Report 00-102

express freight Train 228

passed signal at Stop

Plimmerton

23 February 2000

Abstract

At about 2000 on Wednesday 23 February 2000, Train 228, a Wellington to Auckland express freight service, passed a signal at Stop and entered Plimmerton station limits. An electric multiple unit, which had been running ahead of Train 228 and terminated at Plimmerton, was standing at the platform on the up main line ready to depart on its return journey to Wellington.

Train 228 stopped about 180 metres short of colliding with the electric multiple unit.

Six safety issues were identified:

- the visibility of signals at authorised line speed
- the failure of the Locomotive Engineer to respond to an Intermediate signal warning him that the next signal in advance, 18 up home signal at Plimmerton, was at Stop
- the absence of any defences to protect a level crossing if a locomotive engineer did not respond to a Stop and Proceed signal in advance
- the lack of warning to road users when signals in close proximity to level crossings are passed at Stop
- the absence of a safe signal overrun distance at Plimmerton
- the locomotive engineer not being immediately relieved after having been involved in a serious operating irregularity.

Three safety recommendations were made to the operator.

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.

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 Web site: www.taic.org.nz

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List of Abbreviations

EMU	electric multiple unit
km	kilometre(s)
km/h	kilometre(s) per hour
LE	locomotive engineer
m	metre(s)
Signal 18	18 up main home signal, Plimmerton

Data Summary

Train type and number:	express freight Train 228
Date and time:	23 February 2000, at about 2000
Location:	Plimmerton, 24.5 km North Island Main Trunk
Type of occurrence:	signal passed at stop
Persons on board:	crew: 1
Injuries:	nil
Damage:	nil
Operator:	Tranz Rail Limited (Tranz Rail)
Investigator-in-charge:	D L Bevin

1. Factual Information

1.1 Narrative

1.1.1 On Wednesday 23 February 2000, Train 228 was a scheduled Wellington to Auckland express freight service consisting of 2 DC class locomotives and a DQ class locomotive operating in multiple, with a train weight of 1064 tonnes gross, and 728 m in length.

1.1.2 The locomotive engineer (LE) of Train 228 had commenced duty in Palmerston North at 1515 on the day of the incident. He had taken Train 245 express freight service from Palmerston North to Wellington and was returning to Palmerston North as LE on Train 228.

1.1.3 Train 228 departed the Wellington marshalling yard at about 1935 and followed an electric multiple unit (EMU) which had departed Wellington platform at 1930 hours on a scheduled passenger service to Plimmerton. It was not unusual for express freight services or other EMU services to closely follow preceding EMU services from Wellington, especially when train density was high.

1.1.4 By the time Train 228 had entered the up main line the preceding EMU was far enough in front that the LE of Train 228 received Clear Proceed (green) indications on all signals as he travelled north from Wellington.

1.1.5 There was a permanent speed restriction of 70 km/h in place for express freight trains between Signal 2088 (between Porirua and Paremata) and Signal 2354 (between Mana and Plimmerton), a distance of 2.66 km. Tranz Rail advised the 70 km/h restriction was to compensate for the close spacing of signals through that area and the braking characteristics of express freight trains.

1.1.6 Signal 2288 was an Intermediate Stop and Proceed[1] signal positioned 657 m before Signal 2354 (refer Figure 1). The LE recalled this signal had displayed a Clear Proceed indication when his train passed it.

