Transport Accident Investigation Commission

Final Report

Rail inquiry RO-2019-102
Clinton derailment
29 March 2019

February 2020

About the Transport Accident Investigation Commission

The Transport Accident Investigation Commission (Commission) is a standing commission of inquiry and an independent Crown entity responsible for inquiring into maritime, aviation and rail accidents and incidents for New Zealand, and co-ordinating and co-operating with other accident investigation organisations overseas.

The principal purpose of its inquiries is to determine the circumstances and causes of occurrences with a view to avoiding similar occurrences in the future. It is not the Commission's purpose to ascribe blame to any person or agency or to pursue (or to assist an agency to pursue) criminal, civil or regulatory action against a person or agency. However, the Commission will not refrain from fully reporting on the circumstances and factors contributing to an accident because fault or liability may be inferred from the findings.

Figure 1: Location of accident

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1 Executive summary

1.1. On 29 March 2019, the three rear wagons of a KiwiRail Holdings Limited freight train derailed as the train exited a crossing loop at Clinton en route from Invercargill to Dunedin. Two of the three derailed wagons overturned onto their sides, causing damage to the wagons, track and a signal.

1.2. The Transport Accident Investigation Commission (Commission) found that the freight train had exceeded the maximum permissible track speed when exiting the crossing loop due to the driver becoming distracted and the downhill gradient of the track allowing the train to accelerate to above the maximum permissible line speed.

1.3. The Commission also found that a phenomenon known as dynamic interaction was very likely the cause of the derailment, where the excessive speed combined with the track geometry at the point of derailment and the centre of gravity of the fully loaded coal wagons caused the wagon to oscillate from side to side. One or more wheels then lifted and climbed the rail, resulting in derailment.

1.4. The wagon condition and loading were found to be within KiwiRail's maximum permissible limits.

1.5. A similar derailment had occurred at the Clinton crossing loop in 2016, which was not investigated by the Commission. At that time KiwiRail took a number of safety actions after the incident, including speed monitoring and track repair. However, a procedural control measure to ensure that loaded trains did not use the crossing loop was not adopted.

1.6. As a result of this occurrence, KiwiRail has taken a number of safety actions that address the issues raised in this report. Therefore, no new recommendations have been made.

1.7. The key lessons arising from this inquiry are:

- a train driver can become distracted even when carrying out tasks specific to their role which, if poorly timed, can have unintended consequences
- to avoid repeat accidents and incidents it is important to learn from previous incidents. This requires a focus on implementing corrective action in accordance with the hierarchy of controls. However, when procedural control measures have been identified they should be implemented, checked and monitored properly to ensure the desired results are achieved.

2 Factual information

Narrative

2.1. On Friday 29 March 2019 a Dunedin-based train driver drove a KiwiRail freight train (Train 927) southbound from Dunedin to Clinton.

2.2. Arriving at Clinton with a train consisting mainly of empty wagons, the driver brought the train to a stop on the main line[1] to await the arrival of an opposing train (Train 920). The opposing train entered the Clinton crossing loop[2] (see Figure 2) and stopped. Both drivers then changed trains ready to commence their return journeys.

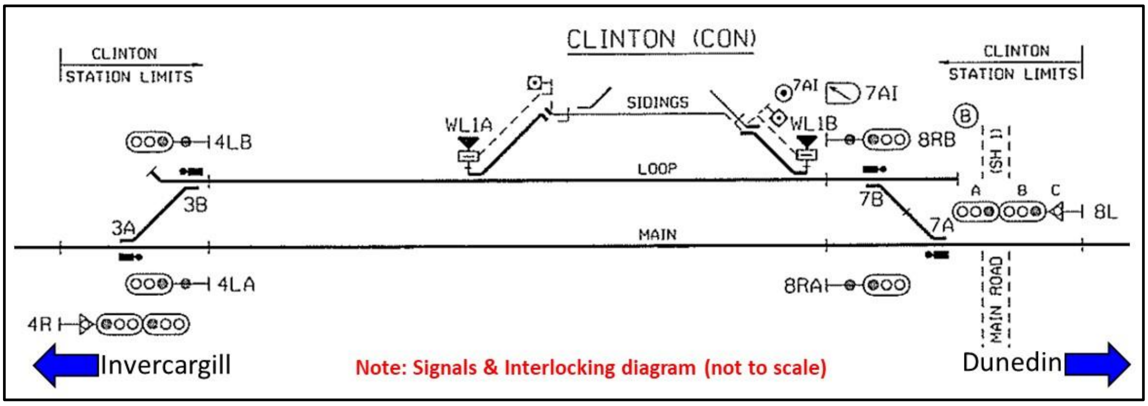

Figure 2: Clinton crossing loop

2.3. At 0258 train control[3] issued a track warrant[4] to the driver of Train 920 in preparation for taking the fully laden train to Dunedin. The driver acted on the track warrant and started to drive the train out of the Clinton crossing loop. The points[5] between the crossing loop and the main line to Dunedin have a maximum speed limit of 25 kilometres per hour (km/h).

2.4. At 0302 the train departed from the crossing loop. As it traversed the level crossing on State Highway 93 it started to descend a downhill gradient. The driver checked the official route paperwork for the journey and while doing so the speed of the train increased to 34 km/h.

2.5. At 0309 the train lost air pressure, which caused the brakes to be applied automatically. This was an indication that the train may have parted[6].

