Transport Accident Investigation Commission

Final report
Tuhinga whakamutunga

Rail inquiry RO-2023-104
Passenger train (Te Huia) signal passed at danger and potential conflict
Penrose, Auckland
17 June 2023

November 2024

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 and incidents 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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Commissioner	Bernadette Roka Arapere
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Key Commission personnel

Chief Executive	Martin Sawyers
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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: Te Huia passenger train
(Credit: nzrailphotos.co.nz)

Figure 2: Location of incident at Penrose, Auckland, New Zealand
(Credit: Toitū Te Whenua, LINZ)

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1 Executive summary
Tuhinga whakarāpopoto

What happened

1.1. On Saturday 17 June 2023, the Te Huia regional passenger train service named Te Huia was travelling from Hamilton to Auckland on a scheduled service.

1.2. At Penrose Station on the North Auckland line, the train passed a stop signal and entered the Onehunga branch line junction[1], damaging the junction points[2].

1.3. The track route and signals, which included the junction points, had been set for an Auckland One Rail commuter train (Service 6516) on the Onehunga branch line. That train was about to depart Penrose platform 3, which was located on the Onehunga branch line.

1.4. The signalling system detected that Te Huia had entered the junction, and the signals on the Onehunga branch line reverted to a stop sequence, alerting the commuter train driver that the route was occupied.

1.5. There were no injuries and there was no damage to the trains. However, Te Huia damaged the junction points, leading to a lengthy disruption to services.

Why it happened

1.6. The locomotive engineer on Te Huia incorrectly interpreted the signal for the Onehunga branch line (signal 312) as their own signal to proceed. The applicable signal (signal 308) for the line on which they were travelling was at stop but was not within their clear view.

1.7. There was no effective engineering control to prevent the signal being passed at stop or mitigate the consequences of the event, meaning Te Huia entered an area of potential conflict.

1.8. The locomotive engineer's absence from operating on the North Auckland line meant they were unfamiliar with the route and the signalling system approaching Penrose Station.

What we can learn

1.9. Complex systems[3] such as rail require robust engineering risk controls[4] to guard against the outcomes associated with human performance limitations. Administrative controls are vulnerable to human error and non-compliance. They should not be solely relied on to keep a system safe.

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[1] A place at which two or more rail routes converge or diverge.
[2] A track component that provides a path for a wheel to transfer from one track to another.
[3] A complex system is one where multiple individual, but interrelated, components interact.
[4] Engineering risk controls work by isolating hazards, generally by way of the physical design of a system.

1.10. Compliance with the rail standards and the management of the risks on the railway network require monitoring to assure those using the system that the risks have been managed appropriately.

Who may benefit

1.11. Rail personnel, rail operators, rail access providers, transport planners and anyone involved in safety auditing and assessments may benefit from the findings in this report.

2 Factual information
Pārongo pono

Background

2.1. The Te Huia regional passenger train service (Te Huia) connected Waikato (Hamilton and Huntly) and Auckland (The Strand station). There were two return services each weekday and one return service on Saturdays. The service was operated by KiwiRail Holdings Limited (KiwiRail) on behalf of Waikato Regional Council.

2.2. The service had limited stops en route to pick up and set down passengers, with the last stop at Papakura before reaching its destination at The Strand.

Narrative

2.3. On Saturday 17 June 2023, at about 0735, Te Huia departed Hamilton via the North Island Main Trunk (NIMT) en route for Auckland.

2.4. The train service was crewed by one locomotive engineer (LE), a train manager and two train attendants[5].

2.5. Te Huia made a passenger stop at Papakura station and departed at about 0930, which was 10 minutes ahead of schedule[6].

2.6. At about 0949 Te Huia travelled through Westfield, leaving the NIMT at the Westfield junction[7] and moving on to the North Auckland line (NAL) headed towards Penrose (*see* Figure 3).

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[5] Train managers are responsible for rail passenger comfort and safety. They manage passenger loading and unloading, provide passengers with information and may issue tickets, handle money and operate emergency equipment. They are supported by the train attendants in this function.

[6] As an inter-regional service, Te Huia did not pick up passengers at Papakura Station, but passengers could disembark to catch other metro connections.

[7] A place at which two or more rail routes converge or diverge.

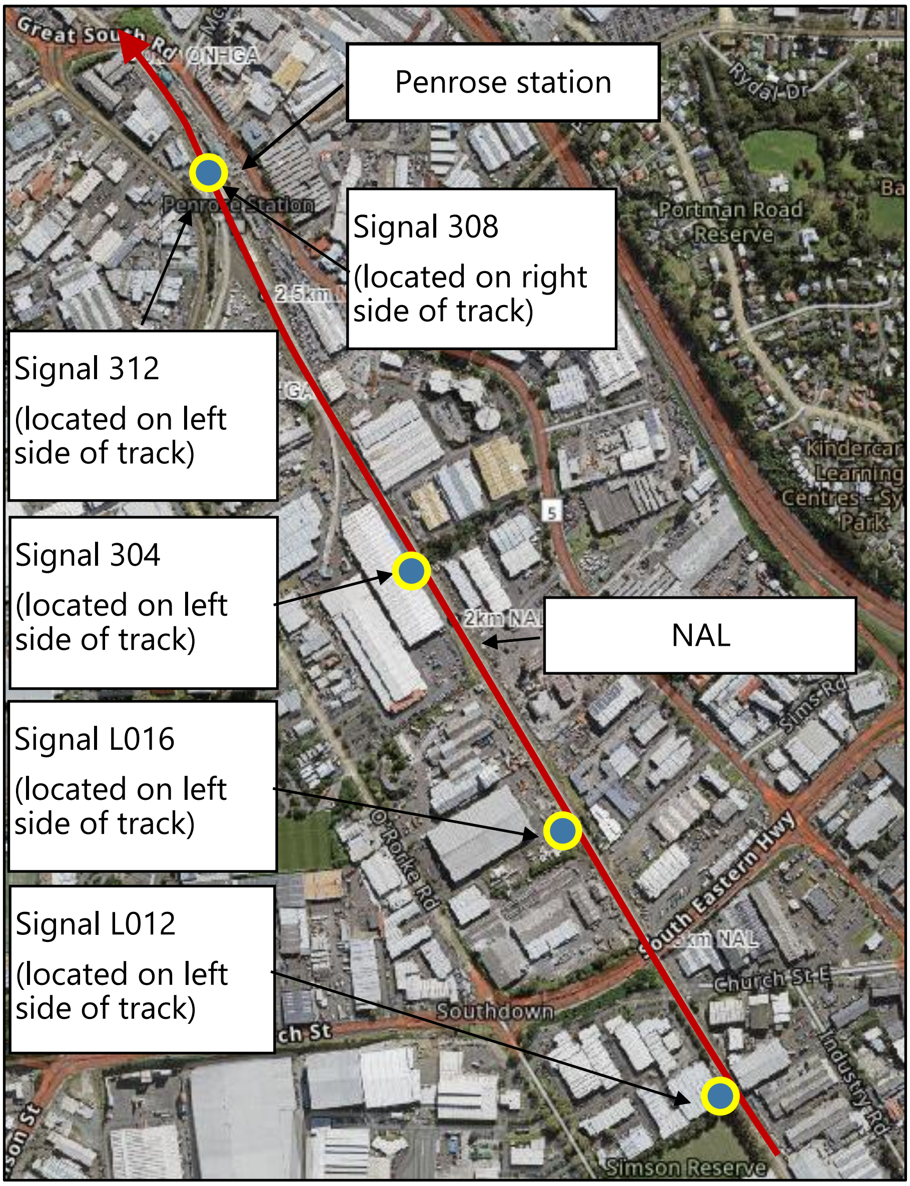


Figure 3: Approach to Penrose Station on the NAL
(Credit: Toitū Te Whenua, LINZ)

2.7. At about 0950 Te Huia approached Penrose, where the sequence of signals indicated that a stop at Penrose Station had been planned by the Train Controller (*see* Figure 4).

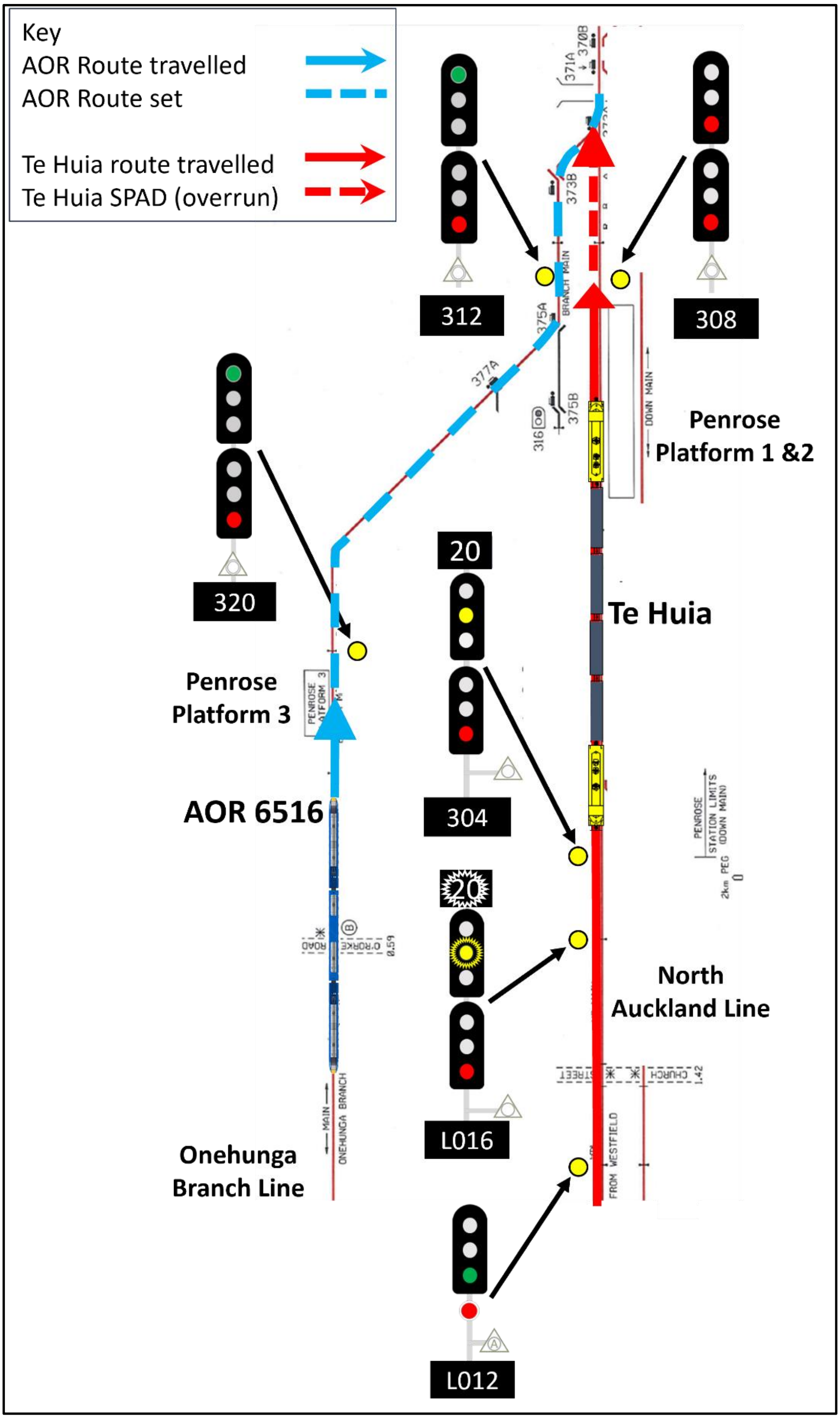
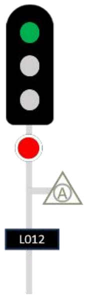