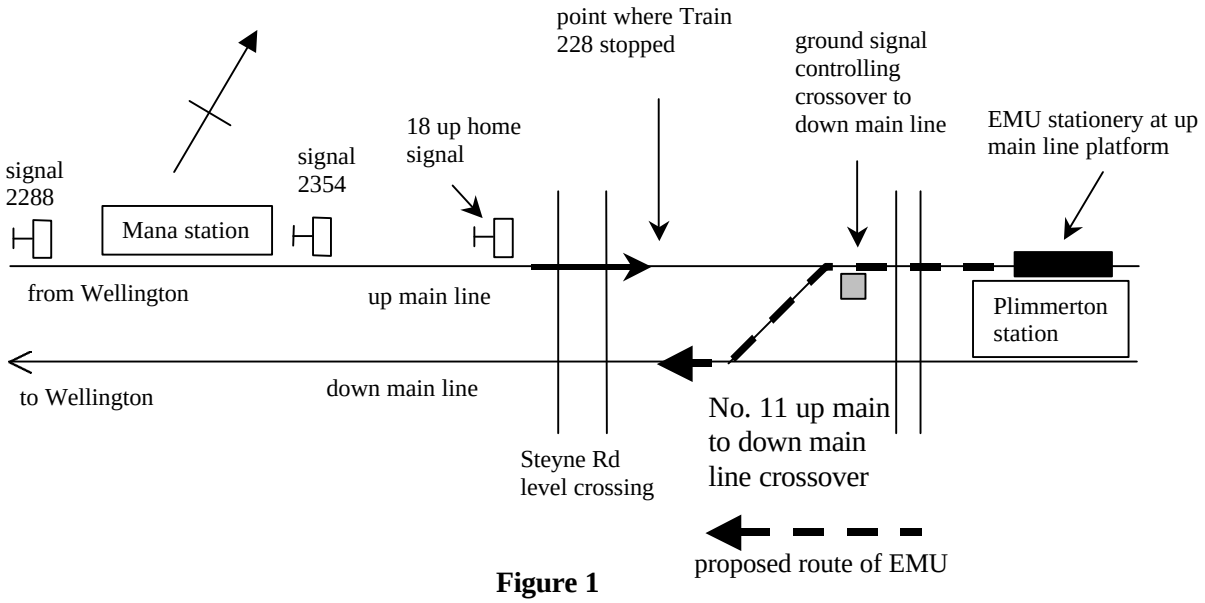

Figure 1
Signalling plan of Plimmerton
(not to scale)

[1] Stop and Proceed Signals – If displaying a Clear Proceed or Caution Proceed indication the train may pass without stopping. If the signal is displaying a Stop indication the train must stop but, after waiting 10 seconds may proceed under conditions detailed in Automatic Signalling Regulations.

1.1.7 Signal 2354 was the next Intermediate signal and acted as a distant signal to warn the LE of the indication that 18 up home Stop and Stay[2] signal at Plimmerton (Signal 18) was displaying at the time. The indications on Signal 2354 were visible from about 200 m away but the LE could not recall what indication it had displayed as his train past it. Signal 18 was 599 m further on from Signal 2354.

1.1.8 After Signal 2354 the track curved to the right then straightened for a short distance before it curved to the left approaching Signal 18 at Plimmerton.

1.1.9 The LE later stated that he had been inattentive in that he was looking at the scenery and not paying attention as he approached Signal 2354. Under normal operating conditions Signal 2354 would be displaying a Caution Proceed (yellow) indication. The first he knew that Signal 18 at Plimmerton was at Stop (red) was when his train rounded the left-hand curve on the approach to the signal and he saw it about 150 m away. On seeing Signal 18 at Stop the LE immediately made a full service brake followed almost immediately by an emergency brake application to bring the train to a stop, but Train 228 overran the signal by about 115 m, and crossed Steyne Avenue level crossing before stopping.

1.1.10 The LE realised that his train would overrun Signal 18 and he was aware the level crossing alarms would not operate until his train tripped the alarm switch at the signal, only 24 m before the level crossing, so he sounded the locomotive horn to warn any road traffic using the level crossing of his approach. A car was on the level crossing at the time the alarms started but had cleared just before the train arrived. The driver of the car was so shaken up that, once the train had stopped, he went across to the LE and expressed his concerns that the crossing alarms had not operated to warn him of the approach of the train. The LE explained to the car driver what had happened and apologised to him.

1.1.11 The LE estimated Train 228 was travelling about 60 km/h, the maximum authorised speed for the curve, as it approached Signal 18. The curve was a 430 m radius curve with a 50 mm cant and was restricted to 60 km/h. The standard for a 430 m radius curve was a 70 mm cant and a speed restriction of 75 km/h. An adjacent 400 m radius curve with a 60 mm cant was restricted to 70 km/h.

1.1.12 Signal 18 was at Stop because the section ahead was occupied by the EMU standing at the up main line platform, ready to depart at 2000 on its return journey to Wellington. Train 228 stopped about 7 m short of No. 11 up main to down main line crossover and about 180 m from where the EMU was standing. The EMU had not applied for the route or signals to the down main line for its departure.

1.1.13 After Train 228 had stopped the LE contacted the train control officer who, after taking the necessary safety precautions, authorised the LE to reverse the train to outside Signal 18. This then allowed the EMU at the platform to obtain the correct route and signals for its departure to Wellington.

1.1.14 Some time after the EMU had departed the LE of Train 228 was instructed by the TCO to continue on to Paekakariki where his train was berthed clear of the main line to avoid delays to following traffic and where a relief LE was sent to take over the train.

