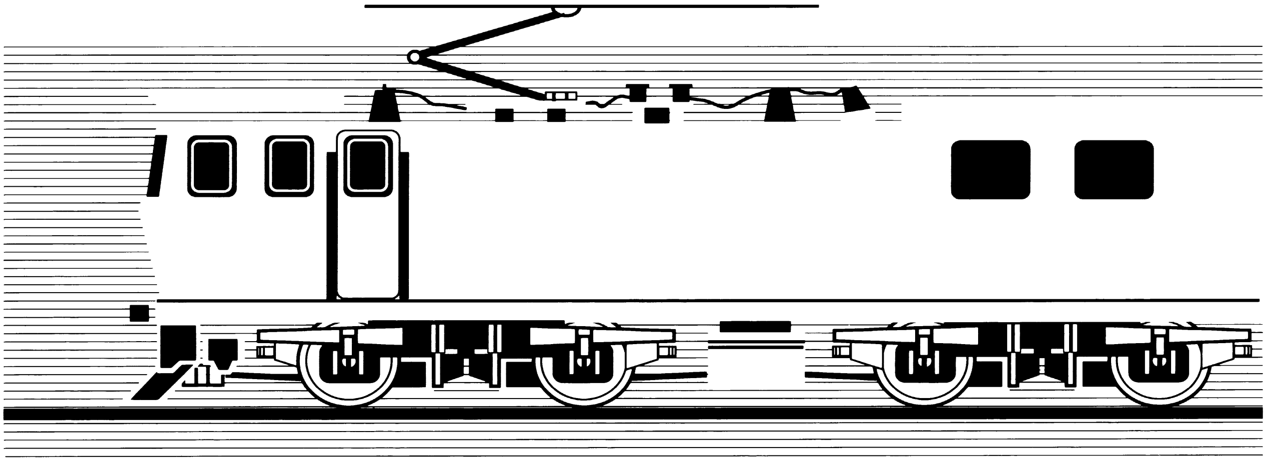
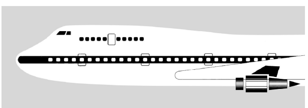
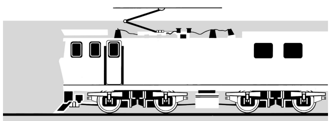
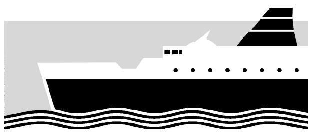


RAILWAY OCCURRENCE REPORT

02-107 express freight Train 530, collision with stationary shunt locomotive, New Plymouth — 29 January 2002

TRANSPORT ACCIDENT INVESTIGATION COMMISSION
NEW ZEALAND

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Report 02-107

express freight Train 530

collision with stationary shunt locomotive

New Plymouth

29 January 2002

Abstract

On Tuesday 29 January 2002 at about 1119, express freight Train 530 collided with a stationary shunting locomotive in New Plymouth when the locomotive engineer fell asleep briefly while berthing.

There were no injuries and the locomotives were only slightly damaged.

The following safety issues were identified:

- the restorative sleep habits of the locomotive engineer while working night shifts
- the inability of the locomotive vigilance system to overcome short-term attention deficits in time to prevent this type of accident.

In view of safety recommendations made to the operator in Rail Occurrence Reports 00-115, 00-117 and 00-121 relating to previous occurrences involving similar attention loss through microsleeps, no further safety recommendations were made to the operator.

Contents

Figures

Abbreviations

km/h	kilometres per hour
NASA	National Aeronautical and Space Administration
Tranz Rail	Tranz Rail Limited

Data Summary

Train type and number:	express freight Train 530
Date and time:	29 January 2002 at 1119
Location:	New Plymouth
Type of occurrence:	collision
Persons on board:	crew: 1
Injuries:	crew: nil
Damage:	Minor to DC4156 and DSG3020
Operator:	Tranz Rail Limited
Investigator-in-charge	D L Bevin

1 Factual Information

1.1 Narrative

1.1.1 On Tuesday 29 January 2002, express freight Train 530 was a Palmerston North to New Plymouth service and consisted of DC locomotives 4156 and 4657 in multiple and 9 wagons for a gross weight of 291 tonnes and was 161 metres in length. It was crewed by a locomotive engineer.