Figure 4: Signals and train movements approaching Penrose Station

2.8. Signal L012 was displaying a green aspect[8], authorising movement in the track section between Westfield and Penrose. The signal was a single unit equipped with a marker disk as the lower light and an 'A' light (*see* Figure 5).

normal clear



proceed at speed not exceeding the limit for class of train and locality (80km/h)

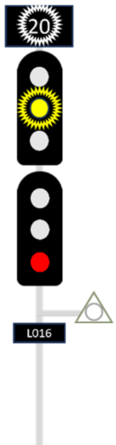
Figure 5: Signal aspect for 'Normal clear when bottom signal is fixed at red'

2.9. Te Huia then crossed Church Street level crossing, located beyond signal L012 (*see* Figure 4) and was approaching the next signal, L016, which was displaying a flashing yellow top unit with a red aspect in the bottom unit. The signal was supplemented with a flashing white numeral '20', which indicated that the next signal was at caution and the maximum speed at the next signal was 20 kilometres per hour (*see* Figure 6).

advanced caution to stop

advanced speed indicators are fitted above the top signal unit on each mast

when illuminated, will display a flashing white speed in km/h that the train must not exceed at the next signal in advance



proceed cautiously prepare to stop at second signal ahead

Figure 6: Signal aspect for 'advanced caution to stop' and 'advanced speed indicator'[9]

2.10. Te Huia passed this signal at about 0951 and was then approaching signal 304, the home[10] signal to Penrose Station. The signal was displaying a steady yellow aspect in the top unit with a red aspect in the bottom unit. The signal was supplemented with a steady white numeral '20', which indicated a caution and that the next signal could be

[8] The aspect of a signal is the visual indication of a lit signal that is given to the operator

[9] A numeric indicator illuminated (flashing) to advise the speed in kilometres per hour that the train must not exceed at the next signal in advance.

[10] A signal that controls the entry to a station or junction.

at stop. The maximum permitted speed for Te Huia was 20 kilometres per hour after passing that signal (*see* Figure 7).

caution to stop

speed indicators are fitted above the top signal unit on each mast

when illuminated, will display a steady white speed in km/h that any train passing that signal must not exceed until the next signal in advance is reached unless ETCS indicates a higher speed

proceed cautiously prepare to stop at next signal ahead

Figure 7: Signal aspect for 'caution to stop' and 'speed indicator[11]'

2.11. Te Huia passed signal 304 at a speed of about 36 kilometres per hour. The LE was still applying power, with the train's speed decreasing to about 32 kilometres per hour. The track on approach to Penrose was on an ascending grade of about 1:50, with the track curving to the right on approach to the station.

2.12. At about 0952, with the speed still at about 32 kilometres per hour, the LE sighted signal 312 at Penrose Station. The signal was displaying a Normal clear with a green aspect in the top unit and a red aspect in the bottom unit (*see* Figure 8). This signal was located to the left of the track.

normal clear

proceed at speed not exceeding the limit for class of train and locality (80km/h)

Figure 8: Signal aspect for 'normal clear' where bottom signal is not fixed

2.13. The LE responded by increasing power and taking the train's speed up to 50 kilometres per hour as it continued towards Penrose Station. The signal the LE had observed,

[11] A numeric indicator illuminated to advise the safe speed for the route set. Normally associated with a warner route (a specific type of route provided at some signals, selected by the signaller, where the full overlap of a signal may not be available).

signal 312, was the signal for the Onehunga branch line (OBL), and not a signal for the NAL on which Te Huia was operating.

2.14. The signal applicable to the NAL was signal 308, which was located to the right of the track beyond the station platform and not in the LE's view. This signal was displaying a red aspect in the top and bottom units, meaning trains had to stop and proceed only when authorised (*see* Figure 9). The signal was set to stop to allow for the passage of a commuter train onto the NAL through the 373A points[12] at the OBL junction.

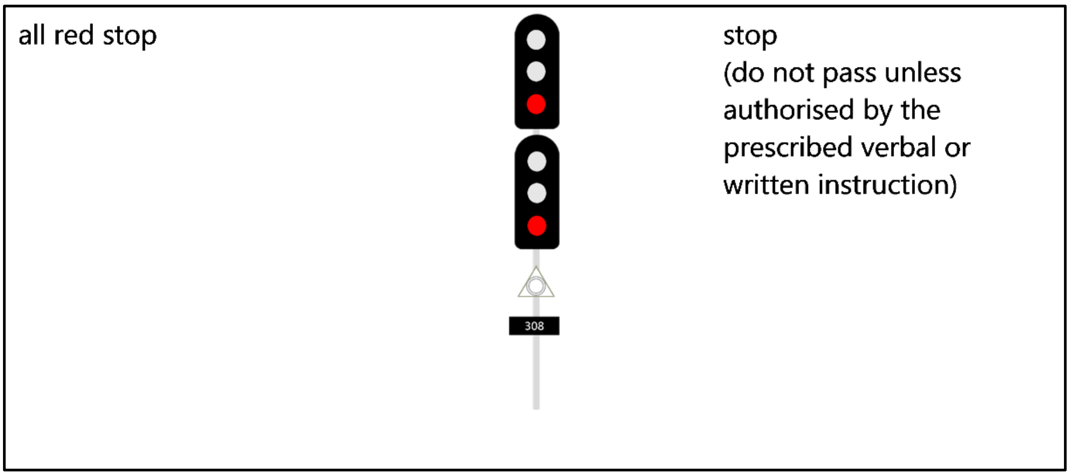


Figure 9: Signal aspect for 'all red stop' signal

2.15. As Te Huia continued past the station, the LE saw the red aspect of signal 308 in their peripheral vision. They realised that they had identified the incorrect signal for the route, and responded by applying the train's brake handle into a 'handle off' position[13]. The LE thought they had applied the train brake handle to the emergency position[14].

2.16. Te Huia continued past signal 308 and travelled a further 195.2 metres before coming to a stop. The train could not be stopped and ran through[15] and damaged the 373A points at the OBL junction (*see* Figure 10).

[12] Items of permanent way that may be aligned to one of two positions to guide a train towards either the straight (Normal) or diversion (Reverse) track.

[13] There are distinct zones for a train's brake, known as quadrants. These are: Release; Minimum reduction; Service zone – during normal operation where the reduction is at service rate [controlled rate]; 'Handle off' position – for conditioning the brake valve where the brake is applied at service rate. Emergency application – where a brake pipe vents to the atmosphere and brakes are applied more rapidly than a service rate through the train. The Emergency position provides all the available brake effort in a shorter time, together with sanding at the wheel/rail interface to reduce the stopping distance.

[14] The Transport Accident Investigation Commission has previously identified the issue concerning the use of emergency braking in inquiries RO-2020-102 and RO-2022-104.

[15] A run-through is an unintended movement of a rail vehicle through a set of points in the trailing direction when the points are set against the movement being carried out.

Figure 10: Location and aspect of signal 308 with Te Huia stopped and obstructing 373A points
(Credit: nzrailphotos.co.nz)

2.17. The Train Controller had set the train control system for the intended passage of the Auckland One Rail (AOR) commuter service from the OBL to the NAL. The system had moved the 373A points to reverse[16] at the junction as required.

2.18. The commuter service had stopped at Penrose platform 3, which is located on the OBL and is a separate platform from the main station. There was a greater-than-usual number of passengers boarding the train, which delayed the departure from the platform.

2.19. The commuter service was about to depart the station platform on a proceed signal when Te Huia passed signal 308 at stop. As a result, the signals applying to the commuter train (signals 320 and 312) reverted to the stop sequence.

2.20. Signal 320, located at the departure end of the station platform, reverted to a caution to stop aspect (yellow signal), while signal 312, which permitted entry to the NAL, reverted to a stop aspect (red signal).

2.21. The train driver on the commuter service observed the aspect change in signal 320 at the platform and responded immediately by applying their emergency brake, preventing their train passing the signal.

2.22. This action left a clear section of about 320 metres[17] of track between the two train services.

[16] Points can be in either 'Reverse' or 'Normal'. Reverse is the position of points set for a less commonly used route. Normal is the position of points set for a more commonly used route, usually straight running.

[17] This comprised the distance between the three-car stopping position on Platform 3 Penrose and signal 320, the distance from signal 320 to signal 312 and the overrun distance past signal 312 to the fouling point where two trains could collide.