[2] Stop and Stay Signals – If displaying a Clear proceed or Caution Proceed indication the train may pass without stopping. If the signal is displaying a Stop indication the train must Stop until the indication changes to either a Clear proceed or Caution Proceed indication.

1.2 Signalling arrangements

1.2.1 The rail corridor between Wellington and Plimmerton consisted of a down main line for trains running to Wellington and an up main line for trains running to Plimmerton. This was defined as double line running. Tranz Rail's Rules and Regulations provided the following definitions relevant to double line automatic signalling:

> **Double Line sections** - A Double Line section is the section of either main line between two interlocked stations the entrance to which is governed by a fixed signal.
>
> **Intermediate Section** – Any division of a double line section the entrance to which is governed by an intermediate signal.
>
> **Interlocked station** – A station for which control of the points and fixed signals is centralised and arranged to prevent conflicting moves. The operation of the points and signals may be manually controlled in addition to being controlled by track circuits.

1.2.2 Tranz Rail's Rule 58(a) described Automatic Running Signals as:

> Automatic Running Signals are divided into three main classes:
> **Stop and Proceed signals**
> **Stop and Stay signals**
> **Departure signals**

Departure signals were not relevant to Double Line Automatic Signalling.

> The light units of **Stop and Proceed** signals are "staggered", i.e., the lower unit is in a diagonal line to the right and not vertically below the upper unit.
>
> The light units of **Stop and Stay** signals and of **Departure** signals are in vertical line, i.e., the lower unit is vertically below the upper unit.

In some cases the lower light unit had been replaced by a metal disc which fulfilled the same purpose.

Figure 2 shows Signal 2354, a single unit Stop and Proceed signal.

1.2.3 Tranz Rail's Rules and Regulations defined the meaning of a Stop and Proceed signal as:

> Stop, then proceed in accordance with the provisions of the Automatic Signalling Regulations – Section is occupied or for some other reason it is required that the train should be stopped.

1.2.4 After departing Porirua Train 228 passed 5 Intermediate signals, all displaying Clear Proceed indications, before passing Signal 2354, which showed a Caution Proceed indication meaning Signal 18 at Plimmerton was at Stop. Plimmerton was "switched out"[3] at the time of the incident.

1.2.5 Tranz Rails Rules and Regulations define the meaning of a Stop and Stay signal as:

> Stop – Section is occupied or for some other reason it is required that the train should be stopped.

[3] Plimmerton was a signal box which could be "switched in" to allow manual control of signals for dispatching EMU services or to meet other operating requirements. It normally operated in the "switched out" mode, which reverted to automatic signalling.

Figure 2
Signal 2354 Stop and Proceed intermediate signal

Figure 3
18 up home Stop and Stay signal Plimmerton

1.2.6 Signalling arrangements at Plimmerton allowed for EMU services to terminate on the up main line and return to Wellington. When departing, EMUs were required to move south approximately 190 m after leaving the platform to No. 11 crossover, where they crossed to the down main line to continue their journey. There were 29 services a day that terminated at Plimmerton and returned to Wellington.

1.2.7 The route setting and clearing of signals for the departing EMU was done by the guard of the service after he had obtained permission from the TCO. This was to ensure there was no other traffic on the down main line which could conflict with the movement of the EMU. Once permission had been obtained the guard applied for the route by pressing a button in a locked box on the Plimmerton station wall. This was done immediately prior to departure to minimise delays to road traffic at the level crossing. Until the EMU had crossed over to the down main line, Signal 18 remained at Stop to prevent any other train entering the section on the up main line. During this time Signal 2354 remained at Caution Proceed to warn the LE of any approaching train that Signal 18 around the bend was at Stop.

1.2.8 A level crossing was located about 24 m past 18 up home signal, the crossing alarms for which were operated automatically in conjunction with the signal indications and train movements to avoid unnecessary delays to road traffic. If 18 up home signal displayed a Stop indication the level crossing alarms did not operate while a train was stopped at the signal. Before changing from Stop to a Proceed indication, there was a time delay of approximately 30 seconds from the time the alarms started operating before the signal cleared. This was to allow any road traffic using the level crossing to get clear before the passage of the train. If 18 up home signal displayed a Proceed indication the crossing alarms operated when the approaching train was about 600 m from the level crossing.

