Inquiry RO-2013-104: Derailment of metro passenger Train 8219
Wellington, 20 May 2013

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

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

Final Report

Rail inquiry RO-2013-104

Derailment of metro passenger Train 8219 Wellington

20 May 2013

Approved for publication: August 2015

Transport Accident Investigation Commission

About the Transport Accident Investigation Commission and this report

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. Its purpose is not 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. The Commission carries out its purpose by informing members of the transport sector and the public, both domestically and internationally, of the lessons that can be learnt from transport accidents and incidents.

It would not be appropriate then to use this urgent recommendation to pursue criminal, civil or regulatory action against any person or agency. The Transport Accident Investigation Commission Act 1990 makes this preliminary report inadmissible as evidence in any proceedings. A full report will be released on completion of the inquiry.

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Important notes

Nature of the final report

This final report has not been prepared for the purpose of supporting any criminal, civil or regulatory action against any person or agency. The Transport Accident Investigation Commission Act 1990 makes this final report inadmissible as evidence in any proceedings with the exception of a Coroner's inquest.

Ownership of report

Citations and referencing

Information derived from interviews during the Commission's inquiry into the occurrence is not cited in this final report. Documents that would normally be accessible to industry participants only and not discoverable under the Official Information Act 1980 have been referenced as footnotes only. Other documents referred to during the Commission's inquiry that are publicly available are cited.

Photographs, diagrams, pictures

Unless otherwise specified, photographs, diagrams and pictures included in this final report are provided by, and owned by, the Commission.

Train 8219 showing rear derailed coach

Source: mapsof.net

Location of accident

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Train type and number:	Train 8219 consisting of passenger coaches EM1367 leading and ET3367, EM1309 and ET3309 trailing. The train was 86 metres long and had a tare weight of 144 tonnes
Manufacturer:	Ganz Mavag in Hungary
Year of manufacture:	1982
Operator:	Tranz Metro, a business unit of KiwiRail
Train owner:	Greater Wellington Rail Limited, a business unit of the Greater Wellington Regional Council

Date and time	20 May 2013 at 0806[1]
Location	the point of derailment was at 1.906 kilometres[2] on the North Island Main Trunk line between Wellington and Kaiwharawhara Stations
Persons involved	a train crew of three (a driver, a train manager and a passenger operator) and 315 passengers
Injuries	four minor
Damage	major damage to disc brake assembly, air reservoirs and air compressor, and structural damage to the floor of derailed passenger coach ET3309

[1] Times in this report are New Zealand Standard Times (universal co-ordinated time + 12 hours) and are expressed in the 24-hour mode.
[2] Distance from a datum marker at Wellington Station.

1. Executive summary

1.1. On Monday 20 May 2013, Train 8219 was the scheduled Tranz Metro passenger train travelling from Porirua to Wellington. The train was an electric multiple unit consisting of four passenger coaches.

1.2. At 0743 the rear coach of the train derailed as it was entering Wellington Station limits. Four of the 315 passengers on board the train received minor injuries. The derailed coach remained upright but sustained extensive damage to machinery underneath the coach floor. An air compressor was forced up through the coach floor into the passenger compartment.

1.3. A component from the train's braking system had fallen onto the track and jammed against the underslung machinery with sufficient force to cause the derailment.

1.4. The Transport Accident Investigation Commission (Commission) *found* that the component fell because, more than 10 weeks before the accident, maintenance staff had omitted to fit retaining split pins to bolts that were holding the component in place.

1.5. The maintenance staff had not been given specific task instructions to follow and against which to record progress. Because of this, when the task of fitting the brake component was interrupted by an overnight change in shift, the omission of fitting the retaining split pins was easily missed.

1.6. Before its inquiry was complete the Commission made *urgent recommendations* to the Chief Executive of KiwiRail to address safety issues with the way maintenance was conducted in its Wellington maintenance depot. The Commission also recommended that the Chief Executive of the NZ Transport Agency monitor the progress of KiwiRail's response to the recommendations.

1.7. The Commission identified the following *key lesson* arising from this inquiry:

- maintenance staff must be given clear instructions for all maintenance tasks and record progress against every important step of the instructions. If a task involves safety-critical systems, there must be an independent check by a responsible person before the train is released back into service.

2. Conduct of the inquiry

2.1. On Monday 20 May 2013 at about 0830, the NZ Transport Agency notified the Transport Accident Investigation Commission (Commission) of the accident under section 13(4) of the Railways Act 2005. The Commission immediately opened an inquiry under section 13(1) of the Transport Accident Investigation Commission Act 1990, to determine the circumstances and causes of the accident. An investigator in charge was appointed and he and two other investigators arrived at the derailment site within 30 minutes of receiving the notification.

2.2. A site examination was conducted and critical components from the debris trail behind the derailed train were taken to the Commission's wreckage facility for further examination.

2.3. On 22 May 2013 investigators examined the maintenance records for the derailed trailer coach, ET3309.

2.4. On 23 May 2013 the Commissioners visited KiwiRail's maintenance facility to examine the coach that had derailed.

2.5. On 23 May 2013 investigators conducted interviews with the train crew.

2.6. On 24 May and 27 May 2013, telephone interviews were held with a total of 15 passengers who had been on board the derailed passenger car.

2.7. The Commission received data from the train's event recorder and from the signals log. This data was analysed to determine the locations and the speeds of the train at specific times.

2.8. On 7 June 2013 investigators held separate discussions with the mechanical engineer who on 7 March 2013 had carried out component replacement work on the derailed passenger coach, and with the mechanical engineer who had released the repaired coach back into service the following day.

2.9. On 7 June 2013 a discussion was conducted with the person who had carried out the annual airbrake code test on the derailed passenger coach on 25 March 2013.

2.10. Two draft urgent recommendations were prepared, one to KiwiRail and one to the NZ Transport Agency, and on 1 August 2013 the Commission approved the draft urgent recommendations for circulation to interested persons for comment.

2.11. Written submissions were received from the NZ Transport Agency, KiwiRail and the mechanical engineer who had carried out the spring park brake replacement on the derailed passenger coach. KiwiRail's submission included its response to the recommendations. This response has been included in the report.

2.12. The Commission approved the urgent safety recommendations for publication on 25 September 2013.

2.13. On 24 June 2015 the Commissioners considered a draft final report on the accident and approved it for distribution to interested persons for comment.

2.14. On 26 August 2015 the Commission considered written submissions from KiwiRail, Greater Wellington Regional Council and the NZ Transport Agency. Changes were made to the report where appropriate.

2.15. On 26 August 2015 the Commission approved the report for publication.

3. Factual information

3.1. Narrative

3.1.1. On Monday 20 May 2013, Train 8219 (the train) was the scheduled 0743 Tranz Metro passenger train travelling from Porirua to Wellington. The train was an electric multiple unit consisting of four coaches.

3.1.2. The train departed from Porirua with a crew of three (a driver, a train manager and a passenger operator) and 49 passengers[3]. The train made scheduled stops en route at Kenepuru, Linden, Tawa, Redwood, Takapu Road and Kaiwharawhara Stations to exchange passengers.

3.1.3. The train departed from Kaiwharawhara Station at 0805:45, the last passenger stop before Wellington. By then there were 315 passengers[4] on board.

3.1.4. At 0806:35 the train was travelling at just under the maximum authorised line speed of 60 kilometres per hour when the train's brake pressure dropped suddenly and the brakes applied automatically. One second later the driver moved the throttle from the powering position to coast. The train stopped 17 seconds after the brake pipe pressure started to drop, during which time it travelled 151 metres.

