Report 99-122

express freight Train 938 and

intercity express freight Train 919

collision

Waipahi

20 October 1999

Abstract

At about 0702 hours on Wednesday, 20 October 1999 Train 938, a northbound express freight, collided with Train 919, a southbound intercity express freight, which was stationary on the main line within station limits at Waipahi on the Main South Line.

The locomotive engineer of Train 919 was fatally injured, and the locomotive engineer of Train 938 was seriously injured.

The two locomotives on Train 919 and the single locomotive on Train 938 were extensively damaged, as were a number of wagons and containers.

Causal factors included one locomotive engineer's misunderstanding of his track warrant limit and the limited effectiveness of the action taken by the operator and the regulator to minimise the possibility of such misunderstandings.

Recommendations were made to the operator and the regulator to address the safety issues identified.

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

Contents

Figures

List of Abbreviations

GPS	global positioning system
ICE	intercity express
km	kilometre(s)
km/h	kilometres per hour
LE	locomotive engineer
LE1	locomotive engineer of Train 938 from Mataura to Waipahi
LE2	locomotive engineer of Train 919
LE3	locomotive engineer of Train 938 from Invercargill to Mataura
LTSA	Land Transport Safety Authority
m	metre(s)
MSL	Main South Line
NZRL	New Zealand Rail Limited
t	tonnes
TAIC	Transport Accident Investigation Commission
TCO	train control officer
Tranz Rail	Tranz Rail Limited
TW	track warrant
TWC	Track Warrant Control
TWACS	Track Warrant Computer System

Data Summary

Train type and number:	express freight 938 intercity express (ICE) freight 919
Date and time:	20 October 1999, about 0702 hours
Location:	Waipahi, 512 km Main South Line (MSL)
Type of occurrence:	collision
Persons on board:	crew: Train 919 1 Train 938 1
Injuries:	Train 919 1 fatal Train 938 1 serious
Damage:	major damage to 3 locomotives, a number of wagons and the track
Operator:	Tranz Rail Limited (Tranz Rail)
Investigator-in-Charge:	R E Howe

The Investigator-in-Charge was assisted by the Commission's organisational factors consultant in the preparation of this report.

1. Factual Information

1.1 Introduction

1.1.1 On Wednesday, 20 October 1999, northbound Train 938 collided with stationary Train 919 on the main line at Waipahi at 512 km MSL.

1.1.2 Events preceding the accident included the interaction of 3 trains. The trains and movements were:

- Train 913 southbound under the control of a locomotive engineer (LE1) to cross northbound Train 938 at Mataura before proceeding to Invercargill following a crew changeover.
- Train 938 northbound under the control of a locomotive engineer (LE3) with an initial crossing with Train 913 at Mataura. At Mataura LE1 took over Train 938 with a track warrant already issued to proceed to Waipahi and enter the loop to cross Train 919.
- Train 919 southbound under the control of a locomotive engineer (LE2) with a track warrant to proceed to Waipahi and enter the main line to cross Train 938.

1.2 Narrative

1.2.1 Operations on the MSL south of Dunedin on the day included a planned crossing of a northbound express freight, Train 938, with southbound ICE Train 919 at Waipahi. Such planned crossings were standard procedure on the single line track operated under the track warrant control (TWC) system. Figure 1 shows the relationship of localities to the planned crossing.

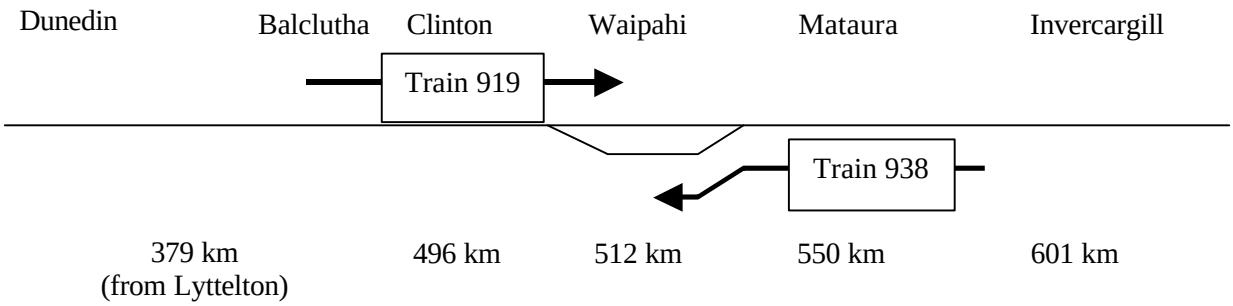


Figure 1
Relationship of localities to the planned crossing

1.2.2 The consist of Train 938 was locomotive DC 4202 and 11 bogie wagons. The train weight was 489 t with a length of 193 m, and it was crewed by LE1 from Mataura.

1.2.3 The consist of Train 919 was locomotives DFT 7254, DX 5448 and 17 bogie wagons. The train weight was 453 t, with a length of 321 m, and it was crewed by LE2. Locomotive DX 5448 was running dead[1].

[1] A term for a locomotive being transported and not under power.

1.2.4 The details covering the crossing were covered by 2 track warrants:

- Track Warrant (TW) 31 issued at 0618 hours authorised Train 938, after the arrival of Train 913 at Mataura, to proceed to the loop at Waipahi to cross Train 919.
- TW 35 issued at 0646 hours authorised Train 919 at Clinton to proceed to the main line at Waipahi to cross Train 938.

A copy of TW 31 is attached as Appendix 1.

1.2.5 Train 913 arrived at Mataura at about 0625 hours to cross Train 938 and, as planned, the crews of the trains changed over to return to their respective bases. LE3 took over Train 913, received a track warrant at 0627 hours, and departed south shortly thereafter. LE1 took over Train 938 with TW 31 already issued, and proceeded north at about the same time.

1.2.6 At 0649 hours LE2 on Train 919 called train control clearing limits at Clinton as he moved south. There was no further communication between train control and either Train 938 or Train 919.

1.2.7 Two independent eyewitness reports placed the arrival of Train 919 on the main line at Waipahi at about 0655 hours, with the train stopping in the middle of the yard and about 500 m before the control box at the south end of the yard controlling the points setting. Tranz Rail regulations required LE2 to then set the route for the opposing train to enter the loop using the south end control box. This route was not set, and there were no witness reports of LE2 leaving the cab between arrival and collision.

1.2.8 The eyewitnesses also saw the approach of Train 938 on the main line a short time after 0700 hours, and one saw Train 938 collide with stationary Train 919 at a speed estimated at "greater than 50 km/h ".

1.2.9 Two witnesses heard a "squeal of brakes". One heard this squeal just after Train 938 had passed a house about 120 m from the point of impact. The other heard the noise "a few seconds" before impact.

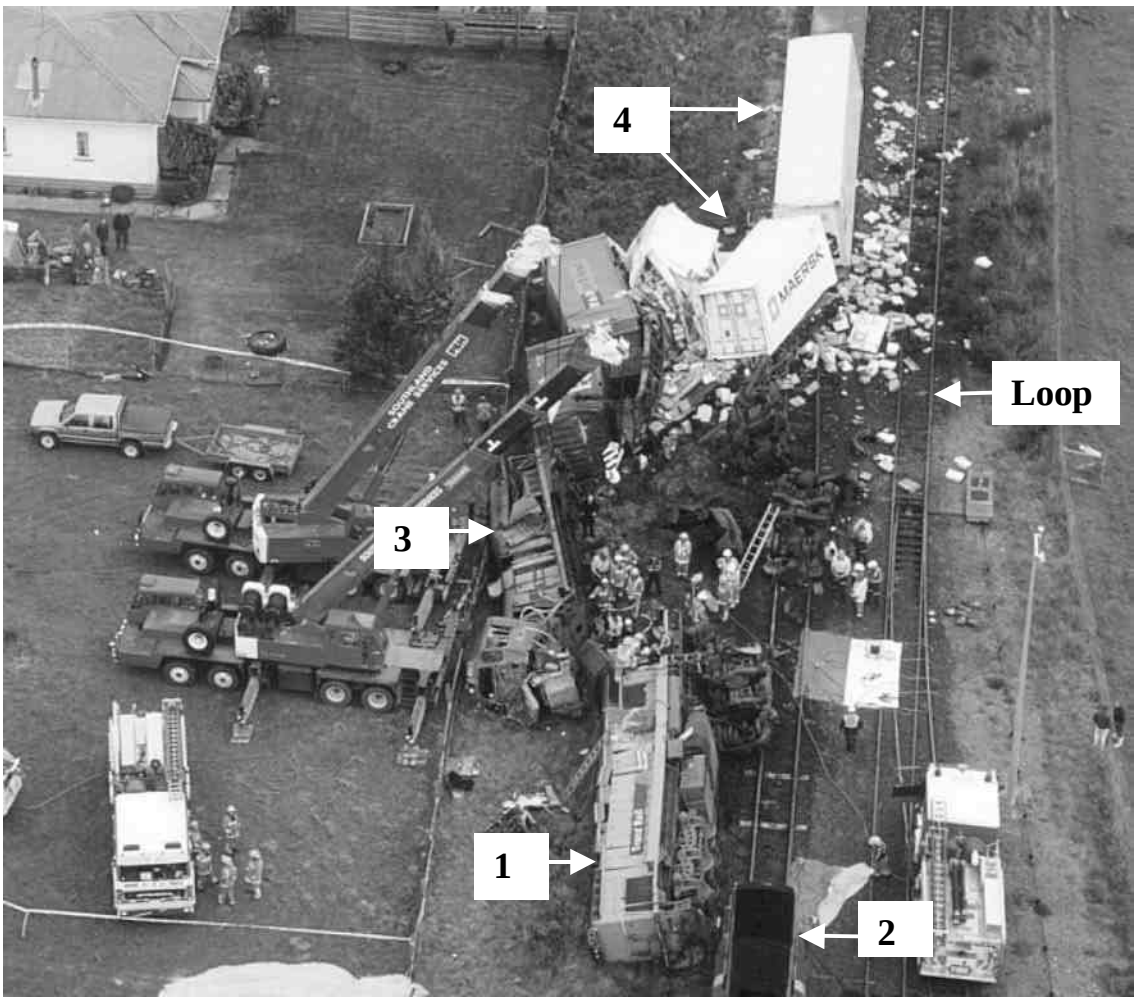
1.2.10 At 0702 hours a vigilance alarm from DC 4202, the locomotive of Train 938, was received in train control. (The vigilance alarm was activated in train control when emergency braking was applied.)

1.2.11 An eyewitness report spoke of the southbound locomotive "rising into the air" at impact and the wagons "rising in the air as high as their length". The force of the impact is also apparent in Figure 2, a photograph taken shortly after the collision. Both lead locomotives ended up on their sides following the collision.

1.2.12 Residents who heard the impact immediately called emergency services and went to the scene. They found the LE of Train 938 on top of the rear left side of the driver's seat in the damaged cab of DC 4202. The LE of Train 919 could not be found initially.

1.2.13 The cab of DFT 7254 on Train 919 was crushed in the impact. Once DC 4202 on Train 938 had been moved, the body of the LE of Train 919 was recovered from the right-hand bottom corner of the crushed cab.

1.2.14 The collision derailed the leading 3 wagons of Train 938 and damaged buffer gear throughout the train. The leading 2 wagons on Train 919 also derailed. These were sprung from the track by the impact and jack-knifed as the locomotive was pushed back, as shown in Figure 3.



(photograph courtesy of Otago Daily Times)

Figure 2
The accident scene looking south

1.	DFT 7254	(The front of
2.	DX 5448	stationary Train 919)
3.	DC 4202	(The front of
4.	Wagons from Train 938	northbound Train 938)

Note: DC 4202 had been moved east (to the left of the photograph) about 1.5 m at this stage to allow access to the cab area of DFT 7254.

Figure 3
The derailed leading 2 wagons on Train 919

1.2.15 The consist of Train 919 included 2 tanks of resin on the wagon immediately behind the locomotives. The tanks were split in the collision and some spillage occurred.

1.2.16 The last 2 wagons on Train 919 contained fireworks. These were not affected by the collision and did not create a hazard.

1.3 Site information

1.3.1 Waipahi was a standard Track Warrant Station sited at 512 km MSL. The loop was about 1070 m long and generally on a curve. Figure 4 shows the station and the approaches.

1.3.2 Northbound trains were on a down grade into Waipahi with the steepest grade, 1 in 155, just before entering the station.

1.3.3 The maximum authorised speed through the area for express freight trains was 80 km/h, but curve limitations through Waipahi limited the maximum authorised speed approaching from the south to 70 km/h.

1.3.4 Spilt diesel from a ruptured locomotive fuel tank, and the wreckage location, established the point of impact at 512.142 km on a short straight between curves. The front of Train 919 was pushed back about 30 m by the impact.

1.3.5 A deposit of sand was found near the left rail approximately 150 m before the impact point. The sand was similar to that used to assist locomotive braking and automatically deposited when emergency braking was applied.

1.3.6 Eyewitnesses reported a clear morning with some light rain but good daylight visibility. They confirmed that both locomotive headlights were operating.

1.3.7 Lineside trees and houses near the track on the right side of the line obstructed the forward view from a northbound train entering Waipahi. Tests after the accident from cab height showed a train standing at 512.142 km (the point of impact) could be seen momentarily by the LE of an approaching northbound train (looking across country and not straight ahead) when some 390 m away. This line of sight was then blocked until a clear view was obtained about 250 m from the standing train.

1.3.8 Had Train 919 pulled up to the south end of Waipahi the LE of Train 938 would have had a clear view of the standing train from a distance of about 900 m.

1.3.9 An unprotected level crossing (Railway Terrace) crossed the main line and loop about half way between the south end loop entry and the point of impact.

1.3.10 The original copies of TW 31 and TW 35, and a partly filled out track warrant for the intended passage of Train 919 beyond Waipahi, were found at the site of the collision.

1.4 Train 919 movements

1.4.1 Train 919 left Dunedin under the control of LE2 at 0439 hours and proceeded under TW 22 to Mosgiel, TW 26 from Mosgiel to Milton, and TW 28 from Milton to Clinton. All authorities were for the main line at the localities quoted.

1.4.2 At 0645 hours TW 35 was dictated to LE2 authorising Train 919 to proceed from Clinton to the main line at Waipahi to cross Train 938. This was repeated back correct at 0646 hours.

1.4.3 At 0649 hours LE2 called train control to advise he was clear of Clinton limits on TW28. This was the last voice communication with Train 919 recorded in train control.

1.4.4 Clinton was a remote controlled interlocked station and train control could see the arrival and departure of trains displayed on a visual display unit. The train control officer (TCO) on duty recorded the departure of Train 919 on the train control diagram as 0648 hours from this source.

1.4.5 The approximate distance travelled by Train 919 from Clinton to the point of impact was 16.14 km. The maximum speed for an express freight train over this area was 80 km/h. Curve restrictions of 75 km/h were in place at 499.5 km and 506 km, and curve speeds of 65 km/h to 50 km/h applied on the last 3 km before Waipahi.

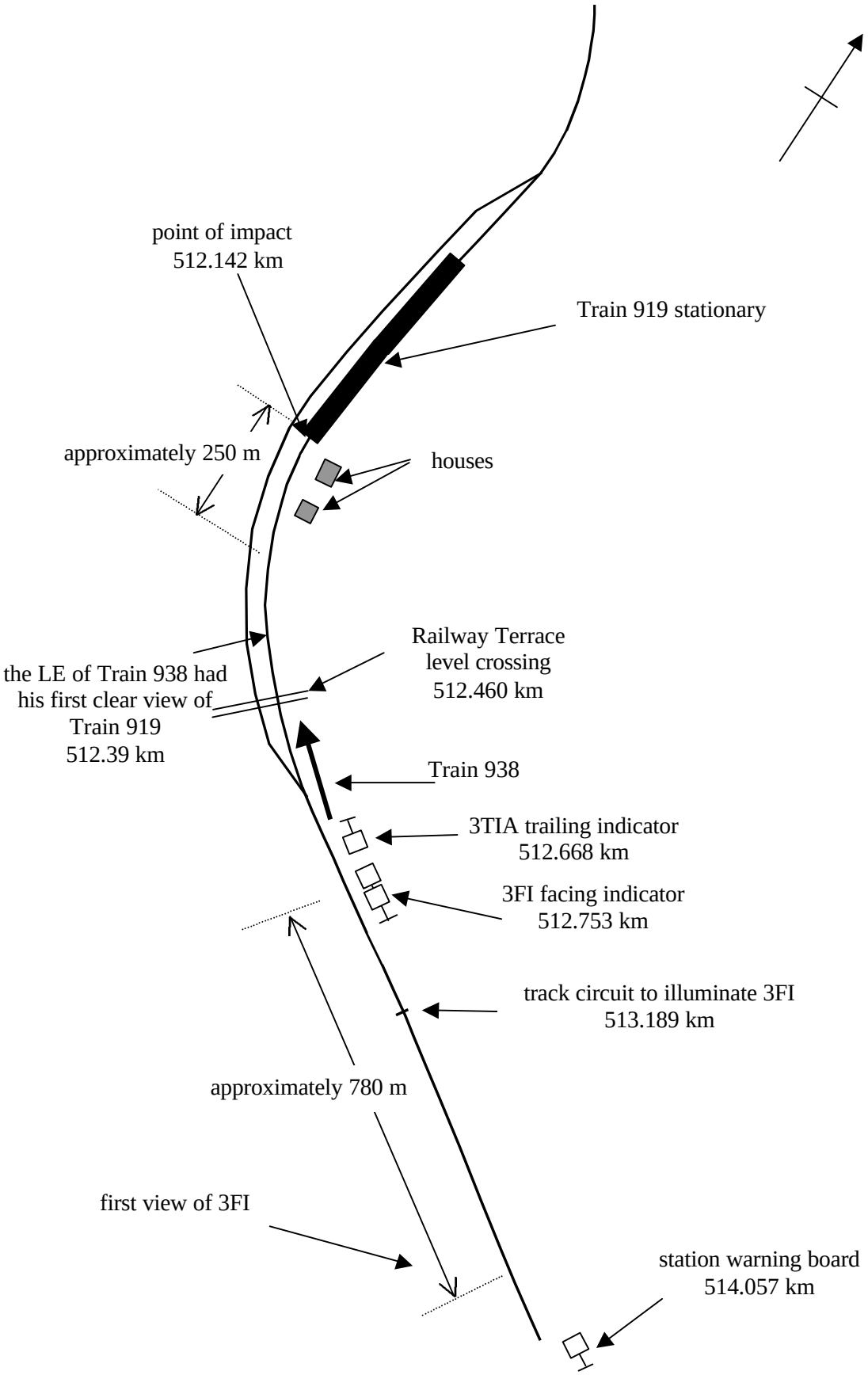


Figure 4
Site plan
(not to scale)