1.1.2 The locomotive engineer commenced duty at Stratford at 0400 that morning and drove Train 573 to Whareroa, where he was rostered to change over with the locomotive engineer of Train 530 and return to New Plymouth.

1.1.3 At Whareroa the locomotive engineer placed the wagons from Train 573 in the sidings then checked on the whereabouts of Train 530 with train control. He was told it was running late, so he arranged to use an available road vehicle to go to Waitotara to meet it.

1.1.4 Train 530 was at Waitotara when he arrived and after a brief discussion with the locomotive engineer he was relieving, he departed at about 0720. He reduced wagons from his train at both Whareroa and Eltham and arrived in Stratford at about 1015. After a short stop to get a drink of water, he departed Stratford at about 1025 for New Plymouth.

1.1.5 About 10 minutes later, as Train 530 passed thorough Midhirst, the locomotive engineer was alerted by the heat sensor[1] that the rail temperature at that point was in excess of 40^{o}C degrees celcius. He immediately advised the train controller, who said he would get the site inspected and as a precaution he issued heat restriction bulletins for other potential high temperature sites on the remainder of the route to New Plymouth.

1.1.6 As Train 530 approached New Plymouth, the locomotive engineer called the terminal team leader to advise of his imminent arrival. The team leader advised him that the train would be berthing on 3 road, and that all points were correctly set. The locomotive engineer was asked to pull well down, as the wagons on his train were to connect with the wharf shunt. The wharf shunt locomotive was parked unattended and stationary on the shunting leg, at what was referred to as the north end of the yard at the time.

1.1.7 The locomotive engineer said later that he thought he was about 4 locomotive lengths (about 70 metres) away from the team leader when he "just relaxed too much and dozed off for a minute second". The next thing he knew was a call on the radio to "Stop", but he was about 3 locomotive lengths past the team leader by then and was heading towards the shunt leg where the wharf shunt locomotive was parked. He immediately "slammed it in to emergency, slammed the independent brake on", but was unable to stop the train before it collided at low speed with the shunt locomotive. There were no injuries and minor damage only was sustained by the locomotives.

1.1.8 The locomotive engineer said later that he thought the train was travelling at about 10 to 15 km/h when he was awakened by the radio call to "stop".

1.2 Site details and signalling arrangements

1.2.1 The line approaching New Plymouth terminal was single track and operated under centralised traffic control rules and regulations. Entry to the terminal was governed by a Stop and Stay Home Signal, equipped with a low speed light and was controlled from the train control office in Wellington.

[1] A trackside radio unit fitted with a thermocouple that measures rail temperature. When a pre-set temperature is detected by the unit, a radio alert is sent to train control and an announcement is broadcast on the local radio channel for trains in the vicinity to hear.

1.2.2 The berthing of main line trains was arranged in consultation with the Team Leader and the Rail Operator in charge of each shunting service, to avoid conflicting movements.

