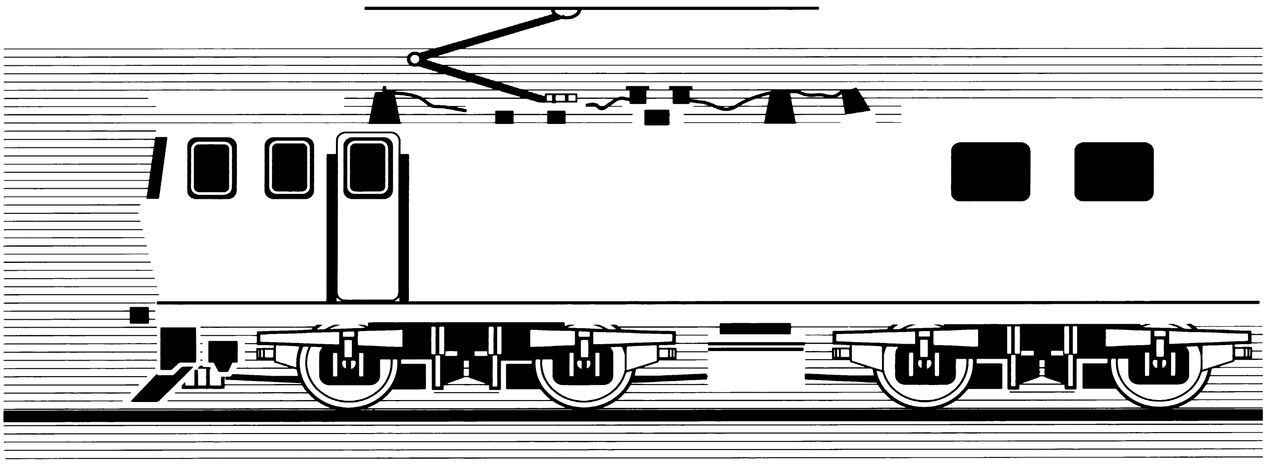
TRANSPORT ACCIDENT INVESTIGATION COMMISSION
TE KOMIHANA TIROTIRO AITUA WAKA



RAILWAY OCCURRENCE REPORT

03-104 express freight Train 380, derailment, near Taumarunui 16 February 2003

TRANSPORT ACCIDENT INVESTIGATION COMMISSION
NEW ZEALAND

Report 03-104

express freight Train 380

derailment

near Taumarunui

16 February 2003

Abstract

On Sunday 16 February 2003, at about 1823, seven wagons at the rear of northbound express freight Train 380 derailed while negotiating a right-hand curve between Taumarunui and Okahukura on the North Island Main Trunk. The curve was covered by a temporary heat restriction of 40 km/h and the train was travelling at about 85 km/h when the derailment occurred. A track buckle was triggered by the passage of the train travelling much faster than the authorised speed.

The safety issues identified included:

- the excessive speed of the train
- the train controller not recognising a fast run and advising the locomotive engineer
- the effectiveness of crew resource management
- a section of track left in a stressed condition for a significant period of time
- the non-standard set up of the locomotive event recorder.

Two safety recommendations have been made to the Chief Executive of Tranz Rail to address the issues.

Contents

Figures

Abbreviations

BRT	basic running time
CRM	crew resource management
CWR	continuous welded rail
hr	hour(s)
km	kilometre(s)
km/h	kilometres per hour
m	metre(s)
POD	point of derailment
SFT	stress free rail temperature
t	tonne(s)
TEM	train end monitor
Tranz Rail	Tranz Rail Limited
THR	temporary heat restriction
TSR	temporary speed restriction
UTC	coordinated universal time

Data Summary

Train type and number:	express freight Train 380
Date and time:	16 February 2003 at about 1823[1]
Location:	near Taumarunui
Persons on board:	crew: 2
Injuries:	nil
Damage:	extensive damage to wagons and track
Operator:	Tranz Rail Limited (Tranz Rail)
Investigator-in-charge	P G Miskell

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

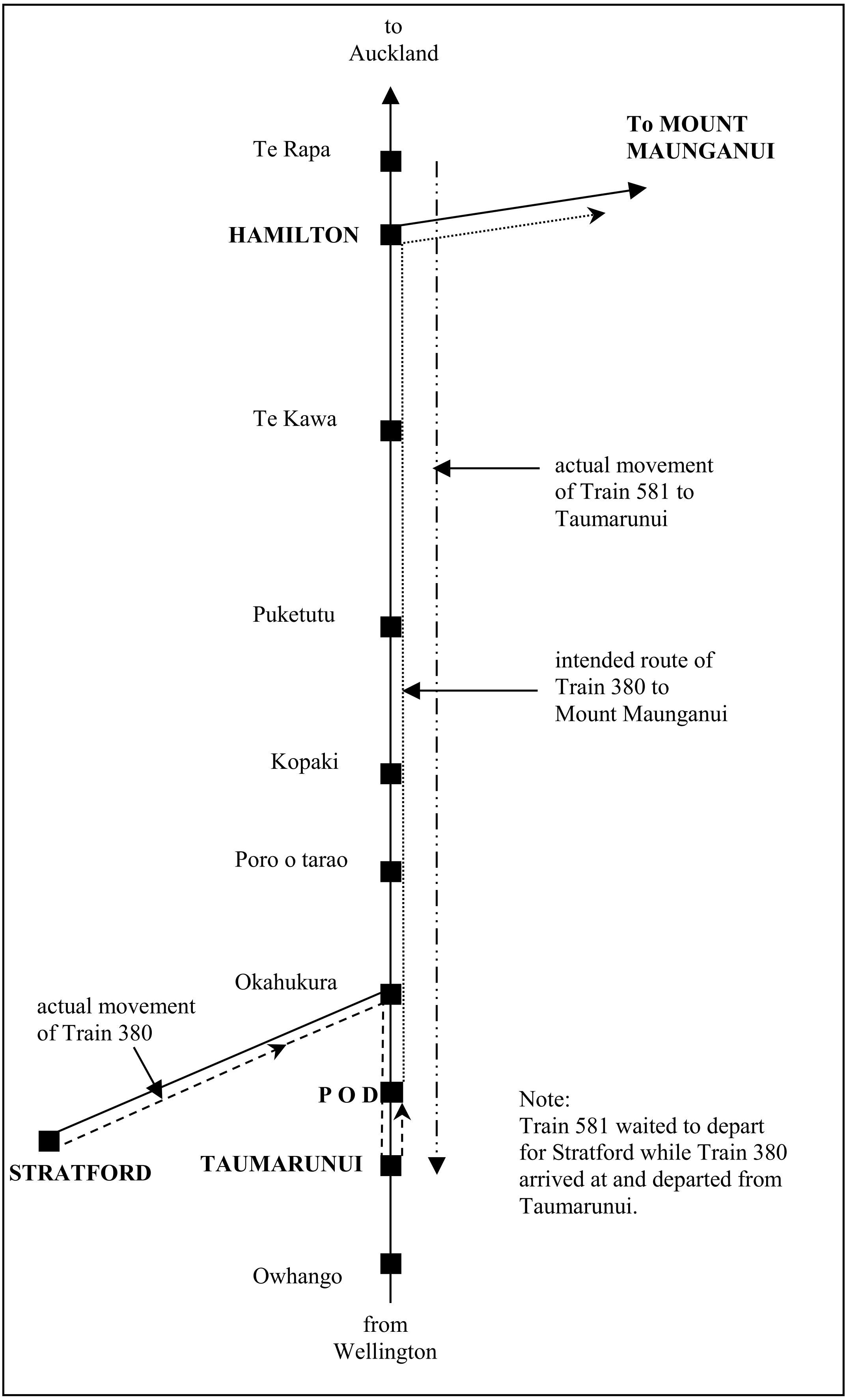


Figure 1
Owhango to Te Rapa track section (not to scale)

1 Factual Information

1.1 Narrative

1.1.1 On Sunday 16 February 2003, Train 380 was an express freight train travelling from Stratford to Taumarunui via the Stratford-Okahakura Line, then from Taumarunui to Mount Maunganui via Hamilton. Departing Taumarunui, the train consisted of electric locomotive EF30013 and 15 wagons for a total gross weight of 510 tonnes and length of 263 m.

