Transport Accident Investigation Commission

Final report
Tuhinga whakamutunga

Rail inquiry RO-2022-102
L71 Mainline Shunt
Derailment and subsequent rollover
Tamaki
1 June 2022

December 2023

The Transport Accident Investigation Commission
Te Kōmihana Tirotiro Aituā Waka

No repeat accidents – ever!

"The principal purpose of the Commission shall be to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future, rather than to ascribe blame to any person."

Transport Accident Investigation Commission Act 1990, s4 Purpose

The Transport Accident Investigation Commission is an independent Crown entity and standing commission of inquiry. We investigate selected maritime, aviation and rail accidents and incidents that occur in New Zealand or involve New Zealand-registered aircraft or vessels.

Our investigations are for the purpose of avoiding similar accidents in the future. We determine and analyse contributing factors, explain circumstances and causes, identify safety issues, and make recommendations to improve safety. Our findings cannot be used to pursue criminal, civil, or regulatory action.

At the end of every inquiry, we share all relevant knowledge in a final report. We use our information and insight to influence others in the transport sector to improve safety, nationally and internationally.

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Key Commission personnel

Chief Executive	Martin Sawyers
Chief Investigator of Accidents	Naveen Kozhuppakalam
Lead Investigator for this inquiry	Jason Lawn
Commission General Counsel	Cathryn Bridge

Notes about Commission reports
Kōrero tāpiri ki ngā pūrongo o te Kōmihana

Citations and referencing

The citations section of this report lists public documents. Documents unavailable to the public (that is, not discoverable under the Official Information Act 1982) are referenced in footnotes. Information derived from interviews during the Commission's inquiry into the occurrence is used without attribution.

Photographs, diagrams, pictures

The Commission owns the photographs, diagrams and pictures in this report unless otherwise specified.

Verbal probability expressions

For clarity, the Commission uses standardised terminology where possible.

One example of this standardisation is the terminology used to describe the degree of probability (or likelihood) that an event happened, or a condition existed in support of a hypothesis. The Commission has adopted this terminology from the Intergovernmental Panel on Climate Change and Australian Transport Safety Bureau models. The Commission chose these models because of their simplicity, usability, and international use. The Commission considers these models reflect its functions. These functions include making findings and issuing recommendations based on a wide range of evidence, whether or not that evidence would be admissible in a court of law.

Terminology	Likelihood	Equivalent terms
Virtually certain	> 99% probability of occurrence	Almost certain
Very likely	> 90% probability	Highly likely, very probable
Likely	> 66% probability	Probable
About as likely as not	33% to 66% probability	More or less likely
Unlikely	< 33% probability	Improbable
Very unlikely	< 10% probability	Highly unlikely
Exceptionally unlikely	< 1% probability	

Figure 1: Locomotive DCP4605

(Credit: John Russell)

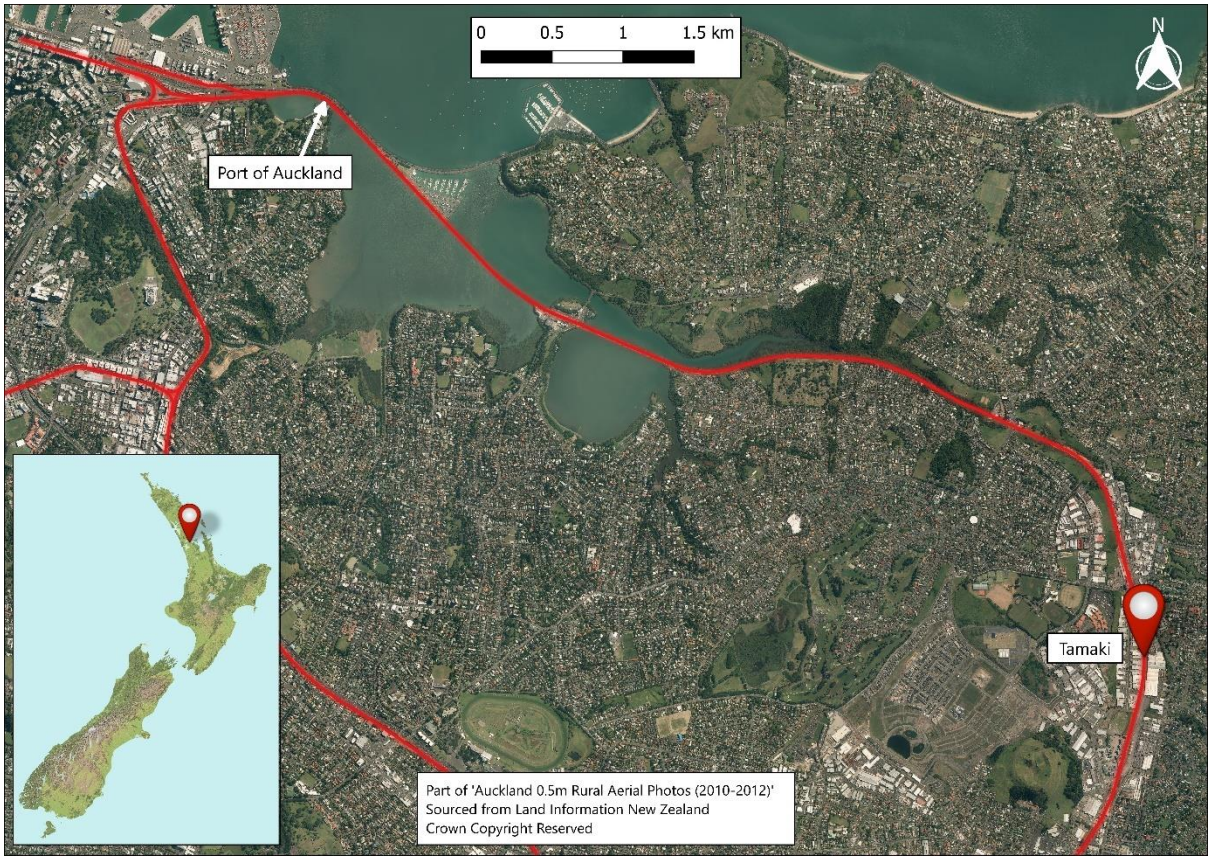

Figure 2: Location map and NIMT rail network – Tamaki

(Credit: Toitū Te Whenua, LINZ)

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1 Executive summary
Tuhinga whakarāpopoto

What happened

1.1. On 31 May 2022, a three-person train crew was transporting freight wagons between the Wiri rail yard and the Port of Auckland on the North Island Main Trunk (NIMT) line. The crew consisted of a locomotive engineer (LE), a rail operator who was under training (the trainee) and another rail operator who was supervising the trainee as a minder (the minder).

1.2. On 1 June 2022, at about 0057, the crew departed the Port of Auckland for their return journey to the Westfield rail terminal following the completion of their scheduled work. Because of planned work on the NIMT, train control set the first part of the route on the bi-directional track[1] back to Westfield using the up mainline in a down direction. The single-cab locomotive was being operated in a long-hood leading configuration,[2] which meant that the LE was unable to see the signals when travelling on the up mainline in the down direction. This required the trainee to observe the rail signal indications along the track and report them to the LE.

1.3. At about 0103 the locomotive, travelling at about 77 kilometres per hour (km/h), entered a track crossover point at Tamaki. As it did so, the locomotive derailed and overturned, coming to rest on its side approximately 55 metres (m) from the point of derailment.

1.4. The three crew members suffered minor to moderate injuries and evacuated the cab through the broken front windscreen of the locomotive.

Why it happened

1.5. The locomotive was unable to cross from one track to another safely because of its high speed. It was travelling approximately 50 km/h faster than the speed set by the signal indications.

1.6. The trainee had been tasked to identify and report the signal indications to the LE along the route. Because of the seating arrangement in the locomotive cab while travelling in a long-hood leading configuration, the minder could not confirm that the trainee was interpreting and reporting the signal indications correctly.

1.7. The trainee incorrectly reported two signal indications to the LE and the LE maintained the speed of the locomotive based on that incorrect information.

1.8. KiwiRail had not undertaken a risk assessment for operating locomotives in the long-hood leading configuration on the Auckland Metro rail network. As a result, the risks associated with long-hood leading operations had not been adequately managed.

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[1] A bi-directional track is a track that is signaled to take trains in both directions rather than just in one direction (*see* Figure 3).

[2] Single-cab locomotives have only one driving cab. When the locomotive is being operated with the cab at the forward end in relation to the direction of travel, it is termed 'short-hood leading' operations. When the locomotive is being operated from the cab at the rear-end in relation to the direction of travel, it is termed 'long-hood leading' operations. Dual-cab locomotives have a driving cab at each end of the locomotive and can be driven in either direction from the front of the locomotive (*see* Figure 4 for dual- and single-cab locomotives).

What we can learn

1.9. Operating locomotives in a long-hood leading configuration on the NIMT line poses additional safety risks. When an activity is infrequent or different from normal operations, a risk assessment should occur, and a risk management plan put in place.

1.10. On-the-job training can introduce additional risks to an operation. Effective supervision of trainees undertaking safety-critical tasks is an important defence against unsafe activity.

1.11. Fitness for duty is an important risk control measure that ensures individuals can focus on the task at hand. Distractions in the form of injuries, illnesses or stresses outside work can impact the ability to concentrate and can impair cognitive performance.[3]

1.12. Crew Resource Management (CRM) is an important tool that enables individuals to work together effectively, particularly when operating in unusual or non-normal circumstances. CRM requires the use of all available resources; communication should include all parties who have relevant operational safety information to share.

1.13. Complex systems require robust engineering-risk controls to guard against variable human performance within the system. Administrative controls, which are vulnerable to human error and non-compliance, should not solely be relied upon to keep a system safe.

1.14. Regulatory oversight is an integral part of any transport safety system. Independent assurance that an operator is appropriately managing their safety-critical risks provides a fundamental layer of defence against the introduction of unsafe operational practices.

Who may benefit

1.15. Rail personnel, transport operators and anyone involved in safety assessments may benefit from the findings in this report.

[3] Cognitive performance comprises the mental processes of perception, learning, memory, understanding, awareness, reasoning, judgment, intuition and language.

2 Factual information
Pārongo pono

Background

2.1. L71 is the service number assigned to a regularly scheduled shunt service that moves rail freight between the Wiri rail yard (Wiri) and the Port of Auckland rail facility (Port of Auckland) using the North Island Main Trunk (NIMT) line, which incorporates a portion of the Auckland Metro rail network.

2.2. The Auckland Metro rail network is a bi-directional track (*see* Figure 3).

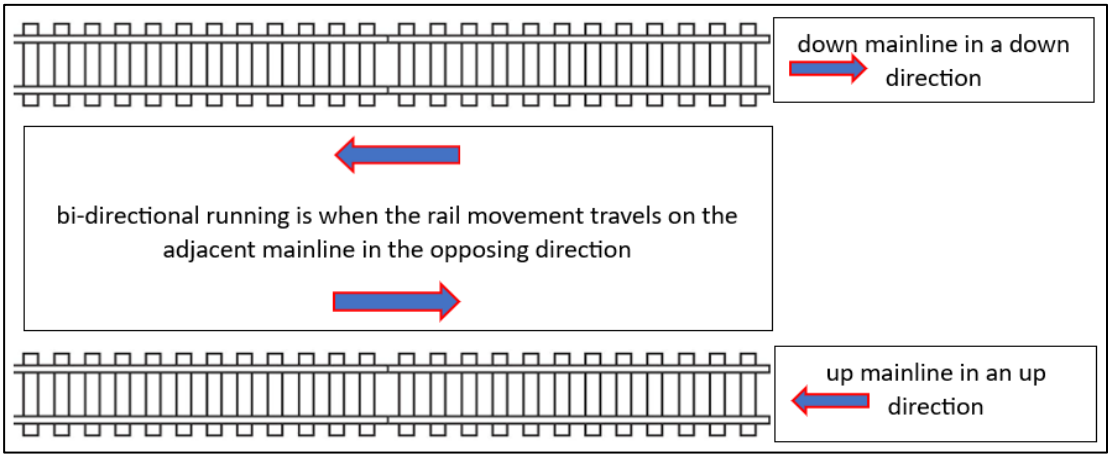

Figure 3: Bi-directional rail movements

2.3. Depending on availability, the locomotive allocation for L71 could be either a dual-cab locomotive or a single-cab locomotive (*see* Figure 4). If a single-cab locomotive is allocated, it can be operated in either the short-hood or long-hood leading direction. The short-hood leading direction is when the cab of the locomotive is at the front of the train's movement. The long-hood leading direction is when the cab of the locomotive is at the rear and the larger engine compartment leads the movement.

Figure 4: Dual-cab locomotive (left) and single-cab locomotive (right)

2.4. The L71 service normally operates with two crew members: the locomotive engineer (LE) drives the locomotive, and the rail operator (RO) attaches and detaches the rail wagons from the locomotive.

