



Report 97-109

Train 138

derailment

Te Kauwhata

30 July 1997

Abstract

On Wednesday 30 July 1997, at about 0952 hours, an express freight train operated by Tranz Rail Limited derailed when it entered a crossover at the south end of Te Kauwhata while travelling too fast. The locomotive and all seven wagons in the train were derailed, with substantial damage to all vehicles and the track. The locomotive engineer suffered a serious injury. The locomotive engineer had incorrectly interpreted a signal aspect and failed to slow the train for passage through the crossover. A safety issue identified in this report is the potential for locomotive engineers to misinterpret medium speed indications on closely spaced signals where only one signal predominantly displays this aspect.

Transport Accident Investigation Commission

Rail Accident Report 97-109

| | |
|--------------------------------|---|
| Train type and number: | Express Freight, 138 |
| Date and time: | 30 July 1997, 0952 hours |
| Location: | Te Kauwhata 591.15 North Island Main Trunk |
| Type of occurrence: | Derailment |
| Persons on board: | Crew: 1 |
| Injuries: | Crew: 1 Serious Others: Nil |
| Nature of damage: | Substantial damage to locomotive, wagons, and track |
| Investigator-in-Charge: | R E Howe |

1. Factual Information

1.1 Narrative

- 1.1.1 On Wednesday 30 July 1997, express freight Train 138 was to run from Te Rapa to Mission Bush near Waiuku. It was crewed by a locomotive engineer (LE) and departed Te Rapa at about 0900 hours.
- 1.1.2 The train consist was DC4755, and seven wagons which contained lime products for the steel mill at Mission Bush. The gross weight of the train was 380 t and the length was 125 m.
- 1.1.3 The weather was fine and the visibility was good.
- 1.1.4 About 16 km north of Huntly, Train 138 approached an automatic running signal designated 59006 by Tranz Rail Limited (Tranz Rail). The aspect it displayed was yellow over green, i.e. the upper of the two-light combination was yellow, and the lower one was green.
- 1.1.5 Signal 59006 was a stop and proceed signal with the lower light unit staggered, i.e. the unit is in a diagonal line to the right and not vertically below the upper unit as viewed by the LE.
- 1.1.6 The yellow over green aspect was defined in Rule 57 of the Tranz Rail Signals Rules as:

| Name | Meaning |
|-----------------------------|--|
| Caution | Section is clear. Proceed at |
| Normal speed. | Normal speed but prepared to |
| Prepare to reduce to Medium | reduce to Medium speed at next |
| Speed. | signal which is at "Caution" or |
| | "Clear" for Medium speed only |
| | except if clause (iii) ¹ applies. |

- 1.1.7 Medium speed was defined in Rule 57 as:
- Means train must not exceed 25 km/h unless a speed board authorising a higher speed is exhibited. Medium speed must be maintained until the train is clear of all points to which the signal applies.
- 1.1.8 Tranz Rail's common use of medium speed was to regulate the speed of trains through points and crossings (track structures where tracks connect together; the simplest and most common type was also called a turnout). Most points and crossings had a safe traversing speed of 25 km/h, although there were some higher speed designs. In most locations where these higher speed designs were installed a train speed board was erected beside the track increasing the authorised speed from 25 km/h, to the higher speed. There were no such boards at the south end of Te Kauwhata and the 25 km/h maximum applied to movements through the turnouts forming the crossover from the up main to the loop.
- 1.1.9 The yellow over green aspect given by signal 59006 therefore advised the LE that the next signal was displaying an aspect which required the train to pass it at medium speed (25 km/h) and therefore he would be required to make a speed reduction before reaching that signal.

¹ clause (iii) related to repeater signals where insufficient braking distance was available and did not apply at Te Kauwhata.

1.1.10 The signal after signal 59006 was signal 2R, the Te Kauwhata Up Home signal. It was located 1.045 km further along the track, close to the points leading to the crossing at Te Kauwhata. This signal was displaying a red over yellow aspect.

