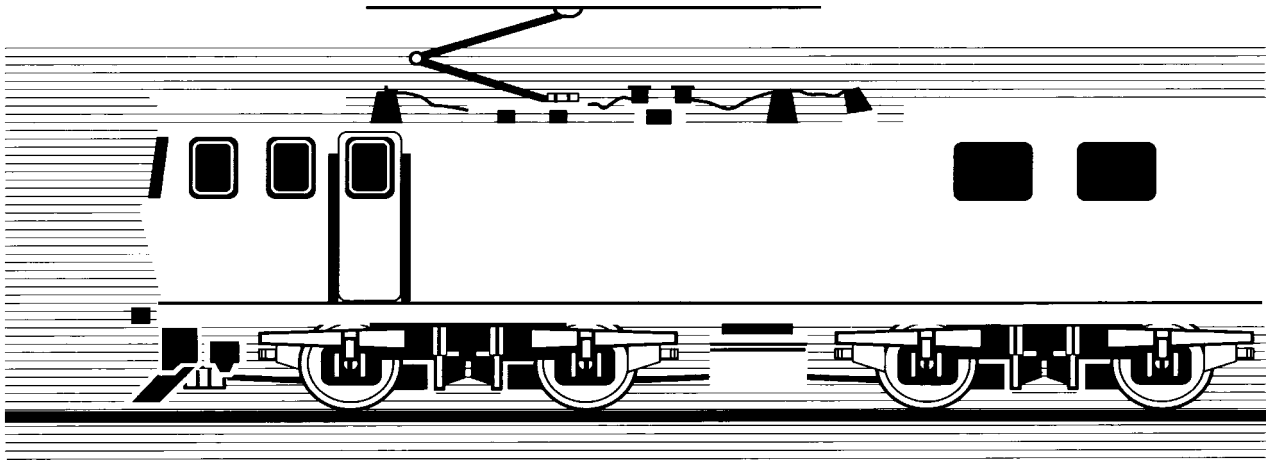
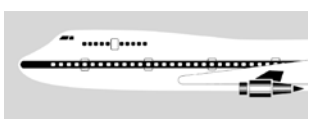
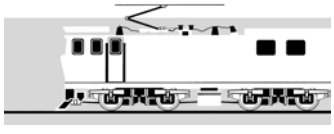


RAILWAY OCCURRENCE REPORT

02-104	Express freight and passenger trains, derailments or near derailment due to heat buckles, various localities	21 December 2001 to 28 January 2002


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 02-104

passenger express, Train 802, Aickens, 21 December 2001
express freight Train 847, Ikamatua, 27 January 2002
express freight, Train 820, Aickens, 28 January 2002

derailments and near-derailment due to track buckles 2001/2002

Abstract

This report examines 3 separate track buckle occurrences on the South Island coal route during the summer of 2001/2002. Two of the track buckles resulted in derailments. Safety issues identified by these incidents included:

- the need for staff training to ensure they recognise and respond to visible track defects
- the need to protect continuous welded rail, formed at unknown neutral temperature
- the need to control tamping and lining to ensure track is not realigned leaving increased compressive stress in the rails.

In view of the safety actions taken and the safety recommendations previously made to the operator to address these issues, no further safety recommendations are included in this report.

Contents

Figures

Abbreviations

C	Celsius
CWR	continuous welded rail
kg/m	kilograms per metre
km	kilometre(s)
km/h	kilometres per hour
lb/yd	pounds per yard
m	metre(s)
mm	millimetre(s)
t	tonne(s)
Tranz Rail	Tranz Rail Limited

Data Summary

Rail Occurrence No	Train	Date	Time[1]	km & Line	Locality
02-104	passenger express 802	21/12/01	1700	138.4 Midland Line	Aickens
02-105	express freight 847	27/1/02	1520	35.62 Stillwater-Westport Line	Ikamatua
02-106	express freight 820	28/1/02	1350	142.32 Midland Line	Aickens

Injuries: crew: nil
passengers: nil

Damage: Various track and wagon damage

Operator: Tranz Rail Limited (Tranz 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.

1 Introduction

1.1 Background

1.1.1 During the summer of 2001/2002 a number of track buckles occurred on continuous welded rail (CWR) on the South Island coal route, causing derailments or near derailments. Because of the commonality, 3 investigations have been combined into a single report. The incidents are summarised below:

- Occurrence 02-104: On Friday 21 December 2001, the locomotive engineer of Train 802 reported a track buckle on the Midland Line between Jackson and Aickens. The train negotiated the buckle without mishap, although it vibrated violently, and there were no injuries to passengers or crew.

- Occurrence 02-105: On Sunday 27 January 2002, 2 empty coal wagons at the rear of Train 847 were derailed near Ikamatua on the Stillwater -Westport Line due to a track buckle. There were no injuries to the crew.

- Occurrence 02-106: On Monday 28 January 2002, the 6th of 20 loaded coal wagons on Train 820 derailed on the Midland Line between Jackson and Aickens due to a track buckle. There were no injuries to the crew.

1.1.2 The factual information and analysis applicable to each incident is dealt with separately, followed by an analysis summary and common sections covering findings and safety recommendations.

1.2 Continuous welded rail and track buckles

1.2.1 The formation of CWR is a well-established world-wide practice, and was first used in New Zealand in the early 1970s. There is no theoretical maximum length of CWR so rail length can potentially be measured in kilometres. As there are no joints in the body of the rail, it is necessary to compensate for the effects of temperature variation and dynamic train handling forces related to braking and acceleration by ensuring the rail is destressed to code requirements and ensuring that the track structure is strong enough to resist the compressive forces.

1.2.2 In addition to specific requirements for rail, sleepers, fastenings, ballast and alignment, it is essential that CWR is formed so that there are no internal longitudinal forces in the rail at a defined rail temperature, usually referred to as the "neutral temperature". When the ambient rail temperature is below the neutral temperature, the longitudinal tensile forces in the rail are resisted by the fastenings connecting the rail to the sleepers, which are embedded in the ballast. When the ambient rail temperature exceeds the neutral temperature, poor sleeper condition, inadequate anchor pattern, light ballast section or recently disturbed track will reduce the ability of the track structure to resist being displaced in an outward (lateral) direction and increase the risk of the track buckling.

