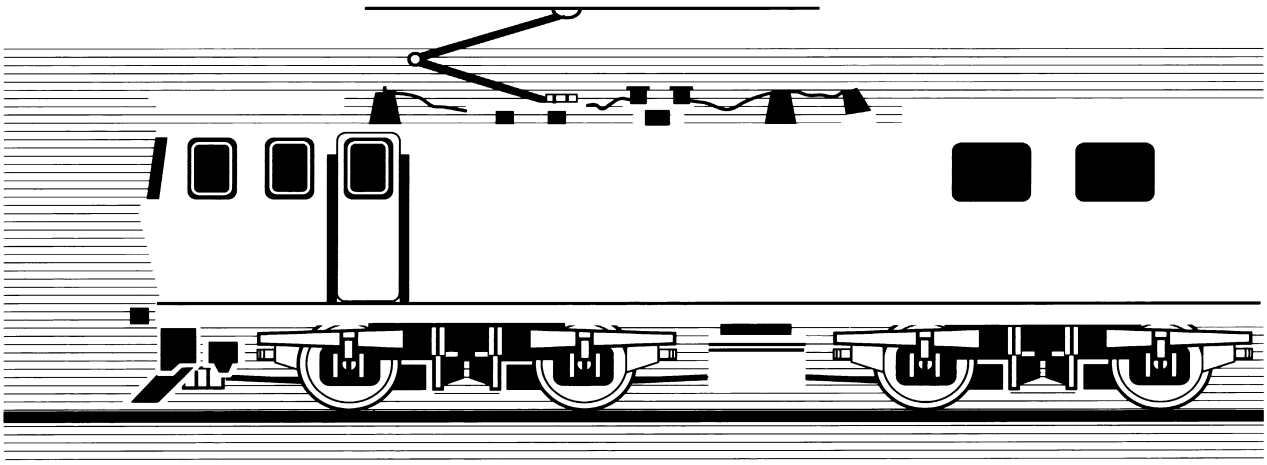
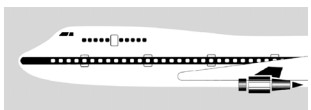
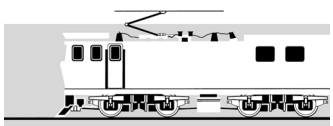


RAILWAY OCCURRENCE REPORT

02-116 **express freight Train 533, derailment, near Te Wera** **26 July 2002**


TRANSPORT ACCIDENT INVESTIGATION COMMISSION
NEW ZEALAND

The Transport Accident Investigation Commission is an independent Crown entity established to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. Accordingly it is inappropriate that reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

The Commission may make recommendations to improve transport safety. The cost of implementing any recommendation must always be balanced against its benefits. Such analysis is a matter for the regulator and the industry.

Report 02-116

express freight Train 533

derailment

near Te Wera

26 July 2002

Abstract

On Friday, 26 July 2002, at about 0150, Train 533, a westbound express freight, derailed as it negotiated a 45 km/h speed restricted curve after descending a 1 in 51 gradient between Whangamomona and Te Wera. The train plunged about 12 m down the side of the track formation killing the locomotive engineer. A second crew member sustained serious injuries.

The 2 locomotives and several wagons on the train were extensively damaged, but the track sustained minor damage only.

Causal factors included:

- the locomotive crew's loss of attention and situational awareness consistent with their having fallen asleep
- consuming alcohol prior to commencing duty
- the accepted non-compliance with track warrant instructions
- the inability of the locomotive vigilance system to overcome such short-term attention deficits in time to prevent this type of accident.

Safety recommendations have been made to address these issues.

Train 533 after derailment
(courtesy Taranaki Daily News)

Contents

Figures

Abbreviations

ATC	alternative train crewing
CTC	centralised traffic control
CTM	Connex Trains Melbourne
EAPA	Employee Assistance Professional Association
ESR	Institute of Environmental Science and Research Ltd
HRV	hi-rail vehicle
km	kilometre(s)
km/h	kilometres per hour
kPa	kilopascals
LINZ	Land Information New Zealand
m	metre(s)
POD	point of derailment
QR	Queensland Rail
RMTU	Rail and Maritime Transport Union Inc
SH43	State Highway 43
SOL	Stratford – Okahukura Line
t	tonne(s)
Tranz Rail	Tranz Rail Limited
TWC	track warrant control
UTC	coordinated universal time
VDU	visual display unit
VHF	very high frequency

Data Summary

Train type and number:	express freight Train 533
Date and time:	26 July 2002 at about 0150[1]
Location:	44.43 km, near Te Wera, on the Stratford – Okahukura Line
Persons on board:	crew: 2 passengers: nil
Injuries:	crew: 1 fatal 1 serious
Damage:	both locomotives and several wagons extensively damaged
Operator:	Tranz Rail Limited (Tranz Rail)
Investigator-in-charge:	D L Bevin

[1] All times in this report are New Zealand Standard Time (UTC+12) and are expressed in the 24-hour mode.

1 Factual Information

1.1 Narrative

1.1.1 On Friday 26 July 2002, Train 533 was a westbound express freight train travelling from Auckland to New Plymouth and consisted of a DX locomotive and a DC locomotive in multiple and 30 wagons for a total gross tonnage of 590 t and a length of 537 m. The train was crewed by a locomotive engineer who was assisted by a rail operator.

1.1.2 The crew had taken over the running of Train 533 at Okahukura on Thursday 25 July 2002 at about 2330, after having taken Train 524, a New Plymouth to Auckland express freight train, from Stratford to Okahukura. They departed from Okahukura at about 2355 on their return journey to Stratford.

1.1.3 At about 0147 on Friday 26 July 2002 Train 533 emerged at about 45 km/h from the western portal of Tunnel 2 between Whangamomona and Te Wera and increased speed as it descended a 1 in 51 gradient towards a 45 km/h, speed restricted left-hand curve, which it entered at about 70 km/h. The train had negotiated about 300 m of the curve when the locomotives left the track, became airborne and plunged about 12 m down the side of the track formation.

1.1.4 The cab of DX5045, the leading locomotive, was crushed by the impact as it rolled on to its side and dug into the mud near a creek, which flowed alongside the track formation. The trailing locomotive, DC4657, turned 180 degrees as it slid down the side of the track formation and came to rest almost alongside DX 5045.

1.1.5 The locomotive engineer died as a result of injuries sustained in the crash and the rail operator was seriously injured.

1.1.6 The rail operator remembered that the weather had been clear during the trip from Stratford to Okahukura on Train 524, but they had encountered patches of fog during the return trip on Train 533.

1.2 Site details

1.2.1 The Stratford - Okahukura Line (SOL) branched off the Marton to New Plymouth Line at Stratford and ran for 143.3 kms through remote and isolated country to Okahukura, where it joined the North Island Main Trunk (see Figure 1).

1.2.2 State Highway 43 (SH43) ran alongside or close to the track at various places but it was lightly used and access to much of the rail route by road was not possible.

1.2.3 Kilometrage on the SOL was designated from Stratford (0.00 km) to Okahukura (143.3 km). The maximum line speed between Stratford and 68.5 km was 70 km/h and on the remaining 74.8 km to Okahukura was 50 km/h (see Figure 1).

1.2.4 Because of the geography and number of tunnels on the SOL, radio coverage on the route was not continuous and so did not meet Alternative Train Crewing (ATC) standards for single-person crewing. Therefore, under Tranz Rail's crewing standard, trains operating on the SOL required a two-person crew.

1.2.5 The derailment occurred as the train was rounding a 150 m radius, 45 km/h left-hand curve in the direction of travel (westbound) at the 44.43 km between Whangamomona and Te Wera. The curve was approached down a 300 m long, 1 in 51 gradient, after exiting Tunnel 2.

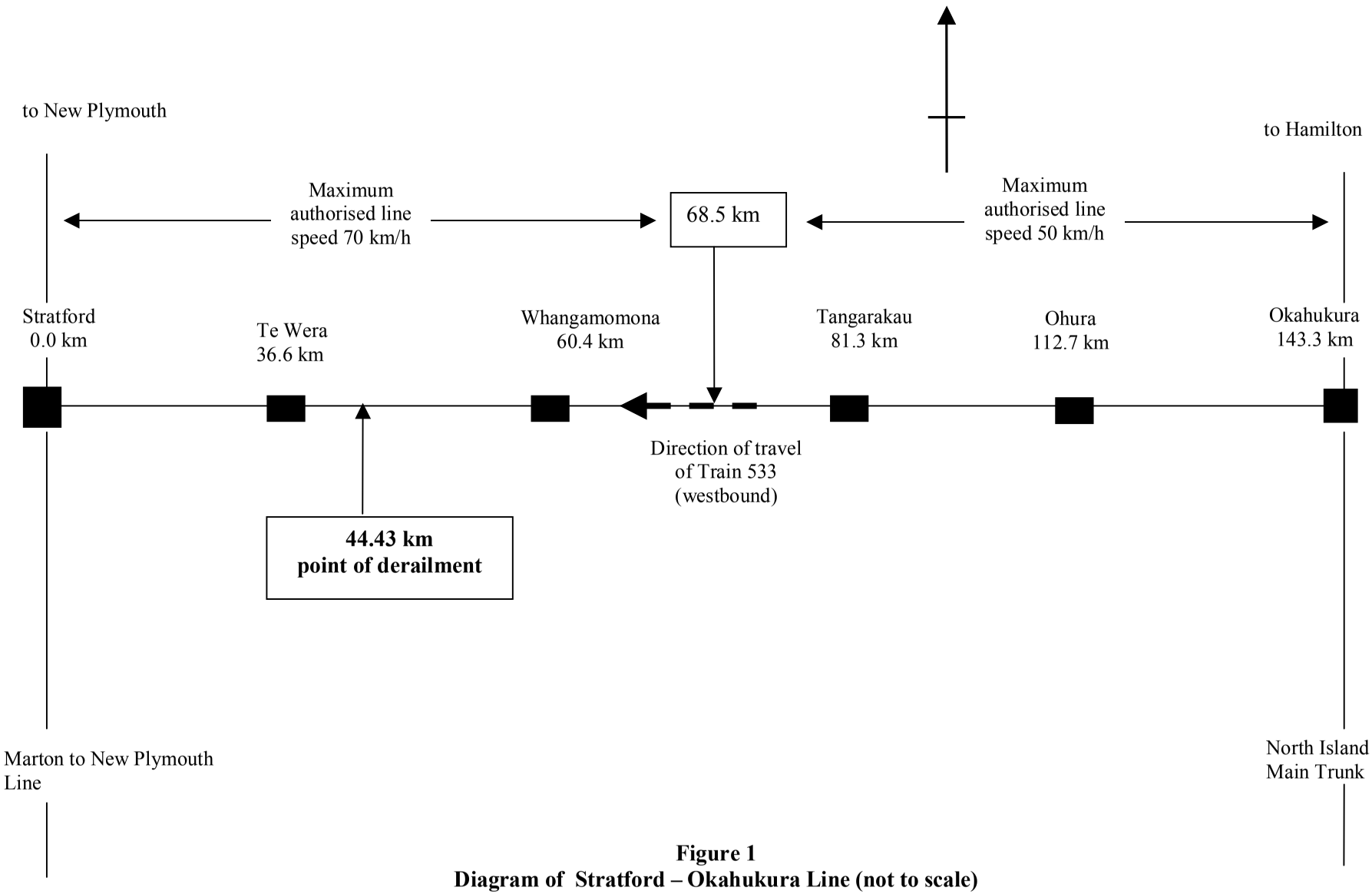


Figure 1
Diagram of Stratford – Okahukura Line (not to scale)

1.2.6 The track formed a 400 m radius, 70 km/h, right-hand curve and straightened for about 40 m before it entered the reverse 160 m radius, 45km/h, left-hand curve on which the train derailed.

1.2.7 The locomotives derailed to the outside (right) of the curve in the direction of travel. Three empty flat deck wagons followed the locomotives down the side of the track formation while another 4 empty flat deck wagons derailed at various angles to the track formation (see Figure 2), the front of one wagon coming to rest about 1 m across adjacent SH43.

Figure 2
The derailment site looking east (courtesy Taranaki Daily News)

1.2.8 To warn locomotive engineers of the upcoming restricted speed curve, a 45 km/h curve warning board[2] was positioned 2.63 m from centre line of track, and 266 m before the start of the curve (see Figure 3). A 45 km/h curve board[3] was positioned 3.35 m from centre line of track and 39 m before the start of the curve (see figure 4). The boards were 574 m and 347 m respectively before the point of derailment (POD), were in good condition, clearly visible and positioned in accordance with Tranz Rail's Engineering Rules 911 (b) and (c).

1.2.9 The nominal overturning speed of a locomotive on the curve was about 75 km/h, close to the 70 km/h maximum authorised line speed for trains for that section of the line, and the curve could be considered a "speed trap."[4]

[2] Curve warning boards were erected to indicate a reduction in speed of more than 15 km/h on a curve ahead. They had a yellow background and were erected at least 200 m from the entrance to the curve to which they referred.
[3] Curve boards were rectangular in shape and had a white background. They were erected near the entrance to the curve to which they applied.
[4] Isolated railway curves were referred to as "speed traps" if they could not be negotiated at the maximum line speed for adjacent sections of line without risk of overturning or wheel flange climbing. Most of such curves had been eliminated from principal routes but some remained on secondary routes such as the SOL.

Figure 3
The 45 km/h curve warning board to the left of the 45 km metrage peg

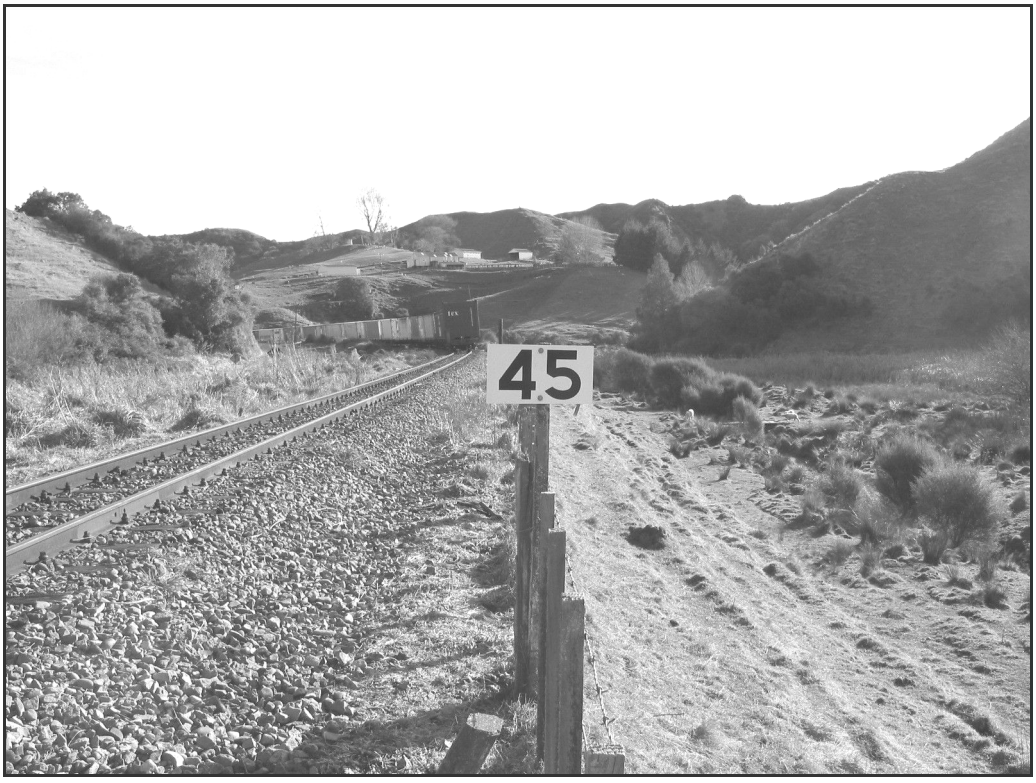


Figure 4
The 45 km/h curve board

1.2.10 The POD was determined as the point where the flange of the wheel of the first axle that derailed started to mount the head of the rail. The position was identified by marks on the rail head near a bolted rail joint (see Figure 5), which indicated that a right-hand wheel flange had started to climb against the gauge side[5] of the high leg rail[6] and had then travelled about 1.2 m along the rail head before dropping off the track.

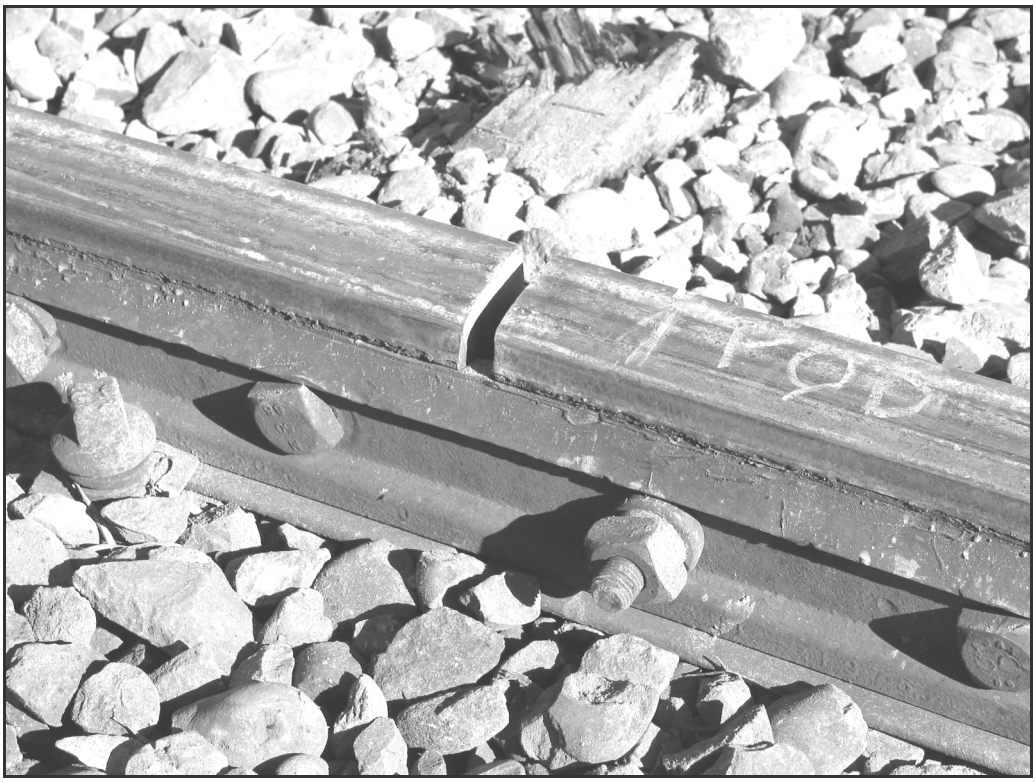


Figure 5
The marks at the point of derailment

1.2.11 About 13 m beyond the POD, 1.1 m of the gauge side of the high leg rail and along the head of the rail was heavily scored (see Figure 6). This scoring indicated where the flanges of either the leading left-hand wheel of the front axle or the left hand wheels of the leading bogie of DX5045 had climbed on to the head of the rail and travelled to the drop off point. The high leg rail was fractured near the end of the scoring (see Figure 7).

[5] The gauge side is the inner side of the rail and is in contact with the wheel flange.
[6] The high leg rail is the outside rail of the curve.

Figure 6
The heavy scoring on the gauge side of the high leg rail

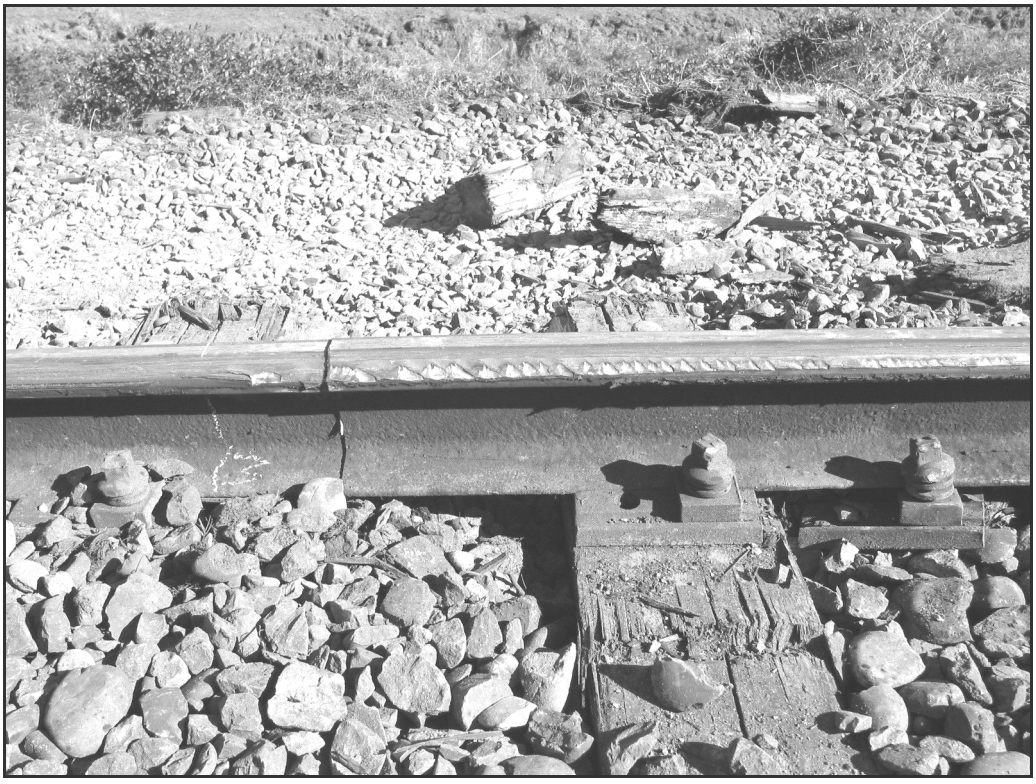


Figure 7
The fractured high leg rail with the heavy scoring visible

1.2.12 The track evaluation car had last travelled through the area on 12 June 2002 and although some minor track defects had been identified at that time these had all been rectified prior to the accident.