3.1.5. The leading bogie[5] of the rear coach (ET3309) had derailed and an air compressor had been forced up through the floor of the passenger compartment (see Figure 1). Passengers sitting in the coach that derailed said that they first heard intermittent "scraping noises" coming from under the coach soon after the train departed from Porirua.

[3] The number of passengers was recorded on the train manager's report form Mis. 7b.
[4] The number of passengers was recorded on the Emergency Services Incident Report log at 08:41:42, before the train evacuation began. The number of passengers recorded on the train manager's report form Mis. 7b was 345.
[5] The term used for the unit consisting of a frame, the wheels, the suspension and the brake system.

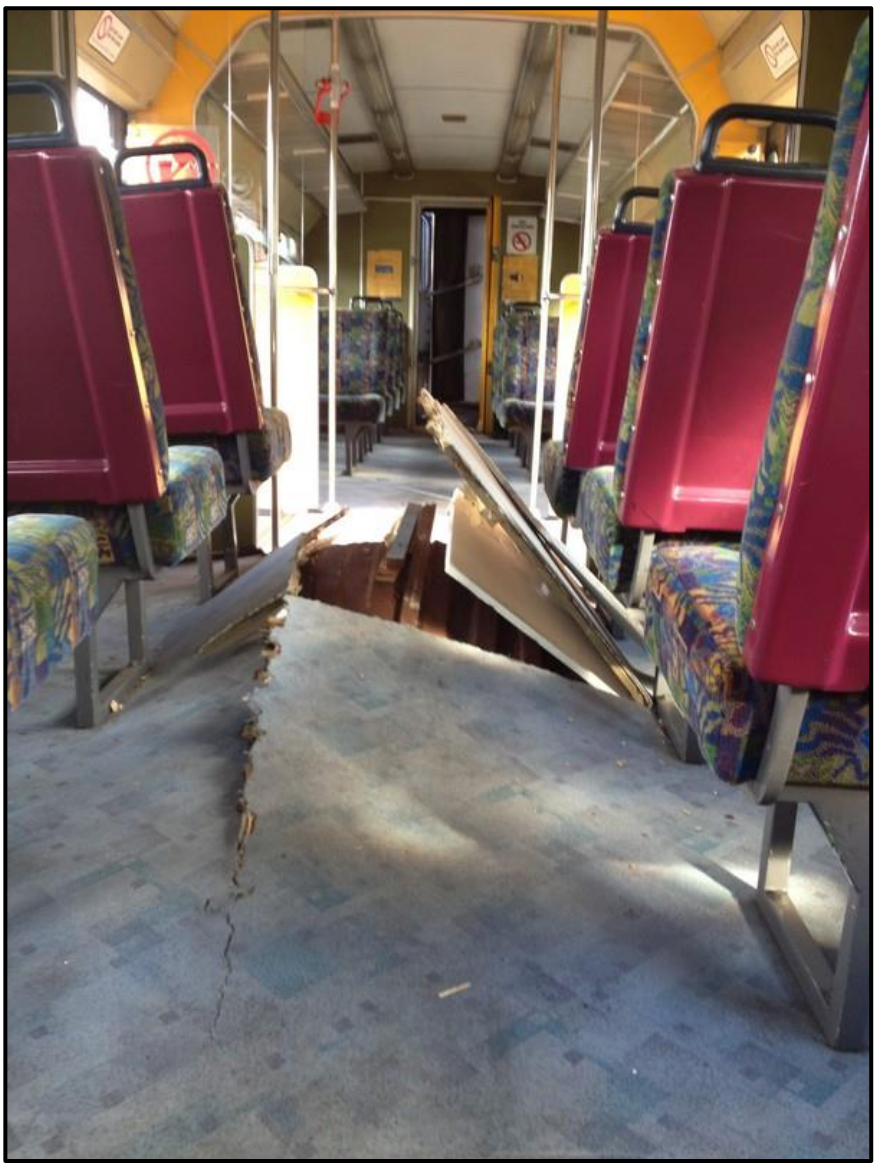


Figure 1
Under-slung air compressor protruding into passenger compartment

3.1.6. A KiwiRail employee and a contractor were standing nearby when they heard a loud bang. The employee turned and saw a three-metre-high water vapour cloud disperse from under the rear passenger coach. He watched the rear coach oscillate from side to side before it derailed.

3.1.7. At 0807:46 the emergency services received a 111 call from one of the passengers, who reported that the train on which he was travelling had derailed at the entrance to Wellington Station. Two other passengers called the emergency services within the next minute.

3.1.8. The first Fire Service crew was dispatched from Thorndon to Wellington Station at 0809:23. A second crew was dispatched from the Wellington depot a few seconds later. Both Fire Service crews arrived at Wellington Station's Platform 9 and were then redirected to the derailed train, about 1.9 kilometres north of Platform 9. A total of four specialist Fire Service crews attended the passenger train derailment.

3.1.9. At 0819:11 a member of the New Zealand Police was established as the Scene Commander, responsible for the site safety and the co-ordination of the passenger evacuation.

3.1.10. At 0826:41 KiwiRail's train controller informed the emergency services communication centre that although the overhead power had been switched off at the control centre, the overhead line had to be treated as 'live' until they were informed otherwise.

3.1.11. Meanwhile, the driver had inspected his train and established that the overhead traction line had not been damaged. He took the precaution of lowering the train pantographs[6] to isolate the train from the overhead power. Paramedics were then allowed to board the train to attend to the injured.

3.1.12. KiwiRail's incident controller informed the Police Scene Commander at 0910 that the overhead power had been earthed and isolated and that it was now safe for the passengers to disembark. The passengers were then evacuated from the train and were escorted to a Police control command centre at KiwiRail's passenger ferry terminal on Aotea Quay, where a further triage assessment was conducted.

3.1.13. All passengers were evacuated from the train by 0950. Four passengers received minor injuries during the derailment.

3.2. Site examination

3.2.1. Each passenger coach had two bogies; one at each end. Each bogie had two sets of wheels. The derailed coach was a trailer class of coach that was fitted with disc brakes. There were two spring park brake assemblies fitted to each bogie, meaning the derailed coach was fitted with four of these assemblies.

3.2.2. Immediately behind the leading bogie were two low-pressure air reservoirs strapped underneath the coach floor. Immediately behind them sat the main air compressor, which kept the air reservoirs pressurised (see Figure 2). A third high-pressure air reservoir sat still further back. The three air reservoirs collectively supplied air to the train brake system and other train services.

Figure 2
Underside of coach arrangement

3.2.3. The debris trail extended as far back as eight kilometres before the point of derailment, where a section of disc pad from the spring park brake assembly was recovered. The spring park brake assembly was part of the disc brake system. It normally hung from two brake-force reaction arms (hangers) on either side of the brake disc and the opposite end had a mounting

[6] A pantograph is an apparatus mounted on the roof of an electric train to collect power through contact with the overhead traction line.

plate that was welded directly to the bogie frame. A bolt[7] and split pin assembly secured the spring park brake assembly to the hangers (see Figure 5).

3.2.4. The rear of the train was 1.83 kilometres from Wellington Station when the train stopped. A spring park brake assembly from the rear (derailed) coach was found between the rails some 113 metres back from the rear of the train (see Figure 3). The spring park brake assembly was extensively damaged, with parts of the brake cylinder having separated from the main assembly.