2.5. When a single-cab locomotive is being used, the RO will also undertake 'second person'[4] duties. One of these duties is to locate rail signals along the track and call the

[4] A second person is trained to assist with a number of duties, one being to call signals to the LE when operating in a long-hood leading configuration. Some signals along the route may not be clearly seen by the LE, who is in charge of controlling the rail vehicle.

signal colours to the LE when the locomotive is being driven in the long-hood leading configuration (*see* Figure 5).

Figure 5: DC class locomotive operated in a long-hood leading configuration
(Credit: John Russell)

Narrative

2.6. At about 1700 on 31 May 2022, the LE[5] arrived at the Westfield rail terminal (Westfield) to prepare for the L71 shift. The LE completed the required paperwork and started the single-cab locomotive (DCP4605) that had been allocated for the shift.

2.7. At about 1800, the LE met the mainline RO at the terminal. The RO was acting as a minder[6] (the minder) for the trainee, who was completing their on-the-job training requirements prior to final certification for second person duties. The trainee arrived at about 1820 and joined the LE and the minder.

2.8. Before departing, the LE retrieved a chair from the Westfield lunchroom and positioned it into the middle rear portion of the locomotive's cab. The chair was for the minder to sit on as the inbuilt retractable seat in the cab was small and considered by the minder to be uncomfortable over long periods of time[7] (*see* Figure 6).

[5] The LE assigned to L71 shift on 31 May 2022 was not the same LE with whom the minder and trainee had worked the previous night.
[6] The role of a minder is to observe and supervise the trainee during on-the-job training. The minder must have an equivalent certification to the role the trainee is learning.
[7] The shift length was scheduled to be 8 hours 15 minutes.

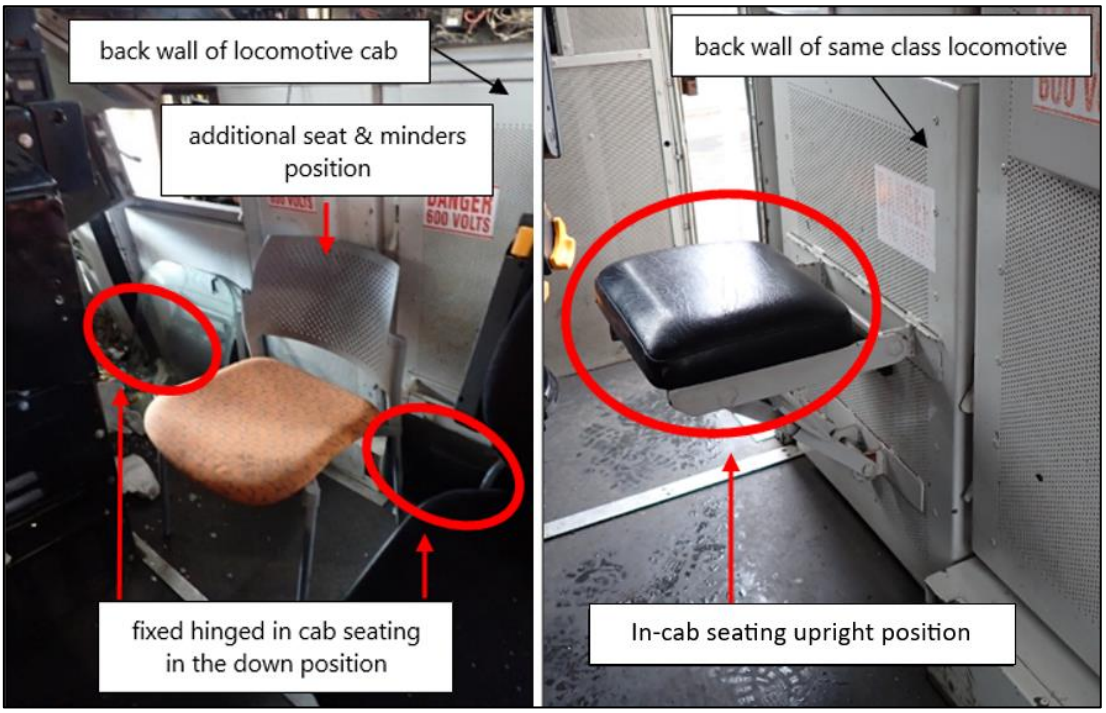

Figure 6: Chair used as additional in-cab seating (left) and unused inbuilt hinged seating (right)

2.9. The minder informed the LE and trainee that, as they had a sore foot, they preferred to elevate their leg as much as possible in the cab. The minder sat in the lunchroom chair with their back to the rear wall and their foot resting on the wash basin (*see* Figure 7)

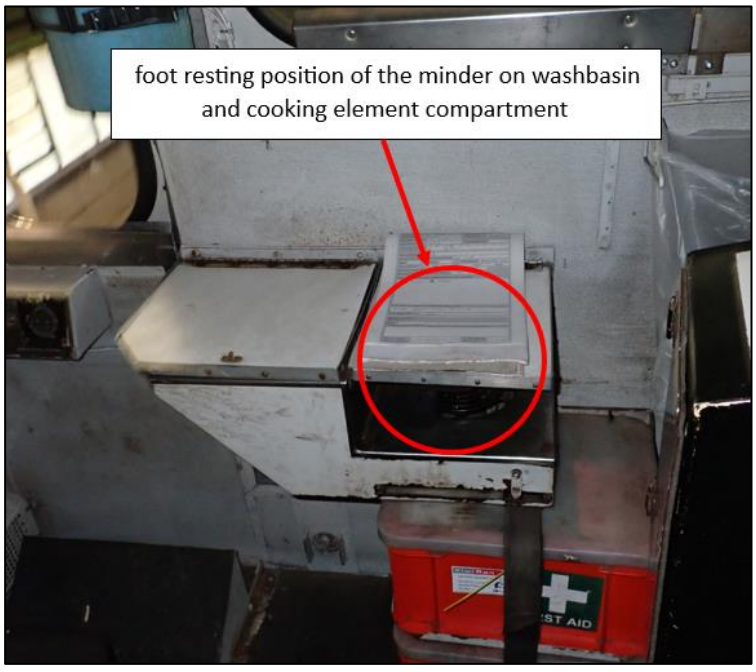

Figure 7: Wash basin on which minder rested their foot

2.10. The trainee informed the LE and minder that they had an unwell family member who might require medical attention the next morning. The trainee was asked whether they wanted to cancel the shift and return home, but they stated that they were happy to continue and would check on the family member throughout the night.

2.11. The L71 crew departed from Westfield soon after 1830 under light to moderate rainfall conditions. They travelled in a southerly direction to Wiri to collect freight wagons that were to be taken to the Port of Auckland.

2.12. Over the course of the night, the crew completed three scheduled freight movements between Wiri and the Port of Auckland. There were no operational issues and the rain eased as the shift progressed.

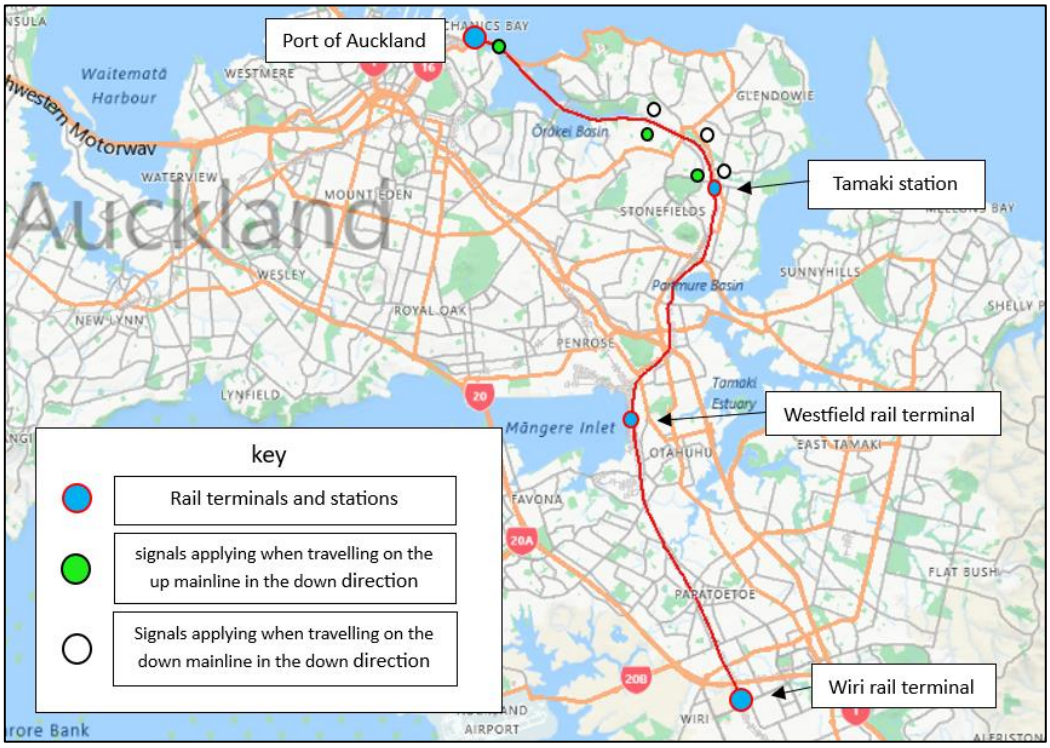

Figure 8: L71 route and position of signals between Port of Auckland and Tamaki station

(Credit: Google maps)

2.13. During the last pickup from Wiri, there was a two-hour delay as freight containers were removed from the wagons. The crew then departed and travelled back to the Port of Auckland for the final freight movement.

2.14. At the Port of Auckland, the crew detached and secured the wagons before the trainee radioed train control to confirm they were ready to return to Westfield.

2.15. Because of planned track maintenance work starting at 2345 on the NIMT, train control set the first part of the route on the bi-directional track back to Westfield using the up mainline in a down direction. Once the locomotive reached Tamaki, it would then cross on to the down mainline for the rest of the journey.

2.16. Train control did not inform the LE that they would be travelling back to Westfield on the up mainline in a down direction, nor did they inform the LE that the locomotive would cross at Tamaki.

2.17. At approximately 0057, the crew departed the Port of Auckland on a 'clear normal' departure signal. Upon leaving the Port of Auckland, the LE could no longer see the track signals from their position in the cab, as the train was travelling on the up mainline in the down direction in a long-hood leading configuration.

2.18. The LE reminded the trainee and minder that there would be fewer signals on the return route to Westfield (*see* Figure 8) and to be alert for their locations as they would not be visible to the LE from their side of the cab (*see* Figures 9 and 10).