1.1.11 The red over yellow aspect was defined in Rule 57 as:

| Name | Meaning |
|--------------------------|--|
| Caution Medium speed. | Section is clear. Proceed at Medium speed until the train is clear of all points to which the signal applies; be prepared to stop at next signal which is displaying a “Stop” or “Low-speed” indication. |

1.1.12 The medium speed aspect on signal 2R was used only for movement off the main line in to the loop. This aspect was not displayed for any other purpose at this signal.

1.1.13 The aspects of the signals and the layout and location of them at Te Kauwhata were shown in Signalling and Interlocking Arrangements, Circular S & I 2408, available to all LEs and operating staff working over that part of the North Island Main Trunk (NIMT). A copy of sheets 2 and 3 of the circular is attached as Appendix 1.

1.1.14 The yellow over green aspect at signal 59006 therefore advised the LE explicitly that the points at the south end of Te Kauwhata were set for the crossing loop.

1.1.15 The next signal after signal 2R for a train running on the up main was signal 8R located at the north end at Te Kauwhata, 1.245 km beyond signal 2R. Signal 8R was the departure signal from Te Kauwhata.

1.1.16 Between Te Rapa and Auckland the NIMT railway consisted of double track except for a short section of single track between Te Kauwhata and Amokura where it crossed the Whangamarino swamp. Northbound trains leaving Te Kauwhata on the up main passed through points on to the single line, and signal 8R regulated this movement by displaying a medium speed aspect.

1.1.17 The turnouts at the north end of Te Kauwhata regulated by signal 8R were of a different design from those at the south end, and had a permissible speed of travel through them of 50 km/h. Signal 8R displayed the same medium speed aspect as signal 2R and the higher permissible speed was advised to LEs by a painted speed board beside the track near the turnout.

1.1.18 When signal 8R displayed a medium speed aspect, signal 2R proceeding it would show a yellow over green aspect to an approaching train.

1.1.19 The LE was therefore expecting to see a yellow over green aspect prior to entering the single line section of the NIMT.

1.1.20 The LE stated he took this to mean that after passing signal 59006, and noting the yellow over green aspect he was “. . . shooting through on to the single line”, and would pass signal 8R next, i.e. he assumed the aspect of signal 59006 was actually at signal 2R despite the physical differences between the two signals.

- 1.1.21 As he approached the south end of Te Kauwhata at approximately 63 km/h he sighted signal 2R. It displayed red over yellow (proceed at medium speed), and he realised that he had made an error and that he was going into the loop.
- 1.1.22 The sighting distance of signal 2R was approximately 230 m. The train was descending a one in 115 grade which was easing to one in 435.
- 1.1.23 Tranz Rail policy was to give sufficient sighting distance for a signal to provide at least 10 seconds visibility to the LE of the fastest train likely to approach it. This standard was met for a train travelling at 80 km/h.
- 1.1.24 The LE stated that he did not realise he had made an error until he was close to signal 2R. He stated he made an emergency brake application but was unable to slow the train appreciably before it entered the crossover. He recalled “. . . when I threw the emergency on I did get a fair bump from the rear of my train. It was a very short heavy train.”
- 1.1.25 The locomotive overturned to the right, as it negotiated the crossover, derailing the following wagons. The locomotive separated from the wagons and travelled on its right side, tangential to the track coming to rest approximately 100 m beyond the point of derailment (POD) and 25 m away from the up main. (See Figure 1 and Figure 2)
- 1.1.26 The seven derailed wagons continued to follow the general line of the down main and came to rest over the up main and loop alignment with the leading wagon at approximately 591.293 km, some 40 m north of the locomotive.
- 1.1.27 The locomotive, wagons and track were damaged substantially.
- 1.1.28 The LE stated that his first memory after the derailment was hearing someone tapping on the locomotive side window and he assumed that he had been unconscious for a short period of time. He received cuts and abrasions. Although these were assessed as minor at the time, later complications required the LE to be off work for several months.
- 1.1.29 The locomotive radio was still operative and after he orientated himself the LE advised Train Control of the derailment.
- 1.1.30 Local residents who witnessed the accident advised the emergency services, which attended promptly. There was a diesel spill from the locomotive which was dealt with by the New Zealand Fire Service.