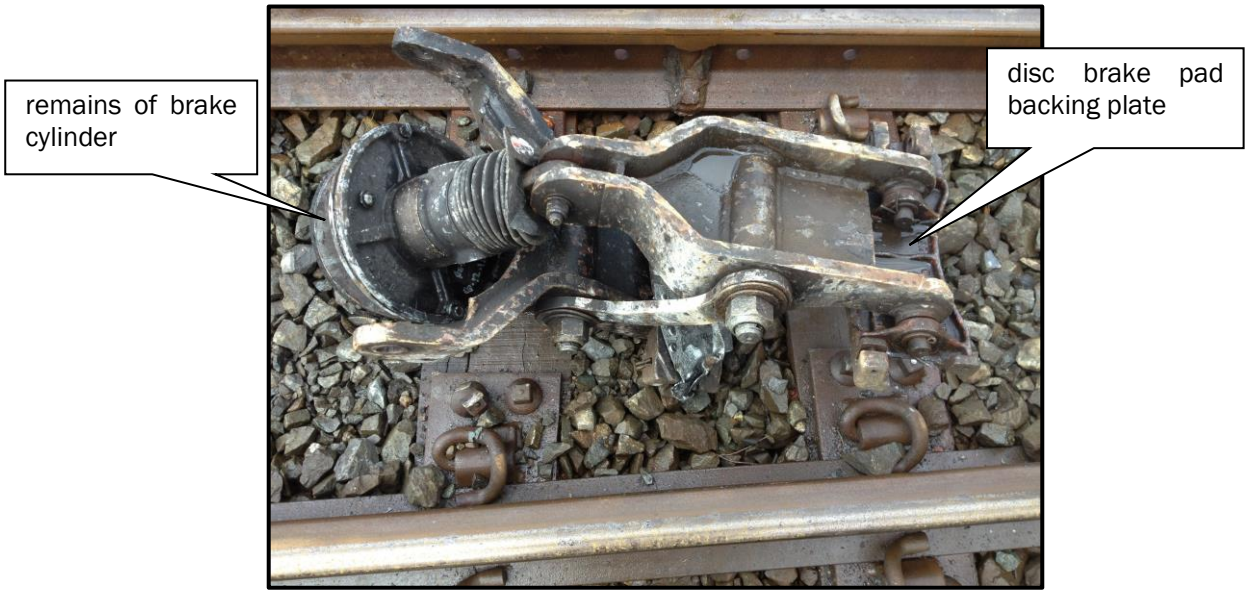


Figure 3
Spring park brake mounting bracket with part of the brake cylinder

3.2.5. The two main air reservoirs had broken free of their mounts and were extensively damaged. They had both been jack-knifed rearwards through 180 degrees and were jammed under the air compressor, forcing the air compressor up through the floor and into the passenger compartment (see Figure 4).

[7] The bolt did not have a thread (and is often referred to as a clevis pin). Instead the spring park brake assembly was secured by a washer and split pin.

Figure 4
Air reservoirs jammed under air compressor

3.2.6. An examination of the number 3 spring park brake assembly from the derailed coach (found 113 metres back from the point of derailment) showed that neither the lug that normally took the bolt and split pin to secure it to the bogie hangers nor the hangers themselves were damaged, except that the inner sleeve was missing from the bolt hole on the inboard hanger (see Figure 5). The two bolts and their split pins were missing and were not found, despite an extensive search of the rail track between the accident site and Porirua.

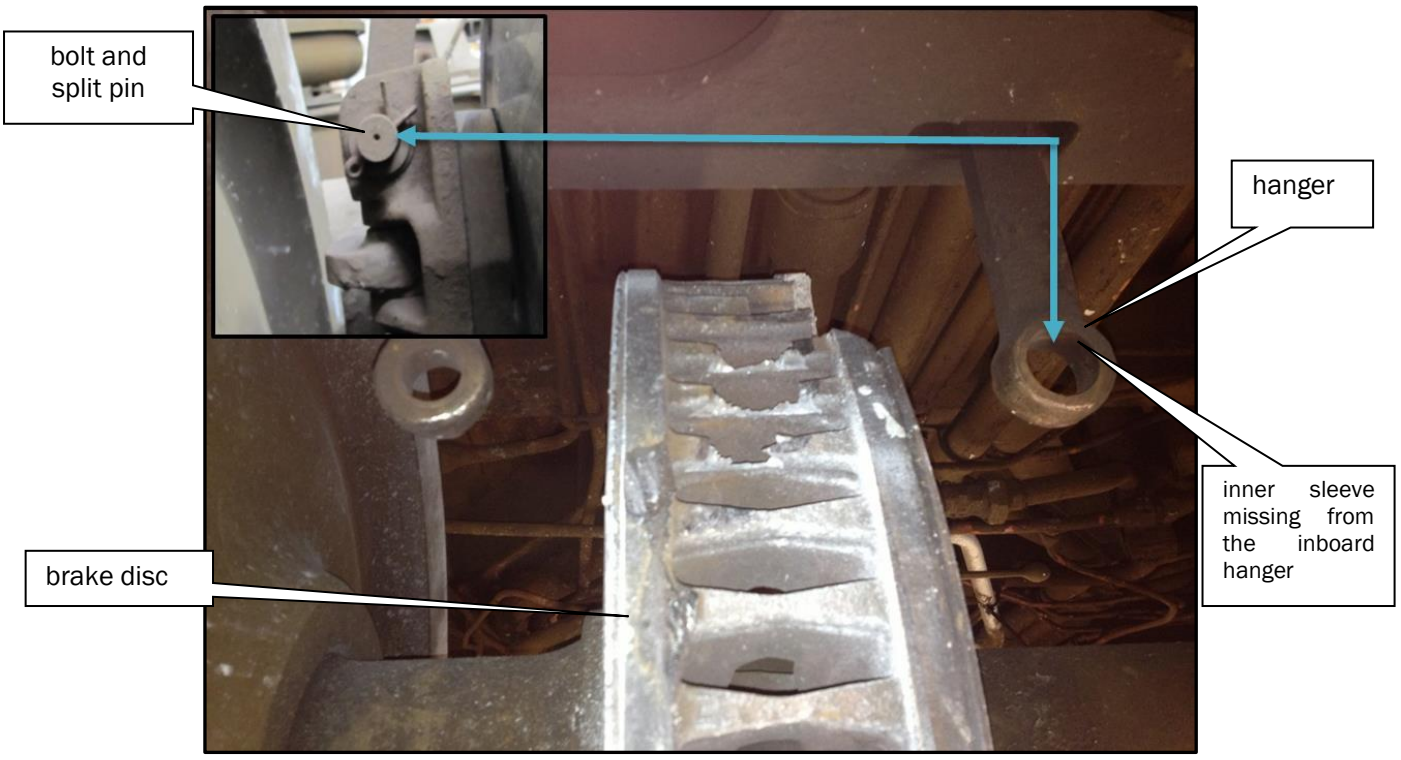


Figure 5
Undamaged hangers either side of brake disc
(Inset – bolt and split pin securing spring park brake assembly to hanger)

3.2.7. The opposite end of the spring park brake assembly was normally attached to a mounting plate, which was welded directly to the bogie frame. This mounting plate had torn away from the bogie (see Figure 6).