Analysis 1

1. Although the curve warning board and the curve board were correctly positioned, in good condition and free of any obstructions, the presence of any fog would have reduced the distance from which they could be seen. However, under normal circumstances the locomotive engineer's situational awareness and route knowledge would have alerted him to their presence and that of the approaching 45 km/h curve to which they referred.

2. No track defects were identified which could have contributed to the derailment. Most of the damage to the track occurred near and immediately beyond the POD, and was probably caused by the locomotives as they derailed.

3. The 45 km/h, 160 m left-hand curve at the POD was a "speed trap" because of its isolation, sharp radius and location in a section where the maximum authorised line speed was 70 km/h. A westbound train travelling at a line speed of 70 km/h and exiting the 400 m curve was required to decelerate to 45 km/h to negotiate the 150 m curve where the train derailed. If the train was not under proper control and did not decelerate sufficiently, or was allowed to accelerate, then the risk of derailment increased with the speed. An independent track engineer estimated that the speed at which a locomotive would derail through a 150 m radius curve was about 75 km/h.

1.3 Locomotive crew

The locomotive engineer

1.3.1 The locomotive engineer commenced his employment as a locomotive trainee in 1984 and was appointed locomotive engineer in 1988. He was a certified grade 1 locomotive engineer and held current certification for the duties he was performing.

1.3.2 He was in good health and was not known to be suffering from any home or work-related stress.

1.3.3 The locomotive engineer attended a Tranz Rail alertness management course in December 2001.

The rail operator

1.3.4 The rail operator had been employed by Tranz Rail for just over 2 years, all as a rail operator.

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

1.3.6 The duties of the rail operator included:

- The coupling of the locomotive to the train at the starting station and at stations where the locomotive was uncoupled
- calling and repeating of signal indications with the locomotive engineer
- remaining vigilant at all times.

1.3.7 If a locomotive engineer became incapacitated while driving the train, the rail operator was trained to stop the train and report the circumstances to train control but was not certified to drive the train. Tranz Rail did not consider the presence of a rail operator in the cab to be an opportunity for potential locomotive engineer driver training.

1.3.8 The rail operator was not training to become a locomotive engineer. Such training included theoretical, simulation and practical elements and was conducted in a comprehensive Tranz Rail programme before trainees undertook on-the-job training.

1.4 The locomotive engineer's activities on Thursday 25 July

1.4.1 The locomotive engineer finished a shift of 9 hours duration at Stratford at 0310 on Thursday 25 July after which he went home to sleep.

1.4.2 The locomotive engineer had been working on a car and had wanted to continue this on Thursday. The car was stored in a work colleague's garage, about 12 minutes driving time from the locomotive engineer's home.

1.4.3 The work colleague had been on the 0400 - 1000 shift on Thursday 25 July and said that the locomotive engineer had telephoned him at work and arranged to come around that afternoon to work on the car.

1.4.4 The work colleague recalled that the locomotive engineer had arrived at about 1300 and had worked on the car until about 1500, during which time they had "each consumed a couple of cans of beer". They also had a cup of coffee before the locomotive engineer left to return home. He said that at that time he considered that the locomotive engineer was okay and looked normal.

1.4.5 The locomotive engineer's colleague did not respond to written questions seeking confirmation of several points, including:

- that the locomotive engineer had telephoned him in the morning
- the time the locomotive engineer arrived at his house
- the amount of alcohol consumed
- the time that the locomotive engineer left to return home.

1.4.6 Records obtained from Telecom New Zealand Limited showed that no telephone calls were made from the locomotive engineer's residence between the hours of 0800 and 1200 on 25 July, but a call was made from Tranz Rail's terminal in Stratford to the residence of the locomotive engineer at 0933 on that day.

1.4.7 The locomotive engineer's wife said that when she returned from work at about 1600 he was at home and remained there until he left for work at about 1900. He planned to buy a Chinese take-away meal on his way to work and eat it before he started his shift. She said "he had left for work, just like starting any other night shift. He was no different". To her, there had not appeared to be anything on his mind and she considered he "was in a fit and proper state to start his shift when he left home." Their home was about 9 kms, about 6 minutes driving time, from the Stratford terminal where he commenced his shifts.

1.4.8 The rail operator said that he purchased fish and chips on the way to work and had arrived at work with them about 5 minutes before the locomotive engineer arrived carrying his meal. They decided to eat before starting duty and watched television while they did.

1.4.9 The rail operator said he had no doubts about the locomotive engineer's fitness for duty, he appeared to be "normal, the same happy self" when he commenced duty. He later said that he had been unaware that the locomotive engineer had been drinking prior to commencing work

until his blood alcohol levels had been disclosed to him during a separate investigation into the accident.

1.4.10 The locomotive engineer team leader, the locomotive engineer's immediate supervisor, had been in the office earlier in the evening on that day before he finished duty. He said that at about 1900 he had received a telephone call from the locomotive engineer at his home who said that he was just getting his gear together and wanted to know who was to be his shift mate as there had been a roster change owing to an injury to the person originally rostered for the job.

1.4.11 The team leader said that the locomotive engineer had been a reliable employee and he had never seen him under the influence of alcohol.

1.5 Alcohol consumption

1.5.1 Tranz Rail's Rules stated that staff were unfit for duty if they were under the influence of alcohol or drugs.

1.5.2 Post mortem toxicology indicated a blood alcohol level in the locomotive engineer at the time of death of about 14 mg/100ml of blood.

1.5.3 Because of conflicting reports it was not possible to determine the exact amount of alcohol the locomotive engineer had consumed prior to commencing duty, nor where he had consumed it. Consumption while on duty was discounted by the reports of the rail operator and the fact that no evidence of alcohol consumption was found in the locomotive cab either after the accident or during salvage operations.

1.5.4 The locomotive engineer's movements between leaving his colleague's residence and arriving home were not able to be established.

1.5.5 Toxicology advice was taken on the locomotive engineer's blood alcohol level as predicted by regression from the sample obtained following the accident. Based on the assumptions of the range of alcohol deactivation rates in humans, and that no alcohol had been consumed once he commenced duty, the following information relating to the locomotive engineer was obtained:

- when he took over the driving of Train 533 at about 2330 at Okahukura he was in the 30 – 50 mg/100ml of blood range
- when he commenced his shift at 1930 at Stratford he was in the 80 –150 mg/100ml of blood range
- when he left home at about 1900 to travel to work he was in the 90 – 160 mg/100ml of blood range
- when he left his colleague's house at 1500, presumably to return home, he was in the 130 – 230 mg/100ml of blood range.

1.5.6 The legally permitted limit of blood alcohol level for motor vehicle drivers was 80 mg/100ml.

1.6 Medical and pathological information

1.6.1 The locomotive plunged down the side of the track formation and came to rest some distance from where it left the tracks. The deceleration forces were considerable and the cab was crushed in the impact. Both members of the crew were trapped by mud, which entered the wreckage during the impact sequence. However, there was no evidence that any measures would have improved the survivability of the accident.

1.6.2 The locomotive engineer died from multiple injuries sustained during impact. There was no evidence of any health condition likely to cause performance impairment, sudden incapacitation or consequential sleep / alertness disorder.

1.6.3 The rail operator sustained serious injuries from the major deceleration forces experienced during impact and the resulting loss of structural integrity of the locomotive cab but his injuries were survivable.

1.6.4 The locomotive engineer's blood was analysed for the presence of medicinal drugs, which may affect the mind, alter mood or cause sleep but no such drugs were detected. The blood was also screened for evidence of the use of amphetamine type drugs and opiate type drugs such as morphine, heroin and cannabis. There was no evidence of the use of amphetamine or opiate type drugs.

1.6.5 The screening test indicated the possible use of cannabis so a more definitive test was carried out. This test showed that no Tetrahydrocannabinol (THC), the active ingredient of cannabis, was present in the blood sample.

Analysis 2

1. A telephone call was made from the Tranz Rail terminal to the locomotive engineer's residence at 0933 on Thursday 25 July. Although the caller could not be positively identified, it was likely to have been the locomotive engineer's colleague calling to advise that he had finished work and was going home. If the locomotive engineer was not already awake at this time the telephone call would have woken him. After the conversation it is likely that the locomotive engineer travelled to his colleague's house, probably arriving between 1015 and 1030.

2. Assuming that no alcohol had been consumed by the locomotive engineer during his shift, the results of the toxicology tests indicated that he had consumed sufficient alcohol by the time he drove home to have been about twice the legally permitted threshold for motor vehicle drivers, and at least one-and-a-half times the legal threshold when he drove to work at 1900.

3. If, as his colleague maintained, the locomotive engineer had consumed a "couple of cans" only up until he left to go home and, if he had not stopped en route to consume more alcohol, he would probably not have been over the legal threshold for driving his car. The resulting level at 1500 would have been further reduced by 1930 when he commenced his shift and probably would have been undetectable in samples taken following the accident. This scenario was supported by the statements of his colleague, his wife, and the rail operator regarding his condition at various stages of the day although it conflicted with the extrapolation of results from the toxicology tests following the accident.

4. If the locomotive engineer had consumed "a couple of cans" only before leaving his colleague's house, but had stopped on the way home to consume more alcohol, he would have had to consume a significant amount to bring his blood alcohol level up to about 170 mg/100mls blood as extrapolated to that time. While this scenario supports his colleague's statement about drinking a "couple of cans", the locomotive engineer reportedly had less than an hour between leaving his colleague's residence and arriving at home. Given the small amount of time, this scenario seems most unlikely. Based on his wife's statement, it was also unlikely that he consumed additional alcohol during the 3 hours between arriving home and leaving again for work.

5. The witness statements regarding the appearance of the locomotive engineer prior to commencing his shift were consistent with each other but not consistent with the later toxicological results. It is doubtful that the locomotive engineer could have consumed as much alcohol as the toxicology report indicated without showing some visible signs of intoxication. Despite that, 3 people who had been with him prior to his starting work stated that he was not showing any effects of alcohol. Toxicology confirmed that the blood alcohol level of the locomotive engineer at the time of the accident

meant that he was probably under the influence of alcohol when he commenced his shift in Stratford.

6. Although the screening test indicated the possible use of cannabis by the locomotive engineer, no THC was detected in his blood sample. The screening test result may have been a false positive result or may have been due to non-recent use of cannabis. If the result was because of past use of the drug, he would not have been affected by it at the time of the accident.

1.7 Train 524

1.7.1 The locomotive engineer and rail operator were rostered to crew Train 524 from Stratford to Okahukura, where they were to change on to Train 533 and return to Stratford. The rail operator's roster had been changed, with his knowledge, to cover a vacancy created by an injury to the staff member originally rostered for the shift.

1.7.2 The rail operator said that the locomotive engineer invited him to drive Train 524 from Stratford to Okahukura and, although he was not certified to do so, he had accepted. He said that this was the first time this particular locomotive engineer had offered to let him drive although he had worked with him on many occasions. He had driven the route before while accompanying "5 or 6 other drivers" and assumed that the locomotive engineer had offered him the opportunity that evening because the locomotive engineer knew he could drive and he was keen to do so. He had been asked by the locomotive engineer to make the en route radio check calls with train control but he had declined.

1.7.3 The trip to Okahukura was uneventful. The rail operator said that he had conversed with the locomotive engineer much of the time, although he thought the locomotive engineer might have slept for part of the journey. On arrival at Okahukura they changed on to Train 533 and the locomotive engineer took over the driving duties.

1.7.4 Although the rail operator had driven Train 524 from Stratford to Okahukura, the locomotive engineer was still responsible for its operation.

1.7.5 The locomotive engineer team leader said he had been unaware of any instances of rail operators being allowed to drive by other locomotive engineers in Stratford prior to the accident but since then another locomotive engineer had admitted that he had allowed this practice but had stopped on the instructions of the team leader.

1.8 Train 533

1.8.1 After the locomotive engineer received a track warrant from train control authorising him to travel to Stratford, Train 533 departed from Okahukura at about 2353.

1.8.2 The track warrant contained a clause 10 check call[7] at Te Wera. The rail operator said he thought the train controller decided as to where he wanted check calls en route and it was usual to only have Te Wera specified. When he had first started working with Tranz Rail there had been 2 check calls, but that had subsequently reduced to one only.

1.8.3 The rail operator said that the locomotive engineer told him he could sleep on the way back to Stratford but he had tried to stay awake. However, he became tired and dozed off at various times during the journey. The heater was on and the cab was warm, which he felt may have encouraged his drowsiness. He remembered passing through Whangamomona but did not remember anything else until he was woken by a violent movement of the locomotive. He

[7] Clause 10 of a track warrant specified locations where it was necessary for the locomotive engineer to contact train control to confirm the whereabouts of the train. This information could also be used to determine that a train had cleared its limits sufficiently to allow a following movement to be authorised.

recalled that when he woke, he thought the train was travelling fairly fast but because he was a bit groggy and the night was foggy he could not estimate the speed.

1.8.4 The rail operator heard the locomotive engineer make a brief exclamation before the brakes were applied. However, before the brakes had time to respond the locomotive became airborne and he said that "everything else was a blur" until the locomotive stopped. He realised that his head was poking out of the cab window but his body was pinned within the confines of the crushed cab.

1.8.5 From his position trapped in the cab, the rail operator later heard radio calls from train control on the radio in DC4657, which was close by, but he was unable to respond to them. At about 0400 he heard on the radio that a ganger was coming by rail from Okahukura to search for them and a short time later he heard a locomotive engineer in Stratford advising train control that a search team was going by car to look for Train 533.

1.8.6 The Stratford search team found the derailed train at about 0548 but the rail operator was not freed from the cab until about 0910, more than 7 hours after the derailment. He was treated at the site by medical staff before he was transferred by helicopter to hospital.

1.8.7 The rail operator said that it would be unusual for an experienced driver to be going as fast as he was and not put the brakes on until right on the curve. The only reason he could see for this happening was that the locomotive engineer had been asleep immediately before the accident.

Analysis 3

1. The locomotive engineer might have realised that he was not fit to drive the train initially and that was why he had telephoned the terminal to find out who was rostered to accompany him on the shift. Once he knew who it was, he realised that the rail operator was capable of driving the train to Okahukura, thereby giving him a chance to recover.

2. The rail operator was not certified as a locomotive engineer, nor was he a trainee locomotive engineer so was not qualified to drive Train 524. Although he demonstrated his ability to drive, his actions in this regard did not contribute directly to the later accident. However, even though the rail operator drove the train, responsibility for its operation rested with the locomotive engineer and there were doubts as to his capability in this regard, especially during the early part of the shift.

3. Although the locomotive engineer had often worked with the rail operator and was aware of his ability to drive a train, this was the first time that he had offered the rail operator an opportunity to drive and his doing so was out of character. Even though he had not personally seen the rail operator drive he still allowed him to do so.

4. The locomotive engineer had probably asked the rail operator to also make the radio check calls with train control on the outward trip in the hope that he could get some extended uninterrupted sleep. The rail operator had declined, probably because he was aware that the train controllers might have realised that the voice was not that of the locomotive engineer.

5. An alternative scenario for the rail operator driving Train 524 was that he realised that the locomotive engineer was not fit to drive and actually offered to drive, an offer which might have been gratefully accepted by the locomotive engineer for obvious reasons. However, the difference in service and roles between the locomotive engineer and the rail operator would have meant that an authority gradient was established, even unconsciously, which may have made the rail operator feel uncomfortable making such an offer, and this scenario has been discarded.

6. The rail operator could have refused to travel with the locomotive engineer, which would have resulted in the calling out of either another locomotive engineer or rail operator, and the possibility of a company internal inquiry. Given the small community in which he lived and worked, to do so would probably have created significant conflicts in both his work and social environments. Therefore, it is not surprising that he opted not to take this course, even if he had considered it. In this context he might have felt that, as he was capable of driving the train, he could monitor the locomotive engineer's performance and cover for him if necessary. Unfortunately, he probably did not consider the possible consequences of himself falling asleep.

7. The rail operator's duties required that he remain vigilant at all times while riding in the locomotive cab so there was a responsibility and an expectation on him to remain awake. The warm cab conditions, the gentle rocking of the locomotive and the resulting fatigue from the concentration required for an inexperienced and unqualified train driver over a demanding route, meant it was not surprising that, despite his best endeavours, he eventually succumbed to sleep.

8. The lurch that woke the rail operator and the locomotive engineer probably occurred as the locomotive entered the 150 m radius curve at excessive speed. Train 533 was at that time travelling at about 70 km/h, which was consistent with the POD being 300 m into the curve.

9. Tranz Rail's alertness management programme was directed at locomotive engineers yet there were many other staff who worked regular night shifts in high risk, safety critical operational areas and who could have benefited from such a course. A safety recommendation covering the introduction of an alertness management course to include all such staff and their families has been made to the Managing Director of Tranz Rail.

10. The locomotive team leader was unaware of the practice of the locomotive engineers in Stratford allowing rail operators to drive trains. It would be unlikely to happen while he was travelling in locomotive cabs for safety observations on the locomotive engineer. Even if he had suspicions it would have been difficult for him to substantiate them for this reason.

1.9 Rostering

The locomotive engineer

1.9.1 The locomotive engineer was rostered on duty for 8 of the 10 days before the accident. His rostered hours totalled 66 hours 20 minutes. The rostered and corresponding actual hours worked by the locomotive engineer are shown in the following table:

Day	Date	Rostered Times	Rostered hours	Actual hours
Monday	15/7/02	Training	8.00	4.00
Tuesday	16/7/02	0600 – 1400 (Stand by)	8.00	8.00 (Stand by)
Wednesday	17/7/02	Off Duty		
Thursday	18/7/02	0130 - 1000	8.30	8.30
Friday	19/7/02	0130 - 1000	8.30	8.30
Saturday	20/7/02	0130 – 1030	9.00	9.00
Sunday	21/7/02	Off duty – Mandatory		
Monday	22/7/02	1420 - 2355	9.35	9.35
Tuesday	23/7/02	1330 - 2015	6.45	6.45
Wednesday	24/7/02	1810 – 0210 (to 25/7/02)	8.00	9.00 (to 0310 25/7/02)
Thursday	25/7/02	1930 - 0430	9.00	
TOTAL			**75 hours 20 minutes**	**55 hours 20 plus 8 hours stand by**

1.9.2 Although his previous shift before the accident was rostered as 8 hours it had been extended to 9 hours because of late running trains and he did not finish until 0310 on Thursday 25 July.

1.9.3 The accident happened about 6 hrs 20 minutes into his shift, which had commenced at 1930 on Thursday 25 July.

The rail operator

1.9.4 The rail operator was also rostered on duty for 8 of the 10 days before the accident. His rostered hours totalled 59 hours 30 minutes. The corresponding actual time worked by the rail operator in the 8 days actually totalled 64 hours 45 minutes.

1.9.5 His previous shift before the accident had been rostered for 10 hours 30 minutes but to cover a staff injury he had agreed to his shift being extended and had actually worked 14 hours 15 minutes, finishing at 0815 instead of his rostered 0430 on Thursday 25 July. His shift was extended because he was required to act as relief rail operator on a train that had derailed earlier in Stratford during his shift. The extended hours were the result of the late running of that train once it had eventually departed.

1.9.6 The accident happened about 6 hrs 20 minutes into his shift, which had commenced at 1930 on Thursday 25 July.

1.9.7 The rail operator had not attended an alertness management course.

1.10 Sleep/Wake information

1.10.1 The locomotive engineer's wife said that he had arrived home at about 0400 on Thursday 25 July after completing his shift. He had something to eat and went to bed, and she had expected that he would get up at about midday, which was his usual practice. He was at home when she left at about 0830 to go to work.

1.10.2 The locomotive engineer's colleague said that the locomotive engineer had arrived at his house at about 1300 on Thursday 25 July to work on the car and had left at about 1500.

Analysis 4

Method for assessing fatigue

1. Fatigue assessment was based on a method developed by the US National Transportation Safety Board and the NASA Fatigue Countermeasures Program.

2. The method seeks information on the following factors known to produce fatigue-related performance impairment:

    - extended wakefulness
    - acute sleep loss and cumulative sleep debt
    - presence of a sleep disorder
    - critical times in the daily cycle of the circadian body clock.

Sleep history

3. Access to details of the locomotive engineer's sleep history on Thursday 25 July was limited by the fact that he did not survive the accident and that his wife was at work until about 1600 and was not, therefore, able to confirm his actual hours of sleep prior to him commencing his shift. However, given that he arrived home at about 0400 and he went to bed probably about 0430, and the timing of the telephone call to his home at about 0933, it is likely that he had a maximum of about 5 hours sleep before being woken up.

4. Based on the information that he left his colleague's residence at about 1500 and was at home when his wife arrived home at about 1600 it is unlikely that he went to bed again before commencing his shift.

5. The locomotive engineer was an experienced shift worker who had developed a sleep pattern for coping with night shift, which included him usually sleeping until about midday. His planned activities on this day indicated that he had intended to rise before midday.

Factors that increase the likelihood of falling asleep uncontrollably

Time of day

6. Biological sleepiness[8] waxes and wanes across the daily cycle of the circadian body clock. There is clear evidence from laboratory studies that people are most prone to falling asleep inadvertently in the early hours of the morning and again in mid-afternoon. This has been confirmed by a German study of locomotive engineers.

7. The German study suggests that locomotive engineers' vigilance is at its worst in the early hours of the morning. Automatic brakings, caused when locomotive engineers failed to push an alertness device while passing a pre-signal set in the warning position, were most likely to occur at around 0300 and again in the early afternoon. A similar pattern was found for the warning hooter which sounded when the locomotive engineers failed to respond to a warning light that switched on every 25 seconds, as a vigilance device.

8. The derailment happened at about 0150, which corresponds to the time in the circadian cycle when the biological tendency to fall asleep was approaching its strongest.

Time on shift

9. The German study also found that the length of time a locomotive engineer had been on shift affected the degree to which his alertness became impaired in the early hours of the morning. The 0300 peak in soundings of the warning hooter, owing to missing the visual warning on the vigilance device, was much more marked among locomotive engineers who were in the 4th to 6th hour of their shift at the time, than among locomotive engineers who were in the first 3 hours of their shift.