1.2 Track and formation marks

- 1.2.1 Damage to a signals location shelter at 591.182 km on the right side of the down main and approximately 2.7 m from track centre, damage to an adjacent curve speed board, and marks in the formation and ground thereafter indicated the position and inclination of the locomotive at various points from the POD until it came to rest.

1.3 Track details

- 1.3.1 The track approaching and through the crossover was heavyweight rail on timber sleepers. All track materials were in good condition. Measurements of the track geometry preceding the POD found it to be within standard tolerances.

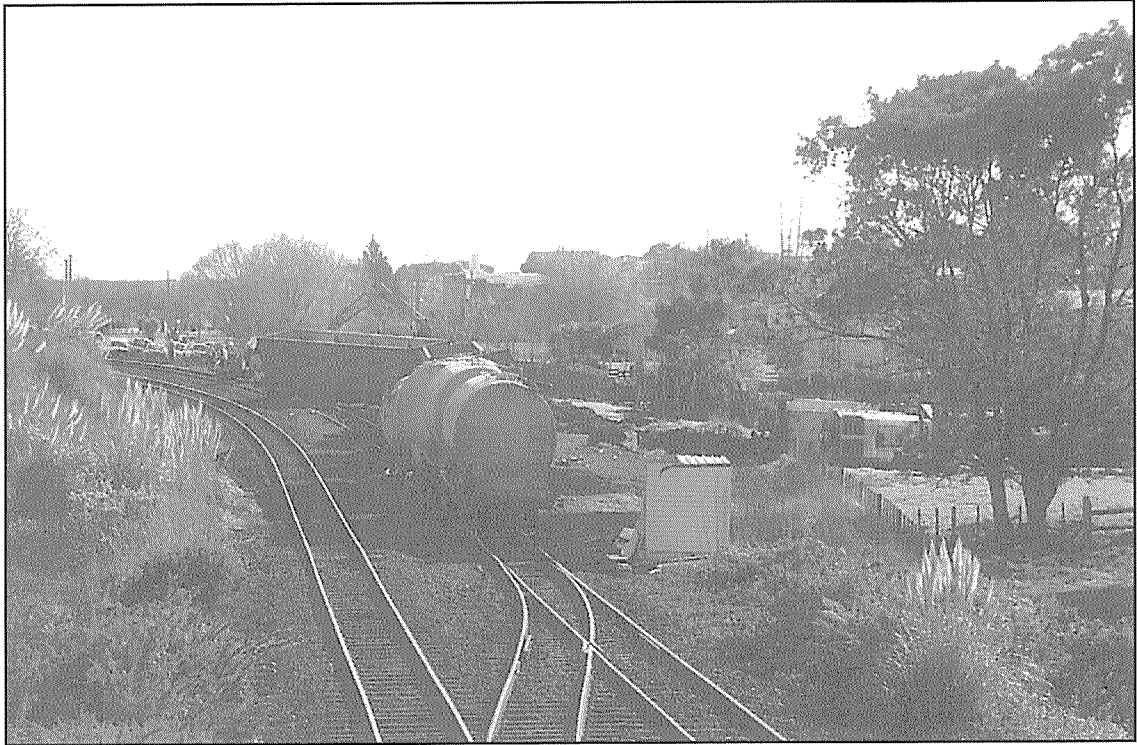


Figure 1
General view of the derailment site looking north



Figure 2
DC 4755 viewed from the east side

1.4 Locomotive event recorder

1.4.1 The locomotive event recorder was extracted and two printed logs were supplied for analysis:

- a) the short log, which gave details of speed, air pressure and throttle position every second for six minutes prior to the completion of recording
- b) the long log, which gave day, time and speed every ten seconds for seven days prior to the completion of the recording.