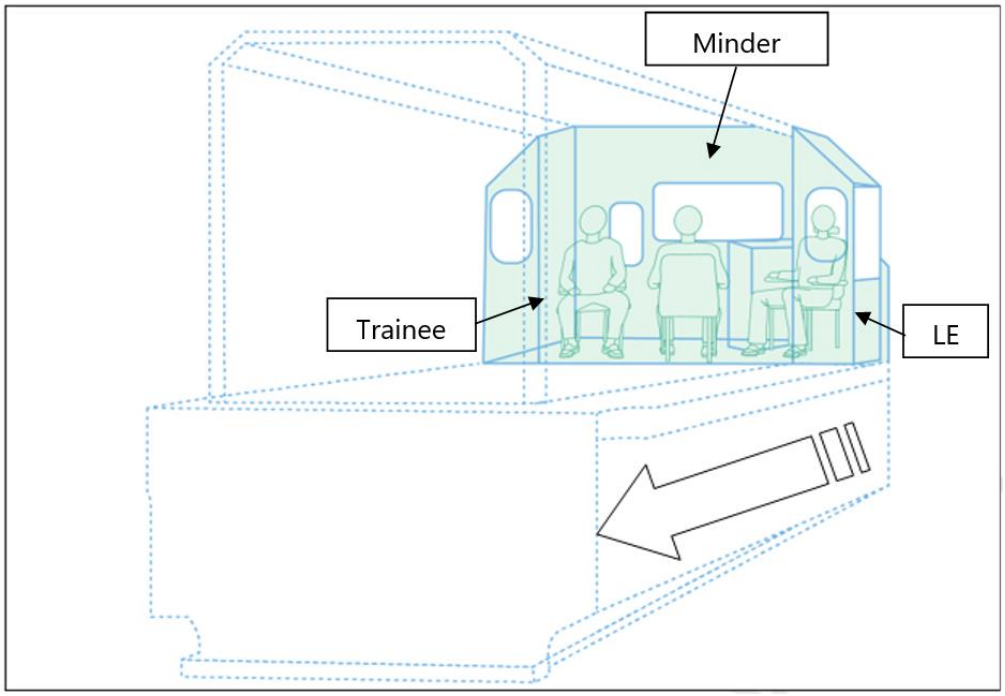

Figure 9: Positions of crew within the locomotive cab

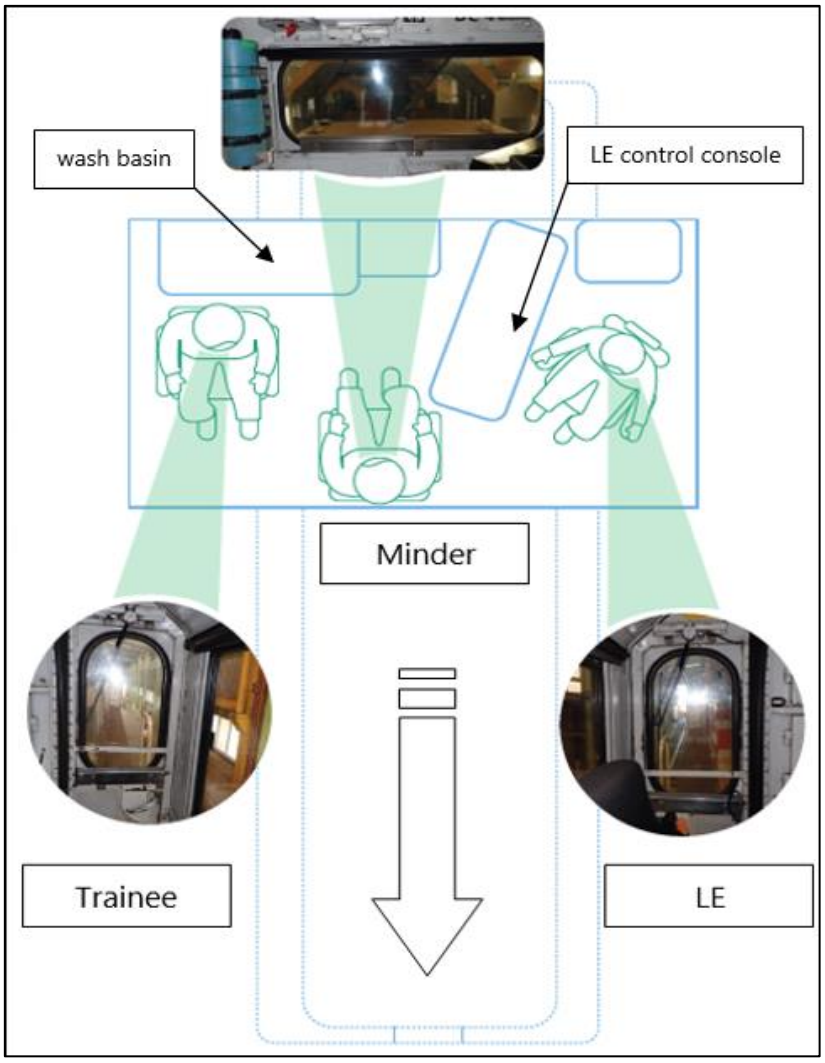

Figure 10: Crew view lines

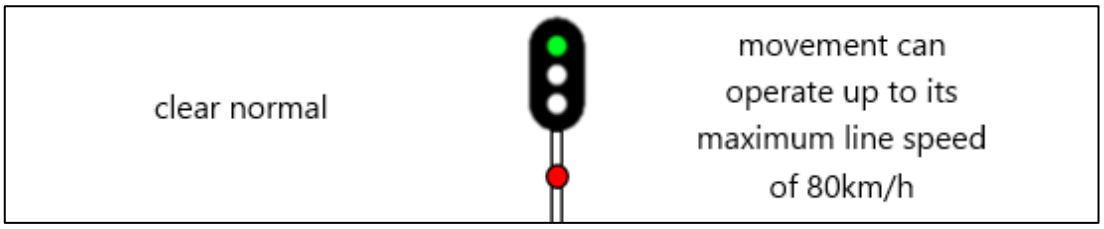

Figure 11: Signal aspect for 'clear normal'

2.19. In accordance with the departure signal (*see* Figure 11) the LE brought the locomotive up to a controlled line speed of 80 km/h. The next signal was positioned approximately 5.3 km along the track and was displaying 'reduce to medium', being a yellow top, green bottom light aspect (*see* Figure 12). This signal requires a speed reduction to 25 km/h before the next signal.

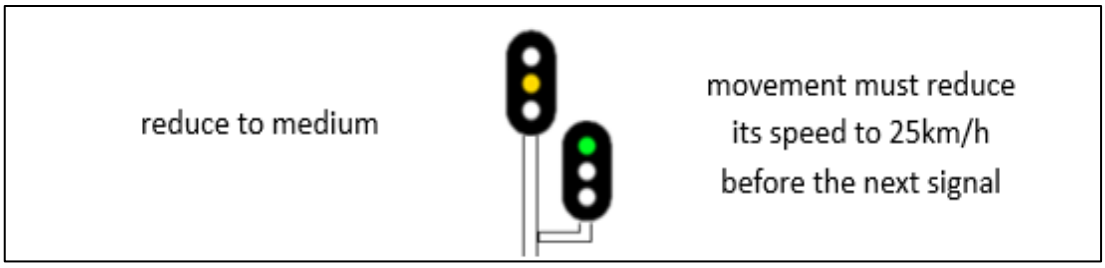

Figure 12: Signal aspect for 'reduce to medium'

2.20. The trainee sighted the signal and called 'green'. The LE repeated the signal call back as 'green'. The LE continued at approximately 74 km/h, assuming the call was referring to a 'clear normal' signal, being a green top, red bottom light aspect.

2.21. The next signal (signal 507) was a further 1.8 km along the line. The signal was displaying a 'clear medium' aspect, being a red top, green bottom light (*see* Figure 13). This signal requires a speed no greater than 25 km/h as the signal is passed. The trainee sighted the signal and called 'green' and the LE repeated the signal call back as 'green'. The LE again assumed the call was referring to a 'clear normal' signal, being a green top, red bottom light aspect, and continued at approximately 76 km/h.

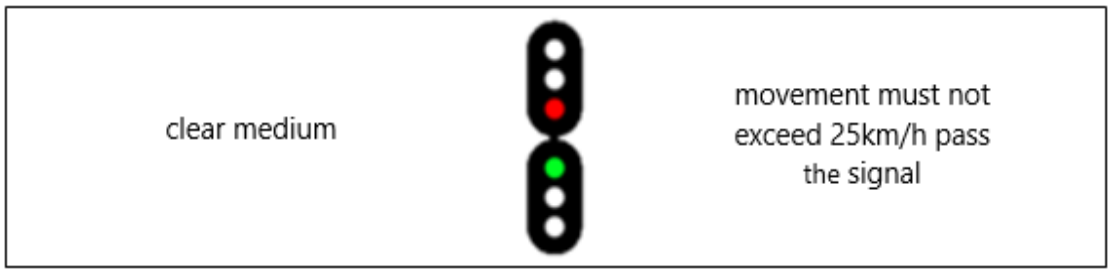

Figure 13: Signal aspect for 'clear medium'

2.22. At approximately 0103, the locomotive passed signal 507 at a speed of 76.8 km/h, rather than the required 25 km/h. The locomotive travelled a further 153m before entering a set of crossover points directing the locomotive from the up mainline across to the down mainline (*see* Figure 14).

Figure 14: Crossover points set to bring the locomotive from the up mainline onto the down mainline.

(Credit: KiwiRail)

2.23. As the locomotive entered the crossover points, it rolled heavily to the right, lifting the locomotive off the left-hand side of the rail head and disengaging the locomotive's wheel sets from the track (*see* Figure 15).

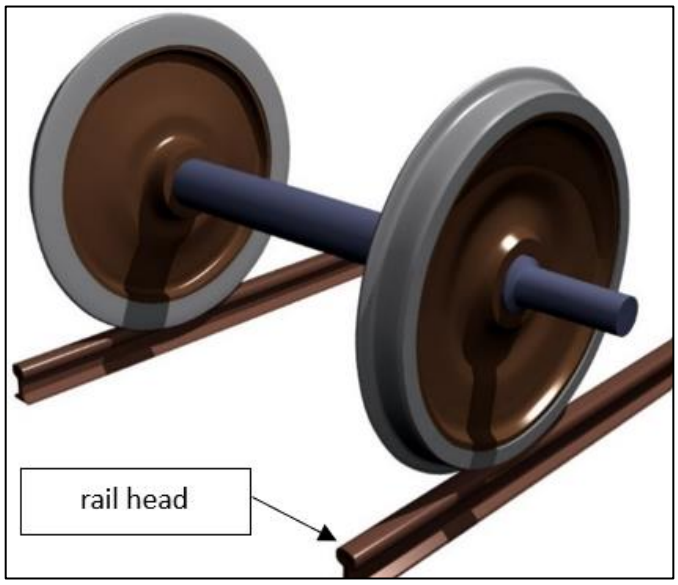

Figure 15: Locomotive wheelset connection to the rail head

2.24. The locomotive then fell back onto the rail head, immediately before the frog junction (circled in red in Figure 16).[8] The locomotive then fell further to the left and entirely off the track.

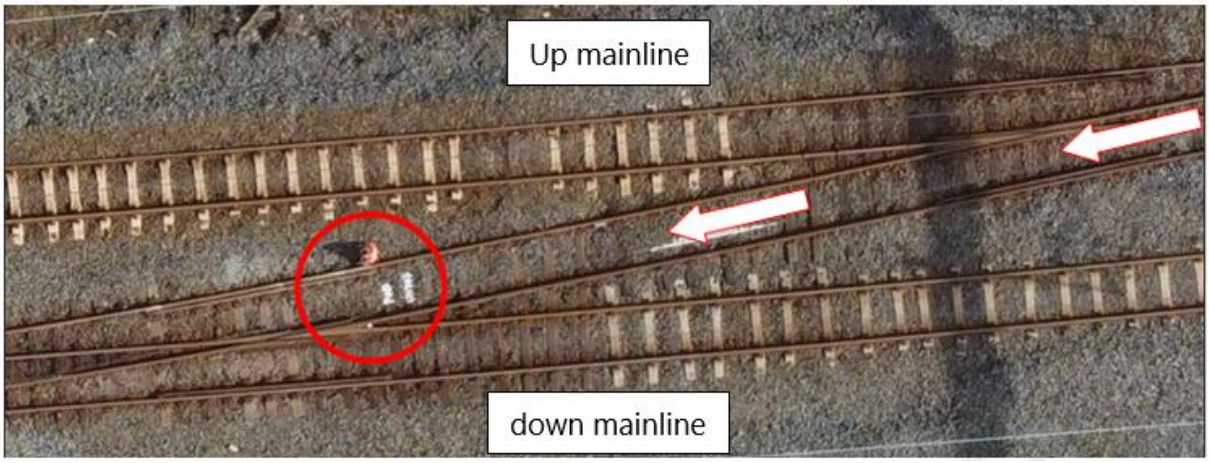

Figure 16: Point of derailment
(Credit: KiwiRail)

2.25. As the locomotive rolled, the LE was lifted out of their seat, unintentionally moving the throttle to maximum power (notch eight) and depressing the emergency mushroom button (*see* Figure 17). Depressing the emergency mushroom button sent an automatic alert to train control through the radio system.

Figure 17: Emergency mushroom button

2.26. As the locomotive derailed and rolled over, the trainee and minder collided then fell onto the LE.

[8] The frog junction is the section of track where the two track junctions join.

2.27. The locomotive slid a further 55 m on its side. The LE's side window shattered, allowing rail track ballast and spoil to enter the cab. The locomotive fuel tank ruptured, and the filling nozzle broke off, spilling diesel on to the ground (*see* Figure 18).

2.28. The locomotive came to a complete stop wedged between the down mainline and the adjacent track.

Figure 18: Position of locomotive following derailment (left) and ruptured fuel tank (right)

2.29. The trainee helped the minder and LE to stand up before attempting to access the door, that was now above their head, and release the sliding windows. However, both were jammed closed.

2.30. Meanwhile, the train controller had observed on their monitor screen a loss of track circuit detection[9] at the Tamaki crossover points (*see* Figure 19). At about the same time they received the emergency radio base call from the locomotive, as a result of the LE unintentionally depressing the emergency mushroom button. The train controller attempted to contact the crew via the radio system on several occasions but received no response.

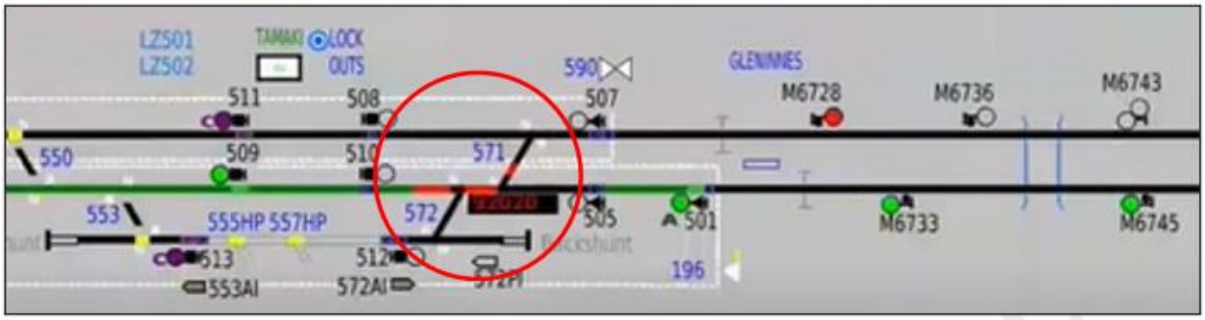

Figure 19: Train control display for Tamaki

(Credit: KiwiRail)

2.31. The crew could hear the train controller trying to make contact, but the radio system was damaged when the locomotive overturned and they could not respond.