2.23. At the time of the incident there were 95 passengers on board Te Huia. There were no injuries to the train crew or passengers on either train service.

2.24. The passengers on board Te Huia were delayed on the service for about two and a half hours before disembarking at the Penrose Station platform.

2.25. The line remained closed until the evening of 18 June 2023 to facilitate repairs to the 373A points.

Personnel information

2.26. The LE of Te Huia was freight and passenger certified, with 48 years' service with KiwiRail. Their safety observations were current.

2.27. The LE had been assessed as fit for duty in accordance with the National Standard for Health Assessment of Rail Safety Workers[18].

2.28. Following the incident the LE was tested for the effects of drugs and alcohol; the results were negative (clear).

Train information

Te Huia regional passenger train service (Te Huia)

2.29. Te Huia was a purpose-built service that had commenced operation in April 2021.

2.30. Te Huia comprised four passenger carriages and two diesel electric locomotives coupled at each end. Its total length was 110 metres and it weighed 326 tonnes.

2.31. Te Huia was fitted with Electronic Train Protection (ETP)[19], but the system was isolated and not operational (discussed further in Section 3: *Engineering risk controls*).

Auckland One Rail commuter service

2.32. The AOR commuter service (train 6516) was an AM class[20] Electric Multiple Unit operated by AOR (see Figure 11).

2.33. This class of vehicle had been introduced to the Auckland electrified network in 2014 and was fitted with the European Train Control System (ETCS) Level 1. The ETCS was an engineering control system that supervised the train's movements (discussed further in Section 3: *Engineering risk controls*).

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[18] The National Transport Commission Standard for Health Assessment of Rail Safety Workers provides a framework for rail operators to manage the risks to safety posed by the ill health of rail safety workers on the National Rail System.

[19] A train stop protection system designed to reduce the consequences of Signal Passed at Danger occurrences. ETP is an on-board system that is able to read a 'signal red' message from an ETCS balise (an electronic beacon or transponder placed between the rails of a railway as part of train control or a protection system). Trackside ETCS was installed throughout the Auckland Metro network as part of the electrification triggered re-signalling.

[20] A designated class of train for the Auckland Metro system, manufactured by Construcciones y Auxiliar de Ferrocarriles.

Figure 11: Auckland One Rail AM class Electric Multiple Unit passenger train

Signalling system

2.34. The signalling layout on approach to Penrose was contained in the *Signalling and Interlocking Arrangements*[21] diagram 3195, dated 25 March 2016 (*see* Figure 12).

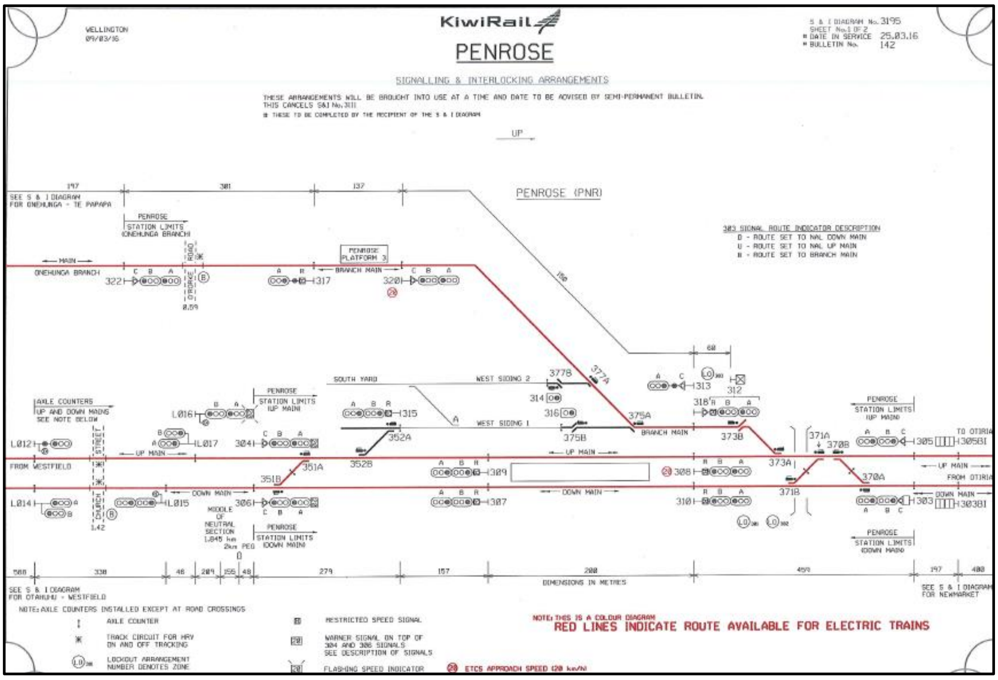

Figure 12: Signalling and interlocking arrangements diagram for Penrose Station

2.35. KiwiRail's signalling rules define not only the authority to occupy sections of track but also the maximum speed at which trains may travel.

[21] A general term applied to the controlling of the setting and releasing of 'signals' and 'points' to prevent unsafe conditions arising.

2.36. Signals provide authority to train drivers to pass or stop at signals and also information about the signals ahead. This information provides warnings to the drivers about the actions they may need to take to control their trains.

2.37. In 2010 signalling was renewed and upgraded to ensure its compatibility with a new 25-kilovolt overhead traction system. The opportunity was also taken to deploy an automatic train protection system, and ETCS Level 1 was selected for this purpose. Track circuitry[22] was replaced with axle counters[23] to accommodate ETCS on the commuter network. The upgrade programme included the replacement of all existing points machines[24] and signals with a fully computerised system to control train movements.

Recorded data

2.38. The locomotive was fitted with a Tranzlog data recorder. Information from the recorder is used in this report where appropriate.

2.39. The Tranzlog data recorder recorded the train's position along the route, including the LE's brake and throttle inputs (*see* Figure 13).

[22] An electrical circuit where current is carried through the rails and used to detect the absence of trains.
[23] A form of train-detection equipment provided in place of the conventional track circuitry.
[24] Machines that move points to guide trains towards either the straight (Normal) or diversion (Reverse) track.

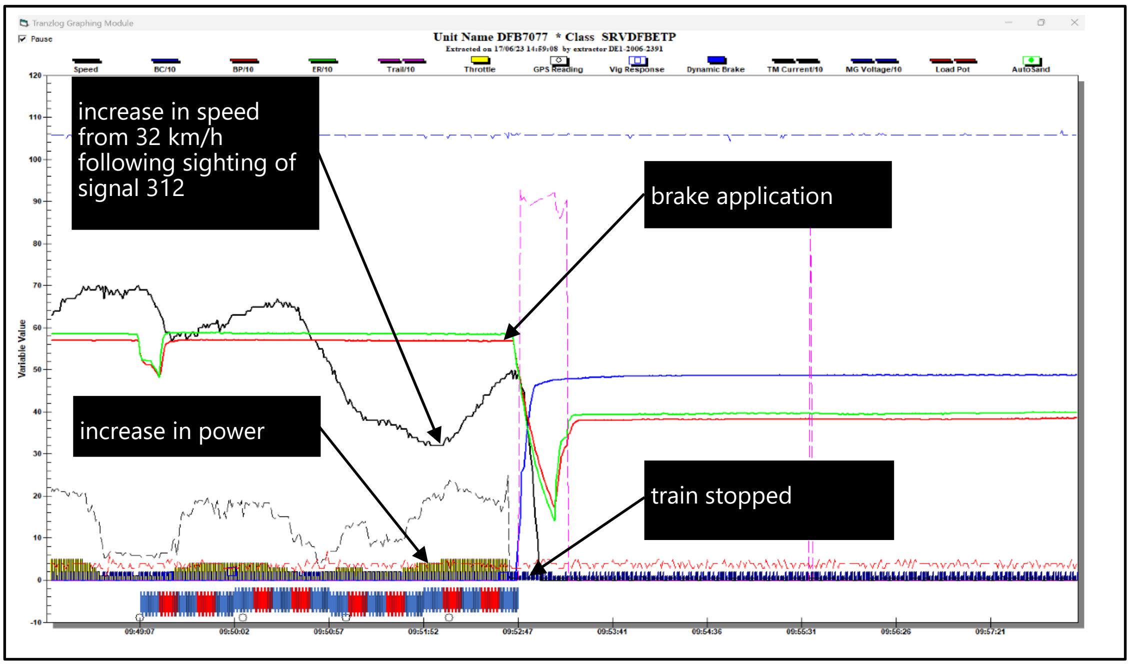

Figure 13: Tranzlog data annotated by TAIC
(Credit: KiwiRail)

Research

Previous occurrences

2.40. In 2022 a shunt locomotive derailed in Auckland and overturned. The Transport Accident Investigation Commission (the Commission) found that complex systems[25] required robust engineering risk controls[26] to guard against variable human performance within the systems. KiwiRail's locomotive fleet was not equipped with ETCS, which could have slowed or stopped the locomotive 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[27].

2.41. In 2020 a passenger service from Southern Cross to Melton in Australia passed a signal at stop. The signal was at stop to protect the movement of another passenger service that was to cross ahead of it. The train passed the signal at about 23 kilometres per hour and continued for about 200 metres before stopping across the junction. The report on the Australian Transport Safety Bureau's investigation[28] commented that the occurrence highlighted the importance of passenger rail networks having engineering controls in place to detect Signal Passed at Danger (SPAD) events and prevent potential consequences, such as a collision.

2.42. In 2019 a SPAD event occurred involving a passenger train passing a signal at stop in the Wellington Station limits, entering a track section already occupied. The

[25] A system where multiple individual but interrelated components interact.
[26] Engineering risk controls work by isolating hazards, generally by way of the physical design of a system.
[27] TAIC RO-2022-102 L71 Mainline Shunt, derailment and subsequent rollover, Tamaki, 1 June 2022.
[28] ATSB RO-2020-019 Signal passed at danger involving passenger train and near collision with another passenger train Docklands, Melbourne, 23 November 2020.

Commission found there were no additional mitigations in place to prevent a train passing the red stop signal and colliding with another train[29].