1.1.2 The locomotive engineer had commenced his shift at Te Rapa at 1415. A second person had been called to work to assist the locomotive engineer when a train end monitor[2] (TEM) was not available at Te Rapa. Initially the locomotive engineer and second person had driven southbound express freight Train 581 from Te Rapa to Taumarunui. Train 581 consisted of electric locomotive EF30013 conveying 10 wagons for a total gross weight of 200 tonnes and a length of 182 m.

1.1.3 At about 1510, before departing Te Rapa, the locomotive engineer contacted train control for an update on the status of the heat restrictions en route and was informed that the temporary heat restrictions (THRs) between Te Rapa and Taumarunui were active and would remain so until 2100. The locomotive engineer had Bulletins No. 93 and 96 both dated 14 February 2003 (see Appendices 1 and 2) among his train work orders when Train 581 departed Hamilton at 1543. These provided general information about THRs and the location of the 18 individual THRs that would be encountered between Te Rapa and Taumarunui.

1.1.4 Train 581 arrived at Taumarunui at about 1800. Train 380 arrived from Stratford about 5 minutes later. The locomotives were exchanged between the trains and after a brake test Train 380 departed Taumarunui with the crew from southbound Train 581. Train 581 was due to depart for Stratford soon after Train 380 but because of the derailment of the latter its departure was delayed.

1.1.5 At about 1823, while travelling at about 90 km/h, Train 380 approached a curve that was covered by a THR. The train had negotiated about 180 m of the curve, slowing to about 85 km/h before the eighth wagon on the train derailed to the low-leg[3] side of the curve. By the time the locomotive and leading 7 wagons stopped, about 800 m past the point of derailment (POD), the train had split into 5 sections (see Figure 2).

1.2 Site information

1.2.1 The derailment occurred at 406.011 km between Taumarunui and Okahukura as Train 380 negotiated a 480 m radius right-hand curve (see Figure 3). The 314 m long curve was on a descending 1 in 239 gradient and was approached from a 400 m long straight at grade[4].

1.2.2 On 6 April 2002, concrete sleepers with standard pandrol "e clip" fastenings were laid to replace treated pinus radiata sleepers on the derailment curve. On 12 June 2002 a production tamper[5], fitted with a computerised track lining system known as 'compuline' (trade name) was used to lift and line the curve. The compuline system measured and recorded the length of the curve and produced a model of the curve and a solution termed 'best fit'.

---

[2] The train end monitor (TEM) consists of 3 distinct components, a transmitter, a battery pack and a bracket. Information regarding brake pipe pressure, last vehicle moving/stopped, marker light on/off, battery charge and battery voltage is transmitted to the locomotive at regular intervals.
[3] The low leg side of a curve is the side closer to the centre of curvature.
[4] Zero gradient, that is level track.
[5] On-track machinery used to vibrate and compact the ballast.

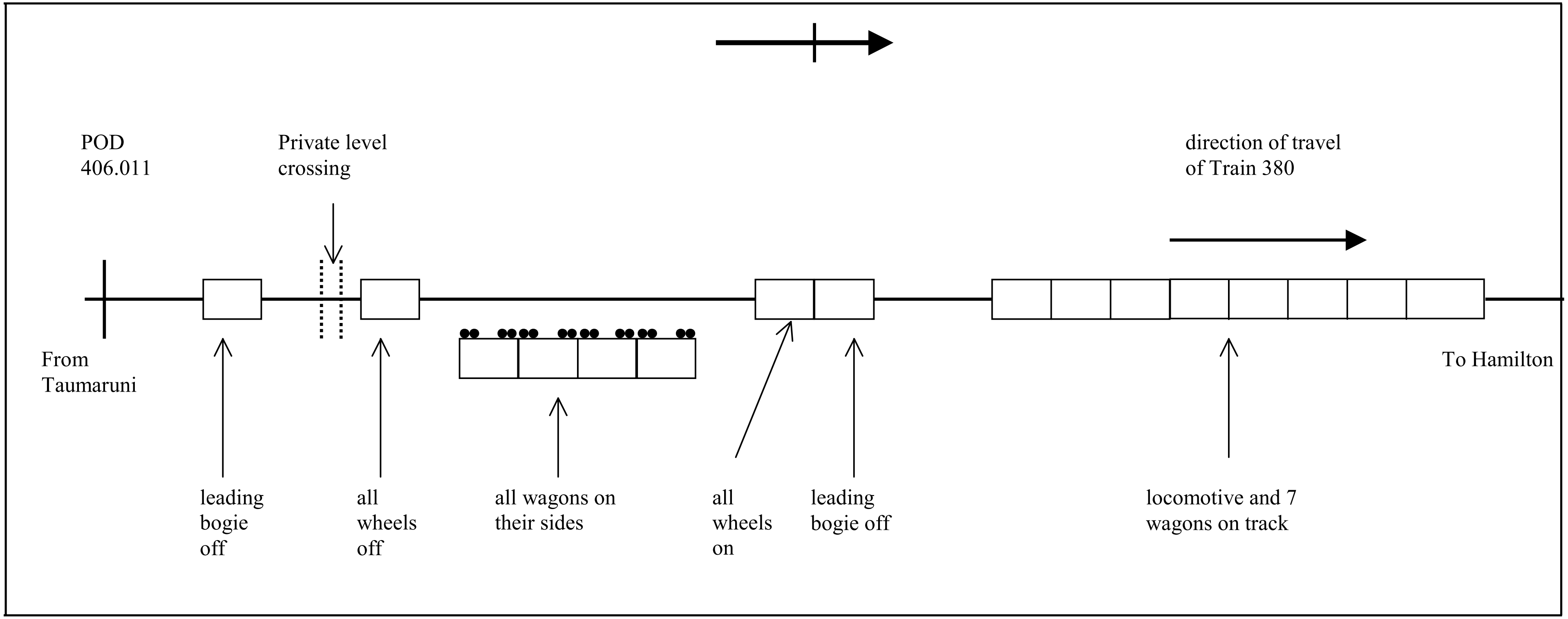
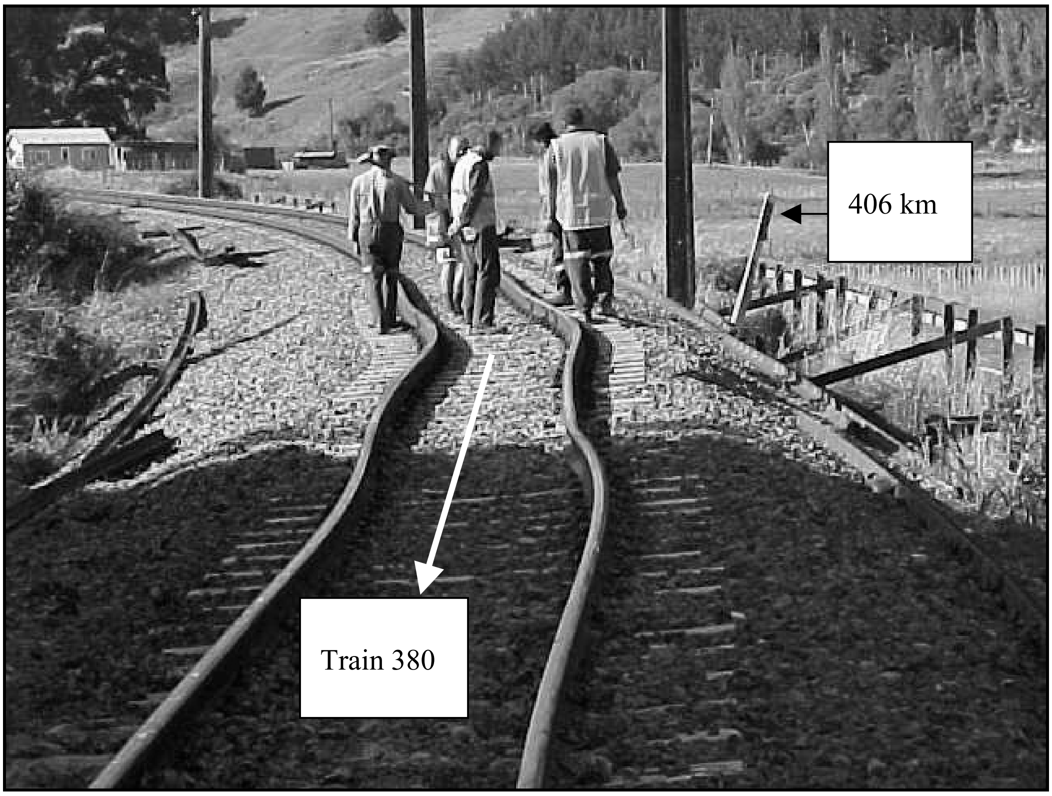