1.2.3 Tranz Rail had progressively raised the neutral temperature to its current level of 38ºC. Raising the neutral temperature decreased the possibility of track buckles but increased the possibility of tension failures (pull-aparts) during the cold weather.

1.2.4 Definitions contained in Tranz Rail's T200 Infrastructure Engineering Handbook:

(a) **Continuous Welded Rail (CWR):**
Rail welded into lengths of 40 m or more.

(b) **Tie Down Temperature:**
The temperature / neutral temperature at which the rail was tied down.
Must be greater or equal to 38ºC.

(c) **Rail Temperature**
Current rail temperature taken with thermometer or pyrometer on the web on the shaded side of the rail.

(d) **Neutral Temperature**
The temperature at which the rail has no internal longitudinal forces. The rail is not in compression (pushing together) or in tension (pulling apart). Currently 38ºC.

2 02-104, Train 802, Aickens, 21 December 2001

2.1 Factual Information

Narrative

2.1.1 On Friday 21 December 2001, Train 802 was the Greymouth to Christchurch *TranzAlpine* passenger express and consisted of 2 DX class locomotives in multiple hauling 10 passenger vehicles for a total tonnage of 297 t and length of 210 m.

2.1.2 The train was crewed by a single locomotive engineer who stated that as he approached a 330 m long, 300 m radius curve between Jackson and Aickens, "the track in front of me was just like plasticine. I was already travelling at a speed less than the posted 40 km/h temporary speed restriction and dared not touch the brake as the train shook violently when it passed over the buckle."

2.1.3 The locomotive engineer had already traversed 2 other track buckles since departing Greymouth and after he had negotiated this buckle at the 138.4 km he immediately contacted the train controller by radio and suggested that he close the Midland Line west of Aickens, until a special track inspection was carried out.

2.1.4 The train controller agreed to this suggestion and Train 802 continued its journey to Christchurch without encountering any further track buckles.

Site information

2.1.5 The CWR track at the track buckle site consisted of 1991, 50 kg/m rail on 1987 treated pinus radiata sleepers with Type R fastenings[2] and 4 rail anchors[3] at every fourth sleeper. The ballast section consisted of good clean ballast with full cribs and a 200 mm shoulder width on the high leg of the curve. The track was on a 1 in 60 rising gradient in the direction of travel of Train 802.

2.1.6 The track buckle affected about 16 m of track and the maximum lateral movement was measured at 120 mm. A rail temperature of 38ºC was recorded at the site, and when the rail had cooled to 22ºC about 30 mm of rail was cut and removed from the curve.

2.1.7 Tranz Rail's Infrastructure Engineering Handbook T:200 prescribed a minimum depth of 300 mm of ballast under the sleeper for new ballast section for CWR and a shoulder width of between 300 mm and 350 mm flush with the top of the sleeper (refer Figure 1). The specified shoulder width was the same standard as for maintaining existing track.

[2] A ribbed, cantered bedplate with screw spikes
[3] Rail anchors are placed against sound timber sleepers in a prescribed pattern to control the movement of the rail through conditions generated by temperature, traffic, grade and train handling dynamics

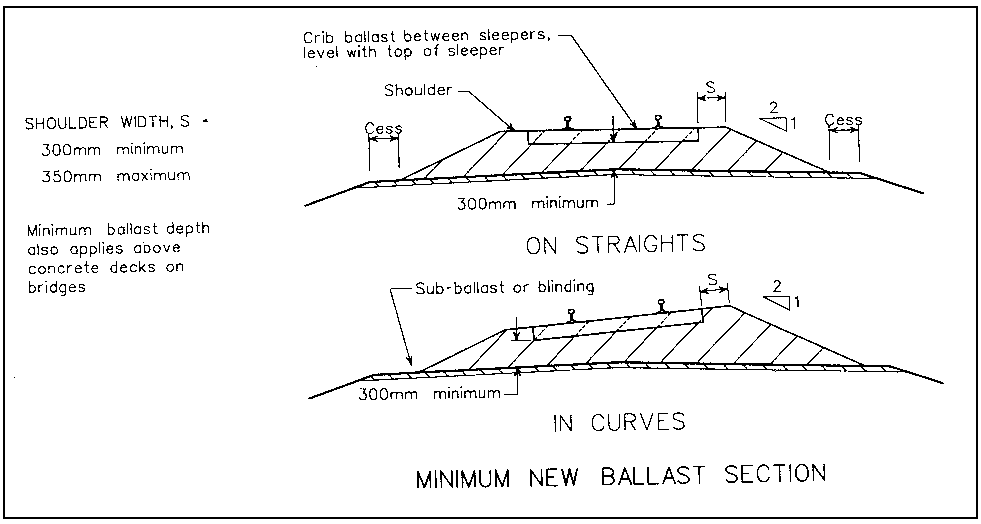


Figure 1
Minimum new ballast section
(diagram from Tranz Rail Infrastructure Handbook, courtesy of Tranz Rail)

2.1.8 The track was formed into CWR and destressed with the rail heaters on 27 November 1996. Tranz Rail records indicated the "tie down" or neutral temperature was 32ºC.

2.1.9 The track buckle occurred at the entrance to a 300 m radius right-hand curve (in the direction of travel). Three previous track buckles had been recorded on this curve since the formation of CWR in late 1996.

Machine production tamping

2.1.10 Tranz Rail operated 2 types of production tamper in the South Island, with different lining capabilities, namely:

- Fairmont Mark 3 tamper fitted with a computerised track lining system known as "compuline' (trade name)
- Plasser Continuous Action tamper fitted with an automatic geometry guidance system.

2.1.11 Transfield Services Infrastructure (New Zealand) Ltd[4] advised that the compuline system measures and records the length of the curve and then produces a model of the curve and a solution termed 'best-fit'. The solution ensures rail is not added or subtracted to the curve. Recording measurements from offset pegs on selected curves has validated the reliability and consistency of the compuline system.