2.6. The driver contacted train control to report the situation and advised that the intention was to take a portable radio and walk the length of the train to investigate the cause of

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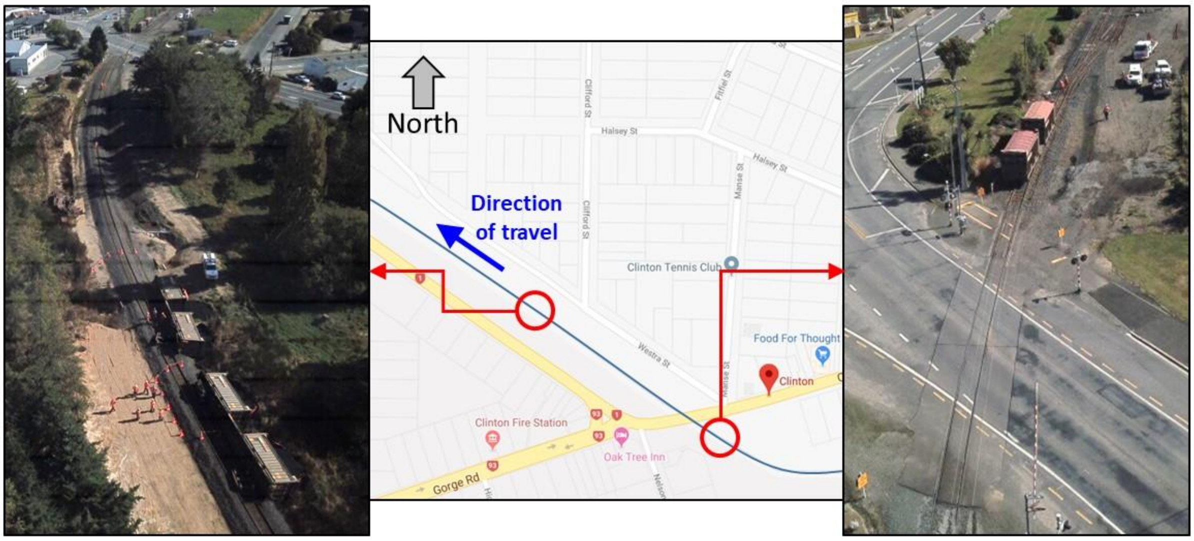
[1] The principal track on a railway.
[2] A loop of track alongside the main line in single-track areas, used by opposing trains to cross each other safely.
[3] The national train control centre in Wellington, where the movements of trains and maintenance track occupancies are authorised by train controllers.
[4] A systematised permission used on some rail lines to authorise trains' use of the lines. Train controllers issue the permissions to drivers of trains instead of using signals. The drivers generally receive track warrants by radio.
[5] An assembly of switches and crossings that are designed to divert trains from one road to another.
[6] Where rail rolling stock has become uncoupled from the adjoining rail vehicle whilst the train was in motion. This causes a loss of brake pipe pressure, which causes the train brakes to apply automatically.

the loss of air pressure. Train control advised the driver that the local fire service, located adjacent to the level crossing, had contacted it to report that they were at the scene and that the rear of the train had derailed.

2.7. As the driver approached the rear of the train, it became evident that the last three wagons had derailed. The third and second last wagons had derailed before the level crossing, but had remained attached to the train until they overturned onto their left sides about 300 metres after passing over the level crossing.

2.8. The front bogie of the last wagon had derailed but the wagon was upright and had not passed over the level crossing (see Figure 3).



1st and 2nd wagons to derail and roll

Last wagon to derail, front bogie only

Figure 3: Location of derailed wagons at Clinton (map source: Google)

2.9. The level crossing was clear of wreckage, but the bells and barriers continued to activate. Each of the three derailed wagons were carrying two containers of coal (see Figure 4).

Figure 4: Wagon with two coal containers

2.10. The driver liaised with the fire service and train control, and ascertained that a signals engineer was en route to Clinton to deactivate the level crossing alarms and barriers.

2.11. The driver underwent compulsory testing for drugs and alcohol, which returned a negative (clear) result.

Key personnel

2.12. The train driver had 40 years' rail experience, initially based at Invercargill and then at Dunedin. The driver held current certification for the role.

The derailment site

2.13. Witness marks[7] on the rail indicated that, when facing the direction of travel, a left-side wheel on a right-hand bend had climbed and then ridden along the rail head[8] for approximately five metres before dropping off the outside edge of the rail (see Figure 5).

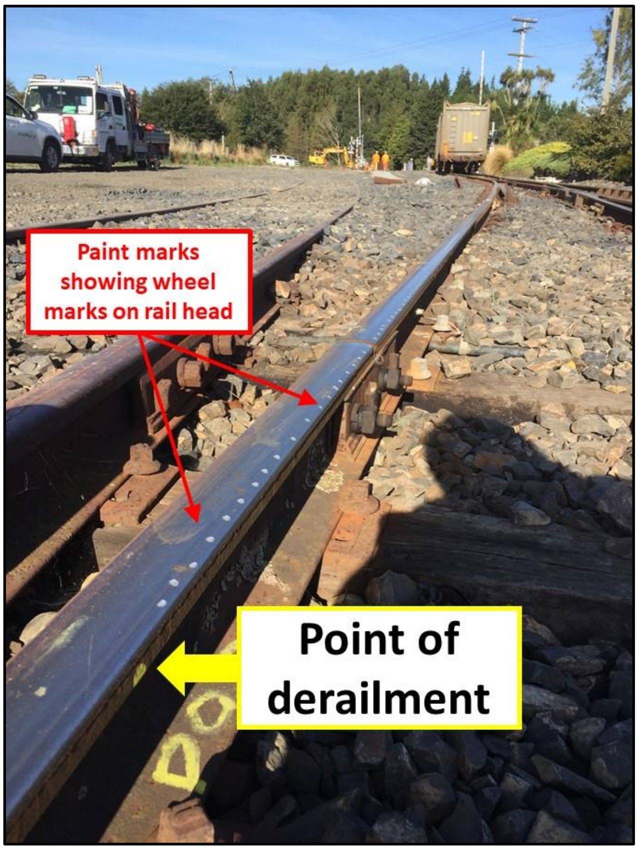


Figure 5: Point of derailment

Post-incident mechanical inspection

2.14. The first wagon to derail was also one of the two wagons that overturned onto their sides. Both the wagons were extensively damaged, such that their decks were written off and no attempt was made to repair them. Maintenance records for the wagons did not indicate any pre-derailment issues.

2.15. The bogies from the first wagon to derail were seized by the Commission. They subsequently underwent post-incident inspections. Both bogies were transported to KiwiRail's Hutt Workshops facility, where they were systematically taken apart and all the

[7] Physical marks such as those made on a rail by a derailed wheel.
[8] The bulbous upper part of a rail section.

critical measurements were recorded. No broken components were found during the strip-down and all the key dimensions were found to be within specification.