10. At the time of the collision, the locomotive engineer had been on shift for about 6 hours 20 minutes, which would have contributed to his decreased alertness and increased biological sleepiness.

Duration of continuous wakefulness

11. Laboratory studies consistently show that biological sleepiness increases the longer a person stays awake.

12. The accident occurred about 16 hours after the end of the locomotive engineer's last estimated sleep period, so extended wakefulness would probably have been expected to contribute to his biological sleepiness.

Prior sleep loss

13. Insufficient prior sleep increases biological sleepiness at all times in the circadian cycle. To be alert and to function well, each person requires a specific amount of nightly sleep. If individual "sleep need" is not met, the consequences are increased biological sleepiness, reduced alertness and impaired physical and mental performance.

14. For most people, getting 2 hours less sleep than they need on one night (an acute sleep loss of 2 hours) is enough to consistently impair their performance and alertness the

[8] Biological sleepiness is effectively a message from the brain that it requires sleep, similar to hunger indicating a need for food or thirst indicating a need for water. Biological sleepiness eventually becomes overwhelming, leading to falling asleep uncontrollably.

next day. The reduction in performance capacity is particularly marked if less than about 5 hours sleep is obtained.

15. For the 3 days prior to the collision, the locomotive engineer had commenced his shifts at 1420, 1330, and 1810. The overall pattern of the locomotive engineer's rostered shifts was generally of forward rotation with consecutive shifts starting progressively later. This is considered to be preferable to backwards rotation, because forward rotations reduced the likelihood of very short breaks between shifts, which can restrict the time available for sleep, because each new shift starts later than the preceding one. Additionally, the circadian cycle has a tendency to run slightly slow, and it is easier to fall asleep later, rather than earlier.

Opportunities for recovery from sleep debt

16. Breaks between shifts must also provide for all the other activities of life, including commuting to work, eating, interactions with family and friends, exercise and other recreation. Where there is insufficient time available for these activities, there could be pressure to cut back sleep time. The amount and quality of sleep that a person can obtain during a break is dependent on the time of day at which the break occurs, the conditions under which sleep is attempted and possible interruptions during sleep.

17. Although the locomotive engineer had developed plans and strategies for coping with sleep when he was on night shift he had not adhered to them during the time leading up to this accident. The conflicting demands on his restorative time between shifts, specifically to work on his son's car, contrived to erode both the length and quality of his restorative sleep between shifts.

18. The amount of sleep that a person can obtain during a break is dependent on the time of day at which the break occurs. Short breaks between shifts, particularly during the day limit the time available for sleep and can accelerate the accumulation of sleep debt across consecutive shifts. Night workers are seldom able to sleep beyond the early afternoon, when the circadian cycle moves the brain into "awake mode" and sleep becomes difficult, if not impossible.

19. The rail operator was in his fourth consecutive night shift and the finishing time of his previous shift had been extended at short notice by 3 hours 45 minutes from 0430 to 0815 to cover the duties of an injured fellow employee. This reduced his time off-duty before commencing work again at 1930 hours from 15 hours 10 minutes to 10 hours 45 minutes. This shift extension would have significantly reduced his opportunity to sleep during the biologically preferred time, and may well have increased his sleep debt at the time of the accident.

Locomotive engineer fatigue summary

20. The collision occurred around the time in the circadian cycle when falling asleep spontaneously would be most likely under normal circumstances. The locomotive engineer had been awake for about 16 hours, so prolonged wakefulness was probably a contributing factor. Sleepiness at all times is increased by inadequate prior sleep and, based on the available evidence, it is probable that he also experienced the effects of some acute sleep loss at the time of the accident, but the extent of this sleep loss could not be reliably determined.

21. Late train running, particularly after night shifts, reduces the time available for sleep and can contribute to the accumulation of sleep debt across consecutive shifts. However, although the locomotive engineer's previous shift had been extended by one hour, he still had a break of 16 hours 20 minutes before starting his next shift and this minimal extension should not have significantly restricted his opportunity to sleep.

22. The timing of the locomotive engineer's shifts in the days before the accident on Monday 22 July and Tuesday 23 July suggested that he would have been able to obtain adequate sleep while working those days. The gap of 20 hours between completing his shift at 2015 on Tuesday 23 July and commencing his next shift at 1810 on Wednesday 24 July should have been sufficient for him to have obtained adequate sleep before commencing the first of his 3 consecutive night shifts. Therefore, his roster was not considered arduous and probably did not contribute to his fatigue.

23. The point at which the locomotive engineer had succumbed to the microsleep was not able to be clearly established. However, analysis of the locomotive event recorder, which is dealt with later in this report, showed a steady acceleration of the train over about 70 seconds before the derailment which suggests he had done so soon after leaving Tunnel 2.

1.11 Train control to train radio system

Locomotive radio Selcall

1.11.1 An automatic selective calling (Selcall) system was used on very high frequency (VHF) radio to send the locomotive identification number and a status or alarm indication to train control (see also 1.27).

1.11.2 The system sent the following status indications to train control:

- vigilance alarm activated by an emergency brake application
- portable radio removed from holder
- portable radio replaced in holder
- transmission from train on the portable radio
- transmission from train on locomotive radio
- base call to train control
- emergency alarm from locomotive.

1.11.3 Tranz Rail advised that the train radio system was not intended to be a train locating system. Radio messages received in train control identified the radio repeater through which the message had been routed. The repeater identification could be used as a guide to train location but the information would need to be confirmed verbally by the locomotive engineer in conjunction with the plot on the train control diagram.

1.11.4 An emergency call from the locomotive would cycle through all radio channels, starting with the channel the radio was currently set to, until an acknowledgement was received from train control. This feature maximised the chance of an emergency call getting through.

Radio coverage on the SOL

1.11.5 To increase the radio coverage on the SOL, radio transmissions from trains were routed via repeaters located enroute at Hikurangi, Pohokura and Paparata. Figure 8 shows the coverage of each repeater across the SOL.

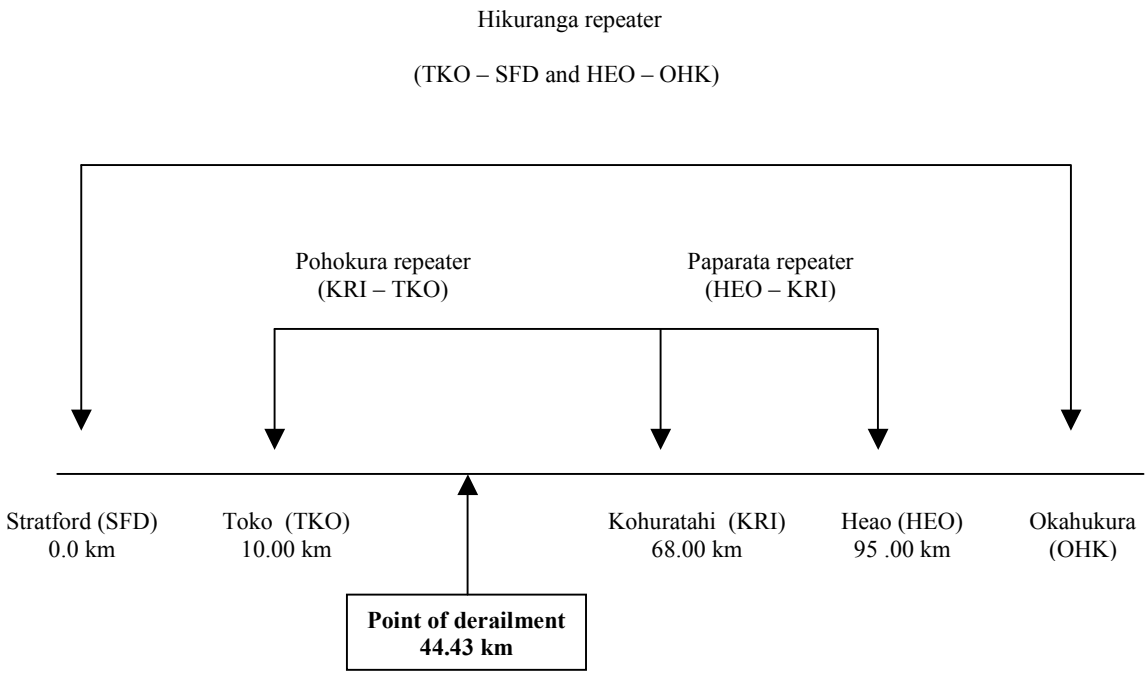


Figure 8
Repeater coverage of the SOL (not to scale)

1.11.6 Messages between train control and trains were displayed on the train control radio visual display unit (VDU). The display included the locomotive and train number, the repeater used and the portion of the route covered by the repeater. The train controller was required to input the locomotive and train identification in the radio computer prior to the commencement of the journey.

1.11.7 When calling a train the controller had to first select the train number from the data held in the radio computer and then select the repeater through which the call was to be routed. The selection of a repeater was relatively easy in centralised traffic control (CTC) areas because the location of the train could be identified from the CTC VDU in front of the train controller. However, in "dark territory"(non-signalled areas) it was often necessary to send calls through more than one repeater to contact the train.

1.11.8 The last radio audit over the SOL was during February 2002. The audit identified that at that time radio reception at the localities of Te Wera, Whangamomona, Tangarakau, and Ohura, as well as other sections of the route, met the standard required for single crew under ATC operations. Coverage of the remainder of the route was not to ATC standard but generally met two-person crewing standards.

1.11.9 Tranz Rail advised that during the months of June and July prior to the accident, train controllers had reported 2 radio faults on the SOL. Neither of these faults resulted in any significant downtime or degradation of the radio system.

1.12 Train control voice tape and radio log

1.12.1 A copy of the train control voice tapes and the radio log were supplied for analysis.

1.13 Train control

1.13.1 The nationwide train control function was centralised to Wellington in 1998, where control duties were carried out from 9 separate desks, each controlling a separate area of the country. The system comprised networked computers for signalling and a computer-based radio system

that allowed train controllers to communicate with locomotive engineers and other track users operating within their respective areas of control. Desks responsible for track warrant control working were also equipped with a computer for the preparation and issue of track warrants. Train controllers had to be certified to operate a particular desk.

1.13.2 The train controller operating the Central North Island train control desk was responsible for train movements between Whangarei and Otiria on the North Auckland Line, Hamilton and Marton on the NIMT, and the SOL.

1.13.3 There were 2 train controllers on duty on the Central North Island desk at the time of the accident. The first, TC1, had been a train controller for about 5 years and was certified to operate the desk. The second, TC2, had 4 years experience as a train controller and was training on his first shift on the Central North Island desk under the supervision of TC1. Their shift had started at 2300.

1.13.4 Tranz Rail had proposed shifting the train control centre from Wellington to Auckland and TC2 had expressed a willingness to transfer to Auckland with the proposed shift of the train control centre and was keen to learn other train control desks. TC1 was assigned to train TC2 on the Central North Island desk, but said it was the first time he had been involved in training and had not received any training himself in this aspect of his duties.

1.14 Train controllers

TC1

1.14.1 During the shift, TC1 monitored TC2's performance from an adjacent unattended train control desk and had periodically reviewed his plan and programme for the shift. Because TC2 was an experienced train controller TC1 felt that the best training was to let TC2 operate the desk while he gave advice and guidance as needed, rather than on an instructional basis.

1.14.2 TC1 said that the radio coverage was not good on the SOL and quite often train controllers could not contact trains en route, and he brought this to TC2's attention. Under TWC locomotive engineers had to call train control at designated locations but because of the perceived poor radio coverage on SOL most train controllers who worked the Central North Island desk required Train 533 to call at Te Wera only. TC1 also said that the previous night it had taken him 5 attempts to get the call at Te Wera and it was not unusual for trains to arrive in Stratford without having been able to make radio contact from Te Wera.

1.14.3 TC1 said he had known trains to take 4 hours to make the journey from Okahukura to Stratford, and no radio contact with the locomotive engineer had been possible until the train had arrived in Stratford. He said that slower than expected running times on the SOL could result from speed restrictions through many of the tunnels because of clearance restrictions for wagons conveying 2.9 m containers. Burst hoses or stallings in areas of poor or non-existent radio coverage also meant that locomotive engineers would be unable to advise train control of such delays. As a result, he was not initially concerned when they had not heard from Train 533 because no vigilance device alarms or radio emergency base calls had been received from the train.

1.14.4 Trains running on the SOL often carried 2.9 m containers but there were none on Train 533 on this particular day. TC1 said that he was unaware of any procedure that required train controllers to be advised if any 2.9 m containers were included in the consist of trains running on the SOL, or of any requirement for train controllers to routinely obtain such information. He was aware that it was available to them through the AMICUS[9] programme. TC1 said that he had not known if there were any 2.9 m containers being conveyed on Train 533.

[9] Tranz Rail's integrated freight accounting, train and rolling stock management system.

1.14.5 By 0330 TC1 had become concerned so he called the network control manager to tell him that there might be a train overdue. TC1 said that the network control manager had not "taken any leadership or anything as far as trying to get them to do anything as in finding the train".

TC2

1.14.6 While preparing the track warrant for Train 533, TC2 had drawn a blue track warrant line on the train control diagram. The line was at a steep angle but he said that it had been drawn to show the limits of the track warrant issued, rather than the anticipated progress of the train. As a result the line he drew allowed for a running time of 2 hours 40 minutes from Okahukura to Stratford. TC1 later said that the line had been optimistic because TC2 hadn't known the running times over the route.

1.14.7 TC2 was experienced in preparing and issuing track warrants but had prepared the track warrant for Train 533 under the supervision of TC1. As part of that preparation he had asked TC1 if there were any clause 10 check calls required and was told Te Wera only. He then issued the track warrant to Train 533.

1.14.8 As the shift progressed, TC2 had talked with TC1 about not hearing from the locomotive engineer of Train 533, but TC1 had assured him that it was not unusual for trains on the SOL to run late. Given TC1's knowledge of the route, TC2 took some comfort from this.

1.14.9 At about 0156 the train controller working the Taranaki desk asked TC2 when Train 533 was expected in Stratford. Despite the fact that his track warrant line showed an expected arrival time of 0230, TC2 advised that arrival time as 0310, which allowed for a running time of 3 hours 20 minutes, which was only 5 minutes different from the scheduled basic running time of 3 hours 15 minutes.

1.14.10 At 0337, 27 minutes after he expected that Train 533 would be in Stratford, the Taranaki train controller asked TC2 for an updated expected time of arrival and was told "I haven't heard from him through Te Horo *(sic)* yet. Between now and then."

1.14.11 TC2 said that there was no defined area assigned to a particular radio repeater, "that comes with local knowledge", and that repeaters could not be relied upon to indicate the location of a train. He had experiences where a call from a train from within the coverage of a particular repeater had been received after it had been routed via a different repeater.

1.14.12 TC2 said that he was unaware of any procedure that required train controllers to be advised if any 2.9 m containers were included in the consist of trains running on the SOL, but he was aware that such restrictions were endorsed on the train consist list in AMICUS, which was accessible to them. He could not recall whether he was aware if there were 2.9 m containers on Train 533 on the day of the accident.

TC3

1.14.13 TC3 was a qualified network control manager and was normally based in Auckland. He was also an experienced train controller and had been certified for the East Coast Main Trunk desk in April 1999, the Auckland desk in November 1999 and the Central North Island desk in September 2000.

1.14.14 On the night of the accident, TC3 was acting in the role of trainer for a trainee controller on the Auckland desk. This train controller had been previously certified on the East Coast Main Trunk desk and, because of his previous experience, and that he had been in training on the Auckland desk for between 6 and 8 weeks, TC3 had left him to manage the shift but monitored his performance from a vacant train control position nearby.

1.14.15 TC3 first become aware of the missing train at about 0415 when TC1 came to him and told him that they could not make contact with Train 533. The Auckland desk was next to the Central

North Island desk so, as he would still be able to monitor the other trainee, he went to assist TC1.

1.14.16 TC3 said that he was aware of the clause 10 check call requirements and always used 2 or sometimes 3 check calls on the SOL. There had been times when he had re-issued a track warrant, which had already been issued with only one check call listed, with 2 check calls.

1.14.17 TC3 said that radio reception problems on the SOL were not uncommon and cited instances in his experience where, because of extreme atmospheric conditions, he had received radio calls from trains in the South Island via the SOL repeaters.

1.15 Definition of an "overdue" train

1.15.1 Although there was no defined time after which a train should be treated as "overdue", Tranz Rail expected that if a call was not received when expected, a follow-up should be made after an appropriate amount of time, allowing for slower than average running.

1.15.2 The Rail Operating Code stated that if an expected call was not received, then the addressee should be contacted and their whereabouts established. Such lapses were to be reported to the network control manager for appropriate action.

1.15.3 Should contact not be established, Tranz Rail expected that the train controller would follow the process as if a vigilance or emergency alarm as defined in Rail Operating Code Supplement 3.4, Instruction 3.20.2 was received. This instruction stated in part:

- Attempt to contact the Locomotive Engineer immediately
- If the first attempt is unsuccessful, continue to call frequently for the next two minutes
- If a reply is not received within two minutes, send a person to the train to find out what has caused the alarm.

1.15.4 Tranz Rail considered this was a standard response and that such a response had been initiated on this occasion, even after a delay in recognising the train was overdue. However, the company was amending these instructions to more clearly define response times.

1.15.5 No vigilance or emergency alarms were received in train control from Train 533.

1.16 Train controllers' response to the "overdue" train

1.16.1 Although TC2 had no recollection of it, the train control tape showed that at about 0150 he had responded to a portable radio call from DC4657, the trailing locomotive on Train 533.

1.16.2 Analysis of the train control tape and radio log confirmed that at 0149:13 a portable radio call from DC4657 had been received in train control, followed about 12 seconds later by a second portable radio call. Both of these calls were transmitted from the locomotive via the Pohokura repeater, which provided coverage between Kohuratahi and Toko (see Figure 8) and were recorded by the train control radio log as follows:

> 01:49:13 VEHICLE_CALL S. "5" "Portable In" from L:8 V: "D4657", "POHOKURA KRI-TKO"
> 01:49:25 VEHICLE_CALL S. "5" "Portable In" from L:8 V: "D4657", "POHOKURA KRI-TKO"

1.16.3 The train control tape confirmed that TC2 reacted immediately to the transmissions with the response:

> "524, are you looking for me or are you looking for somebody? Over."

1.16.4 TC2 received no response from DC4657 and he did not repeat his transmission. TC1 had not been at the desk when TC2 received the radio transmissions from the handset of DC4657 at 0149.

1.16.5 TC2 could not explain why he responded to the call in that manner. DC4657 had been transferred from Train 524 to Train 533 in Okahukura, and the change had been entered in the radio computer by TC2. At the time these transmissions were received, Train 524 was arriving in Hamilton so nothing from that train should have been expected, especially via the Pohokura repeater.

1.16.6 TC1 said that at about 0330 he discussed the situation regarding Train 533 with other train controllers in the train control centre, and at the same time tried without success to make radio contact with the locomotive engineer.

1.16.7 The train control radio log showed that at 0347, 2 base calls had been sent via the Hikurangi repeater to DX5045, the lead locomotive of Train 533, but this repeater did not cover the area where the train was.

1.16.8 At 0403 TC2 made a radio voice call to Train 533 via the Hikurangi repeater and at 0417 TC1 made a radio voice call to Train 533 via the Paparata repeater but neither of these repeaters covered the area where the train was.

1.16.9 At 0419 TC1 sent another base call to Train 533, this time via the Pohokura repeater and noticed for the first time that the transmission had locked on to DC4657. There was no response to the transmission and TC1 realised that the transmission was locked on to the trailing locomotive rather than the lead locomotive.

1.16.10 At this point TC1 discussed the situation with TC3, telling him that the transmissions were locking on to the rear rather than the front locomotive. TC1 sent another voice message to Train 533 via the Pohokura repeater, but although it again locked on to DC4657, there was still no response.

1.16.11 TC1 was aware that the cue "KTI – TKO" against the Pohokura repeater on the radio computer VDU designated the places between which the repeater supplied coverage. However, he was unsure what the abbreviations stood for. TC3 told him the "TKO" was probably Toko and that Train 533 might have called from there.

1.16.12 At 0420 TC1 made another base call to Train 533 via the Pohokura repeater. The call again locked on to DC4657, but there was no response.

1.16.13 TC1, TC2 and TC3 debated why the base calls were only locking on to the trailing locomotive. The only reason TC1 could think of was that something had happened to the lead locomotive but TC2 commented that if something had happened a vigilance alarm would have been received in the train control centre.

1.16.14 At 0421 TC1 made yet another radio voice call to Train 533 via the Pohokura repeater but again it locked on to DC4657 and there was still no response.

1.16.15 At 0426 TC1 made a call to the ganger in Taumarunui to advise him of the situation and asked him to undertake a rail search from Okahukura towards Whangamomona to look for the train. This call-out was confirmed through the help desk[10] at 0430.

1.16.16 Train controllers sometimes attempted to contact trains via radio repeaters on either side of the designated one, in case the lack of initial response was due to atmospheric or other adverse conditions, so contact through an overlapping repeater may be successful.

[10] A 24 hour call centre, the duties of which included calling out staff to respond to emergency situations when requested by train control.

1.16.17 A neighbouring train controller working the Marton to New Plymouth desk was using the Te Popo repeater for Stratford. At 0440 TC3 asked him to try a base call for Train 533 through that repeater, and also the Hurleyville repeater, which covered South Taranaki to Waitotara. This other train controller subsequently advised that he had been unable to make contact with either of the locomotives on Train 533 via those repeaters.

1.16.18 At 0447 the train controllers were again discussing the area of coverage of the Pohokura repeater and still trying to determine what TKO stood for. TC1 thought it was Toko while TC3 now thought it was Tokorima but neither knew what KRI (Kohuratahi) stood for. The reported area of coverage for the Pohokura repeater was from Kohuratahi to Toko, which were both historic rail locations but no longer used and so were not identified on the SOL train control diagram.