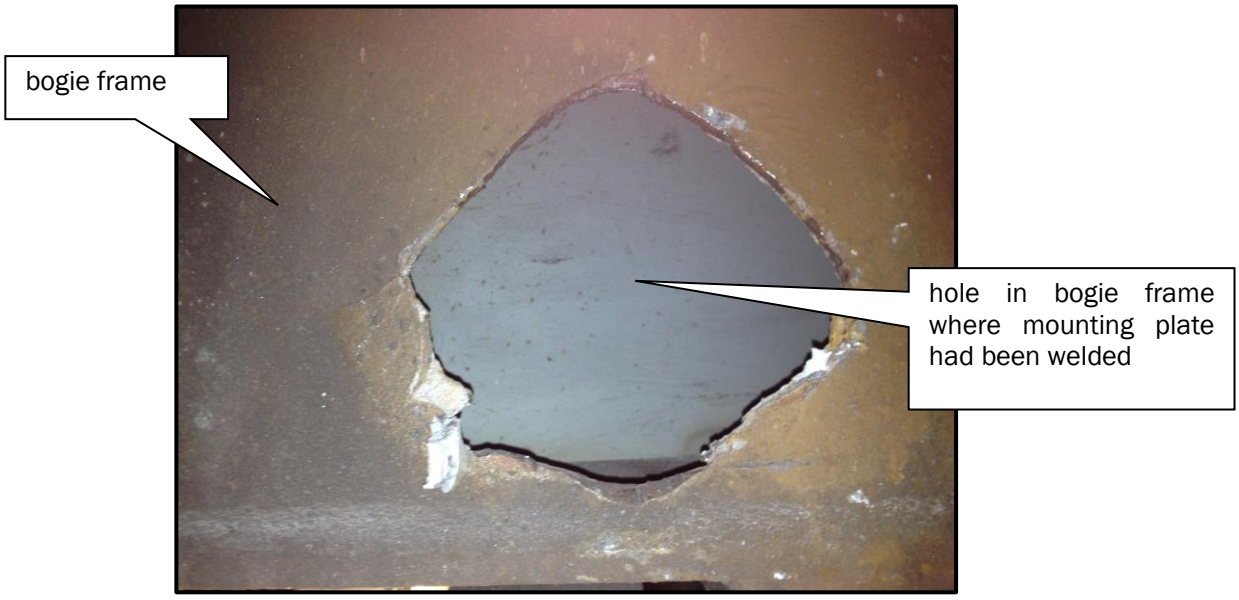


Figure 6
Hole in bogie frame where spring park brake mounting plate had been welded

3.2.8. The fact that the spring park brake assembly was torn away from its location without damaging the lug or hangers to which it should have been attached is an indication that the two bolts and split pins were not present when the train derailed. This led the Commission to examine the maintenance history of the coach.

3.3. Maintenance history

3.3.1. Scheduled mechanical inspections and maintenance work on the Ganz Mavag fleet were carried out by KiwiRail staff at the Wellington metro maintenance depot under contract to the fleet owner, the Greater Wellington Regional Council. Issue 8 of KiwiRail's Mechanical Code M2000 (the Code) outlined the policy and procedures for conducting the maintenance.

3.3.2. A terminal brake test and an in-cab vigilance test had been carried out before the passenger train entered service on 20 May 2013. The test had showed that the braking system operated correctly.

3.3.3. The Code determined that scheduled inspections be carried out on the Ganz Mavag fleet at intervals of not more than 15,000 kilometres. The most recent scheduled inspection of the coach before the derailment had been made about four months earlier on 26 January 2013. During that inspection one of the four spring park brake assemblies on the trailer coach was found to be not functioning. The coach was put back into service and the replacement of the defective spring park brake was scheduled for a later date.

3.3.4. KiwiRail's Mechanical Design Report 80130_3, EM/ET Park Brake Minima, dated 16 March 2011, concluded that only three of eight park brake assemblies were required to hold an EM/ET class multiple unit set on the steepest gradient in the Wellington rail network. The report recommended that, while it was preferable that a set had eight functioning spring park brake assemblies, a two-coach set could be released from the depot with a minimum of four serviceable spring park brakes. This was as long as each passenger coach had a minimum of two spring park brake assemblies functioning.

3.3.5. The replacement of the defective spring park brake assembly on the trailer coach was scheduled for 7 March 2013. A mechanical engineer and his trade assistant started the change-out of the spring park brake assembly during the evening shift on that day. They were

unable to complete the task and test the componentry before the end of their shift at 2300. The mechanical engineer then went on six days of annual leave.

3.3.6. As part of the depot handover procedure the mechanical engineer sent an email to other senior maintenance depot staff before he left the depot. The email stated (in part):

> *Em1309 [the motor coach] we have put the SPBC [spring park brake cylinder] in place with wheel set back to get the set back into depot.*
>
> *All that needs to be done is – lock wire bottom bolts – release pin split pin and test for correct function*
>
> *We have check[ed] and recorded the T/m earth brushes on No. 3 + 4 T/m so only 1 + 2 T/m earth brushes to do*
>
> *[Name of trade assistant] is on duty Friday and knows what stage Em 1309 [the motor coach] is at*

3.3.7. Owing to staff leave requirements, the trade assistant started work at 0900 the next day, after he had observed a minimum 10-hour rest period.

3.3.8. The day-shift team leader responsible for completing the spring park brake assembly replacement work had read the email from the mechanical engineer. He assumed that the trade assistant would have completed the work on the spring park brake assembly. He thought that he had asked the trade assistant if all the work was complete, and that he had received an affirmative response. The trade assistant could not recall being asked, and confirmed that he had not completed the work by fitting the split pins to the bolts[8].

3.3.9. The day-shift team leader signed the 'release from depot sheet' for the coach at 1130 on 8 March 2013, without having first examined it to confirm that all the outstanding work had been completed to a satisfactory standard.

3.3.10. On 25 March 2013, some two weeks after the number 3 spring park brake assembly was replaced, the two-coach set was scheduled for its annual airbrake and pneumatic inspection and testing to KiwiRail's Code supplement M9309. The results of the inspection and testing were recorded and signed off as being complete on 28 March 2013. This test was designed to ensure the correct functioning of the systems, so did not include a check of all the mechanical linkages, such as the presence of split pins in the spring park brake assembly.

3.4. Personnel information

The evening-shift mechanical engineer

3.4.1. The evening-shift mechanical engineer who started the spring park brake replacement on 7 March 2013 had been employed by KiwiRail and its predecessors since 1972. He had spent time in Hungary with a Ganz Mavag commissioning and verification unit before the fleet entered service on the Wellington network during 1982. Since then he had been actively involved in the inspection and maintenance of the Ganz Mavag fleet.

3.4.2. He had been appointed to a variety of roles in the metro maintenance depot, having had more than 25 years' experience as a team leader, service co-ordinator and acting depot manager. His certification was current for the work he was performing.

[8] Both the team leader and the trade assistant were recalling events that had happened 10 weeks before the accident.

The day-shift team leader

3.4.3. The day-shift team leader had about 40 years' maintenance experience, of which 12 years had been within the rail industry. He had worked at the metro maintenance depot for the previous six years and he had been appointed to a team leader position early in 2012. He said that about 60% of his work time was spent maintaining the Ganz Mavag fleet. The remaining 40% of his work was spent maintaining its replacement third-generation 'Matangi' electric multiple units that had progressively entered service since 2011.

The mechanical engineer's trade assistant

3.4.4. The person assisting the mechanical engineer with the spring park brake assembly replacement had had more than 42 years' work experience with KiwiRail. He had worked at several mechanical depots within the Wellington area. He had worked with a team leader at the metro maintenance depot maintaining the Ganz Mavag fleet for the previous 12 years.

4. Analysis

4.1. Introduction

4.1.1. The downloaded data from the train's event recorder showed that the train was travelling below the authorised line speed at the time of the derailment. There is nothing to suggest that the way the train was being driven contributed to the accident.

4.1.2. It is almost certain that the trailer passenger coach had been put back into service on 8 March 2013 without the bolts that connected the spring park brake assembly to their hangers being either lock-wired or having their split pins fitted.

