OCI Office of the Chief Investigator
Transport Safety

# Collision of truck with passenger coach

Western Highway, Pentland Hills, Victoria on 21 September 2022

**OCI Transport Safety Investigation Report**
Bus Occurrence Investigation
BUS/22-1519
FINAL – 12 December 2024

**Cover photo:** Office of the Chief Investigator

This investigation was conducted under the *Transport (Compliance & Miscellaneous) Act 1983* (Vic) by the Office of the Chief Investigator (OCI).

OCI is the operating office of Victoria's Chief Investigator, Transport Safety, a statutory position under Part 7 of the *Transport Integration Act 2010* (Vic). The object of the position is to seek to improve transport safety by providing for the independent no blame investigation of transport safety matters consistent with the vision statement and the transport system objectives. The primary focus of an investigation is to determine what factors caused the incident, rather than apportion blame for the incident, and to identify issues that may require review, monitoring or further consideration.

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# Executive summary

## What happened

At about 0315 on Wednesday 21 September 2022, a B-double truck travelling from Nhill to Melbourne in Victoria collided with the rear of a passenger coach at Pentland Hills, near Bacchus Marsh. The coach operated by Little's Coaches had been chartered by Loreto College Ballarat. It had slowed to comply with a temporary 40 km/h speed zone when it was impacted by the truck travelling at high speed. The impact caused the coach to leave the Western Freeway, career down an embankment and roll onto its side.

The passenger coach was carrying 27 high school students, 4 adult passengers and the driver. Eleven passengers sustained injuries requiring hospitalisation and the remaining passengers and driver sustained a range of minor injuries. The driver of the truck was also injured and required hospitalisation.

## What was found

As a result of an incident earlier that night, traffic management by VicRoads had established a reduced speed zone and the closure of one lane on the eastbound carriageway of the Western Freeway. Signage was installed to reduce traffic speed to 80 km/h and then to 40 km/h through the location of the lane closure.

It was found that the passenger coach was travelling at or below the 40 km/h temporary speed limit in the single lane section. The truck (a prime mover with 2 semitrailers in B-double configuration) was probably travelling at a speed of at least 100 km/h when it collided with the coach.

The driver of the truck was not able to slow the truck to avoid colliding with the passenger coach. It was found that the brakes on both semitrailers were out of adjustment resulting in ineffective service brake performance. The maintenance regime of the semitrailer operator did not ensure that the brakes on both trailers were within the manufacturer's specified adjustment.

The driver had experienced braking difficulties on the descent to Pykes Creek Reservoir about 13 km before this incident. They continued their journey towards Melbourne, probably influenced by several factors including: an incomplete awareness of the condition of the trailer brakes, an expectation that braking would improve with the replenishment of system air reservoirs that had been exhausted on that descent, an expectation that the road ahead would be clear, and the driver's desire to complete the journey to Melbourne. There was a missed opportunity for the driver of the truck to take corrective action in response to the braking difficulties at Pykes Creek.

In addition to ineffective service brakes, the prime mover's engine brakes were probably not available to supplement the service brakes. Although the B-double combination was required to meet braking performance requirements without engine brakes, these brakes are typically used during descents to reduce the load on service brakes of the prime mover and trailers. Heavy application of the service brakes for a prolonged period while descending can overheat brake linings resulting in a partial or complete loss of braking. It was found that prime mover brake assemblies had clear indications of having overheated which further reduced the braking capability of the truck combination.

It was also found that:

- the operation of the passenger coach by its driver did not contribute to the collision
- the procedures of Loreto College Ballarat implemented by its staff probably led to most students wearing seat belts
- the use of seatbelts by most coach passengers probably limited the number of severe injuries and reduced the likelihood of fatality in this roll-over incident
- the traffic management implemented on the freeway at the time of the incident was consistent with AustRoads guidelines.

Other areas identified during this investigation for potential improvement in road safety include:

- opportunities for the National Heavy Vehicle Regulator to review the effectiveness of its monitoring of heavy vehicle maintenance systems, with a specific focus on operators using older vehicles
- consideration of the latest regulatory developments in the United States of America on anti-ejection safety countermeasures in buses and their potential application to Australian Design Rules
- consideration of mandating seatbelt reminder systems on buses to place less reliance on the need for verbal seatbelt reminders.

## What has been done as a result

The operator of the semitrailers advised that they had implemented several actions since the incident including training in manual brake inspection and adjustment. Other proactive safety actions included modifications to inspection and servicing schedules, assuring increased awareness of driver pe-start checks and reinforcing driver reporting of any safety concerns.

The National Heavy Vehicle Regulator advised that they were working to establish a standardised approach to heavy vehicle inspections with the introduction of a consistent national Risk-Based Heavy Vehicle Inspection Scheme (RBHVIS). This new scheme would increase the frequency of vehicle inspections based on risk metrics.

The Commonwealth department responsible for the Australian Design Rules advised that a Bus Safety Working Group has been established which brings together industry and government experts to consider options to improve bus safety. The working group would also consider issues raised in this report.

OCI has made one safety recommendation on the operability and use of engine brakes on prime movers used in heavy haulage.

# Contents

# The occurrence

## Prior to the incident

### *The truck route*

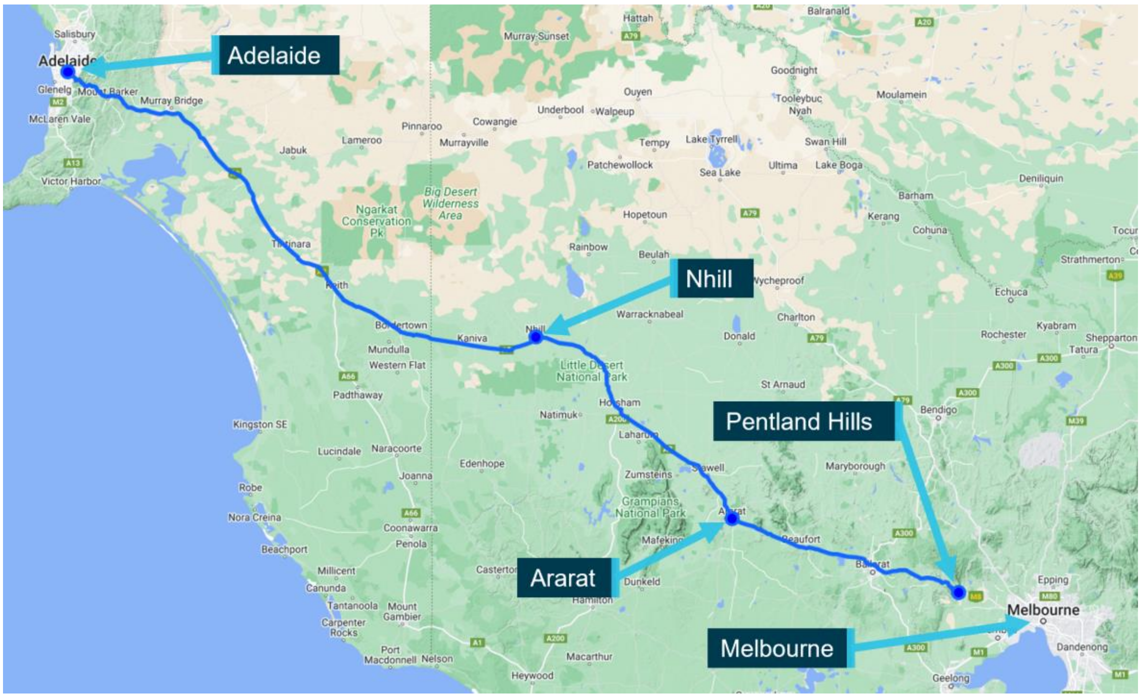
At about 1800 on 20 September 2022, a heavy vehicle comprising of a prime mover[1] with 2 semitrailers in B-double combination[2] departed Melbourne en route to Nhill in regional Victoria, a journey of about 412 km in a northwest direction. The 2 semitrailers were loaded with general freight destined for South Australia. They were hauled to a changeover point in Nhill where they were to be re-coupled to another prime mover to complete the journey to Adelaide.

Earlier that same evening, 2 semitrailers loaded with sand had been hauled from Adelaide to the Nhill change-over point where they were to be re-coupled to the Melbourne based prime mover for hauling back to Melbourne. During semitrailer change over, the drivers exchanged consignment paperwork, briefly discussed what they were hauling and performed basic safety checks on their re-coupled trailers.

At about 2330, after taking a 30-minute break, the driver of the Melbourne based prime mover departed Nhill on the journey back to Melbourne along the Western Freeway. The prime mover was hauling the recently coupled semitrailers laden with 24 bags of sand totalling 36 tonnes.

The following morning on 21 September at about 0130, the driver stopped at Ararat for a 20-minute rest break before recommencing the journey toward Melbourne (Figure 1).

**Figure 1: Route of laden semitrailers from Adelaide to Pentland Hills**




Source: Google Maps, annotated by the Office of the Chief Investigator

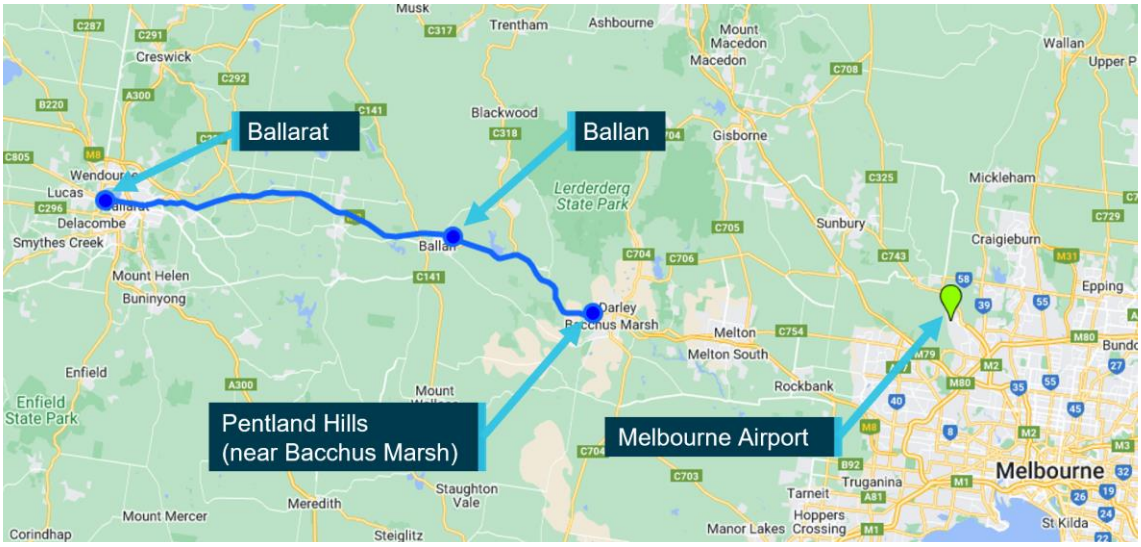
1 Prime mover: a heavy motor vehicle designed to tow a semitrailer.

2 B-double combination: a heavy vehicle combination consisting of a prime mover towing 2 semitrailers, with the first semitrailer being attached directly to the prime mover by a fifth wheel coupling and the second semitrailer being mounted on the rear of the first semitrailer by a fifth wheel coupling on the first semitrailer.

### *The passenger coach route*

At about 0220, a passenger coach carrying 29 passengers departed from Loreto College in Ballarat en route to Melbourne Airport at Tullamarine, north of Melbourne. The passenger coach was carrying 25 students and 4 staff members. They arrived at Ballan at about 0255 to pick up 2 more students, making a total of 31 passengers. It then departed Ballan at about 0300 en route to Bacchus Marsh where one more student was to be picked up (Figure 2).