1.5 Operating details

1.5.1 Unlike passenger trains Tranz Rail's freight trains do not run to a published scheduled timetable.

1.5.2 Freight train schedule information is printed on the relevant train work order. All train schedules are plotted on the Train Control diagram.

1.5.3 The LE of Train 138 was regularly rostered through Te Kauwhata as part of his scheduled duties. He stated that he could not remember ever being signalled into the loop at the south end of Te Kauwhata.

1.5.4 He stated he had occasionally entered the loop from the north end and this was “. . . usually associated with the southbound steel train being pulled out to let southbound Train 201, the *Overlander*, through.”

1.5.5 As part of Tranz Rail's normal operating procedures there was an instruction for one train per day to be routed through the loop at Te Kauwhata for de-rusting purposes. But for this, rust could develop on the surface of the rails as the loop and the crossover at Te Kauwhata were not used very often. Rust could prevent reliable detection of trains on the track circuits, leading to faulty signal indications.

1.5.6 It was this de-rusting requirement that led to a movement which resulted in a similar derailment in 1993 (Section 1.7 refers).

1.5.7 The Train Control Officer's (TCO's) report indicated that the routing of Train 138 to the loop was primarily to suit the particular train movements at the time, although it also achieved the de-rusting requirement. Figure 3 is a plot of part of the Train Control diagram for 30 July 1997.

1.5.8 The circumstances which prompted the routing of Train 138 to the loop were:

- southbound passenger Train 201 running to time
- southbound freight Train 141 running approximately an hour ahead of its standard plot and ahead of Train 201
- northbound passenger Train 300 running close to time (Train 300 was not pulled out at Te Rapa until after the TCO had set the loop for Train 138 at Te Kauwhata)
- northbound Train 138 running over an hour ahead of the standard plot.