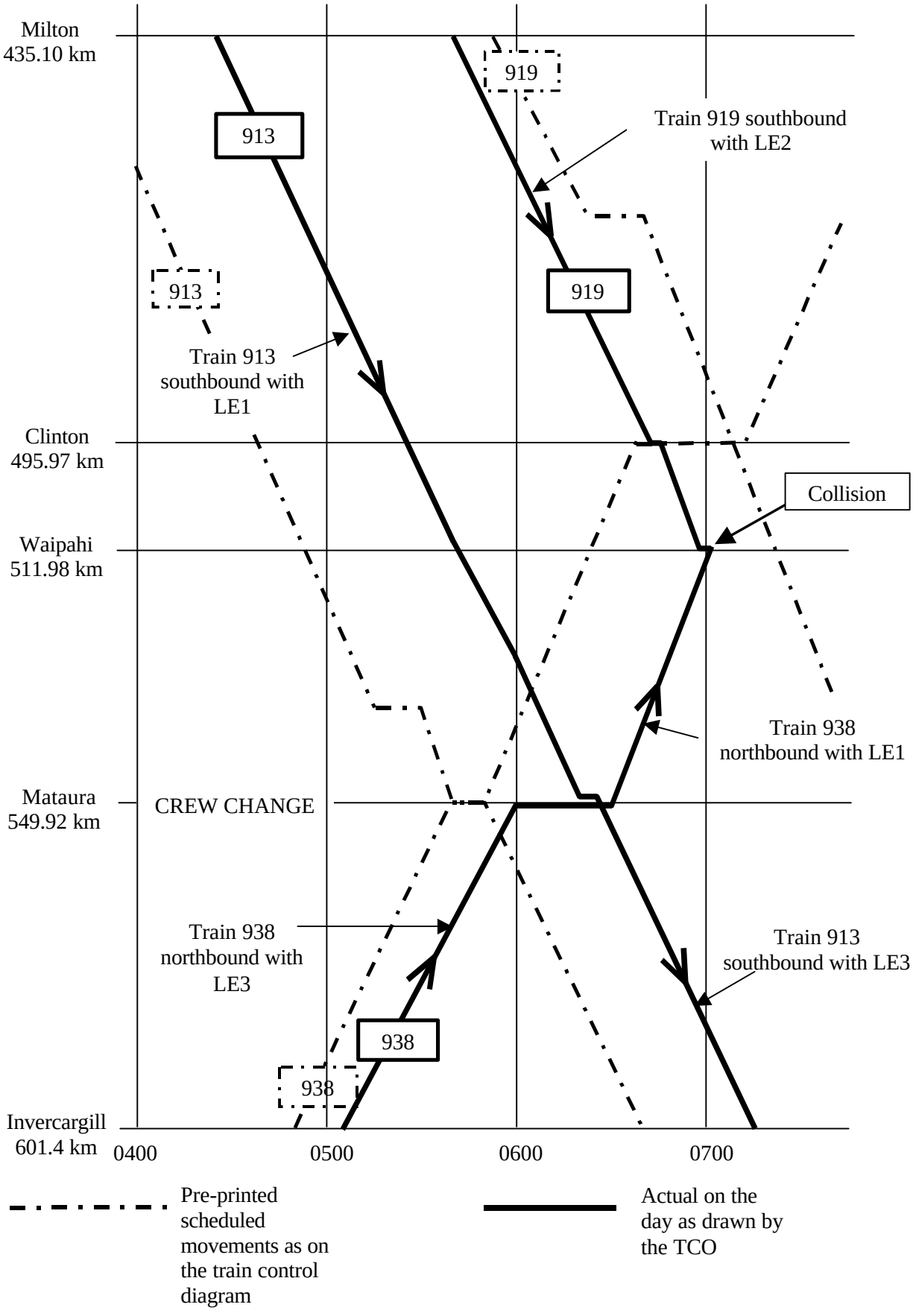


Figure 5
Simplified Train Control Diagram
showing scheduled and actual train movements

1.5 Train 913 and Train 938 movements

1.5.1 Train 913 left Dunedin under the control of LE1 at about 0330 hours and proceeded to the main line at Waipahi. The track warrant also required calls at Milton and Clinton.

1.5.2 Train 913 then proceeded from Waipahi to McNab, and from McNab to Mataura to cross Train 938. This was a crew changeover and LE1 then took over Train 938 to return north.

1.5.3 Train 938 had been made up in Invercargill the previous evening. During the inspection the brakes would not apply on UK 2412 immediately behind the locomotive. The brakes on this wagon were cut out, the Train Work Order was endorsed, and the wagon was listed for maintenance. Before Train 938 departed on the 20 October 1999 an intermediate brake test was carried out and the train brakes worked correctly. The process followed for brake test and train inspection complied with the relevant Tranz Rail Rules. As Train 938 was conveying 11 bogie wagons it was permissible for the train to convey one wagon with brakes not connected in accordance with Tranz Rail Rule 159.

1.5.4 Train 938 departed Invercargill at 0502 hours under the control of LE3 to proceed to the south end of Mataura, and then to Mataura loop for the crew changeover with Train 913, arriving at about 0600 hours.

1.5.5 At about 0615 hours LE3 applied for a track warrant for Train 938 to proceed north, knowing Train 913 was approaching from the north for a crossing and that he would be transferring to Train 913 when it arrived. Applying for a warrant some 10 to 15 minutes before the arrival of a crossing train was a standard procedure for operating efficiency and was used in such circumstances whether a crew change was involved or not.

1.5.6 At 0616 hours TW 31 was dictated to LE3, authorising Train 938, after the arrival of Train 913, to proceed to the loop at Waipahi to cross Train 919. This was repeated back correctly at 0618 hours. Such a track warrant was termed a conditional track warrant as it had a condition which had to be fulfilled before the track warrant could be acted upon. This condition was the arrival of Train 913 at Mataura. There was no further radio communication between Train 938 and train control.

1.5.7 At about 0625 hours Train 913 arrived at Mataura and the crew changeover took place.

1.5.8 Figure 5, derived from the train control diagram, shows the scheduled and actual paths of Trains 913, 919 and 938 on the day.

1.5.9 LE3 who drove Train 938 to Mataura and received TW 31, said he placed it in the track warrant clip, and that it was the only document on the clip. When Train 913 arrived it stopped cab to cab with Train 938 and he stepped over to the Train 913 cab. He recalled telling LE1 that Train 938 had a track warrant to enter the loop at Waipahi to cross Train 919 to which LE1 responded by saying "yes, okay and you have got one to here" (Mataura).

1.5.10 When first interviewed LE1 stated that the LE leaving Train 938 told him he had a warrant to Clinton. However, when interviewed later he said that he could not recall the changeover[2] and was not sure what the LE he changed over with had said.

[2] LE1 received head injuries in the accident. At no stage could he recall events immediately preceding the accident, and his recollection of events about the time of the crew changeover varied over time.

1.5.11 In his original interview LE1 stated he did not recall looking at TW 31 on the trip after taking over Train 938, and that his normal practice was to refer to his track warrant prior to the terminating station to see whether he would go to the loop or the main, and not necessarily before, but he normally had a look to see if he had calls[3] anywhere. He said he believed his track warrant limit was Clinton, and his actions on the day were based on this belief. When later interviewed he said he could not imagine that he would not look at a track warrant that someone else had filled out before leaving a station.

1.5.12 LE1 said he had no recollection of what he saw or did as he approached Waipahi. The possible sequence of events has been reconstructed from eyewitness reports and known information from points indicators and the train event recorder.

1.6 Communications

1.6.1 The section of track between 500 km (about 4 km south of Clinton) and 598 km (about 2 km north of Invercargill) was covered by channel 4 for train control to train crew communication and was bounded by channel 3 and 2 to the north. Channel 1 was used for short-range train-to-train communication.

1.6.2 Tranz Rail radio communication records showed that the call between train control and Train 919 at Milton for the issue of TW 28 at about 0541 hours was through the Mt Hyde repeater and therefore on channel 3. At about this time LE1 had been issued TW27 when at Waipahi and cleared the limits of this track warrant south of Waipahi at 0543 hours. These calls were through the Gore repeater and therefore on channel 4.

1.6.3 The call between train control and Train 938 at 0616 hours for the issue of TW 31 from Mataura to Waipahi was directed through a repeater at Gore and was therefore on channel 4. During this period LE1 on Train 913 was travelling between McNab and Mataura in channel 4 territory.

1.6.4 The call between train control and Train 919 at 0645 hours for the issue of TW 35 from Clinton to Waipahi and the subsequent clearance of Clinton limits were through the Kaitangata repeater and therefore on channel 2. During this period LE1 on Train 938 would have been between Mataura and Waipahi in channel 4 territory.

1.6.5 Subsequent radio tests, carried out by Tranz Rail, showed:

- Channel 1 coverage was good up to 5 km either side of Waipahi.
- Channel 4 calls from about 500 km (south of Clinton) could be heard directed through the Gore repeater between Mataura and Waipahi but channel 2 calls directed through the Kaitangata repeater from the same location could not.

1.7 Locomotive event recorders

1.7.1 An event recorder was recovered from each of the 3 locomotives with the following results:

- The event recorder from DFT 7254 on Train 919 was unserviceable with no memory available due to the dislodgement of memory chips in the collision.
- The event recorder from DX 5448 on Train 938 was recovered undamaged but contained no information relevant to the accident as the locomotive was running dead.
- The event recorder from DC 4202 on Train 938, although damaged, was able to be downloaded and analysed. The recorder was one of Tranz Rail's recent Kaitiaki installations.

[3] Clause 10 of a TW listed localities at which LEs were required to call train control.

1.8 Rolling stock details

1.8.1 Inspection of DC 4202 (Train 938) following the accident found the automatic brake valve handle in the emergency brake position, the independent brake valve handle in full application position and the throttle handle in the off position. The brake blocks showed blue heat marks consistent with heavy braking in emergency application.

1.8.2 Damage to the cab of DFT 7254 (Train 919) did not allow brake handle positions to be determined. The brakes on the train were found applied, following the impact, but whether this was as a result of the LE's actions or burst hoses at impact could not be determined.

1.8.3 The radio in DC 4202 (Train 938) was set to channel 4. The radio in DFT 7245 (Train 919) was badly damaged and channel selection could not be determined.

1.8.4 Post accident inspection of the locomotive and wagons on Train 938 showed they had been in good mechanical operating condition prior to the accident.

1.8.5 Tranz Rail advised that the DC and DFT cabs are "very similar in many design philosophies". Both were resiliently mounted to the locomotive underframe with 4 rubber mounts. Both cabs reflected an American approach to cab design. Crashworthiness features of these and similar cab designs were not considered in isolation but rather as part of the whole vehicle design.

This approach was to use the locomotive underframe and superstructure around the cab as the primary means for absorbing significant collision or accident forces. The cab then formed a survival space even if it was severely deformed in an accident.

The primary features beyond the cab of these locomotives that protect the crew in an accident were:

- use of the underframe to provide lateral and longitudinal perimeter protection of the cab
- override beams across the top of each headstock to minimise the chances of colliding vehicles climbing over each other
- collision posts above the front headstocks to resist any frontal impacts above underframe level
- the superstructure ahead and behind the cab limits deformation of the cab in rollover situations. The superstructure behind the cab also protects the cab from rearward impacts above underframe level.

1.9 Medical details

1.9.1 The body of LE2 was found in the wreckage behind the normal driving position which had been obliterated as DC 4202 overrode the front of DFT 7254. During the impact he had received trunk and limb injuries which were not survivable.

1.9.2 LE1 driving DC 4202 sustained moderate head injuries in the accident. As a result of traumatic brain injury there was a significant loss of memory for events preceding the accident.

1.9.3 No medical factors for either driver were detected that would have caused them to be impaired or incapacitated prior to impact.

1.10 Operating system

TWC

1.10.1 TWC was introduced into New Zealand Railways in 1988 as an alternative to a signalling system as a method of train operation for lower density lines. TWC was a method for ensuring that only one train had a warrant authorising occupation of a section of the track at any time. A key requirement was TWC Regulation 2(a) which stated:

> 2. Operating in Track Warrant Control Area-
> (a) A Train, Mobile Track Equipment, or shunting movement must not enter upon or foul any part of the main line without the authority of a track warrant. This includes the main line within station limits ...

Track warrants were issued by TCOs, who dictated the necessary details over radio or telephone to LEs, who then wrote the details onto a prepared form and read them back to the TCO as a check. When the train reached the limits of the track warrant, the LE was required to advise the TCO and authorise cancellation of the track warrant.

1.10.2 On Tranz Rail the management of TWC was enhanced by the use of a Track Warrant Computer System (TWACS) in train control. The computer programme would not normally or inadvertently allow issue of a track warrant if another warrant already existed for the same track section.

1.10.3 The MSL between Dunedin and Invercargill is mostly single track. To enable trains travelling in opposite directions to pass one another sections of double track ("crossing loops") are provided at regular intervals. To control such crossings, TCOs stipulated conditions on the track warrant.

1.10.4 The method of carrying out a train crossing in TWC territory depended on the equipment provided to change the points. At Waipahi the points were operated by electric motors, and two position Colour-light Points Indicators were installed. Unlike signals, which gave instructions to LEs about whether they may proceed or not and at what speed, points indicators only indicated the direction the points were set (Appendix 2, Regulation 9(e)). The signalling and interlocking diagram for Waipahi detailing the position of point indicators is attached as Appendix 3.

1.10.5 At Waipahi the point indicators at the south end were approach lit. This meant that as a train approached, it passed over an insulated joint in the rails and activated an electrical track circuit that caused the indicators to light up. The insulated joint at Waipahi controlling the south end points indication was approximately 436 m ahead of the facing points indicator at the south end (termed 3FI by Tranz Rail). 3FI was also illuminated by a train arriving from the north entering the main line and claiming the track circuit just inside the north end points. This occurred on the day as soon as Train 919 entered Waipahi on the main line, and 3FI was illuminated well before the arrival of Train 938.

1.10.6 3FI comprised 2 lights, one above the other. Once illuminated, the following possible light combinations were displayed:

Display	**Meaning**
purple over red	points set for the main line (straight ahead)
red over purple	points set for the loop (diverging)
red over red	stop-points may not be properly set and locked

Any other display or no lights displayed on approach indicated a fault.

1.10.7 Inspection and tests following the accident showed the south end points were set for the main line, and 3FI correctly displayed a purple over red indication when required. The point indicating system was tested and found to be operating as intended.

Crew changes

1.10.8 The transfer of track warrants at a crew change was covered by Regulation 7 of the TWC Regulations which stated:

> **7 Transfer of track warrants**-when a Locomotive Engineer hands over a train to another Locomotive Engineer he must hand over any track warrants which are still in effect.
>
> Track warrants addressed to other than locomotive engineers must not be transferred. When it is necessary for an addressee to be relieved a new track warrant which cancels the previous one must be issued. The track warrant for the new addressee must be sent to the employee being relieved who must hand it to the relieving addressee and point out particulars of the track warrant.

1.10.9 Arising from Land Transport Safety Authority (LTSA) commissioned audits during 1995 and 1996 Tranz Rail had also issued "recommendations/suggestions" to locomotive engineers through the medium of the *Locomotive Engineers' Bulletin*. This was an informal document distributed periodically, drawing the attention of locomotive engineers to matters relating to their duties.

1.10.10 The June 1996 *Locomotive Engineers Bulletin* (1996/2) included the following:

> Item 3 CHANGEOVER PROCEDURES
> Track Warrant regulation 7 says that when one Locomotive Engineer hands the train over to another he must hand over any track warrants which are still in effect.
>
> When you change over with a warrant still in effect you should make a point of telling the new Locomotive Engineer the limits to which his ongoing warrant is for, and get an acknowledgement from him that he understands this. This way the warrant is reinforced in his mind, similar to what occurred when you repeated the warrant back to train control.

1.10.11 In addition the January 1997 and July 1999 Locomotive Engineers Bulletins included:

> IT'S A GOOD HABIT TO BE IN TO CHECK YOUR WARRANT AT EACH AND EVERY STATION WARNING BOARD AND INTERMEDIATE BOARD.

Crossing requirements

1.10.12 The relevant TWC regulation governing the operation of the train crossing at Waipahi was Regulation 10(b) which included:

> (b) At Stations not provided with Arrival Signals –
>
> (i) If a crossing is to take place and the first train to arrive berths on the main line, a crew member of that train must set the route for the opposing train to enter the loop and, except at stations equipped with Points Indicators, handsignal the train into the loop.

(ii) When trains are required to cross, the Locomotive Engineer of the train which is required to berth on the loop must, before entering the loop, establish the whereabouts of the opposing train. If the opposing train is closely approaching the station he must communicate with the Locomotive Engineer of that train and come to a clear understanding as to the berthing arrangements which will prevent both trains entering the station at the same time. Should it not be possible to establish the whereabouts of the opposing train or to make contact with the Locomotive Engineer of that train then the train taking the loop may berth after establishing that the other train is not entering the main line.

(Note: the underlined sentence was included as an amendment to the TWC Regulations in amendment 11 of 17 November 1996.)

(iii) The employee who uses any hand points on the main line or loop must ensure that they are restored to normal after use. Where the lever has locking facilities it must also be locked.

(iv) At Warrant stations equipped with motor points and Points Indicators the push-button controls must be operated in the following circumstances.

Situation	**Action required**
The first train to arrive for a crossing has berthed on the main line	The "stop" button at the main line Trailing points Indicator must be operated and the door of the control box closed
A train is to berth on the loop but the Facing Points Indicator shows that the points are set for the main line.	The "stop" button at the Facing Points Indicator must be operated and when the time delay light has extinguished the "loop" button must be operated and the door of the control box closed …

(v) The duties of the Train crew as specified in the foregoing provisions may be varied by Train Control.

Visibility of points indicator 3FI

1.10.13 The visibility of the purple and red lights on points indicator 3FI were tested following the accident. Both the red and the purple lamps had incandescent bulbs at the time of the accident. Tests on the purple lights were made using both incandescent bulbs and the newer halogen bulbs which give higher visibility[4]. At the time of the testing, the incandescent bulb in the top purple at Waipahi had been changed to halogen as part of a planned replacement programme.

1.10.14 The tests showed the following:

- At 436 m before 3FI (the position of the insulated joint which approach lit 3FI) the purple on the top and purple on the bottom indications were clearly distinguishable with both incandescent and halogen bulbs in the purple indicator.
- At 570 m before 3FI a purple on the top became indistinguishable with an incandescent bulb, but was clearly distinguishable with a halogen bulb.

[4] The halogen bulbs were also tested to compare with the incandescent bulbs as the visibility of the purple loop light on points indicators had been identified as a safety issue in Railway Occurrence Report 98-117 regarding a collision at Rangiora on 21 October 1998.

- At 780 m before 3FI (the first point at which 3FI came into view to a north bound train) a purple on the top with a halogen bulb was still clearly distinguishable.
- In all cases the red light indications were visible.