**Figure 2: Route of the passenger coach from Ballarat to Pentland Hills**




Source: Google Maps, annotated by the Office of the Chief Investigator

### *The road and traffic management*

On the approach to Bacchus Marsh along the east bound lanes of the Western Freeway, the vehicle speed limit was reduced from 110 km/h to 80 km/h then to 40 km/h under a temporary traffic management (TTM) arrangement.[3] The right lane of the carriageway was closed and vehicles routed into the left lane. This arrangement was in place to enable the safe recovery of a heavy vehicle involved in a collision that occurred the previous evening at Pentland Hills.

At the time of the incident, the recovery from the previous collision was complete and removal of lane cones at the eastern end of the lane closure had commenced. The speed reduction and merge left signage, and traffic management attenuator trucks (TMA)[4] were still in place (Figure 3).

3 Arrangements for the systematic control of road traffic on the approaches and through temporary road work sites. They create a safe work area to facilitate construction, maintenance and other activities which occur on or near a road.

4 A road work truck with a rear attenuator designed to protect road workers from approaching traffic.

**Figure 3: Temporary traffic management arrangement – Western Freeway eastbound**

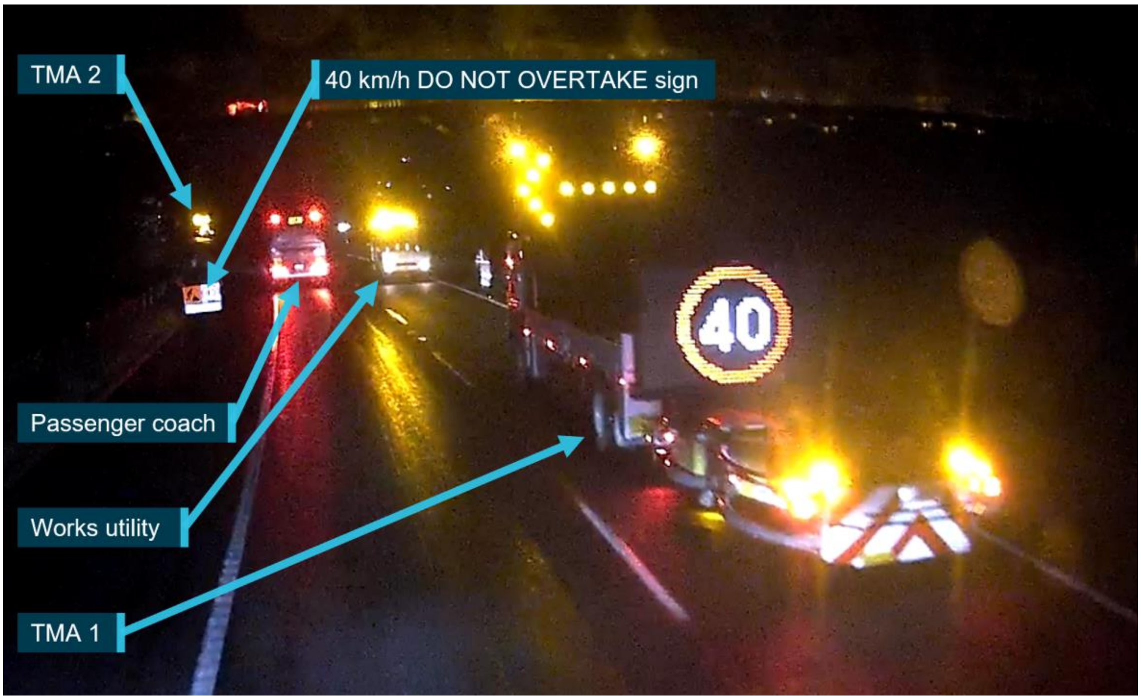

Source: nearmap, annotated by the Office of the Chief Investigator

## The incident

At about 0311, the driver of the Melbourne bound prime mover hauling semitrailers laden with sand began the descent from Pentland Hills on the Western Freeway towards Bacchus Marsh. The driver reported that during the descent they experienced reduced braking capacity on the B-double truck. Soon after, while approaching a descending left hand sweeping bend, the driver observed the 80 km/h speed reduction road sign. However, they were unable to arrest the vehicle speed to the reduced speed limit.

Dashcam footage from another truck following the passenger coach showed the coach apply its brakes as it approached the 80 km/h speed zone. At about 0315, the passenger coach was observed to hold its speed under braking as it approached and passed to the left of the works utility (Figure 4). It was then observed to approach TMA 2 with its brake lights still illuminated and was travelling at or below 40 km/h. The truck following the coach was in a B-double configuration and was maintaining a safe distance behind.

**Figure 4: Passenger coach passing TMA 1**




Source: Dashcam footage annotated by the Office of the Chief Investigator

The incident truck was rapidly approaching the lane closure. A road crew worker in TMA 1 stated that they observed the incident truck pass by in the left-hand lane significantly exceeding the reduced speed limit. This was corroborated in the video footage from the dashcams fitted to the road crew vehicles.

At that point, the driver of the B-Double truck directly following the passenger coach observed the rapidly approaching incident truck in their rear-view mirror and they manoeuvred left to allow the vehicle to pass between it and TMA 2. Their dashcam footage showed the incident truck pass to the right travelling at a speed of at least 100 km/h, then steer back into the left-hand lane before heavily impacting the rear of the passenger coach. The impact caused the passenger coach to veer to the left, mount the roadside barrier and traverse down an embankment where it rolled on to its left side before coming to rest (Figure 5).

**Figure 5: Passenger coach in final resting position**


Source: Office of the Chief Investigator

As a result of the collision, 4 passengers were ejected from the coach, of which 3 sustained injuries requiring hospitalisation. Of the remaining 27 passengers and driver, 8 sustained injuries requiring hospitalisation while the rest sustained minor injuries. 2 passengers were airlifted to Melbourne for treatment. The other injured passengers were treated in Ballarat hospital, in other metropolitan hospitals and on site.

The truck sustained major frontal damage on impact and continued a further 425 m before coming to rest facing an easterly direction on the exit ramp to Bacchus Marsh Road (Figure 6).

The truck driver was injured and needed to be freed from the extensively damaged cabin of the prime mover. They were airlifted to Melbourne for treatment.

**Figure 6: Prime mover and semitrailers in final resting position**


Source: Office of the Chief Investigator

# Context

## The freeway

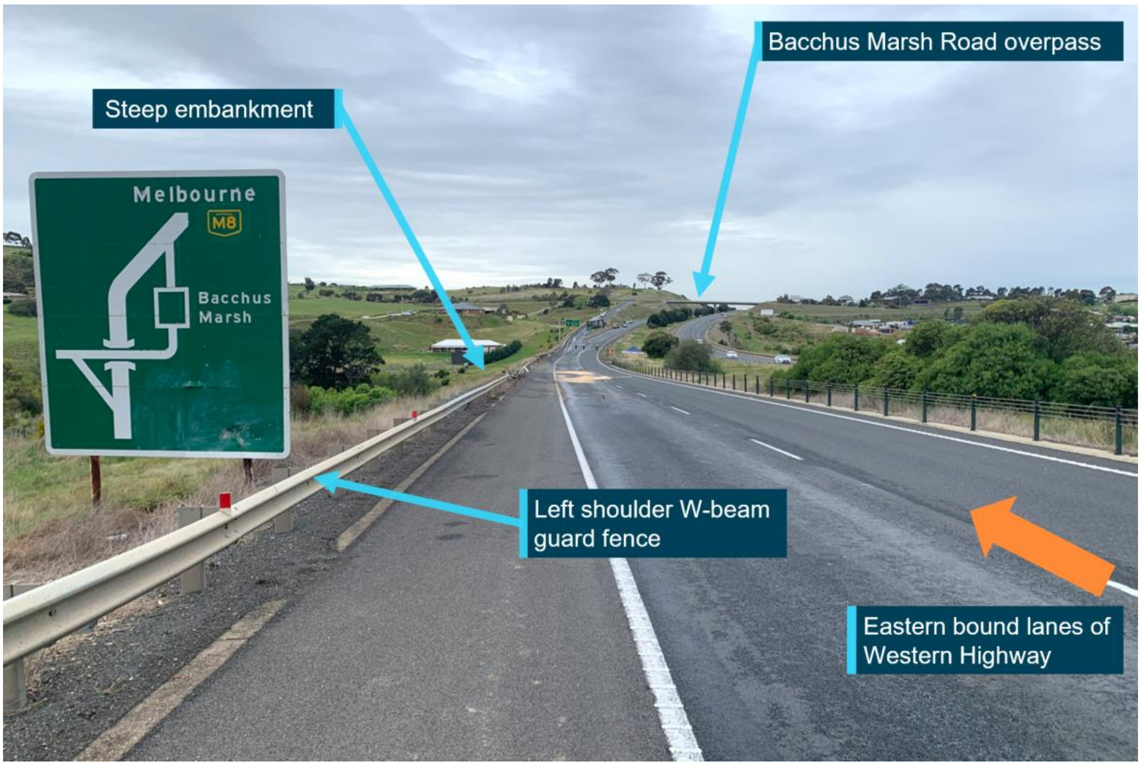
### *Road infrastructure*

Pentland Hills is about 65 km northwest of Melbourne, situated in the Moorabool Shire. The Western Freeway is managed by the Grampians region of Regional Roads Victoria (RRV). RRV is part of VicRoads[5] within the Victorian state government Department of Transport and Planning.

The incident occurred on the east bound lanes of the Western Freeway in Pentland Hills, about 740 m west of the Bacchus Marsh Road overpass. At this location, the freeway was a dual carriageway with the 2-lane eastbound carriageway separated from the westbound carriageway by a median strip flanked with wire-rope safety barriers. The left shoulder of the eastbound carriageway had a tactile edge line and was bordered by a W-beam guard fence system that protected traffic from a steep embankment covered with grass and small shrubs (Figure 7).

A maximum speed limit of 110 km/h applied to this section of freeway and the chip-seal road surface was in good condition.

**Figure 7: location where the passenger coach left the freeway**




Source: Office of the Chief Investigator

### *Environmental conditions.*

Visibility was clear on the early morning of the incident, with a minimum temperature of about 10º C recorded at the Bureau of Meteorology She Oaks weather station 37 km SW of the incident site. Rainfall had been recorded at 2.4 mm on that day. Witness dashcam footage showed that the road surface was damp due to occasional light rain showers.

At 0315, there was no ambient lighting with the moon yet to rise above the horizon. In this area of freeway, there was no roadside lighting other than the temporary flashing warning lights of the

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5 VicRoads is a Victorian government entity which provides, operates, and maintains the road system in Victoria.

Traffic Management Attenuator (TMA) trucks and light board on the roadworks utility. The section of freeway had a slight left-hand bend leading to the reduced speed zone. The flashing warning lights were visible in the left lane from about 260 m on approach. There were no environmental factors affecting visibility along the road ahead at the time of the incident.

## Temporary speed reduction and lane closure

### *Lane closures due to a prior incident*

At approximately 2000 on 20 September, VicRoads were requested by Victoria Police to manage the temporary closure of the eastbound traffic lanes on the Western Freeway at Pentland Hills. This was necessary to enable the safe recovery and debris removal from a road tanker roll-over incident. The incident had occurred earlier that evening on the freeway with the vehicle initially obstructing the Ballarat bound outer lane 500 m west of the Bacchus Marsh Road overpass.

### *Road closure guidelines*

On the eastbound carriageway, speed was reduced from 110 km/h to 40 km/h with the right lane closed under a temporary traffic management (TTM) arrangement facilitated by VicRoads and implemented by their traffic management sub-contractor.

TTM for the control of road traffic through, past and on the approaches to road work sites involved the setup and use of temporary road signage to manage road traffic speed, direction and flow. The setup was specific to each site condition and was referred to as the TTM plan.

Procedures for developing a TTM plan were guided by relevant Australian Standards, Austroads[6] publications and VicRoads supplementary publications.[7] They are formulated for safely managing the risks associated with roadside works while minimising the impact on road users. The procedures specified, amongst other requirements, the layout and type of road signage for different types of roadway and road speed.