1.3 Signal sighting policy

1.3.1 Tranz Rail advised that current policy regarding signal sighting distances was:

- Minimum sighting distance of signals shall be equivalent to 12 seconds of maximum approach speed for locality with a minimum of 10 seconds (must be achieved on intermediate signals immediately prior to an interlocking).
- In interlockings, 10 seconds is not always achievable due to site physical constraints, and in some cases approach signals may be used.

1.4 Signal overrun distance

1.4.1 Tranz Rail advised that signal overrun as it related to Plimmerton was defined as:

> ***Signal Overrun*** distance in this case was the distance from the home signal to the nearest point of conflict (in this case a down train departing from the Up main line while traversing through crossover No 11), a distance of approximately 120 metres.

1.5 LE relief

1.5.1 Tranz Rail's Operating Code, Section 6, Operating Instructions for Train Control, Instruction 26.1, stated:

> **Operating Irregularities**
>
> When an operating irregularity occurs and the Locomotive Engineer may be at fault, the train must not be authorised to continue until the Locomotive Engineers Manager has been advised by Train Control.
>
> It is the decision of the Locomotive Engineers Manager in conjunction with the NCM [Network Control Manager] to direct if he should be relieved immediately or allowed to continue.

Tranz Rail advised that the decision to allow the LE to continue to Paekakariki before being relieved was made by the network control manager after attempts to contact the LE's manager were unsuccessful and to avoid delays to following passenger and freight services.

1.5.2 During the Commission's investigation into a track warrant irregularity involving Train 701 between Claverley and Oaro on 31 October 1994 (Rail Occurrence Report 94-125) the following safety action was recorded:

> During the course of the investigation NZRL [now Tranz Rail] advised that the appropriateness of the relief arrangements following the incident had been reviewed and operating staff had been made aware of the need to critically assess all immediately available sources of information and to immediately relieve all staff in cases where their possible involvement in serious operating irregularities was indicated.

1.5.3 An investigation of a track warrant irregularity involving Train 902 between Mosgiel and Dunedin on 21 May 1999 (Rail Occurrence Report 99-109) in which the LE was not relieved resulted in a safety recommendation to the Managing Director of Tranz Rail that he:

> standardise and enforce relief arrangements for LEs involved in serious operating irregularities. (002/00)

Tranz Rail replied on 6 July 2000 that a review of procedures associated with Locomotive Engineers involved in serious operating irregularities was planned. This reply was received after the publication of the report.

1.6 Event recorder data extraction

1.6.1 The locomotive event recorder data was not extracted. Tranz Rail advised that it did not have a formal policy on extracting data from the locomotive event recorder. It was usually done on demand and depended on the circumstances and if it was considered the log may assist in providing supportive information. It was considered by Tranz Rail to be only one part of the information and could be why an extraction was sometimes not requested.

1.7 Signals testing

1.7.1 The signals were not tested following the incident. Tranz Rail advised that such tests were normally only carried out if there was an allegation of a signalling irregularity. There were no reports of malfunctioning signals immediately before or after the incident.

1.8 Personnel

1.8.1 The LE was certified for the duties he was undertaking. He had worked 11.5 hours the previous day (rostered 11 hours), 7.3 hours the day before that (rostered 6.75 hours), and worked 7.5 hours the day before that (rostered 7.25 hours). The fourth day prior to that had been a day off duty.

1.8.2 On the day of the incident the LE was rostered to work 7.9 hours and had completed 4.75 hours of his rostered shift at the time of the incident.

2. Analysis

2.1 Train 228

2.1.1 Factors contributing to this incident were:

- the failure of the LE to see and respond to the Caution Proceed indication on Signal 2354
- Tranz Rail not viewing level crossings as "points of conflict" for the purposes of determining safe signal overrun distances.

2.1.2 Prior to his departure from Wellington the LE had been aware of EMU services travelling past the freight yards but he had not paid much attention to them as his experience had been that such movements didn't usually impact on the running of Train 228. On other scheduled freight services he had followed EMU services from Wellington and had been stopped at Signal 18 at Plimmerton while they had cleared the section ahead, but he had not previously encountered this on Train 228. If Train 228 had followed closer to the EMU after departing the Wellington marshalling yard the LE would have received Caution Proceed indications, instead of the Clear Proceed indications he did receive, and this may have reminded him of the presence of the EMU ahead and prepared him for the possibility of a Stop indication on Signal 18 at Plimmerton.