2.1.12 Transfield Services Infrastructure (New Zealand) Ltd also advised that when Tranz Rail took delivery of the Plasser Continuous Action tamper about 11 years ago, it was fitted with automatic geometry guidance system. Plasser did not commission the lining system because the information generated was found to be unreliable. This reliability was not sufficiently enhanced by a subsequent software upgrade. Plasser, the manufacturer, deemed the system to be guidance only, and not a tool for generating solutions to curves. It could not be relied upon for ensuring rail was not added to the curve. With the automatic geometry guidance system switched off, the Plasser machine uses a 2 wire lining system for the curves, where the machine measures the versine over its own length.

[4] Infrastructure service provider for Tranz Rail

2.1.13 Tranz Rail advised that the track had last been machine tamped and lined, with the Plasser Continuous Action tamper, on 8 November 2001 (6 weeks prior to the buckle) at a recorded rail temperature of below 27ºC. The curve had been tamped on 3 other occasions during the previous 3 years but there were no datums[5] on the curve to position the track.

Track inspections

2.1.14 Tranz Rail advised that the last detailed track inspection over the area on 20 December 2001, had revealed no track issues at the buckle location. The Track Inspector's condition summary report had a Priority 2 (programme for maintenance) entry, dated 2 April 2001, which identified bad rail burns between 138.3 km and 138.4 km.

2.1.15 Tranz Rail track code (the code) clause P22 Special Inspections stated that:

> In times of danger special inspections shall be carried out.
> Length Gangers must arrange for such inspections as considered necessary to safeguard the passage of trains when:
>
> - There is a likelihood of damage or obstruction to the line due to storm, flooding, earthquake, fire or wind;
> - There is a risk to trains from any other cause, such as track damage from defective rolling stock, dragging equipment, and overgauge or displaced loads;
> - There is a possibility of track buckles.

2.1.16 A special inspection in compliance with this instruction had not been carried out on the day of the incident, although the rail temperatures were such that track buckles were a possibility.

Special temporary speed restrictions

2.1.17 On 19 December 2001, 2 days prior to the track buckle, a temporary speed restriction of 40 km/h was imposed on the section of track from the 138 km to 140.6 km Midland Line because of the need to carry out rail joint repairs.

2.1.18 To limit the consequences of track buckling, the Tranz Rail safety system included the use of Heat 40 speed restrictions. These were dormant 40 km/h speed restrictions posted on defined sections of track and activated when there was a risk of track misalignment due to high rail temperatures. The Heat 40 restrictions could either be activated by train control following the triggering of a heat sensor alarm[6] or on advice from track staff, based on hot rail conditions. Their use was covered by Semi-permanent Bulletin No. 759 dated 24 October 2001, a copy of which is attached as Appendix 1.

2.1.19 Tranz Rail had not considered the curve to be susceptible to heat buckles, and it was therefore not listed as requiring any speed restriction in the event of hot rail conditions. The sites at which the Heat 40 speed restriction must be applied were listed in Semi-permanent Bulletin No. 951 dated 20 December 2001, a copy of which is attached as Appendix 2.

2.1.20 The closest heat sensor was located at Aickens (less than 2 km from this recorded buckle) and the trigger temperature was set at 40ºC. The sensor sent an over-temperature radio alert to train control at 1257 on 21 December 2001 and the Heat 40 restrictions identified in Bulletin No. 951 were activated. The locomotive engineer confirmed that he had been advised by train control of the Heat 40 restrictions.

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[5] A trackside reference post used to position the track

[6] A trackside radio unit fitted with a thermocouple that measures rail temperature. When a pre-set temperature is detected by the unit, a radio alert is sent to train control and an announcement is broadcast on the local radio channel for trains in the vicinity to hear.

Personnel

2.1.21 Train 802 was driven by a suitably qualified Grade 1 locomotive engineer with 39 years experience.

2.1.22 All staff involved with track inspection and maintenance on gang length MD3 (from 129.3 km to 191 km Midland Line) were appropriately qualified, each with many years of local knowledge and experience.

Analysis 1

1. A general track weakness had been recognised on 19 December 2001. An appropriate temporary speed restriction was imposed between 138 km and 140.6 km and caution boards were erected.

2. The ballast profile was inadequate in that the shoulder section was less than the code requirement and this contributed to the lowering of resistance to buckling during hot rail conditions.

3. The rail anchor pattern was also inadequate and did not meet Tranz Rail's Infrastructure Handbook requirements, which were that for grades steeper than 1 in 100, rail anchors should be installed in box pattern on every second sleeper. The reduced number of rail anchors installed lowered the resistance to buckling.

4. A possible contributing factor to the track buckle was increased compressive stress developed as a result of nett downhill[7] movement of the track from traffic and during maintenance work since 1996. Repetitive tamping and realignment of the curve during the previous 3 years and most recently within 6 weeks of this reported track buckle, had probably caused, over time, the lowering of the effective neutral temperature by downhill movements of the track. Three previous track buckles had been reported on this curve since 1988. There was no evidence that datums were being used to ensure that the track was positioned in its stress-free design alignment.

3 02-105, Train 847, Ikamatua, 27 January 2002

3.1 Factual Information

Narrative

3.1.1 On Sunday 27 January 2002, express freight Train 847 was a westbound Christchurch to Ngakawau empty coal train and consisted of 2 DX class locomotives in multiple hauling 20 empty coal wagons for a total tonnage of 378 t and length of 356 m. The train was crewed by 2 locomotive engineers.

3.1.2 At about 1520, Train 847 was travelling at about 50 km/h around a right-hand curve at 36.65 km on the Stillwater – Westport Line, north of Ikamatua, when the locomotive engineer observed a "little kick" in the track about 50 m ahead of the train. He reduced power and later said "the train appeared to travel through the kick very well and no excessive surge was felt".