### *Implementation of guidelines on the night of the incident*

A risk assessment was conducted by VicRoads on the traffic management operation accounting for the potential hazards. The assessment identified the appropriate lane closure layout in accordance with the Austroads guidelines based on road speed and configuration. Layout details included the positioning of signage for speed reduction, lane merge, lane closure and the location of TMAs with illuminated flashing speed sign and merge arrow boards. The risk assessment was also accompanied by safe work method statements (SWMS) for road services activities on this section of freeway.

Early on the morning of 21 September, the roadside traffic management crew contracted by VicRoads commenced the setup of the TTM plan arrangement. This involved closing the east bound right lane and progressively reducing the speed in the left lane to 40 km/h. The setup took about 45 minutes to complete.

At about 0300, once the carriageway had been cleared of wreckage from the previous incident, the roadside traffic management crew commenced removal of the traffic control arrangement, commencing with lane closure cones closest to the incident. Speed reduction signage for traffic approaching from the west was unchanged from their original locations and the TMAs and a works utility, all with illuminated light boards, were positioned to protect the road crew from

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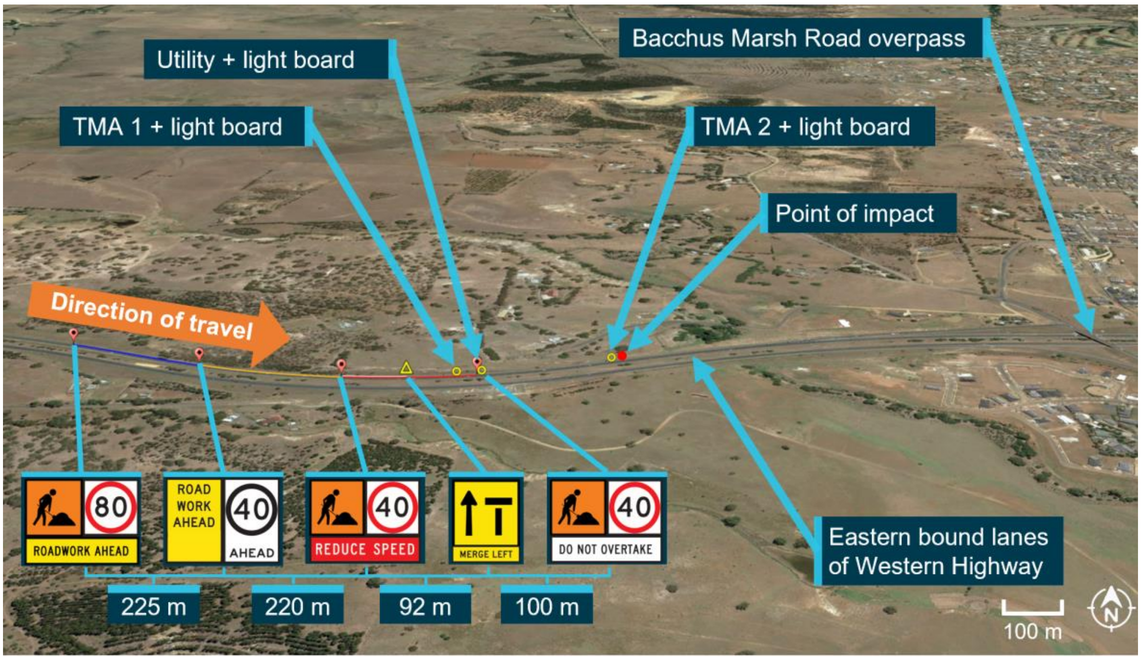
6 Austroads is the association of the Australian and New Zealand transport agencies representing all levels of government to provide research, standards and tools to improve road network safety, efficiency and sustainability.

7 AS 1742.3:2019 - Manual of uniform traffic control devices. Part 3: Traffic control for works on roads
Traffic Control for Works on Roads, Edition 2.0, September 2022, Department of Transport, Victoria State Government
Austroads Guide to Temporary Traffic Management – Edition 1.1 published September 2021
Austroads Guide to Road Design - Edition 3.4 published February 2021

approaching traffic. A depiction of the approach signage at the time of the collision is shown in Figure 8.

**Figure 8: Temporary traffic management arrangement**




Source: Google Earth Pro, annotated by the Office of the Chief Investigator

The setup implementation was consistent with the requirements for layout sequence and signage separation distances outlined in the applicable standards and guidelines (Table 1).

**Table 1: Temporary road signage setup**

| Signage detail | Distance after the previous sign (m) | Guideline minimum distance (m) | Distance from collision (m) |
|---|---|---|---|
| 80 km/h 'ROADWORK AHEAD' | - | - | 840 |
| 40 km/h 'AHEAD' and 'ROAD WORK AHEAD' | 225 | 200 | 615 |
| 40 km/h 'REDUCE SPEED' | 220 | 200 | 395 |
| 'MERGE LEFT' and Right Lane of 2 Lanes Closed | 92 | 80 | 303 |
| 40 km/h 'DO NOT OVERTAKE' | 100 | 80 | 203 |

## The passenger coach

### *Passenger coach type and configuration*

The passenger coach (Figure 9) was built in January 2015 by Express Coach Builders, a NSW passenger coach manufacturer established in 1995. It was built for K&R Little Pty Ltd, a Ballarat based school tour and charter bus company. It had a Scania K320 IB 4 x 2 axle chassis with a 6,270 mm wheelbase. The passenger coach was powered by a 9 litre inline 5 cylinder diesel engine coupled to a 6 speed automatic transmission mounted in the chassis rearward of the drive axle.

The body was a 12.7 m design built specifically for school tour and charter work. It had a 57 passenger seating capacity over 14 seating rows, each seat being fitted with a lap-sash retractable seatbelt.[8]

The passenger coach had 2 emergency exit windows, an emergency exit door, 2 emergency exit roof hatches and a front service door that doubled as an emergency exit.

**Figure 9: Scania K320 passenger coach similar to the incident vehicle**


Source: Little's Coaches

## *Passenger coach damage*

The main impact from the truck was to the rear superstructure of the passenger coach in a longitudinal direction slightly offset to the right (driver side) of the vehicle. This led to the passenger coach heavily impacting the W-beam guard fence system at an acute angle causing the fence support posts to dislodge and the passenger coach to mount the barrier. After leaving the freeway, the passenger coach careered down an embankment and rolled onto its left side.

The rear impact caused the engine and transmission to separate from the chassis and the rear crash beam to deform (Figure 10). Bodywork at the rear of the passenger coach was severely damaged leading to the 3 right rear glass panels fracturing. On the left side of the passenger coach, all the glass panels had fractured due to the roll over.

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8 A lap-sash seatbelt is a seatbelt assembly combining a lap strap designed to provide pelvic restraint, and a torso strap designed to provide upper torso restraint.

**Figure 10: Passenger coach rear impact damage**


Source: Victoria Police, annotated by the Office of the Chief Investigator

Although severely damaged from the initial impact and subsequent roll-over on the left side, the passenger coach superstructure, seating and seatbelt anchorages withstood the impact forces (Figure 11). Along with the majority of passengers wearing seatbelts, this is likely to have contributed to limiting the number of serious injuries.

**Figure 11: Passenger coach interior damage (view toward the rear of the vehicle)**


Source: Victoria Police, annotated by the Office of the Chief Investigator

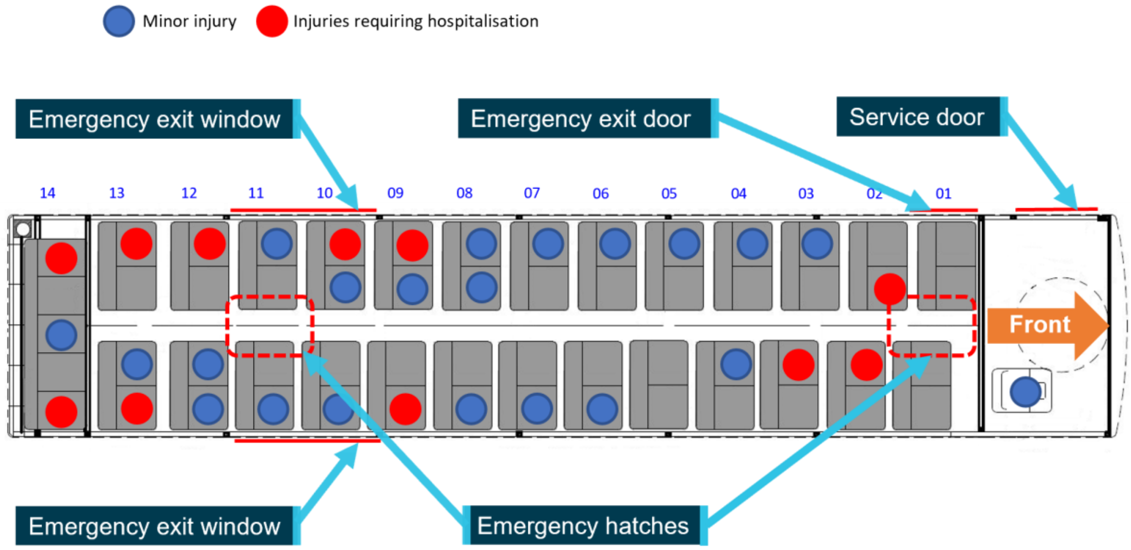
## *Passenger coach occupant injuries*

The passengers on the passenger coach were:

- Four teachers and staff employees from Loreto College, Ballarat
- Twenty seven students from a Loreto College, Ballarat ranging in age from 14 to 18 years.

Eleven of the passengers suffered injuries that required hospital treatment. The remaining passengers either attended hospital for assessment and were not admitted or were assessed by paramedics at the incident site. Of the 11 passengers that suffered injuries requiring hospitalisation, 6 were seated on the left side of the passenger coach and 5 on the right side. Four passengers were fully ejected from the passenger coach prior to it coming to rest, 3 of them suffered injuries requiring hospitalisation. The passengers and driver that remained within the passenger coach after it came to rest exited via the emergency hatches in the roof or the front windscreen, which had partially separated from its frame during the rollover. The driver and passenger seating positions are shown in Figure 12.

**Figure 12: Seating position of driver and passengers**




Source: Express Coach Builders, annotated by the Office of the Chief Investigator

## *Seatbelt usage*

Of the 57 passenger seating positions in the coach, 31 were occupied at the time of the incident. Post incident inspection of the passenger coach indicated that all seatbelts could be clipped into their buckles and retractors were functional. Although witness accounts recalled most passengers wearing seatbelts, there were a small number that were not wearing a seatbelt at the time of the incident.

## *School procedures*

The school risk assessment for the trip identified several transport risks including the risk of a passenger coach crash. The documented risk mitigation measures relating to the passenger coach and operator were:

- use reputable providers
- staff to check the tread on tyres and ensure the coach was fitted with seatbelts
- staff to check the general condition of the vehicle prior to boarding and if deemed not suitable, refuse to travel
- staff to speak to the driver prior to boarding to ensure they were not under the influence of alcohol
- staff to monitor driving to ensure compliance with the speed limit.

Although wearing of seatbelts was not specifically recorded as a risk mitigation measure, it was included in the pre-departure passenger coach briefing notes of the risk assessment document.

Responsibility for the pre-departure risk management was assigned to the college assistant principal. A written account from the assistant principal of the pre-departure risk mitigation checks performed on the morning of the incident included:

- checked for general condition of bus lighting and tyres
- discussion with the driver to identify any issues with fatigue
- discussions with the driver to detect any indication of alcohol consumption
- checked the wearing of seatbelts once all students were onboard and seated.

In addition to the checks for wearing of seatbelts, the assistant principal stated that seatbelt wearing reminders were also repeated to the students by the passenger coach's driver and the college tour leader preceding the coach departure.

## The passenger coach driver

The 56-year-old driver of the passenger coach had the required certification to drive the coach. They held a valid and current Victorian heavy vehicle driver licence and had been employed by K&R Little Pty Ltd as a coach driver for the past 24 years.