2.1.3 Visibility for Signal 2354, at about 200 m, was within Tranz Rail's minimum signal sighting policy of 10 seconds of maximum approach speed for locality at the authorised line speed of 70 km/h. The restricted view of 18 up home signal at Plimmerton of 150 m because of the foliage and overhead power pole did not meet the minimum signal sighting requirement. At the maximum authorised line speed of 60 km/h less than 9 seconds line of sight was available.

2.1.4 The signal sighting policy was based on the LE being able to see the signal indications, not on his ability to react to the signal and stop his train. Calculations indicated that at the maximum authorised line speed of 60 km/h, Train 228 would have required about 230 m to stop from the place the LE saw and responded to the signal although it actually took 265 m to stop. This extra 35 m can be explained by either the train travelling slightly faster than 60 km/h as it approached the signal or, more likely, the LE's response time being fractionally slower because of his relaxed frame of mind and his action in going first to a full service brake application before making an emergency brake application once he realised he was going to overrun the signal. This was considered a normal procedure for such occurrences and showed good train handling skills on the part of the LE. Travelling at the maximum curve speed of 60 km/h Train 228 would have covered the extra 35 m in about 2 seconds. This curve speed restriction of 60 km/h was in effect because of the presence of No 11 crossover at Plimmerton.

2.1.5 The speed of Train 228 as it approached Signal 18 could not be confirmed because the locomotive event recorder data was not downloaded after the incident. The data available, however, does indicate that the LE noticed the Stop indication on Signal 18 almost immediately it came into view, and acted appropriately thereafter.

2.1.6 Although the LE could remember the Clear Proceed indication on Signal 2288, he had allowed himself to be distracted after he had passed it and had missed the indication on Signal 2354. With his experience in driving trains out of Wellington the LE knew of Signal 2354 and that its indications related to Signal 18 at Plimmerton. Had he seen and responded to Signal 2354 there was ample time and distance for him to have stopped his train short of Signal 18 at the maximum authorised line speed of 70 km/h, reducing to 60 km/h.

2.1.7 The signal was hidden by a combination of overhanging foliage and a pole supporting the overhead power line, which together reduced the signal sighting distance for Signal 18 below Tranz Rail's specified minimum of 10 seconds. A safety recommendation covering this issue is made in Section 5 of this report.

2.1.8 The LE's perception that there was no traffic in front of him was probably created by the Clear Proceed signal indications he had received after departing from Wellington and was further reinforced by his previous experiences with Train 228. This was caused by what is considered, within the framework of human factors ideology, as a slip brought on by an automatic mode of behaviour based on previous experience, in which conscious attention is diverted elsewhere. This type of slip is not uncommon in all types of human activity.

2.1.9 The LE was unlikely to have been suffering from fatigue based on his roster, and by his own admission he was feeling well. No other factors were identified that could suggest why he acted any different from other LEs. The passing of signals at danger is a problem worldwide, in other industries as well as rail.

2.1.10 Following an incident it is a normal human behaviour for persons who have been involved to feel downcast at the thought of having contributed to it, often to the detriment of their ability to function normally for the rest of their shift. There was no doubt that the LE was involved in a serious operating irregularity. The presence of the EMU in the section ahead and the location of the level crossing close ahead meant that the potential for a serious accident existed. The actions of the very upset driver of the motor vehicle on the level crossing at the time in going to the locomotive and discussing his concerns would have placed additional stress on the LE. To not relieve a staff member in such a situation is not in the best interests of rail safety. Similar concerns were echoed in Rail Occurrence Report 99-109 mentioned in Section 1.5.3 of this report.

2.1.11 The decision to allow the LE to continue to Paekakariki before being relieved was inconsistent with Tranz Rail's stated policy of immediately relieving staff "where their possible involvement in serious operating irregularities was indicated".

2.2 Signalling arrangements

2.2.1 Signal 2288 was clearly visible to the LE as it was positioned alongside a long, straight section of track.

2.2.2 Signal 2354 was probably displaying a Caution Proceed indication, but only the LE could have confirmed this and he did not recall seeing it.

2.2.3 Had the foliage in particular not been obstructing Signal 18 the LE could have sighted the signal about 50 m earlier which at 60 km/h would still have given insufficient stopping distance to avoid the overrun, but the train would probably have approached the level crossing at a slower speed.