3.1.3 About 400 m after negotiating the kick, the locomotive engineer noticed a reduction in brake pipe pressure and he stopped the train. The assisting locomotive engineer walked back to find the cause and found that the two rear wagons on the train had derailed. The brake pipe was broken between them which had resulted in the loss of air. The leading axles of the trailing bogies of both of these wagons had derailed but the wagons had remained upright and attached

[7] In the direction towards the centre of curvature

to the train. The locomotive engineer called train control by radio and advised of the track buckle derailment.

Special temporary speed restrictions

3.1.4 Heat 40 restrictions (refer Appendix 3) on the Stillwater – Westport Line had been activated on 27 January in full but no restriction was in place at the location of this particular track buckle.

Site information

3.1.5 A loaded coal train had travelled through the track buckle site some 30 minutes earlier but its locomotive engineer had not noticed any misalignment.

3.1.6 The track buckle occurred 80 m into a 200 m long, 400 m radius right-hand curve on a rising gradient of 1 in 330 in the direction of travel of Train 847.

3.1.7 The track in the area of the derailment consisted of 1992, 50 kg/m rail in 38 m lengths on 1989 treated pinus radiata sleepers with Type R fastenings. There was a full ballast section with a shoulder width of 300 mm.

3.1.8 The track buckle occurred within 6 m of a bolted joint and affected about 5 m of track. The ganger could not recall any previous track buckles on this curve and there were no entries of such in Tranz Rail's Track Database.

3.1.9 Although the ballast profile complied with the code, a localised "mud spot"[8] had developed on the low leg of the curve near the track buckle point.

3.1.10 On arrival at the derailment site, at about 1600 the track ganger recorded a rail temperature of 47ºC and an air temperature of 32ºC.

3.1.11 On 16 October 2001, a track evaluation was conducted, which showed that the line and top on the derailment curve was within code.

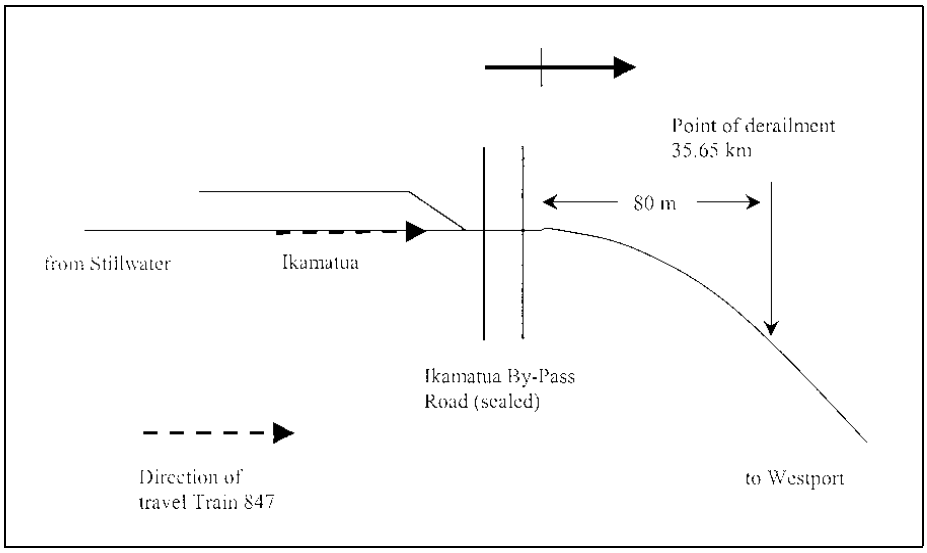

Figure 2
Site plan of track buckle derailment at Ikamatua
(not to scale)

[8] A localised section of track ballast contaminated by fine material

3.1.12 Ikamatua Bypass Road crossed the track at the southern entry to the curve while at the northern end the 50 kg rail of the curve butted on to CWR straight track which consisted of 75 lb/yd rail on 1987 treated pinus radiata sleepers with Type A[9] fastenings. Tranz Rail's code permitted Type A fastenings on CWR straights and curves of 1000 m radius or more, but 4 rail anchors must be installed at every second sleeper. The CWR had been neither destressed nor anchored.

3.1.13 Following the derailment, 200 mm of rail was cut and removed from the high leg and 150 mm from the low leg of the derailment curve.

Track inspections

3.1.14 The last detailed track inspection over the area had been on 25 January 2002 and the inspector identified no track issues on the derailment curve at that time. His condition report summary had a Priority 2 entry, dated 4 May 2001 which identified a rotten sleeper within the curve.

3.1.15 In accordance with the track code, the length ganger had carried out a special inspection during the afternoon of 27 January 2002, because of the risk of possible track misalignment as a result of hot rail conditions. He had identified 2 other locations with track misalignment and imposed 25 km/h temporary speed restrictions at these locations in addition to the Heat 40 restrictions already in effect on his section. The point of derailment was not included within these additional sites.

Locomotive event recorder

3.1.16 The locomotive event recorder data extracted following the derailment showed that the train was travelling at about 55 km/h immediately prior to the derailment, which was 5 km/h faster than the maximum authorised line speed.

Personnel

3.1.17 Train 847 was driven by a suitably qualified Grade 1 locomotive engineer with 17 years experience, including considerable experience at handling coal trains on this route.

3.1.18 The track ganger had approximately 20 years railway experience and had been an appointed ganger on the section for 6 years.

3.1.19 The acting track inspector was an appointed ganger, who had attended and successfully completed a track inspector training course. He had a total of 20 years railway experience from 2 separate periods of employment.

Analysis 2

1. The track buckle was probably initiated at the mud spot by the loaded coal train that had negotiated the curve about 30 minutes before Train 847. Mud had infiltrated the ballast under the sleepers which would have encouraged pumping (vertical movement of the track under load) and reduced the lateral stability.

2. The Type A fastenings provided limited longitudinal restraint to the rail on the adjacent straight, and with loaded coal trains travelling down the gradient, the sealed level crossing some 80 m south of the buckle site, provided an anchor point. This anchor point prevented rail creep continuing in the direction of the loaded trains but allowed rail stresses to build up in the curve, increasing the probability of track buckling during hot rail conditions. The lack of anchors on the straight adjacent to the derailment curve lowered the resistance to track buckling.