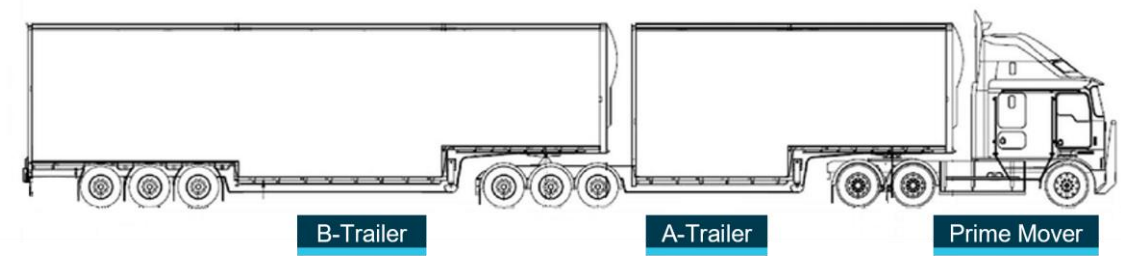
The driver typically drove the morning and afternoon school runs. In addition to the regular school runs, the company operated a small number of passenger coaches that were used for charter work. The driver was scheduled to drive the charter service between Ballarat and Melbourne Airport on the morning of the incident.

## The prime mover and trailers

### *Configuration of the prime mover and semitrailers*

The prime mover with 2 semitrailers consisted of a 2005 model year Freightliner Argosy dual drive cabover prime mover and 2 Vawdrey 2009 model year tri-axle drop-deck curtain side trailers in a 9 axle B-double configuration (Figure 13). The B-double was loaded with 24 bags of bulk sand totalling 36 t and had an estimated combined mass of 65 t which was within the maximum limits specified by the trailer manufacturer and allowable limits for this combination specified by the National Heavy Vehicle Regulator (NHVR) [9, 10, 11].

**Figure 13: 9-axle combination in B-double configuration**




Source: Office of the Chief Investigator

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9 Heavy vehicle: defined in the Heavy Vehicle National Law as a vehicle that has a gross vehicle mass (GVM) or aggregate trailer mass (ATM) of more than 4.5 tonnes.

10 NHVR is Australia's regulator for heavy vehicles in all States and Territories other than WA and NT. It administers the heavy vehicle national law and associated regulations.

11 National heavy vehicle mass and dimension limits, NHVR July 2016

### *The prime mover*

The Freightliner Argosy prime mover was owned and operated by L&A Freight Express. The company was a small privately owned Melbourne based operation established in 2018, specialising in contract hauling for the road freight transport industry. They had 3 prime movers servicing contracts across a number of freight logistics companies.

Post-incident inspection of the Freightliner prime mover found that the rear axle brakes had sufficient brake lining material and appeared to be adjusted correctly. However, the linings were observed to have areas of decomposition of the binding resin within the lining material, indicating that the brake drums and linings had overheated.

Due to extensive damage to the front axle, brake system and powertrain unit, it was not possible to assess the front steer axle brake adjustment.

The prime mover was fitted with an engine brake[12] system that was activated by an on/off switch and an engine brake intensity switch located on the cabin dashboard. The activation switch was observed to be in the off position during the post incident inspection. The crash damage prevented the operation of the engine brake to be verified. However, the driver stated at interview that the engine brake was inoperative at the time of the incident due to a mechanical fault identified earlier that week.

A visual inspection of the steering, suspension and tyre systems did not identify any pre-incident defects.

### *The semitrailers*

The Vawdrey curtain side trailers were owned and operated by Kangaroo Transport Industries[13] (KTI). Located in Adelaide, KTI was a privately owned transport and logistics business founded in 1987. The company operated their own fleet and engaged a number of sub-contractors to haul their semitrailers.

The front trailer sustained only minor damage when the cabin of the prime mover struck its air deflector. The rear trailer did not sustain any damage. This enabled a detailed inspection of the major mechanical systems and testing of the brake system in their pre-incident condition. Other than defects to the brake system, the trailers were assessed to have no other faults or failures.

The brake system on all 6 axles of the trailer combination consisted of air activated drum brakes with manual slack adjusters (Figure 14). A post-incident inspection found that although each of the drum brake assemblies had sufficient brake lining material, all were out of adjustment leading to ineffective braking performance. The air brake actuator on the driver side third axle was noted to have broken away from the axle mount bracket. The condition of the bracket fracture surface and the actuator piston indicated that the actuator had probably broken away from the axle some time prior to the incident.

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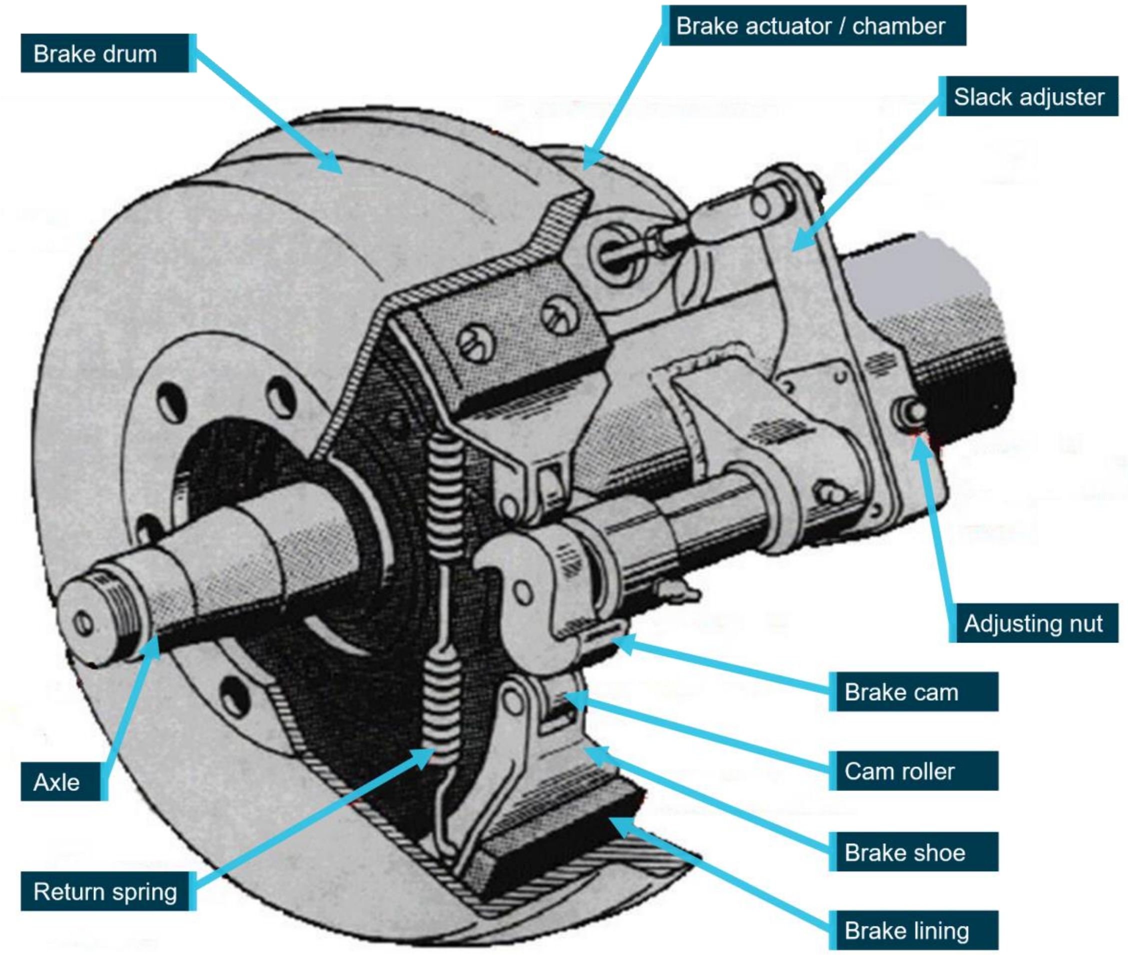
12 An engine brake is a device fitted to the engine of a heavy vehicle to slow the vehicle down by releasing compressed gas from the engine cylinders. It is often referred to as an 'auxiliary braking device' or a 'secondary retarder' and is typically controlled by a switch or switches on the vehicle dashboard.

13 Aussietrans Pty Ltd trading as Kangaroo Transport Industries (KTI)

**Figure 14: Heavy vehicle drum brake general arrangement**




Source: Government of the Province of British Columbia, annotated by the Office of the Chief Investigator

After the initial brake system inspection, the trailers were coupled to a prime mover[14] and tested on a portable roller brake tester (RBT) operated by technicians from the NHVR. Dynamic testing on the RBT was intended to verify the functionality of the trailer braking system and measure braking performance.

The RBT testing concluded that the trailers failed to meet both the overall minimum deceleration requirement[15] and the brake force balance requirement[16] specified by the Heavy Vehicle (Vehicle Standards) National Regulation[17] and the National Heavy Vehicle Inspection Manual (NHVIM).[18] It was also found that the park brake[19] when applied and tested was ineffective across the 3 axles on both trailers.

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14 Due to the incident prime mover being inoperable, 2 different surrogate prime movers were used to provide an air supply and a brake signal to the trailers for testing purposes.

15 Minimum average deceleration rate ≥ 2.8 $m/s^2$ and a minimum peak deceleration rate ≥ 4.4 $m/s^2$.

16 Imbalance if there is more than 30% difference in the brake performance between the wheels on the same axle.

17 Heavy Vehicle (Vehicle Standards) National Regulation as applied through the National Heavy Vehicle Inspection Manual (NHVIM).

18 National Heavy Vehicle Inspection Manual - Version 3.0 October 2021. © National Heavy Vehicle Regulator (2021).

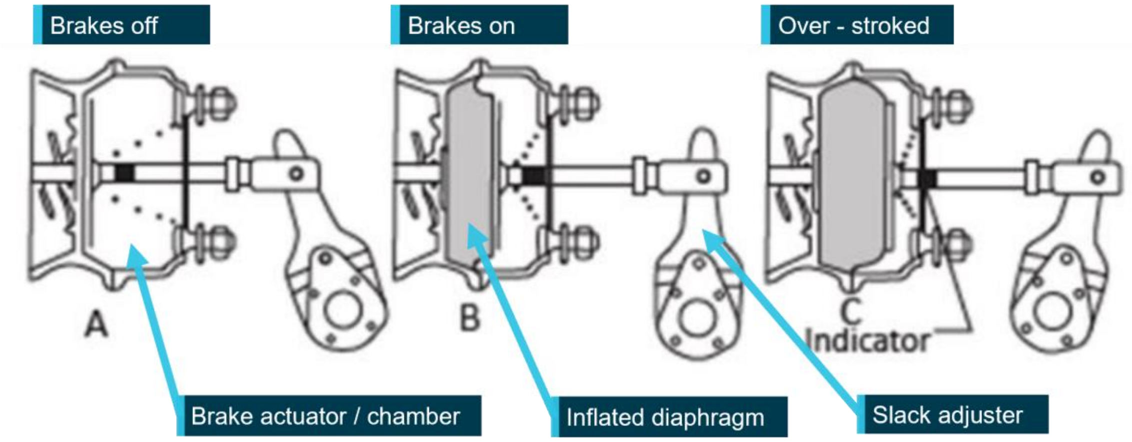
19 Park brake on a heavy vehicle combination utilises spring mechanisms to hold the axle brakes on the prime mover and all connected trailers without the need for air pressure. They are often referred to as the 'maxi brakes'.

A further inspection was conducted on behalf of the Office of the Chief Investigator to assess the trailers against the technical requirements of the Australian Design Rules (ADRs) and the NHVIM.

The inspection identified that the brakes on both trailers were not adjusted in accordance with the NHVIM and the manufacturer's maintenance and service bulletins.[20] On applying a brake test pressure of 650 kPa, all but one of the 12 actuators were measured to exceed the maximum stroke specified by the manufacturer. For the one actuator that did not reach maximum stroke, the stroke measured 96% of nominal full stroke. However, for this actuator the slack adjuster was still loose at the 96% stroke position, indicating the actuator had fully stroked without applying significant force to the brake assembly.