1.11 Compliance monitoring

1.11.1 During 1999 a centrally based compliance monitoring regime was being devolved to local managers. For Dunedin- and Invercargill-based LEs this meant that during the transition period formal safety observations (part of the new compliance monitoring system) were being carried out by the previous Supervisor Training and Operating Practices. Although he had been appointed Operations Manager at Dunedin in June 1999 he carried out formal safety observations as and when opportunity offered for the 38 LEs based at Dunedin and Invercargill. This transition period resulted in many of the Invercargill based LEs not having any formal compliance monitoring for up to 13 months at the time of the accident. However, Dunedin-based LEs had received more attention and the longest gap was 9 months.

1.11.2 Both LE1 and LE2 had been regularly monitored, including safety observations after June 1999. The detailed record for each was:

LE1

- 19 June 1998 Train Handling Mastery (including steep grade)
- 19 August 1998 Biennial recertification in rules and codes
- 29 March 1999 Train Handling Mastery (including steep grade)
- 14 April 1999 Train Handling Mastery
- 17 August 1999 Formal Safety Observation Program.

LE2

- 19 June 1998 Biennial recertification in rules and codes
- 20 June 1998 Train Handling Mastery (including steep grade)
- 8 October 1998 Train Handling Mastery
- 15 January 1999Train Handling Mastery
- 23 March 1999 Train Handling Mastery (including steep grade)
- 5 May 1999 Train Handling Mastery (including steep grade)
- 18 August 1999 Formal Safety Observation Program.

1.11.3 The new safety observation procedures required formal observations 3 times within 24 months with a maximum of no more than 9 months between separate observations. Of these 3 assessments a minimum of one was required to be a Level A observation carried out by a person holding a license to operate for the tasks being evaluated. The monitoring of both LE1 and LE2 met this criteria from its date of introduction.

1.12 Personnel

The LE of Train 938

1.12.1 LE1 had 22 years service all of which was based in Dunedin. He was a Grade 1 LE and held a current certification for the duties he was performing.

1.12.2 He was in good health and not suffering from any home- or work-related stress.

1.12.3 His shift commenced at 0220 hours on the day of the accident. The previous day he had been on a similar 0220 hours to 0930 hours shift which involved a crossing with Train 919 at Clinton. Sunday and Monday were days off, giving 72 hours off duty from the previous fortnight roster.

1.12.4 The previous 2 fortnights he had worked 80 hours and then 92 hours. Of the 10 shifts in the first fortnight the last 6 commenced between 0220 and 0400 hours. Of the 11 shifts in the second fortnight the first 6 commenced between 0400 and 0645 hours, while the last 5 were late shifts and finished between 0245 and 0500 hours.

1.12.5 LE1 did comment on the general work patterns during the 3 weeks before the accident, which he described as "I had just finished the rubbish at the bottom of the roster." This was a reference to a concentration of shifts commencing in the early hours of the morning.

1.12.6 On 15 June 1999 the Train 938/919 scheduled crossing point had changed from Balclutha to Clinton due to a change of timetabling. Since that date LE1 had been on Train 938 for 4 crossings with Train 919 prior to the accident, 3 at Clinton and 1 at Balclutha. He had also been on Train 919 for 2 crossings with Train 938, one at Waipahi and one at Clinton.

1.12.7 During discussion with LE1 about his operating practices in his day-to-day driving the following was established:

- In common with many LEs interviewed, he pre-prepared warrants to a certain stage before contacting train control.
- He stated it was quite common that there was no communication between trains when they were crossing.
- He recalled at least one example in his recent driving past when he had the same pattern and the same TW termination point for three days and on the fourth day had a warrant to a different destination but believed it was for the same destination as the three days before.

The LE of Train 919

1.12.8 LE2 had 34 years experience, most of which was in the Dunedin area. He was a Grade 1 LE and held a current certification for the duties he was performing.

1.12.9 His shift commenced at 0400 hours. He had been off duty for the 6 days before. During the 2 previous fortnight rostered cycles he had worked 78 hours and then 76 hours.

1.13 The role of the regulator

Audit

1.13.1 Regular audits were carried out on a six-monthly basis by Telarc, an auditor proposed by Tranz Rail, approved and appointed by the LTSA (on the Director of LTSA being satisfied as to the competence and independence of the proposed auditor) and paid for by Tranz Rail. A review of Telarc was carried out in early 1999 by International Risk Management Services at the request of the LTSA. This review found that while the audit process was independent, professional and effective in meeting the requirements of the Transport Services Licensing Act 1989, there was a need for improvement in the content of the reports made to the LTSA. The review also noted LTSA had a number of concerns, namely that:

- there was the possibility of a conflict of interest arising from the fact that the auditor was paid by the operator being audited
- variations were being made to the safety system without LTSA knowledge
- the Act restricted the ability of the LTSA to intervene to ensure compliance.

LTSA special audits and safety studies

1.13.2 In 1995 the LTSA commissioned a special safety audit regarding a report made by Kaikoura New Zealand Rail Limited employees to Mr J Anderton MP. This audit was carried out by United Kingdom based consultants from Australian company GHD-Transmark, and included amongst the terms of reference concerns raised by Kaikoura staff regarding the operation of TWC on the Main North Line. This audit included observations that the various rules and instructions could be consolidated and brought together, procedures for radio contact were unclear, the heavy dependence on human input called for more information on the behaviour in TWC situations and dictated that observance of rules was essential. The audit concluded that the system was not judged unsafe, but that there were inherent risks and areas of weakness that could and should be improved. Specific recommendations included:

- consideration of situational monitoring equipment
- requiring LEs to report clear of every station
- restricting the use of lengthy through warrants
- proactive use of train graphs by controllers
- reconsideration of the practice of issuing conditional warrants
- introducing in-cab aids to alert LEs to warrant limits
- monitoring warrant compliance by comparison with train control information
- monitoring radio communication
- improving the overall monitoring of the safety system
- consideration of the introduction of global positioning systems (GPS).

1.13.3 The audit suggested specific enhancements including the following:

- discontinuation of the issue of track warrants before the arrival of the opposing train (conditional track warrants)
- recovery and auditing of track warrants as a matter of course.

Concurrently LTSA was evaluating the Tranz Rail safety system for approval under the Transport Service Licensing Act 1989. This approval was granted in December 1995.

1.13.4 In August 1996 GHD-Transmark completed a post implementation review of the 1995 special safety audit. This noted that suggestions made with respect to the issue of track warrants had been partially adopted. The review repeated concern that conditional track warrants still remained in use. The auditors did consider the intent of the Kaikoura audit recommendations were being increasingly understood and acted on.

1.13.5 In 1996 LTSA separately commissioned GHD-Transmark to carry out a risk assessment exercise of TWC throughout the Tranz Rail network which was also completed in August 1996. This study included reference to the following issues:

- a need to retain and audit track warrants
- the undesirability of conditional track warrants
- the dangers of LEs losing awareness of location
- the need for improved procedures regarding contact between trains at crossing stations.

In particular, the report included the following 2 recommendations:

> 7.2 At crew changeovers, the arrangements in respect of train warrants should be amended to either:
>
> Option A
> Issue a warrant with a limit at the crew change over point so that the relieving LE must acquire a new warrant for the forward journey, or
>
> Option B
> Require the relieving LE, before any movement takes place, to repeat to the control centre the authorities on the warrant being transferred and receive confirmation that he has done so correctly.
>
> Either of these options provides the stimulus to ensure that the fresh LE has been involved in the warrant authorising the movement of his train but Option A is preferred since the LE's involvement is absolute.
>
> …
>
> 7.4 Tranz Rail Limited should build on the requirement that on the approach to a warrant station where a crossing is to take place, the LE must establish contact on channel 1 of the radio with the LE of the train to be crossed. This should be done by requiring both LE's to endorse their warrants with the time, confirming that this contact was in fact made. This could then be audited.

1.13.6 Specific sections of the risk study report generally relating to the background and relevance of these 2 recommendations for TWC are quoted below to put the recommendations in context.

- Section 5, Observation, included:

> TWC is a method of control, the safety of which is largely vested in the human resource and the human interaction between Controller and LE. The authority to move lies in the track warrant – the responsibility of the movement lies in the LE. Therefore compliance and awareness are paramount since, like other low cost systems, there is no second line of defence. Reference has been made to Tranz Rail Ltd Incident Reports at Section 3 of this Study and in three of the four incidents discussed, LE error was the prime cause, fortunately with no accident occurring in consequence. Nevertheless, it underscores this inherent risk in the control system – the human factor. Again it is only proper to record that the same human factor is still a weakness on lines signalled in the traditional manner or even with modern "hi-tech" signalling systems. Only by investing huge sums of money in systems such as Automatic Train Protection (ATP) can this factor be significantly controlled (but not necessarily eliminated). Such sums are inappropriate in this New Zealand context.
>
> The authors consider that LEs on TWC lines would benefit from measures which increase "stimuli" in the task of driving. This is in keeping with the declared policy of Tranz Rail Ltd. They also correspond to the findings of [Tranz Rail's human resource management consultant] about "confronting" the LE with the Warrant regularly. In Section 7, certain "low/no cost" actions are recommended as positive risk mitigation measures, aimed at ensuring the risks are kept "as low as reasonably practicable" (ALARP), by involving LEs.
>
> In the case of the "conditional" warrant and long through warrants, the decision of Tranz Rail Ltd to take no action on recommendations was largely based on "time penalties on already time sensitive trains". This is understood, but the authors are surprised that this could not be reflected in a financial value, i.e. what cost is put on delay by the minute? This would appear to be a prerequisite to applying a cost/benefit analysis exercise to any suggested remedial actions or improvements.
>
> These adaptations of the straightforward warrant have been defended by managers as no worse than in other industries, and as posing no greater risk, provided the LE concentrates on them as exceptional. The authors consider nevertheless that the exceptional nature of such warrants must be reinforced at every opportunity, and that this is not costly. Recommendations are made in Section 7. Again it is necessary to point out that, unlike the situation in some other countries, the New Zealand LE is alone in the cab and has to self-check.

- Section 6, Conclusions, included:

> TWC is a method of train control which the authors, having conducted research for this report and as professional railway operators in the past, accept as basically a safe and appropriate method of working as applied in the New Zealand operation.
>
> However, there are still two adaptations of the system – the "conditional" warrant and the long through warrant – which continue to cause the authors some concern as currently applied. Some further "no cost" control measures are offered in Section 7 as recommendations and these would certainly ease their concern. Subject to these control measures being implemented by Tranz Rail Ltd, it is felt that the matter need not be pursued.

1.13.7 The LTSA advised that following receipt of the report it provided Tranz Rail with a copy. The recommendations affecting Tranz Rail were not formalised by the LTSA to the operator.

1.13.8 As part of the current investigation, rail safety staff at LTSA were interviewed to ascertain what action had been taken in respect of the above recommendations.

1.13.9 The LTSA advised that it monitored operator compliance through a regular audit process using auditors proposed by the operator and approved by LTSA. As a matter of policy the LTSA held the position that, as the creator of the risk, it was up to the operator to mitigate the risk and that the LTSA did not seek to impose solutions. The LTSA had not required compliance with the 1996 risk study recommendations as a variation to the approved safety system (clause 6F(1) of the Transport Services Licencing Act).

1.13.10 This matter was explored further at a more senior level. The LTSA confirmed that the recommendations, while not arising from a special audit, had the same significance to the LTSA as if it had been a special audit. The LTSA advised it was unable to enforce the provisions because there had been no significant TWC incidents or fatalities, there was not enough evidence that it was "necessary in the interests of avoiding a significant risk of death or serious injury" (clause 6F(1) of the Transport Services Licensing Act) and therefore it had no grounds on which to pursue the recommendations, other than the expressed views of the GHD-Transmark consultant.

1.13.11 Tranz Rail was asked for its perception of the 2 recommendations, and action taken since the recommendations were made in 1996. It considered changes in TWC made at the time effectively did implement the intent of option B of recommendation 7.2 regarding crew changeover procedures. These changes related to the "recommendations/suggestions" referred to in 1.10.9, 1.10.10 and 1.10.11. Tranz Rail advised action in this area was taken after advice from its human resource management consultant, an industrial psychologist. This advice was primarily twofold:

> (a) The behaviour of LEs was likely to be more effectively changed by encouraging them to develop certain habits, such as checking the limits of their warrant as they approached warrant stations, through recommendations/suggestions rather than imposing a rules-based requirement;
>
> (b) It was only really in the case of long warrants that any benefit was gained by having some interaction between train control and the LE.

1.13.12 Tranz Rail stated that safety at reasonable cost was not the basis for the steps taken on this recommendation, but it did note that in 1996 cost of delays associated with implementing option A had been assessed at $3500 per week for the Main North Line.

1.13.13 Recommendation 7.4, channel 1 radio procedures, was not implemented because it was thought by Tranz Rail to be extremely impractical. Tranz Rail advised that its view was that to audit the system properly and get a safety improvement from it implied a more thorough process than was apparently intended by the recommendation. Two aspects in particular were quoted as being of concern in any system to audit warrant endorsement:

- the need for independent verification requiring comparison of two track warrants, and the logistics of achieving this
- the number of warrants required to be retained to the end of the journey increasing the risk of a misunderstanding or confusion.

As a result no changes were made that either:

- built on the requirement that on the approach to a warrant station where a crossing is to take place, the LE must establish contact on channel 1 of the radio with the LE of the train to be crossed
- required both LEs to endorse their track warrants confirming contact had been made
- audited such endorsements.

1.13.14 A further factor was the possible advance in technology permitting channel 1 radio to be randomly recorded and retrieved as part of compliance monitoring. This was referred to in 1996 and Tranz Rail have now purchased and are about to install equipment which will allow monitoring of the rule change introduced in March 2000 (see Safety Actions, section 4 of this report).

1.13.15 Tranz Rail advised that in not implementing recommendation 7.4 regarding radio communication and warrant endorsement "safety at reasonable cost" did not have to be considered and that quantified risk assessment was not needed as the recommendation was clearly not practical.

1.13.16 Both the special audit and the risk study made reference to the quantified risk study being undertaken by Tranz Rail. Having identified concerns regarding some aspects of the TWC system, the auditors in the special audit commented "The risk assessment study is of deep significance in terms of understanding the failure mechanisms and possible mitigation measures." The quantified risk assessment was started in May 1995 and completed in November 1998. The main conclusions of this study were:

1. The occupational risk to a locomotive engineer operating on the Main North Line under Track Warrant Control is approximately the same as that experienced by a locomotive engineer on the North Island Main Trunk operating under Centralised Traffic Control and is therefore acceptably safe.
2. In all cases the probability of a fatal accident occurring is low.
3. The most significant accident type to a locomotive engineer irrespective of the operating system is collision with an obstruction on the track.
4. There is a higher chance of an inter-train collision occurring under the TWC operating system then [sic] under CTC, reflecting the greater responsibility of drivers operating under TWC. Under TWC the locomotive engineer must be aware of the train's location and the limits of the track warrant to ensure the train is stopped at the correct location. Additionally, on route all crossings stations must be approached with caution to ensure the train can be stopped before entering the station.

Safety at reasonable cost

1.13.17 The concept of safety at reasonable cost is the underlying principle of safety in all modes of transport in New Zealand, and safety at reasonable cost has been defined.

Some significant references to safety at reasonable cost in New Zealand's regulations framework are:

- The Ministry of Transport mission:

  "We work for safe sustainable transport at reasonable cost …

  At reasonable cost:
  means where the benefits to New Zealand exceed the costs to New Zealand."

- The Land Transport Act 1998 – Part 12

  169. Functions of Minister – (1) The Minister's principal function under this Act is to promote land transport safety at a reasonable cost.
  (2) The Minister also has the following functions under this Act:
  (a) To make ordinary rules under Part 11:
  (b) To enter into a performance agreement with the Authority and to monitor the Authority's performance.
  (3) The Minister must ensure that New Zealand's obligations under international conventions concerning road safety are implemented and must administer New Zealand's participation in them.
  (4) For the purposes for this section, a cost is a reasonable cost if the value of the cost to the nation is exceeded by the value of the resulting benefit to the nation.

- Civil Aviation Act 1990 – Part II

  14. Functions of Minister – (1) The principal functions of the Minister under this Act shall be to promote safety in civil aviation at a reasonable cost, and to ensure that New Zealand's obligations under international civil aviation agreements are implemented ...

  (3) For the purposes of subsection (1) of this section, a cost is a reasonable cost where the value of the cost to the nation is exceeded by the value of the resulting benefit to the nation ...

annotated in Brooker's Aviation Law by:

> ... CV14.04 For the first time in legislation of this kind Parliament has made reference to cost benefit analysis. There is an acknowledgement by the Legislature that there is no such thing as absolute safety. The standard set by subs (3), whereby the cost to the nation is weighed against the benefit to the nation, requires the sort of calculation with which economists will be familiar. This requires the making of assumptions as to the variables involved, such as the monetary value that can be assigned to each life saved balanced against the cost.

- In particular regard to rail service operations the Transport Services Licensing Act 6c(1):

  6c. Matters to be taken into account in considering proposed safety system – (1) In considering a proposed safety system, the [Director] shall have regard to, and give such weight as he or she considers appropriate to, the following matters:

  (a) The nature of the proposed rail service operation:
  (b) The safety system attainable, consistent with the nature of the service, at a reasonable cost:
  (c) The relationship between the proposed safety system and comparable safety systems applicable to competing modes of transport:
  (d) The past history and performance (if any) of the applicant within the transport industry:
  (e) Any submissions or representations received from the operator of any railway that the applicant intends to use.

1.14 The role of the operator

General organisation

1.14.1 The Tranz Rail Board was responsible for ensuring the safe operation of Tranz Rail. Reporting to the Managing Director were two main divisions with input into operational safety: Corporate Services and Service Delivery.

1.14.2 Accountability for safety within these divisions was split between a support function; Corporate Services, and an operating function; Service Delivery.

1.14.3 Within the support function, safety was managed by Corporate Manager Quality and Safety, who was responsible to the Executive Manager Corporate Services for the development and monitoring of the safety system.

1.14.4 Specific operating rules, regulations and procedures covering day-to-day safety was a line responsibility. Responsibility for safe operation rested with Group General Manager Service Delivery, with the assistance of the Network Manager, and under him the Manager Codes and Authority. Within the Service Delivery division this responsibility was further delegated to regional and operations managers.