2.16. One anomaly was found during the inspection: one wheelset[9] out of the four was fitted with wheels that were thicker than the other three (see Figure 6). The wheels on axle four, the rear axle, were 130 millimetres (mm) thick compared with 115 mm for the other axles. The thinner wheels are an older design.

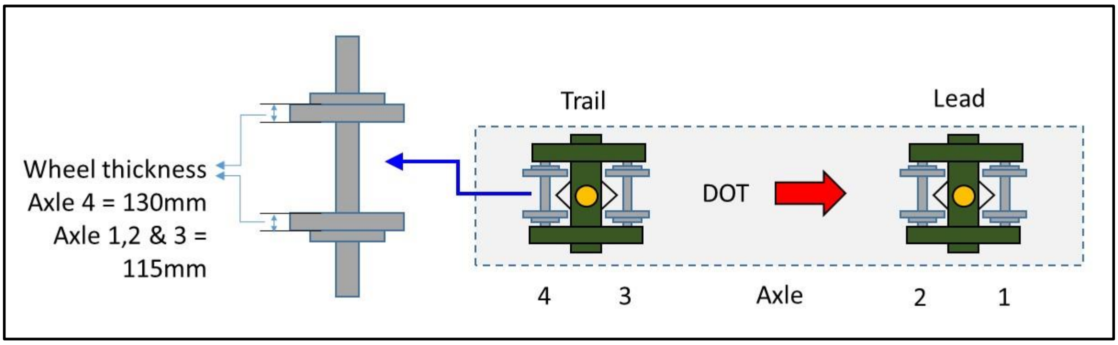


Figure 6: Wagon and bogie layout

2.17. The fitting of different-thickness wheels on an axle to make a wheelset is not allowed. Wheelsets with different-thickness wheels on an individual bogie are allowed in the specification but discouraged and considered undesirable.

2.18. It is likely that this bogie had previously been damaged and had been repaired with the replacement of a single wheelset at a remote depot. It should be noted that each individual wheelset did have matching-thickness wheels at each end. The anomaly across the four axles was not considered contributory to the derailment.

Track geometry

2.19. KiwiRail use a dedicated Track Evaluation Car rail vehicle, known as EM80, to measure critical dimensions of track geometry around the New Zealand rail network, using laser scanning, transducers, accelerometers and camera systems. The track inspection programme is determined by the frequency of track use. It can vary from four inspections a year on a metropolitan commuter network to one inspection a year at crossing loops similar to that at Clinton.

2.20. The track geometry at Clinton had most recently been measured on 19 September 2018, six months before the March 2019 derailment. At that time the track geometry showed a fault, which was programmed for rectification. The rectification work was completed on 12 October 2018.

2.21. After the derailment, a manual measurement of the track geometry either side of the point of derailment showed a track twist[10], which was just within the acceptable maintenance tolerance limit (see Figure 7). This level of track twist required no action to be taken; however, once it deteriorated to the tolerance, maintenance would be planned to bring the track geometry back within limits.

[9] Two rail wheels mounted on a joining axle.
[10] The difference in height of two rails. On a curve the outer rail is generally higher than the inner rail to allow trains through the curve at higher speeds.

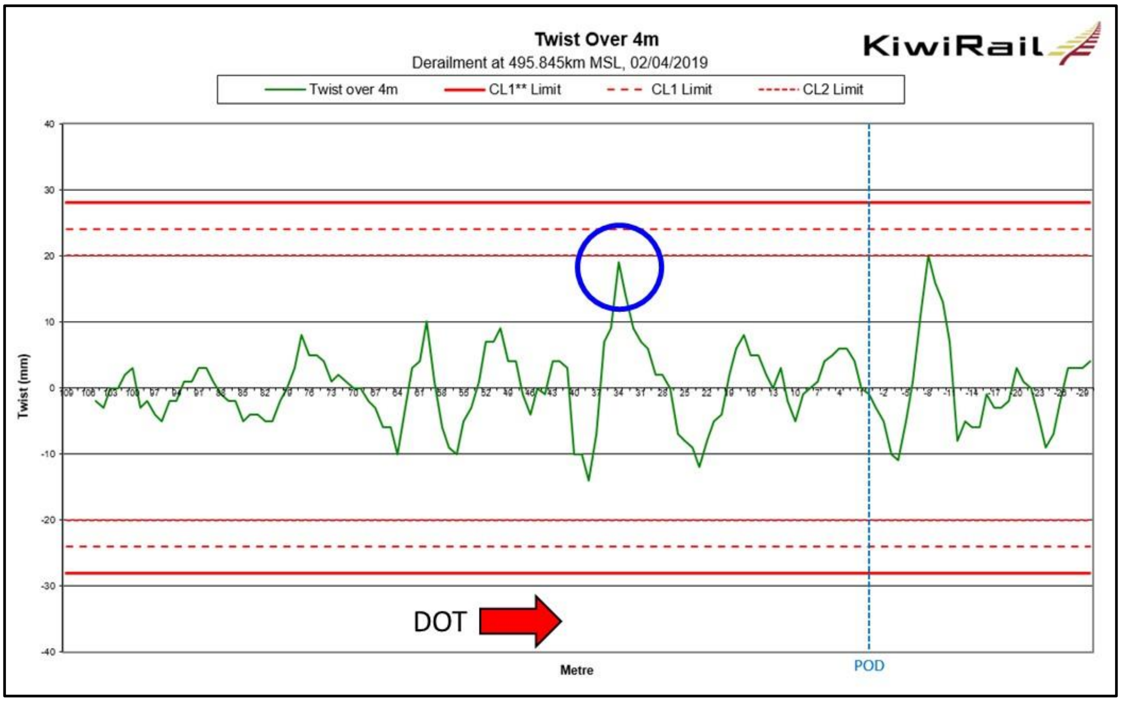


Figure 7: Track twist graph

Previous occurrence

2.22. In 2016 a northbound freight train hauling 49 wagons derailed at the same location when departing the Clinton crossing loop. On that occasion the train parted in five places. The rear six wagons, which were carrying coal, derailed and five overturned onto their sides. There was extensive wagon and track damage but no injuries. This incident was not investigated by the Commission.