[9] Spring clip with screw spike

3. Rail creep introduced large compressive forces into the curve, which became so great with thermal expansion on a particularly hot day that the lateral resistance of the track structure was exceeded and the track buckled.

4. The train was travelling about 5 km/h above the authorised line speed but the increased speed had no influence on the cause of the track buckle and was unlikely to have contributed to the resulting derailment.

4 02-106, Train 820, Aickens, 28 January 2002

4.1 Factual Information

Narrative

4.1.1 On Monday 28 January 2002, express freight Train 820 was an eastbound Ngakawau to Christchurch loaded coal train and consisted of 1 DC class locomotive and 1 DX class locomotive in multiple hauling 20 full coal wagons for a total tonnage of 1300 t and length of 356 m. The train was crewed by a single locomotive engineer.

4.1.2 The locomotive engineer had earlier driven Train 847, an eastbound empty coal train, from his home depot of Christchurch to Jackson where he had changed on to Train 820 for his return to Christchurch. He had not observed any signs of track misalignment at the track buckle site on his outward journey.

4.1.3 At about 1350, shortly after departing Jackson on the homeward journey, Train 820 was leaving a 300 m radius curve and entering a 260 m radius curve at about 142.4 km when the locomotive engineer "… spotted a heat buckle. It was too late to brake, and I thought if I put the brake on, everything will lock up and there is more risk of derailing than there was with trying to ride it out".

4.1.4 The locomotives and first 5 wagons successfully negotiated the track buckle but the trailing bogie of the sixth wagon derailed although the wagon remained upright and attached to the train. The remaining 14 wagons safely negotiated the track buckle without derailing.

Site information

4.1.5 The CWR track in the area of the derailment consisted of 1986, 50 kg/m rail on 1983 treated pinus radiata sleepers with Type R fastenings. The CWR was formed in 1997, and the rail was stretched with rail tensors to a tie-down temperature equivalent to 28ºC, which was within Tranz Rail's specified neutral temperature range at that time. The ballast cribs were not full and therefore the ballast profile did not comply with Code requirements. (Refer Figure 1).

4.1.6 The derailment occurred on a 260 m radius curve on a rising 1 in 130 gradient. The acting track inspector had inspected this section of track earlier in the day and had identified no maintenance issues.

4.1.7 When the CWR was formed on the derailment curve, the actual tie-down temperature was not recorded on the destress form, nor was it required to be, although the track database had a value of 28ºC recorded. The calculation for the rail extension required to simulate a tie-down temperature of 28ºC gave a value of less than what it should have been.

4.1.8 The adjacent curve had been re-railed and destressed in January 2001 using rail heaters but the calculation for the rail extension required to simulate the neutral temperature of 38ºC gave a value less than the correct value.

4.1.9 There had been no previous track buckles recorded on this curve since the formation of CWR in 1997. It had been tamped and lined by the Continuous Action tamper during November 2001, some 2 months prior to the heat buckle derailment.

4.1.10 An air temperature of 30ºC and a rail temperature of 46ºC was recorded at the derailment site at 1630 hours, about 150 minutes after the derailment.

Special temporary speed restrictions

4.1.11 The rail heat detection sensor located at Aickens (137 km) had sent an over-temperature radio alert to Train Control at 1224 on 28 January 2002. The trigger temperature was set at 40ºC. On receipt of the radio alert, train control activated the Heat 40 restrictions identified in Bulletin No. 64, attached as Appendix 3. The first Heat 40 restriction that was applicable to Train 820 was located at 96.7 km, about 40 kms closer to Christchurch.

4.1.12 Train 847 passed through Aickens after train control had received the alert from the rail heat detection sensor but the locomotive engineer stated that he "…had not been advised that the alarms had gone off".

Track inspections

4.1.13 A special inspection in compliance with the track code had been carried out on the derailment curve before the passage of Trains 847 and 820, but no track misalignment had been identified.

Locomotive event recorder

4.1.14 Following the derailment, the locomotive event recorder data was extracted and confirmed that Train 820 was travelling at 45 km/h. This was within the maximum authorised track speed as it approached the derailment curve.

Personnel

4.1.15 Train 820 was driven by a suitably qualified Grade 1 locomotive engineer with 37 years experience.

4.1.16 The acting track inspector was an appointed ganger who had attended and successfully completed a track inspector training course. He had a total of about 20 years railway track experience from 2 separate periods of employment.

4.1.17 The track ganger was experienced in all aspects of track maintenance and had been a section length ganger for nearly 10 years.

Analysis 3

1. The probable causes of this track buckle and the subsequent derailment were:

   - the incomplete and inaccurate destress records, which resulted in an unknown effective tie-down temperature less than the code requirement
   - recent disturbance of the track due to tamping. The curve had been tamped and lined but there was no evidence that datums were used to return the track to its stress-free alignment, thus introducing additional compressive forces.
   - a substandard ballast profile, which provided a reduced sleeper resistance to lateral movement.

5 Analysis Summary

1. A review of the features associated with these 3 occurrences showed:

   - none of the 3 track buckle sites had been identified as a potential weakness to be activated under Heat 40 speed restriction conditions, although one site had a 40 km/h temporary speed restriction imposed 2 days previously
   - 2 buckles occurred on CWR and one on track not meeting Tranz Rail's definition of CWR but caused by adjoining CWR
   - both the CWR sites had been disturbed by tamping and lining shortly before the incidents, which possibly resulted in downhill movement of the track, which introduced additional compressive forces
   - one of the CWR sites had a history of track buckles and the other CWR site had an unknown neutral temperature
   - the ballast profile on the CWR sites did not comply with the code
   - none of the 3 sites had datums to which the stress-free design alignment could be pulled.

2. Arising from these features are the following safety issues:

   - the need for staff training to better enable them to recognise and respond to visible track weaknesses
   - the need to determine the neutral temperature of all CWR sites and protect the "at risk" sites until such time as they can be destressed.
   - the need to control tamping and lining in such a way that it does not introduce longitudinal stress into the track.