2.32. The LE exited the cab through the front middle window, followed by the minder and the trainee (*see* Figure 20).

[9] Train control can understand the condition and position of points via a live monitoring system of signals and understands what section of track the rail vehicle is in. This is done by axle-counter systems located on the track at set locations.

Figure 20: Locomotive following derailment, showing window through which crew exited.

2.33. A security guard working nearby heard the noise of the accident and went to investigate. On seeing the overturned locomotive, they called 111 and requested all three emergency services to attend. The security guard then opened the access gate and crossed the tracks to render assistance to the crew.

2.34. At approximately 0107 the train controller, still unaware of what had happened but unable to contact the crew, called emergency services and was informed that services were already en route to attend.

2.35. Another train controller assisting with the Auckland Metro network called a rail vehicle nearby and directed the driver to attend the locomotive's last known location and report back to train control.

2.36. Once out of the cab, the LE used their work mobile phone to alert train control that the locomotive had derailed and was on its side and that all three crew members were out but had suffered injuries. Train control then arranged for the overhead traction power line[10] to be isolated and organised the Rail Incident Coordinator to attend and control the site.

2.37. The locomotive's fuel tank ruptured when it rolled over, allowing approximately 1800 litres of diesel to be spilled under the overturned locomotive and surrounding area.

2.38. At around 0115, NZ Police arrived at the site, followed closely by Fire and Emergency NZ and the ambulance service.

2.39. The LE and minder both sustained moderate injuries and were taken to hospital by ambulance, remaining in hospital until about 0800. The trainee had sustained minor injuries and elected to wait for the KiwiRail manager to arrive, who then took them home. All three crew members returned negative drug and alcohol tests.

[10] Overhead traction lines carry live electrical current for the Auckland Metro network and connect a train's electrical system to the overhead power source. The L71 locomotive did not require the power source as it operates a diesel engine.

Personnel information

2.40. The LE was employed by KiwiRail in 2015. Their last safety observation took place on 3 February 2022. This included assessment of signals knowledge out on the mainline and reviewing train-handling practices to meet the current rules, codes and standards.

2.41. The minder was employed as an RO by KiwiRail in 2011. They were also certified as a remote-control operator. Their last safety observation took place on 27 April 2022. This included assessment of signals knowledge within the shunting yard.

2.42. The trainee was employed as an RO by KiwiRail in 2019. They were certified within the Westfield rail terminal and were in the process of training to become a mainline RO (second person duties). Their last safety observation took place on 23 May 2022 and included assessment of signals knowledge within the shunting yard.

2.43. None of the three crew members had received training on escape methods following a rollover nor been given first aid training.

Train/vehicle information

2.44. DCP4605[11] was an 82 tonne, 14.1 m, single-cab locomotive built by General Motors and powered by a diesel engine[12]. The locomotive had a maximum line speed of 100 km/h.

2.45. All required scheduled maintenance had been carried out in accordance with the KiwiRail maintenance schedule requirements and any fault-related issues rectified.

2.46. There were no known mechanical issues with the locomotive at the time of the accident.

2.47. There was an escape system fitted to the two side windows at the front of the locomotive's cab (*see* Figure 21).

[11] The train numbering system includes the class type and a four-digit number. The train is registered with KiwiRail as a DCP class, allowing the locomotive to be used on passenger services.

[12] Engine rating of 1650 hp (1230 kW).

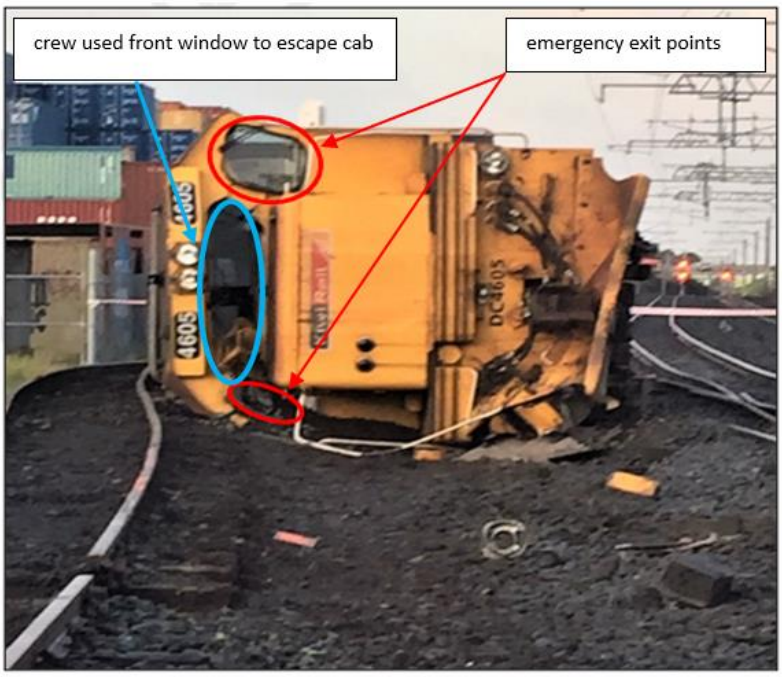

Figure 21: Window escape location and emergency exit points

Recorded data

2.48. The locomotive was fitted with a Tranzlog data recorder (*see* Figure 22).[13] This confirmed that the speed inputs and train handling control made by the LE were in accordance with the signal information given to them by the trainee.

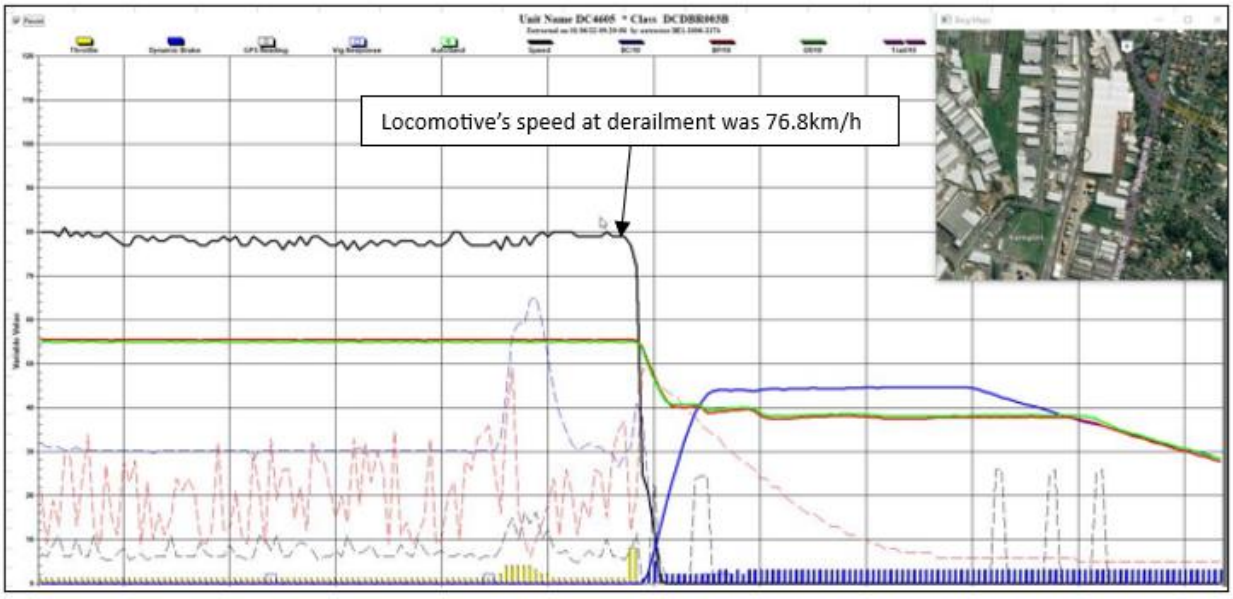

Figure 22: Tranzlog data showing point of derailment

(Credit: KiwiRail)

[13] Tranzlog is the data recorder installed in all mainline locomotives. It records and stores data from the locomotive's control inputs for up to 30 days. The Commission had the speeds and control inputs from the locomotive confirmed and verified by certified personnel.

Organisational information

2.49. KiwiRail Holdings Limited (KiwiRail) is a New Zealand state-owned enterprise, operating trains and rail vehicles, controlling rail movements on the national rail network, and maintaining the railway infrastructure as the access provider.[14]

Rail Operating Code Procedures

2.50. At the time of the accident, KiwiRail's Rail Operating Code, Section 1, Rule 9 stated:

> *DC, DH and DXR locomotives when running as the train locomotive will run short hood leading with the following exemptions: when running circuit shunts, scheduled services (where turning facilities are not available).*

2.51. At the time of the accident, KiwiRail's Rail Operating Code, Section 4.1, Rule 1.23 stated:

> *When a second person is assisting in watching for signals, the signal indications must be called and repeated between both people. The Locomotive Engineer must ensure the second person is not attending to other work as the train is approaching signals.*

Training for Second Person duties

2.52. The theory training for second person duties consists of a day of theory followed by approximately 1.5 hours of practical tuition in the cab of each locomotive class that the second person could operate in.

2.53. Following the theory training, trainees then have on-the-job training under the supervision of a 'minder'. There are no minimum hour requirements or standards that must be met during on-the-job training. Once the minder considers a trainee is capable, the trainee is then assessed to confirm they are competent by KiwiRail's competency manager and signed-off to undertake second person duties. There are no further periodic training assessments or on-the-job observations required to ensure their competency is maintained.

Non-technical skills training

2.54. KiwiRail provides LEs, ROs and train controllers with non-technical skills (NTS) training. The NTS module is part of induction training and covers situational awareness, teamwork and communication, workload management and decision-making.

2.55. As part of their NTS training, train controllers are advised to proactively communicate certain intentions to field personnel to facilitate situational awareness and allow an opportunity to detect and correct errors.

2.56. Train controllers are advised to inform LEs, wherever practicable, if they will be routed onto an unexpected track. This does not apply to circuit shunts like L71; they do not normally need proactive routing advice because their movements are always "as directed by train control."[15]

2.57. There is no practical assessment of NTS for either LEs or ROs. However, train controllers are assessed as part of regularly scheduled desk-based safety observations.

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[14] Access provider is the owner of the national rail network in New Zealand, which provides rail network infrastructure to allow rail vehicle movements to operate.

[15] KiwiRail NTCC Project Refresh 2020 Module One, Section 10.1 Train Control Operating Instructions.

2.58. Neither the LE, RO nor minder involved in this accident had received the NTS training module.

Risk management for long-hood leading operations

2.59. In August 2021, because of a shortage of locomotives within the South Island, KiwiRail undertook a risk assessment of some mainline rail movements to operate in the long-hood leading configuration.

2.60. The risk assessment identified five hazards, one of which was the LE being unable to view the signals and signage on the track when driving in a long-hood leading configuration. The risks associated with this hazard were listed as:

- personal injury or death
- damage to KiwiRail property/reputation.

2.61. The risk assessment listed the 'known root causes' for the hazard as:

- signals and important signage located on the right-hand side of the track
- confusion between the LE and second person.

2.62. The risk assessment identified that a 'competent second person in the cab' would be a required control measure. To support this, ROs operating as the second person were required to have additional familiarisation documentation of all the at-risk signals and their locations on the network. In addition to the signal locations, the documentation contained pictures of signal aspects, their meanings, and expectations for signal calling.

2.63. The ergonomic challenges associated with long-hood leading operations were also considered.

2.64. The risk assessment did not identify the risks of operating with a trainee under supervision or the ergonomic seating positions from which supervision could be achieved.

2.65. No similar risk assessment was undertaken for the North Island routes, where locomotives operate in the long-hood leading configuration at the following locations:

- Wellington to Paekakariki and to Gracefield
- Te Rapa to Waitoa, Te Awamutu and Hautapu
- Port of Auckland to Westfield/Wiri
- Whangarei to Kauri.

Previous occurrences

New Zealand

2.66. The Commission has previously investigated five locomotive derailments and rollovers, making safety recommendations regarding CRM, wrong line running of train services and unusual train movements:

- RO-2014-102 – High-speed derailment rollover (crossover points)
- RO-2002-116 – Derailment rollover (exceeded curve speed, one fatality)
- RO-1997-109 – High-speed derailment rollover (crossover points)

- RO-1995-117 – Derailment rollover (exceeded curve speed, one fatality)
- RO-1993-124 – High-speed derailment rollover (crossover points).