Senior management responses

1.14.5 Accountability for the establishment and maintenance of a safety system rested with the Managing Director and senior management team. An initial analysis of the events surrounding the accident raised questions regarding the effectiveness of the operating procedures in place at the time. Given that operating practices and procedures were established by management rather than staff, interviews with the Managing Director and senior managers were requested. A brief meeting was held with the Tranz Rail Managing Director and legal counsel. At this meeting the investigators were advised that, in the opinion of Tranz Rail the causes of the crash were "pretty clear" and that they saw no reason why the investigation should extend to the senior management team. Subsequent correspondence reinforced the Tranz Rail position that "there is no reason to think, at this stage, that, prima facie, the Waipahi accident was contributed to by high level managerial decision making." Following further representations, interviews with the Group General Manager Service Delivery, Network Manager, Executive Manager Corporate Services, a previous Corporate Manager Quality and Safety and a former Manager Codes and Authority were held to obtain a senior management perspective.

1.14.6 When asked to identify foreseeable risks associated with TWC, the managers interviewed identified seven main categories:

- collision
- roll-over
- warrant not unique
- error entered onto warrant
- incorrectly written warrant
- misinterpretation of warrant
- forgetting warrant limits.

1.14.7 The defences identified to minimise the risks were:

- TWACS
- the repeat-back process

- reliance on the driver to read the warrant correctly
- ensuring the train is travelling at a speed at which it can stop before entering the station
- rules and operating code
- certification
- experience
- revised rosters
- vigilance system
- radio coverage
- simulator
- occurrence logging system
- train control audits
- looking at the warrant.

1.14.8 The managers spoke of processes used to keep them informed on operational issues. These included incident reports, hot-line calls (of which there had been 3 over the previous 8 months) verbal reports, occurrence logs and union representations. While mention was made of irregular field visits none spoke of regular planned or proactive contact with operational staff as a primary method of keeping informed.

1.14.9 The managers stated that effective supervision of TWC was being provided by train control and the Safety Observation system.

1.14.10 With respect to track warrant handover procedures, the managers emphasised that the track warrant stayed in the cab and was therefore always available and that it was up to the LEs concerned to make sure they handed over correctly. One manager believed that as the warrant had already been repeated back, and as it was always assumed that the LE receiving would read it, that there was no need for a further repeat back procedure when a track warrant was taken over by another LE, while another manager believed that the regulations required the LE to read the track warrant.

1.14.11 None of the managers interviewed were able to give a clear explanation as to why only the LE entering the loop was required to initiate radio contact. Alternative actions open to an LE unable to establish contact were seen as contacting train control or "eyeballing" the yard.

1.14.12 All of the managers interviewed indicated that the requirement that an LE "must" set the route for the loop in Regulation 10(b)(i) was not mandatory and that the regulation could be varied by LEs depending on the circumstances. Responses to the question "does 'must' mean it is mandatory?", included:

- "We are conscious of that word and, again, I believe that the intent it was written in was to say that, 'Our expectation is that you will go and reverse those points to facilitate a more efficient crossing'".
- "Well, I suppose there are some situations where for whatever reason you are going to have a train that stops short of the indicator when he pulls in and it could be for whatever the operating reason."
- "... Is it mandatory that one does the other? It is not exactly mandatory. It would not be a sacking offence if someone did not do it, because there may be some compelling reason, I can not think of one. There is an operational efficiency for the guy on the main to come up."

None mentioned the potential role of train control in such a change of duties as allowed for in Regulation 10(b)(v).

1.14.13 The managers were aware of the existence of the various studies and audit reports regarding TWC.

1.14.14 Common to all interviews were repeated comments that the LEs "should" read their warrants.

Response to the 1995 special audit

1.14.15 A review of responses to the 1995 report on safety aspects of TWC showed the different view of the operator to defined weaknesses and recommended defences. Paragraph 2.10 of the 1995 Special Audit, for example, stated:

> Taken together, certain of the issues covered in the Special Audit **do** constitute a foreseeable risk of death or serious injury in that they could conspire to create a train collision on Track Warrant Controlled lines. The significance of that risk has not been calculated in quantifiable terms – it is however being managed and can be further controlled, if the recommended opportunities are grasped to improve the control measures.
> [Emphasis added]

This conclusion was followed immediately by:

> NZRL comment:
>
> The Transmark consultant, when debriefing NZRL management at the completion of the field investigation, confirmed that he had identified no safety issues that required immediate attention. Further, there is **no suggestion** that there are reasonable grounds to believe any person is likely to be put at significant risk of death or serious injury from the method of operation on the Main North Line. Accidents are "foreseeable" on all forms of transport. The Report acknowledges the risk has not been quantified and therefore it makes no judgement as to whether an accident is likely.
> [Emphasis added]

A similar different view was reflected in approximately 70% of the NZRL responses in this audit.

Legal challenge

1.14.16 During interviews with LTSA management reference was made by them to early attempts to gain operator compliance with the Act being repeatedly met by the possibility of legal challenge from Tranz Rail. During the Commission's inquiries for the purpose of this report reference was also made by Tranz Rail to the possibility of legal challenge, both when arranging interviews with senior managers and during the course of these interviews.

Interviews with field managers

1.14.17 Field managers represented the interface between executive management and operational staff. Interviews were conducted with the South Island Regional Manager Service Delivery, an Area Service Delivery Manager and a Service Coordinator, previously a Supervisor Training and Operating Practices. Key points arising from these interviews were:

- **Communication procedures in simultaneous berthings**
  It was recognised that, for reasons of operational efficiency, crossings should be scheduled as closely as possible. Only one of the interviewees was clear about the wording of Regulation 10(b)(2) and none could offer a method of establishing contact other than channel 1 or looking to see if the main was clear. All felt there should be a greater use of radio contact between drivers.

- **Setting the points for the train entering the loop**
  The interviewees expressed puzzlement at why LE2 had not pulled forward and set the points for LE1. There was agreement that, while it did not happen all the time, the interviewees were aware, or had become aware since the accident, of circumstances under which the LE required to set the points had not done so.

- **Warrant hand-over procedures**
  All were of the view that Regulation 7 permitting inheritance of a track warrant at a crew change undermined the repeat-back defence and opened up an opportunity for error. Two of the interviewees felt that there should be a procedure in place to ensure the relieving LE was fully aware of the warrant limits, ideally by requiring a fresh warrant to be obtained. One interviewee suggested that the reason for allowing conditional warrants prior to a crew change was expediency.

- **Knowledge of previous audits**
  One interviewee was aware of the previous audits but had no awareness of any specific direction from management on any action to be taken as a result of the audits. The other 2 were not aware of previous audits.

- **Risks with TWC**
  TWC was seen as being no more risky than other types of operations providing everyone did what they were supposed to do. One interviewee expressed concern about the possibility of complacency creeping in as a consequence of a reduced emphasis on monitoring and compliance enforcement, while another recognised that while there was a need to guard against too many hard and fast rules, at the end of the day there was a need for some "commonsense" to ensure consistent operating practices.

Staff responses

1.14.18 Twelve LEs of the 38 locomotive engineers employed by Tranz Rail at Invercargill and Dunedin were interviewed in January 2000 to obtain an understanding of the day-to-day practice of TWC in that area. The sample was a high proportion of LEs in that area, but not of the 428 LEs nationwide. The following summaries have been taken from the transcripts:

- **Training**
  Most indicated that they had received 2 days of initial training approximately 8 years to 10 years earlier and that there had been no refresher training. The annual re-certification was described by most as a "half hour, tick in the box". Some mentioned simulator training but felt it was not TWC-focused.

- **Pre-preparing warrants**
  All respondents indicated that they pre-prepared warrants, usually filling in the headings that they knew would be in the warrant. This was done to save time and because quite often the train controllers gave the information too quickly to write easily.

- **Handing over warrants at crew changeover**
  Most drivers indicated that they told the other driver the warrant limit and when they received a warrant they double checked it themselves. Some indicated they had never forgotten to mention the warrant limits, while others volunteered that there had been times they had forgotten to do so.

- **Mishearing warrants**
  Several respondents agreed that it was easy to mishear warrants but that mistakes were picked up by the repeat-back process. One driver outlined a personal habit of contacting train control as soon as his movement was under way after he had received a warrant from another driver, to make sure it was correct.

- **Misperception of warrants**
  Four drivers admitted to having formed the wrong impression about the limits of a track warrant. This was seen as more likely to happen when there was a departure from a previous pattern.

- **Loop not set**
  Nearly all respondents cited examples of situations where the points had not been set by the LE of the train that had arrived first and berthed on the main. Some put this down to "bloody-mindedness" on the other driver's part, while others felt there were no hard and fast rules or guidelines about who should do what. Several expressed strong concerns about the dangers associated with this lack of procedural clarity. None spoke of any role played by train control in controlling such exceptions to Regulation 10(b)(i) as permitted by Regulation 10(b)(v).

- **Stopping short at Railway Terrace**
  Five drivers had either stopped short of the Railway Terrace level crossing on the main line at Waipahi or had been involved in crossings where the other train had stopped short to avoid disruption to road traffic using the level crossing.

- **Contact on berthing**
  Nearly all respondents indicated that this was an area of uncertainty. Some indicated that they tried once and, if that failed, entered and berthed, while others felt that many drivers did not even try to make contact in the first place.

- **Supervision**
  There was almost unanimous agreement that supervision had been virtually non-existent for at least a year. There was a perception that the current supervisors knew very little about TWC and seldom, if ever, carried out direct supervision. Train control was seen as one form of supervision, but most drivers saw themselves as being self-supervising.

- **Performance feedback**
  Without exception LEs stated they received little, if any, positive feedback on their performance. When positive feedback did occur, it was usually in relation to commercial objectives. Drivers said negative feedback was far more forthcoming.

- **Managerial focus**
  The primary areas focused on by managers related to ways to improve commercial performance or shunting practices. Very few related to safety practices.

- **Anonymous reporting**
  There was almost unanimous agreement that the self-reporting of mistakes could have serious repercussions for the person concerned. There was a strong belief that it was better to say nothing. A number of drivers were not aware of the existing hot-line.

- **Radio communications**
  The majority of drivers felt that radio reception was around 90% but there were examples of not being able to contact drivers even when the trains were in sight of each other. Comment was made that some areas such as Clinton and Waipahi had reception problems. At least one driver indicated that he carry a cell-phone as a back-up. Also mentioned were issues with radios being locked on one channel or the handpiece not being pressed far enough to allow scanning to start.

- **Fitness for duty**
  No drivers were aware of active measures to assess fitness for duty other than a 2 yearly medical.

- **System design**
  Nearly all drivers expressed genuine concerns that the TWC system placed a very heavy reliance on human awareness and perception. There was a feeling that the system was very vulnerable to fatigue and had no fail-safe back-up built into it.

- **Distraction**
  Over three-quarters of the drivers agreed that there had been times when their minds had wandered while driving and that they had travelled sections of track while in this state. One driver described the state as a sort of a "trance", and several indicated that mistakes had been made while in this state.

- **Change in behaviour**
  Half of the drivers indicated an increased sense of alertness following the accident, although one felt this would soon revert to the pre-Waipahi level.

Almost without exception reference was made to the particular long experience, depth of knowledge and high standing of the two LEs involved in the accident.

1.15 Rail safety in New Zealand – legislative framework

Minister of Transport

1.15.1 The protection for the travelling public is embodied in the Land Transport Act 1998, which holds the Minister of Transport responsible for promoting land transport safety at a reasonable cost. The Minister's functions include entering into a performance agreement with the LTSA and monitoring the Authority's performance.

Land Transport Safety Authority

1.15.2 The right to operate a railway was granted by the Director of the Land Transport Safety Authority under the general provisions detailed in Section 6 to 6I of the Transport Services Licensing Act 1989. To meet the criteria for licensing, an operator was required to have, amongst other things, proposed a safety system, gained approval of that safety system and obtained approval for variations to the safety system.

1.15.3 In proposing the safety system the operator must have identified standards, compliance procedures, reporting systems, management systems, training and experience standards, audit procedures and identified its proposed auditors.

1.15.4 When evaluating the proposed safety system, the LTSA was required to be mindful of the nature of the service, the level of safety attainable at reasonable cost, comparative safety with competing modes of transport, past history and performance of the applicant and submissions and representations from the operator.

1.15.5 In approving a safety system, the LTSA must have been convinced that it reasonably protected persons likely to be at risk of death or serious injury, was established and maintained by the operator and would provide an effective level of training and supervision.

1.15.6 The Act required that the LTSA monitor compliance with the approved safety system and control compliance through powers to impose conditions on or suspend rail service licences, revoke rail service licenses, impose prohibitions or conditions on the operation of rail service vehicles or detail or immobilise particular rail service vehicles or classes of rail vehicles vehicle, remove persons not fit and proper persons to have control or an involvement in the operation of a rail service and require variations to the approved safety system.

1.15.7 The Act also prescribed an audit process that comprised regular audits conducted by LTSA approved auditors who were proposed and paid by the operator, and special safety audits. The results of audits were reported to the LTSA and the operator. Where non-compliance issues were identified the LTSA was required to advise the operator in writing and take whatever steps were necessary to ensure compliance.

1.15.8 More specific details of the audit process were contained in the LTSA publication *Rail Safety licensing and Audit Guidelines*. This document outlined a 10-point audit plan covering:

- compliance with safety system
- LTSA conditions and previous audits
- management responsibility
- mechanical safety
- infrastructure
- operations
- personnel
- accidents, incidents and other occurrences
- recommendations
- operator response.

Tranz Rail

1.15.9 The requirement that Tranz Rail operate safely was embodied in the Transport Services Licensing Act 1989. Tranz Rail was to propose a safety system that set out in writing standards, practices and procedures the operator proposes to follow in order to ensure the safety of persons who are likely to be significantly at risk of death or serious injury through the operation of a rail service vehicle. Tranz Rail was also required to commission regular audits and to notify the LTSA of any changes to the approved safety system.

1.15.10 Tranz Rail was granted a licence to operate in November 1995 by the LTSA, following a report and recommendation by GHD-Transmark Ltd. This report examined all relevant Tranz Rail documentation to confirm that it was consistent with acceptable international quality systems and railroad practice and experience. As part of this process, 2 in-depth audits were carried out, one on track buckling and the other on shunting practices. The focus of the approval process was on whether the declared safety system met the requirements of the Transport Services Licensing Act. By design, this did not involve a detailed examination of TWC practices and procedures per se.

1.15.11 The GHD-Transmark Ltd report made reference to the Kaikoura Special Audit, and the authors noted that they had been advised by Tranz Rail that some of the recommendations were being addressed. They recommended that Tranz Rail continue to address the outstanding issues arising from the Special Audit. In connection with the events surrounding the Kaikoura report, the authors raised a doubt that there may be a "dilution of commitment above Area Level to raising the safety profile of the company."

1.16 Previous track warrant irregularities

1.16.1 The Transport Accident Investigation Commission (TAIC) has investigated 3 incidents involving track warrant irregularities which have a bearing on the events at Waipahi:

- Report 94-109, Reefton, dated 12 October 1994:

  This involved an incident in which the LE of Lyttelton to Westport Freight Train 847 on 30 March 1994 did not stop his train at the limit of the track warrant and overran it by 23 km. The safety issues related to the issue and observance of track warrants. One recommendation (070/94) arising from the investigation was that the practice of issuing track warrants prior to their immediate need be reviewed to minimise the potential for the suppression of the track warrants details by more recent events affecting the LE. New Zealand Rail Limited (NZRL) advised that having reviewed their safety system, it did not consider the recommendation appropriate.

- Report 94-125, Claverley-Oaro, dated 16 August 1995:

  This incident on 31 October 1994 involved an LE losing situational awareness resulting in irregular track warrant cancellation procedures associated with a crossing movement. The report referred to the need to retain and audit track warrants, and included a recommendation (006/95) that NZRL review the adequacy of existing audit procedures to assess compliance with TWC rules.

  NZRL responded:

  > The focus of this recommendation should be widened to include all operating methods rather than identifying just track warrant control rules.
  >
  > Reword as follows:
  >
  > "Review the adequacy of procedures to assess compliance with operating rules and practices."
  >
  > Again procedures are continually reviewed and they are updated and so the recommendation really may not be necessary.

- Report 96-101, Waipara, dated 23 October 1996:

  This incident occurred on 8 January 1996. Train 701, the southbound *Coastal Pacific* passenger service, overran Waipara without a valid track warrant and continued approximately 24 km into the next section before the error was realised. There was no opposing traffic or obstruction, and once the overrun was discovered a valid track warrant was issued and Train 701 continued its journey. The causal factor was the LE's failure to recognise the limits of his authority to proceed. Safety issues identified were the long distances for which track warrants were issued and the need to reinforce track warrant requirements, particularly following crew changeovers.

  Safety recommendations made to Tranz Rail included (004/96) that it introduce procedures governing the issue of track warrants to require an LE taking control of a train after a crew change to have to "accept" an open track warrant with the same "double-check" procedures associated with the issue of new track warrants.

  Tranz Rail responded to the safety recommendation advising of action carried out which met the intent of the recommendation as related to long open track warrants, and advising it proposed a review of options to achieve the intent of the recommendation for crew changes involving track warrant with only short distances to be run.

1.17 Global positioning systems

1.17.1 The possible advantage of using global positioning systems (GPS) had been raised by TWC auditors. In view of recent announcements regarding an increase in accuracy in such systems[5], Tranz Rail was asked during this investigation how this may affect possible TWC enhancements.

1.17.2 Tranz Rail advised it was aware of attempts to utilise GPS in overseas rail administrations with operating systems similar to TWC. Tranz Rail were looking at 2 separate aspects:

- an overlay system to support and enhance the current TWC
- a new system to replace TWC.

1.17.3 Tranz Rail were focussing on 3 separate areas for both short- and long-term improvements:

- locomotives
- radio transmission
- train control.

Although there are no GPS-specific proposals for enhancement of TWC at this stage, developments in transmissions are currently active. Tranz Rail see a period of 3 to 5 years for introducing possible enhancements without the attributes of a vital system[6] reliance, and beyond that a possibility of a low cost, vital system to achieve the level of certainty necessary to ensure safe control of rail traffic.

2. Analysis

2.1 General

2.1.1 A combination of active failures, local factors, and organisational factors contributed to this accident. How and why each has occurred and how they all came together to create the causal path leading to the collision is discussed below.

2.2 The actions of the LE of Train 919

2.2.1 According to witness reports, Train 919 arrived at Waipahi at about 0657 hours, some 5 minutes before Train 938. There is strong evidence that Train 919 departed Clinton at about 0647 hours, based on:

- the warrant confirmation at 0646 hours
- the TCO's annotation (which would have occurred after Train 919 had moved off and cleared the south end of Clinton) at 0648 hours
- LE2's call clear of Clinton at 0649 hours.

[5] On 1 May 2000 the United States Government announced the end of dithering/selective availability for such systems.
[6] "Vital system" is a railway signalling term for a system with a very low probability of a wrong side failure.