Figure 2
Location of wagons after the derailment



(Photograph courtesy of Tranz Rail)

Figure 3
Track at the point of derailment (looking south)

1.2.3 On 30 June 2002, new rail was laid in 153.4 m lengths on the derailment curve. A tie-down temperature of 18º C was recorded when the rail was fastened to the sleepers. However, because the Taurmarunui track gang's rail tensor[6] was being used on destressing work in Wellington, the track had not been destressed between the time of laying and when the derailment occurred.

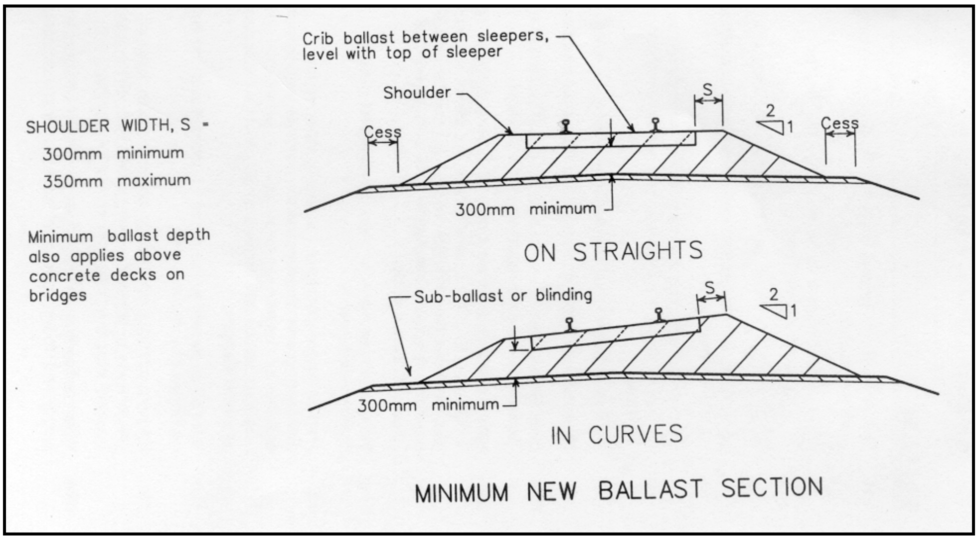
1.2.4 At the time of the derailment, the thermal expansion gap of the rail joint approximately 20 m past the POD was tight.

1.2.5 The clean crushed ballast had a depth of 300 mm under the sleeper at the POD. The cribs were full and the ballast shoulder width was 100 mm on the high leg, and 250 mm on the low leg. Tranz Rail standard specified a ballast shoulder width of between 300 and 350 mm on curved track to provide lateral restraint to the track structure. (see Figure 4).

1.2.6 The train crew did not observe any signs of track misalignment when they approached the derailment curve on Train 380 or earlier when on southbound Train 581.

1.2.7 The weather was fine and a rail temperature of 41º C was recorded near the POD at 1915.

[6] A rail tensor is used to stretch the rail to such length that would naturally occur at 32º C.



(diagram from Tranz Rail Infrastructure Handbook)

Figure 4
Minimum ballast profile

1.3 Continuous welded rail and track buckle prevention

1.3.1 The formation of continuous welded rail (CWR) is a well-established worldwide practice, and was first used outside tunnels 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 relating to braking and acceleration by ensuring the rail is destressed and the track structure is strong enough to properly resist the compressive and lateral forces.

1.3.2 In addition to specific requirements for rail, sleepers, fastenings, ballast and alignment, it is essential that CWR is formed at a defined rail temperature (neutral temperature) midway between the extremes of hot and cold likely to be encountered so that the rail is not subjected to either excessive tensile or compressive forces. When an ambient rail temperature is below the neutral temperature, the longitudinal tensile force in the rail is resisted by the fastenings connecting the rail to the sleepers that are embedded in the ballast. When the ambient rail temperature exceeds the neutral temperature, the combined lateral strength of the sleepers, fastenings and ballast prevent the track from buckling under the compressive forces. Poor sleeper condition, inadequate anchor pattern, light ballast section or recently disturbed track all reduce the lateral resistance of the track structure and increase the risk of track buckling.

1.3.3 Tranz Rail T200 Infrastructure Engineering Handbook Clause 451 stated in part:

(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.

(c) **Rail temperature:**
Current rail temperature taken with thermometer or pyrometer on the web on the shaded side of the rail. Magnetic thermometers should be left for 15 minutes to get an accurate reading.

1.3.4 Tranz Rail Code Supplement Permanent Way Section 31 stated in part:

Stress free	rail is stress free when it is not subjected to any thermal stresses. [The rail is not in compression (pushing together) or in tension (pulling apart)].
Neutral temperature	has been set at 32º C.