1.5.9 The TCO set signal 2R accordingly. Signal 59006 automatically adjusted to the setting of signal 2R.

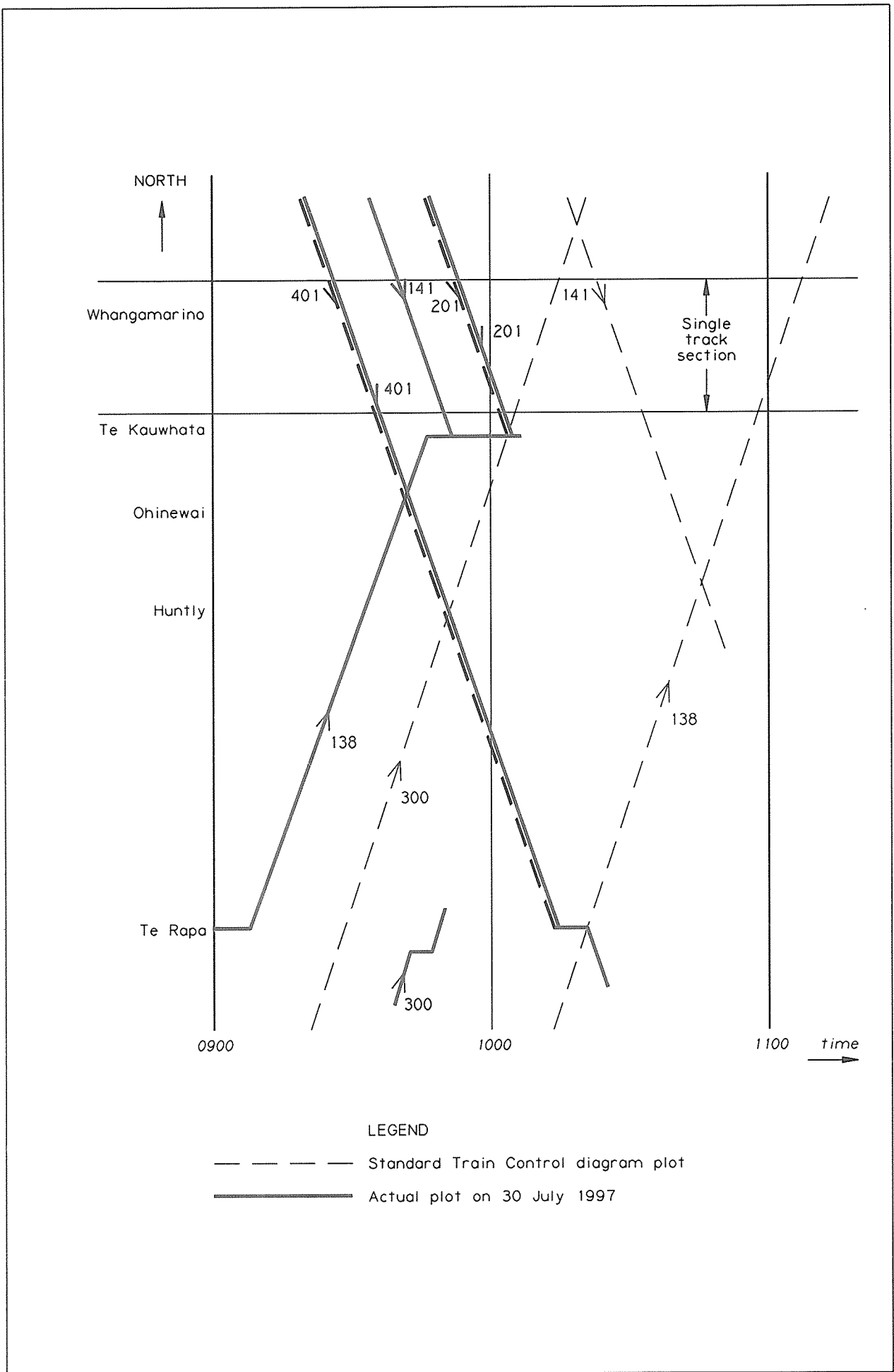


Figure 3
Train movements

- 1.5.10 Tranz Rail did not require the TCO to advise the LE by radio that his train was to be diverted into the loop at Te Kauwhata, and the TCO did not do so.
- 1.5.11 The LE stated that when Train 138 was between Huntly and Ohinewai (at approximately 0940 hours) he overheard a discussion between Te Rapa Signal Box and Train 300 on his train radio. This related to operating problems with Train 300 and the need for it to be pulled out at Te Rapa (see Figure 3).

1.6 Personnel

- 1.6.1 The LE had 27 years experience, was a Grade 1 LE, and held the appropriate operating certificate for the duties he was carrying out.
- 1.6.2 The week before the accident the LE had attended a simulator training course for DF locomotives in Wellington, returning home on Friday evening. His first shift following his return was on Monday 28 July 1997 from 1130 hours to 2015 hours, followed by 0715 hours to 1800 hours on Tuesday 20 July 1997.
- 1.6.3 He stated his sleep and recreational patterns were normal, although he found the simulator course particularly demanding. He felt rested and back to normal by Wednesday 30 July 1997.
- 1.6.4 He stated he enjoyed good health, and was not taking any medication which could have affected his performance.

1.7 Previous derailment

- 1.7.1 A similar derailment occurred in 1993 in the same locality when a train signalled into the loop from the south end entered at excessive speed. (TAIC Occurrence Report 93-124.)
- 1.7.2 In the 1993 derailment the train had been diverted to achieve the de-rusting requirement. The LE at the time misinterpreted signal 59006 for signal 2R (then termed signal 12L) and entered the crossover at approximately 60 km/h.
- 1.7.3 Following the 1993 derailment the Commission recommended to New Zealand Rail Limited (NZRL) that they:

Set guidelines for Train Control Officers to advise Locomotive Engineers by radio of unusual movements or circumstances which may be significantly different from the expectancy of the Locomotive Engineer. (037/94)

Investigate the practicability of introducing an intermediate speed² aspect for the signals 12L and 6L³ at Te Kauwhata and other similar locations. (038/94)

² In some locations NZRL had introduced an aspect for a speed of 50 km/h, called intermediate speed. The aspect used the same colours as for medium speed, but the lower light flashed. If Te Kauwhata had been equipped with this system then signal 59006 would have still given a yellow over green indication, but signal 2R (signal 12L in 1993) would have been a yellow over flashing green aspect to advise LEs that the next signal, 8R (signal 6L in 1993), was showing an intermediate speed aspect. An LE expecting a yellow over flashing green aspect prior to reaching signal 8R may then have been alerted by the yellow over green of signal 59006 that something was out of line with his expectation.