6 Findings

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

6.1 02-104, passenger express train 802, Aickens, 21 December 2001

6.1.1 A potential track weakness in the area had been recognised and a 40 km/h temporary speed restriction imposed over a 2.4 km length, which included the track buckle site, 2 days before the track buckle occurred.

6.1.2 The ballast profile was less than that required to ensure stability of CWR.

6.1.3 The rail anchor pattern was less than that required for CWR track on a 1 in 60 gradient.

6.1.4 The disturbance of the track during recent maintenance tamping had possibly realigned the track and placed the CWR track under increased compressive stress which increased the likelihood of track buckles in hot rail conditions.

6.1.5 Three previous buckles had been recorded on this curve since the formation of CWR in late 1996.

6.2 02-105, freight train 847, Ikamatua, 27 January 2002

6.2.1 The Tranz Rail safety system had not recognised the potential weakness of this area and therefore not ensured that appropriate restrictions were in place during hot rail conditions.

6.2.2 Rail creep down the gradient in the direction of the heavy traffic flow was not sufficiently restrained by the Type A fastenings on the adjacent CWR track which was neither destressed nor anchored.

6.3 02-106, express freight train 820, Aickens, 28 January 2002

6.3.1 The Tranz Rail safety system had not recognised the potential weakness of this area and therefore not ensured that appropriate restrictions were in place during hot rail conditions.

6.3.2 The disturbance of the track during recent maintenance tamping had possibly realigned the track and placed the CWR track under increased compressive stress which increased the likelihood of track buckles in hot rail conditions.

6.3.3 Incomplete and inaccurate destress records resulted in the formation of CWR at an unknown neutral temperature.

7 Safety Actions

7.1 Following these occurrences Tranz Rail redesigned the destressing form to incorporate tie-down temperature information, and a copy of the new form is attached as Appendix 4. In view of this action, no safety recommendation has been made covering this issue.

8 Safety Recommendations

8.1 On 26 June 2001 the following safety recommendations made to the Managing Director of Tranz Rail relating to identification, protection and management of CWR sites at unknown neutral temperatures were included in Railway Occurrence Report 00-118 regarding derailments or near derailments attributable to heat buckles between 5 December 2000 and 2 March 2001.

8.1.1 carry out specific training to ensure key staff are aware of the vulnerability of sites that have an unknown neutral temperature, and the site deficiencies that justify inclusion of sites in “heat 40” lists (020/01)

8.1.2 quantify lengths of CWR that have an unknown neutral temperature and ensure they are assessed, and protected where appropriate until destressing can be arranged (021/01)

8.1.3 introduce alignment control procedures to ensure maintenance tamping does not result in an effective uncontrolled lowering of the neutral temperature of the rail (022/01)

8.2 On 16 July 2001 the managing director of Tranz Rail replied:

020/01: Tranz Rail accept this recommendation. Specific system wide training for track staff was carried out in March 2001. This training will be repeated in September 2001.

021/01: Tranz Rail accept this recommendation. These sites have been identified during a recent survey carried out to assist preparation of the de-stressing programme and to reconfirm sites requiring “heat 40” speed restrictions.

022/01: Tranz Rail accept this recommendation. This is currently under investigation.

8.3 On 31 August 2002, the managing director of Tranz Rail further responded to safety recommendation 020/01:

> The "Hot Weather Track Maintenance and Buckling Prevention" presentation to appropriate staff has been completed. This covered topics such as heat sensors, heat 40 speed restrictions, special track inspections and factors to consider when assessing buckle risk. In addition, forms have been altered to provide better site details when reporting track buckles. (020/01)

8.4 On 11 October 2002, the managing director of Tranz Rail further responded to safety recommendations 021/01 and 022/01:

> The hot rail stability analysis process* has addressed this recommendation. It has been completed on all passenger routes. It has been partially completed for other routes. Full completion for the network is planned by June 2003. (021/01)
>
> Instructions have been drafted to require monumenting of curves radius 400m or less to enable correct alignment to be maintained. This was also recommended in the Halcrow report. (022/01)

8.5 Also on 11 October 2002 the managing director of Tranz Rail advised that Tranz Rail had:

> … undertaken a complete review of CWR management practices over the last 6 months. This has resulted in some changes and improvements to past practice. Key points are summarised below.
>
> **CWR Management System**
>
> * CWR management practice has been reviewed internally. An external expert (Halcrow Pacific Ppty Ltd) has completed a review of Tranz Rail CWR management practice. Their report has been made available to the LTSA.
>
>   Key technical changes resulting from these reviews are:
>   * Design neutral temperature has been changed from 38 to 32 degrees celsius.
>   * Curves radius less than 400m will be monumented to enable design alignment to be maintained.
>   * A process for analysing CWR stability in hot rail conditions has been designed.
>
> * The hot rail stability analysis process for CWR has been implemented. This process uses information from Track Database supplemented by information from special field inspections to identify CWR locations which may be unstable in hot rail conditions. Actual rail stress free temperature determined by site measurement is incorporated into the analysis as this information becomes available.
>
> * The stability analysis enables prioritisation of destressing work to be done based on much improved information.
>
> * The stability analysis enable sites which will require heat restrictions in hot rail conditions to be identified based on much improved information.

* See paragraph 8.5 CWR Management System

Physical Progress

* destressing crews have been working over the winter to destress priority sites. To date 72km of destressing has been completed since April 2002.

* Rail temperature testing crews have been working over the winter to test actual rail stress free temperature. To date 370km of rail has been tested since April 2002.

* Both destressing and rail testing will continue over the summer. Productivity is likely to be reduced as these activities cannot be carried out when the rail temperature is high. Work methods are being reviewed to enable the work to be done at night and in the early morning.

* All passenger routes have been analysed using the stability analysis process described above. The information has been used to assist in establishing the heat restriction areas required for summer 2002/03.

Summer 2002/03

* The quantity of track to be held under heat restriction has increased compared to 2001/02 summer. This is due to the improved knowledge of CWR stability status obtained from the analysis process.

* Heat restrictions will have a significant operating impact this summer particularly in metro areas.

8.6 In view of the progress to date, and the ongoing programme to address these previous safety recommendations, no further safety recommendations have been made.