2.23. The KiwiRail investigation found that, at the time of the derailment, the train was travelling at 32 km/h, 7 km/h above the maximum permissible speed limit when exiting the Clinton crossing loop. The track geometry was found to be within code[11] at normal line speed. However, when the excess speed was factored in, the maximum permissible cant deficiency[12] limit had been exceeded and was deemed to have caused the derailment.

2.24. After the 2016 Clinton derailment, KiwiRail completed an audit of crossing loop exit speeds and put in place a monitoring programme to determine the level of compliance with the speed limit. Additionally, the track condition was measured and all issues rectified. There was a suggestion to allow only empty Invercargill-bound services to use the crossing loop at Clinton, thereby removing two potential contributory factors – the downhill gradient and the high centre of gravity of a full coal wagon. However, the suggestion was not subsequently formalised for a variety of reasons beyond the scope of this investigation.

[11] Section 8 Manual Y+Track Geometry Maintenance Tolerances of KiwiRail Track Standard Track Geometry standard T-ST-AM-5120.
[12] Cant is the designed amount that one rail is raised above the other on a curve. Cant deficiency is the theoretical amount the high rail must be raised to restore equilibrium for a train travelling at speed on a curve with a given cant.

3 Analysis

Introduction

3.1. The derailment of a freight train is a serious event and has the potential to cause significant damage and injury. Derailments do therefore have significant implications for transport safety. Following this derailment two of the derailed wagons passed over a level crossing, potentially creating a significant risk to the public waiting for the train to cross.

3.2. The following analysis discusses the possible factors that contributed either directly or indirectly to the derailment, and the factors that were evaluated and found to be non-contributory.

Factors contributing to the derailment

3.3. Train derailments can be caused by a single factor or a combination of factors that may include track condition, rolling stock condition and train handling.

3.4. The Commission found that it was very likely the excessive speed, combined with a track twist that was within code and the high centre of gravity of the load on the derailed wagons that led to the derailment. In the past the Commission has investigated a series of derailments similar to this incident, the latest one being rail inquiry RO-2012-103. The report highlighted the effect of a phenomenon known as dynamic interaction. Dynamic interaction was very likely the cause of this derailment. It has been described in previous reports and is worthy of repetition;

> A train derailment attributed to dynamic interaction occurs when the track geometry, wagon condition, wagon loading and train speed are individually within tolerance limits, or marginally in excess, but not to an extent that each variation on its own is sufficient to be a prime cause of the derailment. However, when in combination these conditions can result in a derailment.

Speed

3.5. An examination of the train's on-board Tranzlog data recorder showed the position of the train controls and speed of the train as it exited the crossing loop at Clinton.

3.6. The data recorder showed that as the train exited the crossing loop it accelerated to a speed of 21 km/h, slightly below the maximum permissible crossing loop exit speed of 25 km/h. However, the train reached 31 km/h when it was allowed to coast[13] while the driver checked the paperwork for the northbound journey to Dunedin.

3.7. When the train exited the Clinton loop, heading north towards Dunedin, it was running on a section of the main line that had a downhill gradient of 1:65. Once the locomotives had cleared the level crossing the train was put into coast and travelled under its own momentum. The downhill track gradient then provided favourable conditions for the train to accelerate slowly.

[13] Movement when no power or braking is applied and the train is allowed to continue under its own momentum.

3.8. At the same time as the train started to accelerate the driver took the opportunity to read the relevant route paperwork associated with the journey to Dunedin. With the driver's attention now focused on reading the paperwork the train continued to accelerate. The remainder of the train was still exiting the Clinton loop and as the wagons progressively joined the main line, they added momentum.

3.9. The first indication the driver had that something was wrong was when the train emergency brake automatically applied. The data recorder showed that at the time the brake was applied the speed of the train had risen to 37 km/h.

3.10. When the first of the last three wagons derailed leaving the crossing loop, the train speed was recorded at 34 km/h, which was 9 km/h or 36% over the maximum permissible line speed at the crossing loop.

3.11. The investigation found that the forces created by excessive speed while the wagons were passing over a curved section of track were a contributory factor to the derailment and part of the phenomenon known as dynamic interaction.

3.12. The driver chose to check the route paperwork, which is a normal train-driving task, while the train was still leaving the crossing loop. It was a critical time when it was essential to control the train speed on a downhill gradient through low speed points. The driver's distraction was not deliberate, but it does demonstrate the ease with which a momentary distraction can lead to unintentional consequences.

Track condition

3.13. Witness marks confirmed that the point of derailment (see Figure 5) was on the left-hand rail in the direction of travel, between 7B and 7A points (see Figure 2), a section of track that was still within the crossing loop (see Figure 8).