1.2.3 The maximum speed for trains travelling within the loop and sidings at New Plymouth was 25 km/h.

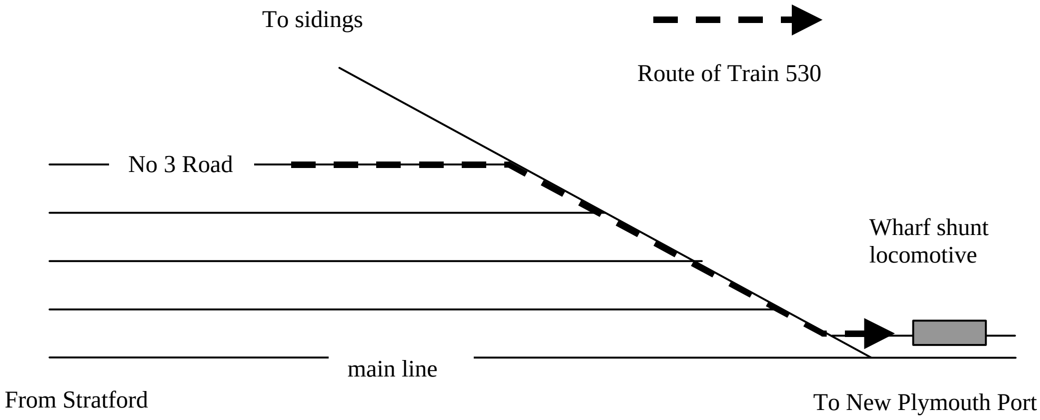

Figure 1
Diagram of north end of New Plymouth yard (not to scale)

1.3 Locomotive event recorder data

1.3.1 The event recorder data from the locomotive was downloaded and supplied for analysis.

1.4 Locomotive vigilance device

1.4.1 The vigilance device went through a cycle of a light illuminating every 50 seconds if no locomotive controls were moved. If there was no response to the light within 10 seconds, a buzzer sounded in the cab. If there was no response to the buzzer in the next 10 seconds, braking was automatically applied and an alarm sounded in train control. The locomotive engineer could reset the vigilance device at any time, by either manually pushing the cancel button, or operating the controls of the locomotive.

1.4.2 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"

and referred to other options to form part of a final assessment. As part of the Commission's investigation into the derailment of Train 521 at Westmere on 22 September 2000, Tranz Rail advised that no changes had been made to the fixed cycle system in use in 1997 as a result of this assessment, and 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.

Then 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.

1.5 Personnel

Locomotive engineer

1.5.1 The locomotive engineer had 17 years experience and held a current certification for the duties he was performing. On the day of the collision his shift had commenced at Stratford, which was his work depot, at 0400. He lived in New Plymouth, which entailed a 20 to 30 minute car journey before and after each shift.

1.5.2 The temperature had been high during the morning, particularly so in the driving position on the eastern side of the locomotive. The locomotive engineer had been in direct sunlight from 0710, when he had taken the train over at Waitotara and by the time he got back to New Plymouth had sustained some sunburn to his arm. During the journey he had removed some articles of clothing in an attempt to keep cool and had stopped for a quick drink of water at Stratford. He said later that he had been looking forward to getting to New Plymouth so he could have his “smoko break”.

1.5.3 After driving Train 530 to New Plymouth, the locomotive engineer was rostered to service the locomotives from the train and then take Train 575 back to Stratford, to complete his shift. He estimated those duties would have taken about 2 hours.

1.5.4 The locomotive engineer had been involved in a previous sleep-induced incident at the controls of a train in September 2000 (Report 00-115). After that incident, Tranz Rail had arranged for him to attend a sleep clinic in Wellington for assessment. No sleep difficulties were identified during that assessment and the locomotive engineer returned to normal duties.

1.5.5 In the 16 days before the incident the locomotive engineer was rostered on duty for 7 days for a total of 60 hours. His 9 days off were either by request or through rostering requirements. The rostered and corresponding actual hours worked by the locomotive engineer are shown in the following table:

			Rostered hours	Actual hours
Sun	13/1	Off Duty		
Mon	14/1	1930 - 0430	09.00	09.30
Tue	15/1	1930 - 0430	09.00	10.00
Wed	16/1	Day in lieu		
Thu	17/1	Off duty - Mandatory		
Fri	18/1	Off duty - Mandatory		
Sat	19/1	Off duty – by request		
Sun	20/1	Off duty – by request		
Mon	21/1	Off duty – by request		
Tue	22/1	0130 - 0900	07.30	07.30
Wed	23/1	0130 - 0900	07.30	07.30
Thu	24/1	0130 - 0900	07.30	08.10
Fri	25/1	Off duty - Mandatory		
Sat	26/1	Off duty - Mandatory		
Sun	27/1	0500 - 1500	10.00	10.00
Mon	28/1	0400 - 1330	09.30	10.00
			60 hours	**62 hours 40 minutes**
Tue	Incident day (29/1)	0400 - 1330	09.30	07.20 (to time of incident)