Approved for publication 27 November 2002

Hon. W P Jeffries
Chief Commissioner

Appendix 1

Network operations

WELLINGTON

BULLETIN NO. 759 (2 pages)
(Semi permanent)

TRANZ RAIL
24 October, 2001

CANCELLATION

Special Bulletin No.686 (Semi-permanent) dated 2 October,.2001 re Special Temporary Speed restrictions is cancelled.

NOTE: Where a paragraph is marked with a vertical line and the print is italic this indicates either it is a new instruction or if it was a previous change a further change has been made.

Special Temporary Speed Restrictions

Commencing **Forthwith** and continuing until further advised the following instructions will operate:-

Speed restrictions for various sections of track which could be at risk for possible misalignment during the following summer months will be included on separate speed restriction Bulletins as the conditions for their operation will be different to that provided for in a normal speed restriction situation.

1. Each restriction will have special outer speed boards erected. These 40km/h Speed Boards with their associated C or H and T boards will remain uncovered at all times and will be erected at positions as specified in Engineering Rule 912. These boards will have the facing side painted yellow with the word "HEAT" and the maximum speed to be run indicated in black, these letters and figures will be shadowed in yellow reflecting material.
   The C and T boards with yellow reflectorised tape on the outer edges are currently being replaced by diamond shaped white reflectorised boards.
   The letter on the "C" board is replaced with an "H"; the letter on the "T" board remains the same.
   Engineering Rule 912 (e) is modified accordingly.
   Where ordinary speed boards need to be used this will be notified on the special temporary speed restriction area Bulletin.

2. The restrictions will only apply on a daily basis when the Ganger for each length advises Train Control. Either **all** the restrictions within each Ganger's length will apply or none at all. The speed restrictions will normally remain in operation until 2100 hours unless Train Control is otherwise advised by the respective Ganger in charge.

3. In areas where the special temporary speed restrictions operate **Locomotive Engineers Must Call Train Control Between 1100 Hours And 2100 Hours Each Day** to ascertain which restrictions are in force, this includes when entering each Train Control area. A space will also be provided on the special temporary speed restriction area Bulletin for Locomotive Engineers to identify the restrictions which will apply.

   Exception-For Locomotive Engineers working multiple units in the Wellington and Auckland suburban areas, and the special temporary speed restrictions are in operation Train Control/Authorities will fax a Bulletin with the updated relevant details to the Platform Co-Ordinator, Wellington, Paekakariki Tranz Metro, Officer in Charge Upper Hutt, Operations Supervisor, Auckland station , or Travel Services Officer, Papakura as the case may be; in addition the Auckland suburban bulletins will also be faxed to the Terminal Supervisor/Team Leader, Westfield. At these locations bulletins are to be attached to the notice/clipboard concerned.

It Will Be The Responsibility Of The Locomotive Engineers Working Multiple Units To Check The Notice/Clipboard Before Each Journey (unless local instructions advise otherwise). Rule 21 is modified accordingly.

NOTE: At Auckland station the staff may need to advise Locomotive Engineers working multiple units not breaking their journey of any speed restrictions which have been recently notified to ensure they are aware of the restriction.

Special Temporary Speed Restrictions - Continued

4.Train Control Responsibilities are:-
"Train Control is to have a fresh copy of these Bulletins available each day and the relevant details completed when advice is received from the respective Ganger. As each train is advised of restrictions in force, Train Control will record the details on the Train Control diagram.
·Ensure Locomotive Engineers Required In Clause 3 To Call Train Control Before Starting Their Journey Have Received The Current Special Temporary Speed Restriction Information.
·If Any Train Is Enroute And In A Speed Restriction Area At The Time Then Train Control Must Advise The Locomotive Engineer/S Concerned.
·When Through Trains Are Running Into A Train Control Area, Train Control Must Ensure The Locomotive Engineer Is Aware Of The Current Special Temporary Speed Restriction Areas.

5. Terminal Managers are to ensure that sufficient copies of each applicable Bulletin are provided to Locomotive Engineers so as to ensure that a fresh copy is available each day for Locomotive Engineers to endorse particulars of restrictions in force.

Appendix 2

Network operations

WELLINGTON

BULLETIN NO. 951
(Semi-permanent)

TRANZ RAIL
20 December, 2001

CANCELLATION

Bulletin No.942 (Semi-permanent) dated 20 December, 2001, re Special Temporary Speed restrictions is **cancelled**.

To be read in conjunction with Bulletin No.759 (Semi-permanent) dated 24 October 2001 re arrangements for Special Temporary Speed Restrictions.

Special Temporary Speed Restriction Areas.

Commencing **forthwith** and continuing until further advised the following instructions will operate:

When advised by Train Control the speed of ALL trains over portions of the line shown below **must not exceed 40 km/h,** (except where a lower speed restriction is in place at/within the specified restriction). The restrictions will normally cease at 2100 hours unless Train Control is otherwise advised by the respective Ganger in charge.

Locomotive Engineers are reminded to contact Train Control:-

- **If on moving train at 1100 hours**
- **If departing from origin or crew changing between 1100 and 2100 hours**

Midland Line And S.W.L.

Metrages Between km km	Locations between	Train No. Advised	Time Advised	Date of Operation
Length Gang MD1 59.70 to 60.00 70.00 to 70.80	 Springfield and Staircase Staircase and Craigieburn			Tick in box if On ❑
Length Gang MD2 93.50 to 96.70	 Cass and Cora Lynn			On ❑
Length Gang MD3 188.40 to 188.55	 Within station limits Kokiri			On ❑
Length Gang MD4 Midland Line **Stillwater – Wesport Line** 3.55 to 3.85 10.05 to 10.55	 Stillwater and Ngahere Kopara Sawmill Sdg and Matai			On ❑
Length Gang SW1 22.40 to 22.80 74.45 to 74.80	 Ahaura and Totara Flat Cronadun and Inangahua			On ❑
Length Gang SW2 98.00 to 127.00	 Buller and Nine Mile			On ❑

Appendix 3

Network operations

WELLINGTON

BULLETIN NO. 64
(Semi-permanent)

TRANZ RAIL

TRANZ RAIL

24 January, 2002

CANCELLATION

Bulletin No.51 (Semi-permanent) dated 22 January, 2002, re Special Temporary Speed restrictions is **cancelled.**

To be read in conjunction with Bulletin No.759 (Semi-permanent) dated 24 October 2001 re arrangements for Special Temporary Speed Restrictions.