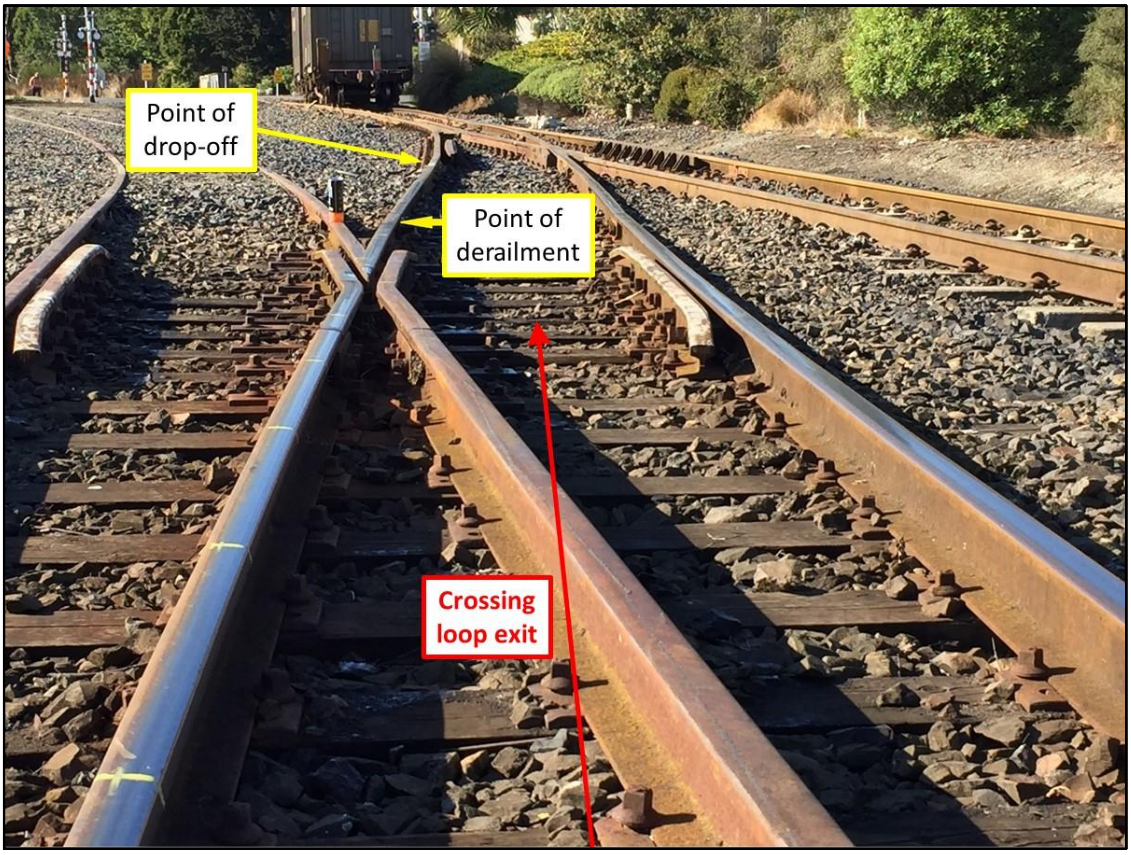


Figure 8: Point of derailment

3.14. It can be seen from Figure 6 that the manual measurement of track geometry post-accident identified a track twist just before the point of derailment. The twist was just within KiwiRail's tolerance limits and was not considered severe enough to have caused the derailment directly.

3.15. The effect of a track twist in relation to derailment is for the twist to start a rocking motion, of the wagons particularly. When the cause of derailment is considered in terms of dynamic interaction, it is very likely that a rocking motion on the wagons created by the track twist was a contributory factor but was not sufficient in itself to have caused the derailment.

Centre of gravity of the loaded coal wagons

3.16. The higher the centre of gravity of a loaded coal wagon, the greater the destabilising effect of any lateral force acting on the wagon, such as centripetal force, created when a wagon is following a curve in a track. In a worst-case scenario the lateral force may cause the centre of gravity to move beyond the pivot point (see Figure 9) and become unstable. A part-filled coal wagon, with a much lower centre of gravity than a full coal wagon, will require a greater lateral force to move the centre of gravity beyond the pivot point for it to become unstable.

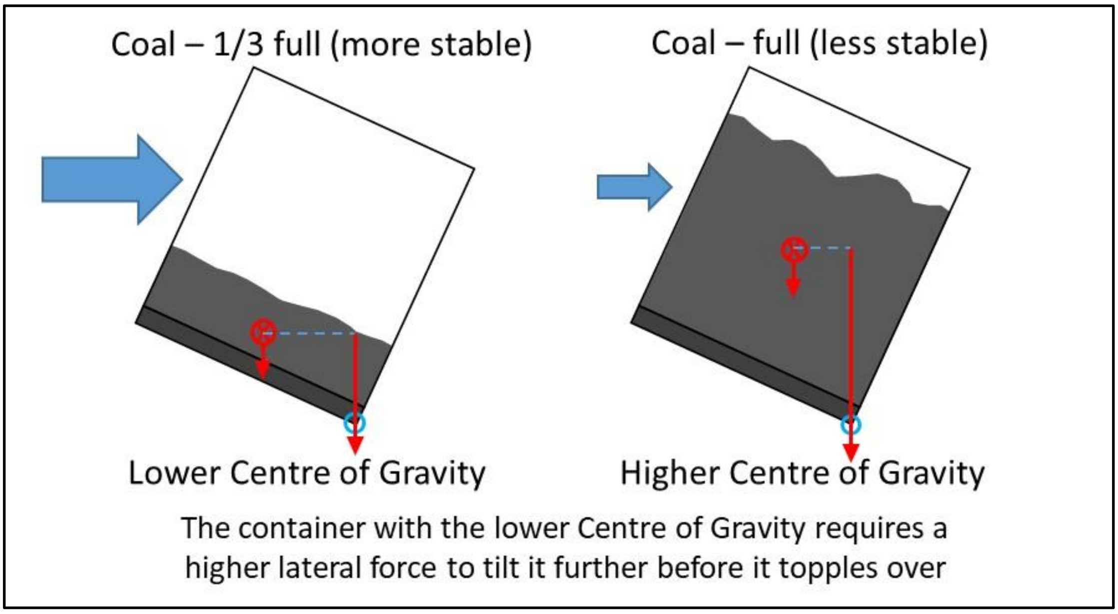


Figure 9: Effect of centre of gravity on stability

3.17. By design, the coal wagons that were involved in the accident had, at maximum capacity, a centre of gravity of 1,849 mm above rail level. The maximum permissible centre of gravity is 2,000 mm above rail level. The loading of the coal wagons involved in this derailment was below the maximum permissible and therefore within tolerance.

3.18. The relatively high centre of gravity of the loaded coal wagons was within permissible limits and is not considered to have caused the derailment by itself. When considering the effect of a lateral force being applied to the centre of gravity of a loaded wagon, such as centripetal force generated by travelling around a curve or a rolling motion force generated by a track twist, the overall effect will be to destabilise the wagon.

3.19. It is considered likely that in this derailment, once a lateral force was applied, the high centre of gravity of the wagons and the resulting reduced stability further contributed to the overall effect of dynamic interaction.

Mechanism of derailment

3.20. The Commission has previously investigated derailments that have involved the phenomenon of dynamic interaction. These reports include rail inquiry RO-2007-102[14] and RO-2012-103[15].

3.21. In this derailment the dynamic interaction of speed, track geometry and reduced stability caused by the high centre of gravity of the load very likely led to a wagon oscillating from side to side, creating the ideal conditions for wheel climb[16] to occur. When viewed in the direction of travel, the oscillating motion very likely resulted in the outer left-hand wheel of the rear bogie of the first wagon derailing and climbing up onto the top of the rail head.