2.43. In 2018 a Queensland Rail suburban passenger train was en route to Brisbane Airport when it passed a signal that was displaying a red aspect (stop indication). The train stopped 220 metres past the signal and 126 metres before a conflict point that another suburban passenger train had just cleared. The driver had mistaken another signal on an adjacent line that was displaying a green aspect for the applicable signal. The Australian Transport Safety Bureau investigated the accident and found that Queensland Rail's management of driver competency assessments did not include planned assurance activities or regular and effective auditing[30].

2.44. In 2014 a Transdev Auckland train passed signal 308 at stop at Penrose, Auckland. The train had passed the preceding signal 304 at a caution (yellow) signal. As the train rounded the right-hand curve, the driver observed a proceed signal, which they took to be the next signal for their movement. However, as the train got closer the driver realised that the signal was for a movement on the OBL. The driver applied full braking but was not able to stop before passing signal 308. While the Commission did not open an inquiry, KiwiRail carried out an investigation (*see* Appendix 1 for a summary of the KiwiRail report).

Organisational information

2.45. KiwiRail is a New Zealand state-owned enterprise. It operates trains and rail vehicles, controls rail movements on the national rail network and maintains the railway infrastructure as the access provider. KiwiRail was the rail operator, infrastructure owner and access provider for the network on which Te Huia operated.

2.46. The commuter train service on the OBL was operated by AOR, a licensed passenger service operator. AOR provides services on behalf of Auckland Transport. These include employing drivers and other train staff, developing timetables, undertaking station operations and maintenance, security and customer-facing activities, and managing the Auckland Network Access Agreement and KiwiRail interface.

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[29] TAIC RO-2019-107 Passenger service SPAD and near collision, Wellington, 6 November 2019.

[30] ATSB RO-2018-002 Signal ME45 passed at danger involving suburban passenger train TP43 and near collision with another suburban passenger train, Bowen Hills, Queensland, 10 January 2018.

3 Analysis
Tātaritanga

Introduction

3.1. The movement of a train to a section of track for which a route has been set for use by another train is a serious incident. A collision of two trains, even at relatively low speeds, has the potential to result in serious injury to people and significant damage to property.

3.2. Those responsible for safe rail movements rely on LEs to respond appropriately to information conveyed via trackside signals. For this to occur, LEs must correctly identify and interpret the signals in time to react using a three-step process of signal detection, signal interpretation and deciding on the correct course of action.

3.3. Integral to this safe operation is the need for accurate recalls of signal locations, which are obtained through training and familiarisation with the routes so that approaches can be planned by the LEs.

3.4. The timely detection and accurate perception of a signal's aspect is facilitated through the correct positioning of signals, having regard to the track alignment, topography and infrastructure. Applying the maximum signal sighting times provides an assurance that the appropriate signals will be identified in sufficient time for the LE to take the appropriate actions in response to the signals aspect.

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

Site information

3.6. The Commission's investigators conducted and recorded in-cab observations of the signalled route from Otahuhu Station to Westfield on the NIMT, and then on the NAL from Westfield to Penrose Station. Further in-cab observations were made from the Penrose Station to Newmarket Station limits, the sections of track beyond where the incident took place. The observations followed the route on which Te Huia had operated and were conducted in a similar locomotive. The recordings showed that of the 10 signals applicable to Te Huia's direction of travel between Otahuhu and Penrose Stations, eight were located to the left of the track and two were to the right (*see* Figure 14).

3.7. Of the two signals to the right, one was on a signal gantry[31] (signal WSF1608) and was clear of obstructions, with signal 308 at Penrose the only pole-mounted signal on the right.

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[31] A framework suspended across train tracks upon which signals can be mounted.

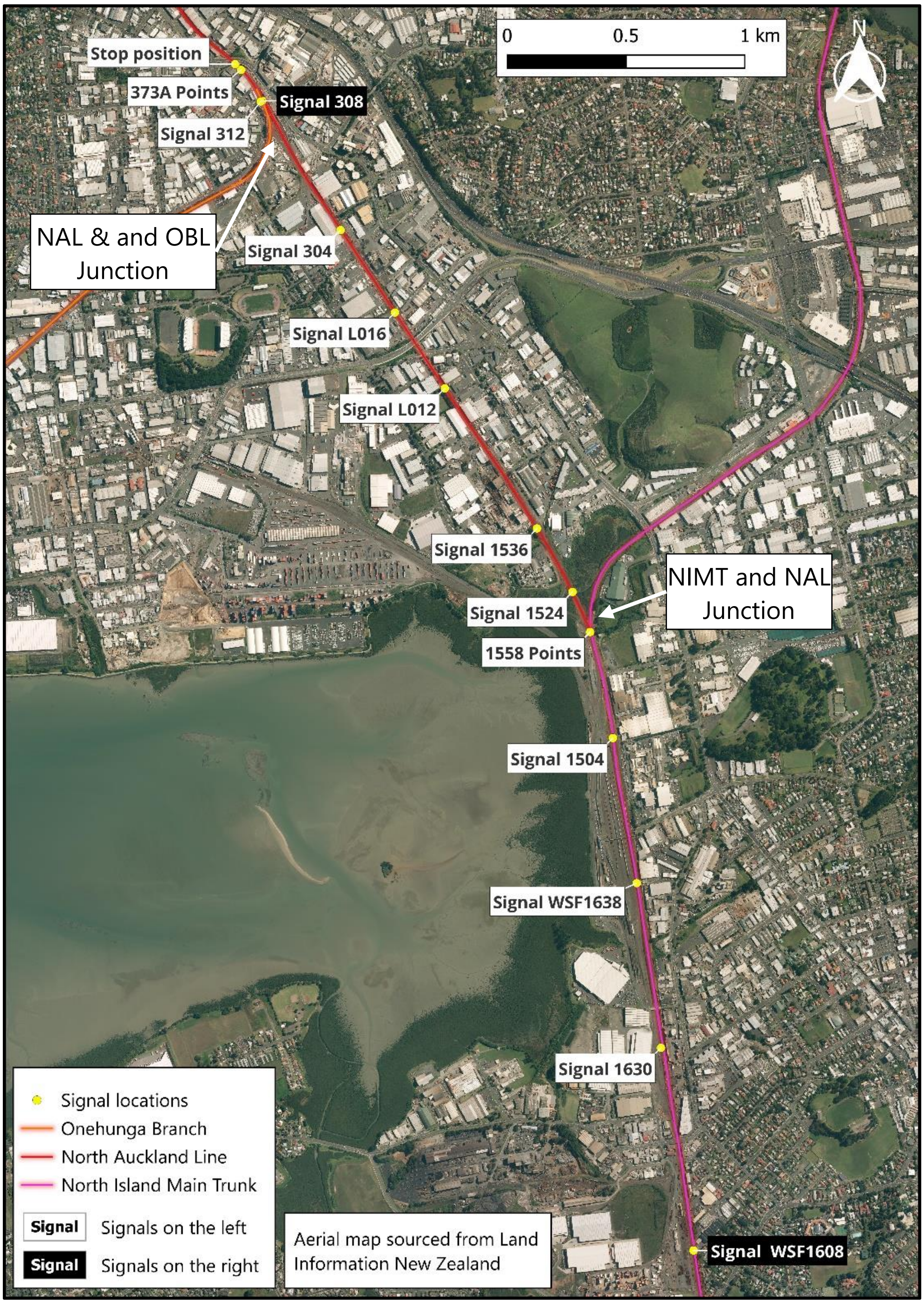

Figure 14: Signal positions and junctions Westfield to Penrose
(Credit: Toitū Te Whenua, LINZ)

3.8. A further cab run beyond Penrose to the Remuera station limits recorded six signals, all of which were to the left and were clearly visible on approach.

3.9. On approach to Penrose Station, signal 312 (the departure signal on the OBL) was located to the left of the track and was the only visible signal.

3.10. Parallel signals on curved approaches pose a particular risk of being 'misread' if signals on other lines are initially more visible and the signals become visible at different times.

3.11. Signal 312 was located adjacent to signal 308 and had retrofitted shields mounted to the right side of the shroud[32]. The purpose of the shields was to prevent the possibility of the LE misreading a signal, known as making a 'read across error'[33] (*see* Figure 15).

Figure 15: Signal 312 viewed from the locomotive cab in the left photographs. The right photograph shows the shields (circled in red) as viewed from the station platform

3.12. The shields had been fitted following a SPAD incident in 2014. The observations by the Commission's investigators when visiting the site were that signal 312 was still clearly visible on approach, and the shields were largely ineffective.

3.13. Signal 308, the correct signal, was obscured by the station walkway, the platform veranda and other lineside equipment. When signal 308 was at red, only the bottom colour aspect could be seen, as the top aspect was obscured until observations were made closer to the signal. The Commission investigators determined that the first point at which the signal was clearly and continually visible was approximately 190 metres away from the signal.

3.14. The design of an operating environment will affect human work performance and reliability – in this case either by supporting the availability of correct information to enable decision-making, or by creating an opportunity for errors to be made. The signals from Westfield to Penrose preceding signal 312 were all to the left, except for one signal on a gantry.

3.15. The placement of signals in this manner and the absence of a clear view of signal 308 **likely** led to an 'expectation bias'[34] by the LE that signal 312, also located to the left, was applicable to their authority to depart.

[32] Shrouds (also known as 'visors') are fitted to signals to improve visibility in bright sun.
[33] An error in which a signal on an adjacent parallel track is mistaken for a signal for authority to proceed.
[34] A term used to describe the influence that previous experience can have on an individual's perceptions and decision-making.

Signal identification and interpretation

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

3.17. On weekdays, the AOR commuter service on the OBL did not extend through the junction, instead terminating at Penrose platform 3. However, on weekends the service proceeded through the junction to the NAL and terminated at Britomart Station. The AOR commuter train was running on time, but Te Huia was running about 10 minutes early. In normal circumstances Te Huia would not have stopped at Penrose Station, instead continuing to the last stop at The Strand.