Lack of adjustment causes a brake actuator to over-stroke (Figure 15) resulting in a significant reduction in brake performance to a level below the minimum design requirements outlined in the ADR.[21] This can also lead to the park brake not operating as designed.

**Figure 15: Brake actuator over-stroke**



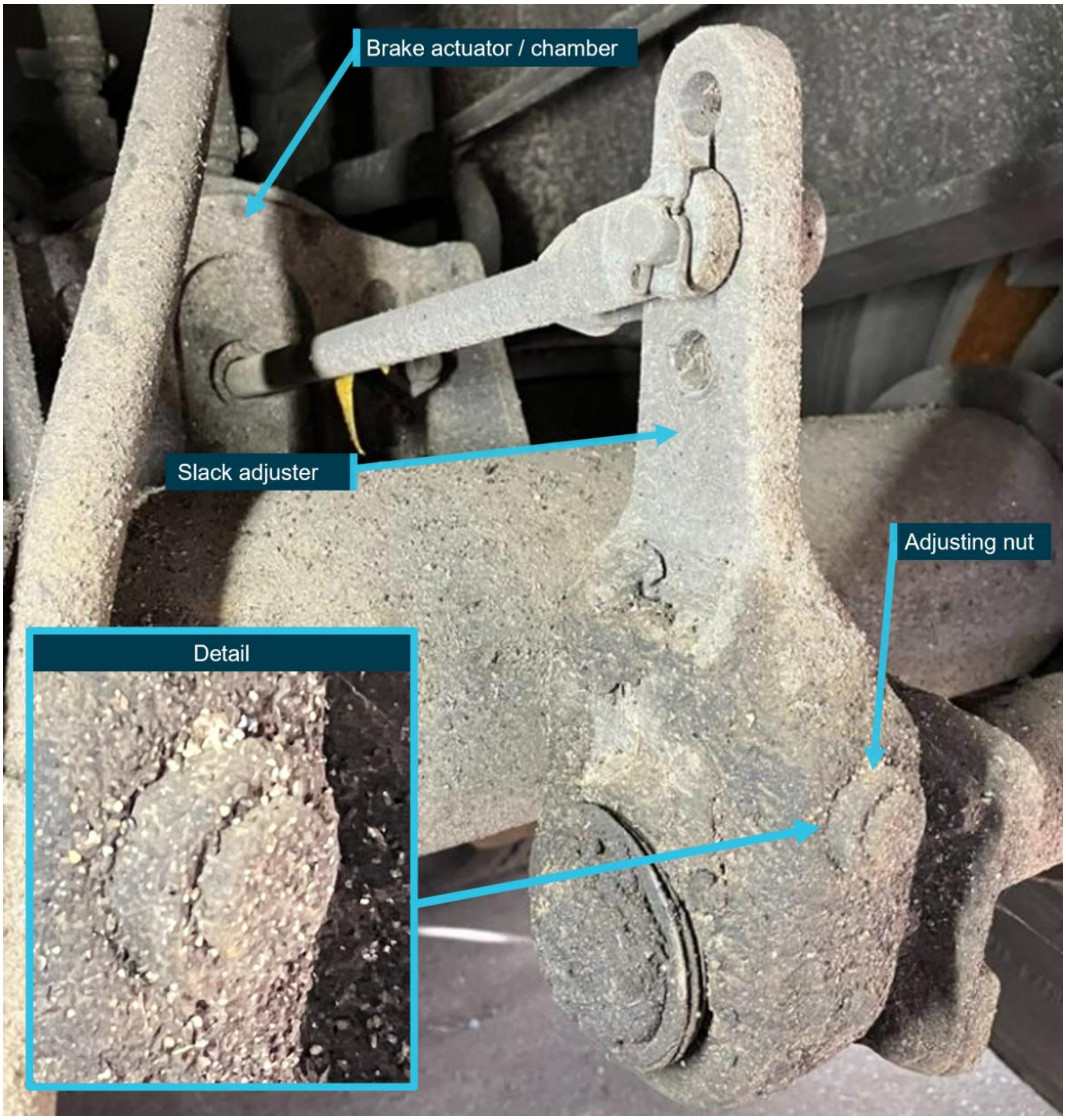

Source: NHVR, annotated by the Office of the Chief Investigator

[20] Fuwa K-Hitch Installation, Maintenance & Service Bulletin No. KPM-008-0410 Rev10 - AXLE BRAKE INFORMATION.

[21] ADR 38/02 Trailer Brake Systems – performance requirements clauses 10, 11, 15.

The inspected condition of the slack adjuster nuts on each axle indicated that they had not been recently adjusted. This suggested that the brakes had been out of adjustment prior to the incident (Figure 16).

**Figure 16: Brake slack adjuster adjusting nut as inspected**




Source: Office of the Chief Investigator

Each axle of the lead trailer was fitted with unmatched actuator brands with design output forces varying by up to 11% from left side to right side. This would have resulted in an unequal braking force and a non-compliance with ADR requirements.[22]

The brake linings fitted to all axles were not in accordance with the manufacturer's approved specification.[23] The capacity of these linings in meeting the ADR performance requirements was unknown.

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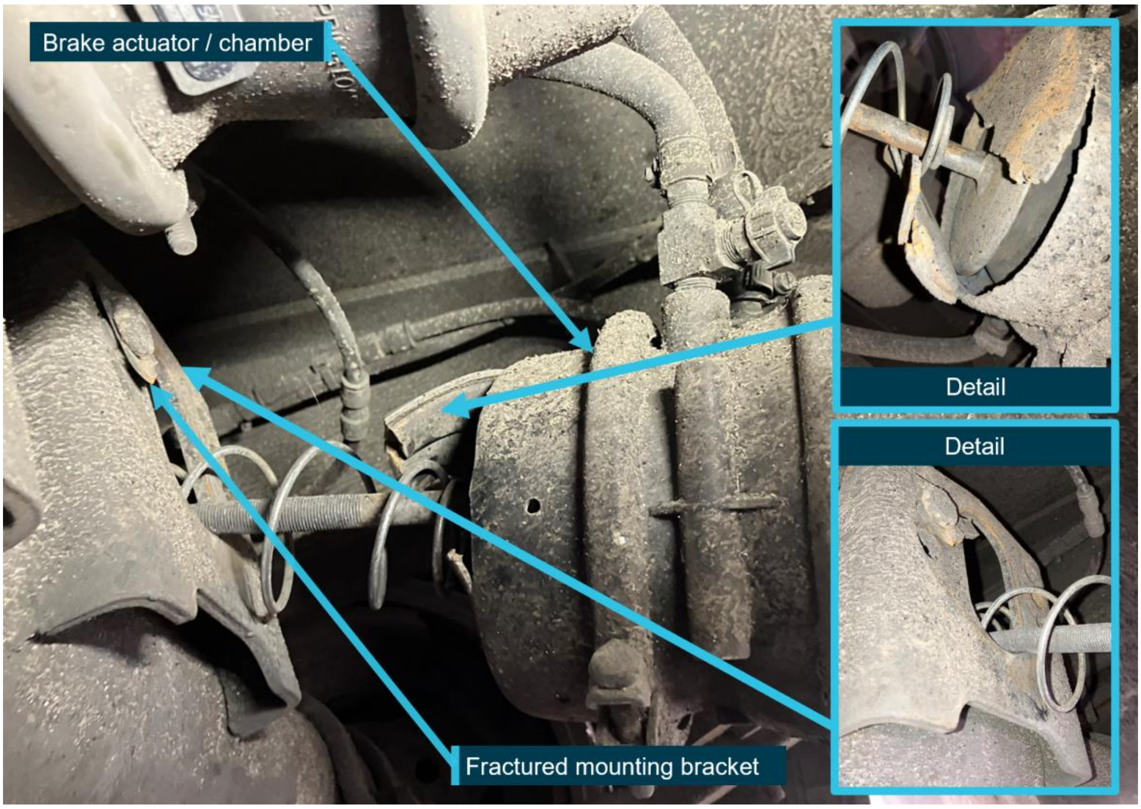
22 ADR 38/02 Trailer Brake Systems – design requirements clause 6.13.

23 Fuwa K-Hitch F2000 420x180 with Sub-Assembly Registration Number 35665. Approved brake lining for FB SARN 35665 is Proline PL133420180. Linings inspected were FRAS LE brand on the front trailer and MERITOR brand on the rear trailer.

The lead trailer brake actuator fitted to the right-hand side of the third axle had broken away from the mounting bracket, reducing the trailer braking performance. Inspection of the bracket fracture surface and the presence or road grime on the piston normally sealed inside the actuator housing indicated that the actuator had probably broken away from the axle prior to the incident (Figure 17).

**Figure 17: Brake actuator bracket failure**




Source: Office of the Chief Investigator

### *Roadworthy and maintenance records.*

The 2 semitrailers had been purchased by KTI in February 2022 from a company specialising in the sale of used heavy trailers. At the time of purchase, the 12-year-old semitrailers were supplied with current Victorian Roadworthy Certificates.

The roadworthy inspection records from the certificates issued in February 2022 included photographs of the brake linings fitted to both trailers at the time of inspection. Photographs of the brake linings fitted to the A-trailer[24] identified them to be the same lining type approved by the axle manufacturer during ADR brake compliance testing.[25] Post incident inspection of this trailer, however, identified different brake lining parts fitted which were not in accordance with the lining type approved during ADR brake compliance testing. The brake lining parts fitted to the B-trailer were also not in accordance with the linings approved by compliance testing.

KTI advised that the brake linings on the two semitrailers had not been changed since purchase and the service records provided by KTI did not note any change to the brake linings. It was not resolved when or where the linings were changed.

Manifest records provided by KTI showed that both semitrailers had travelled about 89,000 km since their purchase. Over that period, they had undergone service checks at about 42,000 km in

[24] The first trailer in the combination.

[25] Report 'ADR 38/02 Foundation Brake test report for Fuwa K-Hitch 20 Inch S-cam'. Report Reference T05-049 dated 20/01/2006.

June 2022 and at about 67,000 km in August 2022. Between the last service in August and the incident, the semitrailers had travelled about 21,000 km.

At each of these service intervals, the service records documented that 21 items were checked. For brakes, the service sheet specified to adjust the brakes and check the linings. For both semitrailers, the records of the August 2022 service indicated this check and adjustment was performed. Checks on the A-Trailer noted that the brake linings had 80% material remaining whereas the linings for the B-Trailer were noted to have 40% material remaining and that they may need to be re-lined at the next service.

## Regulation of heavy vehicles

### *National law*

The Australia Heavy Vehicle National law (HVNL) applied in all Australia's states and territories except the Northern Territory and Western Australia. The HVNL and its regulations commenced in February 2014 and regulated the use of heavy vehicles with a Gross Vehicle Mass (GVM) greater than 4.5 tonnes.

In October 2018, the HVNL was amended to include Chain of Responsibility (CoR) legislation designed to impart legal obligations on all parties in the heavy vehicle transport supply chain to ensure the safety of their operations. Responsible parties to the CoR legislation include those that have control or influence over safe operation of any transport task.

### *Safety management oversight*

As an effective tool to systematically manage safety aspects of an organisational structure, the NHVR encourages organisations operating in the road freight industry to implement Safety Management Systems, accountabilities, risk management policies and procedures. One of the key focus areas of the NHVR is accrediting systems for managing the risks associated with poorly maintained or unroadworthy heavy vehicles.