1.3.5 By measuring and calculating the in situ stress free rail temperature (SFT), Tranz Rail developed guidelines to identify sections of track that were at risk of buckling. These included:

- when the SFT was less than 23º C the track section was considered to be at risk of buckling and included in the Heat 40 TSRs
- when the SFT was between 23 ºC and 27º C the need for a Heat 40 TSR was dependent on site conditions such as destress history, ballast profile, alignment history, track disturbance, sleeper and fastening condition, rail movement and track geometry
- when the SFT exceeded 27º C there was no need for a Heat 40 TSR unless history determined the need for such restriction.

1.3.6 The benefits of imposing a THR were principally to reduce the dynamic lateral forces that may trigger track buckles in hot weather and to lessen the consequences of any derailment caused. Imposing a THR will not guarantee the track won't buckle should hot rail conditions occur.

1.3.7 On 10 December 2002 a SFT of 23º C was recorded on the left rail and 20º C on the right rail of the derailment curve. Therefore, the curve was identified as an at risk site and included on the THR list.

1.3.8 Tranz Rail Bulletin No. 96 identified 18 sites between Taumarunui and Hamilton, with a total length of 38.34 km, which were restricted to a maximum speed of 40 km/h when the hot rail conditions prevailed. The restricted train speed was to be maintained until the last wagon on the train cleared the limit of the restriction.

From (km)	To (km)	Length of speed restriction (km)
399.26	399.67	0.41
401.00	402.50	1.50
405.75	409.78	4.03
413.40	413.90	0.50
415.67	416.36	0.69
418.05	422.00	3.95
423.00	425.60	2.60
435.00	436.72	1.72
453.30	454.02	0.72
455.80	458.15	2.35
463.85	464.40	0.55
465.45	469.30	3.85
472.15	473.95	1.80
487.90	492.50	4.60
505.59	510.32	4.73
513.50	516.30	2.80
526.62	527.15	0.53
529.00	530.01	1.01

1.3.9 When the maximum line speed was reduced for THRs, a speed warning board (see example in Figure 5) was erected at least 1500 m in advance of the speed restriction board and displayed in such a position that locomotive engineers were able to gain a distant view of the board.

1.3.10 The inner speed board was a white diamond-shaped board with a black lettered "H" at the commencement of the restriction and "T" at the termination of the heat restricted track section (see Figure 6).

Figure 5
Special outer speed warning board for heat restrictions

1.3.11 An inspection of the speed boards after the derailment confirmed that the warning and speed boards for the THR were correctly positioned.

Figure 6
Temporary Heat Restriction board approaching the derailment curve

1.4 Other temporary speed restrictions between Hamilton and Taumarunui

1.4.1 In addition to the THRs that were in effect between Hamilton and Taumarunui at the time of the derailment, there were 5 other Temporary Speed Restrictions (TSRs) where the maximum line speed was reduced.

- 436.00 – 436.70 700 m 40 km/h
- 441.05 – 441.20 150 m 25 km/h
- 530.00 – 530.5 500 m 40 km/h
- 533.43 – 533.65 220 m 25 km/h
- 536.50 – 537.00 500 m 40 km/h

1.5 Route information

1.5.1 There was a total distance of 144 km of track between Te Rapa and Taumarunui. Train 581 crossed 23 separate track sections governed by either THRs or TSRs and one permanent speed restriction. Allowing for the length of the train, there was a total of 45.46 km of track where the train speed was restricted to 40 km/h or less.

1.6 Track inspections

1.6.1 There are 2 types of track inspection:

- Scheduled inspections and
- Special inspections

Scheduled inspections

1.6.2 Scheduled track inspections were carried out to ensure that the track and structures were safe for the passage of trains at authorised speeds.

1.6.3 Tranz Rail Infrastructure Group Track Code required the track between Taumarunui and Hamilton be inspected twice per week. The most recent inspections prior to the derailment were carried out on 10 and 13 February 2003. The track inspector, aware that the derailment curve was included on the THR list, did not identify any other nonconforming track conditions on the curve during the inspections.

Special inspections

1.6.4 Tranz Rail Infrastructure Track Code required a special track inspection to be carried out when rail temperatures were high and there was a likelihood of track buckles occurring.

1.6.5 At 1142 on the day of the derailment, the heat sensor alarm[7] located at 404.09 km between Taumarunui and Okahukura, had identified rail temperatures exceeding the pre-set trigger temperature of 40º C. The train controller immediately applied THRs to the 9 track sections between Owhango and Poro o tarao identified in Bulletin No. 96.

1.6.6 A track ganger based at Taumarunui commenced a special hot weather inspection between Kopaki and Owhango at about 1200. He paid particular attention to the sites identified in Bulletin No. 96 and recorded a rail temperature of 41º C near the derailment curve at 1400.

[7] A trackside radio unit fitted with a thermocouple that measured rail temperature. When a pre-set temperature is detected, a radio alert is sent to train control and an announcement is broadcast on the local radio channel.

After completing the inspection at about 1500, the ganger advised train control that the track between Kopaki and Owhango was safe for the passage of trains at the posted[8] speed.

1.6.7 At 1215 the rail temperature sensoring unit at Puketutu (459.68 km) recorded a rail temperature of 40º C and at 1238 the trigger temperature at TeKawa (509.01 km) was exceeded. From 1238 train control activated the THRs between Taumarunui and Te Rapa.

1.7 Basic running time

1.7.1 Section 7 of Tranz Rail, Rail Operating Code stated in part:

> **Basic Running Time (BRT)**
>
> A basic running time refers to a specific section of track, locomotive, train weight and train type. For any given set of conditions, the basic running time may be defined as the least time the specified weight of train could run through the particular section of track, the speed being kept at all times as close as possible to the authorised speeds, up to the performance capacity of the locomotive.
>
> BRT's are based on:
>
> - Normal operating conditions.
> - Normal condition of locomotives and rolling stock, e.g. for locomotive performance and train resistance.
> - Authorised speeds as defined in the Working Timetable for the locomotive and train concerned, including permanent speed restrictions.
> - Curve speeds as authorised by Group General Manager, Infrastructure.
>
> A basic running time does not include any allowance for:
>
> - Starting and stopping at the beginning and end of the specified sections.
> - Temporary speed restrictions or deceleration and acceleration in connection herewith.
> - Standing time at intermediate stops for crossings, crew changes, etc.
> - Abnormal weather.
> - Efficiency of signalling system.
> - Contingencies or make-up time.
>
> Where the BRT is mainly governed by locomotive performance such as on long undulating grades, trains of less than the scheduled load can run through the section in less than the BRT for scheduled load trains, without exceeding the authorised speeds.

1.7.2 The train control diagram recorded the scheduled BRT for the Te Rapa to Taumarunui section as 2 hours 40 minutes.

1.7.3 Tranz Rail conducted a re-enactment of Train 581's journey on 23 February 2003. A light locomotive travelled the distance, Hamilton to Okahukura, in 2 hours 47 minutes observing all THRs and TSRs that were in effect on 16 February 2003 and without having to wait for a train crossing. Tranz Rail estimated an additional 10 to 13 minutes would be required to travel the remainder of the journey from Okahukura to Taumarunui, giving an overall approximate journey time of 3 hours.