1.16.19 TC1 later said that he thought TKO was Tokirima but didn't know where KRI was because the abbreviation did not seem to represent any station on the train control diagram between Stratford and Okahukura. Some of the repeaters on the radio computer had abbreviations consistent with the shortened names on the train control diagram and on the CTC VDUs but others did not.

1.16.20 At 0450 TC2 contacted the help desk and asked that a ganger be called out at Stratford to start a second search for the missing train from that end of the route. The Stratford ganger did not contact train control until about 0630, following a second request, this time by TC3, to the help desk at about 0600. Tranz Rail was unable to advise what action had been taken by the help desk on receipt of the initial call from TC2 at 0450.

1.16.21 At 0451 the ganger who had been called out in Taumarunui telephoned train control from his work depot before heading for Okahukura to on-track in his hi-rail vehicle (HRV). He was not told about the radio transmissions via the Pohokura repeater locking on to Train 533, nor was he asked if he knew what the KRI – TKO boundaries of that repeater were. However, he said that even if he had been asked he would not have known. In a later discussion, during which the boundary abbreviations were explained to him, he said that he would have been able to significantly reduce the search area had he known at the time.

1.16.22 At 0500 TC2 spoke with a locomotive engineer in Stratford and asked him to arrange a search team to travel by road towards Tangarakau to look for the train. This team left at about 0509 and was the team that eventually located the derailed train at the 44.43 km at about 0548.

1.17 Network control manager

1.17.1 The role of the network control manager included in part:

> Manage the network through the Network Control Centre on a continuous roster or callout basis so that network control, train control…and mainline rail operations operate as an effective, integrated unit in support of Tranz Rail business needs
>
> Maintain a total network overview of rail operations including the integration of rail ferry operations and maintain an overview of train control operations
>
> Network Control is responsible for the reporting and investigation of incidents and taking control of co-ordination of incidents and accidents in accordance with the occurrence management manual and other codes.

1.17.2 The network control manager had originally been based in Wellington but in late January 2002, as part of a planned move of the operations function, including the train control centre, was moved to Auckland.

1.17.3 The network control manager said that he had been advised by train control at about 0415 that they had not been able to contact Train 533 since it left Okahukura at 2355 and that they had arranged for gangers to on-track their HRVs at Okahukura to search for the train. This time of notification differed from that given by TC1.

1.17.4 Some time later, he was not sure exactly when, train control contacted him again and advised that a search team had also been dispatched by road from Stratford. At 0445 he had contacted the general manager, network operations and informed him of the missing train and the actions taken so far. He also advised local management in New Plymouth.

1.17.5 At 0515 the network control manager contacted train control and was told the ganger and the track maintainer had on-tracked at Okahukura and Tokirima respectively.

1.17.6 At about 0540 train control contacted the network control manager and told him that the train had been found and that one crew member was injured and the other possibly deceased. He immediately passed this information on to Tranz Rail management.

1.17.7 The network control manager said that being physically removed from the train control centre meant that he was totally dependent on other people for information and that had restricted his ability to manage the situation.

1.17.8 The network control manager's position was transferred back to Wellington on Monday 10 March 2003.

Analysis 5

1. Radio coverage on the SOL generally met the two-person crewing standard so it was likely that if Train 533 had been delayed for any reason it would have been in an area of acceptable radio coverage or an area from where the crew could have made contact with train control without much delay. It was, therefore, unlikely that the amount of time Train 533 was overdue could have been attributed to either a mechanical delay or poor radio coverage.

2. The speed restrictions for trains conveying 2.9 m containers on the SOL, and referred to by TC1 as a reason for slower than expected running times, were classified as permanent speed restrictions, but were not included in the scheduled basic running times. The presence of these containers on a train would have increased its running time slightly, and should be allowed for when the train controller plotted its anticipated progress. As there were no 2.9 m containers on Train 533 on this day, there was no reason to expect a slow running time.

3. TC1 and TC2 did not know if there were any 2.9 m containers on Train 533 because neither had checked the train consist list available in AMICUS although they were aware that the information was available to them. Had they obtained this information they would have been able to rule out one of the reasons for a potentially slower than normal run.

4. Although there was a perception among train controllers that the radio coverage was unreliable and that calls from Te Wera could not be relied on, the lack of reported faults during the 2 months leading up to the accident did not support the perception. Many of the examples given by the train controllers were possibly "irritants" rather than technical faults and had not been reported for that reason. Although many of the train controllers were genuinely concerned, the radio coverage over the SOL operated as designed on the night of the accident.

5. Train control processes and procedures did not vary between desks. Although TC2 was technically training on the Central North Island desk he was a fully certified train

controller and train control duties such as plotting, issuing of track warrants and operating the train control radio were not new to him. With his experience, he should have been adequately equipped to cope with anything that was not route specific so it was appropriate that TC1 had let him manage the shift with the minimum of assistance.

6. Plot lines on the train control diagram were used to show the anticipated progress of the train and the limits of the track warrant issued to the train, hence the secondary use of the blue pencil. In this case there was no anticipated programme plot line drawn; only the blue line showing the limits of the issued track warrant. TC2 did not have to plan any crossings with opposing trains while Train 533 was en route from Okahukura to Stratford so the requirement to accurately plot its anticipated progress was probably diminished in his mind.

7. Because it was his first shift on the desk TC2 would not have known the basic running times for the route. However, an accurate plot line for Train 533, based on Tranz Rail's scheduled basic running times, was printed on the train control diagram and he could have used that line as a guide to plot the anticipated journey of the train.

8. When TC1 noticed the lack of a programme plot line and an unrealistic track warrant line, he should have required TC2 to correct the plot as part of his training. TC1 probably considered that as TC2 was a certified train controller there was no need to monitor his plotting procedures as part of his training. Despite his experience, TC2 did not plot correctly for Train 533. An accurate anticipated programme plot might have alerted TC2 to the overdue status of the train earlier.

9. When TC2 received the radio transmission from DC4657 it should have alerted him to a potential problem. Why he thought it came from Train 524 was not clear. This was the first missed opportunity to realise that Train 533 may have been in trouble.

10. Seven minutes later, when TC2 was asked for an expected arrival time for Train 533 into Stratford, had he tried to get an update from the train, the inability to get a radio base call locked on to DX5045 might have been identified at that early stage.

11. The scheduled running time for Train 533 from Te Wera to Stratford was about 40 minutes so, to meet TC2's initial anticipated arrival time of 0310 for Train 533 in Stratford, he should have anticipated a check call at Te Wera at about 0230, although his track warrant line showed an expected check call time of 0150.

12. When he received a second request for an updated arrival time for Train 533 in Stratford, the expected 0230 check call at Te Wera for an 0310 arrival was already 67 minutes overdue. TC2's reference to the train control diagram at that stage was probably the first time he had reviewed the running of Train 533 since 0156 when he had given his first estimated arrival time in Stratford. During that time TC2's original expected check call time at Te Wera of 0230 had passed without him noticing. If Train 533 was 67 minutes late making a check call at Te Wera, its expected arrival time in Stratford was at least 107 minutes late based on TC2's anticipated arrival time of 0310, making at best an arrival time of 0500. This equated to a run in excess of 5 hours from Okahukura to Stratford, yet still no concerns were evident within train control.

13. Had TC2 responded to the delay at this point and connected it to the earlier radio transmissions from DC4657 at 0149, he might have realised that something was wrong with Train 533. This was already 100 minutes after the accident but nearly 60 minutes before the first search team was called out.

14. Although he was officially "in training", TC2 was a certified train controller experienced in track warrant operations and should have been aware of all the requirements for the safe operation of track warrant control, including clause 10 check calls. His following without question TC1's comment of a single check call indicated that he was not as familiar with the clause 10 requirements as he needed to be. If an experienced train controller such as TC2 unquestioningly adopted the practice on the first night of his training on the Central North Island desk he would probably have continued it and passed it on to other trainees in the future.

15. When spoken to after the accident TC1 appeared to have known of the instruction regarding clause 10 check calls, but it was possible that he had not been familiar with it beforehand. There does however, appear to be no doubt that TC1 was unaware of the procedures to be followed when such check calls were not received, or when trains were potentially overdue.

16. The transmissions received from the portable radio of DC4657 at 0149 should have alerted TC2 to the fact that something was wrong with Train 533 for the following reasons:

- the messages were not base calls from the locomotive, as would be expected under normal circumstances, but were messages advising that the portable radio had been replaced
- the crew of Train 533 had not previously requested permission to remove the portable radio from DC4657, so its replacement was unexpected
- DC4657 was the unoccupied trailing locomotive so any portable radio message coming from that locomotive was unexpected.

17. These radio transmissions corresponded to the time that Train 533 derailed and they probably resulted from the portable radio being rocked in its holding cradle in DC4657 during the derailment.

18. Why TC2 had responded to the original portable radio transmissions from DC4657 by referring to it as Train 524 could not be determined, as these transmissions would have been clearly identified on the radio VDU as having come from Train 533. When there was no response to his radio voice call to DC4657, TC2 should have tried to contact the crew in DX5045. Had he done so, it is likely that the failure of the radio base calls to lock on to DX5045 would have been noticed almost immediately after the accident, instead of two and a half hours later and would probably have brought an emergency response into effect much sooner. This opportunity was lost when TC2 assumed that the portable radio transmission was not from one of his trains and took no further action.

19. TC2 could not have initially been aware of the accident because an emergency alarm from Train 533 had not been received in train control. However, the portable radio transmissions received contained crucial information as the call cues on the radio VDU showed that DC4657 had transmitted via the Pohokura repeater, which provided radio coverage from Kohuratahi to Toko. The radio repeater coverage narrowed the area where Train 533 might be to within a 58 km section of the total 143 km route, but TC2 had not noticed the cues when he responded to the transmissions. The limited knowledge of the train controllers, together with the lack of information available to them regarding the areas of coverage of the Pohokura radio repeater, meant that even if they had suspected there was a problem they were unable to accurately position the train because they did not know what the abbreviated boundaries of the repeater coverage represented.

20. Each time a base call was transmitted to Train 533 via the Pohokura repeater and locked on to DC5647, sufficient information was contained on the radio VDU screen

to have guided the train controllers as to the most likely whereabouts of the train. Although the train radio system was not considered to be a train locating system, the train controllers would have been justified in accepting the Pohokura repeater identification as a guide to the location of Train 533 and acted accordingly. However, the train controllers did not recognise the importance of that information.

21. The inability of the train controllers to exactly determine the area of coverage of the Pohokura radio repeater once the base calls had locked on to DC4657 was compounded by the fact that abbreviations were used that were (a) confusing, TKO could have meant Toko or Tokorima and (b) Toko and KRI (Kohuratahi) were not marked on the train control diagram because they were no longer active as rail operations sites. However, although Toko did not appear on the train control diagram, its existence was probably known to the train controllers because of its close proximity to Stratford. A safety recommendation relating to the dissemination of information regarding the coverage areas of radio repeaters to train controllers is made to the Managing Director of Tranz Rail.

22. The decision to start the rail search from Okahukura was based on the knowledge that Train 533 could reasonably be expected to be ahead of the search vehicle and, therefore, there would be little, if any, risk of a collision. The use of detonators by the HRV driver who on-tracked at Tokorima added a further positive safety defence against a collision.

23. Why the request by TC2 for a ganger to start a search from Stratford was not acted on until a subsequent request from TC3 60 minutes later, was not clear. Had it not been for the Stratford search team, made up of staff from the terminal, leaving about the time of the first request, the delay might have had significant impact on the rescue of the rail operator.

24. The implementation of a road search from Stratford, instead of a rail search, was correct even though the railroad was not visible from the road in many parts of the route and it was possible that the search team may not have seen the train. When last heard from, Train 533 was travelling towards Stratford and a rail search would have created the potential for a head-on collision because Train 533 had not been located and there was a slight chance that it was still moving towards Stratford.

25. The reason that a road search eventuated from Stratford was probably because the locomotive engineer in Stratford had become concerned as at no stage during discussions between the train controllers had the possibility of such a search been raised.

26. With a light workload on the Central North Island desk, particularly with 2 train controllers present, a more proactive and earlier approach to the overdue train should have been expected. This highlighted a need for possible continual managerial supervision within the train control centre.

27. Because the network control manager was located in Auckland, his ability to become actively involved in the response to the accident was limited. As a consequence, the management of the emergency response rested largely with the train controllers. The train control centre was the hub and first point of call for Tranz Rail's operations and to have the network control manager removed from that environment effectively reduced his management capability and made it almost impossible for him to fulfil that part of the role of "maintaining an overview of train control operations". It is possible that had he been present and accessible to the train controllers, the response to the developing situation may have been more timely and effective. However, in view of Tranz Rail's decision to shift the network control manager's position back to

Wellington no safety recommendation covering supervision of the train control centre has been made.

28. As in previous investigations the train control voice recording and radio log information was crucial. However, the provision and use of such recording facilities are not requirements of rail operators' safety systems. With the potential for a number of different operators' to share the network, reliable records become even more important for accident and incident analysis and prevention and a recommendation that such records be kept is made.

1.18 The search programme

The Taumarunui search team

1.18.1 The search team from Taumarunui consisted of a ganger and a track maintainer, each in their own HRVs. At about 0450 the ganger contacted train control prior to departing from Taumarunui and said that to cover some of the area more quickly he had also called out a track maintainer so that one could start at Okahukura and the other could start at Tokirima, 43 km nearer Stratford.

1.18.2 The ganger on-tracked his HRV at Okahukura at about 0515 to travel to Tokorima and at about 0530 the track maintainer called from Tokorima and on-tracked his HRV to travel to Whangamomona. Before departing from Tokorima, the track maintainer placed detonators on the track to warn the locomotive engineer of Train 533, in case it was still behind him, of his presence ahead. Visibility was restricted by fog so both HRVs travelled cautiously.

1.18.3 At about 0600 the ganger said he overheard on the train control radio that Train 533 had been located at the 44 km by the search team from Stratford. He advised TC1 that he would immediately off-track and continue on to the site by road.

1.18.4 The track maintainer said he heard the same information and shortly afterwards was contacted by train control and told that the train had been located 2 km south of Te Wera, that it was an emergency situation and he was to travel there as quickly as possible. He acknowledged the call and took it as authority to continue by rail beyond his original limit of Whangamomona to the site.

1.18.5 As the track maintainer approached Tunnel 2, he established radio contact with the leader of the Stratford search party who, he thought, told him that "the train was past the 2 curves and down on the straight." The transcript of the train control voice tape showed that the message from the leader of the Stratford search party was that the train was "about the bottom of Tunnel 2, heading towards Te Wera. The last wagon is about 50 m out from the curve."

The Stratford search team

1.18.6 A locomotive engineer had arrived at Stratford terminal at about 0350 to start work at 0400. He asked another member of the staff where Train 533 was and was told it "should be here at 3.10". As he went out to start his work, he heard other staff members saying that Train 533 should have arrived. While he worked on some locomotives for about half an hour he heard train control trying to make radio contact with Train 533.

1.18.7 At about 0430 the locomotive engineer telephoned train control to find out where Train 533 was because he had become concerned by the lack of response to the radio calls by the crew of Train 533. He spoke to TC2 who told him the train had not been heard from "since about midnight". TC2 asked him if he would go by car to look for the train and asked how long it would take to get to Tangarakau. The locomotive engineer, who became the Stratford search team leader,

estimated that it would take about 2 hours, and also said that there were a lot of places where he might not see the train from the road. TC2 told him that search teams had been called out from Taumarunui and were travelling by rail from Okahukura.

1.18.8 The search team leader took his cellular telephone phone and a portable radio and, together with 2 other Stratford staff members, he left Stratford at about 0510. They had expected to find the train at Tangarakau because that was a known potential trouble area.

1.18.9 The search team stopped at Te Wera and tried to contact train control by portable radio but there was no radio reception. As there was also no cell phone coverage, the search team leader decided to carry on to the top of Pohokura Saddle from where they would try to make contact.

1.18.10 About 5 km further along the road, the driver swerved to miss an object jutting out from the side of the road, which looked like something covered with fern. As they passed the object the search team leader saw some wagons standing on the track adjacent to SH43 and he called to the driver to stop the car. They reversed and realised that the object in the road was a flat deck wagon covered in ferns and dirt. He thought the time was about 0525.

1.18.11 When the search team got out of the car, they immediately heard the rail operator shouting. Taking their torches, they climbed over the wagons and proceeded down the side of the track formation towards where the locomotives lay. They found both locomotives facing west, in the direction of travel, and almost side-by-side, with the cab of DC4657, the trailing locomotive, about 7 m back from the damaged cab of DX5045.

1.18.12 Two of the search team went immediately to DX5045 to provide assistance to the crew while the leader went towards DC4657, where he planned to use the locomotive radio to contact train control because his portable radio would not work. However, before reaching DC4657 he decided it would be better if he went by car to the top of the Pohokura Saddle, about 2 km further east, and used his cellular telephone to call train control from there. He told another member of the search team of his plan and then returned to the car. As he drove to the top of the Pohokura Saddle he heard on his portable radio one of the search team members calling train control from the locomotive radio of DC4657.

1.18.13 When the search team leader reached the top of the Pohokura Saddle he called train control on his cellular telephone. His call was answered and immediately transferred to the Central North Island desk. He was later not sure which train controller he had spoken to, but he told him that he was at the corner of State Highway 43, and Junction Road, a side road, and that the derailment was about 2 km south of that. He asked train control to arrange for emergency services to attend and then he returned to the derailment site.

1.18.14 When the search team leader got back to the derailed train the other search team members told him that they could not find the train locomotive engineer. He looked around the locomotives, but could not see in to the cab of DX5045 because of mud, so he walked back to where the locomotives had left the track. He could find no sign of the locomotive engineer so he returned to the locomotives and helped with making the rail operator comfortable. The rail operator was not able to give them any information as he had not seen or heard from the locomotive engineer since the accident.

1.18.15 The rail operator was trapped in the left hand side of the cab by mud and debris that had entered the cab during impact. The rescue team were unable to dig the mud away with their hands to free him, so did what they could to make him comfortable until emergency services could get to the scene.

1.18.16 Some time later, he was not sure how long, the search team leader heard the track maintainer calling train control by radio from Tunnel 2. He immediately contacted him by radio on the train control channel and told him to come down the hill and that the end of the train was “50 metres out from the curve”. He was unsure if he had told the track maintainer that the rear of the train was towards the end from which he was approaching, but said that he seemed to

understand the message. He was not sure what time he first saw the track maintainer walking over the flat deck wagons to reach the site.

1.19 Emergency response

Procedures

1.19.1 Instruction 23 of Rail Operating Code Section 6 Operating Instructions for Train Control stated the following:

> 23.1 When contacting the Emergency Services the following points will assist them to effectively deal with an emergency.
>
> - State that you are calling from the National Train Control Centre.
> - State the nearest town to the emergency.
> - Use crossroads near the railway to identify location where possible.
> - Use a map grid reference if necessary for clarification.
> - State the exact nature of the emergency.
> - Advise what type of train is involved i.e:
>
> Passenger
> Freight
> Freight with Dangerous goods
>
> 23.2 Police Communications Centre
> In situations where accidents or emergencies occur and Train Control is notified or deems that the emergency services are required, the direct emergency number for the respective Police Communications Centre should be used to notify Police who will mobilise Fire and Ambulance resources.

1.19.2 Topographical maps, produced by Land Information New Zealand (LINZ) were available in the train control centre for reference purposes in emergency situations, and each kilometre of the rail route was endorsed on them. Map 260 Q20 (the Te Wera map) showed the rail route and SH43 from Stratford to a point 36 km east towards Whangamomona and included Te Wera. Adjoining Map 260 R19 (the Pohokura map) showed the rail route and SH43 from that point to beyond Whangamomona and included the Pohokura Saddle and the derailment site.

1.19.3 Train controllers were trained in map reading as part of their initial training, and proficiency in this task was tested as part of the safety observation process as follows:

> Ensure the employee is able to locate and read "Lands & Survey" maps of the area being observed.
> Ensure employee can provide grid reference to a selected location on a "Lands & Survey" map.

Train control response

1.19.4 At about 0548, TC2 received a radio call from a member of the Stratford search team who advised that the train had been located "4 ks heading towards Taumarunui, just north/south of Te Wera" and requested emergency services to attend. TC2 immediately sought confirmation that the site was 4 km south of Te Wera but the search team member responded that they were "at least 2 ks from Te Wera, heading towards Whangamomona". There was no further reference to the train being south of Te Wera as TC2 had heard in the initial message.

1.19.5 At about 0552, TC2 spoke to the Fire Service and advised them of the circumstances and that the accident site was about "2 ks south of Te Wera, between Te Wera and Whangamomona". He clarified this almost immediately by saying "2 ks on the Whangamomona side of Te Wera".

1.19.6 The search team member called again by radio at about 0553 saying that he was calling "from the 45 kilometre peg". The reference to this specific location was not registered by either TC2 or TC3, both of whom were on telephone calls at the time. TC3 responded to the radio call some seconds later and asked the search team member for more information.

1.19.7 At about 0556, the search team leader called train control by radio from the top of the Pohokura saddle: "Control from crash site at Pohokura. Can you answer your phone please, I'm on my cellphone trying to get hold of you." TC3 immediately responded to the telephone call and asked for road names because "I need to know exactly where you are." The search team leader replied "I'm on the corner of Matau Road, wait a minute, Junction Road and it's the main road going between Stratford and Whangamomona". TC3 asked if that was SH43, which the search team leader confirmed.

1.19.8 During the telephone conversation the search team leader had said "If I go back down the hill you won't get hold of me on the cellphone". TC3 thought that he was calling from the road immediately adjacent to the accident site and that by going "back down the hill" he meant returning to the locomotives, which lay at the bottom of the track formation. TC3 did not realise that the call had been made from the top of the Pohokura Saddle, about 2 km from the actual derailment site.

1.19.9 Junction Road ran from its intersection with SH43 on the Pohokura Saddle to Matau Road near the community of Matau (see Figure 9). Matau was signposted at the intersection of Junction Road and SH43. Matau Road was marked briefly but not named on the Te Wera map where it intersected with Mohakau Road, and it did not appear on the Pohokura map.