4.1.3. Without anything to secure the bolts in place, they worked loose over the following 10 weeks in service and eventually dropped out. Without being supported by the hangers, the entire weight of the assembly was taken on its welded connection to the bogie frame. The main purpose of the connection between the spring park brake assembly and the hangers was to absorb the rotational force applied by the brake pads to the brake disc when the brakes were applied. Without the hanger pins in place to react against the braking forces, the application of the brake would have exerted higher-than-normal forces on the welded connection, which was already supporting the entire weight of the spring park brake assembly.

4.1.4. Eventually the welded connection failed, allowing the spring park brake assembly to fall to the track, where it jammed on the underslung air reservoirs and air compressor. The forces involved pushed the air compressor up through the coach floor and were sufficient to derail the train.

4.1.5. Passengers on the derailed coach recalled hearing scraping noises before the accident. These were most likely associated with the spring park brake assembly being forced downwards when the driver made brake applications.

4.1.6. The Commission considered the emergency response to the accident and concluded that, under the circumstances, it was appropriate. For first responders to a train accident there will inevitably be a delicate balance between the need to provide assistance immediately and the risks associated with a derailed train in contact with a high-voltage overhead traction contact wire.

4.1.7. The high-voltage overhead traction contact wire was not damaged in the derailment, and the driver took the initiative to lower the pantographs that connected the train to the overhead line. As a precaution the evacuation was delayed until it was confirmed that the overhead traction line had been isolated and earthed. Given the minor nature of the injuries it was reasonable to hold the passengers on board until there was absolutely certainty of no risk to passengers and first-response rescue teams.

4.1.8. The safety issues arising from this accident relates to the standard of maintenance for a safety-critical braking system, in particular the procedures for ensuring that maintenance was conducted in accordance with best engineering practice and that there were independent final checks of critical systems before electric multiple units were released back into service.

4.2. Maintenance procedures

4.2.1. The Wellington metro maintenance depot had various procedures for each type of check. However, there were no documented task instructions setting out how safety-critical tasks were to be performed on the Ganz Mavag fleet, and no means of recording progress against the individual steps in the task. Instead, for the previous 30 years depot management had relied on the institutional knowledge and experience of its staff to conduct proper maintenance and ensure that trains were fit for purpose when returned to service.

4.2.2. The braking system on a train is a safety-critical system, as are its components. A simple check by an appropriate person to confirm that the split pins had been inserted in the hanger bolts would have prevented this accident.

4.2.3. However, no systematic assessment had been undertaken to identify safety-critical systems and their components. Also, there were no mandatory checks by people independent of those doing the work that the work had been performed in accordance with the Code.

4.2.4. The Commission has reported on a similar safety issue involving the maintenance of the Auckland metropolitan train fleet. Following a series of maintenance-related occurrences[9], in 2007 the Commission made a safety recommendation to the Director of Land Transport New Zealand (now the NZ Transport Agency) aimed at improving the standards of maintenance conducted in the Auckland metro maintenance depot. The recommendation was for the Director to ensure that:

- engineering standards consistent with world standard practice are identified and adhered to
- manufacturers' inspection, repair and maintenance instructions are documented and followed
- safety-critical components are identified and documented
- work instructions are issued for maintaining safety-critical equipment
- work on safety-critical components is signed off by someone other than the maintainer
- all maintenance work is recorded.

4.2.5. The previous recommendation to address the Auckland situation is equally applicable to the safety issue identified with the Wellington metro maintenance depot during this inquiry. Accordingly, on 13 August 2013, before this inquiry was complete, the Commission made the same urgent recommendation to the Chief Executive of KiwiRail to address the same issues identified in its Wellington metro maintenance depot. The Commission also made a recommendation to the Chief Executive of the NZ Transport Agency to monitor KiwiRail's implementation of the Commission's recommendation (refer to the recommendations section of this report for the full recommendations and responses).

4.2.6. KiwiRail made a number of improvements to its Wellington depot maintenance procedures as the Commission's inquiry progressed. Refer to Section 6 ('Safety actions') for a full description of the timing and nature of those improvements.

[9] Commission report 06-101, diesel multiple unit passenger Train 3163, fire in diesel auxiliary engine, Manurewa, 15 March 2006, Recommendation 015/07.

5. Findings

5.1. A spring park brake assembly became disconnected underneath the passenger coach and caused sufficient disruption to the underfloor air compressor and reservoirs to cause the train to derail.

5.2. The spring park brake assembly disconnected underneath the passenger coach because, more than 10 weeks before the accident, maintenance staff had omitted to fit retaining split pins on two bolts that secured it to the bogie.

5.3. Maintenance staff had omitted to fit the retaining split pins to the bolts securing the spring park brake assembly because the staff member who was fitting it did not have documented task instructions to follow and against which to record progress, so when the task was interrupted by an overnight change in shift the step of fitting the split pins was easily missed.

5.4. In the Wellington metro maintenance depot there was a universal absence of documented task instructions for maintaining the Ganz Mavag fleet, and no requirement for work on safety-critical systems, and their components, to be checked and signed off by people not directly involved in the work. Had there been it is highly likely that the omission would have been avoided, or at least detected and rectified, before the coach was released to service.

6. Safety actions

General

6.1 The Commission classifies safety actions by two types:

(a) safety actions taken by the regulator or an operator to address safety issues identified by the Commission during an inquiry that would otherwise result in the Commission issuing a recommendation

(b) safety actions taken by the regulator or an operator to address other safety issues that would not normally result in the Commission issuing a recommendation.

Safety actions addressing safety issues identified during the inquiry

6.2 Post-derailment fleet inspection and corrective action

KiwiRail withdrew the other 24 Ganz Mavag sets from service immediately after the derailment. Brake cylinder security checks covering the pins, bolts and welds associated with the spring park brake assemblies were carried out on all trailer coaches. These included for each set:

- inspecting both sides of the horizontal pedestal for weld integrity before brushing
- wire brushing the pedestal and repeating the inspection
- inspecting the four pedestal mounting bolts
- inspecting all other mounting pins and bolts
- inspecting all other lock wires and split pins to confirm that they were in place
- a general inspection of the brake cylinder assembly.

6.3 KiwiRail's Mechanical Code M2000 stated in part:

> Brake Rigging
>
> a) All rigging including safety straps and chains must be secure and correctly positioned.
>
> b) Any lever, rod, brake beam or hanger, or any pin or pin hole or chain link may not be worn beyond 75% of its original cross-sectional area, cracked, broken or missing. All pins shall be secured in place by welding, or with cotters, nuts, split pins or R-clips, and all replacement split pins shall have each leg splayed at least 20° and preferably 45°.

6.4 The post-derailment special inspections revealed that four coaches had some split pins splayed at non-compliant angles. Loose pedestal bolts were either replaced or tightened on six other coaches. Corrective actions were taken at the time of the inspections. Seventeen two-car Ganz Mavag coach sets were passed out as fit for service on the day of the derailment. Seven more two-coach sets were available for service the following day.

6.5 KiwiRail implemented a programme to replace all split pins associated with the brake rigging assemblies in the entire Ganz Mavag fleet at the next scheduled maintenance service checks.

6.6 On 6 August 2013 the shift handover instructions were amended by adding more detail for team leaders to record, including updating the status of all work orders. If any job had not been completed the work order had to show clearly the stage of the work, and all work orders were required to be stapled to the completed handover sheet. In addition, the depot service delivery manager and breakdown team leader had to review the previous night's work and plan the completion of the outstanding tasks. In view of the action taken, no recommendation will be made to address this issue.