3.18. The unscheduled stop by Te Huia was to allow the AOR commuter service to proceed ahead through the junction. While not a requirement, commuter rail was given precedence over other rail traffic on the Auckland metro rail network.

3.19. On the day of the incident, the LE of Te Huia was not expecting to stop at Penrose Station. As the LE departed Westfield Station towards Penrose, they encountered restricted signalling aspects of flashing yellow and yellow signals, indicating that a stop at Penrose had been planned by the Train Controller. The LE assumed that this signal sequencing was a consequence of their following another train on the network.

3.20. In the absence of a complete set of information on a situation, an individual will draw on familiarity and expectation to shape their mental model[35]. If their mental model is inaccurate, information can be perceived incorrectly, and errors made. Interferences can come from environmental distractions, as well as individual's mental model of their situation.

3.21. When interviewed by the Commission, the LE stated that they had thought they were following another train on approach to Penrose, given that the signals ahead were flashing yellow and yellow. With the signal at Penrose at green, they assumed that the other train had 'gotten away'. The observation of signal 312 at green to proceed, together with the LE's mental model that they were following a train, was **likely** taken by the LE to mean that the train ahead had cleared the section and a clear run through Penrose was available.

Signal commissioning process

Safety issue 1: The risk assessment for the commissioning of signal 308 was incomplete and did not identify all the hazards associated with the positioning of the signals. The opportunity to implement risk controls to address those hazards was missed, resulting in the correct signal not being observed and a wrong signal being responded to, increasing the risk to rail users.

3.22. Signal sighting assessments are used by the rail industry to confirm that persons tasked with operating rail vehicles on the network can read, interpret and respond to

[35] An internal representation of how an individual understands a particular situation to be. Representations develop from cues in the immediate environment as well as knowledge gained through training and experience.

signal aspect indications reliably. The application of signalling principles, standards and processes ensures that risks are appropriately managed. The application of standards includes those for signal positioning and sighting.

3.23. The Auckland electrification project in 2010 coincided with an upgrade of the Auckland signalling system. The upgrade included the production of a new signalling principles document where previous codes and code supplements had applied.

3.24. KiwiRail developed a standard for signal sighting (standard S-ST-SG 2124 Signal Sighting) that followed accepted railway practices. The standard set expectations for and stressed the importance of minimum signal sighting distances and the need to prevent read-across errors such as a rail vehicle operator mistaking an adjacent signal on a parallel line as authority to proceed (*see* Appendices 2 and 3).

3.25. The standard required a minimum sighting time of 12 seconds. This meant the distance for sighting a signal on approach to Penrose Station at the maximum permitted line speed of 80 kilometres per hour was 267 metres. The standard permitted a reduced sighting time of 10 seconds in exceptional circumstances and required the reasoning to be documented. The sighting time included the ability to see all aspects of the signals on approach, clear of any obstructions. Any justification for not carrying out a full sighting exercise had to be recorded.

3.26. Signal commissioning was a static exercise[36] that did not include in-cab testing at line speed for each signal aspect to check for issues. No modelling was done on signal 308 and its surroundings.

3.27. The purpose of completing a Signal Sighting Form during the commissioning process was to provide assurance that the construction and positioning of a signal placed on the network met the requirements of the standard. In situations where a sighting standard could not be met, there were opportunities to use additional measures such as banner signals[37] to provide additional warnings of signal aspects.

3.28. The standard also required signals that faced in the same direction and were positioned on parallel lines to be given additional consideration in their placements to avoid the possibility of read across errors by LEs (*see* Appendix 4).

3.29. Following any concerns expressed by rail operators or reports of incidents where sighting issues were alleged, the standard required the convening of a Signal Sighting Committee to review the signals' visibility. These processes were in addition to normal operating processes that required the signals to be inspected annually.

3.30. The Commission obtained the Signal Sighting Form completed at the time of the signal upgrade at Penrose, dated 11 October 2010. It recorded the recommendations of the Sighting Committee (*see* Figure 16). Some sections of the form were incomplete.

[36] The testing was done in the field rather than in a rail vehicle.

[37] Banner signals – sometimes referred to as banner repeaters or indicators – are provided on the approaches to certain signals, usually those that have restricted sighting due to the curvature of a line, building or tunnel on the approach, to give advance information of the signal aspects.

3.31. The required minimum sighting distance recorded for signal 308 was 222 metres at 10 seconds when travelling at 80 kilometres per hour. The 'maximum sighting distance available' was left blank.

3.32. The section in the form asking whether there was 'Confusion with other signals/Read through risk' was completed as N/A (not applicable).

ONTRACK

Signal Sighting Form

Serial Number: SSF-SP2-308		Plan No: S.26712	
Recommendations of meeting held on : 11/10/10			
Interlocking Area	Penrose	Signal Number	308
Direction/Line	UM / NAL	Existing Position (Km)	~~N/A~~ 10 RR
Proposed Position (Km)	2.684 km	Agreed Position (Km)	2·757
Line Speed	80 km/h	Reason for movement from Proposed Position	FOOTBRIDGE RAMP EFFECTING VIEWLINE
Required Min Distance at 10 Sec	222 m	Maximum Sighting Distance available	
Background Interference	N/A	Confusion with other signals/Read through risk	N/A
Obstructions affecting approach view	FOOTBRIDGE RAMP	Distance to signal ahead, visible?	
Aspect requirements (e.g. hot spot, long hoods)	N/A	Re-inspection required, reason/when?	N/A

Special Requirements / Remarks: REQUEST TO MOVE 73m UP DIRECTION TO EXISTING SIGNALS
– REQUEST DECLINED AS SEVERLY HAMPERS OPERATIONS
(ALSO OFFERS NO ADDITIONAL SIGHTING BENEFIT)

Attendance

Name | Cor

Redacted information

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Figure 16: Signal Sighting Form for signal 308 at Penrose

3.33. On the form, under 'Obstructions affecting approach view', the footbridge ramp and the station veranda were noted.

3.34. Under 'Special Requirements / Remarks' on the form, a request to move the signal 73 metres in the Up direction (further from the station) was declined on the basis that it hampered operations and would 'offer no additional sighting benefit'.

3.35. The section asking whether re-inspection was required and 'reason/when' was also incomplete.

3.36. Based on the Commission's site visit, the uninterrupted sighting distance was calculated as approximately 190 metres, some 32 metres short of the required minimum distance listed at 222 metres at 10 seconds, and 77 metres short at 267 metres using 12 seconds.

3.37. Had the signal sighting process for signal 308 been fully completed, the hazards of an inadequate sighting distance and the possibility of a read across error with signal 312 would **likely** have been identified and the associated risks managed appropriately.

3.38. No further action or follow-up assessment of signal 308's compliance with the standard was undertaken. Without a further analysis of the risk, the opportunity to identify and remediate the hazards was missed.

Engineering risk controls

Safety issue 2: The use of different engineering risk controls on rail vehicles using the Auckland metro network results in varying levels of protection, increasing the complexity of the rail system.

3.39. Rail transportation is a complex, safety-critical system[38] where the prevention of accidents and incidents requires robust risk controls. These include controls associated with human performance limitations. In this incident, the existing administrative controls were not effective in preventing the signal being passed at stop.

3.40. ETP was an engineering risk control, providing a safety system that monitored a train's progress at signal limits. It used electronic loops on the track known as balises[39], which communicated with trains fitted with the appropriate receivers. ETCS was also an engineering risk control, providing a safety system designed to reduce the consequences of a SPAD incident. The balises in the Auckland commuter network were common to both the ETP and ETCS systems.

3.41. Te Huia was retrofitted with ETP, but the system was isolated and not operational at the time of the Penrose incident.

3.42. KiwiRail initially planned the introduction of ETP to coincide with change to the push-pull mode[40] operation in the Te Huia service. The vehicle modifications and staff training for these changes were to be done as a package. ETP was subsequently separated from the push-pull mode change and was introduced to services from 10 July 2023, about a month after this incident.

3.43. When a signal is at stop, the ETP system reads a 'signal at stop' message from the ETCS balise and applies the emergency brakes. The system relies on positive transmission between the balise and the train receiver. Since the train's system does not know where to expect a balise message, it will never know if the transmission is disrupted. For this reason, ETP cannot be considered fail-safe. The information on the ETP system's status could be observed by the LE through the driver machine interface (*see* Figure 17).

3.44. For the ETP system to have been effective, the train would have needed to be stopped before signal 308 at stop. If this had not occurred, the train would have needed to have been stopped within the overlap[41] before it entered the fouling

[38] A complex safety-critical system is one where multiple individual, but interrelated, 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.

[39] A balise is an electronic beacon or transponder placed between the rails of a railway as part of train control or a protection system.

[40] Where a locomotive at one end of a train is connected via controls to an unpowered vehicle equipped with a control cab at the other end of the train.

[41] The section of line in advance of a stop signal that must be unoccupied.

zone[42]. The overlap distance beyond signal 308 was 90 metres, less than the optimum of 150 metres required by the standards and principles of signalling set out in KiwiRail's safety system. The reduced overlap[43] distance was due to the constraints of the existing railway infrastructure.