1.5.6 To minimise disturbance to his daytime sleep, the locomotive engineer slept in a detached sleepout, although the sleepout often became unbearably hot, which made sleeping difficult. When working night shifts, he had developed a routine of having about 4 hours sleep when he got home and then sleeping again before going to work. He also regularly took controlled naps while waiting for opposing trains to pass.

1.5.7 The locomotive engineer's self-reported bed and nap times from 20 January 2002 were:

Date	Nap	Bed	Awake (next day)	Total rest
Sun 20/01		2330	0730	8 hours
Mon 21/01		1830	0115	6 hours 45 minutes
Tues 22/01	1000 – 1300	1900	0100	9 hours
Wed 23/01	0945 – 1245	1850	0100	9 hours 10 minutes
Thu 24/01	1045 – 1330	2210	0630	11 hours 5 minutes
Fri 25/01		2030	0700	10 hours 30 minutes
Sat 26/01		2030	0500	8 hours 30 minutes
Sun 27/01		2000	0330	7 hours 30 minutes
Mon 28/01	1700 - 1730	2030	0315	7 hours 15 minutes

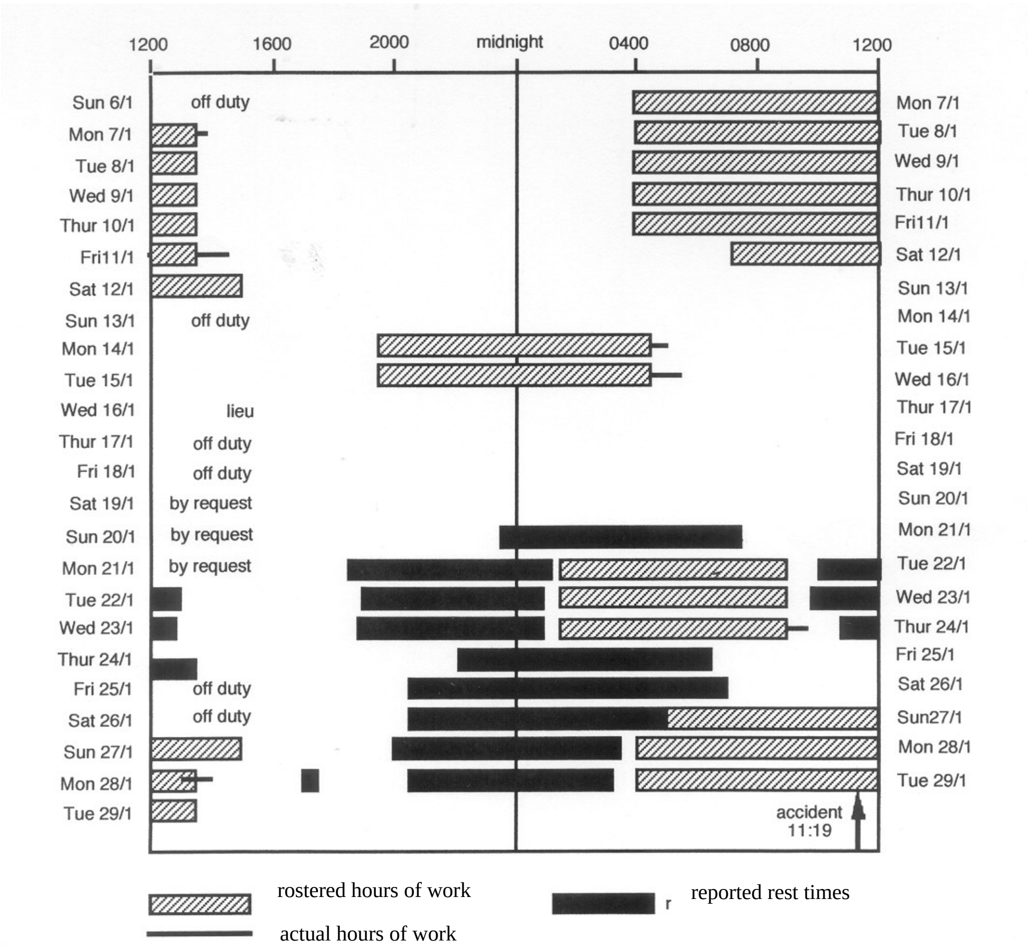

Figure 2
The work and rest patterns for the locomotive engineer over the 3 weeks prior to the collision

1.5.8 The locomotive engineer's wife also worked shift work which, at times conflicted with his restorative periods between shifts. On such occasions he had to care for their infant son.

Team leader

1.5.9 The team leader had worked for Tranz Rail for about 30 years and was responsible for the berthing of trains arriving at the New Plymouth terminal. Before berthing any train, he had to first check with other terminal staff that the road was correctly set for the incoming train and satisfy himself that there were no potential conflicting movements within the terminal at the time.

1.5.10 After he had been contacted by the locomotive engineer of Train 530, the team leader had checked with terminal staff and then told the locomotive engineer that the road was correctly set for his train to berth on 3 road. He satisfied himself that the yard shunt locomotive was clear of the area and that the wharf shunt locomotive was parked on the shunting leg, before going out into the yard to await the train's arrival.

1.5.11 As Train 530 approached him, the team leader became aware that it was travelling "fairly fast" and did not appear to be slowing down. When he realised that it was not going to stop, he called "Stop. Stop. Stop." to the locomotive engineer by radio. The locomotive had passed him when he heard the train's brakes go on, but it was too late to avoid the collision.