Australia

2.67. On 10 September 2021, the Australian Transport Safety Bureau (ATSB) released a preliminary report into a fatal collision between a locomotive and a coal train in Westwood, Queensland (Australian Transport Safety Bureau, 2021). At the time of the collision the locomotive was running in the long-hood leading configuration with three crew inside the cab who were positioned similarly to the crew in this accident. Both the driver and co-driver were receiving route tuition, and the tutor was positioned on a removable chair facing away from the direction of travel.

2.68. On 25 June 2021 the Australian Office of the National Rail Safety Regulator (ONRSR) issued Rail Safety Alert RSA-2021-001 to Australian rail transport operators. This Safety Alert required rail transport operators to conduct a review of risks associated with long-hood leading operations and to ensure that they could meet the SFAIRP[16] requirement by 30 July 2021 (*see* Appendix 1).

2.69. ONRSR also outlined how those risks, such as train-on-train collision, train-to-vehicle collision, train-to-person collision and derailment, are heightened when operating in the long-hood leading configuration.

2.70. In August 2021, ONRSR contacted Australian rail transport operators to review the work undertaken in response to the Safety Alert. Some rail transport operators were not able to mitigate the risks required under SFAIRP and had therefore ceased all long-hood leading operations.

[16] The Rail Safety National Law (Australia) requires that rail transport operators manage the risks associated with rail operators and ensure safety "so far as is reasonably practicable" (SFAIRP). So far as is reasonably practicable is a term used within New Zealand's Health and Safety at Work Act 2015 and is outlined in New Zealand's Railways Act 2005 – part 2 section 7 point (1).

3 Analysis
Tātaritanga

Introduction

3.1. Safe rail movements rely on the LE responding appropriately to the information conveyed via track signals. For this to occur, the signals must be identified and then interpreted correctly. This includes timely detection and accurate perception of the signal aspect. For the most part, the three-step process of signal detection, discrimination and deciding the correct course of action is performed by the LE. When the LE cannot see the signals, the second person is responsible for signal detection, perception of the signal aspect, and calling the aspect correctly. The LE remains responsible for interpretation of what the aspect means and managing the locomotive speed accordingly.

3.2. In this accident, the LE received incorrect signal information from the trainee who was under the supervision of a minder. As a result, the locomotive was travelling at a speed that was too fast for it to safely enter the set of crossover points at Tamaki, causing it to derail and roll onto its side.

3.3. Despite egress options being limited, the three crew members were able to escape the cab with minor to moderate injuries.

3.4. The following section analyses the circumstances surrounding the event to identify those factors that increased the likelihood of the event occurring or increased the severity of its outcome. It also examines any safety issues that have the potential to adversely affect future operations.

Signal identification and interpretation

3.5. Signals are used to control train movements along various sections of the track. Due to the amount of time that it takes for a train to respond to brake and throttle inputs from the LE, signal indications are progressive; the preceding signal indicates what the next signal will potentially display. In this manner, signal indications convey speed instructions for the section of track the train is entering, as well as advance information for the section beyond.

3.6. The signal information is displayed through colour light aspects. The position of the light provides information about the speed the train may do in the current section of track. The colour of the light provides information about what to expect at the next signal or beyond into the next section of track. Interpretation of the aspect meaning therefore requires both the colour and position information.

3.7. When calling signals from in cab the colours are called from the top to the bottom aspect, for example “red top, green bottom”.

3.8. As the locomotive departed the Port of Auckland, the LE could see the first (departure) signal. From that point on, the signals controlling the route were on the right-hand side when travelling on the up main in a down direction. The LE, positioned on the left side, could not see the signals and was completely reliant on the trainee not only to see the signals, but also to call the aspects correctly. In this accident, the signal indications that had been set by train control were appropriate for

the planned route, however the trainee's calls for the second and third signals were not correct. The incorrect calls meant that the LE's management of the locomotive's speed were not appropriate for the section of track (*see* Appendix 2 for signal calls and meanings).

3.9. Errors associated with this type of activity tend to be related to the limitations of attentional resource.[17] The amount of energy required for repetitive and routine tasks means the activity can become relatively automated, requiring little conscious attention. However, this type of 'skill-based' performance is vulnerable to interferences, which can lead to errors being made. Interferences can come from environmental distractions, as well as the individual's mental model[18] of their situation.

3.10. In the absence of a complete set of information about a situation, individuals will draw on familiarity and expectation to shape their mental model. However, if their mental model is inaccurate, this can lead to information being perceived incorrectly and errors being made. When the trainee crewed on the L71 shift the previous night, the locomotive travelled the full distance from the Port of Auckland to Westfield on the up mainline in the down direction. On the night of the accident, the crew had not been made aware by train control that the locomotive was going to be crossed over to the down mainline. The previous night's experience **likely** led the trainee to incorrectly assume that this trip would be the same, influencing their mental model of the journey back to Westfield.

3.11. As the locomotive was travelling in the down direction on the up mainline, the signals for L71 were on the right-hand side of the track. The trainee could see these signals but could also see the more frequently occurring signals on the left-hand side of the track, which applied to the down mainline. After L71 departed the Port of Auckland, the trainee would have passed two green signals on the left-hand side of the track before calling the incorrect aspect on signal number two on the right-hand side. On their own, the prevalence of the other green signals along the track may not have caused the trainee to perceive L71's signals incorrectly. However, the expectation[19] that the locomotive would remain on the up mainline for the entire journey **likely** increased the likelihood for this to occur.

3.12. Both the LE and the minder had an opportunity to capture and correct the errors being made by the trainee. Only calling one colour does not follow the standard signal-calling procedures and this should have been challenged by both the LE and the minder. Requiring the aspect to be verbalised and then confirmed by the LE provides an additional safety defence within the communication process. Not adhering to this procedure undermines the basic concept of redundancy associated with having a cross-check process.

[17] Attentional resource is the amount of attention available to perform tasks that require effort.

[18] A mental model is an internal representation of how an individual understands a particular situation to be. They develop from cues in the immediate environment as well as knowledge gained through training and experience.

[19] Expectation bias is the term used to describe the influence previous experience can have on an individual's perception and decision-making.

Fitness for duty

3.13. Fitness for duty is a factor that can impact individual performance as well as the ability of the crew to perform collectively as a team. While all three crew members were adequately rested before their shift, distractions in the form of medical issues and stresses outside work were present. The minder was experiencing foot pain, which they attempted to alleviate during the night by remaining seated in the cab with their leg elevated. The trainee had a family-related concern that required attending to upon completion of the shift.

3.14. The crew members informed each other of these issues before the start of the shift. However, they may not have fully appreciated the degree to which these distractions could impact their ability to concentrate and negatively impede performance. This is especially true for monitoring and detection tasks such as signal identification, which take place in a low-stimulus environment. Being fit for duty is an important risk control for train personnel, particularly when less controllable factors – such as constant engine noise and vibration from the locomotive – can also affect vigilance[20] (United States Department of Transportation, 1998).

3.15. KiwiRail utilises FAID[21] to support fatigue risk management when planning LE work shifts. However, this system is not in place for ROs. Similarly, while LEs have in-cab fatigue monitoring by way of the vigilance alert system, no such system is used to identify fatigue events for ROs. While the Commission determined that fatigue did not appear to be a factor in this accident, it highlights a disparity within KiwiRail's management of fatigue for operating personnel with safety-critical roles.

Training

Safety issue: KiwiRail's non-technical skills training did not provide the crew with adequate techniques on how to work together to manage threats.

3.16. The safe operation of the locomotive was dependent on the level of situational awareness that the L71 crew was able to achieve as a team. Crew Resource Management (CRM) relates to the effective use of all available resources to assure safe and efficient operational outcomes. This includes the ability for individuals to work together cohesively to identify and manage situations that may be a threat to safety. In this regard, communication extends beyond a simple transfer of information, and becomes fundamental to building a collective or 'shared' mental model of situational awareness.

3.17. CRM promotes effective communication through crew briefings to identify potential threats and discuss how they are to be managed. For this to be successful, information from all available resources should be used. In this case, the crew were not made aware that train control had planned to cross the locomotive over from the up mainline to the down mainline at Tamaki. Similarly, train control was not aware that the crew would be running in a long-hood leading configuration on the way back to Westfield. Had this information been exchanged between the two parties, a common understanding of the situation could have been developed, allowing for more accurate threat management by the L71 crew.

[20] Vigilance refers to the ability to maintain concentrated attention to a task over a period of time.
[21] FAID is a fatigue risk management tool.

3.18. The trainee had no previous experience running in a long-hood leading configuration in the opposite-to-normal track direction. In these circumstances, the potential for a signal misidentification should have been well-recognised as a risk that required careful management. Shared knowledge of signal locations, adherence to standard signal calling, and how increased vigilance levels might be maintained within the cab, would have been relevant points to cover in a crew briefing, particularly given it was the last movement before finishing their shift.[22]

3.19. In addition to misidentifying signal aspects, the potential for a signal not to be detected was also a risk that required management. As the locomotive departed the Port of Auckland, the LE reminded the trainee and minder that there would be fewer signals on the up mainline but no further information was shared, such as the location or number of signals to expect. The ability to detect a signal is improved if its location is known, as this facilitates the ability to recognise whether a signal is absent or imperfectly displayed. Conversely, unfamiliarity with signal location means that detection is reactive and the ability to forward plan is limited or non-existent, which defeats the principles of effective CRM.

3.20. Signal locations for the KiwiRail network are depicted on signalling and interlocking diagrams (*see* Appendix 3). The trainee was not provided with any of the diagrams as part of their training. Their signal placement knowledge was based on accumulation of experience as their training progressed. By chance, the trainee happened to have operated along the up mainline in the down direction the previous night and so had some memory of where the signals were located. To place a trainee with limited track knowledge in this position is indicative of inadequate risk management for this type of operation.

3.21. Despite being an administrative risk control,[23] proficiency in CRM is widely regarded as an effective tool to manage threats to safety. Had the L71 crew had a more thorough understanding of how to work together as a cohesive unit, including the importance of using all available resources, it is **likely** that the accident could have been prevented. The Commission considers that the lack of CRM proficiency shown by the crew indicates a substantial gap within the operator's non-technical skills training.

Safety issue: KiwiRail's second person training was inadequate to ensure that, once trained, the rail operator could carry out second person duties safely. Specifically:

- ***training was not provided by a suitably qualified trainer***
- ***approved training material was omitted***
- ***there was no document control of training material***
- ***there was no assurance or monitoring of competency once signed off.***

3.22. The trainee had completed their theory training for second person duties in December 2021. The Commission found that the training was not conducted in accordance with KiwiRail's three-step assessment process, specifically observing, facilitating, and being assessed and signed off on training delivery.

[22] Get-home-itis describes the phenomenon whereby desire to get home or finish a shift can (intentionally or unintentionally) lead to a reduction in adherence to rules or procedures.

[23] Administrative risk controls establish practices that reduce the duration, frequency or intensity of exposure to hazards. Employee training, establishment of rules, and operating procedures are all examples of administrative risk controls.

3.23. This training should have been delivered by a qualified and current KiwiRail Learning and Development (L&D) training facilitator. However, because of their unavailability, an Occupational Competency Manager (OCM) conducted the second person training.

3.24. The OCM had previously been an L&D training facilitator but had not facilitated the second person duties training nor completed the three-step assessment process.

3.25. The OCM created additional material that was not part of the training curriculum, and omitted to provide essential documentation to trainees, such as signalling and interlocking diagrams and station information. The number of trainees also exceeded the allowable training ratio, which at the time was set at two trainees to one facilitator.

3.26. Training employees to perform safety-critical tasks is a significant undertaking. KiwiRail recognised this and had an assessment process in place to ensure training was delivered by personnel who were certified to do so. Electing to operate outside that process meant that consistency of training standards for second person duties could not be assured, and regular assessments had not been conducted.

3.27. KiwiRail's quality assurance system requires training content to be approved and reviewed periodically. Documentation is controlled to ensure consistency. The training documentation used by the OCM had not been approved and there was no version control.

3.28. The training curriculum for second person duties included how to call signal aspects using the location of the signal colours (for example 'yellow top, green bottom'). However, the meaning of the signal aspects was not taught (such as 'yellow top, green bottom' means 'reduce to medium', so the LE must reduce the locomotive's speed to 25 km/h before the next signal).

3.29. This differs from the signal training LEs receive whereby LEs are taught to identify signal aspects by their colour locations, what the aspect indicates and how that indication is interpreted. Not imparting this information to ROs training for second person duties meant that effective closed-loop communication[24] could not be used in the cab as there was no ability for the RO to ensure the LE was executing the correct locomotive control response.

3.30. The training curriculum for second person duties did not include testing the ROs theory-based knowledge. The ability to identify signal aspects correctly is a safety-critical task. Not having any requirement to examine signal knowledge and recall differs from LE training, where testing is part of their certification.

3.31. On-the-job training is fundamental to a trainee converting their theory-based knowledge to practical application in the operating environment. During this early stage of learning, it is essential that trainees are properly supervised by an appropriately qualified RO.

3.32. The Commission identified that the seating layout of the cab did not allow the minder to provide appropriate supervision of the trainee when operating in a long-hood leading configuration.