[8] The posted speed is the appropriate line speed or restricted speed, such as a temporary heat restriction, applying to any particular section of track at the time.

1.7.4 Locomotive Operations Managers monitored train speeds using random event recorder extractions and speed radar checks. The radar checks were carried out on a regular basis on curves, temporary speed restrictions (including THRs), maximum line speed and through turnouts.

1.8 Operation of Train 581

1.8.1 Train 581 completed the journey from Hamilton to Taumarunui in 2 hours 17 minutes including a 9-minute stop at Kopaki while waiting for an opposing northbound train to pass.

1.8.2 Tranz Rail Operating Code required the train controller to contact the locomotive engineer when the progress of the train appeared to be quicker than the scheduled BRT. Judgement was required where freight trains were concerned as the length and weight could have a bearing on the time taken to travel through a track section.

1.8.3 The train controller stated that he had not considered the actual running time for Train 581 to be fast as the train was only just over 200 tonnes in weight and 182 m long. He considered that quick acceleration from individual heat restrictions made it possible for the running times through each section to be close to normal running times. The train controller stated that he had previously noticed a wide variation in running times between individual locomotive engineers when the heat restrictions were on which made it sometimes difficult to forecast train arrival times.

1.9 The locomotive event recorder

1.9.1 The data from the event recorder on EF 30013 was downloaded and made available for analysis.

1.10 Duties of the locomotive engineer

1.10.1 Tranz Rail's Rule 104 stated in part:

> A train is in the charge of the locomotive engineer who is responsible for its safe running. He must be sufficiently familiar with the track over which he is required to work to ensure that he can maintain full control of his train at all times and have a thorough knowledge of any special instructions and signals controlling the movement of trains over that track.
>
> All members of the train crew must obey his instructions as to the working of the train.

1.11 Duties of second person in the locomotive

1.11.1 Tranz Rail Operating Code Instructions Section 3 identified circumstances when a second crew member was required for a mainline train normally crewed by a locomotive engineer only.

> 3.3.5.1 if arrangements cannot be made to supply a TEM, a second crew member will be assigned to the train.

1.11.2 Tranz Rail Operating Code Section 4 identified the duties of the second crew member as:

> **1.22 Second Persons**
>
> **1.22.1 Assist in Watching for Signals**
> When travelling through various areas locomotive engineers will be aware of where signals are located and strict attention to the indications of the signals displayed is important for safe operations.
>
> When a second person is assisting in watching for signals, the signal indications must be called and repeated between both members. The locomotive engineer must ensure the second person is not attending to other work as the train is approaching the signals.

1.11.3 Tranz Rail Rules and Regulations, Rule 108 also referred to the duties of the train crew and stated in part:

> **108 (a) Duties of Train Crew -** A locomotive engineer is responsible for seeing that the duties of his train crew are properly performed.
>
> **(b) Calling and Repeating of Signal Indications** - The indication of all signals affecting the running of the locomotive must be called and repeated between the locomotive engineer and train/rail operator (when travelling in the locomotive).
>
> **(c) Locomotive Crew to Look Back and be Vigilant and Cautious** - The locomotive engineer and the train/rail operator must both look back frequently to note the safety of the train at all times. After leaving a station or passing a station, level crossing, or any person upon or alongside the line, they must be prepared to act upon signals shown by such person. They must not, however, depend entirely upon such signals, but must at all times be vigilant.

1.12 Personnel

Locomotive engineer

1.12.1 The locomotive engineer commenced his employment with Tranz Rail as a trainee locomotive engineer in February 1981. He gained his second grade locomotive engineer's qualification in 1986, and his first grade qualification 2 years later. He passed his most recent bi-annual theory assessment on 12 August 2002 and attended a defensive driving technique for locomotive engineers workshop the same day.

1.12.2 The locomotive engineer met Tranz Rail's requirements for road knowledge and was deemed competent to operate trains on the Te Rapa to Taumarunui section. His most recent formal safety observations had been carried out on 2 December 2002 and 9 January 2003, during which no safety concerns were identified.

1.12.3 Tranz Rail advised that the locomotive engineer had taken Train 231 from Hamilton to Taumarunui on Wednesday 5 February 2003. He covered the entire journey in 2 hours and 8 minutes despite the THRs being in force throughout the journey.

1.12.4 On Wednesday 12 February 2003 the locomotive engineer departed Taumarunui on Train 220 at 1900 and arrived at Te Rapa 2 hours and 10 minutes later, after waiting at Kopaki for 5 to 6 minutes to cross an opposing train. The THRs were active throughout the journey.

1.12.5 The locomotive engineer said his normal running time from Te Rapa to Taumarunui was 2 hours 20 minutes and about two and half hours when the THRs were applied but these times depended on the length and weight of the train.

1.12.6 The locomotive engineer said the track was pretty good at most of the THR sites as the track had been worked on and he couldn't see or feel anything unusual when passing over these sites. He said his train speed over the THR sites varied between 40 and 55 km/h.

Second person

1.12.7 The second person started his employment with Tranz Rail in July 1985. He was based at Morrinsville for 17 years where he was qualified to carry out shunting and train examination duties.

1.12.8 On 9 June 2002, he commenced locomotive engineer training at Woburn. On completion of the 12-week course he relocated to Te Rapa for his practical on-the-job training under the direction of a "minder driver."

1.12.9 At about 1430 on the day of the derailment he received a telephone call from the locomotive engineer roster centre requesting that he fill the position of second person on Train 581 because of the unavailability of a TEM for that service.

1.12.10 Train 581 was almost ready to depart at that time, but he accepted the offer to work the additional shift. He had driven that route only once or twice during daylight hours and saw the shift as an opportunity to gain more route knowledge, without the responsibility of driving the train. He thought that because he was replacing the train end monitor, he was just going along for the ride rather than carrying out the full second man duties.

1.12.11 The second person said he looked at the locomotive speedometer 2 or 3 times during the journey to Taumarunui while inside track sections covered by the THRs but he considered it to be rude if he was continually looking at the locomotive speedometer as it would almost appear as if he didn't trust the locomotive engineer. However he said that when he had observed a speed in excess of the authorised speed, he commented to the locomotive engineer but was unsure whether he had been heard because the locomotive engineer did not respond or reduce the train speed. The second person said that at no stage did he feel unsafe during the journey from Hamilton to Taumarunui.

1.13 Crew resource management

1.13.1 In 2001 Tranz Rail developed a Crew Resource Management (CRM) training module that focused on a team approach to improving safety performance by creating an environment whereby staff would feel comfortable to question and challenge should they feel unsafe in an operational environment. The inter-active workshops identified influences to effective communication and developed strategies for ensuring rules and procedures were clear, understood and followed.

1.13.2 The locomotive engineer completed CRM and Alertness Management training on 16 April 2002. He did not invite challenger response from the less experienced second person when driving Train 581.

1.13.3 Tranz Rail advised that the second person was introduced to CRM and Alertness Management training at Woburn during his initial locomotive engineer training. However, the second person was unable to recall the content of the CRM training module or the principles of CRM. The second person said he felt he had insufficient driving experience but was not confident enough to speak up and challenge the locomotive engineer about the speed of the train during the journey from Hamilton to Taumarunui.