1.5.12 The team leader thought that the maximum allowable speed in the terminal was 15 km/h, and that the train had been exceeding that speed as it approached him.

1.6 Sleep/Wake information

1.6.1 The locomotive engineer reported that he had "relaxed too much and just dozed off" which prompted a close look at the possible role of acute or cumulative sleep debt and fatigue in this incident. The Commission engaged the services of Associate Professor Philippa Gander PhD, an internationally recognised sleep and fatigue management expert. Her analysis is included in sections 2.2 and 2.3 of this report.

1.6.2 The locomotive engineer had provided a sleep summary page and details of his sleep patterns from his diary for analysis.

1.7 Previous occurrences involving attention loss

1.7.1 The Commission has investigated 3 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.

1.7.2 In addition Report 00-111, Tapuata, a track warrant overrun on 14 June 2000, concluded 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.

1.7.3 Report 01-104, Mokoia, a collision between 2 southbound express freight trains, 7 March 2001, concluded 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.

2 Analysis

2.1 Locomotive event recorder data

2.1.1 The speed of Train 530 was 14 km/h when the locomotive engineer throttled up from notch 2 to notch 4 as he approached 3 Road, about 65 seconds before impact. No further changes were made to the locomotive control settings for the next 50 seconds during which time the train travelled about 350 metres and increased speed to 35 km/h.

2.1.2 When the locomotive engineer responded to the "stop" warning from the team leader, he was about 15 seconds and about 100 metres from the shunt locomotive. Although he made an emergency brake application and also applied the locomotive independent brake, there was insufficient distance to avoid a collision.

2.1.3 Train 530 was travelling at about 7 km/h at the time of impact.

2.2 Locomotive vigilance device

2.2.1 Prior to the locomotive engineer making the emergency brake application, the vigilance device cycle was last reset when he had operated the locomotive controls 50 seconds earlier.