³ Signals 12L and 6L referred to in the 1993 report have now been re-designated 2R and 8R respectively.

1.7.4 NZRL responded:

The provision of intermediate speed aspects for the signals 12L and 6L at Te Kauwhata and other similar locations should be considered at a future time as part of a resignalling or major upgrade to the signalling system in relation to meeting business objectives. (038/94)

1.7.5 Following the 1997 accident Tranz Rail were requested to supply details of any action taken with respect to recommendations 037/94 and 038/94.

1.7.6 On 12 August 1997 Tranz Rail advised:

Recommendations 037/94 was not adopted as Te Kauwhata is a fully interlocked station at which the control of points and signals is centralised to prevent conflicting movements. The signals are three position type and as such, indicate the permissible speed and give advance information about the next signal ahead. From the aspects displayed the Locomotive Engineer is aware of the route his train is signalled to take and the speed to be applied. Locomotive engineers as part of their road knowledge are aware of the location of fixed signals and their strict attention to the indications of the signals displayed is important for safe operations.

Any dilution of the signalling system by Locomotive Engineers relying on receiving advice from Train Control of unusual movements or circumstances which may be significantly different from the expectancy of the Locomotive Engineer (it is hard to know what these would be if the indications displayed by fixed signals were being observed) was not acceptable.

Recommendation 038/94: There has been no action taken in regard to this recommendation as there has been no resignalling or major upgrade work undertaken to the system at Te Kauwhata or other similar locations since this incident.

2. Analysis

2.1 Train Speed

- 2.1.1 Analysis of the short log enabled confirmation of events immediately preceding the derailment.
- 2.1.2 Approximately seven seconds prior to derailment the locomotive was under power in notch 1 with normal 500 kpa brake pipe pressure and zero brake cylinder pressure and travelling at 63 km/h. The derived kilometrage was 591.030 km, i.e. some 76 m before signal 2R and 100 m before the turnout leading from the up main to the loop.
- 2.1.3 Approximately six seconds prior to derailment the locomotive was still travelling at 63 km/h but brake pipe pressure had dropped to 420 kpa and the throttle position was zero. This confirmed the LE's recollection of realising the implication of red over yellow before reaching the signal (1.1.24) and making an emergency brake application.
- 2.1.4 Over this period of six seconds train speed was relatively constant at approximate 62 km/h before a sharp drop to 25 km/h over the next second. Speed then fell away to zero over two seconds from which it was deduced the derailment occurred at a speed of 62 km/h at a factor of 2.5 above the permissible speed of 25 km/h. This is considered a predicable outcome and one not requiring specific overturning calculations to substantiate cause.