1.19.10 After TC3 finished talking with the Stratford search team member at the 45 km and the search team leader at Pohokura, he asked TC1 for the Te Wera map on which he identified the settlement of Te Wera and Mohakau Road, which intersected SH43 just west of the community. Satisfied that this was the location of the derailment site, he contacted the Fire Service and gave directions to that position.

1.19.11 At about 0634 TC1 was talking by radio to the ganger who was about to depart by road from Stratford for the accident site. As he was telling the ganger the site was "…about the 38 k, just a couple of ks on the Whanga side of Te Wera," the transmission was interrupted by an unidentified caller from the site, who advised the site was "3 ks out of Te Wera, on the 45 k curve at Pohokura". The ganger in Stratford confirmed with the person on-site that the curve was on the approach to Tunnel 2, then advised TC1 that the site was in fact 8 km from Te Wera, at the 44.5 km. This was the first time that train control had become aware of the exact location of the accident site.

1.19.12 When TC1 referred to the Te Wera map, he found it did not cover the accident site so he got the Pohokura map to identify the true location.

1.19.13 Three train controllers were involved in various aspects of the recovery response.

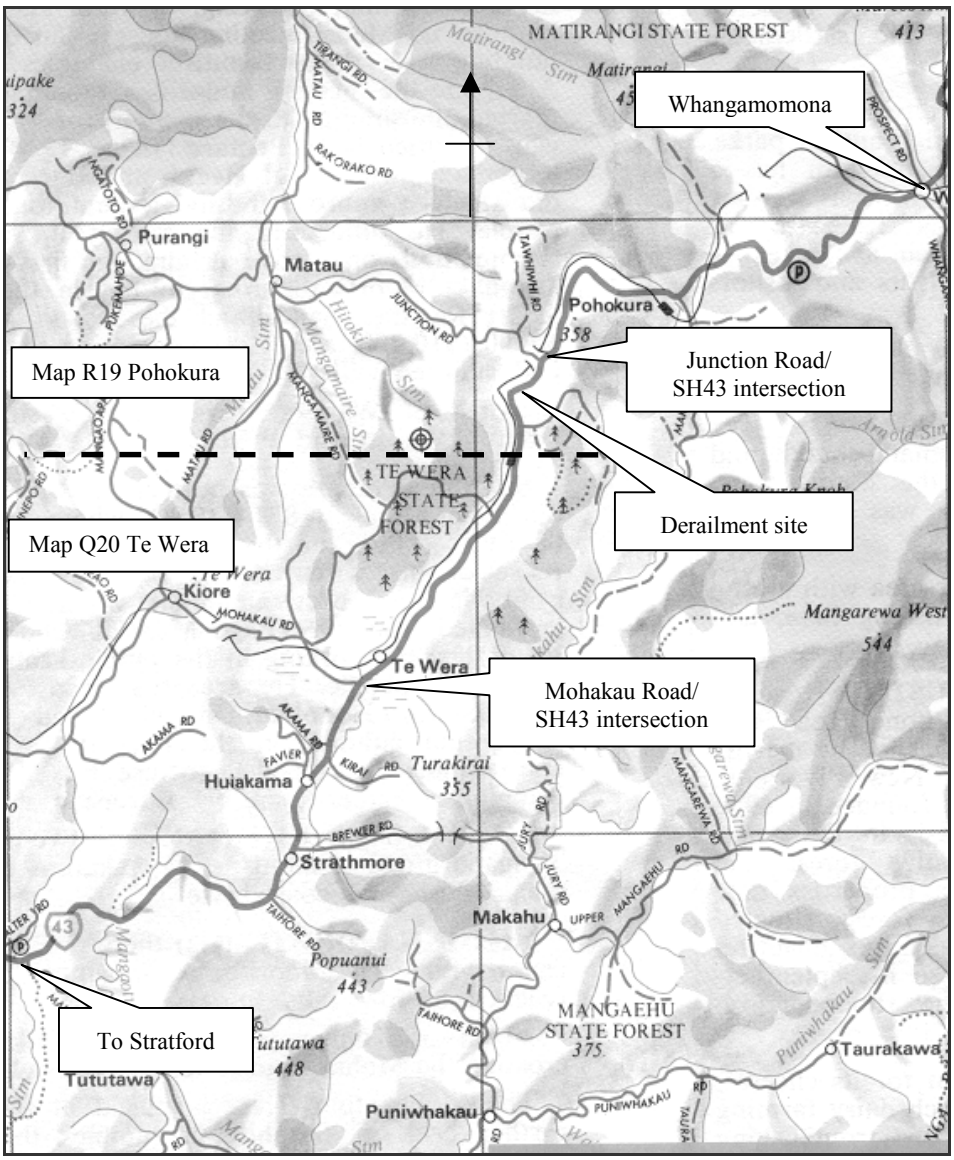


Figure 9
Automobile Association map showing relevant sites and delineation of LINZ maps

Emergency services response

1.19.14 The New Zealand Fire Service was notified of the accident at 0551 by train control via the 111 emergency telephone line. The first emergency vehicle was dispatched from Stratford at 0603.

1.19.15 Acting on initial information received from train control, the first emergency vehicle was dispatched to the intersection of Mohakau Road and SH43 at Te Wera. From the intersection, Mohakau Road ran parallel to the SOL and crossed it by level crossing about 1 km away.

1.19.16 When the first emergency vehicle arrived at that location there was no sign of the train so the crew requested an update from train control. The emergency vehicles were directed to continue along SH43 to a point about 7 km north of Te Wera where a motor vehicle, with its hazard warning lights flashing, was parked on the side of the road adjacent to the derailment site.

1.19.17 The first emergency vehicle arrived on site at about 0643, followed by 2 more at 0649 and 0704.

Workplace support

1.19.18 Tranz Rail advised that workplace support was provided for staff involved from the morning of the accident. This support was facilitated at Stratford and staff attended as they returned from the site and continued depending on individual needs.

1.19.19 Assistance was also provided to families affected and included regular briefings as Tranz Rail's internal investigation progressed.

1.19.20 During the investigation Tranz Rail staff acknowledged the availability of such services although not all staff took advantage of them.

Analysis 6

1. The decision by the Taumarunui search team to separate and undertake their rail search from different locations ensured that a greater route distance was covered more quickly. There was a risk, albeit a small one, that Train 533 had not reached Tokirima at the time the track maintainer on-tracked there and may have caught up to him from behind, but the use of detonators as a protection against any following movements minimised this risk.

2. The original notification of the derailment site location by the Stratford search team member was confused by his use of the words "north" and "south" of Te Wera, especially as the SOL runs generally west to east. However, he corrected himself and gave a distance between Te Wera and Whangamomona. Although his distance estimate was wrong, he had clarified that the accident site was on the Whangamomona side of Te Wera rather than the Stratford side. His initial confusion was understandable given the scene that had greeted him at the site.

3. TC3 had not realised that the search team leader had called from the top of the Pohokura Saddle, about 2 km away from the accident site, so took the intersection details given as identifying the derailment site. Unfortunately he also confused Matau Road, which the Stratford search team leader had originally given but immediately corrected to Junction Road, with Mohakau Road, which he later found on the Te Wera map. The team leader had mentioned Junction Road but his later comment "it's the main road going between Stratford and Whangamomona" probably led TC3 to believe that Junction Road was SH43.

4. The settlement of Matau was sign posted at the intersection of Junction Road and SH43 so, as the team leader tried to find his bearings, it was not surprising that he initially mentioned the name of Matau Road. During the call to TC3 there was no distracting background noise and the cellular telephone reception was excellent, so it was not clear how TC3 had missed his reference to being at Pohokura, nor how he established Mohakau Road as the site of the accident when Mohakau Road had not been mentioned by the team leader.

5. The train controllers talking on telephones, radios and amongst themselves created a noisy and disjointed environment in which to effectively manage an emergency response and was probably the reason why vital pieces of information that could have more quickly identified the accident site were missed. For example, the Stratford search team member's reference to the "45 kilometre peg" was an accurate position but it was missed.

6. The endorsement of the rail route kilometrages on the topographical maps was useful in assisting train controllers to locate rail sites and corresponding road access. However, the train controllers did not hear the Stratford search team member's reference to the "45 kilometre peg" so were not able to relate that reference to any road access, although TC1 had earlier cross referenced the "2 kilometres north of Te

Wera" to the 38 km railway kilometrage on the map. It was 48 minutes after train control received the first notification that the train had been found before they knew the exact railway kilometrage at the site.

7. As controller of the Central North Island desk, it would have been appropriate for TC1 to have taken charge of the situation. With TC2 training on the desk there were sufficient resources to have managed without further assistance. Why TC1 felt the need to seek assistance from TC3 was not clear but was possibly in the knowledge that he was a qualified network control manager. Although TC3 became instrumental in the response activities, none of the controllers took the responsibility as 'team leader'.

8. Although Tranz Rail's emergency response procedures nominated the Police Communications Centre as the first point of contact, the initial telephone calls were directed to the fire service. However, this deviation from procedures did not additionally effect the response time.

9. Under the same procedures, map grid references should have been added for clarity but, without knowing the exact position of the train, such references might have added to the confusion rather than added clarity.

10. Although the initial information to the emergency services was incorrect, it did direct their response in the right direction so that when the site locality was finally confirmed the vehicles were on the right road. The small additional delay in getting the emergency services to the site did not adversely affect the rail operator's condition or recovery in this instance but could well do so in any future situations requiring emergency service response.

11. Tranz Rail's efforts in arranging workplace support meant that appropriate help for those requiring it was available without delay.

12 The train control centre is the primary receiving point for all notifications of emergencies involving the Tranz Rail network and this accident highlighted significant shortcomings in the response from the train control centre. The delay in recognising that Train 533 was missing and then locating it extended the rail operator's discomfort but did not adversely affect his recovery from his injuries. The locomotive engineer would not have survived even had no delays occurred. A safety recommendation covering emergency response training for train controllers is made to the Managing Director of Tranz Rail.

1.20 Track Warrant Control

1.20.1 Track Warrant Control (TWC) was introduced into New Zealand Railways in 1988 as an alternative to a signalling system for train operation on lower density lines. TWC was a method for ensuring that only one vehicle had authority to occupy a section of the track at any time.

1.20.2 Before issuing a track warrant train controllers dictated the necessary details by radio or telephone to locomotive engineers, who wrote the details onto a prepared form before repeating them back to the train controller as a check. When the train reached the limit of the track warrant, the locomotive engineer was required to advise the train controller and authorise cancellation of the track warrant.

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

1.20.4 The SOL between Stratford and Okahukura was mostly single track. To enable trains travelling in opposite directions to pass, sections of double track (crossing loops) were provided at regular intervals. Crossing loops on the SOL were provided at Te Wera, Whangamomona, Tangarakau

and Ohura. To control such crossings, train controllers stipulated conditions on the track warrant.

1.20.5 Rail Operating Code, Section 6, Operating Instructions for Train Control, Instruction 12.8.4 stated:

> A proceed warrant which is issued to an addressee and has an anticipated 2 hours or more to run from the "repeat correct time" before the limits will be cleared, must have a clause 10 call specified from a Track Warrant Station at approximately each hourly interval and at a Track Warrant Station which is in the vicinity of 25 to 30km from the terminating limit.
>
> When the addressee calls, they will advise the location from where the call is being made as well as the terminating limit of the warrant they hold. A check to confirm this information must be made against the warrant line drawn on the (train control) diagram, in addition to the call being logged in TWACS (if in use), the time must also be endorsed alongside the call location on the diagram and the relevant circled track warrant number crossed out.
>
> If it is noticed that a call has not been received, then the addressee should be contacted and their whereabouts established. Such lapses must be reported to the Network Control Manager for appropriate action.

No similar instruction regarding track warrants with an anticipated 2 hours or more to run was contained in locomotive engineers' instructions for TWC.

1.20.6 When TC1 was asked if there was a requirement to have a set number of clause 10 check calls en route he replied that there was an instruction in the Rail Operating Code which required check calls approximately every 60 minutes and that since the accident the company had focused on that requirement. He also said that following the accident he asked if there was an instruction regarding what to do if "you don't hear from a train" but he didn't think there was as far as he knew.

1.20.7 Tranz Rail's Operating Rule 412, Calling Train Control Enroute, stated in part:

> 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.

1.20.8 The track warrant issued to the locomotive engineer of Train 533 at Okahukura contained a clause 10 "Call train control at Te Wera" only.

1.21 Train control diagram

1.21.1 Train control diagrams showed the timetables of all scheduled trains, printed in green, on the route where they ran. The SOL train control diagram showed the timetable for Train 533 as Okahukura depart 0030, Stratford arrive 0345 (3 hours 15 minutes).

1.21.2 Train controllers drew plot lines on the diagram using a black pencil to show the anticipated progress of trains, based on the actual time of departure. The pencil plot line was overwritten by a blue line when a track warrant was issued. The blue line corresponded to, and replaced, the pencil plot line and showed the anticipated progress of the train, including intermediate stopovers for shunts etc, and the limits of the track warrant issued.

1.22 Track warrant documentation audit process

1.22.1 Tranz Rail's Operating Code provided for "systemic checks of various aspects of Train Control duties" to be carried out to monitor the standard of work. These checks, or audits, of train

control graphs and the associated track warrant operation, were conducted by train control and network control managers who were qualified train controllers.

1.22.2 The train control diagram audit check sheet contained only 2 references to specific track warrant issues:

- That the plot line was drawn in green
- That track warrants were shown as cancelled

Tranz Rail's track warrant plotting procedures stated that all movements authorised by track warrant must be plotted in blue on the train control diagram, not green as stated on the audit check sheet.

1.22.3 There was no documented frequency requirement for the auditing of train control graphs. The last audit of a train control graph covering the SOL had been done by a suitably qualified network control manager on 8 May 2002 and no discrepancies had been identified by that audit.

1.22.4 Audit results provided by Tranz Rail showed that during the period 13 March 2002 to 15 May 2002 no train control diagrams had been returned to train controllers working the Central North Island desk for correction of discrepancies identified by audit.

1.22.5 A Train Control Operations Review commissioned by the Director of Land Transport Safety and undertaken by international consultants in October 2001 made the following comments:

- Auditing train control graphs is generally a tedious exercise, though careful auditing provides a good indication when errors are being made…
- Early intervention and corrective action is required before incorrect processes become established and accepted as normal and perhaps taught to others.

The Review concluded that:

> There is scope for improving Auditing practices within Tranz Rail.
>
> Improvements should include increasing the rate of overall train graph audits.

and recommended that:

> …train graph auditing should be significantly increased overall to improve data management standards of Tranz Rail Train Controllers.
>
> Auditing at this level to include coaching, process correction and mentoring…
>
> Priority should be given to Audit Tasks…

1.22.6 Locomotive engineer supervisory staff undertook audits of locomotive engineers who operated in TWC areas. This included a review of an employee's Mis 88 book[11] currently in use or recently completed. There was no requirement for such audits to include clause 10 check calls or their frequency.

[11] The book of forms on which the locomotive engineer enters the details of his track warrant as it is issued by train control.

1.23 Review of SOL train control and TWC documentation by the Commission

1.23.1 As part of its investigation the Commission undertook a review of train control diagrams and track warrant documentation specific to the 18 times Train 533 ran on the SOL during the month of July prior to the accident. The review identified that:

- the running times of Train 533 between Okahukura and Te Wera varied between 2 hours 10 minutes and 3 hours 20 minutes and averaged 2 hours 35 minutes
- the running times of Train 533 between Okahukura and Stratford varied between 2 hours 50 minutes and 4 hours and averaged 3 hours 17 minutes
- Te Wera was the only clause 10 check call location specified in 17 of the 18 times the train ran
- in all cases the time of receipt of the check call from Te Wera had been endorsed on the train control diagram
- there was evidence of radio communication between train control and various trains on the SOL from Ohura, Tangarakau, and Whangamomona.

1.23.2 The review showed 15 (84%) of the trips had been made within 15 minutes either side of the basic running time of 3 hours 15 minutes. Of the other 3, one was faster at 2 hours 50 minutes and 2 slower at 3 hours 40 minutes and 4 hours.

1.23.3 During the review period no trains had been delayed by stallings, burst hoses or for other mechanical reasons. There were no radio failures endorsed on the train control diagrams.

1.23.4 The review identified Ohura, Tangarakau and Whangamomona as locations where, because of the train activities carried out at each of them, adequate radio communication between trains and train control was available.

Analysis 7

1. The belief that radio calls from Te Wera could not be guaranteed, although voiced by several train controllers, was not substantiated by the low number of radio faults reported to the help desk in the 2 months prior to the accident. Based on the advice given to TC2 about radio coverage he was not unduly concerned when there had not been check a call from Train 533 at Te Wera as he probably expected the train to arrive in Stratford without him receiving the call.

2. The remoteness of the area through which the SOL ran should have reinforced the need for clause 10 check calls with train controllers as being essential in monitoring the progress and safety of trains and their crews over the route. Non-compliance with Tranz Rail's documented procedures had probably been occurring over a considerable length of time, and the use of Te Wera as the only check call location by westbound trains, particularly Train 533, had become standard practice and was even taught to new train controllers. Tranz Rail's audits did not identify this ongoing non-compliance, which might indicate that a similar situation exists in other TWC areas.

3. Although the train control diagram audit check sheet did not specify a requirement regarding clause 10 check calls, network control managers, being qualified train controllers themselves, should have been aware of the requirement when undertaking compliance checks of the train control diagrams. The auditing procedures and compliance checks had either not identified the ongoing non-compliance or had identified the practice but had allowed it to continue. However, the integrity of the audit from a track warrant perspective was questionable given that it required the

auditor to check that the track warrant plot line was drawn in green when in fact the procedures dictated that such lines should be drawn in blue.

4. The shortcomings in the auditing process, which were identified in this investigation, showed that the comments and recommendations included in the Train Control Operations Review had not been implemented by Tranz Rail at the time of the accident and a safety recommendation relating to TWC audit procedures is made to the Managing Director of Tranz Rail.

5. The clause 10 check call requirements were contained in instructions for train controllers but no similar instructions were issued to locomotive engineers. Therefore, through "enforced ignorance", the locomotive engineers accepted and acted on track warrants, which sometimes technically breached operating procedures. Clause 10 requirements were introduced to encourage locomotive engineers to look at and read their track warrants, and to carry out a check of their limits with train control, particularly during long journeys, but its effectiveness as an additional safety defence in track warrant operation was eroded as locomotive engineers were not formally aware of the check call requirement. Had locomotive engineers operating on the SOL been aware of the clause 10 requirement and the additional safety defence it brought to track warrant operation, the practice of only one such check call en route may not have become established.

6. The safety defence of clause 10 calls was eroded by the fact that it was not necessary for a locomotive engineer to wait for a call acknowledgement before continuing on. If the locomotive engineer's check call was not acknowledged immediately by the train controller for any reason, the train could have entered another section before the required check of track warrant limits between the locomotive engineer and the train controller had been done. A safety recommendation covering the integrity of clause 10 check calls under existing procedures has been made to the Managing Director of Tranz Rail.

7. Had the required number of check calls been established, train control would have been better able to monitor the progress of Train 533 and would probably have realised sooner that the train was overdue as they would have had an updated plot line from its last reported call. Also, once it was established that the train was overdue, the area of the search could have been more accurately defined, based on the time of the previous call.

8. Because Te Wera was the only specified check call on this occasion, the location of Train 533 was difficult to establish once it had departed from Okahukura, unless the train controller tried to establish radio contact with the train. This was reflected in the fact that it was necessary to cover the whole route once a search was initiated.

9. The single check call for westbound trains met one clause 10 requirement in that Te Wera was between 25 and 30 km from the terminating point of the track warrant held. The relevance in terms of safety, however, was doubtful as the train would by then have completed the major portion of the journey from Okahukura unmonitored. Train controllers probably used the check call at Te Wera more as an opportunity to update the expected arrival times of trains in Stratford rather than to record the progress of the train. This was highlighted when TC2 was asked for an estimated arrival time for Train 533 into Stratford and responded that the train had not yet called at Te Wera, indicating that he felt unable to give an expected arrival time until he had received that check call.

10. The apparent lack of importance attached to the Te Wera check calls by train controllers was reinforced by the fact that they often did not necessarily expect to receive a call because of radio conditions at Te Wera. This, in turn, gave rise to the

practice of accepting the call belatedly after arriving in Stratford. However, the Commission's review showed that in all cases in which Train 533 had run in July prior to the accident, acknowledgement of the check calls at Te Wera had been endorsed on the train control diagram, which suggested that radio reception at Te Wera was generally of an acceptable standard.

11. The Commission's review identified 3 stations other than Te Wera where adequate radio coverage was available and could have been used for clause 10 radio check calls.

12. The review did not identify any journeys on the SOL that had been affected by mechanical failures indicating that such delays were rare and therefore should not have been given undue significance when establishing if a train was overdue.

1.24 The locomotive event recorder

1.24.1 The event recorder on DX5045 was of the Kaitiaki type and the data was downloaded and supplied for analysis.

1.25 Basic running times

1.25.1 The maximum authorised line speed on the SOL was 70 km/h between Stratford and 68.5 km and reduced to 50 km/h between 68.5 km and Okahukura, because of a significant number of tight radius, speed restricted curves on that section.

1.25.2 The scheduled basic running time for westbound express freight trains from Okahukura to Whangamomona was 2 hours and from Whangamomona to Stratford was 1 hour 15 minutes, making a total of 3 hours 15 minutes.

1.25.3 The permanent speed restrictions in effect between Stratford and Okahukura at the time of the accident were listed in Table 2.4.3 in the Working Timetable and Bulletin 452 dated 25 July 2002.