Under this scheme, vehicle maintenance management accreditation is designed to encourage heavy vehicle operators to take responsibility for correctly maintaining their vehicles and ensuring they are always in good mechanical condition. Accreditation is based on a series of 8 minimum standards, forming a Maintenance Management System (MMS):

- daily checks: documented instructions for performing and recording daily safety checks on vehicles in use
- fault recording and reporting: procedures for recording and reporting vehicle faults by drivers
- fault repair: procedures for identifying and assessing the risk, acting on reported faults, and determining the priority placed on repair of the fault
- maintenance schedules and methods: documented periodic maintenance schedules, with identified service periods, that describe the tasks to be completed
- records and documentation: procedures for retaining documented evidence of vehicle maintenance
- responsibilities: detailed authorities, responsibilities and duties of all positions involved in the MMS
- internal review: the MMS must undergo internal reviews on a quarterly and annual basis to verify compliance with internal policies, procedures and instructions
- training and education: people who hold a position of responsibility under the MMS are trained in, and familiar with, the specific policy, procedure and instructions they are to carry out.

Accredited operators are audited periodically by an independent auditor, approved by the NHVR, to ensure standards are met. An audit pass is required to maintain accreditation. Where deficiencies are found during an audit, the operator must demonstrate corrective actions to ensure continued accreditation.

### *Regulator audits of the trailer operator*

The KTI vehicle MMS was audited at their South Australia facility by an NHVR approved auditor on 5 April 2022, 5 and a half months prior to the incident. During the audit, maintenance records for 25 vehicles were selected for inspection. These records were for a mixture of both prime movers and semitrailers. The 2 semitrailers involved in the incident were not selected for audit.

The audit concluded that the operator met all the requirements of the National Heavy Vehicle Accreditation Scheme (NHVAS) Business Rules and Standards for maintenance management accreditation. No corrective action requests were issued as a result of the audit.

KTI was also accredited under the Western Australia Heavy Vehicle Accreditation (WAHVA) scheme, a requirement for operating heavy vehicles in that state. Like the NHVAS, operators under the WAHVA scheme undergo regular audits against the requirements for vehicle maintenance, driver fatigue and vehicle dimension and loading. For vehicle maintenance management, the requirements and associated audit practice are closely aligned to the NHVAS.

On 16 February 2022, the operator was audited by an accredited independent auditor for Mainroads Western Australia under the WAHVA scheme. The audit assessed compliance against the vehicle maintenance, driver fatigue, and vehicle dimension and load requirements. Maintenance records were reviewed for 5 vehicles of which 3 were multi-combination trailer units. The 2 semitrailers involved in the incident were not selected for audit.

The WAHVA scheme audit concluded that the operator met all requirements of accreditation for the modules assessed and the vehicle records selected for audit were deemed to meet the required standards.

## The truck driver

### *Licence and experience*

The truck driver was 59 years old and held a valid and current Victorian heavy vehicle driving licence permitting them to drive a multi combination vehicle. They stated that they had about 9 years experience driving heavy combination trucks, including 3-trailer road trains in Western Australia. Experience with the current company spanned the last 15 months. During that period, they had predominantly driven the same prime mover hauling trailers in a B-double combination on the same route.

### *Fitness for duty*

The truck driver was rostered on night shifts and had driven the Melbourne to Nhill return route for the last 15 months, typically on a Monday through Friday roster. Night shifts commenced at 1730 each evening, and usually ended at 0530 the following morning. In a typical shift, 2 breaks were taken at various points along the route depending on the schedule.

On the night of the incident, the driver stated that they arrived at the company yard at 1730 after a 30 minute drive from home. Two breaks were taken on that shift, the first break for 30 minutes at 2300 in Nhill after exchanging trailers and the second break for 20 minutes at 0130 in Ararat on the return leg. The previous night shift had been uneventful and the driver stated they had had their normal sleep period and were not feeling tired.

The stated working hours and scheduled breaks were in accordance with the work and rest requirements outlined in the HVNL for solo driver standard hours. Although the driver had maintained a logbook to record working hours and rest times, the document recovered from the incident vehicle was damaged beyond the point of legibility.

Tests conducted after the incident indicated that the driver did not have a level of alcohol or drugs in their system in contravention of the *Road Safety Act 1986*.

### *Truck driver pre-checks.*

The driver of the incident truck stated that, at the beginning of each shift they conducted a series of pre-checks on their vehicle prior to departing from the depot in Melbourne. The driver relied on their experience to perform these checks as there were no check sheets used to either prompt the driver or to record the checks being carried out.

The driver stated that the checks on the prime mover included oil and coolant levels, tyre condition, air brake system faults and inspection for mechanical breakages such as on suspension parts. When they coupled the prime mover to the semitrailers, they verified that the turntables were securely locked in, checked the trailer lighting, tyres, rear signs, and inspected for mechanical breakages. It was reported that these semitrailer checks were also performed by the driver at the changeover point in Nhill. This was conducted after the trailers were exchanged with the driver from Adelaide and coupled to the prime mover prior to the journey back to Melbourne.

### *Braking prior to collision*

The driver stated that they had experienced a loss of braking prior to the incident while descending towards Pykes Creek Reservoir.[26] They reported that the braking system lost air pressure during repeated brake applications and attributed this to the trailer brakes.[27] The driver stated that the brake air pressure in the reservoir tanks was replenished while ascending away from Pykes Creek Reservoir.

## Recorded information

### *Dashcam footage*

A B-double truck immediately following the passenger coach at the time of collision was equipped with a forward-facing camera that recorded both high definition video and audio. Footage from the camera started at about 2 km west of the collision point and recorded the rear of the passenger coach up to the point where the B-double truck was overtaken by the incident truck (Figure 18) which went on to impact the rear of the passenger coach. The B-double truck fitted with the dashcam was able to adequately slow to the reduced speed limit and maintain a safe distance behind the passenger coach.

Analysis of the video footage indicated the passenger coach speed just prior to the collision was at or below the 40 km/h temporary speed limit and the B-double incident truck was probably travelling at a speed of at least 100 km/h.

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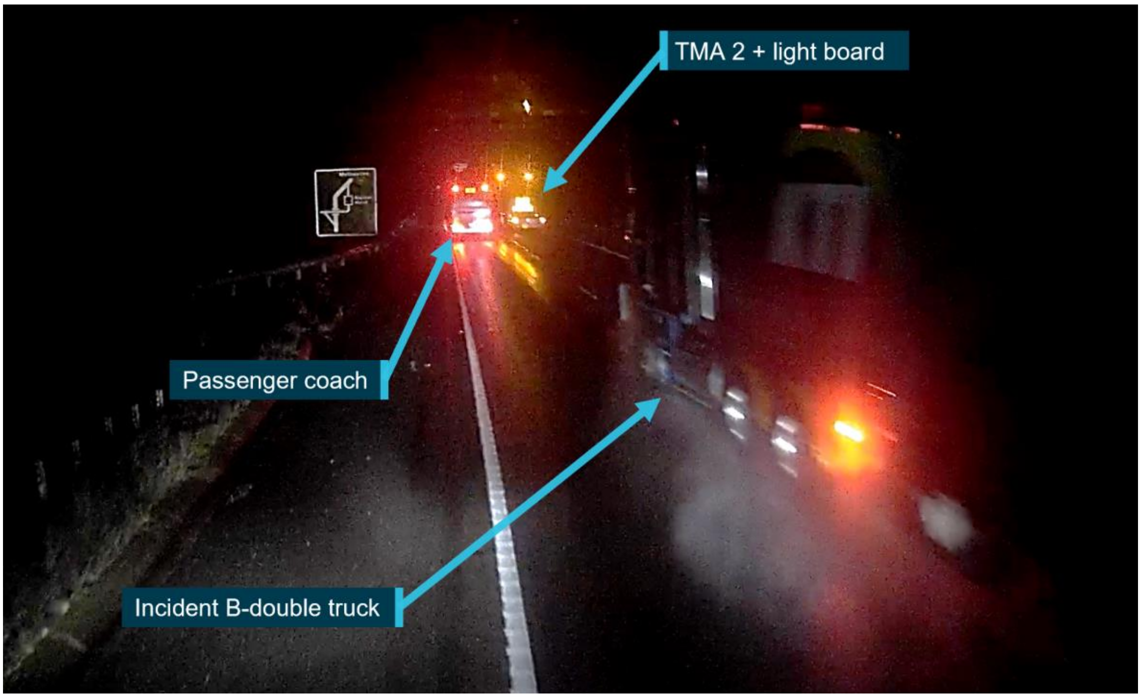
[26] Pykes Creek Reservoir is located about 13 km northwest of the incident site.

[27] The braking system on the prime mover and semitrailers was activated by air pressure from an air compressor powered by the prime mover engine. The air pressure was contained in air reservoir tanks located in both the prime mover and semitrailers. The prime mover was fitted with dash mounted pressure gauges.

**Figure 18: Dashcam footage of Incident truck**




*This image shows the incident truck overtaking the truck that was following the passenger coach.*
Source: Dashcam footage annotated by the Office of the Chief Investigator

## *Roadcrew vehicle cameras*

The roadcrew TMA trucks were also fitted with video cameras that recorded footage from both a forward and rearward facing direction. Footage sourced from these cameras leading up to the incident showed several other B-double trucks passing the TMAs at the reduced speed required due to the lane closure.

# Safety analysis

## Introduction

At about 0315 on 21 September 2022, a passenger coach carrying students and staff from Loreto College, Ballarat was struck from behind by a prime mover towing 2 semitrailers loaded with sand. The passenger coach was travelling at or below the 40 km/h temporary speed limit while the truck was probably travelling at a speed of at least 100 km/h when it collided with the coach. As a result of the impact the passenger coach veered to the left, mounted the roadside barrier and careered down an embankment to the left of the freeway, rolling onto its left-hand side.

Statements by the truck driver indicated that the truck and trailer combination brakes were not operating as expected and they could not adequately reduce the speed of the vehicle as it descended. With the road speed limit temporarily reduced to 40 km/h and the traffic diverted into one lane, the truck driver was not able to slow the vehicle to avoid colliding with the passenger coach.

There was no evidence to suggest that fatigue or a medical condition of the truck driver contributed to the incident. Nor was there any evidence that the traffic management arrangements implemented at the time of the incident, or the actions of the coach driver had contributed.

This analysis examines:

- decision making of the truck driver
- braking system of the truck-trailer combination
- National Heavy Vehicle Regulator oversight
- occupant protection in buses
- seatbelt usage in buses
- bus passenger ejections.

## Decision making of the truck driver

About 13 km before the collision, while descending toward Pykes Creek Reservoir, the truck driver applied the brakes but found that they were non-responsive. They believed that this was primarily due to air exhausting from the trailer brakes. Although the air brake reservoirs were replenished as they ascended away from Pykes Creek, the subsequent approach to Pentland Hills also comprised a long descent.

Despite experiencing the loss of braking and knowing the terrain ahead from regularly driving this route, the truck driver continued the journey toward Pentland Hills. This was possibly influenced by an incomplete awareness of the condition of the trailer brakes, an expectation that braking would improve with the replenishment of the braking system air reservoirs, a belief that the road ahead would be clear and the driver's desire to complete the journey to Melbourne.

The truck driver stated that they were 'just trying to do the right thing' to get the consignment delivered, and not let the customer or the company down. They also stated that from their experience it was common for other drivers to knowingly take similar risks just to 'get the job done' under commercial pressures.

When considering whether to continue driving a heavy vehicle that may be unsafe, drivers may perceive that there are pressures to complete a delivery rather than taking their vehicle off the road for repairs. Small business operations in other industries exhibit similar risky behaviours where 'balancing the competing demands of safety and productivity may be extremely difficult for many small operators, which places a heavy reliance on the decision making of individuals'

(Bearman, et al., 2009).[28] In this instance, there was a missed opportunity for the driver to take corrective action in response to the braking difficulties 13 km prior to the collision.

## Braking system of the truck-trailer combination

### *Heavy vehicle braking systems*

The braking systems of heavy vehicles operating on the roads in Australia cover a wide range of designs. This is reflective of a market with both local manufacture and product importation from major foreign manufacturers in North America, Europe and Japan. Australia also has some unique operating conditions utilising heavy vehicle combinations not permitted in other countries.

Regardless of the design origin, the fundamental elements of the heavy vehicle braking system are the service brake, the secondary brake and the parking brake.[29] The service brake is the primary braking system that applies a braking force to the vehicle's wheels in normal operation when the brake pedal is depressed. The service brake is often supplemented by an auxiliary system such as engine brakes.