2.2 Train operations

- 2.2.1 On 30 July 1997 both Train 138 and Train 141 were running ahead of their standard plot.
- 2.2.2 The TCO responded to the particular conflicting movements resulting from this by signalling Train 138 into the loop at Te Kauwhata to give priority to the two passenger trains, 201 and 300, with Train 141 running ahead of 201.
- 2.2.3 This was a correct use of the automatic signalling system to optimise train movements.
- 2.2.4 The automatic signalling system on Tranz Rail was a speed signalling system, whereby the colour lights gave instructions about the section of track ahead and also about the aspect of the next signal.
- 2.2.5 The philosophy behind the provision of automatic signals required that the LE act upon the aspect of every signal using his knowledge of train handling, and of the route, to control the train so that the aspect of the next signal could be obeyed.
- 2.2.6 Essential elements of route knowledge were the location of signals, the location and steepness of grades, the location and sharpness of curves and the authorised speeds.
- 2.2.7 Essential elements of train handling knowledge were the braking characteristics of trains on straight and curved tracks, and on grades, in both wet and dry weather.
- 2.2.8 Intermediate signals such as signal 59006 were not intended simply to shape the expectation of the driver prior to observing the next signal, but to provide information which had to be acted upon.
- 2.2.9 Despite this, two experienced LEs have made a similar incorrect interpretation at the same locality when confronted with identical signal aspects advising medium speed entry into the loop at Te Kauwhata.
- 2.2.10 The report on the 1993 derailment recommended NZRL investigate the practicability of introducing intermediate speed aspects at Te Kauwhata and other similar locations. Tranz Rail advised that there has been no resignalling or upgrading initiatives at Te Kauwhata to justify consideration of this option since 1993.
- 2.2.11 The 1993 report also recommended NZRL set guidelines for TCOs to advise LEs by radio of unusual movements or circumstances. Tranz Rail did not adopt this recommendation for the reasons outlined in 1.7.6.
- 2.2.12 This second derailment has confirmed the potential for misinterpretation at Te Kauwhata and the Commission considers action as recommended in Section 4 is now essential to avoid any future derailments from similar causes.
- 2.2.13 Although the LE's training and experience had made him fully conversant with the automatic signalling system, and he was certified accordingly, his expectations on that day were shaped by:
- passing an on-time Train 401 at approximately 0940 hours
 - his knowledge of the normal timing of Train 201
 - his lack of knowledge that Train 141 was running ahead of Train 201
 - the radio conversation he overheard at approximately 0940 hours which made him aware that Train 300 had been delayed at Te Rapa.

- 2.2.14 These inputs created in his mind an expectation that he would be proceeding through Te Kauwhata on the up main and into the single line section without stopping.
- 2.2.15 The LE was aware that in the normal course of events he had to reduce speed to 50 km/h by the time he reached the north end of Te Kauwhata, but he had not contemplated a reduction to 25 km/h at any point.

3. Findings

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

- 3.1 The signalling system worked correctly.
- 3.2 The aspect of signal 59006 was intended to inform the LE that he was required to slow to medium speed by the next signal, which was Signal 2R, and that the points were set for the loop at Te Kauwhata.
- 3.3 The LE had an expectation that he would be proceeding directly through Te Kauwhata and on to the single line section of track.
- 3.4 The LE's expectation that he would proceed directly through Te Kauwhata was based on his 12 years experience of operating trains through Te Kauwhata, and his knowledge that Train 300 had been delayed at Te Rapa.
- 3.5 The LE interpreted the aspect of signal 59006 incorrectly to conform with his expectation.
- 3.6 The LE did not realise his error until he saw signal 2R, by which time he was too close to the signal to slow the train sufficiently to conform with the requirement of its aspect.
- 3.7 The derailment was a direct consequence of the train entering the crossover at approximately 62 km/h rather than the authorised speed of 25 km/h.
- 3.8 Neither the track geometry nor its condition contributed to the derailment.
- 3.9 The TCO's decision to signal Train 138 into that loop at Te Kauwhata was an appropriate response to the operating conditions.
- 3.10 The TCO was not required to advise the LE of the intention to divert the train into the loop, even though this was an infrequent event.
- 3.11 If the LE had been advised of the diversion of his train into the loop, it is unlikely the derailment would have occurred.
- 3.12 If signal 59006 had been able to show routing to the loop by other than a yellow over green indication it is unlikely the LE would have misinterpreted the signal.

4. Safety Recommendations

4.1 It was recommended to the Managing Director of Tranz Rail that he:

4.1.1 Take action to restrict movements through the crossover at the south end of Te Kauwhata, such that signal 59006 is not required to give a medium speed indication for a routing to the loop. (074/97)

4.1.2 Take the appropriate action to reduce the possibility of similar incidents occurring at any other localities where adjacent signals capable of giving medium speed indications under similar routing patterns could lead to similar misunderstandings. (075/97)

4.2 The Managing Director of Tranz Rail responded as follows:

4.2.1 An amended Signalling & Interlocking Diagram outlining the proposed changes to meet the recommendations has been sent out for local approval, subject to ratification of this it is expected that the necessary changes will proceed.