[24] Closed-loop communication ensures the sender of the information knows that the receiver has heard and understood their instructions. This goes beyond simply ensuring a message has been heard correctly and provides an additional layer of defense against misinterpretation of information.

3.33. The Commission also found that training for second person duties was inconsistent with training requirements for other safety-critical roles, particularly with respect to how competency was assessed and recorded. There was no minimum requirement for the number of hours or shifts that trainees should undertake for their on-the-job training. Nor was there a requirement to record daily observations of what the trainee had completed during this period.

3.34. Having no minimum requirements or a documented standard that trainees were required to achieve resulted in competency being assessed ad hoc.

3.35. Once the trainee was signed off as competent to conduct second person duties, there was no requirement for ongoing assessment of competency. This is at odds with other safety-critical roles, such as the LE, which are periodically assessed to ensure they can demonstrate the competencies to perform their job safely. Without any further assessment, KiwiRail cannot be assured that ROs undertaking second person duties continue to perform to an acceptable standard.

Risk assessment for long-hood leading operations

Safety issue: There was no risk assessment for long-hood leading operations on the NIMT and therefore hazards were not identified or mitigated with risk controls.

3.36. Operating a locomotive in a long-hood leading configuration presents additional challenges when compared to normal operations. In addition to the LE not always having visibility of signals, they must also change their normal seating position. Facing the opposite direction results in the driving console being on the right of the LE instead of on the left (*see* Figures 6 and 7). Consequently, the LE must now operate the controls in a reverse fashion to achieve the same control inputs.

3.37. Additionally, when driving with a long-hood leading configuration the LE is facing away from the instrumentation on the gauge console, which includes the speedometer. Such arrangements are not ideal as they create ergonomic and human factor difficulties (*see* United States Department of Transportation, 1998).

3.38. Before departing Westfield, the LE placed a lunchroom chair in the locomotive cab for the minder to sit on during the shift. The Commission found that the use of removable chairs is common practice when more than two people are travelling in a locomotive cab. There is no policy on the use of additional seating in locomotive cabs.

3.39. From an ergonomic perspective, using a single-cab locomotive in a long-hood leading configuration for training purposes was not conducive to safety. Physically, the minder was unable to position themself to have visibility of the signals that the trainee was calling. From their seated position in the cab facing backwards to the direction of travel, the minder could not provide a proper degree of supervision or assurance that the trainee was calling the signal aspects correctly.

3.40. The risks associated with operating a locomotive in a long-hood leading configuration were known to KiwiRail. A risk assessment for long-hood leading operations had been conducted for the South Island a year before this accident. That risk assessment had identified additional measures to ensure ROs undertaking second person duties were familiar with the route and had knowledge of signal locations. Ergonomic challenges for the LE were also addressed by retrofitting the cab to

improve visibility and access to critical instrumentation and controls such as the speedometer.

3.41. Risk management of long-hood leading operations was not consistent across the KiwiRail network. For a safety system to be effective, risk management must be a coordinated activity within an organisation. This allows for the appropriate resources to be directed to those activities that are identified as hazardous and provides assurance to an organisation that risks are being managed through a consistent and proactive framework.

Risk controls in complex systems

Safety issue: Without engineering risk controls, the Auckland Metro network does not have an adequate level of defence to ensure the safe operation of rail within a complex system.

3.42. Rail transportation is a complex system[25] and one that requires robust risk controls to guard against the outcomes associated with human performance limitations. This means that administrative controls, which are vulnerable to human error or non-compliance, should not solely be relied upon to keep the system safe. In this accident, the existing administrative controls proved inadequate to prevent the derailment as they failed to compensate for variabilities in human performance.

3.43. Complex systems require multiple and more reliable defences such as engineering controls[26] to maintain acceptable levels of safety. The absence of these controls can predispose a system to failure, as occurred in this accident. The European Train Control System (ETCS) is an example of an engineering solution that provides a robust engineering risk control and is widely used around the world.

3.44. ETCS Level 1 works via lineside electronic equipment connected to the signalling infrastructure system, which translates the signal aspect information into a digital movement authority feeding this information directly to the LE. As the train moves along the track it passes over balise transponders[27]. The train's onboard system reads the signal from the balise, updates its position and calculates the train's maximum allowable speed and route length (*see* Figure 23).

3.45. At the time of the accident, ETCS Level 1 infrastructure was in place and available on the portion of track where the accident occurred. However, while the Auckland commuter trains were equipped with ETCS Level 1, the KiwiRail locomotives had not been fitted with ETCS and so were not capable of receiving the ETCS safety benefits. Had ETCS been fully integrated on the locomotive, the locomotive would have responded correctly to the signal aspects that were displayed, overriding any incorrect speed management by the LE. Had this been the case, the derailment and rollover **almost certainly** would not have occurred.

[25] A complex system is one where multiple individual, but inter-related, components interact. Within complex systems, safety is considered to be an emergent property of the system as a whole, not the result of individual components acting in isolation.

[26] Engineering risk controls work by isolating hazards, generally by way of the physical design of a system.

[27] A balise transponder, also known as a balise tag or simply balise, is a device used in railway signalling systems. It is a small electronic transponder, typically mounted on or near the track, which communicates with passing trains, exchanging data and information.

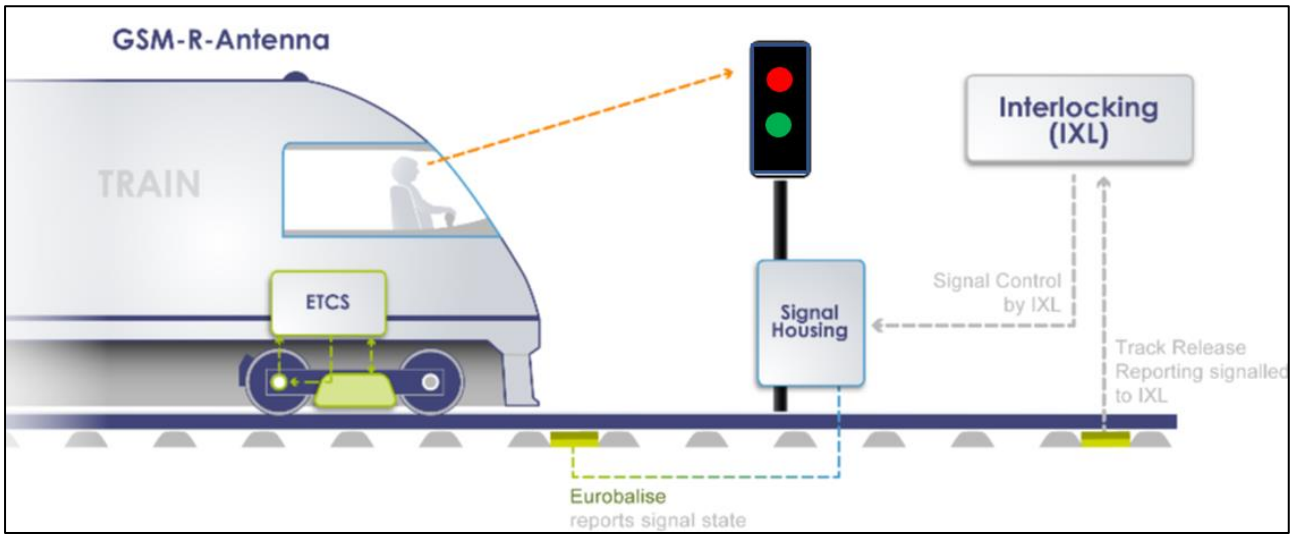


Figure 23: ETCS Level 1

Crashworthiness and survivability

Safety issue: No risk assessment or training had been conducted for the safe evacuation of crew from a locomotive in the event of a derailment and rollover. This increased the risk of crew becoming trapped and delays during the evacuation process.

3.46. KiwiRail did not provide training to staff on how to escape from the cab of a locomotive that had derailed onto its side.

3.47. The Commission found that because of the size of the emergency escape windows in the locomotive cab, none of the train crew would be unable to escape if required to do so.

3.48. The emergency escape windows were operated by pulling on keystrip pull tabs to release the rubber tube and remove the glass panel. The keystrip pull tab stickers, located on the inside of the cab window, were ambiguous and could cause confusion in an emergency, as the actual location of the tab was outside of the window (*see* Figure 24). This requires a crew member to extend their arm outside of the side window and reach around to the front of the locomotive in order to pull the tab to release the rubber tube and remove the glass panel (*see* Figure 25).

Figure 24: Keystrip pull tab locations (left/centre), window with no tabs (right).

Figure 25: Keystrip pull tab re-enactment

3.49. By comparison the DL class and EF class 30 locomotives' egress points had easy access to the internal release mechanisms, allowing the window to hinge downward once opened (*see* Figure 26).

Figure 26: DL class locomotive egress points

4 Findings
Ngā kitenga

4.1. The locomotive derailed and subsequently rolled over when it entered a set of crossover points at Tamaki at a speed more than three times the authorised line speed.

4.2. When operating on a bi-directional line in a long-hood leading configuration, the LE relied on the trainee to accurately interpret and communicate the signal aspect, as the LE's driving position obstructed their direct visibility of the signal when traveling on the up mainline in the down direction.

4.3. The trainee called the two signal aspects incorrectly to the LE, resulting in the LE maintaining a speed that was not appropriate for the section of track for the locomotive.

4.4. The trainee's incorrect calling of the signal aspects was **likely** due to a combination of expectation bias, sighting other green signals along the route, and reduced attentional capacity due to distraction.

4.5. The minder was unable to observe the signal aspects from their position within the cab and therefore could not provide a proper degree of supervision or assurance that the trainee was calling the signal aspects correctly.

4.6. The trainee did not call the signal aspects in accordance with the rules and codes. Had these calls been challenged at the time by either the LE or the minder, the derailment **very likely** would have been prevented.

4.7. Had the crew and train controller had a more thorough understanding of how to work together as a cohesive unit, including the importance of using all available resources, it is **likely** that the accident would have been prevented.

4.8. The crew were not trained in how to respond in emergencies; specifically they were not familiar with evacuation procedures or first aid.

4.9. KiwiRail had not provided the trainee with an appropriate level of training or assessment to ensure they could perform second person duties to a safe standard.

4.10. KiwiRail did not have robust document management of the training material for second person training. This allowed unapproved and incomplete information to be delivered to trainees.

4.11. KiwiRail had not undertaken a risk assessment for long-hood leading operations on the Auckland Metro network and therefore risk controls, which may have prevented this accident, had not been identified.

4.12. KiwiRail had not assessed the ergonomic suitability of using a single-cab locomotive in long-hood leading configuration when conducting in-cab training.

4.13. KiwiRail's locomotive fleet was not equipped with ETCS, an engineering risk control, that could have slowed or stopped the locomotive from entering the set of crossover points at excessive speed. Had the locomotive been fitted with ETCS, the derailment and rollover **almost certainly** would not have occurred.

5 Safety issues and remedial action
Ngā take haumanu me ngā mahi whakatika

General

5.1. Safety issues are an output from the Commission's analysis. They may not always relate to factors directly contributing to the accident or incident. They typically describe a system problem that has the potential to adversely affect future transport safety.

5.2. Safety issues may be addressed by safety actions taken by a participant. Otherwise the Commission may issue a recommendation to address the issue.

Safety issue: KiwiRail's non-technical skills training did not provide the crew with adequate techniques on how to work together to manage safety threats.

5.3. As a result of an internal investigation of this accident, KiwiRail identified the need to provide refresher coaching to teams, reminding them of the importance of the correct signal-calling process, and to challenge if this process is not being performed correctly.

5.4. The Commission welcomes the safety action to date. However, it believes more action needs to be taken to ensure the safety of future operations. Therefore, the Commission has made a recommendation in Section 6 to address this issue.

Safety issue: KiwiRail's second person training was inadequate to ensure that, once trained, the rail operator could carry out second person duties safely. Specifically:

- ***training was not provided by a suitably qualified trainer***
- ***approved training material was omitted***
- ***there was no document control of training material***
- ***there was no assurance or monitoring of competency once signed off.***

5.5. On 14 June 2023, KiwiRail supplied the Commission with its internal investigation report, in which the following corrective actions were identified:

- Investigate opportunity to simplify signal calling procedure where the Second Person calls signal aspects for the top and bottom units only
- Investigate opportunity to improve familiarisation training and observation regarding bi-directional running in the Auckland Metro Area
- Investigate opportunity to provide clarity and consistency to area familiarisation training and competency requirements.

5.6. KiwiRail informed the Commission on 7 September 2023 that a working group was scheduled to meet in September 2023 to review the requirements and training for second person duties.

5.7. The Commission welcomes the safety action to date. However, it believes more action needs to be taken to ensure the safety of future operations. Therefore, the Commission has made a recommendation in Section 6 to address this issue.

Safety issue: There was no risk assessment for long-hood leading operations on the NIMT and therefore hazards were not identified or mitigated with risk controls.