[14] Rail inquiry RO2007-102 freight train main line derailments, various locations on the national rail network.

[15] Rail inquiry RO2012-103 derailment of freight Train 229 Rangitawa-Maewa.

[16] When the lateral force on a rail wheel flange exceeds the downwards force (axle load). There should be twice as much downward force holding the wheel to the rail as lateral force to prevent the wheel climbing up onto the top of the rail.

3.22. The wheel then continued to travel along the top of the rail for approximately five metres. The wheel flange created witness marks on the rail head before it dropped off the outside edge of the rail. The subsequent effect was that a further two wagons derailed until the last wagon parted from the train, severing the air supply and automatically applying the train brakes.

Non-contributing factors

3.23. The Commission examined several other factors but determined that they were not contributory to the derailment.

Fatigue

3.24. While many shift workers tend to sleep directly before a nightshift and utilise the time after the shift for normal daily activities, this driver retired to bed immediately after a nightshift, slept for seven hours and then woke nine hours before the next nightshift to undertake normal daily activities before starting work.

3.25. This could be considered an unusual sequence of work, relax and sleep. However, it was the driver's usual routine and the driver's roster provided ample opportunity between shifts for adequate rest and recovery. There were no indications that driver fatigue played a part in this derailment.

Loading

3.26. The process used for loading the coal wagons was carefully examined to see if it was possible to overload the coal containers or to load them with a significant weight bias front to back or left to right, which could contribute to the instability of a wagon.

3.27. Coal was loaded into each coal container with a front loader excavator fitted with a weight-monitoring system, allowing the operator to fill the containers to capacity accurately. The container was clearly marked internally with a maximum capacity line and the loading company had robust documented procedures in place to manage the loading process.

3.28. The Commission found that the coal loading process and weight distribution were unlikely to have contributed to the derailment.

Rolling stock

3.29. The three wagons that derailed, carrying a total of six coal containers, were UKK class wagons. The bogies fitted to them were standard Type 14. Both the class of wagon and the type of bogie are overrepresented in KiwiRail's derailment statistics.

3.30. Type 14 bogies represent approximately 40% of rail traffic (based on kilometres travelled) but were involved in 80% of (8 out of 10) derailments in 2018. UKK wagons make up around 12% of rail traffic but featured in 70% (7 out of 10) of these derailments.

3.31. However, the systematic, detailed examination of the bogies did not reveal anything out of tolerance or identify any parts that were unfit for purpose. The Commission found no evidence to suggest that the Type 14 bogies or the wagon design contributed to the accident.

Previous derailment at the Clinton crossing loop

3.32. This incident was effectively a repeat of the derailment in 2016, which was not investigated by the Commission. The actions taken in response to that accident had included track repair and crossing loop exit speed monitoring.

3.33. Post the 2016 investigation by KiwiRail, there was a suggestion from the operations department to prevent the heavier train using the crossing loop. This would have meant that coal-laden trains bound for Dunedin would always use the main line to pass an opposing train at Clinton. The empty coal wagon trains bound for Invercargill would therefore use the crossing loop and would benefit from the uphill gradient assisting to keep the train speed down.

3.34. Unfortunately this suggestion was not adopted and therefore the existing system continued. KiwiRail has now adopted the idea and formally implemented it; see section 7 of this report.

4 Findings

4.1. There was no single factor that caused the derailment, rather it was a combination of speed, the effects of track twist that was within tolerance and the relatively high centre of gravity of the coal wagons.

4.2. The phenomenon known as dynamic interaction was very likely the cause of this derailment.

4.3. The forces created by excessive speed while the wagons were passing over a curved section of track were a contributory factor to the derailment and part of the phenomenon known as dynamic interaction.

4.4. In terms of dynamic interaction, it is very likely that an oscillating motion on the wagons created by a track twist that was within tolerance. This contributed to the derailment occurring, but was not sufficient in itself to cause the derailment.

4.5. It is likely that once a lateral force was applied to the wagons, their high centre of gravity and resulting reduced stability further contributed to the overall effect of dynamic interaction.

4.6. The train driver became distracted reading the route paperwork. It occurred at a critical time in the journey, which, combined with the downhill gradient leaving the crossing loop, allowed the speed of the train to increase and exceed the maximum permissible crossing loop exit speed.

5 Safety issues and remedial action

General

5.1. Safety Issues are an output from the Commission's analysis. They typically describe a system problem that has the potential to adversely affect future operations on a wide scale.

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 action

5.3. In response to the 2019 Clinton derailment, KiwiRail took a number of actions to address the issues found to have contributed to it.

5.4. A briefing was issued to all train drivers reinforcing the need to adhere to speed limits when passing through turnouts/points, for example when departing crossing loops (see Appendix 1).

5.5. A redesign of the points configuration at Clinton is planned which is intended to change the curve alignment and reduce the effect of excessive speed.

5.6. A new local instruction has been formalised to ensure that fully laden coal trains heading to Dunedin use only the main line when passing through Clinton. This means that the speed of empty Invercargill bound trains entering the loop is reduced by the uphill geometry of the track. It also avoids fully laden trains having to proceed through the crossing loop points (see Figure 10).

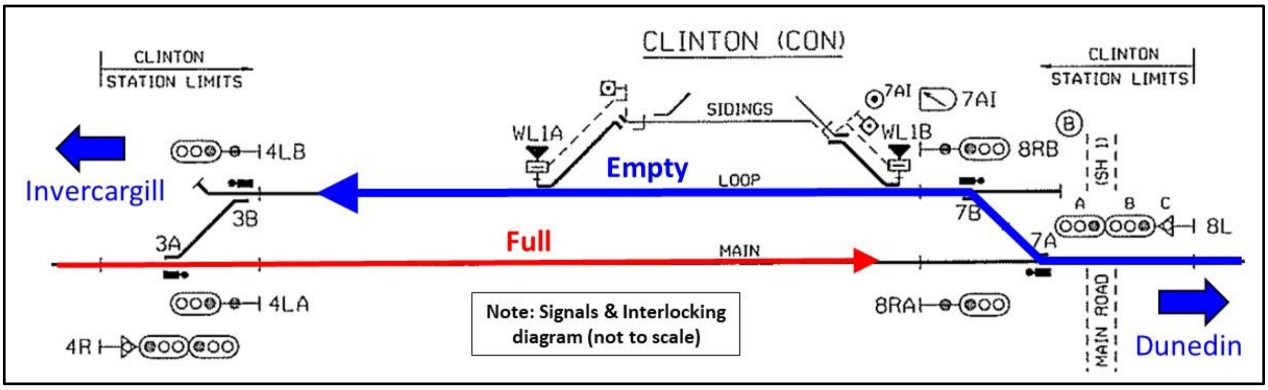


Figure 10: New priority berthing instruction at Clinton

5.7. The new instruction was published in KiwiRail's Semi-Permanent Bulletin No. 913 – dated 27 September 2019 (see Appendix 2). It included:

> Crossing Trains at Clinton (new instruction)
>
> Up Trains must be berthed on the Main at Clinton when crossing Down Trains. Exception: Light Locomotives, EM80, MTMV's travelling as a train, and Work Trains may be berthed on the Loop when travelling in the Up direction. It is essential that Down Trains are given priority to berth when trains approach Clinton in close sequence. This is to facilitate the berthing on the uphill gradient at the north end of Clinton, and to minimise the operation of the level crossings warning devices over Main Road (SH1) at the north end of Clinton.

6 Recommendations

General

6.1. The Commission may issue, or give notice of, recommendations to any person or organisation that it considers the most appropriate to address the identified safety issues, depending on whether these safety issues are applicable to a single operator only or to the wider transport sector. In this case, a recommendation has been issued to the Director of Civil Aviation, with notice of the recommendation given to the Secretary of Transport.

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

New recommendations

6.3. No new recommendations have been made as a result of this inquiry.

7 Key lessons

7.1. A train driver can become distracted even when carrying out tasks specific to the role which, if poorly timed, can have unintended consequences.

7.2. To avoid repeat accidents and incidents it is important to learn from previous incidents. This requires a focus on implementing corrective action in accordance with the hierarchy of controls. However, when procedural control measures have been identified they should be implemented, checked and monitored properly to ensure the desired results have been achieved.

8 Data summary

Vehicle particulars

Train type and number:	freight Train 920 consisting of 42 wagons
Train length:	740 metres
Train weight:	1,643 tonnes
Classification:	DXC 5258 (lead) and DFT 7092 (trail)
Operator:	KiwiRail Holdings Limited

Date and time	29 March 2019 0000
Location	Clinton crossing loop on the Main South Line
Operating crew	train driver
Injuries	none
Damage	significant damage to two derailed wagons as well as damage to the track and a signal post

9 Conduct of the inquiry

9.1. The accident occurred at about 0309 on Friday 29 March 2019. The NZ Transport Agency (the Agency) notified the Transport Accident Investigation Commission (Commission). The Commission opened an inquiry under section 13(1) of the Transport Accident Investigation Commission Act 1990 to determine the circumstances and causes of the incident and appointed an investigator in charge.

9.2. On 29 March 2019, the Commission issued a protection order restricting persons from moving or transporting the bogies of the first wagon to derail. The bogies were subsequently transported to KiwiRail Holdings Limited's (KiwiRail's) Hutt Workshops with the Commission's approval.

9.3. Commission investigators travelled to the accident site on Tuesday 2 April 2019 to commence the investigation.

9.4. Commission investigators interviewed the:

- train driver
- track maintenance workers.

9.5. The Commission obtained the following documents and records for analysis:

- the maintenance and condition records for the track and rolling stock
- the training records for the driver
- the roster details for the driver
- the event recorder download data from the lead locomotive
- recordings of the communications between the train controller and the train driver.

9.6. On 9 May 2019, Commission investigators, with assistance from KiwiRail staff, systematically stripped down the bogies from the first wagon to derail at KiwiRail's Hutt Workshops.

9.7. On 23 October 2019, the Commission considered a draft report and approved it to be sent to interested persons for consultation.

9.8. Three written submissions were received. The Commission considered the submissions, and changes as a result of those submissions have been included in the final report.

9.9. On 19 February 2020, the Commission approved the final report for publication.

10 Report information

Abbreviations

CoG	centre of gravity
KiwiRail	KiwiRail Holdings Limited
km/h	kilometre(s) per hour
mm	millimetre(s)
m	metre(s)
NZTA	New Zealand Transport Agency (The Agency)
POD	point of derailment
TAIC	Transport Accident Investigation Commission (Commission)

Glossary

bogie	a metal frame equipped with two or three wheelsets and able to rotate freely in plan, used in pairs under rail vehicles to improve ride quality and better distribute forces to the track
cant deficiency	cant is the designed amount that one rail is raised above the other on a curve. Cant deficiency is the theoretical amount the high rail must be raised to restore equilibrium for a train travelling at speed on a curve with a given cant
coast	movement when no power or braking is applied and the train is allowed to continue under its own momentum
crossing loop	a loop of track alongside the mainline in single-track areas, used by opposing trains to cross each other safely
dynamic interaction	occurs when the track geometry, wagon condition, wagon loading and train speed are individually within tolerance limits, or marginally in excess, but not to an extent that each variation on its own is sufficient to be a prime cause of the derailment. However, when in combination these conditions can result in a derailment
main line	the principal track on a railway
parted	where rail rolling stock has become uncoupled from the adjoining rail vehicle whilst the train was in motion, This causes a loss of brake pipe pressure, which causes the train brakes to apply automatically
points	an assembly of switches and crossings that are designed to divert trains from one road to another

rail head	the bulbous upper part of a rail section
track twist	the difference in height of two rails. On a curve the outer rail is generally higher than the inner rail to allow trains through the curve at higher speeds
track warrant	a systematised permission used on some rail lines to authorise a trains' use of the lines. Train controllers issue the permissions to drivers of trains instead of using signals. The drivers generally receive track warrants by radio
train control	the national train control centre in Wellington, where the movements of trains and maintenance track occupancies are authorised by train controllers
wheel climb	occurs when the lateral force on a rail wheel flange exceeds the downwards force (axle load). There should be twice as much downward force holding the wheel to the rail as lateral force to prevent the wheel from climbing up on to the top of the rail.
wheelset	two rail wheels mounted on a joining axle
witness marks	physical marks such as those made on a rail by a derailed wheel

11 Notes about Commission reports

Commissioners

Chief Commissioner	Jane Meares
Deputy Chief Commissioner	Stephen Davies Howard
Commissioner	Richard Marchant
Commissioner	Paula Rose, QSO

Key Commission personnel

Chief Executive	Lois Hutchinson
Chief Investigator of Accidents	Aaron Holman
Investigator in Charge	Chris Asbery
General Counsel	Cathryn Bridge

Citations and referencing

This draft report does not cite information derived from interviews during the Commission's inquiry into the occurrence. Documents normally accessible to industry participants only and not discoverable under the Official Information Act 1982 are referenced as footnotes only. Publicly available documents referred to during the Commission's inquiry are cited.