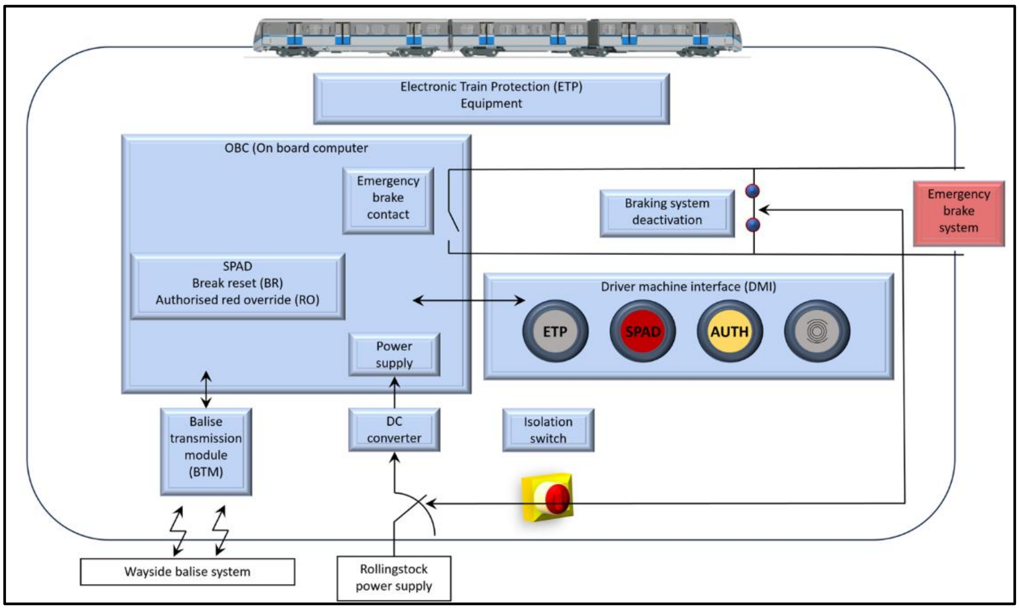

Figure 17: ETP system schematic

3.45. For the ETP system to be effective and stop the train before it entered the fouling zone, Te Huia had to be travelling at or below the speed shown on the speed indicator. In this instance a speed any greater than 20 kilometres per hour reduced the effectiveness of the ETP in preventing entry into the fouling zone because of the trains increased stopping distance at higher speeds.

3.46. The risk to safe operations was the loss of separation assurance between rail vehicles after the signal was passed at stop, but the potential for serious consequences arose when Te Huia entered the fouling zone in potential conflict with another train.

3.47. Speed indicators were located above the signal aspects, and when illuminated with a steady white light they indicated to the LE the maximum speed of the train once passing that signal and until passing the next signal in advance. Speed indicators were introduced to the signalling system for non-ETCS-equipped trains to add another layer of defence. They relied on human performance without any further engineering controls (*see* Appendix 6).

3.48. Had the ETP system been active on Te Huia, it is **virtually certain** an emergency brake would have been applied.

3.49. The ETP system would not have prevented the SPAD and would not have prevented the train entering the fouling zone, because its speed at the time of passing signal 308 was approximately 50 kilometres per hour.

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[42] A position at which entry will obstruct or collide with rail traffic on an adjacent line.
[43] An overlap that is shorter than the minimum permitted length of a full overlap.

3.50. All AOR passenger services had been fitted with ETCS Level 1 as part of the interface specification for Electric Multiple Unit passenger trains operating in the Auckland Electrified Area[44].

3.51. The ETCS system monitored the appropriate signal aspect and authority limits set for the train's movements. It monitored the operations through the supervision of train speeds and calculated the braking curves for the location where the train was required to stop.

3.52. The rules permitted speeds in excess of those displayed on the speed indicators for ETCS-equipped trains, as the system was designed to monitor the movement authorities and the speeds. The permitted speeds were determined by trains' braking parameters, which were specific to each class of train.

3.53. If Te Huia had been fitted with ETCS Level 1, it is **unlikely** that this incident would have occurred. The system would have detected that Te Huia was operating outside the train's braking parameters on approach to signal 308 at stop. The on board system would have provided an alert to the LE that a speed reduction was required to maintain safe operational parameters. Any delays by the LE to address the issue would have resulted in a system-induced brake application.

3.54. ETP was a mitigating risk control, meaning it was about managing the effects of an unwanted event after it had materialised. In comparison, the ETCS was a preventive risk control[45], meaning the system was designed to prevent an unwanted event.

Route knowledge training

Safety issue 3: KiwiRail's locomotive engineer route knowledge training system was inadequate to identify gaps in knowledge or reduced frequency of exposure to a route. This means that locomotive engineers may have insufficient knowledge to safely drive on a particular route.

3.55. The KiwiRail Rail Operating Code required LEs to undergo training before operating trains over a section of track.

3.56. The training included site and area familiarisation, in which trainees visited locations in road vehicles to:

- observe the geography of the areas
- identify crew relief locations
- observe access points.

3.57. The initial knowledge and train-handling skills gained on a particular track section, known as 'route knowledge', were obtained through on-job training supervised by experienced and qualified LEs. Route knowledge extended to include unique features of stations and junctions, track geometry, authorised speeds, signals and their locations, and other special operating instructions.

[44] The Auckland Electrified Area refers to the sections of Auckland's suburban rail network that have been electrified to support electric train services.

[45] Risk controls are preventive if they stop events occurring, while mitigation controls are those that attempt to limit the extent of harm or the consequences of unwanted events.

3.58. The on-job training was followed by assessments for certification undertaken by authorised personnel. Further assessments were required by the Operations Manager or supervisor over one route each month and again five, seven and nine months following certification.

3.59. These processes assured KiwiRail that the LE had received appropriate training and route familiarisation.

3.60. Before extending a route on which an LE normally operated, KiwiRail required consultation and communication between planning staff and the Line Haul Manager.

3.61. Similarly, routes on which an LE travelled infrequently, and the occasions on which an LE travelled to the limits of each route were to be documented by the Regional Roster Coordination Centre. The purpose of this was to ensure that the LE's competency was maintained, as competence was considered to have expired once an LE had not travelled a route or parts of the route in the preceding 12 months.

3.62. The LE on Te Huia was not based locally, and their experience was predominantly between Hamilton and Westfield. The route along the NIMT via Westfield to Ōrākei was the more frequently travelled when required.

3.63. The deviation to the NAL was due to the closure of the NIMT from Westfield to Ōrākei as part of a staged rail network rebuild. This portion of the line had been closed from 20 March 2023 until 14 January 2024.

3.64. Training and familiarisation with the route on the NAL had not been provided to the LE, despite it's being a requirement for route re-certification. The LE had been absent from the route for more than 12 months and had not undertaken a route revalidation by an authorised person, as required by the Rail Operating Code, Section 4.1 Training and Certification.

3.65. In KiwiRail's competency management process, maintaining situational awareness[46] and actively monitoring an operational environment were achieved using non-technical skills[47] such as risk-triggered commentary train driving[48] and the stabilised approach[49]. However, these tools were only effective if relevant LEs had accurate recalls of route knowledge that enabled them to anticipate signal locations and plan their approaches.

3.66. In operational railways, train-driving competency assessments, which include tests of route knowledge, provide drivers with opportunities to discuss, learn about and refresh their knowledge of competencies not practised on a frequent basis. They also provide assurance that safe working practices are understood and are being followed.

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[46] Situational awareness involves an individual's ability to understand their environment. This includes perceiving data from their surroundings, comprehending the meaning and significance of the situation, and projecting future states and events.

[47] Also known as soft skills, non-technical skills go beyond the technical skills directly related to performing specific tasks. The Railway Safety and Standards Board (RSSB, United Kingdom) lists them in categories that include situational awareness, self-management, cooperation with others, communication, conscientiousness and workload management.

[48] Risk-triggered commentary train driving provides a methodology for drivers to improve their retention in working memory of safety-critical information and to check their intended actions against retained knowledge and long-term memory.

[49] The stabilised approach, based on aviation practices, has been developed by RSSB into the non-technical skills training as the Observe, Understand, Decide and Act model.

3.67. The LE on approach to Penrose was familiar with the signalling aspects displayed by signal 304 at caution to stop and was anticipating a stop at the next signal. They were less familiar with the speed indicator signalling and the requirement to maintain a speed of less than 20 kilometres per hour until the next signal was passed. They were also unfamiliar with the location of signal 308, the signal applicable to the movement.

3.68. LE competency and route knowledge are integral to safe train operations. Rail operators should monitor and maintain competencies through adequate processes to provide assurance that train crew possess the skills and knowledge required to perform their tasks.

4 Findings
Ngā kitenga

4.1. The locomotive engineer of Te Huia had not undertaken recent training in and familiarisation with the new route on the North Auckland line, despite it being a requirement for route certification.

4.2. The locomotive engineer misread signal 312 as applying to the North Auckland line, **likely** because of a combination of the following:

- They were not familiar with the route.
- They were expecting to sight the signal on the same side as the previous signals.
- They were not expecting to stop at Penrose.
- The applicable signal (signal 308) was partly obscured from view on approach to Penrose Station.

4.3. The locomotive engineer's observation of signal 312 at green to proceed, their lack of route familiarity, and the mental model that they were following a train were **likely** taken to mean that there was a clear run available through Penrose Station.

4.4. Had the signal sighting process been fully completed for signal 308, the hazards of an inadequate sighting distance and the possibility of a read across error with signal 312 would **likely** have been identified and the associated risks managed appropriately.

4.5. The engineering risk controls used by KiwiRail and Auckland One Rail on the Auckland rail network are different (being Electronic Train Protection and the European Train Control System (ETCS)). They offer varying levels of protection, increasing the complexity of the rail system.

4.6. The ETP system fitted to Te Huia at the time of the incident was not connected. Had it been operating it would not have prevented the Signal Passed at Danger (SPAD) and would not have prevented the train entering the fouling zone, because the speed at the time of passing signal 308 was approximately 50 kilometres per hour.

4.7. Had Te Huia been fitted with ETCS, like all Auckland One Rail passenger services, it is **unlikely** the SPAD would have occurred, because the ETCS would have supervised the speed of the train as it approached the signal held at stop (signal 308).

5 Safety issues and remedial action
Ngā take haumaru 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 1: The risk assessment for the commissioning of signal 308 was incomplete and did not identify all the hazards associated with the positioning of the signals. The opportunity to implement risk controls to address those hazards was missed, resulting in the correct signal not being observed and a wrong signal being responded to, increasing the risk to rail users.

5.3. Since this incident, KiwiRail has identified two options to mitigate the sighting risk associated with signal 308:

Option 1: Eliminate 312 Signal. This is KiwiRail's preferred option but does require extensive re-signalling of the Onehunga Junction; or

Option 2: Relocate signal 308 to the left-hand side of the Up Main suspended from a gantry structure and introduce a Banner Indicator on approach.