5.8. In June 2023 KiwiRail completed a risk assessment for mainline long-hood leading operations and as a result of the risk assessment ceased some of its long-hood leading operations on the mainline from 20 June 2023. However, exceptions to this remained.

5.9. KiwiRail informed the Commission on 7 September 2023 that:

> KiwiRail has continued to review and refine its management of long hood leading operations. Long hood operations have ceased in KiwiRail nationally with the exceptions (as set out in local instructions) of the following:
>
> • DH running in Auckland (Westfield-Penrose) with controls in place. DH locos will be replaced over the next year with DSG locomotives.
>
> • Local running in station limits, Chch.
>
> • Emergency use as per Semi-Permanent Bulletin 565 section 9 (issued 12 July 2023).[28]

5.10. In the Commission's view, this safety action has addressed the safety issue. Therefore, the Commission has not made a recommendation.

Safety issue: Without engineering risk controls, the Auckland Metro network does not have an adequate level of defence to ensure the safe operation of rail within a complex system.

5.11. No action has been taken to address this safety issue. Therefore, the Commission has made a recommendation in Section 6 to address this.

Safety issue: No risk assessment or training had been conducted for the safe evacuation of crew from a locomotive in the event of a derailment and rollover. This increased the risk of crew becoming trapped and delays during the evacuation process.

5.12. No action has been taken to address this safety issue. Therefore, the Commission has made a recommendation in Section 6 to address this.

[28] *See* Appendix 4

6 Recommendations
Ngā tūtohutanga

General

6.1. The Commission issues recommendations to address safety issues found by its investigations. Recommendations may be addressed to organisations or people and can relate to safety issues found within an organisation or within the wider transport system that have the potential to contribute to future transport accidents and incidents.

6.2. In the interests of transport safety, it is important that recommendations are implemented without delay to help prevent similar accidents or incidents occurring in the future.

Recommendations to KiwiRail

6.3. On 25 October 2023, the Commission recommended that KiwiRail undertakes a review of its non-technical skills training to ensure it provides adequate training on how to work together to manage threats. **(034/23)**

6.4. On 25 October 2023, the Commission recommended that KiwiRail reviews its second person training approach to ensure:

- the document management of the training material is robust
- the training material is fit for purpose and consistent with the training provided to other safety-critical roles
- supervision during on-the-job training is adequate. **(035/23)**

6.5. On 25 October 2023, the Commission recommended that KiwiRail integrates fully with the technology on the Auckland Metro network, to ensure the safe operation of rail within a complex system. **(036/23)**

6.6. On 25 October 2023, the Commission recommended that KiwiRail provides first aid training and evacuation training to all rail personnel that work in rail vehicles. **(037/23)**

6.7. On 15 November 2023, KiwiRail replied:

> 034/23 The Commission recommended that KiwiRail undertakes a review of its non-technical skills training to ensure it provides adequate training on how to work together to manage threats.
>
> This recommendation was accepted and implemented.
>
> Non-Technical skills is provided in the Future You programmes for Infrastructure and Protection new starters, also Trainee Rail Operators and Trainee Locomotive Engineers in Yard school. They cover:
>
> - Safe Work conversation for why non-technical skills make situations safer and/or how they can prevent incidents.
> - KiwiRail Non-Technical skills, what are they in more detail. Uses videos and includes examples for how these are relevant to the learners role
> - Introduction to Above and Below the line
> - Interactive session for how you can apply Above and Below the Line to Non-Technical skills.

For roles outside of these, an eLearn module was developed and can be accessed through the KiwiRail Learning Exchange (KLE). This is automatically assigned to all new starters and forms a part of the onboarding programme.

In addition to this, Trainee Locomotive Engineers also complete a Unit Standard assessment for 29376 Maintaining a safe and secure rail environment which embeds Non-Technical skills to meet the following outcomes:

- Identify, assess and manage risks when working on or near the rail corridor
- Demonstrate knowledge of factors that can lead to degraded personal performance

The STAR process and the Life Saving Behaviour for being fit for work plays a large theme in this assessment.

035/23 The Commission recommended that KiwiRail review its second person training approach to ensure:

- The document management of the training is robust
- The training material is fit for purpose and consistent with the training provided to other safety critical roles
- Supervision during on-the-job training is adequate

This recommendation is under consideration.

Current rules relating to second persons have been reviewed by a working group. The role of the second person in regard to signal recognition/calling will go through a risk review process early in 2024 to determine:

- Role of second person now that long hood leading is no longer used in KiwiRail
- If second person roles are required, what level of training/expectations regarding signal recognition/calling.
- OJT process and assurance will be reviewed and aligned appropriately.

036/23 The Commission recommended that KiwiRail integrates fully with the technology on the Auckland Metro Network to ensure the safe operation of rail within a complex system

This recommendation is accepted.

Retro-fitting of ETCS to locomotives is a significant task with limited available space and the safety critical nature of the ETCS equipment. A specific design is required for each new class fitted followed by prototype fitment, testing for safety assurance and then individual vehicle fitout and assurance testing. The cost and timeframe associated with this process is significant. Accordingly many factors need to be taken into consideration with respect to retro fitting of old locomotives. These include:

- KiwiRail is currently installing ETCS to 53 DL class locomotives. First prototype is expected to be delivered in 2024
- All new locomotives purchased for mainline running on the KiwiRail network are designed to be ETCS ready
- Any new locomotives intended for mainline running in the Auckland suburban area will be fitted with ETCS at factory – currently this includes the fitment of 20 DM class locomotives destined for North Island operations
- DC and DH classes will be retired over the next five or so years. We are now primarily using DL's on the Port duty (which will be fitted with ETCS) and will be transferring DSG's into Auckland for the Westfield local shunts (Penrose / Sylvia Park etc.) We still have to work through a strategy of ETCS but it has been discussed in

relation to the class.

037/23 The Commission recommended that KiwiRail provides first aid training and evacuation training to all rail personnel that work in rail vehicles

This recommendation is under consideration.

All infrastructure trainees are trained in First Aid as part of the Future You programme. Evacuation training is covered specifically in our Tunnel courses, where we train the use of SCSR and Gas masks.

For Scenic passenger staff, this is extended further with the Scenic Safety and Emergency Procedures course which is revalidated every 12 months.

6.8. On 1 April 2025, KiwiRail provided an update:

On 15 November 2023 KiwiRail responded that all infrastructure trainees are trained in First Aid as part of the Future You programme. Evacuation training is covered specifically in our Tunnel courses, where we train the use of SCSR and Gas masks.

For Scenic passenger staff, this is extended further with the Scenic Safety and Emergency Procedures course which is revalidated every 12 months.

This recommendation is (Under consideration)

Summary:

We are satisfied our actions have addressed this rec and

No further action required

Therefore we are treating this recommendation as closed.

Recommendation to Waka Kotahi

6.9. On 25 October 2023, the Commission recommended that Waka Kotahi reviews the operation of long-hood leading locomotives by all rail participants to ensure sufficient risk controls are in place. **(038/23)**

6.10. On 15 November 2023, Waka Kotahi replied:

Whilst the recommendation has been accepted and implemented from a KiwiRail point of view, Waka Kotahi NZ Transport Agency (as Rail Safety Regulator) still needs to ensure all participants who operate long-hood leading locomotives are reviewed to ensure sufficient risk controls are in place.

Waka Kotahi is undertaking work with all rail licence holders that operate in long hood leading mode, including:

- consulting each of these rail licence holders on their use of long hood leading mode by 31 December 2023
- reviewing the safety management system of each of these rail licence holders by 31 March 2024. This will be focused on assessing how they are incorporating the required controls to manage the risks associated with long hood leading mode.

Semi-Permanent Bulletin No. 665 (12 July, 2023) was provided for evidence of the recommendation having been completed by KiwiRail.

7 Key lessons
Ngā akoranga matua

7.1. Operating locomotives in a long-hood leading configuration creates additional safety risks. Activities which take place infrequently or are considered different from normal operations should always trigger a risk assessment and risk management plan.

7.2. On-the-job training can introduce risk to an operation. Effective supervision of employees undertaking safety-critical tasks is an important defence against unsafe activity.

7.3. Fitness for duty is an important risk control measure that ensures individuals can fully focus on the task at hand. Distractions in the form of injuries, illnesses or stresses outside work can impact the ability to concentrate and impair cognitive-related performance.

7.4. Crew Resource Management (CRM) is an important tool that enables individuals to work together effectively, particularly when operating in unusual or non-normal circumstances. CRM requires the use of all available resources. Communication should include all parties who have relevant operational safety information to share.

7.5. Complex systems require robust engineering risk controls to guard against the outcomes associated with variable human performance within the system. Administrative controls, which are vulnerable to human error and non-compliance, should not solely be relied upon to keep a system safe.

7.6. Regulatory oversight is an integral part of any transport safety system. Independent assurance that an operator is appropriately managing their safety-critical risks provides a fundamental layer of defence against the introduction of unsafe operational practices.

8 Data summary
Whakarāpopoto raraunga

Vehicle particulars

Train type and number:	L71 mainline freight shunt – DCP4605
Classification:	Diesel electric locomotive
Year of Manufacture:	DA 1961–67 DC conversion 1980–83 DCP later conversion for passenger services.
Operator:	KiwiRail

Date and time	1 June 2022, 0103
Location	Tamaki, Auckland – North Island Main Truck
Operating crew	One locomotive engineer, one trainee second person rail operator, and one rail operator minder.
Injuries	The three crew received minor to moderate injuries requiring medical attention.
Damage	The locomotive sustained extensive damage to its left-hand side, rupturing the locomotive's fuel tank. The locomotive was later written off by KiwiRail. The track infrastructure had extensive damage to the up and down mainlines including an adjacent line, track turnout points and crossover junction.

9 Conduct of the Inquiry
He tikanga rapunga

9.1. On1 June 2022, Waka Kotahi NZ Transport Agency notified the Commission of the occurrence. The Commission subsequently opened an inquiry under section 13(1) of the Transport Accident Investigation Commission Act 1990 and appointed an Investigator-in-Charge.

9.2. The Commission obtained documentation and records including:

- Tranzlog data of the locomotive, signal logs, mobile phone records, maintenance records, track and infrastructure records, and train control voice recordings
- training documentation
- risk assessments
- shift rostering of the crew.

9.3. The Commission conducted 14 interviews and two follow-up interviews with the crew members.

9.4. On 1 and 2 June 2022, the Commission conducted a site examination and examined the locomotive.

9.5. On 26 July 2023 the Commission approved a draft report for circulation to six interested parties for their comment.

9.6. The Commission received six submissions, and changes as a result of these have been included in the final report.

9.7. On 25 October 2023, the Commission approved the final report for publication.

Abbreviations
Whakapotonga

ATSB	Australian Transport Safety Bureau
CRM	Crew Resource Management
ETCS	European Train Control System
L71	Local circuit shunting service
LE	Locomotive Engineer
L&D	KiwiRail Learning and Development
NIMT	North Island Main Trunk
OCM	Occupation Competency Manager
ONRSR	Officer of the National Rail Safety Regulator (Australia)
RO	Rail Operator

Glossary
Kuputaka

Bi-directional signalling system	The signalling system that allows one or more tracks to be used for rail movements in either direction on the track. This allows more flexibility for running multiple trains.
Derailment	When a rail vehicle has disengaged one or more of the vehicle's wheels that connects to the top of the rail head.
ETCS	European Train Control System is a system that allows the signalled authority to communicate with the train's computer system and trackside monitoring infrastructure. This allows the train to be controlled to operate within a safety envelope.
Dual-cab	Dual-cab locomotives have a cab at each end of the locomotive allowing forward-facing-direction travel when moving on the rail network
Locomotive	A locomotive is a rail transportation vehicle that provides the motive power to pull or push other rail vehicles on a rail network.
Locomotive engineer	A locomotive engineer is certified by examination to operate the in-cab controls for the train's speed and braking applications to conform with the signal indications on the rail network.
Long-hood leading configuration	When the locomotive's rear engine compartment (known as the long hood) is driven in the leading direction of travel. This places the cab of the locomotive at the rear of the train and restricts operator view lines compared to short-hood leading operation.
Minder	The role of a minder is to observe and supervise a trainee during on-the-job training. The minder must have equivalent certification to the role the trainee is learning.
North Island Main Trunk	The railway network that runs from Auckland to Wellington and is connected to various other mainline rail networks, stations and rail sidings to operate trains and rail vehicles for the movements of commuter passengers and freight.
Rail operator	A rail operator is certified to operate railway equipment and to undertake a selection of rail-based duties within rail yards and terminals.

Second person	A second person is trained to assist with a number of duties, one being to call signals to the LE when operating in a long-hood leading configuration. Some signals along the route may not be clearly seen by the LE who is in charge of controlling the rail vehicle.
Train controller	Rail personnel who control rail vehicle movements on a rail network.
Vigilance device	The locomotive vigilance device is a safety system fitted to locomotives that ensures the LE is actively responding to an in-cab warning light followed by a whistle alarm before the train will apply the brakes automatically.
Wagon	Rail vehicle used to transport goods and equipment on the rail network.