Special Temporary Speed Restriction Areas.

Commencing **forthwith** and continuing until further advised the following instructions will operate:

When advised by Train Control the speed of ALL trains over portions of the line shown below **must not exceed 40 km/h,** (except where a lower speed restriction is in place at/within the specified restriction). The restrictions will normally cease at 2100 hours unless Train Control is otherwise advised by the respective Ganger in charge.

Locomotive Engineers are reminded to contact Train Control:-

- **If on moving train at 1100 hours**
- **If departing from origin or crew changing between 1100 and 2100 hours**

Midland Line And S.W.L.

Metrages Between km km	Locations between	Train No. Advised	Time Advised	Date of Operation
Length Gang MD1 59.70 to 60.00 70.00 to 70.80 75.20 to 75.40	 Springfield and Staircase Staircase and Craigieburn Staircase and Craigieburn			Tick in box if On ❑
Length Gang MD2 96.00 to 96.70	Cass and Cora Lynn			On ❑
Length Gang MD3				On ❑
Length Gang MD4 **Midland Line** **Stillwater – Wesport Line** 3.55 to 3.85 9.50 to 10.55	 Stillwater and Ngahere Kopara Sawmill Sdg and Matai			On ❑
Length Gang SW1 22.40 to 22.80 74.45 to 74.80	 Ahaura and Totara Flat Cronadun and Inangahua			On ❑
Length Gang SW2 98.00 to 127.00	Buller and Nine Mile			On ❑

DESTRESSING

TRANSFIELD SERVICES

GANG LENGTH..... DATE:..... LINE:..... METRAGE: From.....km to .....km

RAIL WEIGHT lb kg	LH ☐ RH ☐	SLEEPERS: (✓) TPR ☐ HW ☐ CONC ☐	FASTENING TYPE:	GRADE: 1:	CURVE RAD

RAIL TEMPERATURE ☐

ANCHOR LENGTHS:

LENGTH UNCLIPPED: m	ANCHOR LENGTH: m	SLEEPER Nos. (End 1):	SLEEPER Nos. (End 2):	ANCHOR LENGTH: m

AMOUNT OF RAIL CUT OUT BEFORE TENSIONING ☐

CALCULATIONS OF PULL LENGTH FROM EXTENSION TABLE WITH **NEUTRAL TEMPERATURE** OF: ☐

PULLING POINT:		km			
DISTANCE OF PULLS (metres)		End 1 (mtr)		End 2 (mtr)	
Calculated Extension	500				
(from extensions table)	200				
refer Temperature (above)	100				
	50				
	10				
	5				
ADD UP CALCULATED EXTENSION			*a*		*b*

TOTAL RAIL MOVEMENT	a + b	=
Minus Existing Gap (when rail free)	e	-
Sub Total		=
Plus Weld gap to cut out		+25
TOTAL AMOUNT TO CUT OUT		

CHECKPOINT EXTENSIONS:

	UP PULL		DOWN PULL	
	Calculated	Actual	Calculated	Actual
¼ point extension				
½point extension				
Anchor length pull through				
Total Rail Movement each Pull				

TOTAL RAIL MOVEMENT ☐

11/09/2002

Pop marked monitoring points:

		Distance Apart	
c. Before Cut			(c)
d. At stress free state			(d)
e. Existing Gap when rail free	d - c		(e)
f. At completion of work			(f)
RAIL EXTENSION:	d - f		☐

Anchors Installed: Y (Ratio 1:) N P-type (circle one)

Closure Joint ☐ Welded ☐ Plated Ballast profile to code Y/N

Track Side Monuments installed. Creep Y/N Shift Y/N

Remarks:.....

.....

Signed:..... Gang.....

FOR OFFICE USE ONLY

Entered into TDB by:..... Date:.....

Calculated Neutral Temperature ☐

M37 for Bridges in section with CWR completed: Yes or Nil

Recent Railway Occurrence Reports published by the Transport Accident Investigation Commission

00-115	freight train 521, derailment, Westmere, near Wanganui, 22 September 2000
00-117	express freight Train 540, derailment, Kai Iwi, 26 November 2000
00-121	express freight Train 828 and express freight Train 951, collision, Middleton, 8 December 2000
00-118	express freight and express passenger trains, derailments or near derailments due to heat buckles, various localities, 5 December 2000 to 2 March 2001
01-101	passenger express Train 901 Southerner and stock truck and trailer unit, collision, Makikihi Beach Road level crossing between Timaru and Oamaru, 8 January 2001
00-123	Train 3130 and Train 3134, collision, Ellerslie, 28 December 2000
01-102	express freight Trains 237 and 144, derailment and collision on double-line track, Paerata-Pukekohe, 23 February 2001
01-104	express freight Train 547 and express freight Train 531, collision, Mokoia, 7 March 2001
01-106	express passenger Train 600 Bay Express and maintenance plant, collision, Muri, 6 May 2001
01-108	express freight Train 842, derailment, Otira Tunnel, 7 July 2001
01-109	passenger EMU Train 8203, doors open on EMU, Tawa, 16 July 2001
01-113	DC4185 light locomotive and private car, collision, Egmont Tanneries private level crossing 164.14 km Stratford, 19 September 2001
01-112	Shunt 84, runaway wagon, Stillwater, 13 September 2001
01-107	passenger baggage car Train 201, broken wheel, Otaihanga, 6 June 2001
01-111	passenger EMU Train 2621, door incident, Ava, 15 August 2001
02-107	express freight Train 530, collision with stationary shunt locomotive, New Plymouth, 29 January 2002
02-113	passenger express Train 700 TranzCoastal and petrol tanker, near collision Vickerman Street level crossing, near Blenheim, 25 April 2002

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