2.2.2 Had the locomotive engineer not been woken by the radio call from the team leader, it is unlikely that he would have been woken by the illumination of the vigilance device, which was due to come on at about the same time.

2.2.3 The audible alarm of the vigilance device would have activated 10 seconds after the illumination alert. Had the train continued at its speed of 35 km/h, it would have travelled the remaining 100 metres to the point of impact in about 10 seconds, which meant that the impact may possibly have coincided with the commencement of the audio alarm. However, had the train continued to accelerate, the impact would have occurred before the audio alarm was activated.

2.2.4 In either scenario, the locomotive engineer would have been unable to respond and this would have resulted in a more serious, and potentially life-threatening, situation. The vigilance device was not able to prevent this accident, nor would it have prevented these alternative scenarios. This continues to raise doubts about the suitability of the vigilance device in its present form, to prevent short-duration microsleeps.

2.3 Locomotive engineer fatigue

Method for assessing fatigue

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

2.3.2 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

2.3.3 The accuracy of sleep history is inherently limited by the fact that subjective reports of sleep duration and timing are not necessarily reliable, and by the fact that the incident had intervened between the sleep episodes and when they were being recalled.

2.3.4 The locomotive engineer was an experienced shift worker, who had developed a pattern of sleep for coping with night shift, including using a sleepout to minimise disturbance to his daytime sleep. He also had a routine of taking naps when he was parked and waiting for another train to cross; a strategy that he used regularly. All of the strategies he described, with regard to managing his sleep, were practical and, if adhered to, would have been expected to be beneficial, and suggested a responsible attitude to prioritising and planning sleep.

2.3.5 The "split sleep" pattern, as practised by the locomotive engineer, is common among night workers and there is considerable scientific evidence to indicate that the sleep period prior to night duty is very effective in improving alertness and performance across the night shift.

2.3.6 There were some minor discrepancies between the sleep times noted in the locomotive engineer's sleep summary page and the sleep times indicated in his diary. For example, the diary had noted a 30 minute nap on the afternoon before the incident but this had not been noted in the sleep summary page, and the reported wakeup times did not always appear to allow sufficient time for him to commute to Stratford to commence his shift at the rostered time.

2.4 Factors that increase the likelihood of falling asleep uncontrollably

Time of day

2.4.1 Biological sleepiness[2] 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 in studies of locomotive engineers.

2.4.2 A 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. The warning hooter was most likely to sound around 0300 and again in the early afternoon.

2.4.3 The collision happened at about 1119, which corresponds to the time in the cycle of the circadian body clock when the biological tendency to fall asleep is generally weakest. It is normally a part of the cycle in which people have some difficulty falling asleep.

Time on shift

2.4.4 The German study also found that how long a locomotive engineer had been on shift affected how impaired his alertness became 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.

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

2.4.5 At the time of the collision the locomotive engineer had been on shift for over 7 hours, about 4 of which had been spent sitting in direct sunlight. Time-on-task fatigue, and possibly dehydration, probably contributed to a lapse in his attention.

Duration of continuous wakefulness

2.4.6 Laboratory studies consistently show that biological sleepiness increases the longer a person stays awake[3].

2.4.7 The collision occurred about 8 hours after the end of the locomotive engineer's last reported sleep period, so extended wakefulness would not have been expected to contribute to his biological sleepiness at the time.

Prior sleep loss

2.4.8 Insufficient prior sleep increases biological sleepiness at all times in the circadian body clock 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.

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

2.4.10 The effects of several nights of reduced sleep accumulate into a "sleep debt", with sleepiness and performance becoming progressively worse. Recovery sleep after an accumulated sleep debt, is usually deeper and more efficient, and the lost hours do not need to be recovered hour-for-hour. It typically takes 2 full nights for sleep and daytime functioning to return to normal after sleep loss.