### *Prime mover engine brakes*

While the service brake provides the primary braking power on a heavy vehicle, most heavy vehicles are also fitted with auxiliary brakes or speed retarders which can slow but not completely stop the vehicle. They operate either on the engine or the drivetrain and are independent of the service brakes.

As these devices provide a supplementary level of braking and may be switched on or off, they are not required, nor tested, with service brakes under the commercial vehicle and trailer braking standards specified in the Australian Design Rules (ADRs). This is to ensure that a heavy vehicle braking system, when operating as designed, is adequate to decelerate a vehicle combination without the aid of engine brake retardation.

Engine brakes fitted to a prime mover towing laden trailers are typically used during descents to reduce the load on the service brakes of the prime mover and trailers. When engine braking is not engaged, heavy application of the service brakes for a prolonged period while descending can overheat the brake linings, causing brake fade[30] which can result in a partial or complete loss of braking power. Brake fade can be intensified on the prime mover when the service brakes on laden towed trailers are not providing adequate braking.

Although not able to be confirmed through post-collision testing, the engine brakes on the prime mover were probably inoperative for this journey. The absence of engine brakes and ineffective trailer brakes would likely have led to the prime mover service brakes providing the majority of the braking force on the descent at Pykes Creek and Pentland Hills, leading to overheating of the brakes. The post incident inspection of the prime mover rear brake linings identified decomposition of the binding resin. This decomposition is consistent with brake drums and linings overheating.

Had the trailer brakes been operating as designed, the B-double combination should have been capable of effectively arresting its road speed. However, the absence of prime mover engine brakes to supplement the service brakes during heavy braking also reduced braking capability and increased the risk of prime mover service brakes overheating.

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28 Bearman, C., Paletz, S., Orasanu, J. & Brooks, B., 2009. Organizational Pressures and Mitigating Strategies in Small Commercial Aviation: Findings from Alaska. Aviation Space and Environmental Medicine, pp. 1055-1058.

29 The secondary brake system provides supplementary vehicle braking in the event of a failure in the service brake system. The park brake is designed only to retain the vehicle in a stationary position and is typically combined with the secondary brake system. In most heavy vehicles, like the incident vehicle, these systems are all operated by air.

30 Brake fade in heavy vehicle drum brakes is the condition where the thermal capacity of the braking system has been exceeded and the system operates at reduced effectiveness.

### Prime mover and trailer service brakes

Service brake systems utilising either disc or drum brake designs are common on heavy vehicles operating in the Australian market. Both systems have their strengths and weaknesses, but early design drum brakes with manual adjustment are generally more maintenance intensive than later designs.

For drum brakes with manual slack adjusters typically fitted in older heavy vehicles, the adjustment and maintenance of the actuator operating angles are critical to ensure optimal braking force and balance across braking axles. As the brake linings wear, regular adjustment of the slack adjusters are required to account for the wear.

Although correct brake adjustment applies to both the prime mover and the towed semitrailers, optimal brake efficiency and balance of heavily laden semitrailers in a road combination is critical for safe braking. The manual slack adjusters of the brakes in both of the semitrailers towed by the prime mover were found to be out of adjustment. This significantly reduced the B-double combination braking effectiveness and balance.

### Maintenance of semitrailer brakes

KTI was accredited under the National Heavy Vehicle Accreditation Scheme (NHVAS) and the Western Australia Heavy Vehicle Accreditation (WAHVA) scheme. Both schemes are administered by government and have similar requirements for managing vehicle mass, vehicle maintenance and driver fatigue.

Audits under both NHVAS and the WAHVA scheme concluded that KTI met the requirements for vehicle maintenance management. In addition to the regular maintenance schedules, the operator was noted to have systems in place for daily checks, fault recording and reporting, and fault repair.

However, evidence of the brake system being significantly out of adjustment on both trailers involved in the collision indicated that although the company had systems and procedures in place, these were not effective to ensure that the trailer brakes on the incident vehicle were maintained, serviced and repaired within the manufacturer specified adjustment.

### Heavy vehicle braking standards – newer technology implementation

Under the ADRs, the incident prime mover and trailers were categorised as NC – Heavy Goods Vehicle and TD - Heavy Trailer respectively.

The 3 applicable standards with respect to heavy vehicle braking of the incident vehicle were:

- ADR 35 - Commercial Vehicle Brake Systems
- ADR 38 - Trailer Brake Systems
- ADR 64 - Heavy Goods Vehicles Designed for Use in Road Trains & B-doubles.

Each of these vehicle standards specified the performance requirements to ensure safe braking under normal and emergency conditions.

In 2007 the Australian Government[31] released the National Heavy Vehicle Braking Strategy (NHVBS). The strategy was intended to review heavy commercial vehicle braking ADRs, with the aim of improving safety performance. In 2011, the NHVBS was divided into 2 phases: phase I to implement antilock braking systems (ABS),[32] and Phase II to implement more advanced braking systems incorporating stability control.

The regulatory impact statement (RIS) for Phase I of the strategy was released in July 2013 by the Commonwealth Department of Infrastructure and Transport. This led to changes to ADR 35/04

[31] National Transport Commission (NTC) and the Department of Infrastructure and Transport

[32] Antilock braking systems (ABS) automatically prevent wheel skidding due to lock-up during heavy braking. Heavy trailers fitted with ABS were also required to have automatic brake adjustment devices fitted.

mandating the fitment of ABS to heavy trucks and buses, and changes to ADR 38/04 mandating the fitment of either ABS or Variable Proportioning (VP)[33] braking systems to heavy trailers.

The Phase II RIS was released in April 2018. This led to changes to ADR 35/06 mandating fitment of Electronic Stability Control (ESC)[34] to new trucks and buses and changes later to ADR 38/05 mandating the fitment of Antilock Brake Systems (ABS) and Roll Stability Control (RSC)[35] to new heavy trailers.

For heavy trailers, the design standard was also amended to mandate devices that automatically adjust the trailer brakes to compensate for changes arising from wear of the brake linings. This change was made to align with international standards[36] and recognising that poorly adjusted brakes continue to be one of the most common safety defects found by heavy vehicle inspectors.[37] Poorly adjusted brakes can increase the vehicle stopping distance, as well as reduce the effectiveness of stability control systems (where fitted) which use braking to maintain vehicle control.

Although the brake automatic adjustment mechanisms are not intended to reduce the need for maintenance, they minimise the risk of poor brake adjustment typically caused by inadequate maintenance practices. A study conducted by Transport Canada on the effect of automatic slack adjusters on brake adjustment in heavy vehicles was published in 2002, 8 years after mandating these mechanisms in their market.[38] The study reported that brake safety check defect rates for vehicles with manual slack adjusters were 150% higher compared to vehicles with automatic slack adjusters. The defects reported were for inadequate brake adjustment. The report concluded that automatic slack adjusters can maintain brake adjustment more reliably than manual slack adjusters.

As the trailers in this incident were built prior to July 2019, they were not required to be fitted with brake automatic adjustment mechanisms. Had these trailers been later models designed to meet the current requirements for braking specified in the ADRs, the risk of an incident caused by inadequate braking performance due to maladjustment would have been reduced.

## National Heavy Vehicle Regulator oversight

The National Heavy Vehicle Regulator (NHVR) have a published Compliance and Enforcement Policy that outlines the guiding principles employed to ‘guide the NHVR’s compliance monitoring and enforcement activities when identifying, preventing, or managing contraventions of the *Heavy Vehicle National Law Act 2012* (the HVNL)’. With the chain of responsibility (CoR) integral to the HVNL, the requirements are a significant part of the compliance and enforcement process.

The NHVR actively utilised both punitive and non-punitive intervention options to manage and deter non-compliance with the HVNL. These included education and engagement through to prosecution of serious breaches.

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33 Variable Proportioning (VP) braking systems automatically adjust the braking force to the axles based on the load in the trailer. VP braking systems were not required to have automatic brake adjustment devices fitted.

34 Electronic Stability Control (ESC) fitted to trucks is an extension of the ABS braking system designed to detect the risk of a rollover and automatically decelerate the vehicle using reduced engine power and braking of individual wheels in response.

35 Roll Stability Control (RSC) fitted to trailers is an extension of the ABS braking system designed to detect the risk of a rollover and automatically decelerate the vehicle using braking of individual wheels in response. RSC was mandated on trailers greater than 10 tonnes Gross Trailer Mass.

36 United Nations Regulation No. 13 - Uniform provisions concerning the approval of vehicles of categories M, N and O with regard to braking. Clause 5.2.1.11.1.

37 Submission by the Department of Planning, Transport and Infrastructure, South Australia to RIS National Heavy Vehicle Braking Strategy Phase II – Improving the Stability and Control of Heavy Vehicles.

38 Assessment of the Effect of Automatic Slack Adjusters on Brake Adjustment, National Research Council of Canada, July 4, 2002.

Guidance on the maintenance of heavy vehicle braking systems has frequently been included in educational material provided by the NHVR both in an online format and in newsletters. Punitive measures applied during road-side blitzes have targeted unroadworthy vehicles with a particular focus on brake system adjustment.

Although KTI was found at audit to meet the maintenance management requirements under the NHVAS, the NHVR later deemed that both of their semitrailers involved in this incident 'failed to meet the minimum testing standard for brake performance, brake balance across an axle and both trailers had an ineffective parking brake when tested on the roller brake tester'.

The NHVR periodically monitors the general state of heavy vehicles operated throughout Australia. In their latest National Roadworthiness Survey,[39] it reported that although roadworthiness defects detected during the 2021 survey had decreased compared to the 2016 baseline survey,[40] the most common non-conformity was vehicle brakes. This finding was consistent with prior surveys and highlighted a strong correlation between vehicle age and the incidence of non-conformity. Braking non-conformity was shown to significantly increase in vehicles older than 12 years. The towed semitrailers in this incident were greater than 12 years old. Although the NHVR had identified the safety risk of older vehicles, further opportunities should be considered with specific focus on the veracity of audits and other monitoring options.

## Occupant protection in buses

At the time of its manufacture, the passenger coach was required to comply with applicable national vehicle standards under the *Motor Vehicle Standards Act 1989* (the Act). Under the Act, the national standards, known as the ADRs, set out minimum design standards for vehicle safety, anti-theft and emissions.

The passenger coach was constructed to comply with the applicable requirements of ADR 59 - Standards for Omnibus Rollover Strength and ADR 68 - Occupant Protection in Buses. These standards were introduced progressively through to mid-1995. They formed the foundation of a safety package that significantly improved passenger coach design following 2 significant Australian passenger coach crashes in 1989.[41]

ADR 59/00 specified the design requirements for passenger coach superstructures to ensure that they withstand forces encountered in rollover crashes. This included the preservation of a 'survival space' to protect occupants from possible collapse of the passenger coach structure around them in event of a roll-over.

ADR 68/00 specified the requirements for seatbelts in buses including seatbelt anchorage strength, seat and seat-anchorage strength, and the protection of occupants from impact with seat backs and seat accessories. This design rule mandated 3-point seatbelts in relevant heavy omnibus category vehicles.[42]

A study of the effectiveness of seatbelts in passenger coach rollover crashes in Sweden[43] found that there was a 'considerable increase in safety for belted occupants through limiting interior contacts, minimising passenger interaction and reducing the possibility of ejection'.

This incident illustrates the safety benefits these changes have made to bus safety standards due to the absence of life-threatening or fatal injuries to the passengers as a result of this collision.

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[39] NHVR National Roadworthiness Survey 2021. Published December 2021.

[40] NHVR National Roadworthiness Baseline Survey 2017 – A Health Check of Australia's Heavy Vehicle Condition. Published June 2017.

[41] Grafton bus crash on 20 October 1989. Kempsey bus crash on 22 December 1989.