7. Safety recommendations

7.1. General

7.1.1. 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 recommendations have been issued to KiwiRail with notice of these recommendations given to the NZ Transport Agency.

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

7.2. Urgent recommendations

KiwiRail

7.2.1. There were two safety issues identified with the Wellington maintenance depot processes:

- there were no individual task instructions on how each job was to be done
- there was no check sheet associated with each task to record that important steps and checks for the task had been completed.

Instead the depot relied on the knowledge of the depot staff to complete each task satisfactorily.

These shortcomings in maintenance control could be indicators of other safety issues in the wider maintenance system at the Wellington maintenance depot.

On 13 August 2013 the Commission recommended that the Chief Executive of KiwiRail urgently address this safety issue by ensuring that at the Wellington maintenance depot, and other maintenance depots under KiwiRail control:

- *maintenance is undertaken in accordance with good railway engineering practice*
- *manufacturers' inspection, repair and maintenance instructions are documented and followed*
- *safety-critical components are identified and documented*
- *work instructions are issued for maintaining all equipment*
- *work on safety-critical components is signed off by someone other than the person responsible for carrying out the maintenance work*
- *all maintenance work is recorded. (020/13)*

On 28 August 2013 KiwiRail replied, in part:

> As a consequence of the derailment and our internal investigation the following actions have already been completed by the Wellington EMU [electric multiple unit] depot management:
>
> 1. *Manufacturers' inspection, repair and maintenance instructions are documented and followed*
> Engineers audited the Ganz Mavag manufacturers' documentation on Friday 16 August to establish what information and/or references are required in documentation and work instructions.

2. *Safety-critical components are identified and documented*
   Staff notice #24 has been issued to detail the safety critical jobs and the information is also in poster form around the depot.

3. *Work instructions are issued for maintaining all equipment*
   Based on the audit of the Ganz manufacturers' documentation, work instructions for the Ganz fleet are being developed starting with the safety critical tasks. There are not currently work instructions for repairs.

4. *Work on safety-critical components is signed off by someone other than the maintainer*
   Safety-critical tasks are now identified and individually checked and signed off by an appropriately qualified staff member who has not completed the job. Requirement for a counter-sign has been added to the work sheets.

5. *All maintenance is recorded*
   SAP is used to record all maintenance and that data was supplied to TAIC [the Commission] during the investigation.

The TAIC preliminary report has also made a much more general recommendation that *Maintenance is undertaken in accordance with good railway engineering practice*. This is already the case as much as can be practicably expected within the profile of the railway fleet. It is unclear to us at this stage that it would be practical to, for example create detailed work instructions for locomotives that are in some cases several decades old. In some cases the assets will end their operational life before such a task could be completed. However, we will put in place a review of this and where it is practical to put this in place – we will. Where it is not we will instead put in place the best practical mitigation.

7.2.2. On 1 May 2015 the Commission received from KiwiRail a copy of a poster that identified nine safety-critical maintenance tasks relating to the Ganz Mavag fleet (see Appendix 1). The tasks included:

- [resistor] bank change
- bogie stabiliser change
- Compessor replacement
- EM brake cylinder replacement
- ET brake cylinder replacement
- ET wheel set change
- MA replacement
- signal trip change
- traction motor and EM wheelset replacement.

A set of step-by-step instructions and associated photographs had been produced for each of the identified safety-critical maintenance tasks. One such safety-critical task instruction, the ET brake cylinder replacement, is shown in Appendix 2.

7.2.3. The back page of the task instruction had to be signed by the mechanical engineer after completing the work. An appropriately qualified person who was not part of the work team had to carry out a visual check of defined key components and test that the main brake cylinder and spring park brake assembly applied and released correctly. The independent checker then certified that the inspection and test were complete.

NZ Transport Agency

7.2.4. The Commission has made an urgent recommendation to the Chief Executive of KiwiRail that he ensure that at the Wellington maintenance depot, and other maintenance depots under KiwiRail control:

- maintenance is undertaken in accordance with good railway engineering practice
- manufacturers' inspection, repair and maintenance instructions are documented and followed
- safety-critical components are identified and documented
- work instructions are issued for maintaining all equipment
- work on safety-critical components is signed off by someone other than the maintainer
- all maintenance work is recorded.

It is important that KiwiRail addresses this urgent safety recommendation. The NZ Transport Agency has various powers under the Railways Act 2005 to monitor and ensure KiwiRail's performance and compliance.

The Commission recommends that the Chief Executive of the NZ Transport Agency take all appropriate steps to ensure that KiwiRail addresses the above recommendation. (021/13)

On 11 October 2013, the NZ Transport Agency replied:

> The urgent recommendation that the Commission have directed to the Chief Executive of KiwiRail is noted. The urgent recommendation made to the Chief Executive of the NZ Transport Agency is accepted. Discussions on it will be initiated with KiwiRail on the publication of the urgent recommendations. These discussions will include, where appropriate, a projected timeframe for implementation. This will be advised to TAIC in due course.

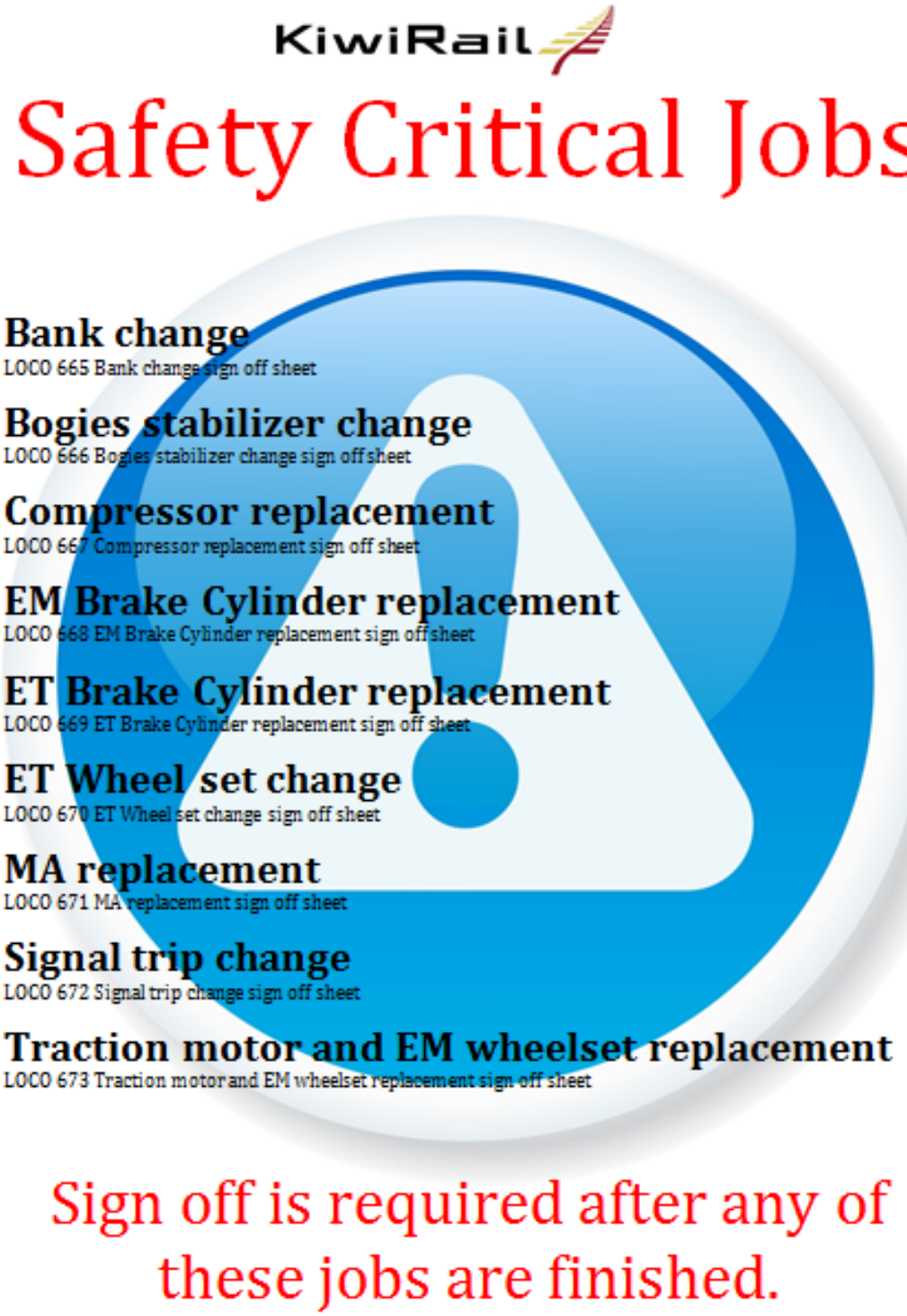
7.2.5. On 19 August 2015, the NZ Transport Agency stated in part:

> The Transport Agency has reviewed the evidence supplied by KiwiRail to date and would submit that KiwiRail has greatly improved the maintenance controls and systems used at the Wellington maintenance depot since and as a consequence of this accident.
>
> The Transport Agency has sought some further assurance from KiwiRail regarding the risk assessment/analysis used to identify the nine 'Safety Critical Jobs' and whether further detail needs to be added to the Safety Critical Task Instructions regarding the placement of 'all split pins'.
>
> A request has also been made to KiwiRail for evidence that demonstrates that there are similar controls and systems working in practice at 'other maintenance depots under KiwiRail control'.

8. Key lesson

8.1. Maintenance staff must be given clear instructions for all maintenance tasks and record progress against every important step of the instructions. If a task involves safety-critical systems, there must be an independent check by a responsible person before the train is released back into service.

Appendix 1: Safety-critical maintenance tasks for Ganz Mavag fleet



Appendix 2: An example of a safety-critical task instruction ET brake cylinder replacement

SAFETY CRITICAL TASK INSTRUCTION

KiwiRail
METRO MAINTENANCE WELLINGTON

Loco 669 ET Brake Cylinder Replacement

Issue 1 Date 22/11/2013

ACCESS

Underframe				

SAFETY ISOLATION REQUIRED

Pneumatics				

Special Tools

Description	Part Number
Torque Wrench capable of 450 Nm	N/A

Materials Required

Description	Qty	Part Number
Either PB Brake Cylinder	1	115453
Or PB-F Brake Cylinder	1	115394
Castrol olista longtime 2 grease	As Required	175488
Inox or equivalent	As Required	

TRADESMAN COMPETENCY: At least one tradesman to be Level 4 or above.

WARNING

ENSURE UNIT IS CHOCKED CORRECTLY TO PREVENT INADVERTANT MOVEMENT

BE AWARE THAT OVERLY BRIGHT LIGHTING FOR EXAMPLE A 5 BULB LED, CAN OBSCURE PHYSICAL DEFECTS I.E. WORN SPLIT PINS

1. Confirm the fault and that the correct cylinder is being replaced.
2. If fitted, inspect the manual release mechanism for correct function and wear. Repair any work linkages before refitting the cylinder.
3. Remove the wheelset IAW task instruction 3.2.
4. Remove the BC and SPB (if fitted) hoses from the cylinder to be replaced. Inspect and replace hoses as required.
5. If fitted, remove the SPB manual release split pin and pin.
6. Remove both calliper pivot pin nuts (1a and 1b) and the outboard pivot pin (1a).

UNCONTROLLED WHEN PRINTED

Task Instruction 6.2
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7. Remove the inboard hanger split pin and pin (6).

8. Swing the calliper assembly out to allow the removal of the inboard pivot pin.

9. Remove the inboard pivot pin (1b) and link arms (2).

10. Support the inboard calliper and remove the calliper to cylinder pin (3).

11. Remove the inboard calliper.

12. Remove the top and bottom calliper to mount pivot bolts (4).

Figure 1

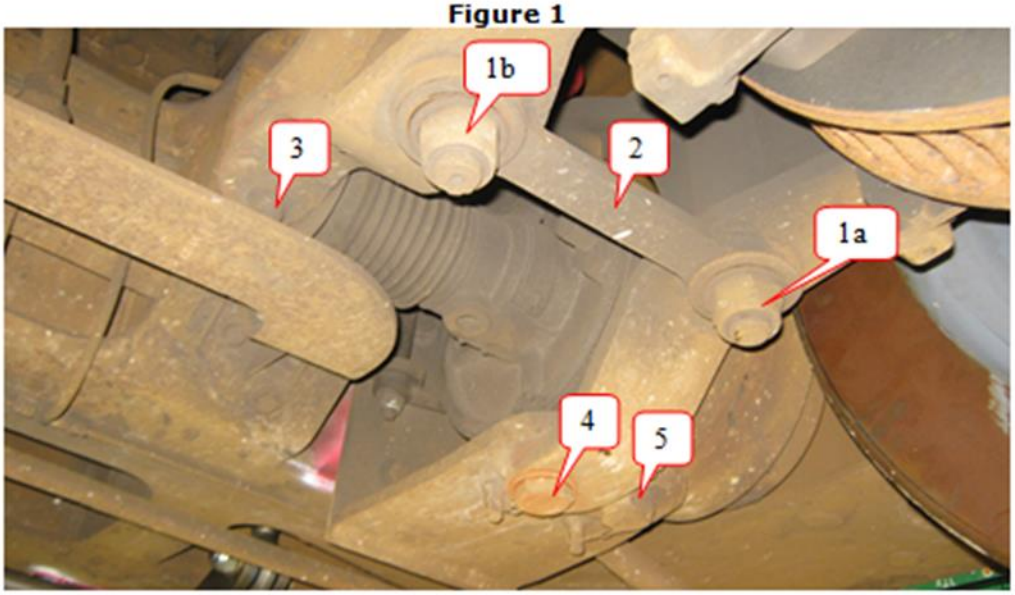
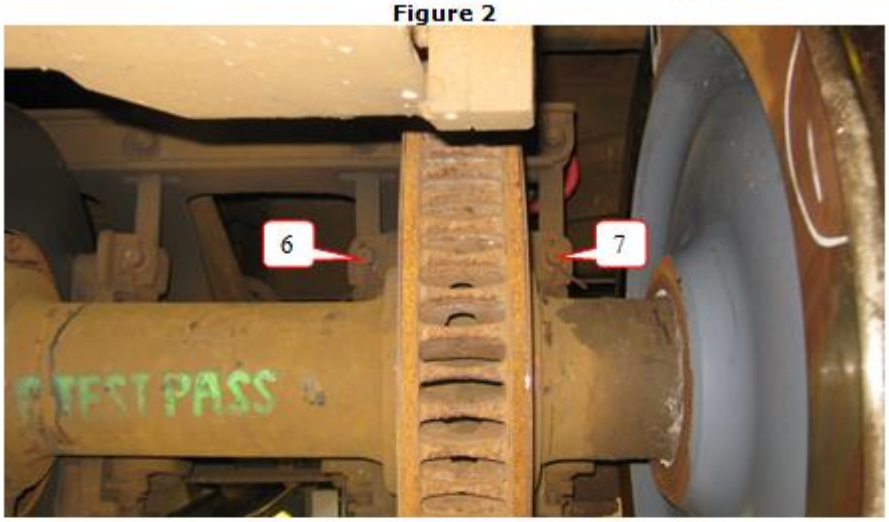


Figure 2



13. Remove the outboard hanger split pin (7). Support the calliper assembly, remove the outboard hanger pin and remove the calliper assembly.