2.2.2 The approximate running time for Train 919 from at rest at Clinton to stopping at Waipahi, allowing for acceleration and deceleration, appropriate curve speeds and a maximum speed of 80 km/h, was calculated as 14 minutes. This compared to the theoretical running time for Train 919 on the day of 14 minutes 17 seconds as derived from Tranz Rail's computer simulation program for the particular locomotive, train weight and train length over that section of track. A 14 minute running time gave an estimated arrival time at Waipahi of 07.01 hours, some 1.5 minutes before impact. Locomotive speed indicators are required to be accurate to within ± 5 km/h between 25 km/h and 100 km/h, giving a possible variation of ± one minute on the running time and a possible earlier arrival time of 0700 hours. Because of the absence of the locomotive event recorder output from the locomotive of Train 919, any such timings can only be approximate, particularly as related to how LE2 may have handled his train between Clinton and Waipahi, but they do not necessarily conflict with Train 919 having arrived at Waipahi some minutes before Train 938.

2.2.3 The witness reports strongly suggested that Train 919 was stationary at 512.142 km and had been for some minutes. This was supported by the partially completed track warrant for travel beyond Waipahi found at the site. LEs would normally fill in such details while stopped waiting for a crossing.

2.2.4 The behaviour of the 2 derailed wagons behind the locomotive of Train 919 gave further support for Train 919 being stationary at the time of impact. The manner in which they jack-knifed indicated that there was no slack in the couplings of Train 919, and that the train brakes were applied at the time of impact.

2.2.5 There is no conclusive evidence as to how long Train 919 was stopped before impact, and for what reason. It is possible, but unlikely, that LE2 still intended to set the points for the opposing train but did not have time. It is more likely, based on the partially completed warrant for his next movement, that he had elected to stop in that position without intending to set the south end points for the loop, and was awaiting the arrival of Train 938.

2.2.6 Non-observance of TWC Regulation 10(b)(1) was not unusual based on interviews with other LEs. There appears little doubt that not setting the points was a reasonably common violation by LEs without formal variation of the train crew duties as allowed by Regulation 10(b)(v). It would have been more understandable if Train 919 had stopped short of Railway Terrace level crossing, some 270 m from the south end points. LE interviews showed this sometimes occurred to avoid disrupting road traffic. A train stopped in this position would have been visible to the LE of an approaching northbound train when some 500 m away.

2.2.7 Given the circumstances as they occurred on the day, in stopping where he did LE2 increased the risk of a possible head-on collision with an opposing train in 2 ways. One was by leaving the points set for the main line, and the other was in not giving Train 938 the early visual warning of Train 919's presence on the main line available if Train 919 had pulled through to the south end.

2.2.8 Had the points been set for the loop as required by the regulations this would have had 2 effects on approaching Train 938:

- LE1, with an understanding that he had a track warrant to Clinton for the crossing, may have seen and reacted to a red over purple loop indication on 3FI as he approached Waipahi.
- If he had not seen or reacted on this information his train would have been diverted to the loop at high speed. Rollover may well have occurred dependant on speed, but collision would have been avoided.

2.3 The actions of the LE of Train 938

2.3.1 There was no indication of any unusual aspect of LE1's behaviour prior to the crew change with Train 913 at Mataura.

2.3.2 His recollection of events from this time on were both dim and variable, due to traumatic amnesia. From the handing-over LE's account of the crew change handover of TW 31 to LE1, it occurred as required by Tranz Rail regulations as reinforced by bulletin. Despite this, LE1 either then or at a subsequent stage on his journey to Waipahi, formed a belief that he had a TW to Clinton.

2.3.3 LE1 had no clear recollection of reading TW 31 between handover and the collision. If he had read his warrant, it is likely that he would have noticed that the warrant was to Waipahi.

2.3.4 LE1 approached Waipahi believing he had a track warrant to Clinton and unaware of the presence of Train 919 on the main line at Waipahi. Based on this belief he had no requirement to contact Train 919 as he approached.

2.3.5 The first visual indication he received of something unusual was that 3FI was illuminated as he approached and not approach-lit by his train. The purple bulb was not initially visible when 3FI first came into view, and LE1 would have seen only a red indication for about 11 seconds until the purple incandescent bulb progressively became visible. This occurred about 6 seconds before Train 938 crossed the insulated joint that normally illuminated 3FI. While either of these early indications could have alerted him to something unusual at Waipahi, i.e. a fault or a possible train on the main line within station limits, there is no evidence that they did. LE1 was aware of the position of the circuit which approach lit 3FI, and his attention may not have been straight ahead when 3FI first came into view. As he neared the circuit trip it then only needed a short diversion of attention for him to lose the chance of appreciating the significance of this warning. The late visibility of the purple indicator on 3FI was not a factor on the day as an early indication red was available. Any early indication seen by LE1 would have alerted him to an unusual situation.

2.3.6 The best indication of his actions approaching Waipahi were obtained by analysing the locomotive event recorder from DC 4202 on Train 938. This showed:

- a train speed of 63 km/h rising to 67 km/h at constant notch 8 throttle over the first 200 m from where 3FI first came into view
- a gradual throttle reduction from notch 8 to notch 2 over about 5 seconds (the throttle reduction commenced at about the same position that the top purple became visible to an approaching LE)
- constant throttle (notch 2) and constant speed (67 km/h) for 17 seconds
- that when Train 938 was 150 m in front of points indicator 3FI a throttle reduction to notch 1 was made
- that train speed dropped to 66 km/h in notch 1 before the next control change, an emergency brake application, some 200 m before the point of impact
- that train speed dropped to about 62 km/h at the point of impact.

Based on the above, and allowing for reaction time, the first awareness LE1 had of the need to brake was about 215 m from the point of impact. This was in agreement with view lines available and the sand deposit. Indications were that LE1 saw Train 919 almost as soon as it came into view and reacted appropriately.

2.3.7 The time delay from initial brake application, some 200 m before impact, to the take-up and "bite" of the brakes heard by witnesses as a squeal, was approximately 6 seconds. During this time Train 938 had travelled about 115 m. During the 85 m left until impact, the train slowed from 66 km/h to just below 62 km/h. This showed a retardation of approximately 0.3 m/sec/sec. Factors such as the down-grade, wet rail, train load and one wagon with brakes cut out would have reduced retardation but even allowing for this the figure was low. However, the actual braking distance was so short that this low figure has no major effect on speed of impact and related survivability.

2.3.8 All indications were that LE1 was driving his train consistent with anticipating a main line points indication at 3FI to take him through the main line to his understood track warrant limit at Clinton. Because of this misconception he unknowingly contravened TWC Regulation 2(a) as soon as he passed 3FI indicator on the main line by entering a part of the main line without the authority of a track warrant.

2.3.9 A combination of factors may have contributed to LE1's misconception that he had a TW to Clinton, including:

- The failure of the crew changeover procedures to provide a defence against misheard or misunderstood track warrant details.
- The failure of the crew changeover procedures to strongly imprint the correct track warrant limits into LE1's awareness to the level achieved by the repeat-back procedures with the TCO.
- Although it was agreed by all staff interviewed that it was the responsibility of an LE to read his warrant and know his limits it is highly likely that LE1 did not read the warrant he inherited. It is of note that for all but conditional track warrants the LE must read back a track warrant to train control as part of the procedure. For conditional track warrants this was not required after a crew changeover. Indeed there was no rule or requirement for an LE to read his track warrant in such circumstances. Although no one thought it acceptable to proceed in such circumstances without reading an inherited track warrant, LE interviews showed LE1's possible failure to read TW 31 was not unique.
- A perceptual set for a crossing at Clinton based on a previously established pattern. Clinton was the scheduled crossing place for Trains 938/919. Over the previous 5 months almost 70 % of crossings had taken place at Clinton and LE1 had crossed Train 919 there the previous day. Although there is no strong pattern associated with LE1, the recency of his last crossing at Clinton, combined with low level fatigue induced by circadian rhythms tiredness, may have been sufficient to have established such a perceptual set .
- Possible fatigue associated with the roster. Given that the accident occurred on the second shift after 2 full rostered days off, it is unlikely that he was unduly fatigued due to inadequate opportunity to rest or from excessive work. However, on both the day of the accident and the preceding day, he had commenced at 0220 hours, which meant that his normal nightly sleep was disrupted. He did have adequate opportunity for daylight sleep on the day before the accident, but the early morning start and the effect of circadian rhythm on performance could have affected performance throughout the shift from handover to the time of the accident. The handover occurred within the 0300 to 0700 hours timeframe. United States National Transportation Safety Board research has indicated that this is a time when there is an increased likelihood of error due to tiredness induced by the natural circadian rhythm of the body. The contribution of fatigue and circadium rhythm effects to this accident, if any, are considered to be low compared to other factors.

2.3.10 Consideration was given to possible confusion arising from radio transmissions overheard by LE1. There is no evidence that radio transmissions overheard by LE1 contributed to his misunderstanding of Clinton as his crossing place.

2.4 Communication between trains

2.4.1 LE2 was not required to call Train 938 before entering Waipahi. LE1 did not contact Train 919 approaching Waipahi because he was not expecting a crossing. Had it been mandatory for both trains to communicate at crossings before either entered a crossing station the accident may have been avoided when related to the timing of events on the day. However, this would not have necessarily avoided a potential head-on collision in the Waipahi/Clinton section if Train 938 had mistakenly passed through Waipahi on that day, before Train 919 was close enough to have initiated radio contact.

2.5 Survivability

2.5.1 LE2 had a maximum 12 seconds warning of the impact from the time at which he could differentiate between Train 938 being on the loop or on the main line. It was likely he was trying to exit the cab at the time of impact. The cab was completely crushed in the collision. This is understandable when considering the speed of the impact and the manner in which DC 4202 rode up onto DFT 7254. In the circumstances it is considered that the crashworthiness features of the DFT were acceptable, although unable to maintain the survivable space for LE2.

2.6 Recommendations arising from LTSA safety study and TAIC investigation

2.6.1 GHD-Transmark's recommendation 7.2, option B, was essentially repeated in TAIC recommendation 004/96, which suggested LEs inheriting TWs at a crew change go through the same repeat-back procedures as the LE who obtained the original warrant. If this had been actioned to the full extent defined and recommended, would LE1 have still had a misconception as to his warrant limit? This cannot be answered with certainty but it is likely it could have either overridden any previous misconception and possible it could have avoided a later change of understanding from whatever source.

2.6.2 GHD-Transmark's recommendation 7.4 was that Tranz Rail should build on the requirement that on the approach to a warrant station where a crossing is to take place the LE must establish contact on channel 1 of the radio with the LE of the train to be crossed, and that this should be done by requiring both LEs to endorse their warrants with the time, confirming that this contact had been made. It was suggested this could then be audited. If this had been actioned then, as it has been since, to involve both LEs whether audited or not, would LE2 have entered the main line without contacting LE1? Again this cannot be answered with certainty but staff interviewed indicated current requirements for the LE entering the loop to make contact are followed in the majority of cases despite the wording of Regulation 10(b)(ii) and the fact that it was not audited. Again it is likely that, given the train timing on the day, Train 919 would have contacted Train 938 during the latter's progress from Mataura to Waipahi, and a defence thus activated that may have avoided the track warrant limit overrun and collision.

2.6.3 Assuming both recommendations had been actioned to the full extent defined and recommended there is a high probability that the accident would not have occurred.

2.6.4 In view of the importance of these recommendations to the events on the day, and the reported incidences of human-factor weaknesses creating hazardous situations as reported by LEs in interviews, the role of the operator and the regulator are examined in some detail in the following sections.

2.7 Safety at reasonable cost

2.7.1 A regulator such as the LTSA required quantified data to be able to assess to what extent safety at reasonable cost was being applied or achieved. This applied to safety enhancements such as those recommended in the 1996 safety study.

2.7.2 Before an assessment could be made as to whether such recommendations met the criteria it was essential that the costs and benefits be quantified and compared. Armed with this information the operator would be in a better position to assess what voluntary action to take on such recommendations, and the regulator should be in a better position to assess what mandatory action may be justified.

2.7.3 No costs and benefits were compared by the operator in the case of the 2 GHD-Transmark recommendations. Similarly there was no evidence that costs versus benefit evidence was ever requested by the regulator.

2.7.4 Tranz Rail, when reaching an understanding that the intent of recommendation 7.2, option B had been effectively implemented, accepted that suggestions were more effective than rules in establishing behaviours. The bulletin (see 1.10.11) suggesting that LEs check their warrants at regular intervals was based on this. Such suggestions can be a useful means of reinforcing a rule or procedure but are not necessarily an effective substitute for a clearly defined rule or procedure requiring that, regardless of how the warrant was received, there was a mandatory read back and verification process.

2.7.5 Tranz Rail advised that recommendation 7.4 regarding train crossing radio procedures was not implemented because it was impractical. The justification for this was based on one scenario assuming complex monitoring of track warrant endorsements. However, a requirement for both LEs to use channel 1 and endorse their track warrants, even without compliance monitoring, offered a possible safety enhancement based on the LE interview responses to Regulation 10(b)(ii). Coupling this with a simple monitoring system involving LEs retaining warrants until the end of the shift for random auditing would have achieved most of the benefits of the recommendation.

2.7.6 Tranz Rail intend to carry out random monitoring of channel 1 radio calls made in accordance with the new regulation 2 (n), introduced in March 2000 and detailed in Section 4.2. These calls are a prompt for the LE making them and will not be made to, or necessarily heard by, any other party. Such monitoring will have taken 5 years to bring from the idea stage to reality and recommendation 7.4 could have effectively bridged the gap until this was introduced. It was also of note that while auditing is important, Tranz Rail had recognised that lack of immediate audit was not a necessary barrier to improvement by introducing rule changes in March 2000 which are not yet able to be audited. There was no compelling evidence that recommendation 7.4 was impractical in all its possible applications. A requirement for quantified risk assessment of optional means of achieving the intent of the recommendation would have allowed this to have been checked.

2.7.7 It is not in the best interests of transport safety if potential "low/no cost actions" (the LTSA's consultant's description of the safety enhancements proposed) arising from a safety authority study are not tested against the criteria of safety at reasonable cost before it is accepted that variable or no action is appropriate. A mechanism and intent is needed within the regulatory regime to achieve this. Both the operator and the regulator have a role to play in this process, and this is reflected in recommendation 006/00 in Safety Recommendations, section 5 of this report.

2.8 Systemic and organisational factors

The operator

2.8.1 In reviewing the information relating to the systems, Tranz Rail had in place at the time of the accident, 3 organisational aspects are identified as having a potentially contributory effect. These are the suitability of defences against the formation of perceptual set, the lack of procedural consistency, and the safety culture of Tranz Rail.

Defences against perceptual set

2.8.2 The various audit reports and the comments of the LEs interviewed repeatedly drew attention to the fact that the TWC process relied totally on the diligence of the LE. This individual must correctly perceive the requirements of the warrant, retain that perception, maintain situational awareness and act exactly in accordance with the regulations and the warrant. If these conditions are met with 100% percent accuracy, then there is no reason why TWC should not be as safe as any other traffic control system.

2.8.3 The reality, however, is that humans do not operate at 100% accuracy. Boredom, distraction, fatigue, illness, anxiety, misunderstanding and sensory problems can degrade performance. Operating inconsistencies can nevertheless be tolerated if there are appropriate defences in place to detect and correct the errors, slips or lapses.

2.8.4 With TWC a foreseeable error is the misperception of warrant limits. One possible form of misperception is the formation of an incorrect perceptual set. Perceptual set is the process by which a person becomes predisposed to perceptions which are consistent with prior experience. Once formed, a perceptual set is unlikely to be challenged by the holder.

2.8.5 One of the prime defences against this risk was the requirement for an LE to repeat the details of the warrant back to train control. While this process did not absolutely ensure that the LE would remember the limits or retain situational awareness, it did reduce the probability of the formation of an incorrect perceptual set.

2.8.6 A second defence was the retention of the warrant within the cab. This was a passive defence and less effective than the active read-back process. Once a perceptual set had been formed, the LE was unlikely to re-check Clause 3 although he may well have read other clauses, such as checking whether he had to make any calls under Clause 10.

2.8.7 A third defence was an LE checking his warrant at the station warning board. Although not a requirement this had been suggested as a good habit (refer 1.10.11). LE1's actions were not consistent with having made such a check. If such a check had been made, there is a high probability that it would have overcome any perceptual set held.

2.8.8 At the time of the accident, repeat-back procedures did not apply when a warrant was taken by one LE and then handed over to another. There was no requirement for an LE handing a warrant over to another LE to ensure the relieving LE understood the content of the warrant, nor did the regulations require the relieving LE to actually read the warrant. The argument could be made that the requirement to read the warrant was self-evident and did not need to be mandated. However, given the fact that understanding the limits of a warrant was one of the most critical components of safe TWC operation, the absence of such a mandatory requirement introduced an opportunity for error.

2.8.9 Recommendations by the risk study authors on ways to overcome problems with conditional warrants were considered by Tranz Rail but not implemented. The authors stated that the main reason cited was that increased costs would be incurred if an LE had to obtain a fresh warrant. The contention was that the costs would arise from the delay incurred waiting for train control to respond. However, Tranz Rail analysis did not include relevant statistical data, such as the mean and standard deviation of the train control response times, nor did it quantify the ability of train control to respond selectively and give precedence to high priority calls should it wish to do so.

2.8.10 Notably, even if the recommendation to require fresh warrants before commencing movement was put aside, Tranz Rail could have substantially addressed the problem by modifying Regulation 7 to incorporate the essence of Regulation 5. This Regulation stipulates that when an addressee who is not in contact with train control receives a warrant he must read it back to the person who originally took it from train control, and both parties must endorse the warrant with the word "Relayed" and the time relayed. The person who took the warrant in the first place must then advise train control of the read back and the time. Alternatively, if time delays were a significant concern, another option would have been to require LEs accepting a warrant taken by another LE to confirm the details with train control as soon as the movement was under way. Apparently some LEs already do this of their own initiative just to reassure themselves the warrant is correct.

Non-standardised crossing procedures

2.8.11 In any system which is heavily reliant on human input and has few, if any, fail safe defences, strict observance of rules is paramount. Reference to this fact was made in all of the GHD-Transmark reports. Deviation from a clearly defined set of procedures inevitably creates opportunities for misunderstanding and error.

2.8.12 Tranz Rail Rules and Regulations are the prime operating documents and compliance with them is an essential safety requirement. Their importance and mandatory status is known to all staff and they form the basis of Tranz Rail's safety system.

2.8.13 Two significant inconsistencies were identified in the information relating to Waipahi. The first concerned the procedures for setting the points for the oncoming train. Regulation 10(b)(i) clearly stated that the train arriving first and entering the main MUST set the points for the train entering the loop. This did not happen at Waipahi for reasons which will never be known, but from the interview responses of staff it is clear that non-compliance with this regulation without train control authority was not uncommon and, not surprisingly, caused ongoing confusion and frustration for the LEs with some citing times when they had let themselves into the loop only to find the other train already sitting on the main. The belief of one manager interviewed was that, given the timings as they occurred on the day, had this regulation been complied with a head on collision would have been avoided.