1.13.4 The locomotive engineer and second person were working together for the first time.

1.13.5 The train controller, who had also attended CRM training, did not properly monitor the progress of Train 581, and bring his quick trip to the attention of the locomotive engineer.

2 Analysis

2.1 Given that the locomotive crew did not observe a track misalignment when northbound Train 380 approached the curve near 406 km, it was probable that the track buckle developed under the moving train. The locomotive engineer had negotiated the derailment curve on Train 581 from the opposite direction, at an undetermined speed, without incident some 30 minutes earlier. The crew bringing Train 380 from Stratford followed Train 581 from Okahukura to Taumarunui by about 5 minutes and also passed over the derailment curve without incident or noticing any track misalignment.

2.2 The inadequate ballast shoulder width of 100 mm, instead of 300 mm, on the high-leg side of the curve near the POD reduced the ability of the track structure to withstand the dynamic lateral forces imposed by the moving train under the hot rail conditions and probably contributed to the track buckle.

2.3 A further contributing factor to the track buckle was that in June 2002 when the curve was re-railed and fastened to the sleepers, the rail temperature was 18°C. To destress the rail to the neutral temperature of 32° C a rail tensor was needed to stretch the rail, but the rail tensor was being used in Wellington and so the rail remained in a stressed condition and at risk of buckling should hot rail conditions prevail. To reduce the risk, the section of track between 405.75 km and 409.78 km was identified in Bulletin 96 as a THR site, with a maximum speed of 40 km/h during such times.

2.4 During the day of the derailment, sensors had indicated that hot rail conditions prevailed and THRs were initiated. A ganger had inspected the track and determined that it was safe for trains at authorised speeds. The derailed train was travelling at over twice the authorised speed, creating increased dynamic forces that increased the risk of track buckling.

2.5 The locomotive engineer had been informed by train control before departing Te Rapa that THRs between Te Rapa and Taumaranui were in effect and would remain so until at least 2100. Details of the location of the restrictions were contained in Bulletin No. 96 which he had among his train work orders in the cab of the locomotive.

2.6 In addition, each THR was properly identified with an advanced caution speed board positioned 1550 m before the THR and an inner speed board located 50 m before the THR. The locomotive engineer did not comply with the caution and speed boards relating to the derailment curve.

2.7 The locomotive event recorder provided 2 sets of data for analysis:

a) the short log, which gave details of speed, air pressure and throttle position every second for 6 minutes prior to the completion of recording and

b) the long log, which gave time and speed every 95 seconds for 7 days prior to the completion of the recording.

The long log of the event recorder on locomotive EF 30013 was not set up in the traditional manner. On 5 February 2003, the sampling time was changed from the normal speed sample rate of once every 10 seconds, to recording the speed once every 95 seconds.

2.8 Because of the non-standard set up of the long log, it was not possible to accurately map the journey from Hamilton to Taumarunui and assign an actual train speed to a particular track location en route. However, it was possible to examine trends from the speed samples of the long log. Active speed restrictions of 40 km/h or less covered 31.6% of the Hamilton to Taumarunui track section, so it could be expected that long log speed values of 40 km/h or less would be recorded for a similar or higher percentage. There were 77 long log entries for Train 581's southbound run from Hamilton to Taumarunui but only 8 (10.4%) of them recorded a speed of 40km/h or less and 30 (39%) of them recorded a speed in excess of the 80 km/h maximum authorised line speed. The highest recorded speed was 94 km/h.

2.9 The higher than authorised speed values were consistent with Train 581's 2 hour 17 minute journey from Hamilton to Taumarunui that included a 9-minute crossing en route. Tranz Rail's re-enactment of the journey using a light locomotive and without a train crossing confirmed that a time of about 3 hours was required to complete the journey from Hamilton to Taumarunui at authorised speeds. Because Train 581 was longer and heavier than the service used for the re-enactment, some additional time would need to be allowed for it to clear the limits of each temporary restriction.

2.10 Analysis of the short log enabled confirmation of events immediately preceding the derailment. Speed values and time from the completion of the recording and final location of the locomotive after the derailment were used to determine the train speed at various locations leading up to the derailment. After departing Taumarunui, Train 380 passed over two THRs, one 410 m long and the other 1500 m long before approaching the derailment curve. The slowest speed recorded on the short log for the track section that included the two speed restrictions was 63 km/h, showing that the locomotive engineer was not complying with the THRs.

2.11 Analysis confirmed the train approached the derailment curve at about 90 km/h and was travelling at about 85 km/h when the first wagon derailed. In general terms, dynamic train forces increase in proportion to the square of the speed, so by negotiating the curve at more than twice the authorised speed, the lateral forces applied to the track structure was increased by a factor of more than four and significantly increased the risk of a track buckle.

2.12 During the 2 weeks prior to the derailment the locomotive engineer had operated a train between Hamilton and Taumarunui in both directions when the THRs were active and he completed each journey in about 2 hours 10 minutes, considerably quicker than the 3 hours taken during the Tranz Rail re-enactment. The time taken to complete the 2 journeys during the previous 2 weeks, and the southbound journey before the derailment, indicated that the locomotive engineer habitually ignored temporary speed restrictions. A safety recommendation relating to monitoring train speeds has been made to the Chief Executive of Tranz Rail.

2.13 The CRM training given to the second person during his locomotive engineer training was ineffective in that he remained unlikely to have sufficient confidence to challenge a superior. When questioned about the content of the training he was unable to recall the content of the training package. While the second person was aware that the locomotive engineer was exceeding the authorised line speed at times, it was likely he did not feel sufficiently comfortable to challenge the locomotive engineer because it was the first time they had worked together and he had limited experience in a locomotive cab. As the person in charge of the train it was expected that the locomotive engineer would have invited comment and feedback from the second person but no such request was made. The second person probably considered his duties to be as a replacement for the TEM only and used the opportunity to further his knowledge of signal location and track gradients without the responsibility for train safety.

2.14 The monitoring of train speeds with a radar gun and event recorder extractions was a random activity that could not be expected to identify all instances of excessive speed. However, the actual running time of every train service was recorded and compared with the basic running time continuously by a train controller. The monitoring and recording of Train 581's progress should have alerted the train controller to the excessive train speed. The actual progress line recorded on the train control diagram was faster than the scheduled basic running time, despite almost one-third of the route being governed by speed restrictions. Train 581 departed Hamilton 40 minutes behind schedule and after waiting 9 minutes for the train to cross at Kopaki it arrived at Taumaranui 5 minutes behind schedule. The train had therefore gained 35 minutes during the journey. The train controller did not identify that the train was travelling faster than it should have been or if he did, he did not raise the issue with the locomotive engineer as required by the Tranz Rail Operating Code.

2.15 While it was clear that the primary cause of the derailment was a track buckle, it was unlikely the buckle would have occurred had Train 380 entered the curve at no more than the authorised speed of 40 km/h given that the same train, crewed by staff from Stratford, had passed over the curve in the opposite direction at the authorised speed about 30 minutes prior to the derailment.

3 Findings

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

3.1 The derailment occurred due to a track buckle probably triggered by Train 380 travelling substantially faster than the authorised speed.

3.2 Southbound Train 581, operated by the same crew as northbound Train 380, had exceeded the authorised speed frequently throughout its journey from Hamilton to Taumarunui.