A review of other possible locations is underway and any signalling changes identified for a location will be considered.

4.2.2 Tranz Rail have since advised that safety recommendation 074/97 was implemented on 29 January 1998.

15 April 1998

W P Jeffries
Chief Commissioner

Appendix 1

Circular S&I No.2408
Sheet No.2 of 3

NS Normal Speed
MS Medium Speed
LS Low Speed

DESCRIPTION OF SIGNALS AND LEVERS ; TE KAUWHATA

| | | |
|-------|------------------------------|---|
| 2RABC | Up Home | NS to Up Main MS to Loop LS to Up Main and Loop |
| 4LA | Down Starting from Down Main | |
| 4LB | Down Starting from Loop | |
| 10R | Up Starting along Loop | |
| 8RAB | Up Departure from Up Main | |
| 8RC | Up Departure from Down Main | |
| 8LABC | Down Home | NS to Down Main MS to Loop LS to Down Main and Loop |

CIRCULAR SAI No. 2408
SHEET No. 3 OF 3

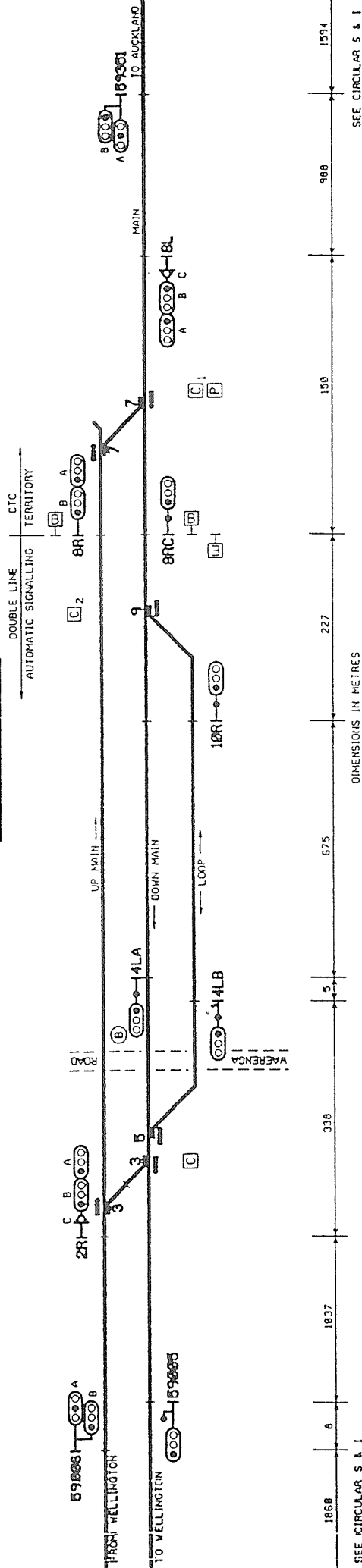
IN SERVICE 20/8/94
T.A. No. 7165

TE KAUWHATA

SIGNALLING & INTERLOCKING ARRANGEMENTS

UP

TE KAUWHATA (TKW)



SEE CIRCULAR S & I
FOR WHANGAREIRO

DIMENSIONS IN METRES

SEE CIRCULAR S & I
FOR KIMBERA

- MOTOR POINTS
- "CTC BEGINS" BOARD
- "CTC ENDS" BOARD
- PILOT KEY
- CRANK HANDLE
- CRANK HANDLE (CODED) FOR USE WITH POINTS No.7
- CRANK HANDLE (CODED) FOR USE WITH POINTS No.9
- BARRIER MANUAL CONTROL

M. J. Farman

MANAGER, SIGNALS ENGINEERING