2.4.3 Stratford – Okahukura Line (amended instruction)

Portion of Line	Kilometres per hour		
	RC	ExpF	F
0.00 km to 68.50 km (Whangamomona – Tangarakau)	**70**	**70**	**55**
Except:			
Down trains from 35.06km to 35.15km (Mohakau Road level crossing)	40	40	40
Between 54.83 km and 55.72 km (Tunnel 3)	25	25	25
Through Tunnels 1, 2 and 3 for 2.9 containers on HK, HKP, IA, IAS, IC IB, IBS, PK, SK, UK UKA and UKC wagons	..	25	25
68.50 km to Okahukura	**50**	**50**	**50**
Except:			
Between 86.30km and 87.59km (Tunnel 10)	25	25	25
Between 88.84 km and 89.96 km (Tunnel 11)	25	25	25
Between 136.40 km and 136.60 km	25	25	25
Between 137.75 km and 139.90 km (Includes Tunnel 24)	25	25	25
Through Tunnels 5 and 7 for 2.9 containers on HK, HKP, IA, IAS, IC IB, IBS, PK, UK UKA and UKC wagons	..	25	25
Through Tunnel 8 for 2.9 containers on HK, HKP, IA, IAS, IC, IB, IBS PK, SK, UK, UKA and UKC wagons	..	10	10
Through Tunnels 10, 11, 15, 16, 17 and 24 for 2.9 containers on HK, HKP, IA, IAS, IC, IB, IBS, PK, UK, UKA and UKC wagons	..	25	25

1.25.4 Tranz Rail advised that all track related permanent speed restrictions listed in the Working Timetable were factored into the M Train simulation used for calculating scheduled basic running times but individual wagon restrictions, which may vary between train consists, were not.

1.25.5 The AMICUS train consist documentation showed there were no 2.9 m containers on Train 533.

1.25.6 The following temporary speed restrictions were also in effect between Okahukura and the POD at the time of the accident:

- 114.18 km - 114.00 km, 180 m of 25 km/h running between Matiere and Ohura
- 92.40 km - 91.80 km, 600 m of 25 km/h running between Haeo and Tangarakau
- 72.00 km – 71.30 km, 700 m of 25 km/h running between Tangarakau and Whangamomona

Each of these temporary speed restrictions was within the 50 km/h maximum authorised line speed portion of the route.

1.25.7 The speed restrictions applied not only to the locomotive but to the full length of the train, so the speed of the locomotive was restricted until it was sufficiently past the limit of the restriction to ensure that the last wagon was also clear of it.

1.26 Time sequence of events

1.26.1 A time sequence of events as derived from the locomotive event recorder is included in Analysis 8.

Analysis 8

1. Data downloaded from the locomotive event recorder of DX5045 for the journey of Train 533 from Okahukura to the 68.5 km, the section over which the maximum authorised line speed was 50 km/h, revealed the following:

   - at 0011 Train 533 reached 55 km/h and continued to travel in excess of the maximum authorised line speed for a further 15 minutes, reaching a maximum speed of 74 km/h during that time
   - at 0029 Train 533 reached 54 km/h and continued to travel in excess of the maximum authorised line speed for a further 7 minutes, reaching a maximum speed of 61 km/h during that time
   - at 0039 Train 533 reached 53 km/h and continued to travel in excess of the maximum authorised line speed for a further 2 minutes, reaching a maximum speed of 59 km/h during that time
   - at 0042 Train 533 reached 53 km/h and continued to travel in excess of the maximum line speed for a further 7 minutes, reaching a maximum speed of 69 km/h during that time
   - at 0104 Train 533 reached 52 km/h and continued to travel in excess of the maximum authorised line speed for a further 2 minutes, reaching a maximum speed of 61 km/h during that time
   - at 0111 Train 533 reached 52 km/h and travelled in excess of the maximum authorised line speed for a further 5 minutes, reaching a maximum speed of 62 km/h during that time.

2. About 7 minutes and 3.4 km after leaving Okahukura, Train 533 reached the first speed restriction travelling at a speed of about 44 km/h. However, on arrival at the speed restriction the train decelerated to about 33 km/h only, instead of to the

restricted speed of 25 km/h, and as a result covered the 2.15 kms of the speed restriction in about 4 minutes, instead of the expected 6.5 minutes.

3. The next permanent speed restriction of 25 km/h commenced at the 136.60 km and went for 200 m. This speed restriction was about 1.15 km after the end of the preceding speed restriction. By the time Train 533, at 537 m in length, had cleared the terminating point of the first restriction, there would have been insufficient distance for the locomotive engineer to accelerate and reduce speed again before the second speed restriction. Therefore, the train should have remained at about 25 km/h over both the speed restrictions and the distance between them. Analysis of the locomotive event recorder showed that after travelling at reduced speed of 33 km/h for a short time, probably until the locomotive had cleared the end of the first speed restriction, the locomotive engineer had accelerated, making no allowance for the second speed restriction, which was crossed at about 48 km/h as the train continued to accelerate.

4. There was a temporary speed restriction of 25 km/h, which commenced at the 72.00 km and went for 700 m. This speed restriction finished about 2.8 km before the 68.5 km, where the maximum authorised line speed increased from 50 km/h to 70 km/h. It was calculated that Train 533 had reached this speed restriction at 0118 and its speed was about 31 km/h. Two minutes later the train had increased speed to 39 km/h and continued to accelerate. The total distance of the temporary speed restriction, allowing for the locomotive to have travelled the length of the train beyond the end of the speed restriction, was 1227 m, which, at a speed of 25 km/h should have taken at least 3 minutes but was actually covered in less than 2 minutes.

5. From Okahukura to the 68.5 km, Train 533 exceeded the maximum authorised line speed of 50 km/h for about 38 minutes. Given the speeds, it was difficult to understand how Train 533 did not roll over on any of the tight curves between Okahukura and the 68.5 km and it can only be that this was avoided because of the locomotive engineer's route knowledge, and he was alert, lucky or both.

6. Train 533 departed from Okahukura at 2350 and reached the POD at about 0148. The distance covered was about 99 kms and took about 1 hour 58 minutes. The scheduled basic running time for the 83 km trip from Okahukura to Whangamomona was 2 hours. The high speeds resulted in Train 533 travelling 99 kms in 2 minutes less than it was scheduled to travel 83 kms.

7. If the required number of clause 10 check calls had been adhered to, it is possible that the fast run of Train 533 may have been recognised and acted on by train control, although the apparent lack of knowledge of the scheduled basic running times for the route displayed by TC1 and TC2 meant that this could not be certain.

8. Analysis of the locomotive event recorder shows the time sequence of events of the 90 seconds before the derailment as follows:

   - About 84 seconds before the derailment Train 533 was travelling at about 41 km/h and the throttle was in notch 4. The train speed had been decreasing for about 8 minutes before that, probably as it climbed the gradient to Tunnel 2
   - About 74 seconds before the derailment the speed of Train 533 had increased to about 42 km/h, probably as the train started its descent from Tunnel 2. At this time the throttle was still in notch 4 and the locomotive engineer had cancelled the light cycle of the vigilance device
   - About 54 seconds before the derailment the throttle was still in notch 4 and the speed had increased to about 45 km/h
   - About 44 seconds before the derailment the throttle was still in notch 4 and the speed had increased to about 50 km/h

- About 34 seconds before the derailment the throttle was still in notch 4 and the speed had increased to about 54 km/h
- About 24 seconds before the derailment the throttle was still in notch 4 and the speed had increased to about 61 km/h
- About 15 seconds before the derailment the throttle was still in notch 4 and the train was travelling at about 67 km/h when the locomotive engineer cancelled the light cycle of the vigilance device
- About 14 seconds before the derailment, while the train was travelling at about 68 km/h, the locomotive engineer throttled back to notch 2 and made a brake application
- There was insufficient time for the brakes to effectively respond and the train had increased speed to about 72 km/h at the time it left the rails.

9. The information provided by the locomotive event recorder was crucial to this investigation, especially as the rail operator had slept for much of the trip from Okahukura and was, therefore, not able to provide much information on the characteristics of the train during that time. This is not the first time such information has been invaluable in the investigation of rail occurrences and a recommendation relating to the installation of event recorders in all locomotives operating on the main line is made.

1.27 Kaitiaki vigilance device

The locomotive vigilance device

1.27.1 The Kaitiaki system was an integrated vigilance device, event recorder and speed measuring system, which could record in detail locomotive activities and crew responses to vigilance stimuli. The locomotive crew vigilance device was an 'alerter' system which monitored the vigilance of the crew. The format comprised fixed time cycles being:

- 50 seconds to illuminating crew vigilance warning light
- +10 seconds to sounding crew vigilance warning whistle
- +10 seconds to application of locomotive vigilance penalty brake

1.27.2 The vigilance cycle was reset when the locomotive engineer pressed the cancellation button. To manage the distractive impact of the vigilance system, the cycle was automatically reset when the locomotive engineer made a change in the controls, such as a change in throttle notch.

Locomotive vigilance device enhancement

1.27.3 As part of the implementation of ATC (single person operation), a 'Selective Calling' (Selcall) function was incorporated into the locomotive radio network. The Selcall system automatically transmitted alarms and a train identifier to train control.

1.27.4 The locomotive Selcall alarms included activation of the locomotive vigilance penalty brake (emergency brake application), the activation of the crew emergency button or upon completion of an uninterrupted 70 second vigilance cycle.

1.27.5 The brakes of the train were held open by air pressure, which was reduced when a brake application was made. The brake pipe air pressure was continually monitored by a transducer. When the transducer detected a reduction of air pressure within the brake pipe to 350 kPa in less than 10 seconds, which constituted an emergency brake application, it activated the Kaitiaki alarm.

Configuration of vigilance device on DX5045

1.27.6 DX5045 was fitted with a Kaitiaki system which activated a Selcall vigilance penalty brake alarm signal if either there was a vigilance activation of the penalty brake or if the brake pipe pressure registered emergency braking conditions, that is the brake pressure was less than 390 kPa, a full service train brake application. The trigger point was 350 kPa.

1.27.7 The Kaitiaki recorder data from DX5045 was downloaded and supplied for analysis. There was a discrepancy of about 58 seconds between the times recorded in the radio log and those recorded on the Kaitiaki recorder.

1.27.8 The Kaitiaki recorder showed a penalty brake application had been made at 01.51:15 (Kaitiaki recorder time), immediately before the recorder shut down but this was not registered on the train control radio log.

General

1.27.9 The Commission's Railway Occurrence Report 00-115 which covered an investigation into a derailment at Westmere 22 September 2000 included the following safety recommendation which was accepted by Tranz Rail:

> Revise the operation of the vigilance device system to provide a better defence against short duration microsleeps. (019/01)

1.27.10 Tranz Rail had previously considered the most appropriate form of vigilance device. Page 52 of the 1997 Tranz Rail Alertness Management booklet included:

> "Four forms of vigilance device are to be assessed as follows:
>
> 1. Fixed time cycles (as used at present)
> 2. Random time cycle to vigilance light
> 3. Speed dependent time to vigilance light
> 4. Fixed time cycle, but with randomly selected vigilance light with associated cancellation button".

The booklet referred to other options to form part of a final assessment. However, no changes had been made to the fixed time cycle system in use in 1997 as a result of this assessment. On 19 April 2001 Tranz Rail had supplied the following update indicating its intention to re-activate the project:

> The enhanced vigilance system known as "Kaitiaki" has been progressively fitted to mainline class locomotives since 1993.
>
> Vigilance systems have been configured to the same cycles as the previous system, but are capable of being adapted to the different cycles outlined in the Alertness Management booklet.
>
> The randomly selected vigilance light was the first to be considered. It was fitted to a locomotive based in Wellington for evaluation by Locomotive Engineers. This system was subsequently withdrawn following feedback it had too much potential to distract Locomotive Engineers from their primary task of handling their train in accordance with visual information provided by signals, curve speed boards, speed restriction boards etc.
>
> The other two versions were fitted to six locomotives during 1997 for evaluation. There was some variable feedback, however the project team involved did not reach any specific conclusion.
>
> It is planned to re-activate the project within the recently formed Locomotive Engineers Council, which includes Tranz Rail and RMTU members.

1.27.11 On 16 January 2003 Tranz Rail advised that a project manager had been appointed to provide variable time cycles and speed cycles of the vigilance system for trials, which were to be conducted for the locomotive engineers' council.

Analysis 9

1. The locomotive engineer cancelled the light cycle of the vigilance alarm about 15 seconds before the derailment, and 9 seconds into the light cycle. His response probably followed him being woken by the same lurch of the locomotive that had woken the rail operator, as it is doubtful that the flashing light alone would have woken him. If the cycle had continued for another second and changed to the warning whistle sequence the audio alarm probably would have woken him but there would have been even less time for him to react.

2. Analysis of the event recorder showed that, up until immediately before the accident, the locomotive engineer's response times to the vigilance alarm generally varied between 2 and 4 seconds, which was within the expected response range. However, there were 2 occasions when he had taken 6 seconds and 7 seconds to respond, which may have resulted from a loss of attention at those times.

3. Although the times from the Kaitiaki recorder were about 58 seconds behind those from the train control radio log, this was not critical as events recorded by both systems at the time of the derailment corresponded. For the purpose of analysis the Kaitiaki times were adjusted to match the train control radio log times, and all subsequent times are as adjusted.

4. Analysis of the data downloaded from the Kaitiaki recorder of DX5045 revealed the following:

   - at 01.41:22 the brake pipe pressure was 547 kPa
   - at 01.49:11 the brake pipe pressure was 536 kPa
   - at 01.49:18 the brake pipe pressure was 492 kPa
   - at 01.49:20 the brake pipe pressure was 484 kPa.

5. From these figures it appears that the locomotive engineer made a brake application immediately prior to 01.49.11 but it was not an emergency application and did not reduce the brake pipe air pressure to 350 kPa within 10 seconds required to activate the emergency signal. In the following 9 seconds following the brake application the brake pipe air pressure had reduced to 484 kPa only.

6. Fourteen seconds after the locomotive engineer made the brake application the train left the tracks. If he had made an emergency application there would have been sufficient time for the required reduction in brake pipe pressure to activate the Kaitiaki vigilance emergency signal before the train derailed and if the vigilance emergency signal had been received in train control at that time, the response to the accident would have been more timely.

7. Why the locomotive engineer did not make an emergency brake application was not clear but might have been because he was disoriented when he woke up and, although he knew the train was travelling fast, he was unsure where he was and what action was required.

8. Even if an emergency brake application had been made it is unlikely that the speed of the train would have reduced sufficiently at that late stage to enable it to safely negotiate the curve.

9. The radio log showed that, based on the movement of the portable radio in its holder, the derailment occurred at about 01.49:25 at about which time the Kaitiaki recorder appeared to do a partial shut down. However, it continued to record although the data provided was of little value, except for the following entries:

   - at 01.51:03 there was a recording "dynamic brake"
   - at 01.52:13 there was a recording "penalty brake applied".

10. The Kaitiaki log indicated that the penalty brake application at 01.52:13 was activated by the vigilance system completing a 70 second cycle following the "dynamic brake" recording, but the radio on DX5045 had been destroyed on impact and was, therefore, not able to transmit an emergency alarm to train control.

11. The vigilance device was not able to prevent this accident and, therefore, doubts continue as to its suitability in its present form as a defence against short-duration microsleeps.

1.28 Collision between HRV and the rear of Train 533

1.28.1 The track maintainer was not familiar with the derailment area as he had not travelled over it for about 2 years. He had called TC2 at 0530 from Tokorima and requested time on-track in his HRV to travel towards Whangamomona. He asked for and was given one hour to complete the trip.

1.28.2 The track maintainer said that at about 0600 he overheard who he thought was the Stratford search team leader on the radio advising train control that the train had been located "south of the Pohokura saddle." He also thought he had heard the 44 km mentioned at that time and assumed that was the location of the train.

1.28.3 Shortly after this TC3 contacted the track maintainer and told him the train had been located 2 km south of Te Wera, that it was an emergency situation and he was required to get to the site as quickly as possible. The site was beyond Whangamomona, to where he had on-track rights, but he took TC3's radio message and the urgency of the situation as his authority to continue on to the site by rail without going through the usual "requesting time on-track" procedures.

1.28.4 TC3 said that he had expected the track maintainer to off- track at Whangamomona and continue by road to the site as he had not given him permission to continue on-track beyond Whangamomona. The ganger had off-tracked once he knew the train had been found and travelled by road to the scene and TC3 had expected the track maintainer to do the same.

1.28.5 The track maintainer said that before he reached Tunnel 2 he had contacted the search team leader by radio and was told that the derailment was on the 45 km/h curve at the 44 km and that the train was out on the straight. He estimated his HRV was travelling at about 20-30 km/h as he exited Tunnel 2 and he tried to slow it by using both the foot and hand brakes but the wheels locked up and the vehicle skidded on the rails, which were greasy because of the foggy conditions. He was still trying to slow the HRV when the rear of the train came unexpectedly into view immediately in front of him.

1.28.6 The track maintainer had not expected to see the rear of the train at that point. He had been looking for the red, flashing light of the train end monitor (TEM)[12] on the rear wagon but instead the rear of the train was marked by a non-illuminated disc[13]. Although the spotlight on

[12] A train end monitor is fitted on to the rear vehicle buffer and is connected to the brake pipe. It monitors among other things brake pressure and whether the tail light is on or off. This information is transmitted to the locomotive engineer by radio.
[13] Red reflectorised discs were used on some classes of trains to mark the end of the train.

his HRV was lit, its effectiveness was reduced by the fog, and he did not see the rear of the train until too late.

1.28.7 The HRV carried a lot of equipment and as a result was very heavy. Although it was slowing it was obvious to the track maintainer a collision was inevitable. He was not wearing a seatbelt, which was not mandatory when the HRV was on-track, and he braced himself against the steering wheel to prepare for the impact.

1.28.8 The collision happened at about 0630. The track maintainer was not injured in the impact and notified train control of the collision before he continued on foot to the derailment site.

Analysis 10

1. The track maintainer originally had authority from train control to travel on-track as far as Whangamomona as part of the search programme but he was in no doubt that the radio message he subsequently received from TC3 implied that he had authority to continue by rail to the derailment site, a further 16 km beyond Whangamomona.

2. There was a fall-down in communication in that TC3 expected the track maintainer to off-track and continue to the derailment site by road, as the ganger had done. Neither had made their intentions clear to the other and although the track maintainer breached the track occupancy procedures, he did so unknowingly and with the best intentions and probably at no risk to himself or other track users at that time. However, breaches of track occupancy procedures for whatever reason cannot be condoned and, under different circumstances his actions could have had more serious consequences.

3. TC3 would probably not have given the track maintainer authority to continue by rail even if he had requested it because although he knew that the accident site was accessible by road, the exact location of the train, in railroad kilometrage, was still not known.

4. The track maintainer received conflicting information regarding the location of the derailment site. Given that he was not familiar with the area and was operating in restricted visibility, it would have been prudent to travel more cautiously. However, he was aware of the seriousness of the situation and the need to get to the site as quickly as possible, which probably influenced his judgement in his speed.

5. The track maintainer was expecting the rear of the train to be marked by the red flashing light of a TEM and had based his stopping strategy on seeing such a light, even in the foggy conditions. The rear of the train being marked by a non-illuminated disk meant that, unbeknown to him, he was dependent on the use of his vehicle lights to locate the rear of the train. The foggy conditions would have degraded the effectiveness of the lights with the result that when the end of the train was illuminated he did not have sufficient distance to stop before colliding with it.

6. The presence of a flashing red light to indicate the rear of the train would probably have given the track maintainer more advanced warning, even in the fog. A safety recommendation covering the use of red flashing lights to indicate the rear of all trains has been made to the Managing Director of Tranz Rail.

1.29 Comments from other train controllers

1.29.1 An experienced train controller, who was certified for the Central North Island train control desk but was not on duty at the time of the accident, said that he usually only put one clause 10 check call on track warrants issued to trains on the SOL because:

- it was the way he had been trained

- from his experience, it was not unusual for locomotive engineers to be unable to contact train control by radio from Te Wera and so both the clause 10 check call and the track warrant cancellation were given together from Stratford
- the practice of one call only had crept in because of poor radio reception over the route.

1.29.2 This train controller also felt that because of frequent radio reception problems, the speed restrictions on the conveying of 2.9 m containers through numerous tunnels, and the not uncommon train stallings or burst hoses in poor or non-existent radio reception areas, he was convinced that his response to the situation may have been similar to that of the train controllers who were on duty.

1.29.3 A second experienced train controller, also certified for the Central North Island desk, said that as a result of an earlier experience on a different track warrant route he always used 2 clause 10 check calls, at Ohura and Te Wera, for trains travelling in either direction on the SOL. Since the accident he had inserted an additional call at Tangarakau, which effectively created 40 minute running sections between Ohura and Te Wera.

1.29.4 When discussing response time to the missing train, this train controller said that a reasonable emergency response time was difficult to determine, particularly as there had been no feedback from the train. Although he would have had an additional clause 10 check call for Train 533 at Ohura this would have only been an advantage when directing search gangs to the area as he would also have been waiting for the check call from Te Wera, which never came.

1.29.5 Both of these train controllers expressed their concerns about track warrant operating practices which they felt had crept in on the SOL and had become accepted by train controllers, locomotive engineers, supervisory staff and Tranz Rail.

1.30 Previous occurrences involving attention loss

1.30.1 The Commission investigated 4 previous occurrences involving attention loss linked to fatigue, which led to microsleeps. Reports on these are:

- Report 00-115, Westmere, a derailment on 22 September 2000, following a high speed entry into a restricted speed curve.
- Report 00-117, Kai Iwi, a derailment on 26 November 2000, also following a high speed entry into a restricted speed curve.
- Report 00-121, Middleton, a collision on 8 December 2000, when a northbound train overran a signal and collided with a southbound train.
- Report 02-107, New Plymouth, a collision on 29 January 2002, when an express freight train collided with a stationary shunt locomotive while berthing.

1.30.2 In addition Report 00-111, Tapuata, a track warrant overrun on 14 June 2000, concluded that a short-term loss of attention may have been a factor in the events that occurred, although sleep loss and fatigue were not considered to be factors.

1.30.3 Report 01-104, Mokoia, a collision between 2 southbound express freight trains, 7 March 2001, concluded that a short-term loss of attention, as a result of fatigue and accumulated sleep debt, may have been a factor in the events that occurred, although no microsleep resulted.