2.8.14 The senior managers interviewed cited specific cases where they would not be surprised to find non-compliance with the Regulation 10(b)(i) requirement to set the route for the opposing train to enter the loop, such as the need to avoid built up areas at night or passenger trains stopping at stations, but this was not linked by them to the need for train control authority. From an organisational factors perspective this raised two important issues. The first was that recurring deliberate breaches of the Regulation without appropriate authority were not detected. The second was that the failure to detect and correct LEs' violation of this Regulation undermined the resilience of the approved safety system by the message it gave to LEs that variable interpretation of mandatory rules was acceptable.

Inadequate communication procedures

2.8.15 The second inconsistency concerned the communication procedures. Regulation 10(b)(ii) placed the onus on the LE of the train entering the loop to make contact with the other train. The LTSA commissioned audits and safety study had emphasised the fact that no opportunity should be missed to establish the whereabouts of the other train. Several of the LEs interviewed expressed a concern that their greatest fear was not knowing were the other train was. None of the senior managers interviewed could provide a clear explanation as to why only one LE was required to make contact prior to a crossing. Requiring both LEs to attempt to establish contact at a crossing would have established a further defence against the situation where one LE misperceived the warrant limits or lost situational awareness. Again, giving the timings as they occurred on the day, had contact been made by LE2, LE1 approaching from the south would almost certainly have realised that he had the wrong destination in mind.

Safety culture

2.8.16 Tranz Rail placed a high value on safety. In its 1999 Annual Report Tranz Rail stated, "The safety of our employees and the integrity of the network is one of our top priorities". There is no reason to doubt the genuineness and sincerity of Tranz Rail's belief in the importance of safety, in particular as shown by independent safety reviews commissioned during 2000 regarding TWC specifically and safety generally. However, the 1995 GHD-Transmark report recommending approval of the Tranz Rail operating licence made reference to the possibility of a "dilution of commitment above Area Level to raising the safety profile of the Company." This possibility may still exist based on the differences found during this investigation between the perceptions of senior mangers, field managers, and the front line staff as to what was happening at the operational level.

2.8.17 These differences were apparent in such matters as supervision practices, compliance monitoring, local variations to procedures and the levels of risk. Senior managers stated, for example, that staff were free to raise concerns whereas staff interviewed said they had serious reservations about doing so. Where the LEs expressed concerns about the risks in the job, the senior managers cited the comparative risk study as evidence that the risks were no greater than other parts of the network. It could be argued that senior managers did not necessarily need to know all aspects of day-to-day practices, but the specific recommendations made in 1995 by GHD-Transmark related to just such day to day practices. However they were dealt with at senior manager level with no evidence of referral to, or input from front-line operating staff.

2.8.18 Tranz Rail's interpretation of the 1995 Special Audit, put forward as evidence of their opinion that "there is no suggestion that there are reasonable grounds to believe any person is likely to be put at significant risk of death or serious injury from the method of operation on the Main North Line" (see 1.14.15), despite reference to specific weaknesses referred to in that report, showed a defence of the status quo rather than a desire to proactively critically review the procedures. The general tenor of responses to sections of the Special Audit confirmed this. The nature and extent of the differing views were surprising when considering the experience and standing of both parties. This attitude was also evident in the manner in which the Tranz Rail quantified risk study was structured and interpreted to compare and justify TWC operation against Centralised Traffic Control operation rather than the elemental risk analysis approach envisaged by the 1995 auditors (see 1.13.16). Such a reactive approach did not create a climate to maximise the benefits arising from the external rail expertise involved. This reactive approach is demonstrated by actions taken since the accident (see 4.2). A Tranz Rail defensive attitude could also be inferred from the manner and timing of the possible use of its right to legal challenge, although Tranz Rail saw this as evidence of natural and healthy constructive friction.

2.8.19 The end result of Tranz Rail's response to the various reports and recommendations since 1995 which related directly to events preceding the Waipahi accident was that an opportunity to implement defined defences to particular defined hazards, and thus reduce risk at "low/no cost", was lost. The Tranz Rail approach to such safety enhancements should be revised to ensure such opportunities are not lost in the future.

The regulator

2.8.20 A key function of the LTSA within the legislative framework was to represent the interests of the travelling public and staff by ensuring that the transport service was as safe as could be achieved given the costs. The LTSA approved the safety system and monitored compliance with that safety system through a series of regular and special audit checks. The position of the LTSA was that they did not impose solutions except "where LTSA had reasonable grounds to believe that a person was likely to be put at significant risk of death or serious injury unless satisfactory action were taken in mitigation of the perceived hazard." This philosophy was based on the observation that imposing solutions transferred ownership of those solutions from the operator to the regulator, which can create a climate in which an operator adopts the position of proving that a particular solution proposed is impractical, and in doing so fails to address the root problem.

2.8.21 In respect of TWC as operated at the time of Waipahi, the appropriateness of the safety system was assessed by GHD-Transmark. While this process acknowledged the existence of the appropriate safety systems, rules, procedures and the like, it was not required to evaluate the completeness or otherwise of the actual rules. Despite this the assessors did draw attention to the 1995 Special Audit which identified weak links in TWC. Later reports made direct reference to the failure of Tranz Rail to implement practices that the auditors felt would reduce the risks. These reports identified recommendations which were "low/no cost" control measures and raised the possibility of death or serious injury with their reference to a possible "cornfield meet"[7]. Despite this the LTSA believed that it had insufficient justification to require adoption of the recommendations because:

- it did not believe the situation met the criteria for "placed, or could have placed, a person at risk of serious injury or death"
- no serious injuries or deaths had occurred in TWC operations
- it considered other priority areas took precedence in the LTSA/Tranz Rail interface, and quoted shunting and track buckling as 2 such areas.

2.8.22 It is clear from the historical record that for a good part of the period in question the LTSA experienced some difficulty in exercising its perceived regulatory responsibilities in respect to Tranz Rail. A *Review of Tranz Rail Ltd Safety Audit Process* carried out on behalf of the LTSA by United Kingdom based consultants IRMS as recently as April 1999 stated that "the relationship between regulator and regulated appears to be at a low level never before experienced by the review team elsewhere," although comment was made that there had been "noticeable improvement recently due to a proposed initiative to produce a Memorandum of Understanding between the LTSA and Tranz Rail." To the credit of both parties, this tension appears to have been significantly reduced over the past year with the negotiation of a further Memorandum of Understanding covering "Safety System Variations" which was completed in March 2000. The possible adverse effect this relationship had on the action taken on reports and recommendations since 1995 cannot be quantified but should not be discounted. This may have contributed to the ineffectiveness of defences in place at the time of the accident.

[7] An American term for a head-on collision under clear, open country conditions.

2.8.23 The Transport Services Licensing Act defined an intervention level for a safety system variation as "necessary in the interests of avoiding a significant risk of death or serious injury." When considering such intervention on recommendations related to safety enhancements from a reputable source, such as recommendation 7.2 and 7.4 made to the LTSA, the only means of determining whether a significant risk is being addressed is to quantify the risk exposure. To then assess whether the criteria of safety at reasonable cost is appropriately considered requires a comparison of the cost of implementing such recommendations to the safety benefits achieved. Specific action is required from the regulator to determine when such intervention is justified.

2.9 Global positioning systems

2.9.1 The circumstance of this accident have highlighted the potential benefit of GPS or other system approaches to reduce the reliance on human behaviour implicit in TWC.

Tranz Rail is aware of the possible advantages GPS may bring to enhancing or replacing TWC and have indicated a commitment to progressive evaluation and implementation within technical and reasonable cost restraints, and no recommendations have been seen as necessary in this area.

3. Findings

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

3.1 LE1 and LE2 were appropriately certified for the duties they were carrying out.

3.2 A change in the compliance monitoring system applicable to LEs had resulted in a lower level of supervision of Invercargill and Dunedin-based LEs, but this did not apply in the case of the LEs involved in the accident.

3.3 Both trains had valid warrants for the crossing intended.

3.4 Although Clinton was the timetabled crossing for Trains 919/938, a crossing at Waipahi was permitted, and not unusual based on actual train running on the day.

3.5 Train 919 had authority to occupy the main line at Waipahi but Train 938 did not.

3.6 For reasons unknown, LE2 stopped Train 919 some 500 m short of the desirable stopping place for a southbound train to stop when setting the south end points for the loop was required.

3.7 LE2 made no attempt to set the south end points for the loop despite the requirements of TWC Regulation 10(b)(1).

3.8 Although Regulation 10(b)(1) was mandatory, there were many occasions when points had not been set for the opposing train to enter the loop.

3.9 There was recognition at all levels of Tranz Rail staff that there were recurring occasions when the points for the opposing train to enter the loop were not set as required by the regulations, but these exceptions were not defined or controlled.

3.10 Had LE2 stopped Train 919 at the south end of Waipahi and set the points for the opposing train into the loop, he would have provided 3 possible defences against the collision occurring despite the misconception of LE1:

- LE1 may have noticed the facing points indicator showing his route was set for the loop and slowed or stopped Train 938.
- LE1 would have seen Train 919 earlier, possibly in time to stop his train.
- If Train 938 had not stopped it would have diverted into the loop.

3.11 LE1 was controlling Train 938 according to his belief that he held a track warrant for a crossing at Clinton and not Waipahi, although when and how he came to this belief could not be determined.

3.12 Factors that may have contributed to LE1 misconstruing the destination of his track warrant were:

- There was no formal requirement for him to read his warrant.
- He relied on the crew changeover procedures to ascertain his right to occupation of the line.
- The procedure for accepting conditional track warrants at crew changeovers did not require LE1 to read or repeat back the track warrant to either train control or the LE handing over the warrant.
- There was a perceptual set which, although not strongly established by any previous pattern, had been strengthened by a crossing with Train 919 at Clinton the day before.
- The suggestion to LEs to check their warrants at station warning boards was not actioned.
- Natural body circadian rhythm at and subsequent to the time of the crew change induced fatigue.

3.13 LE1 did not respond to the early illumination of 3FI indicator initiated by the arrival of Train 919.

3.14 In passing 3FI indicator and entering the main line at Waipahi LE1 unknowingly exceeded his track warrant limit and contravened TWC Regulation 2 (a).

3.15 Had LE2 been required to make radio contact with LE1 before entering the main line at Waipahi, LE1's misconception as to his warrant limit may have been corrected in sufficient time to avoid the collision.

3.16 LE1's control of Train 938 approaching Waipahi and his emergency brake application showed he was alert and responsive prior to the collision. His unchanged action despite the early points indicator displayed on 3FI due to the presence of Train 919 on the main line was probably influenced by the indication being for the main line, where he was expecting to go, and the timing of the focussing of his attention.

3.17 Recommendations regarding the transfer of warrants at crew changes made to the LTSA in 1996 by its consultants, and to Tranz Rail by the Commission in 1996, were not tested against the criteria of safety at reasonable cost. Neither was the recommendation made to the LTSA by its consultants in 1996 regarding the need for Tranz Rail to build on communication requirements.

3.18 By choosing not to adopt the recommendations in the manner defined Tranz Rail missed an opportunity to put in place defences to defined weaknesses which may have avoided this accident.

3.19 Tranz Rail's reactive as opposed to proactive response to suggestions related to the suitability of the TWC system made during the years 1995 to 1997 may have contributed to the lost opportunity, and to the level of weaknesses and related hazards reported during LE interviews.

3.20 The LTSA considered the recommendations that had been made were a matter for Tranz Rail to determine and that there was insufficient justification to meet the intervention threshold as defined in the TSL Act to require the mandatory introduction of the proposed safety enhancements in the form recommended.

3.21 Despite the recommendations made to the LTSA, an opportunity to provide 2 "low/no cost" defences which may have avoided this accident was not realised during the subsequent regulator/operator interface.

3.22 Any such safety enhancements providing additional defences to a system so heavily reliant on human input should be assessed against the criteria of safety at reasonable cost before any non-implementation is accepted.

3.23 Decisions on safety enhancements affecting the detailed day to day operation of TWC had been made by Tranz Rail at senior management level with no evidence of referral to those carrying out and supervising such operations in the field.

3.24 The TWC regulations contained inconsistencies relating to procedures for reading warrants and communicating at crossings.

4. Safety Actions

4.1 Since the Waipahi accident there has been active follow-up by both the operator and regulator on issues arising, including formal interaction. In addition Tranz Rail set up a special working party with the users of TWC in mind. It included LEs, track workers and train controllers, as well as unions and senior management.

4.2 On Friday, 31 March 2000 Tranz Rail issued Bulletin 183 introducing the following rule changes to the TWC regulations.

> **Implement Mandatory Calling of Limits Held**
>
> **2. Operating in Track Warrant Control Area**
> **(Additional new sub-clause)**
> (n) As a train approaches a station warning board or intermediate signal, the addressee must call on radio channel 1 advising the train number, location being approached and the terminating limit of the warrant held.
>
> Track Maintenance Vehicles operating with a track warrant must also comply with this procedure, advising the vehicle identification number if not operating with a train number.
>
> When calling on the radio make sure there are no other transmissions on channel 1 otherwise your transmission will not be heard correctly.
>
> * **Transferring of Track Warrants**
> **Current Track Warrant Control Regulation 7 – Transfer of Track Warrants, now becomes Regulation 7 (a)**

(7b) Crew Change Over
(New Track Warrant Control Regulation)
On a train where a change of Locomotive Engineer takes place the relieving Locomotive Engineer must obtain a new track warrant before the train departs from that station.

After Locomotive Engineer changeover a train may complete berthing up to the trailing indicator, signal or fouling point at the station for train crossing purposes when authorised on the existing track warrant.

This procedure also applies if a crew change takes place at a location on the main line between stations (i.e. by car, or a work train).

*** 3. <u>Procedure at Crossing Stations</u>**
10 Working of a Warrant Station
(b) At Stations not provided with Arrival signals
(clause (ii) reworded as follows)

When crossings are required the Addressees must, before entering the station.

- establish the whereabouts of each other by calling on the radio channel

Should it not be possible to establish radio contact:

- entry into the station may occur after visual observation indicates it is safe to do so
  or
- request train control to establish and advise the whereabouts of the opposing train.

In all situations a clear understanding must be achieved as to the berthing arrangements to prevent both movements entering the station at the same time.

4.3 Tranz Rail advised progress on the following additional safety actions:

- Equipment is about to be installed to monitor the channel 1 calls locomotive engineers are to make under Regulation 2(n).
- New carbonised Track Warrant Forms will be introduced at an early date. The purpose of these is to make the limits of Track Warrants more visible and to provide a carbon copy for audit purposes to examine such things as legibility and accuracy of information from train control.
- It is proposed to extend the scope of train control voice recorded playback by providing feedback to the locomotive engineers and maintenance staff on the quality of their calls with train control.

The following are also under investigation:

- A redesign of Track Warrant stations equipped with Points Indicators to detect trains standing on the main line and indicate this by means of an indication to the locomotive engineer of another train approaching the station. This will provide additional protection at stations where two trains are crossing. These indications will detect the presence of another train if it is standing on or approaching the main line within a crossing station and will require the LE to stop if there is a red indication.
- A locally generated warrant station alert message to warn the locomotive engineer to check the limits of his Track Warrant and train speed.

- An overrun alert using GPS technology warning locomotive engineers that they have exceeded the limits of their Track Warrant.

4.4 The LTSA advised that since the Waipahi accident safety actions taken were that Tranz Rail should:

1. Review the procedure for warrant exchange on change over of LEs with a requirement to adopt either of the GHD Transmark Option A or B recommendations or an equally satisfactory alternative to reduce the risks associated with driver relief.
2. Reinforce the requirement for train/train calling arrangements at crossing loops.
3. Reinforce Regulation 10(b)(i) as not being discretionary.
4. Review train control monitoring of train position (by random calling perhaps).
5. Review the regular audit process of TWC system for improvement.
6. Review Risk Analysis.

LTSA also commissioned jointly with Tranz Rail a "*Review of Tranz Rail Risk Management Analysis of the Track Warrant Control Operating System*". The final report of this review was not completed as at September 2000.

5. Safety Recommendations

5.1 On 23 September 2000 it was recommended to the Director of Land Transport Safety that he:

5.1.1 obtain quantified costs and benefits of implementing recommendations, arising from audits or safety studies commissioned by LTSA, that are intended to reduce undesirable risk exposure as perceived by the recommendations' author, and compare these costs and benefits against the criteria of safety at reasonable cost when deciding whether implementation should be left to the operator's discretion or enforced. (006/00)

5.2 On 6 October 2000 the Director of Land Transport Safety replied:

5.2.1 Whilst the Land Transport Safety Authority (LTSA) agrees that the value of requiring a cost/safety benefit study is implicit in consideration of the adoption of safety recommendations made by a third party, under the present provisions of the Transport Services Licensing (TSL) Act, in many instances, it would not always be possible for this Authority to enforce implementation of any such recommendations made. A pre-requisite of the legislation is that before requiring a recommendation to be implemented by the operator, there be sufficient grounds for the Director to believe that a person was likely to be placed at significant risk of death or serious injury, if the recommendation was not implemented.

It is not always possible to establish these grounds. Therefore, even though a recommendation may meet the safety at reasonable cost criterion, it may still be challenged by the operator as not meeting the second requirement.

We have recommended to the Ministry of Transport that the legislation be reviewed to remove this additional 'hurdle', as part of the expected legislative changes required to implement the findings of the Wilson Inquiry into the Occupational Health and Safety practices of Tranz Rail.

5.3 On 16 February 2000 it was recommended to the Managing Director of Tranz Rail that he:

5.3.1 immediately prohibit the issue of conditional track warrants to the locomotive engineers of trains which are awaiting a crew change (115/99)

5.3.2 amend the rules for working Warrant Stations to require all crossing trains, whether berthing on the main line or the loop, to establish the whereabouts of the opposing train before entering the appropriate main line or loop (116/99)

5.3.3 introduce a procedure for endorsing Track Warrants with the time and train number associated with radio calls made to establish the whereabouts of opposing trains prior to crossings, and ensure it is audited. (117/99)

5.4 On 1 May 2000 the Managing Director of Tranz Rail replied:

> **115/99** We have reviewed this process in a Working Party forum, involving users and Union. A similar result will be produced by adopting a process whereby a LE takes his warrant after changeover. This procedure includes LE's changing from road vehicles. This change was implemented on Friday 31 March 2000 after advising staff of the change on Bulletin No. 183 (Semi-permanent) dated 29 March 2000.
>
> **116/99** This recommendation has been considered by the same Working Party. Their recommendation to proceed with implementing this change was accepted. This change was implemented on Friday 31 March 2000. Bulletin No 183 refers.
>
> **117/99** Tranz Rail has introduced mandatory calls approaching all Track Warrant stations, whereby the LE provides Train No., current location and Warrant Limit. Bulletin No. 183 refers. These calls and the additional call required at crossing stations under 116/99 above will be randomly monitored by relocatable recording radio equipment. This approach meets the aim of your recommendation in a manner that we consider will result in a more robust and less easily compromised audit trail. We have adopted this instead of following the procedure in your recommendation.