Photographs, diagrams, pictures

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

Verbal probability expressions

This report uses standard terminology to describe the degree of probability (or likelihood) that an event happened, or a condition existed in support of a hypothesis. The expressions are defined in the table below.

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	

*Adopted from the Intergovernmental Panel on Climate Change

Appendix 1: Train driver briefing

SAFETY, HEALTH AND ENVIRONMENT

KiwiRail

Notice

Turn Out Speeds and the Risk of Derailment

Issue No.	[Record Ref]	Issue date:	1/08/2019	Originator:	Continuous Improvement
IRIS No.	192944			BU reference:	Continuous Improvement
Content endorsed by:		Soren low		Related docs:	ROC, RORP
Content authorised by:		John Gousmett		Job title:	Operations Improvement Manager

Background

Train 626 derailed on the Branch Main Palmerston North,and PNGL Line. Five log wagons derailed fouling the Main and bringing down traction poles and over head lines

Important information or action to be taken

Train speed was a contributing factor to a serious derailment. It is critical that operators of rail vehicles do not exceed the maximum speeds anywhere in the rail corridor. The posted speed must be adhered to until the whole of the train or rail vehicle is clear of the section to which that speed applies.

- Locomotive Engineers and Remote Control Operators MUST ensure the speed of the whole length of the train does not exceed the maximum speed of the turnout
- The End of Train speed is critical as any speed that exceeds the posted speed of the turn out will make the wagons become unstable and increases the risk of derailment

ROC 1.16 MAXIMUM SPEED

- Locomotive Engineers must not exceed the maximum speeds shown in the RORP Section 10

Turnouts RORP 7.7.3

- The speed of all trains through the curved roads of turnouts must **not** exceed 25 km/h unless a speed board / ETCS authorising a higher speed is exhibited or shown in the schedule of maximum speeds.

Remember for SHE communication:

- *Red icon for an Alert = Stop. Assess the Alert and take any required actions before proceeding. (Face to face communication is critical.)*
- *Amber icon for an Advice = Pause. Prepare to stop if necessary. Assess the advice and take any required actions.*
- *Green icon for a Notice = Proceed but pay attention.*

Appendix 2: Extract from KiwiRail Semi-Permanent Bulletin No. 913

Semi-Permanent Bulletin No. **913**
27 September, 2019
Page 1 of 8

KiwiRail

SUMMARY SHEET

Rail Operating Rules & Procedures Local Instructions

Section L7 – Main South Line

Page 7 of 8

***Crossing Trains at Clinton** (new instruction)*

Up Trains must be berthed on the Main at Clinton when crossing Down Trains.
***Exception:** Light Locomotives, EM80, MTMV's travelling as a train, and Work Trains may be berthed on the Loop when travelling in the Up direction.*
It is essential that Down Trains are given priority to berth when trains approach Clinton in close sequence.
This is to facilitate the berthing on the uphill gradient at the north end of Clinton, and to minimise the operation of the level crossings warning devices over Main Road (SH1) at the north end of Clinton.

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

RO-2018-102	Freight train SPAD and wrong-routing, Taimate, 1 October 2018
RO-2018-101	Metropolitan passenger train, derailment, Britomart Transport Centre, Auckland, 9 May 2018
RO-2017-106	Mainline locomotives, Wrong-routing and collision with work vehicle, Invercargill, 16 November 2017
RO-2017-105	Collision between freight Train 353 and heavy motor vehicle, Lambert Road, level crossing, near Kawerau, 6 October 2017
RO-2017-104	Unauthorised immobilisation of passenger train, at Baldwin Avenue Station, Avondale, 17 September 2017
RO-2017-101	Signal Passed at Danger 'A' at compulsory stop boards protected worksite, Pongakawa, Bay of Plenty, 7 February 2017
RO-2017-103	Potential collision between passenger trains, Wellington Railway Station, 15 May 2017
RO-2017-102	Signalling irregularity, Wellington Railway Station, 3 April 2017
RO-2016-101	Signal passed at danger leading to near collision, Wellington Railway Station, 28 May 2016
RO-2016-102	Train 140 passed Signal 10R at 'Stop', Mission Bush Branch line, Paerata, 25 October 2016
RO-2015-103	Track occupation irregularity, leading to near collision, between Manunui and Taumarunui, 15 December 2015
RO-2014-105	Near collision between train and hi-rail excavator, Wairarapa Line near Featherston, 11 August 2014
RO-2013-101	Derailment of freight Train 345, Mission Bush Branch line, 9 January 2013
RO-2015-102	Electric locomotive fire at Palmerston North Terminal, 24 November 2015
RO-2014-104	Express freight train striking hi-rail excavator, within a protected work area, Raurimu Spiral, North Island Main Trunk line, 17 June 2014

TAIC Kōwhaiwhai - Māori scroll designs

TAIC commissioned its kōwhaiwhai, Māori scroll designs, from artist Sandy Rodgers (Ngati Raukawa, Tuwharetoa, MacDougal). Sandy began from thinking of the Commission as a vehicle or vessel for seeking knowledge to understand transport accident tragedies and how to prevent them. A 'waka whai mārama (i te ara haumaru) is 'a vessel/vehicle in pursuit of understanding'. Waka is 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 represent 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.

Marine: 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 'Marine'.

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.

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