1.30.4 The following table compares 3 previous occurrences involving suspected microsleeps with this occurrence:

	Westmere Derailment (00-115) 22/9/2000	Kai Iwi Derailment (00-118) 26/11/2000	Middleton Collision (00-121) 8/12/2000	44.43 km Derailment (02-116) 26 July 2002
Time of day	2338	0105	0400	0150
Time on shift	4 hrs	3 hrs 25 mins	6 hrs	6 hrs 20 mins
Consecutive night shifts	5th	5th	6th	2nd
Completed shifts since last 2-night break	4	4	10	3
Late running on prior night shifts	4/4 (average 1.6 hrs)	4/4 (average 1.4 hrs)	4/5 (average 38 mins)*	1/1 (1 hour)

* The 2 night shifts preceding the incident had run an average of 1.2 hrs late.

1.30.5 These accidents have in common that they occurred at least 3 hours into a night shift and where the preceding night shift had run late. They all occurred at or near the daily peak in biological sleepiness.

1.30.6 The locomotive engineer was on his second consecutive rostered night shift. Tranz Rail's rostering policy following the previous accidents allowed for a maximum of 3 consecutive night shifts followed by mandatory off duty time.

1.31 Other relevant occurrences investigated by the Commission

Train 701, track warrant irregularity, Waipara, occurrence report 96-101

1.31.1 In January 1996 Train 701, the southbound *"Coastal Pacific"* Picton to Christchurch passenger express, overran Waipara without a valid track warrant and continued for approximately 24 km into the next section before the error was realised. The causal factor was the locomotive engineer's failure to recognise the limits of his authority to proceed. Safety issues identified included the long distance for which track warrants were issued and the need to reinforce track warrant requirements.

1.31.2 A finding in this report was:

> 3.5 The lack of opportunity for the locomotive engineer's awareness of the track warrant limits to be reinforced with train control probably contributed to this failure.

1.31.3 As a result of this occurrence it was recommended to the Managing Director of Tranz Rail on 29 January 1996 that he:

> introduce procedures governing the issue of track warrants to limit the length over which a track warrant is issued. (003/96)

1.31.4 On 12 April 1996 Tranz Rail advised that they had approved and were implementing specific actions, which were relevant to the Waipara incident but had not been in force at the time. Part of those actions were:

> A procedure to be introduced whereby Train Control Officers will be required to specify a check call on all warrants where the expected running time from issue of the warrant is over two hours long. The call is to be specified for a recognised track warrant location in the range 25 to 30 kilometres from the terminating limit of the warrant held.

Train 523, derailment Train 902, Islington, 98-110

1.31.5 In June 1998, the northbound *"Southerner"* Invercargill to Christchurch passenger express, derailed at Islington when motorised points moved under the train. Causal factors included non-compliance with intended procedures for points operation. Safety issues identified included the effectiveness of compliance monitoring.

1.31.6 Findings in this report included:

> 3.4 The non-compliance with Code 9.3.4 was not an isolated occurrence
>
> 3.7 The non-compliance with Rule 96 was not an isolated occurrence

1.31.7 As a result of this occurrence it was recommended to the Managing Director of Tranz Rail on 12 April 1999 that he:

> take steps to identify and correct the repetitive non-compliance with Tranz Rail's rules and procedures for safe operation identified during the investigation of this incident (024/99): and
>
> confirm the effectiveness of Tranz Rail's compliance monitoring regime in identifying repeated non-compliances at an early stage, and initiating appropriate follow-up action (031/99).

1.31.8 On 15 September 1999 the Managing Director of Tranz Rail responded:

> 024/99: A safety observation process has been formalised and will meet the requirement of this recommendation…
>
> 031/99: Implementation of a safety observation process is underway and will meet the requirement of this recommendation.

1.31.9 These safety recommendations are considered relevant to this investigation and have been repeated to the Managing Director of Tranz Rail.

1.32 Research into substance induced performance impairment

1.32.1 The Commission researched substance induced impairment policies identified in rail accident investigation reports involving overseas railroads. New Zealand research included New Zealand industries and Tranz Rail. The findings of that research follow.

Victoria, Australia

Occurrence A

1.32.2 On 26 November 1999 a collision occurred between a freight train and a ballast train at Ararat in Victoria[14], which resulted in serious injuries to the two-person crew of one of the trains. The other 4 people involved in the collision were the two-person crew of the other train, the train controller (at a remote site in Adelaide) and a train examiner.

1.32.3 The uninjured train crew and the train controller were breath tested by Police but tested negative. The train examiner and the injured crew were not tested, either by breath test or by blood test on arrival at the separate hospitals to which they had been admitted. The rail operator believed that blood samples had been taken when the crew were admitted to hospital and did not find out for several days that this was not the case.

1.32.4 The Australian Transport Safety Bureau's report into the accident stated that:

> Section 97 of the Transport Act refers to 'Blood samples to be taken in certain cases'. That reference states that 'if a worker enters or is brought to a designated place for examination or treatment in consequence of an accident (whether in Victoria or not), the worker must allow a doctor to take from the worker at that designated place a sample of his or her blood for analysis'. The Act does not state that such actions are the responsibility of employers, nor does the Act state that the taking of blood samples in such cases is mandatory.
>
> Hospital staff at both Ararat and Melbourne's Alfred Hospital, advised that while it was a routine procedure to take blood samples following the admittance of motor vehicle accident victims, it was not a routine procedure for those involved in rail accidents. Those hospital staff further advised that it is likely that samples would have been taken had a reasonable request been made to do so. Company procedures specified by rail operators and track access providers normally require that a breath test be conducted following an accident.
>
> Although three employees directly involved in the accident were not tested for alcohol or other drugs, no evidence was provided to the investigation team to suggest that drugs or alcohol were a contributing factor to this accident.

1.32.5 The investigation concluded that there was a need to ensure, either through legislation or other means, that all operational personnel involved in rail accidents were subjected to appropriate tests for the presence of alcohol or other drugs following an accident.

Occurrence B

1.32.6 On 26 July 2000 a collision occurred between Train 2018, a stationery passenger train, and Train 2020, an empty non-stop passenger train, both operated by Connex Trains Melbourne (CTM), at Holmsglen Railway Station in Victoria[15]. The collision resulted in the 2 train drivers and 10 passengers being injured and taken to hospital.

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[14] Australian Transport Safety Bureau Rail Investigation Report R1/2000

[15] Safety and Technical Services Branch, Department of Infrastructure, Office of the Director of Public Transport Report, May 2001

1.32.7 The report on the collision stated that the driver of Train 2020 regularly took medication prescribed by his doctor and had done so the evening before the collision. Medical studies into the medication, undertaken in 1996, showed that fatigue and dizziness were potential side effects. However, under CTM's procedures staff were not required to declare to their employer any change in medical condition or health which may impact on rail safety or performance of their duty. Instead procedures required that "a person should contact the Public Transport Corporation Occupational Medical Unit if they have any doubt regarding their fitness for duty while on medication". These procedures also required "the responsible manager to ensure the implementation and maintenance of a drug free working environment".

1.32.8 The report concluded that a contributing factor to the collision was "[the lack of] measures to capture and record the use of medication which could affect performance by operating staff". A resulting recommendation was that "Effective processes be implemented to ensure that the potential impact of prescribed medication on a driver's ability are known to relevant driver managers."

1.32.9 On 18 October 2001, new drug and alcohol laws to combat rail accidents were introduced in Victoria. The new legislation "prohibits people undertaking safety related work, such as operating a tram or train or working on or near tracks whilst impaired by drugs".

1.32.10 Under the then current law, workers in safety related positions were subject to a zero blood alcohol level, but the laws did not address the use of drugs and medication at work. The new laws cover all types of drugs that have the potential to create impairment, including prescription and over-the-counter drugs as well as illegal drugs, and would "require rail operators to have a management system in place to ensure that their workers do not perform safety related work after consuming alcohol or whilst being impaired by any other drug..."

1.32.11 When introducing the changes, the Victorian Minister For Transport said "the chief aim of these new provisions is the prevention of accidents – not the prosecution and punishment of workers". He concluded by saying "These reforms pick up on recommendations of investigations into rail accidents at Ararat in November 1999 and Holmsglen Station in July 2000, which highlighted the need for improvements to alcohol and drug controls in the rail industry, particularly in regard to prescription drugs".

Occurrence C

1.32.12 On 5 June 2001, a collision occurred between Train 6371, an empty passenger express train and Train 6369, a stationary passenger train, both operated by Bayside Trains, at Footscray Railway Station in Victoria[16]. The collision resulted in one of the train drivers and 2 passengers receiving minor injuries.

1.32.13 Following the collision, the driver of Train 6371 tested negative to blood tests for the presence of alcohol or drugs.

1.32.14 The ATSB report into the collision stated that:

> The driver of train 6371 was taking a course of prescribed medication to assist in a psychiatric medical condition. The evidence available suggested that the driver adhered to his prescribed medication regime.

[16] Australian Transport Safety Bureau Report published November 2001.

1.32.15 At the time of the accident, and for at least 3 years prior, the driver had been suffering with at least 6 medical conditions. During this time his treatment had included the use of 7 different prescribed medications to counter the different medical conditions. The ATSB Report stated that:

> The expert opinion of the transport medical consultant is that…none of the medications that he had been taking are considered compatible with the safe operation of a public transport vehicle. In addition, most of these medications, apart from adverse central nervous system effects, can cause vision disturbance.

1.32.16 In its analysis the ATSB Report stated that:

> There is an argument for medical self-assessment/disclosure by drivers, in the interest of the travelling public. The onus, however, must be on either the employer and/or the regulatory authority to provide and manage a medical examination and monitoring system that reduces to a level that is low as practicable, the risk of allowing an unfit driver to operate.
>
> It is probable that the driver's medication would have had an adverse impact on his ability to concentrate and maintain wakefulness.

1.32.17 Findings into the collision included:

- The performance of the driver of Train 6371 was probably impaired by his medical condition
- It was probable that the medication taken by the driver would have had an adverse impact on his ability to concentrate and maintain wakefulness

1.32.18 The ATSB recommended that medical standards should be reviewed and amended to include, among other things:

- a system to monitor self medication of over-the-counter and non-prescription medication
- better monitoring of drivers' health and ensure a full past history and current medical regime is taken.

1.32.19 The operator responded that a policy covering the use of prescription drugs by safe working personnel had been drafted.

Queensland, Australia

Occurrence D

1.32.20 On 1 July 2001, Train EG37, a loaded coal train operated by Queensland Rail (QR) derailed as it negotiated the steep descent of the Connors Range, en route to the export coal port of Hay Point[17]. There were no injuries to the two-person train crew.

1.32.21 QR's policy in relation to alcohol and drugs was contained within its safety management system. The purpose of that policy was to "set the arrangements for the management of risks associated with alcohol and other drugs in the workplace".

[17] Joint Queensland Rail, Australian Transport Safety Bureau, Queensland Government Report, October 2001.

1.32.22 The report into the accident stated that:

> Subsection 7.1.2 of that policy describes company procedures in relation to alcohol and drug testing and states that testing can only be undertaken in accordance with:
>
> - The Queensland *Traffic Act 1949* by a police officer: and
> - The Queensland *Transport Infrastructure Act 1994* by a police officer or an authorised person under the provisions of the Act.
>
> The *Traffic Act 1949* requires that train drivers must have a blood alcohol level of 0.00 per cent whilst on duty.

1.32.23 The Queensland *Transport Infrastructure Act 1994* refers to the powers of Authorised Persons to investigate railway occurrences and states:

> The authorised person may require an employee of a railway manager or operator to take an alcohol test, drug test or medical examination if the person reasonably suspects that:
>
> - the employee caused, or was directly involved in, the incident: and
> - the result of the test or examination may help in deciding the circumstances and probable causes of the incident
>
> The test must take place within 2 hours after the incident happens.

1.32.24 When designated as an Authorised Person, a QR employee did not have the power or qualification to conduct a breath or blood test, but did have the power to require such tests to be taken.

New South Wales, Australia

Occurrence E

1.32.25 On 2 December 1999,Train W534, an inter urban passenger service operated by State Rail Authority of New South Wales collided with the *Indian Pacific* passenger train at Glenbrook, New South Wales. The *Indian Pacific* had been stopped at a signal and had just started to move off when Train W534 approached from the rear and could not stop before it collided with the rear wagon on the train. As a result of the collision 7 people were killed and 51 passengers were hospitalised for treatment of their injuries.

1.32.26 A Special Commission of Inquiry[18] was appointed on 9 December 1999 under the authority of the Special Commissions of Inquiry Act 1983, to inquire into and report on the accident to the Governor of the State of New South Wales. The final report of the Commission of Inquiry was published in April 2001.

1.32.27 Although the presence of performance impairing substances was not identified as a causal or contributing factor in the accident the Commission of Inquiry made the following comments relating to alcohol and other drug testing:

> Section 61 of the Rail Safety Act 1993 makes it a condition of accreditation that an accredited person must ensure that all railway employees, employed, or contracted, by the person to perform railway safety work, are not under the influence of alcohol or other drugs when about to carry out, or while carrying out, railway safety work.

[18] Special Commission of Inquiry Into the Glenbrook Rail Accident, The Honourable Peter Aloysius McInerney, Final Report, April 2001.

Section 61(4) states "Schedule 2 has effect". Schedule 2 relates to alcohol or other drugs and authorises the random testing of railway employees, where an authorised officer has reasonable cause to believe that a railway employee is about to carry out railway safety work.

The mechanism by which random testing for alcohol or drugs may be conducted is limited to circumstances where the Director General of the Department of Transport has made the necessary arrangement with an accredited person for this to be done or, after an accident or incident has occurred. What is significant is that there is no random alcohol or drug testing of employees actually engaged in railway safety work.

In my opinion, this is a serious omission from the legislative framework. Although there is no evidence that any serious problem exists at the present time, it is necessary for the protection of the public and the employees themselves that the deterrent effect of random alcohol and drug testing be introduced to minimise the risk of a problem developing in this area. The prevalence of the use of alcohol and so called recreational drugs is widespread in the community. Public safety requires measures to control this risk.

In the public interest, the law at present authorises random testing for motorists, who may be driving in the course of their employment or on a private journey. Train drivers, signallers, and other persons carrying out safety critical work, are responsible for the safety of members of the travelling public. In my opinion, the law in relation to the random testing of railway employees should not be limited to circumstances where the Director General of the Department of Transport makes an arrangement with an accredited railway entity for this to occur. Nor should the circumstances be confined to testing after an accident has occurred.

1.32.28 The Commission of Inquiry made 3 recommendations regarding drug and alcohol testing:

- there should be random breath testing by authorised officers of the Rail Safety Inspectorate of railway employees engaged in safety critical work
- there should be drug testing of railway employees involved in an accident or incident
- the Rail Safety Inspectorate should examine the advantages and disadvantages of introducing a system which enables the immediate and reliable assessment of the fitness to commence duties of safety critical employees.

1.32.29 On 29 November 2001 the Minister for Transport for New South Wales announced new safety reforms arising from the Final Glenbrook Report. These reforms included legislation to provide for random alcohol and drug testing for employees involved in rail safety work. He said the amendments to legislation required to implement the random testing would be introduced in the first session of Parliament in the new-year. The Minister also said that "State Rail have also started work on a draft policy concerning random testing and will work with unions and employees to implement the changes…"

1.32.30 Section 42 of the Rail Safety Act 2002 stated that:

42 Railway employees—alcohol or other drugs

(1) It is a condition of accreditation that an accredited person must:

- (a) prepare and implement a drug and alcohol program for its railway employees that complies with guidelines issued by the Director-General for the purposes of this section and published in the Gazette, and

- (b) ensure that all railway employees employed, or contracted, by the person to perform railway safety work are not under the influence of alcohol or any other drug when about to carry out, or while on duty for the purpose of carrying out (whether or not carrying out), railway safety work.

(2) The drug and alcohol program is to include any matters required to be included by the guidelines issued by the Director-General for the purposes of this section.

(3) Without limiting subsection (1) (a), the guidelines are to include provisions for or with respect to the following:

- (a) protocols for fair procedures,
- (b) education and assistance of railway employees.

(4) The Director-General may at any time arrange with an accredited person for the random testing of any person on duty for the purpose of carrying out railway safety work for the presence of alcohol or any other drug to ensure that the accredited person is complying with the terms of the person's accreditation.

(5) Schedule 1 has effect.

(6) For the purposes of this section, a railway employee is to be regarded as being about to carry out railway safety work if the employee:

- (a) has left home or a temporary residence for work (being railway safety work), and
- (b) has not commenced work after having so left home or the temporary residence.

United States of America

1.32.31 The problem of alcohol use on American railroads is as old as the industry itself, and efforts to deter it by carrier rules began at least a century ago[19]. For many years, railroads have prohibited operating employees from possessing alcohol or being intoxicated while on duty, and from consuming alcoholic beverages while subject to being called for duty. More recently, these proscriptions have been expanded to forbid possession or use of certain drugs. These restrictions are embodied in "Rule G", an industry-wide operating rule promulgated by the Association of American Railroads, and are enforced, in various formulations, by virtually every railroad in the country. The customary sanction for Rule G violations is dismissal.

1.32.32 In July 1983 the Federal Railroad Administration (FRA) expressed concern that these industry efforts were not adequate to curb alcohol and drug abuse by railroad employees and pointed to evidence indicating that on-the-job intoxication was a significant problem in the railroad industry.

1.32.33 After a review of accident investigation reports, the FRA found that from 1972 to 1983 "the nation's railroads experienced at least 21 significant train accidents involving alcohol or drug use as a probable cause or contributing factor", and that these accidents "resulted in 25 fatalities and 61 non-fatal injuries". The FRA also identified "an additional 17 fatalities to operating employees working on or around rail rolling stock that involved alcohol or drugs as a contributing factor". In light of these problems, the FRA solicited comments from interested parties on various regulatory approaches to the problem of alcohol and drug abuse throughout the Nation's railroad system.

[19] U.S. Supreme Court Opinion, 21 March 1989, Skinner, Secretary of Transportation, et al. v. Railway Labor Executives' Association et al.

1.32.34 Comments submitted in response to this request indicated that railroads were able to detect a relatively small number of Rule G violations owing, primarily, to their practice of relying on the observation of supervisors and co-workers to enforce the rule. At the same time, "industry participants…confirmed that alcohol and drug use [did] occur on the railroads with unacceptable frequency," and available information from all sources "suggest[ed] that the problem include[ed] 'pockets' of drinking and drug use involving multiple crew members (before and during work), sporadic cases of individuals reporting to work impaired, and repeated drinking and drug use by individual employees who are chemically or psychologically dependent on those substances."

1.32.35 In view of the obvious safety hazards of alcohol and drug use by railroad employees, the FRA announced in June 1984 its intention to promulgate federal regulations on the subject. The employees covered by the regulations were prohibited from using or possessing alcohol or any controlled substance, and further prohibited from reporting for duty while under the influence of, or impaired by alcohol or any controlled substance.

1.32.36 Two subparts of the regulations related to testing. Subpart C, which was entitled "Post-Accident Toxicological Testing" was mandatory. It provided that railroads "shall take all practicable steps to assure that all covered employees of the railroad directly involved…provide blood and urine samples for toxicological testing by FRA", upon the occurrence of certain specified events. Toxicological testing was required following a "major train accident," which was defined as any train accident that involved (i) a fatality, (ii) the release of hazardous material accompanied by an evacuation or a reportable injury, or (iii) damage to railroad property of $500,000 or more.

1.32.37 Subpart D of the regulations, which was entitled "Authorization to Test for Cause" was permissive. It authorized railroads to require covered employees to submit to breath or urine tests in certain circumstances not addressed by Subpart C. Such tests could be ordered:

- after a reportable accident or incident , where a supervisor has a "reasonable suspicion" that an employee's acts or omissions contributed to the occurrence or severity of the accident or incident
- in the event of certain specific rule violations, including non-compliance with a signal and excessive speeding
- where a supervisor has a "reasonable suspicion" that an employee is under the influence of alcohol, based on specific, personal observations concerning the appearance, behaviour, speech or body odours of the employee

1.32.38 The FRA noted that a 1979 study examining the scope of alcohol abuse on 7 major railroads found that "an estimated one out of every eight railroad workers drank at least once while on duty during the study year". In addition, "5% of workers reported to work 'very drunk' or got 'very drunk' on duty at least once in the study year", and "13% of workers reported to work at least a 'little drunk' one or more times during that period". The study also found that 23% of the operating personnel were "problem drinkers", but that only 4% of these employees "were receiving help through an employee assistance program, and even fewer were handled through disciplinary procedures."

1.32.39 The General Code of Operating Rules[20] governed the operation of over 150 railroads within the United States of America. Instruction 1.5, Drugs and Alcohol stated:

> The use or possession of alcoholic beverages while on duty or on company property is prohibited. Employees must not have any measurable alcohol in their breath or in their body fluids when reporting for duty, while on duty, or while on company property.
>
> The use or possession of intoxicants, over-the-counter or prescription drugs, narcotics, controlled substances, or medication that may adversely affect safe performance is prohibited while on duty or on company property, except medication that is permitted by a medical practitioner and used as prescribed. Employees must not have any prohibited substances in their bodily fluids when reporting for duty, while on duty, or while on company property.

New Zealand

1.32.40 In July 2003 a paper entitled Implementing Effective Alcohol and Drug Programmes in New Zealand Businesses[21] was delivered to the New Zealand Institute of Safety Management Expo in Tauranga. The paper stated that:

> Alcohol and drug abuse is an increasingly visible and controversial problem. Research indicates that the most effective method of eliminating the effect of alcohol and drug abuse in the workplace is to introduce a comprehensive Alcohol and Drug Free Workplace programme…
>
> While about 14% of the problem issues in the workplace are alcohol and drug related, about 6 [%] out of this 14% are people who need treatment for dependency…

1.32.41 The paper continued [emphases contained in original paper]:

> New Zealand statistics on *alcohol and drug use in the workplace do not exist*. Though data is often only anecdotal, overseas trends can indicate the size of the problem:
>
> United States
>
> - 70% of abusers have jobs
> - Abusers are five times more likely to cause accidents involving themselves and their workmates
> - 40% of industrial fatalities are caused by impaired workers…

and concluded:

> Historically, solutions that have only incorporated policy and procedures driven by a testing regime to weed out alcohol and drug abusers have not succeeded, or lost impetus quickly due to insufficient management commitment. They did not succeed because that approach did not directly address the issue of **changing employees attitudes and behaviours** in the use of alcohol and drugs before and during work. Programmes that incorporate a philosophy of improving performance by educating all employees, rehabilitating those that need help and being firm over the use of alcohol and drugs before and during work have been successful.