5.5 On 23 September 2000 it was recommended to the Managing Director of Tranz Rail that he:

5.5.1 take note of staff perceptions and experiences revealed by interviews carried out during this investigation and put processes in place, including regular personal familiarisation with operating practices, to improve corporate safety culture and its understanding at field level (065/00)

5.5.2 undertake a comprehensive zero-based revision of the TWC Regulations (and their associated practices) to ensure that adequate defences are in place to combat foreseeable risks arising out of human error (066/00)

5.5.3 decide whether flexible interpretation of Regulation 10(b)(i) by other than train control is to be permitted, and if so amend the regulations and introduce procedures to control any exceptions. (084/00)

5.6 On 9 October 2000 the Managing Director of Tranz Rail advised that recommendations 065/00, 066/00 and 084/00 were accepted.

Approved for publication 27 September 2000

Hon. W P Jeffries
Chief Commissioner

Appendix 1
Track Warrant 31

Tranz Rail

Mis. 88

Track Warrant

Track Warrant Number 31 Wednes day 20th October (Date)

To LE 938
(Designation, Name, Train, etc.)

At Matauna

1. ☐ Track Warrant Number _____ is cancelled.
2. ☒ After *~~departure~~ arrival of 913 *~~from~~ at Matauna
3. ☒ Proceed from Matauna . to Waipahi
4. ☐ Work between _____ and _____
5. ☒ Enter loop at Waipahi *to cross 919
6. ☒ Main line reported clear 0605 *(except for 913)
7. ☐ No other warrants issued between these limits after _____
8. ☐ _____ is Switched Out
9. ☐ Number _____ will NOT be signalled at _____
(Regulation 19 applies)
10. ☐ Call Train Control at _____
11. ☐ Clear main line before _____ hours
12. ☐ Other instructions _____

D Green Train Control Officer

Repeat correct at 0618 hours

Limits reported clear by _____ at _____ hours

(Mark "X" in box for each item instructed)
(*Delete words not required)

Appendix 2
Track Warrant Control Regulations

Table of Contents

Table of Amendments

Page No.	*Amendment No.*	*Page No.*	*Amendment No.*
321–322	Section Cover	333	11
323	12	334	11
324	12	335	12
325	10	336	12
326	10	337	12
327	12	338	12
328	12	339	9
329	12	340	9
330	12	341 to 500	Reserved for future use
331	7		
332	7		

Tranz Rail

Mis. 87

TRACK WARRANT

Track Warrant No. .... *day* ..... *(Date)*

To .....
(Designation, Name, Train, etc.)

At .....

1. ☐ *Track Warrant No.* ..... *is cancelled.*
2. ☐ *After* **departure / arrival* *of* ..... **from / at* .....
3. ☐ *Proceed from* ..... *to* .....
4. ☐ *Work between* ..... *and* .....
5. ☐ *Enter* ..... *at* ..... **to cross* .....
6. ☐ *Main line reported clear* .....* *(except for* ..... *)*
7. ☐ *No other warrants issued between these limits after* .....
8. ☐ ..... *is Switched Out*
9. ☐ *No.* ..... *will NOT be signalled at* .....
   (Reg. 19 applies)
10. ☐ *Call Train Control at* .....
11. ☐ *Clear main line before* ..... *hrs.*
12. ☐ *Other instructions*.....

.....

.....

.....

.....

..... *Train Control Officer*

Relayed to ..... *at* ..... *hrs.*

Repeat correct at ..... *hrs.*

Limits reported clear by ..... *at* ..... *hrs.*

(Mark "X" in box for each item instructed)
(*Delete words not required)

Specimen of Mis. 87 form (Train Control copy)

Tranz Rail

Mis. 88

TRACK WARRANT

Track Warrant No. .... *day* ..... *(Date)*

To .....
(Designation, Name, Train, etc.)

At .....

1. ☐ *Track Warrant No.* ..... *is cancelled.*
2. ☐ *After* **departure / arrival* *of* ..... **from / at* .....
3. ☐ *Proceed from* ..... *to* .....
4. ☐ *Work between* ..... *and* .....
5. ☐ *Enter* ..... *at* ..... **to cross* .....
6. ☐ *Main line reported clear* .....* *(except for* ..... *)*
7. ☐ *No other warrants issued between these limits after* .....
8. ☐ ..... *is Switched Out*
9. ☐ *No.* ..... *will NOT be signalled at* .....
   (Reg. 19 applies)
10. ☐ *Call Train Control at* .....
11. ☐ *Clear main line before* ..... *hrs.*
12. ☐ *Other instructions*.....

.....

.....

.....

.....

..... *Train Control Officer*

Repeat correct at ..... *hrs.*

Limits reported clear by ..... *at* ..... *hrs.*

(Mark "X" in box for each item instructed)
(*Delete words not required)

Specimen of Mis. 88 form (Addressee's copy)

TRACK WARRANT CONTROL (TWC) REGULATIONS

In Track Warrant Control territory occupation of the main line is controlled by instructions issued by Train Control and entered on a track warrant Track Warrant Control (TWC) is used in areas where Automatic Signalling or CTC, is not in use

TWC areas are arranged and equipped with Interlocked stations and Warrant stations, Interlocked stations will he remotely controlled or attended when switched in or may be switched out. Warrant stations are equipped with either motor points with indicators, or hand points and are normally operated by train crews,

The areas worked under Track Warrant Control are specified in the Working Timetable.

The beginning and end of each TWC area will be defined by Notice Boards.

The following definitions will apply in Track Warrant Control territory—

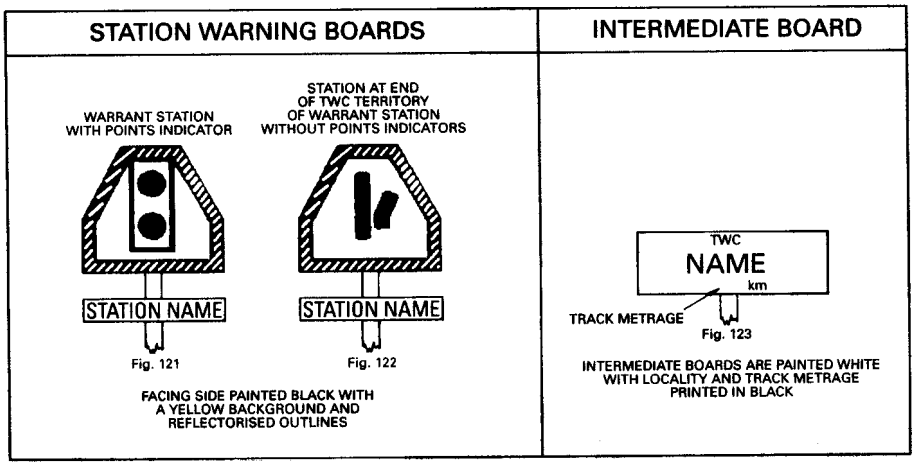
(a) Interlocked Station—A station at which the apparatus for working the signals and points is arranged to prevent conflicting movements, and can be manually controlled, Interlocked stations arc protected by home signals.

(b) Warrant Station—A non-Interlocked station provided for the crossing of trains, or the junction of two main lines. Warrant Stations are either protected by Arrival signals or where signals are not provided the approaches from each direction will be marked with a Station Warning Board (See Figs 121 and 122).

(c) Intermediate Board—A notice board (See Fig. 123) provided between stations or sidings to identify a location which may be used to designate a limit for a track warrant. The locations of Intermediate Boards are listed in the Working Timetable.

(d) Addressee—The Locomotive Engineer, Ganger or other employee to whom the track warrant is addressed and who is responsible for ensuring the provisions of the track warrant are carried out.

(e) Station Warning Board—A notice board (see figures 121 and 122) provided to mark the approaches to a Warrant Station or the end of TWC territory, where a fixed signal is not provided for the purpose.



I. Circumstances which call for Special Action—When circumstances arise which call for special or unusual action requiring a departure from a Track Warrant Control Regulation, duly authorised Officers may authorise such action by the issue of a train advice which must incorporate any instructions necessary to ensure safe working. When this occurs a full report of the circumstances must be forwarded to the Group General Manager Service Delivery.

2. Operating in Track Warrant Control Area—

(a) A Train, Mobile Track Equipment, or shunting movement must not enter upon or foul any part of the main line without the authority or a track warrant, This includes the main line within station limits.

(b) The authority of a track warrant will apply to the main line only.

(c) Main line points operated by a hand lever must not be unlocked until a track warrant to occupy or work on that part of the main line is obtained.

(d) A track warrant may be issued to allow work on or alongside the main line without other protection. A track warrant issued for other than trains must be addressed to the member responsible for safe working. He must hold the appropriate current Operating Certificate.

(e) In addition to authorising occupancy of the main line within designated limits, a track warrant may contain other instructions with which the addressee must comply.

When clause 10 of a track warrant specifies that a call is to be made at a location, then that call must be made but the train need not stop for an acknowledgement from Train Control. When Train Control acknowledges the addressee will advise their location and the terminating limit of the warrant held.

(f) When a track warrant authorises a movement to "proceed" the movement must proceed in the direction specified except when verbally authorised by Train Control for shunting at a station or siding. Train Control must not give such authority for any part of the line where another movement or work has been authorised.

(g) When a track warrant authorises a movement to "work" the movement may work in either direction between the locations specified. The movement must not enter a station or siding which is a limit of the track warrant unless authorised to do so.

(h) A track warrant, Once in effect, must not be altered in any way.

(i) When a track warrant is in effect and it is necessary to change its limits or instructions, a new track warrant must be issued. The new track warrant must contain the words "Track warrant No. ..... is cancelled", and give the number of the track warrant being invalidated.

(j) If a time by which the main line is to be clear is shown in the track warrant, the work authorised must be clear of the limits by the time specified unless another track warrant has been obtained.

(k) Separate track warrants must be issued to and from a station at which the train is to cross or pass another train, except when the first train is waiting in clear of the main line at the station where the crossing is to take place at the time the track warrant is issued to the second train. If the first train is standing on the loop the Locomotive Engineer of the second train must be advised accordingly.

(l) A track warrant which specifies that a movement or work is authorised "after" a train, may only be issued when the addressee is at the location at which the train is to arrive at or depart from; and, the train after which the movement is to take place has been authorised to proceed in one direction only.

When the movement is to be carried out after arrival of a train the addressee must ensure the train specified has in fact arrived, before carrying out the movement or work authorised.

When the movement is to be carried out after departure of a train, the addressee must ensure that the departing train has cleared the area far enough for the movement or work to be safely performed.

2. *continued*

(m) The Locomotive Engineer of a train reporting limits clear of a track warrant or portion of the limits clear, must only do so when it has been confirmed that the train is complete.

3. Limits of a Track Warrant—

(a) The limits of a track warrant will be designated by specifying stations, sidings, Intermediate boards, signals, Points Indicators, points or track metrage pegs. A track metrage peg must not be used to designate the limit to which a train is authorised to "proceed".

(b) The authority of a track warrant which commences at a station or siding will extend from—

(i) *At an Interlocked station*—The last main line to loop points met when leaving the station, or if there is no loop the last main line points. When the movement over these points is controlled by a signal the authority will extend from that signal.

(ii) *At a Warrant station*—the last main line to loop points met leaving the station, or if there is no loop the last main line points. When these points are equipped with a Points Indicator then the authority will extend from the Points Indicator.

(iii) *At a siding*—the last main line points met leaving the siding.

(c) The authority of a track warrant which terminates at a station or siding will extend to—

(i) *At a station*—Station limits at the entrance to the station.

(ii) *At a siding*—the first main line points met approaching the siding.

When the track warrant instructs the movement to enter the main the authority will extend to the last main line to loop points, or if there is no loop, to the last main line points. When these points are equipped with a signal or points indicator which applies to the movement the authority will end at that signal or points indicator.

When the track warrant instructs the movement to enter the loop or siding the authority will extend to and include the first facing points which give access to the loop or siding.

(d) The movement must not stand foul of points when these are the limits of the track warrant.

4. Occupying Same Limits—A track warrant must not be issued for any portion of the line for which another track warrant is still in effect except in the following circumstances:

(a) That portion of the line which is common to both track warrants is within the "work between" limits of each warrant. The respective track warrants must advise the addressees of each other's presence on the same part of the line, and contain any instructions necessary to ensure safe working.

(b) A train is following another which is authorised to proceed in one direction only and either:

(i) The train in front has reached a station, siding or Intermediate board beyond any location to which the following train is being authorised; or

(ii) The train in front has passed through a station in advance and the following train is authorised up to or into that station; or

(iii) The train in front has berthed in clear on the main at a station in advance and the following train is authorised up to or into the loop at that station.

4. *continued*

(c) The second track warrant authorises a movement "after the arrival" of a train whose track warrant is still in effect.

(d) The second track warrant authorises shunting or other work on or foul of the main line "after the departure" of a train whose track warrant is still in effect.

5. Method of Issuing Track Warrants—The Train Control Officer must enter the relevant details on a Mis. 87 and transmit the particulars direct to the addressee for entry on a Mis. 88.

When the addressee has correctly repeated the instructions back the Train Control Officer will confirm by the words "that is correct", followed by the time. Both members will endorse this time in the space provided in the track warrant which will then be in effect.

Should Train Control not have direct communication with the addressee, the track warrant particulars may be relayed through another employee qualified in the operation of Track Warrant Control. The employee relaying the track warrant must correctly repeat the particulars back to the Train Control Officer before being instructed to relay the track warrant to the addressee. When the track warrant has been relayed to the addressee and read back correctly the relaying employee will confirm by the words "that is correct", followed by the time. Both these members will endorse this time in the space provided in the track warrant which will then be in effect. The employee relaying the track warrant will then advise Train Control that the track warrant has been relayed to the addressee and the time the correct repeat was obtained. The Train Control Officer will endorse this time on his copy of the track warrant. The relaying employee will then write "Relayed" across the face of the warrant and forward it to their local Training Manager.

6. Cancelling Track Warrants—

(a) The addressee must report to Train Control when he has cleared the main line within the limits of the track warrant. Train Control will then correctly acknowledge the track warrant being cancelled with the addressee followed by the time. The addressee will confirm by the words "that is correct". After reporting clear of the limits the addressee must not again act on the authority of that track warrant.

(b) A track warrant, once issued, is in effect until either:

(i) The addressee has reported clear of the limits of the track warrant; or

(ii) It has been cancelled by a further track warrant.

(c) The word "Cancelled" must be written across the track warrant when either:

(i) The addressee has reported clear of the limits; or

(ii) The track warrant has been cancelled by a further track warrant.

7. Transfer of Track Warrants—When a Locomotive Engineer hands over a train to another Locomotive Engineer he must hand over any track warrants which are still in effect.

7. continued

Track warrants addressed to other than Locomotive Engineers must not be transferred. When it is necessary for an addressee to be relieved a new track warrant which cancels the previous one must be issued. The track warrant for the new addressee must be sent to the employee being relieved who must hand it to the relieving addressee and point out particulars of the track warrant.

WARRANT STATION

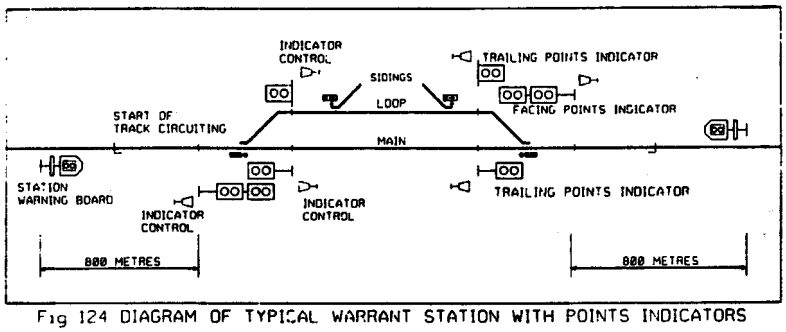


Fig 124 DIAGRAM OF TYPICAL WARRANT STATION WITH POINTS INDICATORS

8. Description of—

(a) The main line points at Warrant stations will be equipped with either motor points or hand points.

Points Indicators will be used in conjunction with all motor points. They will be controlled by track circuiting and operate automatically for most movements. They may also be controlled manually by operation of push-button controls near the Points Indicators.

Where the main line points are equipped with a hand lever they will either be protected by an Arrival signal and secured with an AS padlock or have no fixed signals and be secured with a TW lever-lock and an AS padlock unless otherwise specified in the Working Timetable. Train crews and other employees who are required to operate these points must carry the appropriate type of key.

When a lever lock is provided the key will be impounded when the lever is unlocked and cannot be removed until the lever is secured in the normal position.

(b) Where an Arrival signal is not provided a Station Warning Board, will be situated approaching the station and below the board will be the name of the station.

After passing a Station Warning Board for a Warrant station equipped with Points Indicators, the Locomotive Engineer must be prepared to stop his train at the Points Indicator at the entrance to the station.

9. Colour Light Points Indicators and Arrival Signals—

Colour Light Points Indicators—

(a) Two position Colour-light Points Indicators (as per Figs 125 to 134 on page 119) are provided at the facing and trailing ends of main line points at some Warrant stations.

9. *continued*

(b) Points Indicators will display a 'Purple' light when the points are correctly set. A 'Red' light will be displayed when the points are not in the proper position. If an indicator fails to illuminate it must be treated as displaying a "Stop" indication.

(c) Facing Points Indicators will have two units, one above the other. A 'Purple' light displayed in the upper unit will indicate that the points are set for the main or other direct route and a 'Purple' light displayed in the lower unit will indicate that the points are set for the loop or other diverging route. When a 'Purple' light is displayed in one unit a 'Red' light will be displayed in the other.

(d) Where necessary a purple arrow (as per Fig. 134 on page 119) is provided in the Trailing Points Indicator on the loop to allow movements to the backshunt. The purple arrow will be operated by a key switch in the box for the controls for the Trailing Points Indicator. When the purple arrow is illuminated the points are set for the backshunt and the movement may pass the Points Indicator on receipt of verbal permission from Train Control.

(e) Points Indicators are provided solely for the purpose of indicating which way the points are set and the addressee must ensure that the correct indication is displayed before the movement passes over the points. The Indicators are not permanently lighted.

(f) If a Points Indicator fails to indicate that the points are in the proper position the addressee must endeavour to obtain a route by operating the push-button controls at the Facing Points Indicator. If a correct indication is still not displayed the addressee must communicate with Train Control then isolate and hand-wind the points to the desired position before passing the Indicator at "Stop". When an indicator fails at a Track Warrant station, level crossing alarms within 400 metres ahead of this indicator must be approached with caution as the alarms may not operate correctly.