3.3 The locomotive engineer ignored instructions, and the correctly located warning boards and speed boards to control the speed of Trains 581 and 380 when passing over temporary heat restrictions.

3.4 The locomotive crew on northbound Train 380 did not observe a track misalignment as the train approached the derailment curve.

3.5 A potential track weakness in the area of the derailment had been recognised and a temporary heat restriction was in place when rail conditions warranted.

3.6 There was an excessive delay in de-stressing the continuous welded rail track on the derailment curve.

3.7 A special track inspection of the continuous welded rail track on the derailment curve was undertaken about 4 hours and 20 minutes before the derailment, and at that time the track was considered safe for the passage of trains at the authorised speed of 40 km/h.

3.8 Crew resource management was less than adequate, not only between the train crew but also between the train controller and the locomotive engineer.

3.9 The train controller did not recognise or alert the locomotive engineer of Train 581 to his fast run.

3.10 The locomotive engineer was correctly certified for the duties concerned.

4 Safety Recommendations

4.1 On 19 March 2004 the Commission recommended to the Chief Executive of Tranz Rail that he:

4.1.1 reinforce with all train controllers the need to monitor actual running times against the scheduled time to complete a track section, and immediately contact the locomotive engineer and his manager when a fast run is identified(005/04).

and

4.1.2 ensure all operating staff understand the principles of crew resource management and that all train crew and train controllers attend formal crew resource management training by 31 December 2004 (006/04).

4.2 On 29 March 2004 the Chief Executive of Tranz Rail replied:

005/04 Tranz Rail accepts this recommendation.

006/04 Tranz Rail accepts this recommendation.

Approved for publication 18 March 2004

Hon W P Jeffries
Chief Commissioner

Appendix 1

Network Operations

WELLINGTON

BULLETIN NO. 93 (3 pages)
(Semi permanent)

14 February, 2003

CANCELLATION

Bulletin No.82 (Semi-permanent) dated 12 February 2003 re Temporary Heat Restrictions instructions are **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.

Temporary Heat Restrictions

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

"Heat 40" 40km/h speed restrictions for various sections of track which could be at risk for possible misalignment during the summer months will be included on separate Heat Restriction Bulletins.

Special outer speed boards will be erected. These 40km/h speed boards with their associated 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.
NOTE : Some T boards are fitted with a miniature H to note the board is for a heat restriction.
Where ordinary speed boards need to be used this will be notified on the relevant heat restriction Bulletin.

The heat restrictions will only apply on a daily basis when a Ganger advises Train Control or on activation of a heat sensor alarm in Train Control. All the restrictions within a specific heat sensor area will apply or none at all. The heat sensor areas are detailed in separate speed heat restriction bulletins.

Locomotive Engineers must call – Train Control to request advise of active heat restrictions when on a train at 11:00 hrs each day or if departing from origin or a crew change station between 11:00 and 21:00 daily. Arrangements for suburban services on a separate semi-permanent bulletin.

Bulletins – Locomotive Operations, Terminal Managers and Train Control must ensure sufficient new bulletins area available for restriction details to be endorsed on a fresh copy each day.
Day Time Temporary Speed Restrictions – will be notified by Amicus Work Order using reason code HOT and will apply between certain daylight hours only, irrespective of temperature. Rule 912 will apply.

Manual Heat Alarm – Manual heat alarm sites will be listed on heat restriction bulletins. Track or Station Staff will take rail temperature measurements hourly between 11:00 and 16:00 daily. Train Control will be advised to apply heat restrictions in the effected area when high rail temperature readings are obtained.

continued on page 2..

Inspections – Priority to be given to passenger trains.
If Track Staff have not commenced an inspection within 60 minutes after a heat alarm activation, The Network Control Manager must be advised.
Movement of Hi- Rail Vehicles - In all cases protection rules for hi-rail vehicle movements must be applied.

Suburban Areas – are defined as all lines between Waitakere and Pukekohe (excluding the Mission Bush Branch and Onehunga Industrial line) and all lines between Wellington, Johnsonville, Paraparaumu, Melling and Upper Hutt.
Empty Passenger Trains – are defined as conveying only the train crew rostered to operate the service.

Reading in descending order under each type of train, the following procedure and conditions will apply:-
Note: This bulletin introduces new conditions for Passenger trains.

continued on page 3

Passenger train between Aickens and Greymouth (Midland Line)	**Passenger train over all lines Except:- < Aickens – Greymouth (ML) Wellington Suburban and Upper Hutt-Masterton area >**	**Freight or Empty Passenger train or Passenger train inside Wellington Suburban and Upper Hutt-Masterton area.**
Heat Alarm Activated or Track / Station Staff advise of high rail temperature, then	Heat Alarm Activated or Track / Station Staff advise of high rail temperature, then	Heat Alarm Activated or Track / Station Staff advise of high rail temperature, then
Train Control apply restrictions, advise all affected services and arrange Track inspections, then	Train Control apply restrictions, advise all affected services and arrange Track inspections, then	Train Control apply restrictions, advise all affected services and arrange Track inspections, then
Train Control and LE to endorse all activations of relevant heat alarm on relevant bulletin. then	Train Control and LE to endorse all activations of relevant heat alarm on relevant bulletin, then	Train Control and LE to endorse all activations of relevant heat alarm on relevant bulletin, then
Do not enter or continue over effected heat sensor area, then		
	Continue to travel being able to stop in half the clear distance ahead over whole heat sensor area, (maximum speed 40 km/h) then	
Track Staff must inspect heat sensor area from Hi-Rail, then	Track Staff inspect heat sensor area;% in extreme hot temperature, adverse weather conditions should be declared . Inspect from Hi-Rail or cab of train, then	
Track Staff give clearance to Train Control for passenger trains to proceed. Clearance to be endorsed on relevant bulletin by TC and LE, then	Track Staff give clearance to Train Control for passenger trains to continue. Clearance to be endorsed on relevant bulletin by TC and LE, then	
Travel at maximum of 40km/h over whole heat sensor area, then	Continue to travel at maximum of 40km/h over whole heat sensor area, then	
		Travel at maximum of 40km/h inside Heat 40 restrictions, then
Track Staff continue inspections, then once	Track Staff continue inspections, then once	Track Staff continue inspections, then once
Heat sensor or manual measurement indicates normal rail temperature, and track staff are satisfied rail temperature will not climb to high levels for remainder of day, advise Train Control of this, then	Heat sensor or manual measurement indicates normal rail temperature, and track staff are satisfied rail temperature will not climb to high levels for remainder of day, advise Train Control of this, then	Heat sensor or manual measurement indicates normal rail temperature, and track staff are satisfied rail temperature will not climb to high levels for remainder of day, advise Train Control of this, then
Train Control to confirm with Train crew or Track Staff that no buckles in the affected area have been observed, then	Train Control to confirm with Train crew or Track Staff that no buckles in the affected area have been observed, then	Train Control to confirm with Train crew or Track Staff that no buckles in the affected area have been observed, then
Heat restrictions can be lifted, Run at normal speed.	Heat restrictions can be lifted, Run at normal speed.	Heat restrictions can be lifted, Run at normal speed.

% Declaration of adverse weather conditions detailed on the current Rules semi-permanent bulletin.