2.4.11 From the available information it was not possible to determine what the usual amount of sleep the locomotive engineer required to feel well-rested. His reported 8 hour sleep on the night of Sunday 20 January followed 4 days of leave, and was not influenced by an early start time, so might be indicative of his normal sleep need. On the other hand, he reported sleeping between 10 and 11 hours on his second night off after night shift, which was also not influenced by shift requirements, so this could indicate that his usual sleep need was considerably more than 8 hours.

2.4.12 For the 3 days prior to the collision, the locomotive engineer had had early starts of 0500, 0400 and 0400. It is common for shift workers to lose significant amounts of sleep in association with early starts because they have difficulty going to sleep early in anticipation, on the evening before. Although the locomotive engineer reported going to bed around 2000 for the 4 nights preceding the collision, it was not possible to determine whether this was when he tried to go to sleep, or how long it took him to fall asleep. In general, people are not very reliable at estimating how long they take to fall asleep.

2.4.13 By his estimation, on the 2 days prior to the collision, the locomotive engineer had averaged about 7 hours 25 minutes of sleep and only had 6 hours 45 minutes of sleep on the night prior to the collision. As a consequence, he may have experienced some level of sleep loss at the time of the collision.

[3] The increase in biological sleepiness associated with increasing time awake is superimposed on the rises and falls in sleepiness associated with the cycle of the circadian biological clock.

2.4.14 In the 7 days prior to the collision the locomotive engineer had been rostered to work 42 hours but had actually worked 43 hours 10 minutes. Of this shift time 26 hours 30 minutes had occurred between 0001 and 0800, that is, during the optimum part of the body clock cycle for sleep. He also had to drive half an hour to and from work, and on the day before the collision his shift had lasted 30 minutes longer than rostered and his sleep period immediately prior to the shift was the shortest of any recorded.

2.4.15 Based on his self-reported sleep, it is possible that the locomotive engineer experienced some effects of acute sleep loss, and of a cumulative sleep loss at the time of the collision, although the precise magnitude of this sleep debt could not be accurately calculated from the information available.

Presence of a sleep disorder

2.4.16 The restorative value of sleep, in terms of reducing biological sleepiness and improving subsequent waking function, depends not only on the amount of sleep obtained but also on its quality. Sleep that is restless and fragmented by frequent awakenings also leaves a person sleepy and at increased risk of impaired alertness and performance.

2.4.17 Although there are a large number of recognised medical disorders that can disrupt the quality of sleep, there was no evidence to suggest that a medical disorder was responsible for the sleep debt experienced by the locomotive engineer.

Opportunities for recovery from sleep debt

2.4.18 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.

2.4.19 Although the locomotive engineer had developed effective plans and strategies for coping with sleep, he had possibly not adhered to them during the time leading up to this incident, in which case, the conflicting demands on his restorative time between shifts by the need to care for his infant son, or poor quality sleep because of summertime heat, may have contrived to erode the quality of his restorative sleeps between shifts.

2.4.20 The collision occurred during the locomotive engineer's third consecutive early start shift following 2 rostered mandatory days off-duty. His starting hours during this portion of his roster had been 0500, 0400 and 0400. Prior to his 2 mandatory rostered days off he had been rostered for, and worked, 3 consecutive 0130 start shifts.

2.4.21 The locomotive engineer's sleep diary showed that, during the 0130 start shifts, he was either napping or in bed for restorative sleep periods of 9 hours, 9 hours 10 minutes and 11 hours 5 minutes respectively between the shifts, although, on the night leading into the first shift, he had only managed 6 hours 45 minutes in bed before he commenced duty. It is possible that he had not achieved quality sleep for those durations and as a result commenced this portion of his roster with a sleep debt from the first night that accumulated during the remaining shifts.

2.4.22 On the mandatory days off the locomotive engineer had recorded 10 hours 30 minutes and 8 hours 30 minutes respectively in bed but it is possible that he did not achieve sufficient quality restorative sleep during those times to repay in full the cumulative sleep debt from the previous 3 shifts. As a consequence the remaining sleep debt was carried over into the next portion of his roster, the 0500 and 0400 starting shifts.