2.2.4 Tranz Rail stated that an overrun distance of approximately 120 m existed at Plimmerton based on the distance from Signal 18 to the "nearest point of conflict", specifically No. 11 up main to down main line crossover. Tranz Rail did not take into account the presence of the level crossing 24 m past Signal 18 and the lack of warning to level crossing users if the signal was overrun. The near collision with the car on the level crossing at the time was definitely a

potential conflict albeit not with another rail service vehicle. When the lights and bells started the train was less than 24 m from the level crossing and, although under emergency braking, would have been on the level crossing before the warning barriers were in place to prevent any other traffic from entering the level crossing. It was not unusual for home signals to be positioned close to level crossings so the potential for such an occurrence was high. In view of the risk to level crossing users in this case the safe overrun distance was only 24 m. A safety recommendation covering this issue is made in Section 5 of this report.

2.2.5 No tests were untaken by Tranz Rail to confirm that the signals were operating correctly at the time of the incident but there had been no reports of malfunctioning signals either before or after the incident.

2.2.6 There was no correlation between signal sighting distances and train stopping distances so that although a signal met the time visible criteria in regards maximum authorised line speeds there was no allowance included for train stopping distance. A safety recommendation covering this issue is made in Section 5 of this report.

2.3 Event recorder data extraction

2.3.1 Considering the seriousness of this operating incident it would have been appropriate to have extracted the locomotive event recorder immediately. A safety recommendation covering this issue is made in Section 5 of this report.

3. Findings

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

3.1 The LE was appropriately certified for the duties being carried out.

3.2 The LE failed to see and act on the indications displayed by Signal 2354, which resulted in his train overrunning Signal 18.

3.3 The LE did not see Signal 2354 probably due to his conscious attention being diverted elsewhere, induced by his expectation that the signal would give him a Clear Proceed indication.

3.4 The sighting distance of Signal 18 was reduced by foliage and a pole supporting the overhead power supply and did not meet Tranz Rail's minimum signal sighting requirements..

3.5 Once the LE had missed Signal 2354, there was no defence in the signalling system that could have prevented Train 228 from passing Signal 18 at Stop, or from passing over the level crossing close ahead with insufficient warning to level crossing users.

3.6 In calculating maximum train speeds and safe overrun distance for the approach to Plimmerton, Tranz Rail did not appear to have considered the level crossing as a "point of conflict", which jeopardised the safety of level crossing users.

3.7 The lack of a safe overrun distance at signals which were positioned in close proximity to level crossings posed a danger to level crossing users.

3.8 The lack of a locomotive event recorder extract meant that some information that would have assisted the investigation had to be estimated. The lack of such information could adversely effect further investigations of this nature.

3.9 There were no guidelines to Tranz Rail staff for when locomotive event recorder extraction was required.

4. Safety Actions

4.1 Following an internal inquiry carried out by Tranz Rail, the LE undertook a full medical examination and completed a rules and regulations assessment which included being observed on a full shift before being returned to footplate duties.

4.2 As a result of a previous investigation carried out by the Commission in which the issue of relief arrangements for LEs involved in serious operating irregularities was highlighted, rail occurrence report 99-109, Mosgiel, a safety recommendation has already been made to Tranz Rail. Based on the response of Tranz Rail to that safety recommendation and likely action arising no additional safety recommendations regarding the relief of LEs involved in serious operating irregularities have been made.

5. Safety Recommendations

5.1 On 15 November 2000 it was recommended to the managing director of Tranz Rail that he:

5.1.1 Ensure that trackside growth and the location of poles and other structures do not interfere with necessary minimum signal sighting distances. (093/00)

5.1.2 Ensure authorised line speed and signal sighting distances provide a safe stopping distance in the event of an Intermediate signal being misread at locations such as Plimmerton where level crossings and conflicting passenger movements create a potential hazard. (094/00)

5.1.3 Publish criteria for staff involved in occurrence investigation which ensures locomotive event recorder extraction follows serious operating incidences such as signal overruns. (095/00)

5.2 On 15 November 2000 the managing director of Tranz Rail replied:

5.2.1 Safety Recommendations 093/00, 094/00 and 095/00

093/00: Tranz Rail has completed a signal sighting inspection confirming that there were issues with trackside growth. Additionally, there was a mobile caravan obstructing the rail lines. The caravan has been removed and the trackside growth has been attended to.

Tranz Rail accept this recommendation.

094/00: Tranz Rail does not accept this recommendation in its present form.

There are a range of issues in regard to locations such as Plimmerton, which need to be taken into account, however Tranz Rail is committed to investigating options to seek a solution, if in fact there is one.

095/00: Tranz Rail accept this recommendation.

A code amendment will be issued in the Rail Operating Code on 27 November 2000.

Approved for publication 22 November 2000

Hon. W P Jeffries
Chief Commissioner