Citations
Ngā tohutoru

Australian Transport Safety Bureau (2021). *Collision between a light engine LET0 and empty coal train EE16, Westwood, Queensland, on 18 June 2021*. ATSB-RO-2021-007.

United States Department of Transportation (1998). *Human Factors Guidelines for Locomotive Cabs*. DOT/FRA/ORD-98/03.

Australian Office of the National Rail Safety Regulator (2021). *Review of risks associated with long-end leading operations*. ONRSR Safety Alert RSA-2021-001.

Appendix 1 Safety Alert RSA-2021-001, Australian Office of the National Rail Safety Regulator Safety Alert

Notice to Rail Transport Operators

national rail safety regulator

Safety Alert – Review of risks associated with 'long end leading' operations

Objective Document ID:	A1227092	
Rail Safety Alert No	RSA-2021-001	
Date Issued	25 June 2021	

1 Subject

Review of risks associated with long end leading locomotive operations

2 Issue

'Long end leading' is the practice of driving a locomotive when the drivers' cab is at the rear of the locomotive relative to the direction of travel.

When locomotives are operated long end leading the driver(s) has a more restrictive view of the route ahead and as a result the risk profile of such operations may be increased. Risks include but are not limited to:

- train to train collision;
- train to vehicle collision;
- train to person collision; and
- derailment.

Depending on the size of the locomotive hood, equipment attached to the side of the hood and positioning of the driver's cab, long end leading may result in the driver's forward vision being further restricted.

(This picture is a historical photo to represent long end leading operations to assist understanding. It is NOT implying anything regarding the safety of the operations depicted.)

The Rail Safety National Law requires that rail transport operators manage the risks associated with rail operations and ensure safety so far as is reasonably practicable (SFAIRP).

Rail infrastructure managers (RIMs) should understand the risks of any long end leading operations that occur on their respective networks and rolling stock operators (RSOs) should understand the risks of operating locomotives long end leading.

ONRSR expects all rail transport operators to review the risks associated with long end leading operations as it applies to their RIM and RSO responsibilities and consider the effectiveness of their safety management system.

ONRSR further expects that these reviews are completed and documented by **30 July 2021**.

From August onwards rail safety officers will be contacting selected rail transport operators to review the work undertaken and expect rail transport operators to be able to demonstrate that any long end leading operations are conducted in a manner that manages the risks to safety SFAIRP.

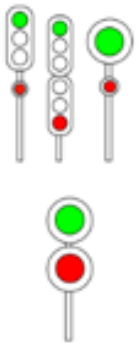
This advice is effective immediately

Peter Doggett

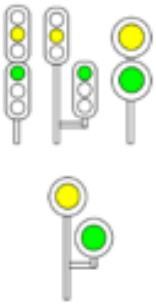
Chief Operating Officer

Appendix 2 Signal aspects and their meanings

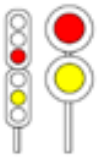
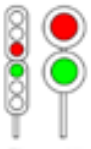
Signal 1 on departure from the port 14ABR

Name	Signal call	Action
Clear Normal speed  Figure 33	**Normal Clear**	Proceed at speed not exceeding maximum speed laid down for class of train and locality

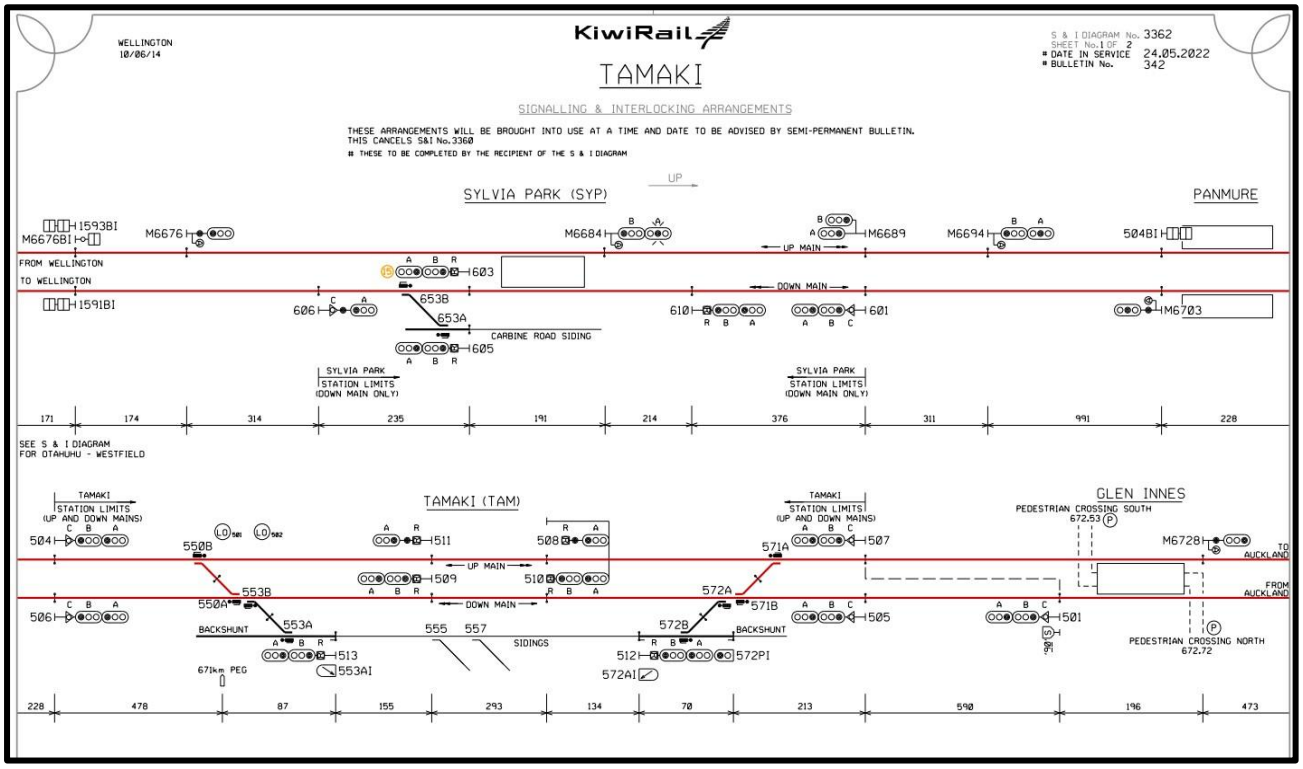
Signal 2 after departure – M6743

Name	Signal call	Action
Caution Reduce to Medium Speed  Figure 28	**Reduce to Medium**	Reduce speed prepare to pass next signal at Medium speed

Signal 3 after departure - 507

Name	Signal call	Action
Caution Medium Speed Prepare to Stop  Figure 26	**Medium to Stop**	Proceed cautiously at Medium Speed, prepare to stop at next signal
Clear Medium Speed  Figure 27	**Medium Clear**	Proceed at Medium Speed

Appendix 3 Tamaki signalling and interlocking diagram



Appendix 4 KiwiRail instructions for long-hood leading operations

KiwiRail

8.2.4 Raurimu Spiral and Owhango Bank (new instruction)

The serial braking rules for descending the Raurimu Spiral and Owhango Bank ruling grades are:

- For all trains exceeding 1700 tonnes, the maximum speed from National Park to Raurimu and from Owhango to Kakahi is 40 km/h
- As speed falls below 20 km/h apply 300 kPa independent brake to ensure the train is fully bunched.
- Releasing speed is stopped.
- If movement occurs when the automatic brake is released, reduce the independent brake to 150 kPa.
- Fully release the independent brake once the brake pipe is fully recharged

9.0 LOCOMOTIVES RUNNING LONG HOOD LEADING

Delete current instruction and replace with the following:

DC, DH, DF Class and DX Class locomotives when running as the train locomotive *on the controlled network and branch lines* will run short hood leading with the following exceptions:

- In emergencies ONLY, when no other options are available.

  NOTE: Emergencies is defined as restricted to life threatening situations, and running long hood is required in order to preserve life, or avoid situations from escalating to a life threatening situation.

  When required to run long hood leading, the locomotive:
  - must not exceed Restricted speed
  - must be *crewed* by 2 Locomotive Engineers
- Where specific exemptions are listed in the local instruction

NOTE: When DF Class and DX Class locomotives equipped with air chutes on the running board run long hood there is restricted vision. The *pilot must* ride in a "Safer Riding Position" (travelling at reduced speed not exceeding 25 km/h *and 10 km/h over level crossings*).

Tunnel breathing apparatus equipment must be available for crew use in all instances of long hood running as permitted in this instruction.

Kōwhaiwhai – Māori scroll designs

TAIC commissioned its four kōwhaiwhai, Māori scroll designs, from artist Sandy Rodgers (Ngāti Raukawa, Tūwharetoa, MacDougal). Sandy began from thinking of the Commission as a vehicle or vessel for seeking knowledge to understand transport accident tragedies and how to avoid them. A 'waka whai mārama' (i te ara haumaru) is 'a vessel/vehicle in pursuit of understanding'. Waka is a metaphor for the Commission. Mārama (from 'te ao mārama' – the world of light) is for the separation of Rangitāne (Sky Father) and Papatūānuku (Earth Mother) by their son Tāne Māhuta (god of man, forests and everything dwelling within), which brought light and thus awareness to the world. 'Te ara' is 'the path' and 'haumaru' is 'safe' or 'risk free'.

Corporate: Te Ara Haumaru – the safe and risk free path

The eye motif looks to the future, watching the path for obstructions. The encased double koru is the mother and child, symbolising protection, safety and guidance. The triple koru represents the three kete of knowledge that Tāne Māhuta collected from the highest of the heavens to pass their wisdom to humanity. The continual wave is the perpetual line of influence. The succession of humps represents the individual inquiries.

Sandy acknowledges Tāne Māhuta in the creation of this Kōwhaiwhai.

Aviation: Ngā hau e whā – the four winds

To Sandy, 'Ngā hau e whā' (the four winds), commonly used in Te Reo Māori to refer to people coming together from across Aotearoa, was also redolent of the aviation environment. The design represents the sky, cloud and wind. There is a manu (bird) form representing the aircraft that move through Aotearoa's 'long white cloud'. The letter 'A' is present, standing for 'Aviation'.

Sandy acknowledges Ranginui (Sky father) and Tāwhirimātea (God of wind) in the creation of this Kōwhaiwhai.

Maritime: Ara wai – waterways

The sections of waves flowing across the design represent the many different 'ara wai' (waterways) that ships sail across. The 'V' shape is a ship's prow and its wake. The letter 'M' is present, standing for 'Maritime.

Sandy acknowledges Tangaroa (God of the sea) in the creation of this Kōwhaiwhai.

Rail: rerewhenua – flowing across the land

The design represents the fluid movement of trains across Aotearoa. 'Rere' is to flow or fly. 'Whenua' is the land. The koru forms represent the earth, land and flora that trains pass over and through. The letter 'R' is present, standing for 'Rail'.

Sandy acknowledges Papatūānuku (Earth Mother) and Tāne Mahuta (God of man and forests and everything that dwells within) in the creation of this Kōwhaiwhai.

Transport Accident Investigation Commission

Recent Rail Occurrence reports published by the Transport Accident Investigation Commission (most recent at top of list)

RO-2022-101	Passenger train, fire in auxiliary generator wagon, Palmerston North, 11 May 2022
RO-2022-103	KiwiRail W6 shunt and Metro (Go Bus) Route 60 bus, near miss at Selwyn Street level crossing, Christchurch, 8 August 2022
RO-2021-105	Unintended movement resulting in locomotive and wagon entering Picton Harbour, Picton, 1 September 2021
RO-2021-106	Derailment of Train 220, South of Hunterville, 13 December 2021
RO-2021-103	Te Huia passenger service, train parting, North Island main trunk line, Paerata, 19 July 2021
RO-2021-102	Freight Train 391, collision with light truck, Saunders Road, Marton, 13 May 2021
RO-2021-101	Serious injury during shunting operations on board the Aratere, Interislander ferry terminal, Wellington, 9 April 2021
RO-2020-101	Level crossing collision, Mulcocks Road, Flaxton, 10 February 2020
RO-2020-104	Safe working irregularity, East Coast Main Trunk Line, Hamilton – Eureka, 21 September 2020
RO-2020-103	Collision between bus and locomotive, Clevely Line level crossing, Bunnythorpe, 16 September 2020
RO-2019-108	Level crossing collision, Piako Road, Morrinsville, 7 December 2019
RO-2020-102	Express freight Train 932, strikes hi-rail vehicle, Limeworks Road, 24 April 2020
RO-2019-105	Express freight Train 268, derailment, Wellington, 2 July 2019
RO-2019-107	Passenger service SPAD and near collision, Wellington, 6 November 2019
RO-2019-106	Passenger train 804, Irregular disembarkation of passengers, Rolleston, Canterbury, 3 September 2019

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