2.4.23 The locomotive engineer's diary entries for the 0500 start shift, and the first of the 0400 start shifts, showed that he had achieved time in bed of 7 hours 30 minutes prior to commencing the first shift and 6 hours 45 minutes between the first and second shifts. Again, it is possible that he did not achieve quality restorative sleep for those durations, with the result that further sleep debt would have been added to that already carried over from his initial 0130 starts.

Conclusions regarding the locomotive engineer having fallen asleep uncontrollably

2.4.24 The collision occurred around the time in the daily body clock cycle when falling asleep spontaneously would be least likely under normal circumstances. The locomotive engineer had been awake for 8 hours, so prolonged wakefulness was not an issue. However, sleepiness at all times is increased by inadequate prior sleep. Based on the available evidence, it is possible that he had experienced the effects of some acute sleep loss and cumulative sleep debt at the time of the collision, but the extent of this sleep loss could not be reliably determined.

2.4.25 The locomotive engineer indicated that he went to sleep around 2000 on the 4 nights preceding the collision, but generally people have difficulty falling asleep in the few hours before their normal bedtime, during that part of the circadian body clock cycle known as the "evening wake maintenance zone". It was not clear from the information gathered whether he had discriminated between times of going to bed and times of falling asleep, but it is possible, given that it was summer and daylight saving time, that he had taken a long time to fall asleep on these nights. If so, this could have increased his level of sleep debt and therefore his sleepiness at the time of the collision.

2.4.26 If the locomotive engineer had slept well throughout the times indicated, his level of sleep debt at the time of the collision would not have been expected to have caused extreme sleepiness, however, the restorative quality of his sleep may have been compromised.

2.4.27 The locomotive engineer had experienced normal night sleeps in the 4 day period prior to the collision. His microsleep had occurred at a time when falling asleep spontaneously was unlikely and prolonged wakefulness was not an issue. Therefore, it is most probable that his vigilance was affected by his being over 7 hours into his shift without a meal break and by dehydration due to sitting for long periods in direct sunlight on a hot day. He was also looking forward to arriving in New Plymouth so he could have his long awaited break and this anticipation probably caused him to relax.

2.4.28 It had not been possible to clearly establish at which point the locomotive engineer had succumbed to the microsleep. However, the steady acceleration of the train suggested he had done so soon after entering the terminal.

3 Findings

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

3.1 Train 530 collided with the stationary shunt locomotive as a result of the locomotive engineer's loss of attention and situational awareness, consistent with his having fallen asleep uncontrollably.

3.2 The extent of the locomotive engineer's tiredness was probably due to his working continuously in excess of 7 hours without a break and from dehydration from sitting for long periods in direct sunlight on a hot day.

3.3 The locomotive engineer was possibly experiencing the effect of an accumulated sleep debt at the commencement of his shift on Tuesday 29 January 2002 as a result of poor quality of sleep during hot summer days and nights and conflicting demands on his restorative period between shifts.

3.4 The collision occurred at a time when the locomotive engineer's biological sleepiness would not have been expected to be high.

3.5 There was no medical disorder identified which may have contributed to the locomotive engineer's accumulated sleep debt.

3.6 Neither rostered hours, nor the hours actually worked by the locomotive engineer would have caused excessive sleep debt.

3.7 The existing locomotive vigilance device may not provide an effective defence against short microsleeps, or prevent similar occurrences in the future.

4 Safety Actions

4.1 Tranz Rail advised that the locomotive engineer had attended a second alertness management training course following the incident.

5 Safety Recommendations

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

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

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

5.2 The Managing Director of Tranz Rail 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 no further safety recommendations are made.

Approved for publication 02 October 2002

Hon. W P Jeffries
Chief Commissioner

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