5.4. KiwiRail is continuing work to make a determination on the path forward for each option.

5.5. With respect to improving the process of commissioning signals, KiwiRail acknowledge this as part of its continuous improvement programme. In the decade since the AEP project, a number of initiatives have been adopted to improve the signals' sighting process, including:

a. The signals sighting standard S-ST-SG-2124 and associated task instruction S-TI-SG-2203, which were produced in 2017 to update and improve the requirements for signals sighting. This document outlines the requirements for new works and modifications, maintenance and post incident.

b. With the emergence of digital engineering, virtual tools that are being used to determine signals' sighting in areas where significant change is occurring. There are several recent examples of this in both the Auckland and Wellington suburban areas. This technology enables an initial signals sighting assessment (and removal of sighting constraints) at design stage, well in advance of construction. Final confirmation is still undertaken with a Signal Sighting Committee before being brought into use.

5.6. The Commission welcomes the safety action to date with respect to signal 308 and the signal commissioning process more generally. However, with respect to signal 308, as the mitigation measures have yet to be implemented, the Commission has made a recommendation in Section 6 to address this issue.

Safety issue 2: The use of different engineering risk controls on rail vehicles using the Auckland metro network results in varying levels of protection, increasing the complexity of the rail system.

5.7. The commissioning of ETP on Te Huia passenger services is a step towards the introduction of an engineering control that mitigates the event of a signal passed at stop. The Commission understands that there are other train services operating on the Auckland commuter rail network that do not have any engineering controls and operated in capacities similar to Te Huia's at the time of the Penrose incident.

5.8. The Commission welcomes the safety action taken to date. However, it believes more actions need 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 3: KiwiRail's locomotive engineer route knowledge training system was inadequate to identify gaps in knowledge or reduced frequency of exposure to a route. This means that locomotive engineers may have insufficient knowledge to drive on a particular route safely.

5.9. Since the incident, KiwiRail has designed and delivered a route knowledge training package to all Te Huia LEs and those who drive freight. The training includes videos of the route from Westfield to The Strand (and return) along with Signal and Interlocking Diagrams with specific points to note (such as Speed Indicators and irregular signal positions). This training has also been observed in practice for each individual LE by the Occupation Competency Manager on week one of the Te Huia start up after this incident, month one, and month three, to ensure all staff are competent.

5.10. The Commission welcomes the safety action to date. However, it believes more actions need to be taken to ensure the safety of operations for all LEs on all routes, not just Te Huia LEs. Therefore, the Commission has made a recommendation in Section 6 to address this issue.

6 Recommendations
Ngā tūtohutanga

General

6.1. The Commission issues recommendations to address safety issues found in 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.

New recommendations

6.3. On 25 September 2024, the Commission recommended that NZ Transport Agency Waka Kotahi work with rail operators to assess the benefits of all rail operators on the Auckland rail network using a common engineering safety system to improve the safety of all users of that network. **(017/24**)

6.4. On 17 October 2024, NZ Transport Agency Waka Kotahi replied:

> We note that this recommendation is a duplicate of 036/23 which was assigned to (and accepted by) KiwiRail following the Commission's investigation into the L71 Mainline Shunt derailment and subsequent rollover at Tamaki, 01 June 2022 (Report RO-2022-102). An update by KiwiRail in the recent Transport Sector Activity Report Status Update on TAIC Safety Recommendations for 1 July 2023 to 30 June 2024 confirmed that; the extension of ETCS for freight locomotives in the Auckland Metro network is underway by KiwiRail.
>
> The benefits of using a common engineering safety system to improve the safety to all users of the Auckland Metro network are clear, they have been assessed, and steps are in hand to realise those benefits. NZTA will maintain oversight of this rollout through routine safety assessments and specific requests to KiwiRail for project progress reports.

6.5. On 25 September 2024, the Commission recommended that KiwiRail review the route knowledge training for locomotive engineers to ensure infrequent driving of the route and prolonged absences are identified so that locomotive engineers have the route knowledge to travel safely. **(018/24)**

6.6. On 8 October 2024, KiwiRail replied:

> This recommendation is accepted. A project is being established around incorporating route knowledge components into the KiwiRail Learning Exchange (KLE) with implementation into the business during second half of 2025.

6.7. On 25 September 2024, the Commission recommended that KiwiRail implement risk controls with respect to signal 308 to ensure that the hazards that have been identified are adequately mitigated. **(019/24)**

6.8. On 8 October 2024, KiwiRail replied:

> This recommendation is accepted and work continues on analysing the options available to manage the hazard.

Notice of recommendations

6.9. The Commission gives notice to KiwiRail and Auckland One Rail that it has issued recommendation **(017/24)** to NZ Transport Agency Waka Kotahi and that this recommendation will require their involvement.

7 Key lessons
Ngā akoranga matua

7.1. Validation and verification processes ensure that systems have been installed correctly and conform with the required safety standards. They also provide assurance to the regulator that the risks are being managed appropriately.

7.2. Renewal projects predicated on the introduction of new technologies require reviews of the compatibility of engineering and operational practices.

7.3. Systems that rely on human performance to maintain adequate levels of safety require robust engineering controls that intervene when human error or non-compliance renders an operation unsafe. Systems should focus on preventive risk controls that work to prevent harm.

7.4. Training and access to tools that enhance the use of non-technical skills and help to maintain situational awareness are integral to safe rail operations.

8 Data summary
Whakarāpopoto raraunga

Vehicle particulars

Train type and number:	Te Huia passenger train – DFB7077
Classification:	diesel electric locomotive
Year of manufacture:	DF 1979-81 DFB Conversion 1980
Operator:	KiwiRail Holdings

Date and time	17 June 2023, 0952
Location	Penrose, Auckland – North Auckland line
Operating crew	one locomotive engineer, one train service manager and two train attendants
Injuries	no injuries
Damage	the track infrastructure – junction points 373A at Onehunga branch line and North Auckland – was damaged. The line was closed until 18 June 2023

9 Conduct of the inquiry
Te whakahaere i te pakirehua

9.1. On 17 June 2023, the NZ Transport Agency Waka Kotahi 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 that included:

- 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 and documentation
- shift rosters
- standards, rules and procedures.

9.3. The Commission conducted seven interviews with train crew, Train Controllers and signal engineers.

9.4. The Commission conducted various observational assessments from locomotive cab rides and recorded runs on the NIMT and NAL during July 2023, with the cooperation of KiwiRail.

9.5. On 29 May 2024 the Commission approved a draft report for circulation to four interested parties for their comments.

9.6. Two interested parties provided detailed submissions, and two interested parties replied that they had no comment. Any changes as a result of the submissions have been included in the final report.

9.7. On 25 September 2024 the Commission approved the final report for publication.

Abbreviations
Whakapotonga

AOR	Auckland One Rail
ETCS	European Train Control System
ETP	Electronic Train Protection
LE	locomotive engineer
NAL	North Auckland line
NIMT	North Island Main Trunk
OBL	Onehunga Branch Line
SPAD	Signal Passed at Danger

Glossary
Kuputaka

aspect	a visual indication of the status of a signal that is given to a train driver, locomotive engineer or other operator of a rail vehicle
fouling zone	a position at which entry will obstruct or collide with rail traffic on an adjacent line
gantry	a framework suspended across train tracks upon which signals can be mounted
junction	a place at which two or more rail routes converge or diverge
points	items of permanent way (the elements of the railway consisting of the rails, the fasteners and sleepers) that may be aligned to one of two positions to guide a train towards either the straight (Normal) or diversion (Reverse) track
sighting distance	the distance from a signal to its sighting point. The sighting distance is designed for 12 seconds' uninterrupted at maximum train approach speed, but 10 seconds is the absolute minimum in difficult situations
signal	a line side device that displays the movement authority to proceed to a train driver
speed indicator	a numeric indicator illuminated to advise the safe speed for the route set. Normally associated with a warner route (a specific type of route provided at some signals, selected by the signaller, where the full overlap of a signal may not be available)

Citations
Ngā tohutoru

Rail Industry and Safety Standards Board. (2017, 09 21). *https://www.rissb.com.au*. Retrieved from Rail Industry and Safety Standards Board: https://www.rissb.com.au/products/as-7454-management-of-network-route-competence-2

Appendix 1 Previous SPAD A Penrose

KiwiRail

SUMMARY REPORT

SPAD A

308 SIGNAL PENROSE NAL

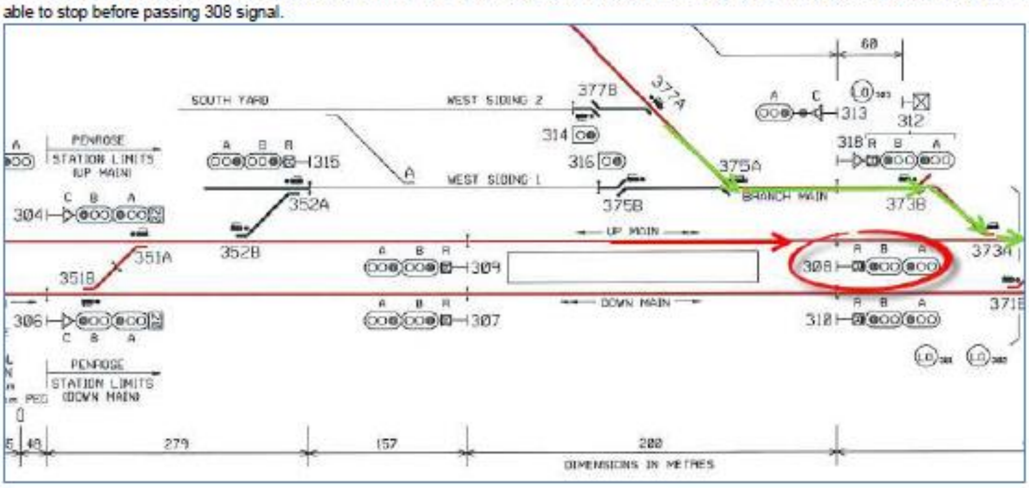
24TH SEPTEMBER 2014

Iris Incident Reference: 145190

Summary

At about 1220 hours Depot Shunt Test Run passed No: 308 signal Penrose at red by 17.8 metres. A Transdev train signalled off the Onehunga branch had not yet claimed the section.