14. Remove the top and bottom cylinder mounting bolts (5).

CAUTION

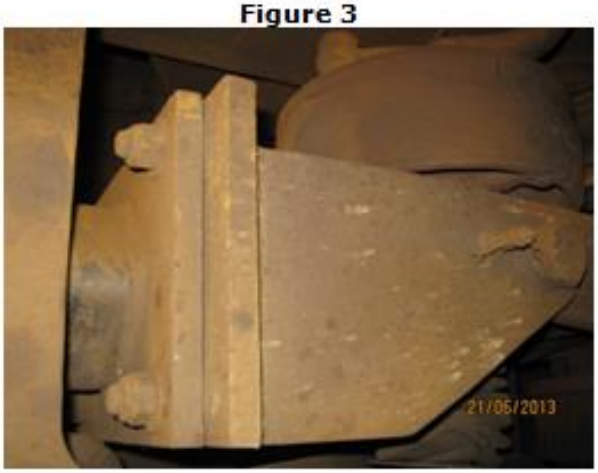
THE CYLINDER IS HEAVY. ENSURE IT DOES NOT MOVE WHILE THE FIXINGS ARE REMOVED.

15. Align the drop table with the cylinder to be removed and slide the cylinder onto the table. Remove the brake cylinder and drop table.

16. Inspect the cylinder mount welds for cracks. Inspect all calliper and cylinder components for wear. Replace as required.

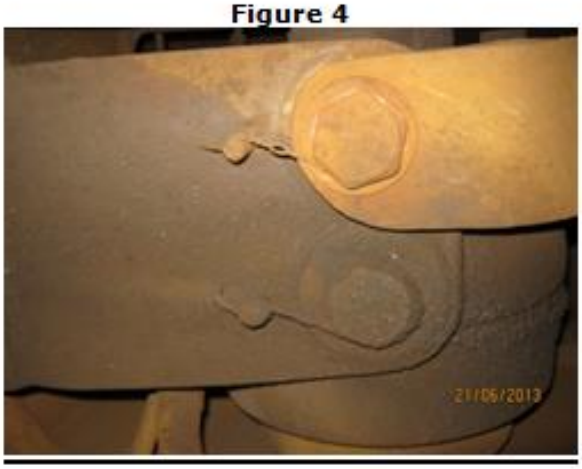
17. Confirm the 4 cylinder mounting bolts are secure.

Figure 3



18. Align the replacement cylinder and fit the top and bottom mounting bolts (5). Torque bolts to 450 Nm.

Figure 4



19. Lift the outboard calliper and fit the outboard hanger pin (7).

20. Refit the top and bottom calliper to mount pivot bolts (4) and torque to 450 Nm.

21. Support the inboard calliper and fit the inboard calliper to cylinder pin (3) with new M16 nylock nut and tighten.

22. Refit the calliper pivot pins (1band 1b) and link arms (2) using new M30 nuts and tighten.

23. Fit the inboard hanger pin (6).

24. Fit both hanger split pins and bend both legs 45 degrees.

25. Lockwire the top and bottom calliper and cylinder pivot bolts (4) and (5).

26. Refit the BC and SPB (if fitted) hoses ensuring they are orientated as horizontal as possible to avoid catching in objects service.

Figure 5

27. If fitted, refit the SPB manual release pin and split pin. Bend both legs of the split pin 45 degrees.

28. Refit the wheelset IAW task instruction 3.2.

29. Replace brake pads if groove is less than 1mm.

30. Functional Testing

1. Pry the callipers open to achieve a gap (approx. 20mm)
2. Reinstate the SPB and BC cocks
3. Apply and release the service brakes. Confirm that the slack adjuster adjusts to approx. 5mm when brakes released and using a bar that positive pressure is being applied to the disk when applied.
4. Apply the SPB's and isolate the BC cock. Using a bar that positive pressure is being applied to the disk when by the SPB.
5. Manually release the SPB and confirm pads release pressure from disk.
6. Reinstate the BC cock. Release the SPB and move the controller to full service.
7. Using soapy water check the cylinder and associated pipework for leaks.

31. Job complete.

KiwiRail
METRO MAINTENANCE WELLINGTON

ET Brake Cylinder replacement check

Unit Number……

Date……

Brake cylinder number……

When multiple cylinders changed, a sign off sheet for each cylinder is required.

Job completed by……

Signed……

Visually check	Sign
Hanger pins, cylinder mounting pins, calliper arm pins, manual release pin are in place	
All split pins replaced and fitted as per M2000. *3.11 …all replacement split pins shall have each leg splayed at least 20° and preferably 45°.*	
Top and bottom cylinder and calliper location bolts lock wired to protect against anti-clockwise rotation.	
Brake pads in place secured by clips.	
BC and SPB hoses correctly orientated (Not looped down)	
Bogie frame to cylinder bracket bolts secure	
Test operating correctly	**Sign**
Main brake cylinder applies and releases	
SPB cylinder applies and releases	
Manual release operates	

Inspection completed by……

(Appropriately experienced staff member who has not completed the job)

Signed……

Appendix 3: Shift handover sheet

KiwiRail
METRO MAINTENANCE WELLINGTON

Shift Handover Sheet

Team Leader		

Released Units not taken from depot by 4pm still to be removed

Date	Unit #	W/O #	Work	Status at end of day	Pre-release check Complete	Restrictions updated	Sign
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	
					Yes / No	Yes / No	

Unplanned work notes

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

Urgent Recommendations RO-2015-101	Pedestrian fatality, Morningside Drive level crossing, West Auckland, 29 January 2015
RO-2013-105	*Capital Connection* passenger train, departed Waikanae Station with mobility hoist deployed 10 June 2013
RO-2014-102	High-speed roll-over, empty passenger Train 5153, Westfield, South Auckland, 2 March 2014
RO-2013-106	Track occupation irregularity, leading to near head-on collision, Otira-Arthur's Pass, 10 June 2013
RO-2012-102	Train control power failure, 26 April 2012
Interim Report RO-2014-103	Metropolitan passenger train, collision with stop block, Melling Station, Wellington, 27 May 2014
RO-2013-108	Near collision between 2 metro passenger trains, Wellington, 9 September 2013
11-106	Hi-rail vehicle nearly struck by passenger train, Crown Road level crossing near Paerata, North Island Main Trunk, 28 November 2011
11-102	Track occupation irregularity, leading to near head-on collision, Staircase-Craigieburn, 13 April 2011
RO-2013-104	Urgent Recommendations: Derailment of metro passenger Train 8219, Wellington, 20 May 2013
11-103	Track workers nearly struck by passenger train, near Paekakariki, North Island Main Trunk, 25 August 2011
10-101	wrong route setting, high-speed transit through turnout, near miss and SPAD (signal passed at danger), Tamaki, 13 August 2010
11-104	Freight Train 261 collision with bus, Beach Road level crossing, Paekakariki, 31 October 2011
10-102	collision between 2 metro passenger trains, after one struck a landslide and derailed between Plimmerton and Pukerua Bay, North Island Main Trunk, 30 September 2010

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