[42] ADR 68 Occupant Protection in Buses does not apply to 'Route Service Omnibuses', or omnibuses with less than 17 'Seats' including the driver and crew, or vehicles in which all passenger 'Seats' have a 'Reference Height' of less than 1.0 metre.

[43] Albertsson, P. Falkmer, T. Kirk, A. Mayrhofer, E. Björnstig, U. 2006, Case study: 128 injured in rollover coach crashes in Sweden—Injury outcome, mechanisms and possible effects of seat belts.

However, 27% of passengers wearing seatbelts who remained within the coach during the collision sustained injuries requiring hospitalisation despite the passenger coach being built to meet these standards. These passenger injuries generally resulted from internal projection within the occupant space.

Since the introduction of the passenger coach occupant protection standards in the mid-1990s, significant advancements have been made in general automotive safety. Although new active safety standards for omnibuses such as advanced emergency braking[44] have been introduced, no changes have been made to the passive safety occupant protection standards since they were first introduced 30 years ago. Nor has there been any recent review of the effectiveness of these occupant protection standards other than studies on the benefits of seatbelts.

Serious injuries were sustained by a number of passengers wearing seatbelts. Further improvements to the occupant protection standards for passenger coaches may reduce injury severity in future rollover incidents.

## Seatbelt usage in buses

Road rules in Victoria[45] required passengers 16 years or older travelling in a motor vehicle to wear a seatbelt if the seating position is fitted with one. Under these rules, the driver of the passenger coach was not required to ensure that each passenger was wearing a seatbelt. Checks were conducted by school staff to ensure all passengers were wearing seatbelts before departure on the morning of the incident.

Prior to the incident, the passenger coach stopped in Ballan to pick up 2 additional students. It is not clear if a reminder to fasten seatbelts was repeated on departure from that stop and this increased the risk for seatbelts to be unfastened and then forgotten to be refastened.

Seatbelt warning lights became mandatory for the driver seating position in passenger cars from 1995. This requirement has progressively been extended with many vehicles now having seatbelt warning lights for all seating positions. However, seatbelt warning lights or reminders are not mandatory in passenger coaches. The coach in this incident was fitted with a seatbelt reminder lamp at the front of the vehicle. It is not clear if this was operational at the time of the incident and given the location at the front of the vehicle, its effectiveness was likely limited.

A recent study[46] conducted on the effectiveness of seatbelt reminder systems in passenger coaches concluded that seatbelt wearing compliance increased by more than 40% when visual seatbelt warning lights were fitted to each seating position. These warning lights illuminated when a passenger occupied a seat and failed to buckle the seatbelt.

Passenger seatbelt wearing compliance in the incident coach was high, probably due to the checks and a verbal reminder by the driver and school staff prior to commencing the journey. However, at the time of the collision there were a small number of passengers not wearing seatbelts. In at least one case, this was due to forgetting to re-buckle after moving seats as reported by a witness. Availability of a seatbelt reminder system effective for each seat would place less reliance on the need for frequent verbal seatbelt wearing reminders.

## Bus passenger ejections

While lap-sash seatbelts can reduce the likelihood of a passenger being ejected from a passenger coach in a rollover incident, they do not eliminate the risk. In this incident, 4 passengers were fully

44 ADR 97/00 - Advanced Emergency Braking for Omnibuses, and Medium and Heavy Goods Vehicles introduced from November 2023.

45 Road Safety Road Rules 2017, Part 16—Rules for persons travelling in or on vehicles.

46 Korea Automobile Testing & Research Institute (KATRI), 'The Effectiveness of Seatbelt Reminders (SBR) by Analysing The Result of the Pilot Project on an Interurban Bus With SBR'. Paper Number 23-0190 presented at the 27th International Technical Conference on the Enhanced Safety of Vehicles, Yokohama, Japan, April 2023.

ejected from the vehicle as a result of the collision and at least one of those passengers was probably wearing a lap-sash seatbelt.

A study conducted by the US National Transportation Safety Board (NTSB) on 36 passenger coach crashes found that, of the 168 occupant fatalities investigated, 106 occurred in rollover crashes. Of those fatalities, 64 were ejected from the passenger coach[47] showing that passengers ejected during a crash have an increased risk of suffering a fatal injury.

Further studies by the NTSB on passenger coach safety found that in crash simulations of lateral impacts and rollovers, the simulated occupant's upper torso was predicted to slide out of the sash of a lap-sash seatbelt. This led to a recommendation[48] that the National Highway Traffic Safety Administration (NHTSA)[49] expand its research 'on current advanced glazing to include its applicability to motorcoach occupant ejection prevention, and revise window glazing requirements for newly manufactured motorcoaches based on the results of this research'.

Since this recommendation, the NHTSA has developed a new proposed Federal Motor Vehicle Safety Standard (FMVSS) No. 217a, Anti-ejection glazing for bus portals.[50] In the proposed new standard, NHTSA stated that the 'Performance requirements would apply to side and rear windows, and to glass panels and windows on the roof to mitigate partial and complete ejection of passengers from these windows and to ensure that emergency exits remain operable after a rollover crash'. The target introduction date for this new standard in the United States is end of 2024. This change complements the introduction of seatbelts to certain buses through Federal Motor Vehicle Safety Standard 208 (FMVSS 208) which regulates automotive occupant crash protection.

Despite seatbelts being fitted to the majority of passenger coaches in Australia built after 1 July 1994, passenger ejections from passenger coach rollover incidents still occur leading to serious or fatal injuries. Correctly worn seatbelts may not prevent partial / full ejection in all cases. NHTSA anti-ejection glazing research and proposed standard should be considered for potential application in Australia.

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[47] NTSB/SIR–99/04 PB98–917006; Highway Special Investigation Report: Bus Crashworthiness Issues; September, 1999.

[48] National Transportation Safety Board, Safety Recommendation H-99-45 through -54, NOV 2 1999.

[49] The National Highway Traffic Safety Administration (NHTSA) is the U.S. federal government agency, part of the Department of Transportation, responsible for developing and administering vehicle safety standards.

[50] US Federal Register / Vol. 81, No. 88 / Friday, May 6, 2016 / Proposed Rules.

# Findings

OCI investigation report findings include 'contributing factors' and 'other factors that increased risk' (factors that did not meet the definition of a contributing factor). Report findings also include 'other safety-related findings' and 'general findings' to provide important summary information.

These report findings should not be read as apportioning blame or liability.

## Contributing factors

For this event, the identified contributing safety factors were:

- The semitrailer service brakes were ineffective due to being out of adjustment.
- The maintenance regime of Kangaroo Transport Industries did not ensure that the brakes on the involved trailers were within the manufacturers' specified adjustment.
- There was a missed opportunity for the driver of the truck to take corrective action in response to the braking difficulties experienced during the descent at Pykes Creek Reservoir.

## Other factors that increased risk

*Other factors that increased risk* are safety factors that existed but did not meet the test for directly contributing to this event.

- The prime mover's engine brakes were probably not available to the driver to supplement the service brakes during heavy braking.

## Other safety-related findings

### *Heavy vehicle regulation*

- The National Heavy Vehicle Regulator audit regime did not identify limitations in the maintenance system of the trailer owner KTI. The National Heavy Vehicle Regulator should consider opportunities to improve the veracity of its monitoring processes.

### *Australian Design Rules*

- The side windows of the passenger coach were not retained during the rollover. Considering the latest regulatory developments in the United States of America, there is potential for review of the Australian Design Rules with respect to anti-ejection countermeasures in buses.
- A small number of passengers were not wearing seatbelts at the time of the collision. Availability of a seatbelt reminder system effective for each seat would place less reliance on the need for frequent verbal seatbelt reminders.
- Serious injuries were sustained by a number of passengers wearing seatbelts. Consideration should be given to the review of occupant protection standards for passenger coaches.

## General findings

- The operation of the passenger coach by its driver did not contribute to the collision.
- The procedures of Loreto College Ballarat implemented by its staff probably led to most students wearing seat belts.
- The use of seatbelts by most bus passengers probably limited the number of severe injuries and reduced the likelihood of fatality in this roll-over incident.
- The traffic management implemented on the freeway at the time of the incident was consistent with AustRoads guidelines.

# Safety actions and recommendations

Organisations were provided with a draft report and invited to provide safety actions they had carried out or were planning to carry out in relation to findings relevant to their organisation.

Recommendations are not made to organisations where appropriate safety action has been taken or is being progressed.

## Safety actions

### *Semitrailer operator*

Kangaroo Transport Industries advised that the following actions had been implemented since the incident:

- additional training has been provided to existing and new workshop staff on brake booster pushrod setup and adjustment
- daily visual spot checks of brake systems and undercarriage components has been introduced for trailers for line-haul use
- brake linings are to be replaced at service if the existing linings will not last through to the next scheduled 45-day service
- new vehicles introduced to the KTI fleet with Victorian roadworthiness certificates are to be inspected prior to use
- trailers on short-haul runs (Adelaide - Melbourne) are to be serviced 2 weeks in advance of their due date
- an increased awareness of drivers doing pre-start checks and raising safety concerns / defects immediately
- an increased awareness of subcontractor fleet condition and maintenance.

### *Regulatory oversight of heavy vehicles*

The National Heavy Vehicle Regulator advised that:

The NHVR is working closely with each of the participating Heavy Vehicle National Law (HVNL) jurisdictions to establish a standardised approach to heavy vehicle inspections that seeks to improve heavy vehicle safety and productivity by replacing the current multiple state-based inspection requirements with a consistent national risk-based inspection regime.

The Risk-Based Heavy Vehicle Inspection Scheme (RBHVIS) will assign a risk rating to operators and their fleets that, in doing so, will establish the frequency at which heavy vehicles should be inspected. Heavy vehicles presenting the highest risks would be inspected by the NHVR or another approved entity more frequently. One of the key risk factors that will increase a vehicle's risk profile is vehicle age. Other factors that would influence a risk rating, either positively or negatively, would include history of vehicle defects, operator compliance history, demonstrated safety management systems, and adoption of vehicle maintenance regimes.

The RBHVIS is being developed by the NHVR for approval by jurisdictions through the Infrastructure and Transport Senior Officials' Committee (ITSOC) before ultimately being sent to the responsible Infrastructure and Transport Ministers for approval to implement. Subject to jurisdictional endorsement of the RBHVIS, the NHVR will seek to commence implementation of the scheme from 2026.

Further, with the recent successful transition of heavy vehicle services in NSW and Queensland, the NHVR is now responsible for on-road compliance and enforcement activities for all Heavy Vehicle National Law (HVNL) participating jurisdictions across Australia. This will provide a nationally consistent approach to heavy vehicle regulation, including through a more unified approach to heavy vehicle safety station inspections that will ensure improved vehicle monitoring and safety outcomes.

### *Review of bus design rules*

The Commonwealth Department of Infrastructure, Transport, Regional Development, Communications and the Arts (DITRDCA) advised:

In response to this and another significant bus crash in NSW,[51] the Assistant Minister for Infrastructure and Transport convened a bus safety roundtable to consider options to reduce the likelihood and severity of bus crashes. The roundtable was attended by representatives of states and territories, the bus manufacturing industry, bus operators and user representatives. Following the roundtable, the Department established the Bus Safety Working Group, which brings together bus manufacturers, operators, state and territory regulators and the Department's vehicle standards experts to consider options to improve bus safety. The working group is currently examining seatbelt requirements with a view to improving seatbelt use in buses. It has also undertaken initial considerations of occupant protection issues. Once finalised, this report will be passed to that group to assist with considerations.

Additionally, since the incident, the Australian Government has made a range of new Australian Design Rules that will increase the safe operation of buses and other heavy vehicles. These standards include new requirements for lane departure warning systems, reversing technologies and advanced emergency braking.

DITRDCA also advised that the issues raised in this report would be considered further by the working group.

## Recommendations

### *Prime mover operator*

It is recommended that L&A Freight Express take safety action to ensure the operability and appropriate use of auxiliary braking systems (such as engine brakes) fitted to their prime movers used for heavy haulage.

[51] Passenger coach rollover, Greta NSW on 11 June 2023