The depot shunt trialing two ADK units had stopped at 304 signal. When this signal was placed to proceed displaying a caution signal the LE moved off. As the train rounded a right-hand curve the LE observed a proceed signal which he took to be for his train. As the train got closer to 308 signal the LE realized that the signal was for a movement off the Onehunga Branch on 312 Signal. The LE applied full braking but was not able to stop before passing 308 signal.



Page 1

ZERO HARM

Appendix 2 KiwiRail standard S-ST-SG 2124 Signal Sighting, Appendix 1

Appendix 1 Reading Time and Distance

Line Speed (km/h)	Min Distance (m) for	
	10 sec Sighting	12 sec Sighting
25	69	83
30	83	100
35	97	117
40	111	133
45	125	150
50	139	167
55	153	183
60	167	200
65	181	217
70	194	233
75	208	250
80	222	267
85	236	283
90	250	300
95	264	317
100	278	333
105	292	350
110	306	367

Appendix 3 KiwiRail standard S-ST-SG 2124 Signal Sighting, Section 8

8. Visibility of signals

Signals shall be placed to optimise visibility and not to just meet the minimum requirements of this standard if better visibility can be reasonably achieved, given associated costs and impact of this optimisation (eg if an additional 10 sec reading time could be gained by simply moving a signal 20 m with minimal cost or impact but whilst still meeting the requirements of this standard).

Also simply designing to the minimum standard may place a signal in a potentially confusing position which may result in increased risk.

Each element of a signal shall be readable for no less than the required reading time for that element for a driver approaching on any line to which that signal applies. To be readable, a signal shall convey the correct information to the driver under clear weather conditions by day and night.

Each signal shall display an apparent uniform display of wavelengths for each colour. This uniformity shall extend to other signals adjacent and visible at the same time. The light wavelength (colour) of the aspects shall meet the description of Red, Yellow and Green as set down in either AREMA Control and Signalling manual section 15.3.10 Criteria for signal colours or British Standard BS1376 Specification for colours of light signals.

The risk of a driver incorrectly interpreting or misreading a signal increases if the signal has a confusing background or has to be picked out from an array of gantry signals. Readability is also influenced by any restrictions or interruptions to visibility on the approach to a signal.

So far as practicable signals shall be aligned so as not to cause confusion in the correct observation and interpretation of other signals by drivers on other lines whilst ensuring a driver has adequate visibility of signals on his or her line.

When stopping at a signal, the signal shall be readable by a driver in the seated driving position with the train stationary at the normal stopping position.

Special attention shall be paid to tunnel signals to ensure LEDs provide requisite visibility but do not dazzle drivers on approach nor cause confusion with adjacent signals.

8.1.1 Reading time

The reading time of each element of a signal for a train approaching at Maximum Line Speed or Maximum Attainable Speed (whichever is slower) shall be 12 seconds or greater, measured from the signal head and in the direction of an approaching train.

In exceptional circumstances, for example the presence of station canopies, tunnels and other obstructions where the cost to move or modify the obstruction is prohibitive the absolute minimum reading time shall be 10 seconds.

Refer to Appendix 1 for a table showing reading time versus Maximum Attainable speed.

Appendix 4 KiwiRail standard S-ST-SG 2124 Signal Sighting, Section 8.1.3

8.1.3 Parallel signals on curved approaches

Parallel signals on curved approaches create a particular risk of misread if signals:

- on other lines are initially more visible than the signal the driver is approaching.
- become visible at different times on the approach.
- become obscured by passing or stationary trains.

When approaching parallel signals on curved approaches, additional reading time shall be provided to enable drivers:

a) to count across from left to right to identify the signal applicable to the line they are on.

b) to correctly identify all parallel signals.

c) to select the applicable signal.

d) to be able to act on the aspect / indication displayed.

8.1.5 Interruptions of view on approach to a signal

So far as is practicable there shall be no interruptions of the drivers' view of a signal during the required reading time and the Sighting Committee shall make recommendations for the removal of obstructions that can be eliminated.

Where interruptions are unavoidable they shall not give rise to unacceptable risks of a driver misreading or disregarding a signal and that any remaining visible elements can't be misread as a less restrictive aspect. Also where interruptions are unacceptably long mitigation shall be applied, for example the use of a Banner Repeater.

10.4 Use of banner repeaters

Whilst it's always preferable to improve the sighting of the Main Signal, it may not always practicable to achieve the visibility requirements for Main Signals by positioning and alignment due to specific features of a given location. Hence it may be necessary to use a Banner Repeater but any proposal to do so shall clearly demonstrate how its use mitigates specific hazards or provides capacity improvements.

Their primary function when used in conjunction with Main Signals with poor visibility is to remind a driver they are approaching a signal and to maximise the reading time on that signal.

Where a Banner Repeater is provided:

- the combined reading time of the Banner and Main Signal shall not be less than the required reading time of the Main Signal.
- both the Banner and Main Signals shall be readable by the driver for a minimum of 4 sec starting 5 sec from the signal calculated at the Maximum Line Speed or Maximum Attainable Speed.

Usually the Main Signal shall become visible after the driver passes the Banner Repeater but it is permissible to have a gap between losing sight of the Banner and the Main Signal coming into view if the net effect is an increase in the total reading time. However the gap shall be as brief as possible and not more than 3 sec.

The positioning of the Main Signal shall be agreed to enable the lateral position of the Banner Repeater to be determined.

Appendix 5 KiwiRail standard S-ST-SG 2124 Signal Sighting, Section 6.1

6.1 Application of a risk based approach

All signalling assets to which this standard applies shall comply with the minimum reading times and the visibility requirements described in this standard.

The full set of requirements from this standard shall be applied on all new works projects.

However for changes to existing infrastructure a risk based approach shall be adopted based on the scope of the change and any local conditions that could have an adverse effect on the visibility of a signal. For example:

- There is no need to do a full Signal Sighting exercise on like for like replacements. However there is a requirement confirm there have been no significant changes in the vicinity of the signal that may impact sighting.
- If relocating an existing signal on straight track where sighting times and visibility exceed the requirements of this standard a site inspection to confirm there have been no changes to adversely impact visibility will be sufficient.

Many signals may not historically have had a sighting form produced or archived when the signal sighting was carried out. This standard does not require a form to be produced in these instances unless the signal is modified.

The Signals Field Engineer shall determine the scope of the sighting activities required based on the proposed change and all site specific conditions that may affect signal sighting. The Signals Field Engineer shall record the details of the changes and justification for not carrying out a full sighting exercise on the Signal Sighting Form.

6.1.4 Signal sighting after allegations or incidents

If a signal sighting issue is alleged and/or if required as part of an investigation into a signalling related incident, the Access Provider shall convene a Sighting Committee to review the signal's visibility in accordance with this standard and recommend any remedial action as required.

This review shall consider the actual signal(s) against which the issue has been identified and may also include those on approach or adjacent to the one in question. The review shall include the viewing from the type of rolling stock involved, any previous SPADs or reports of poor visibility on that particular signal and also the assessment of overrun risks as per the Operational Risk Review. The formal report, recommendations and, if required, signed Signal Sighting Form shall be submitted to the Access Provider for their approval and be copied to the Train Operator.

6.1.2 The use of dummy signal heads and periscopes and other tools

If required, to aid the sighting process dummy signal heads, periscopes and other tools may be used.

Commissioning checks of signal sighting

The compliance of the 'as built' signal against an approved Signal Sighting Form shall be conducted as part of commissioning and before the signal is brought into use.

A check shall also be carried out to ensure there is sufficient visibility to allow a driver to correctly identify the applicable signal, observe and interpret the aspect within the minimum reading time. The checks required shall again be risk based dependent on the scope of the change(s) and local conditions. For example:

- On straight track with reading times well in excess of the minimum required by this standard it may only be necessary to undertake a simple site inspection to confirm there are no interruptions or other changes affecting sighting/reading times.
- In locations where reading time may be interrupted a more detailed check shall be carried out, if necessary using a periscope from the track level at the point of initial sighting and a track walk to confirm reading times and any interruptions are as per the requirements of this standard.
- In extreme cases it may be necessary to use a test train.

Appendix 6 KiwiRail Rules, Rule 47 Speed indicators

47. Speed Indicators

Speed Indicators

Speed Indicators are fitted above the top signal unit on each mast.

When illuminated, will display a steady white speed in km/h that any train passing that signal must not exceed until the next signal in advance is reached unless ETCS indicates a higher speed.

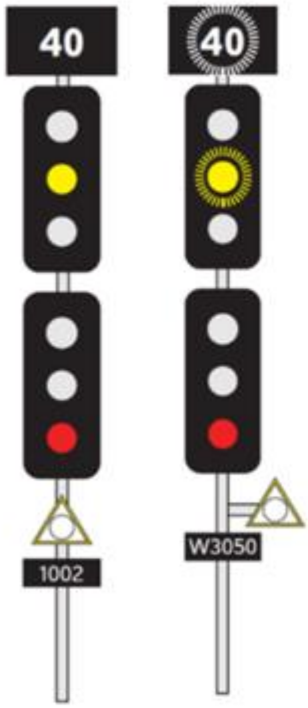
As shown on S&I diagrams

Advanced Speed Indicators

Advanced Speed are fitted above the top signal unit on each mast.

When illuminated will display a flashing white speed in km/h that the train must not exceed at the next signal in advance.

As shown on S&I diagrams



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 a '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-2021-104	Passenger train 6205, train derailment, Kāpiti, 17 August 2021
RO-2023-102	Freight train 360, derailment, Te Puke, 29 January 2023
RO-2023-101	Hi rail vehicle collision near Te Puna, 86.43 km East Coast Main Trunk Line, 10 January 2023
RO-2023-103	Safe working irregularity, 3.85km, Johnsonville line, tunnel 5, 4 May 2023
RO-2022-104	Shunt train L51 and heavy goods vehicle, level crossing collision and derailment, Whangārei, 7 December 2022
RO-2022-102	L71 Mainline Shunt, derailment and subsequent rollover, Tamaki, 1 June 2022
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

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