[20] General Code of Operating Rules, Fourth Edition, effective 2 April 2000.
[21] Matt Beattie, Instep Limited 2003.

1.32.42 In 2001, the Employee Assistance Professional Association (EAPA) surveyed their 6000 members worldwide and asked them "what employee personal issues are challenging employers and their employees to such a degree that it affects workplace performance?" The figures under "Global" in the following table are the results.

Instep Limited analysed the New Zealand workplaces that it supports (from September 1998 to September 2003). Those results are included in the table for comparison purposes.

Employee Assistance Programme Diagnosis Issues 1998 - 2003

	Global EAPA, 2001	New Zealand Instep, 1998-2003
Family issues	25%	25%
Stress	23%	22%
Depression	21%	16%
Alcohol & drug abuse/dependency	12%	15%
Job conflict	9%	6%
Critical incident/trauma	2%	8%
Legal/financial	6%	6%
Other	2%	2%

Sources: Employee Assistance Professionals Association 2001 and Matthew Beattie, Instep Limited, EAP Diagnosis Issues, September 2003.

1.32.43 The Forestry Training Council identified the risk of alcohol and drug abuse amongst forestry staff. This risk identified not only alcohol and "recreational" drugs, such as marijuana and "speed", but also prescription drugs which, although legal, carried with them the potential for impairment in the workplace.

1.32.44 As a result one major participant in the forestry industry developed a three-stage programme aimed at managing the risks associated with alcohol and drug abuse. The programme was introduced as follows:

- stage 1 – pre-employment testing to create an awareness amongst staff of the company's policy
- stage 2 – post incident testing
- stage 3 – random testing

Its experience was that testing was not enough; rather there needed to be provision for education and a commitment to rehabilitation within the policy. There was no disciplinary action, the focus was on establishing that an employee had a problem and the avenues that were open to try and rectify it. The programme effectively put in place a health and wellbeing programme, as opposed to a negative disciplinary culture.

1.32.45 The New Zealand Press Association (NZPA) reported in September 2003 on a survey carried out by Port Nelson into the incidence of drug use by it's employees. The report stated in part:

> About 18% of prospective casual workers at Port Nelson have tested positive for illegal drugs since mandatory testing was introduced in November last year, the port company says.

> The results are comparable with two other regional employers, New Zealand King Salmon and Weyerhaueser New Zealand, which have reported positive testing rates from about 10% to more than 20%.
>
> …the percentage of people testing positive at the three companies has declined since testing was first introduced.
> Port Nelson's testing applies to all new appointments within the company, including internal transfers.
>
> …13 out of 72 casual staff who have applied since November have tested positive.
>
> Only one out of 41 permanent employees has tested positive since testing for them was introduced in September 2001.The company now plans to test workers where there is reasonable cause to suspect the influence of illegal drugs following a workplace incident.

1.32.46 The Chief Executive for Port Nelson said:

> "Drug and alcohol testing was introduced as a health and safety precaution because much of the company's work involved heavy equipment and machinery."

1.32.47 Despite there being no legislative requirement for it to do so, Tranz Rail, the major rail operator in New Zealand, developed a drug and alcohol policy under which the company reserved the right to implement a testing programme to include:

- pre-employment testing "to screen prospective employees to ensure that, at work, their safety and that of other employees and the public will not be compromised"
- reasonable cause testing for employees involved in workplace incidents or unsafe behaviour
- random testing

Trans Rail's policy had the general approval of the Rail and Maritime Transport Union Inc (RMTU), except for the inclusion of random testing (see 1.32.49). The RMTU supported "post incident" and "reasonable cause" cause testing, and these procedures were included in the collective agreement between Tranz Rail and RMTU dated March 2002, therefore making it an explicit agreement rather than a general approval. Although part of the policy, "random testing" was not included in the collective agreement.

Tranz Rail advised that since it had implemented pre-employment, post incident and reasonable cause testing, between 10 and 20% of those tested had returned positive results.

1.32.48 Under Tranz Rail's policy, a positive test result would only be recorded after a sample failed a two-stage test carried out by the Institute of Environmental Science and Research Ltd (ESR) as follows:

- stage 1 – a screening test. At this stage ESR tested for any trace of drugs in the sample
- stage 2 – full screening carried out at ESR laboratory. This full screening test was designed to specifically identify the nature of the substance found at stage 1.

Tranz Rail was only advised of a positive test result once a sample had been tested at both stages and ESR confirmed there were levels of drugs or alcohol in the system that were consistent with impairment or, in the case of drugs, reflected recent or chronic use.

1.32.49 Although the agreement between Tranz Rail and RMTU allowed for "reasonable cause" and "post incident" testing, RMTU viewed random testing as both undesirable and unnecessary. The RMTU was of the opinion that the rail industry had a culture of non-reporting of incidents as a consequence of operating in a low trust relationship between workers and management. It had been working with Tranz Rail to promote a culture of full and open reporting of incidents and accidents, with the implementation of a "no blame" policy and it believed that the introduction of random testing would be perceived as apportioning blame and perpetuating low trust. The RMTU also had concerns about what it considered "the unreliability of the tests".

1.32.50 In determining the standards for positive and negative results, ESR used Australian / New Zealand Standard 4308:2001 for the collection, detection and quantification of drugs of abuse in urine. In the case of alcohol, a positive test equated to failing the road alcohol limits while in the case of drugs, the cut-off levels were specified for each type of drug and reflected recent or chronic use. These levels were considered to be those which would adversely affect a person's performance. ESR testing has been used successfully in legal proceedings on numerous occasions and was considered to be reliable.

1.32.51 Tranz Rail's perspective on "random testing" was that it is designed to assist in managing alcohol and drug issues, before they caused an accident or incident. The company believed that effective management of substance impairment prior to that impairment causing an accident or incident was important and that random alcohol and drug-testing was one way that employers could seek to meet their health and safety responsibilities in this area. Provision for random testing was included in legislative rail regimes overseas as a tool for managing substance impairment, particularly in safety critical roles.

Analysis 11

1. Research figures indicate that the incidence of substance impaired performance in the New Zealand workplace is comparable to that overseas and may even be higher. Given the percentage of the population reported to have a substance use problem, it can be reasonably deduced that a similar percentage will be present in any particular workforce as indicated in the forestry and Port Nelson studies, and probably includes the rail industry.

2. No full study has been carried out to identify and quantify the extent of the problem in New Zealand but the figure quoted by Tranz Rail for pre-employment, reasonable cause and post occurrence testing indicate that a number of rail industry employees may be affected by a substance induced performance impairment problem.

3. Accidents caused by performance-impairing substances have occurred in the rail industries of Australia and the United States of America, and there is evidence to suggest that New Zealand is probably no different. Although this investigation is the first time the Commission has identified possible substance impairment in a rail accident or incident, the lack of mandatory testing post accident or incident has likely precluded such identification in previous investigations. Reasonable cause and post incident or accident testing carried out in the previous 12 months under the agreement between Tranz Rail and RMTU resulted in positive results despite pre-employment screening.

4. While substance abuse was identified as a major causal factor in some of the overseas accidents highlighted in this report, shortfalls in legislation regarding testing and the need for railroad employees to advise their employer of any medical conditions or the

use of prescription medication was identified in others. This demonstrated the need for legislation to be in place for substance testing, and that testing include prescription and over the counter drugs as well as other potentially harmful substances.

5. In both Australia and the United States of America lessons learned have influenced changes to State or Federal legislation to improve procedures for dealing with the substance abuse problem. There were some superficial differences in the wording of the respective legislations but they have all been driven by an international recognition of a "significant risk of death or serious injury" as a result of the presence of unacceptable substances in railroad workers. While the problem has been acknowledged and addressed by company procedures by many businesses within New Zealand, no legislative controls are in place, despite evidence that alcohol and drug abuse or dependency in New Zealand may be higher than the international figures.

6. There is every indication that a problem of substance impaired performance exists across the New Zealand workplace, prompting high-risk industries such as forestry and railways to develop their own drug and alcohol free workplace policies. With the increasing number of contractors and service providers being used by current rail operators, the management of such policies should be regulated and the provision of guidelines, either through changes to current legislation or enacted in new legislation, would be highly desirable in the interests of preventing accidents. Ideally such legislative changes should require each existing licensed operator, and any future operator, to have a substance abuse policy detailed within their safety system.

7. International experience suggests that "post accident / incident" and "reasonable cause" testing were not, on their own, sufficient deterrents against illicit substance abuse and, as a result, random testing was subsequently incorporated into drug and alcohol legislation to enforce prevention. The New Zealand experience may reflect this and it may become necessary in time to expand legislation to include this procedure.

2 Findings

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

2.1 The derailment of Train 533 resulted from the train entering a posted 45 km/h restricted speed curve at excessive speed.

2.2 The excessive speed was consistent with the locomotive engineer and rail operator's loss of attention and situational awareness consistent with their having fallen asleep.

2.3 The locomotive engineer was probably impaired by alcohol when starting his shift. However, his observed blood alcohol level for the time of the accident was low and any associated impairment would have been minor and not have played a significant role.

2.4 At the commencement of his shift on Thursday 25 July the locomotive engineer was probably experiencing the effects of an accumulated sleep debt as the result of extended hours of wakefulness between shifts. The effects of this fatigue may have been exacerbated by the effects of his previous consumption of a significant amount of alcohol.

2.5 Neither rostered hours, nor the hours actually worked by the locomotive engineer would have caused excessive sleep debt or contributed to the accident.

2.6 The derailment occurred at a time when the locomotive engineer's biological sleepiness would be expected to be increasing rapidly towards its daily maximum.

2.7 There was no evidence of any medical condition likely to have caused performance impairment, nor of sudden incapacitation or consequential sleep/alertness disorder.

2.8 The locomotive engineer died from multiple injuries sustained during the impact sequence and the rail operator sustained serious injuries from the major deceleration forces experienced during impact and the loss of the structural integrity of the locomotive cab.

2.9 There was no evidence that a different cab design would have improved the survivability of the accident.

2.10 The locomotive engineer did not made an emergency brake application immediately before the derailment, but even had he done so it would not have changed the outcome. The existing locomotive vigilance system may not provide an effective defence against microsleeps and the possibility of similar occurrences.

2.11 The rail operator's actions in driving Train 524, even though he was not certified to do so, did not directly contribute to the accident, although his ability to do so might have influenced the locomotive engineer's decision to commence his shift.

2.12 The practice of locomotive engineers allowing rail operators to drive trains was common in Stratford.

2.13 The radio coverage on the SOL generally met the required standard and did not contribute to the accident.

2.14 Although emergency services were initially directed to the wrong site, this had little bearing on their response time to the accident.

2.15 The lack of supervision in the train control centre meant that the initial response to the missing train, then in arranging a recovery programme, was delayed and not effectively managed.

2.16 The non-compliance with the instructions regarding additional clause 10 check calls did not contribute to the accident, but compliance might have ensured a quicker response to the missing train and allowed the train controllers to better define the search area.

2.17 The train controllers had not placed the appropriate importance on the train control diagram when planning and plotting the movement of Train 533.

2.18 The train controllers were not adequately trained in emergency response procedures, which resulted in a delay in correctly identifying the exact location of the train when several critical references from people on-site were missed.

2.19 The lack of documented information to assist the train controllers in determining the boundaries of the Pohokura radio repeater contributed to the delay in locating the missing train.

2.20 The workload on the Central North Island train control desk during the shift was such that it did not contribute to the delay in firstly recognising and then responding to the fact that Train 533 was overdue.

2.21 Tranz Rail's internal auditing procedures did not detect the frequent departures from specified track warrant procedures on the Stratford - Okahukura Line by train controllers working on the Central North Island desk, despite recommendations contained in the Train Control Operations Review.

2.22 There was no requirement for operators within the rail industry in New Zealand to develop, implement or maintain a policy relating to the management and control of performance impairing substances within the workplace.

3 Safety Recommendations

Safety recommendations are listed in order of development and not in order of priority.

3.1 On 5 September 2002 the Commission recommended to the Director of Land Transport Safety that he:

> Investigate train operations and route management on the Stratford to Okahukura Line, and other routes through remote areas; such investigation to include:
>
> - the performance of the train control radio system
> - the suitability of, and compliance with procedures, for tracking the progress of trains en route
> - the procedures when en route track warrant clause 10 radio check calls are not acknowledged by train control
> - the effectiveness of any existing emergency response plan
> - crew arrangements and rostering
>
> and initiate the action necessary to address any deficiencies found (046/02).

3.2 On 18 September 2002 the Director of Land Transport Safety replied, in part:

> The Land Transport Safety Authority (LTSA) accepts your final recommendation to perform an investigation on Tranz Rail's train operations and route management through remote areas.
>
> The LTSA is currently preparing a request for proposal (RFP) inviting suitably qualified consultants to conduct the investigation along with and on behalf of LTSA.
>
> The LTSA intends to commence implementation of your final safety recommendation prior to 31 October 2002.

3.3 On 14 October 2003 the Commission received a final copy of the "Review of Remote Line Operation" from the Land Transport Safety Authority.

3.4 On 6 June 2003 the Commission recommended to the Managing Director of Tranz Rail that he:

3.4.1 ensure that all employees who carry out safety-critical duties within the operations area receive formal training in fatigue awareness and management with priority being given to shift workers. Such courses should also be made available to staff members' families and be completed by the end of 2004 (015/03)

3.4.2 introduce procedures that define permanent, pre-determined call locations on routes under track warrant control, from where locomotive engineers must call train control to confirm their whereabouts; together with a requirement that if such calls are not acknowledged by train control, the train must stop at the next track warrant station or designated intermediate board until communication is established. (016/03)

3.4.3 take steps to improve the effectiveness of Tranz Rail's track warrant compliance monitoring regime in identifying repeated non-compliances at an early stage, and initiating appropriate follow-up action (018/03)

3.4.4 redevelop the current emergency response training programme for train controllers and network control managers, in conjunction with appropriate external agencies, to include but not limited to:

- responding to emergency notifications
- dealing with potentially distraught people reporting emergencies
- procedures for ensuring emergency sites are identified and confirmed
- the use of maps and map grid references when establishing such sites
- procedures for contacting emergency services

and ensure that such a course is mandatory prior to initial certification of a train controller and is part of ongoing train controller re-certifications (020/03)

3.4.5 provide train controllers with documentation clearly defining and illustrating the boundaries of radio repeaters in use on the respective routes of the network (022/03).

3.5 On 26 August 2003 the Managing Director advised that Tranz Rail accepted the recommendations.

3.6 On 6 June 2003 the Commission recommended to the Managing Director of Tranz Rail that he:

introduce the use of flashing red lights to identify the rear of all trains, not only those operating under ATC conditions (021/03)

3.7 On 1 July 2003 the Managing Director advised that Tranz Rail intended to further investigate end of train protection.

3.8 The following safety recommendations were made to the Managing Director of Tranz Rail on 19 June 2001, and were included in Rail Occurrence Report 00-115, regarding a derailment at Westmere on 25 September 2000:

implement Alertness Management training courses to reach at least 90 of locomotive engineers by the end of 2001 and 100% by the end of 2002 (018/01).

revise the operation of the vigilance device system to provide a better defence against short duration microsleeps (19/01).

These recommendations were also included in Rail Occurrence Report 02-107, regarding a collision at New Plymouth on 29 January 2002.

3.9 On 25 June 2001 the Managing Director of Tranz Rail advised that he accepted these recommendations and Tranz Rail were still in the process of implementation. The focus of these recommendations is equally applicable to this occurrence and a safety recommendation regarding the expanding of the Alertness Management training courses to include all Tranz Rail employees involved in shift work is included in this report.

3.10 On 16 January 2003 Tranz Rail advised:

> With reference to Safety Recommendation 019/01, a project engineer has been appointed by Alstom to provide variable time cycles and speed cycles of the vigilance system for trial. Trials are being conducted for the Locomotive Engineers council.

In view of the actions taken to date by Tranz Rail no safety recommendation relating to locomotive vigilance devices has been included in this report.

3.11 This investigation identified a need for safety recommendations relating to substance induced impairment, the requirement for the fitting of locomotive event recorders to all main line locomotives and the provision of train control voice recording and radio log facilities.

3.12 Preliminary safety recommendations to address these issues in all operators' safety systems were discussed with the Director of Land Transport Safety. The Director said that, although he acknowledged the safety merit of the recommendations, he did not intend to implement them by varying existing operators' safety systems.

3.13 In a letter to the Commission dated 17 October the Director noted that there was a division of legal opinion with the Crown Law Office and the Commission's legal counsel holding differing views. The Director stated in part that:

> Based on legal advice I have received I believe I do not have the power to implement the recommendations by means of requiring a change to [operators safety systems] under present legislation, because installing the recommended devices is unlikely, by itself, to avoid any significant risk of death or serious injury.

3.14 The Director did not consider that implementation of the safety recommendations was necessary in the interests of avoiding a significant risk of death or serious injury. However, the Commission, while acknowledging that the presence of recording systems may not stop a particular occurrence, believes that the lessons learned by the information gathered can avoid future occurrences involving a significant risk of death or serious injury. Furthermore, the Commission believes that the introduction of substance induced performance impairment policies will have a direct influence in avoiding such occurrences.

3.15 The findings of the investigation identify a need to act on these issues. If legislation prevents these safety recommendations being implemented, the Commission is of the view that legislation should be changed at the earliest opportunity and that the Railways Bill, which is currently before Parliament, may be the appropriate vehicle for incorporating such changes.

3.16 Therefore, on 18 September 2003 the Commission recommended to the Director of Land Transport Safety that he:

3.16.1 Either invoke Section 6F (1) of the Transport Services Licensing Act 1989 or, alternatively, procure changes to legislation or, alternatively, by any other process you judge suitable, ensure that the approved safety system for all rail operators includes a policy for managing the risks associated with substance induced performance impairment.

Such a policy should:

- be focused on education
- include all levels of staff and be collaborative between them
- include major contractors working for the licence holder
- encourage co-worker intervention after recognition of risk of or actual impairment
- allow for rehabilitation rather than punishment should a problem be identified
- include all substances that have the potential to impair performance, including those for medicinal use (prescription or otherwise), any toxic elements accidentally ingested or inhaled and any taken for recreational purposes
- include the requirement for individuals to be promptly tested for the presence of such substances where reasonable cause is shown and, in all cases, after an accident or incident (012/03)

3.16.2 Either invoke Section 6F (1) of the Transport Services Licensing Act 1989 or, alternatively, procure changes to legislation or, alternatively, by any other process you judge suitable, ensure that the approved safety system for all operators operating on the principal lines and loops of the national rail network, includes a requirement for the use of locomotive event recording devices in any locomotive, railcar, electric multiple unit or diesel multiple unit operated on a principal line or loop , together with the facilities to extract, store and print such information within an acceptable time span for the purposes of accident or incident investigation should the need arise.

The event recorder should meet or exceed existing Kaitiaki event recorder (as used by Tranz Rail) standards of accuracy, reliability and crash worthiness and be capable of recording data relevant to the running of the vehicle for a period of 2 months, including:

- speed
- brake cylinder pressure
- brake pipe pressure
- throttle notch
- train end monitor pressure (where applicable)
- vigilance event log.

Where maintenance schedules allow, priority should be given to the fitting of event recorders to electric multiple units and diesel multiple units.

The Commission recognises the difficulty of fitting the above event recorders to steam locomotives. Such locomotives, capable of exceeding 50 km/h while being operated on the main line, should be fitted with a locomotive event recorder that meets or exceeds the existing "Orange Box" event recorder currently used by heritage operators and should record, at a minimum, the speed of the locomotive at 10 second intervals. Such data should be accessible for a period of 7 days.

The development of any upgraded version of the "Orange Box" recorders should give consideration to the recording of additional information such as brake cylinder pressure, throttle setting and steam boiler pressure (013/03).

3.16.3 Either invoke Section 6F (1) of the Transport Services Licensing Act 1989 or, alternatively, procure changes to legislation or, alternatively, by any other process you judge suitable, ensure that the approved safety system for all operators operating on the principal lines, loops and sidings of the national rail network includes a requirement for a train control voice-recording facility and a train control radio log capable of being downloaded for analytical purposes.

The voice recording facility and radio log should meet or exceed the quality and standards produced by equipment currently used by Tranz Rail and should be capable of recording such voice channels as internal and external telephone lines and all train control radio channels and of recording and retaining relevant data for a period of 2 weeks (014/03).

3.17 On 22 September 2003 the Director of Land Transport Safety replied in part:

> I regret to advise that I am unable to implement the final recommendations as they have been worded.
>
> As we have discussed, Crown Law office opinion supports the Land Transport Safety Authority (LTSA) view that I do not have the power to require safety system variations as outlined in these recommendations.
>
> I also have no power to "procure changes to legislation". As such, that recommendation is inappropriately directed to me and should instead be directed to the Ministry of Transport. We are however discussing options to progress this issue.
>
> You have also recommended that "alternatively, by any other process you judge suitable, ensure that the approved safety system…" but under current legislation, there is very little other process available to me. If the LTSA received a new licence application and was considering a new safety system, we could require provisions in line with your recommendations, however I envisage very few new applications under current legislation.

3.18 While these safety recommendations have been made to the Director of Land Transport Safety, the Commission also draws them to the attention of the Minister of Transport.

3.19 Because of the safety implications of these recommendations 012/03, 013/03 and 014/03, possible procedures through which they may be implemented are the subject of on-going discussion with the Ministry of Transport and the Land Transport Safety Authority.

Approved for publication 21 October 2003

Hon W P Jeffries
Chief Commissioner

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