Arrival Signals—

(g) Stop and Proceed signals where provided at the entrance to Warrant stations are called Arrival signals. Each Arrival signal is fitted with a short range light which shows a white letter "L" when the points are set for the loop and all points off the loop are in the normal position.

When the points are set for the loop the Arrival signal controlling the entrance of a train into the station will be at "Stop". The "L" light indicates that the road is correctly set but not that it is unobstructed. Locomotive Engineers on trains instructed to enter the loop must, when the "L" light is illuminated, satisfy themselves that the road is clear.

When both sets of points are set correctly for the main line the Arrival signal will normally display a "Caution" indication for an approaching train.

(h)(i) *Arrival signal at Stop when train not required to cross another train at the station.*

The train must be stopped and the main line points restored for the main line if necessary. If after the expiration of 10 seconds the signal is still at "stop" the train may proceed cautiously past the signal, examining all the main line points prior to passing over them to ensure they are correctly set for the main line so that the train may proceed safely over them.

(ii) *Arrival signal at Stop when train required to cross another train at the station*

If the "L" light does not illuminate when the points are set for the loop all the points on the loop must first be examined and if they are correctly set the train may then enter the loop. Once a train has berthed on the loop and the opposing train is to berth on the main line but the Arrival Signal is at "Stop" then it may be passed at "Stop" in accordance with clause (i) above.

9. *continued*

(i) The Intermediate Stop and Proceed signal in rear of the Arrival signal at a Warrant station will be at "Caution" when the Arrival signal is at "Caution" or "Stop". As a train occupies the clearing track circuit (from 400 metres to 1,200 metres from the loop facing points) it will cause the opposing Arrival signal (which is normally at "Caution") to change to "Stop".

10. Working of a Warrant Station—

(a) At Stations provided with Arrival Signals—

(i) The main line points at each end of a Warrant station are operated by a hand lever fixed near the points, the lever being secured by an AS padlock. The points are electrically connected with the signals so that when the points at either end of the station are reversed both Arrival signals will go to "Stop" and the "L" light is illuminated at the end at which the points are reversed.

(ii) If a train which is to cross another train at a Warrant station arrives before the train from the opposite direction, it may be found that the Arrival signal is at "Proceed". When this occurs the Locomotive Engineer, must be careful to observe the instructions given in the track warrant and when given, those of Train Control.

(iii) If the first train to arrive at a Warrant station is instructed to enter the station on the main line and the Arrival signal is at "Proceed", the train may enter the station stopping short of the fouling-point board. When the train has come to a stand on the main line a member of the train crew must at once go forward and set the points for the opposing train to enter the loop.

When the opposing train approaches, a member of the crew of the train berthed on the main line, after seeing that the points are correctly set and secure and that the line is clear into the loop, must verbally authorise or hand signal the train to enter the loop. The Locomotive Engineer of the train authorised to enter the loop, after satisfying himself that the "L" light is illuminated, must take the train into the loop. After it is in clear of the fouling point the points must be set in the normal position for the main line and the points lever padlocked.

(iv) If, upon arrival the Locomotive Engineer of the train which is instructed to enter the loop observes the opposing train stopped at the Arrival signal at the other end of the station, or if the train instructed to enter the loop arrives first, the train must not pass the Arrival signal, unless the "L" light is illuminated. If the "L" light is not illuminated then a member of the train crew must go forward and set the points for the train to enter the loop. After ascertaining that the points are secure, that the line is clear into the loop, and that a train is not entering or leaving the opposite end of the station, the Locomotive Engineer, on ensuring that the "L" light is illuminated must take the train into the loop.

If Train Control so instructs, the points are to be set for the main line and the points lever padlocked, once the train has passed into the loop and is clear of the fouling point. The Arrival signal for the train approaching from the opposite direction will then go to "Proceed" and this train may, if instructed to do so in the track warrant, then enter the station on the main line.

(v) Sidings connected to the loop at crossing stations are provided with trap points. Points off the loop and associated trap points are locked and operated by a ground lever secured by an A.S. padlock.

10. (a) (v) *continued*

When it is necessary to use the sidings the lever must be unlocked and the points operated as required. After shunting is completed the employee in charge of the shunting operations must place the lever in its normal position and padlock it.

(vi) The duties of the train crew as specified in the foregoing provisions may be varied by Train Control.

(b) At Stations not provided with Arrival Signals—

(i) If a crossing is to take place and the first train to arrive berths on the main line, a crew member of that train must set the route for the opposing train to enter the loop and, except at stations equipped with Points Indicators, handsignal the train into the loop.

(ii) When trains are required to cross, the Locomotive Engineer of the train which is required to berth on the loop must, before entering the loop, establish the whereabouts of the opposing train. If the opposing train is closely approaching the station he must communicate with the Locomotive Engineer of that train and come to a clear understanding as to the berthing arrangements which will prevent both trains entering the station at the same time. Should it not be possible to establish the whereabouts of the opposing train or to make contact with the Locomotive Engineer of that train then the train taking the loop may berth after establishing that the other train is not entering the main line.

(iii) The employee who uses any hand points on the main line or loop must ensure they are restored to normal after use. Where the lever has locking facilities it must also be locked.

(iv) At Warrant stations equipped with motor points and Points Indicators the push-button controls must be operated in the following circumstances.

Situation	*Action Required*
The first train to arrive for a crossing has berthed on the main line.	The "stop" button at the main line Trailing Points Indicator must be operated and the door of the control box closed.
A train is to berth on the loop but the Facing Points Indicator shows that the points are set for the main line.	The "stop" button at the Facing Points Indicator must be operated and when the time delay light has extinguished the "loop" button must be operated and the door of the control box closed.
A train is to depart (or shunt) from the loop when no crossing has taken place	The "loop" button at the Trailing Points Indicator must be operated and the door of the control box closed.
The points are required to be operated for shunting purposes.	The points and indicators may be controlled from the control box at the Facing Points Indicator.
It is necessary to hold an Indicator at "Stop".	The stop button must be operated and the door of the control box left open.
It is necessary to obtain a purple indication after the "stop" button has been operated.	The relevant "main" or "loop" push-button must be operated and the door of the control box closed.

10. *continued*

Situation (ctd)	*Action Required* (ctd)
A vehicle or vehicles which cannot be relied upon to operate track circuits requires to berth on or depart from the loop.	The "loop", push-button at the Facing Points Indicator for that end of the station must be operated, and, the door of the control box must be left open *until the movement has passed completely over the points.*
A vehicle or vehicles which cannot be relied upon to operate track circuits requires to berth on or depart from the main line.	The Gangers Control switch at that end of the station must be operated and left in the "ON" position *until the movement has passed completely over the points.*
A movement is to enter or leave the backshunt at the end of the loop.	The key switch alongside the control buttons for the Trailing Points Indicator must be operated and left in the "GO" position until the movement is clear of the points.
When a train has been delayed at a warrant station equipped with Points Indicators and there is a level crossing situated within 600 metres of the indicator at which the train is stopped the Locomotive Engineer must ensure the alarms do not operate continuously and delay road traffic unnecessarily.	The Points indicator control stop button should be operated to revert the indicator to red and stop the alarms after a predetermined time delay. Once the train is ready to proceed then the Main or Loop/Branch button, as the case may be, can be operated and await the Indicator to display a purple aspect.

(v) The duties of the Train Crew as specified in the foregoing provisions may be varied by Train Control.

(vi) At junction stations equipped with motor points and Points Indicators the operation of the push button controls will be as outlined in S&I Diagrams and local working timetable instructions.

11. Fouling Loop at Warrant Stations—The loop at a Warrant station must not be fouled or obstructed without the verbal permission of Train Control.

12. Sidetracked Trains to be Drawn in Clear—Sidetracked trains must be drawn in clear of signals, Points Indicators or the fouling point before advising Train Control that the train has arrived.

13. Working of Sidings off the Main Line—

(a) Siding points on the main line in TWC areas are operated by a hand lever secured by a TW lever-lock and an AS padlock unless otherwise specified in the Working Timetable. These points must not be unlocked until the appropriate track warrant has been obtained.

(b) After the main line points at any siding have been operated the addressee must ensure they are left locked in the normal position and all is safe for the passage of trains through on the main line.

13. *continued*

(c) When it is necessary for a train to completely enter a siding and allow other trains to run through on the main line, the following procedure must be carried out before any movement is authorised on the main line.

(i) The track warrant held by the train berthed in the siding must be cancelled.

(ii) The Locomotive Engineer of the train berthed in the siding must certify to Train Control that the main line points are secured in the normal position and he will not again foul the main line, or operate the main line points, until authorised to do so by subsequent track warrant.

(d) Track warrants issued to trains running through on the main line while the train is locked in a siding must contain advice of the train in the siding.

14. Clearing Signals for Trains—A signal must not be set at "Proceed" for any movement which requires the authority of a track warrant until the track warrant has been issued. This does not apply to signals at stations which are switched Out.

15. Clearing Two Position Home or Outer Home Signals For Trains Not Timed to Stop—

(a) When the train is not required to stop at the station—the Home signal and, where provided, the Outer Home signal must not be placed at "Proceed" unless the line ahead is dear for the train to proceed and, where provided, the Starting signal is also at "Proceed". Where Starting signals are not provided, a clear hand signal must be given from the platform in addition to placing the Home Signal at "Proceed" unless the station is switched Out.

(b) When for any reason it is necessary to stop the train at the Station—the Home signal and, where provided the Outer Home signal must be kept at "Stop" until the train has been brought to a stand or almost so. The Signalman may then place these signals at "Proceed" for the train to move ahead, provided that—

(i) **Where a Starting signal is provided**—it is at "Stop" and the line is clear to the next fixed signal in advance applicable to the train.

(ii) **Where a Starting signal is not provided**—The line is dear within station limits. After the signal has been placed at "Proceed", the train must move cautiously into the station.

16. Train Detained at a Fixed Signal—The Locomotive Engineer must advise Train Control that the train is standing at the signal.

17. Passing of Signals at "Stop"—

(a) Signals Controlled by a Signalman—Any signal may be passed at "Stop" on receipt of verbal or written instructions from, or the exhibition of proper hand signals by the Signalman who controls that signal. The Signalman must not give such verbal or written instructions or hand signal when a fixed signal can properly be used for the movement.

(b) Signals at a Station Which is Switched Out—Train Control may verbally authorise the passing of any signal at "Stop" after ensuring that the station is switched Out. Before the movement passes over any points at the station, the addressee must ensure that the points are so secured that the movement may pass safely over therm.

(c) The permission to pass a signal at "Stop" must be given only when the train or other movement is stopped at the signal concerned.

17. *continued*

(d) Train Stopped at Intermediate Stop and Proceed Signal—

(i) When a Locomotive Engineer observes a Stop and Proceed signal at "Stop" he must stop the train, if, at the expiration of 10 seconds, the signal is still at "Stop" the train may proceed cautiously in accordance with the conditions of the Track Warrant, the Locomotive Engineer being prepared to find the line ahead to the next fixed signal occupied or obstructed, displaced rail, or points wrongly set.

Where there are main-line points on the line ahead of a Stop and Proceed Signal which has been passed at "Stop" the Locomotive Engineer must examine the points to see they are correctly set and secured so that the train may pass over them.

(ii) After passing a Stop and Proceed signal at "Stop" the Locomotive Engineer must regulate the speed of the train so that it can be stopped within the distance he can see ahead and clear of any obstruction.

Level crossings on the line ahead equipped with automatic warning devices must also be approached with caution as they may not operate correctly.

18. Switch out Interlocked Stations—

(a) When the station is switched Out, the main line signals will either clear automatically for the passage of each train or be locked at "Proceed".

(b) Permission must be obtained from Train Control before a station is switched In or switched Out. Train Control must be advised when this has been accomplished.

19. Suspension of Signalling at Certain Stations—

(a) Where provided in the Working Timetable or Train Advice the use of fixed signals for specified trains at certain stations may be suspended in accordance with this Regulation.

(b) Officer in charge to Certify Line Secure—The Officer in Charge, at each station at which signalling is suspended for any train must certify by T.R. telegram to Train Control after departure of the last Signalled train that—

(i) The train line points have been examined personally and are locked in the normal position;

(ii) The keys (where provided) are secured in their appointed place;

(iii) Everything is safe for the passage of trains through the station.

A certificate to this effect must be given by the code word "Security" followed by the times during which signalling will be suspended (e.g. 'Security 1500 hrs Tues to 0600 his Wed'). After having dispatched a security telegram the Officer in Charge must not again operate the main line points without the verbal permission of Train Control.

(c) The lights of fixed signals at stations where signalling is suspended must, unless otherwise authorised in the Working Timetable, be extinguished for the passage of the train. The Locomotive Engineer may pass these fixed signals unless there is a fixed signal light or a danger hand signal against him.

(d) If the Train Control Officer does not receive the required "Security" telegram, he may issue the track warrant which must include instructions for the Locomotive Engineer to examine the points before passing over them at the station in respect of which the "Security" telegram was not received, and to take such other measures as may be necessary in the circumstances.

19. *continued*

(e) Speed over Facing Points—Locomotive Engineers of trains authorised to run without being signalled, must reduce the speed of their trains to 15 kilometres per hour while passing over facing points at stations through which the trains are authorised to pass without being signalled, and must be alert for signals when approaching stations.

(f) Stopping a Non-signalled Train—If it should become necessary to stop a train authorised to run without being signalled, and the Locomotive Engineer cannot be previously advised, hand signals must be exhibited in addition to the fixed signals, where provided in addition, two detonators, 10 metres apart, must be placed on each rail at sufficient distance from the signal to warn the Locomotive Engineer to be on the alert for a signal indication. At night, fixed signal lamps must be lighted.

(g) Shunting When Staff Off Duty—Where shunting is necessary when staff are not on duty, and special locked boxes are provided, the Officer in Charge, before going off duty, must place the necessary points key or keys in the special locked box provided. The Locomotive Engineer or other member must obtain the key from the box and replace it after the shunting movement has been completed.

(h) Trains Shunting at Stations at Which Signalling is Suspended—Where a train, which is authorised to run without being signalled at certain stations, carries out movements which involve the operation of the main line points at any of the stations concerned, the Locomotive Engineer of the train must, after such movements are completed and the main line points have been restored to the normal position and locked, the keys have been replaced in the appointed place, and everything is again safe for the passage of trains through the station, certify accordingly to Train Control. The certificate must be given from the station concerned (or from such other place as may be arranged by Train Control) using the code word "Security" followed by the name of the station, the Locomotive Engineer's signature and the train number (e.g. "Security Inglewood . . . Locomotive Engineer No. 572").

20. Reserved for future use.

21. Train Divided—

(a) Accidental—

When a train has been accidentally divided and both portions have come to a stop within sight of each other, and a signal box does not intervene, the front portion may be signalled back to the rear portion, provided the two portions can be effectively coupled. If there is a locomotive assisting in the rear of the train the permission of the Locomotive Engineer of that locomotive must be obtained.

Should the rear portion not be in sight a member of the train crew must proceed back and, once the whereabouts of the rear portion has been established the front of the train can then be moved back provided the two portions can be effectively coupled.

21. Train Divided—*continued*

(b) Planned—

When a train is carrying out maintenance work and it is necessary, because of the nature of the work to divide the train then, after the rear portion has been adequately secured, the front portion of the train can be moved forward to carry out the required work. Once this has been completed the front portion must return to the remainder of the train and be recoupled.

(c) Brake Test—

Each time the train is recoupled an intermediate brake test must be carried out before proceeding.

22. Train Stopped by Accident, Failure, or Obstruction on Line—

(a) When an accident, failure, or obstruction of any kind occurs on any part of the line—

(i) Measures must be taken to ensure immediate safety.

(ii) *Train Staff to Confer*—A Locomotive Engineer, after taking such steps as may be necessary for the safety of the train, must immediately communicate with Train Control and come to an understanding as to the direction from which assistance is to be obtained and the measures to be adopted to meet the situation.

(iii) *Prompt Advice to be Given*—Particulars must be promptly reported to Train Control by the most expeditious means available. Train Control must advise the Officer Controlling Train-running who will in turn advise the appropriate officers concerned, and those stations where the starting or crossing of other trains is liable to be affected by the delay.

(iv) *Responsibility for Clearing Line*—The Ganger, or senior Track and Structures staff member will take charge of the operations for clearing the line. The lifting and placing of rolling stock on the line must be done to the satisfaction of the senior member of the Mechanical staff or Locomotive Engineer if no such member is present at the obstruction.

(v) *Ascertaining Cause of Accident*—Particular care must be taken by all employees to note any facts which appear to explain the cause of the accident, such as the state of the track, condition and position of the rolling stock, time of accident, speed of train, distribution of load, etc., and the attention of the responsible member at the obstruction must be called to any facts which may be observed.

(vi) *Warning Staff Affected of Unusual Movements*—When it is intended for any unusual movement to take place all employees working in the vicinity and likely to be affected must be informed.

(b) Train Disabled—

When a train becomes disabled the Locomotive Engineer must immediately advise particulars to Train Control who in turn will arrange for a relief locomotive to assist the disabled train from the section. A new track warrant must be issued instructing the disabled train to remain where it is disabled until arrival of the relief locomotive. A member of the crew of the disabled train must then proceed in the direction from which the relief locomotive is to approach and at 200 metres from the disabled train place two detonators on each rail 10 metres apart; should a fixed signal intervene then the detonators may be placed on the line at the signal. From this point the crew member of the disabled train can pilot the relief locomotive to the disabled train.

22.(b) Train Divided—*continued*

The track warrant which authorises the relief locomotive to enter the part of the line where the train is disabled will advise the Locomotive Engineer of the relief locomotive the location of the disabled train and the method to be adopted for its removal.

(c) Train Divided or Stalled: Protection of Rear Portion—When a train is divided or stalled owing to an accident or the inability of the locomotive to take the whole of the train forward, and the locomotive has to take forward a portion of the train and return for the remainder, the following procedure must be adopted:

(i) The Locomotive Engineer must arrange for the rear portion of the train to be secured.

(ii) A member of the train crew must uncouple the portion that is to be taken forward and hand signal the Locomotive Engineer to move this portion forward approximately 200 metres. Two detonators must be placed 10 metres apart, on each rail at a distance of about 200 metres from the front vehicle of the rear portion to warn the Locomotive Engineer, when returning, of the position of the remainder of the train.

The Locomotive Engineer must be advised the class and number of the rear vehicle on the front portion. Upon arrival at the first station the Locomotive Engineer must satisfy himself that the front portion is complete before returning for the rear portion of the train.

(iii) *Display of Tail Lamp*—A tail lamp must not be carried on the locomotive or last vehicle of the front portion of the train while in a Track Warrant Control area. If the locomotive or front portion of the train has to pass out of a Track Warrant Control area a tail lamp must then be placed on the rear.

Appendix 3
Waipahi-Clinton S and I Circular