Appendix 2

Network Operations
WELLINGTON

BULLETIN NO.96 (3 pages)
(Semi-permanent)

TRANZ RAIL

14 February, 2003

CANCELLATION

Bulletin No.70 (Semi-permanent) dated 29 January, 2003, re Heat Restriction Areas is **cancelled**.

To be read in conjunction with current Semi-permanent Bulletin re Temporary Heat Restrictions.

Commencing **forthwith** and continuing until further advised.

Heat Restriction Areas
Palmerston North - Te Rapa
Okahukura to Whangamomona

Heat Sensor at Metrages **Between km km**	**Locations between** **Depot(s) to be called**	**Date of** **Operation ....**	Time Advised Track Staff	 Train No.	Length Inspection complete: Time	Clearance For pass trains: Yes or No
Rangitawa Alarm Area 144.85 to 145.25 151.48 to 151.78 155.95 to 156.15 162.15 to 163.82 174.10 to 175.15	**Palmerston North to Marton** **Call Out Palmerston North(N) Gang** Palm Nth and Bunnythorpe Aorangi and Feilding Feilding and Maewa Maewa and Rangitawa Rangitawa and Greatford	Tick in box if On ❑				
Hunterville Alarm Area 199.00 to 202.00 229.10 to 229.75 241.60 to 242.30% 248.12 to 248.42	**Marton to Taihape.** **Call Out Palm Nth (N) & Taihape** Porewa and Hunterville Manganoho and Mangaweka Mangaweka and Utiku Utiku and Taihape	Tick in box if On ❑				
Hihitahi Alarm Area 252.00 to 252.45 253.40 to 253.70% 258.40 to 258.60% 268.00 to 268.50% 270.50 to 271.30 273.40 to 273.60% 276.30 to 276.50% 277.75 to 278.00 281.00 to 281.40% 281.74 to 282.46 290.10 to 290.20% 293.83 to 294.70%	**Taihape to Karioi.** **Call Out Taihape Gang** Taihape Station limits Taihape and Mataroa Taihape and Mataroa Mataroa and Ngaurukehu Ngaurukehu Stn Limits Ngaurukehu and Hihitahi Ngaurukehu and Hihitahi Hihitahi and Waiouru Hihitahi and Waiouru Hihitahi and Waiouru Waiouru Stn Limits Waiouru and Tangiwai	Tick in box if On ❑				

continued on page 2

Bulletin No.96 - continued
(Semi- permanent)

Wellington 14.2.03

Palmerston North - Te Rapa – continued
Okahukura to Whangamomona – continued

Heat Sensor at Metrages Between km km	Locations between Depot(s) to be called	Date of Operation	Time Advised		Length	Clearance
			Track Staff	Train No.	Inspection complete: Time	For pass trains: Yes or No
Karioi Alarm Area 313.50 to 314.90% 320.00 to 323.00% 326.50 to 326.61% 349.70 to 357.90% 363.50 to 366.71%	**Karioi to Owhango. Call Out Ohakune & Taihape Gangs** Karioi and Ohakune Ohakune and Horopito Ohakune and Horopito National Park and Raurimu Raurimu and Oio	Tick in box if On ❑				
Okahukura Alarm Area 378.03 to 378.37 399.26 to 399.67 401.00 to 402.50 405.75 to 409.78 413.40 to 413.90 415.67 to 416.36 418.05 to 422.00 423.00 to 425.60 435.00 to 436.72 61.00 to 62.00 98.00 to 99.70 106.35 to 107.40 117.00 to 121.45	**Owhango to Porootarao Call out Taumarunui Gang** Owhango and Kakahi Taumarunui and Okahukura Taumarunui and Okahukura Taumarunui and Ongarue Okahukura and Ongarue Okahukura and Ongarue Okahukura and Waimiha Ongarue and Waimiha Waimiha and Porootarao **Okahukura to Whangamomona Call Out Taumarunui Gang** Whangamomana and Tangarakau Heao and Ohura Heao and Ohura Ohura and Matiere	Tick in box if On ❑				

continued on page 3…

Bulletin No.96 - continued
(Semi- permanent)

Wellington 14.2.03

Palmerston North - Te Rapa - continued
Okahukura to Whangamomona – continued

Heat Sensor at Metrages Between km km	Locations between Depot(s) to be called	Date of Operation	Time Advised		Length	Clearance
			Track Staff	Train No.	Inspection complete: Time	For pass trains: Yes or No
Puketutu Alarm Area	**Porootarao to Te Kuiti. Call out Te Kuiti & Taumarunui Gangs**	Tick in box if On ❑				
453.30 to 454.02	Porootarao and Kopaki					
455.80 to 458.15	Kopaki and Puketutu					
463.85 to 464.40	Puketutu and Te Kuiti					
465.45 to 469.30	Puketutu and Te Kuiti					
472.15 to 473.95	Puketutu and Te Kuiti					
Te Kawa Alarm Area	**Te Kuiti to Te Rapa. Call out Te Kuiti and Hamilton Gangs**	Tick in box if On ❑				
487.90 to 492.50	Hangatiki and Otorohanga					
505.59 to 510.32	Otorohanga and Te Awamutu					
513.50 to 516.30	Te Kawa and Te Awamutu					
526.62 to 527.15	Te Awamutu and Ohaupo					
529.00 to 530.01	Ohaupo and Rukuhia					

% Normal Outer Speed boards are erected for this restriction.

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

03-104	express freight Train 380, derailment, Taumarunui, 16 February 2003
03-103	hi-rail vehicle and express freight Train 142, track occupancy irregularity, Amokura, 10 February 2003
03-101	express freight Train 226, person injured while stepping down from wagon, Paekakariki, 7 January 2003
02-130	express freight Train 220, derailment, Rukuhia, 18 December 2002
02-127	Train 526, track warrant overrun, Waitotara, 17 November 2002
02-126	hi-rail vehicle 64892, occupied track section without authority, near Kai Iwi, 18 November 2002
02-120	electric multiple units, Trains 9351 and 3647, collision, Wellington, 31 August 2002
02-118	express freight Train 484, near collision with hi-rail vehicle, Tauranga, 7 August 2002
02-117	express freight Train 328 signal passed at stop, Te Rapa 31 July 2002
02-116	express freight Train 533, derailment, near Te Wera, 26 July 2002
02-112	passenger fell from the Rail Forest Express, Tunnel 29, Nihotupu Tramline, Waitakere, Saturday 4 May 2002
02-104	express freight and passenger trains, derailments or near derailments due to heat buckles, various localities, 21 December 2001 to 28 January 2002
02-113	passenger express Train 700 TranzCoastal and petrol tanker, near collision Vickerman Street level crossing, near Blenheim, 25 April 2002
02-107	express freight Train 530, collision with stationary shunt locomotive, New Plymouth, 29 January 2002
01-111	passenger EMU Train 2621, door incident, Ava, 15 August 2001
01-107	passenger baggage car Train 201, broken wheel, Otaihanga, 6 June 2001

Transport Accident Investigation Commission
P O Box 10-323, Wellington, New Zealand
Phone +64 4 473 3112   Fax +64 4 499 1510
E-mail: reports@taic.org.nz   Website: www.taic.org.nz

Price $ 26.00

ISSN 0112-6962