OTSI Office of Transport Safety Investigations

BUS SAFETY INVESTIGATION REPORT

SCHOOL BUS FIRE

SAYWERS GULLY, NSW

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THE OFFICE OF TRANSPORT SAFETY INVESTIGATIONS

The Office of Transport Safety Investigations (OTSI) is an independent NSW agency whose purpose is to improve transport safety through the investigation of incidents and accidents in the rail, bus and ferry industries. OTSI investigations are independent of regulatory, operator or other external entities.

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Once OTSI has completed an investigation, its report is provided to the NSW Minister for Transport and Infrastructure for tabling in Parliament. The Minister is required to table the report in both Houses of the NSW Parliament within seven days of receiving it. Following tabling, the report is published on OTSI's website at www.otsi.nsw.gov.au.

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EXECUTIVE SUMMARY

On the afternoon of Monday 6 March 2017, a Hunter Valley Buses school bus caught fire on the Hunter Expressway at Sawyers Gully, NSW. At the time, the bus, a 1997 Mercedes O400, was travelling northwest with 60 school students and a driver on board.

As the bus approached an ascending gradient the bus appeared to lose power. The driver noticed smoke and flames coming from the rear of the bus. The driver pulled to the side of the road and evacuated all passengers. The driver used the on board fire extinguisher to extinguish the fire.

There were no injuries and damage was limited to the engine bay.

The investigation found that it was likely the fire started due to an electrical short circuit in the wiring on the lower left hand side of the engine bay at the rear of the bus. Two areas were identified as possible initiation points: the cabling from the rear of the alternator; and the wiring loom on the left hand side of the engine bay.

The engine bay sustained fire damage to its near side, with substantial damage to electrical wiring and air conditioning hoses on that side.

The bus was not fitted with an engine bay fire suppression system at the time of the incident. All buses in the fleet have since been fitted with engine bay fire suppression systems.

OTSI has recommended that the design and placement of electrical cabling be examined, that training for maintenance personnel be reviewed, and driver training be conducted at regular intervals to maintain drivers' familiarity with current emergency procedures.

Full details of the Findings and Recommendations of this bus safety investigation are contained in Parts 3 and 4 respectively.

PART 1 FACTUAL INFORMATION

Events leading up to the occurrence

1.1 On 6 March 2017, at approximately 1537[1], a Hunter Valley Buses[2] school service was travelling north-west along the Hunter Expressway at Sawyers Gully (see *Figure 1*). It was travelling towards Singleton with 60 school students (K-12) on board.

Source: Geoscience Australia

Figure 1: Map of incident location

The occurrence

1.2 The bus was travelling at approximately 100 km/h immediately prior to the incident. The driver said that the bus was operating normally prior to the incident. As the bus travelled along the expressway and started an uphill gradient the driver noticed a loss of engine power. The driver first looked in

[1] Times in this report are in 24-hour clock form in Australian Eastern Daylight-saving Time.
[2] Hunter Valley Buses is part of the Comfort DelGro Australia group.

the offside mirror and observed smoke coming from the rear of the bus. The driver then looked at the nearside mirror and saw flames coming from the rear of the bus.

1.3 The driver pulled to the side of the road just as the bus lost all power. The driver turned the ignition off. With the cabin filling with smoke, the driver decided to evacuate the bus by opening the front door. The door failed to open so the driver attempted to open the door with the emergency release button located above the door (see *Figure 2*).

Source: OTSI

Figure 2: Emergency door release button

1.4 The driver pressed the button and then pulled at the folding type door, which resisted any attempt at moving. The driver, never having operated this emergency button previously, struggled against the door then pressed the button again and noted the door moved slightly. The driver realised that by holding the button while applying force to the door, air was released from the system and allowed the door to open.

1.5 The driver instructed the children to slowly leave the bus and directed them to an open space away from the bus and traffic. The driver instructed one of the older children to take charge of keeping the group of exiting passengers together and to count how many were present.

1.6 The driver inspected the smoke at the rear and then quickly retrieved the portable dry chemical fire extinguisher from the front of the bus. The driver then attempted to extinguish the fire by directing the nozzle through gaps in the body panels without opening the engine hatch. The driver discharged the extinguisher until the flames went out.

Events following the occurrence

1.7 The driver then attempted to contact the radio room via the onboard radio, however, the driver did not receive a response. The bus was in an area with poor radio reception. The driver then called the Singleton base using his mobile phone. The base responded and called emergency services and dispatched a second bus to remove the children from the side of the road.

1.8 The driver boarded the bus again and opened windows to allow the smoke-filled cabin to ventilate while they waited for emergency services. NSW Fire and Rescue arrived approximately 10 minutes later and made the area safe by closing lanes on the expressway. They checked the engine bay and confirmed that the fire was extinguished.

1.9 Noting that a number of children were on the phone, the driver instructed the children to inform their parents that everything was safe and that another bus was on its way for them to continue their journey. When the replacement bus arrived, the driver supervised the children boarding and confirmed all were accounted for. The replacement bus then completed the school run.

1.10 The damaged bus was towed back to the depot pending examination by OTSI investigators.

Incident location

1.11 The incident occurred at Sawyers Gully, about 50 km northwest of Newcastle. The road is a dual carriageway with a 110 km/h speed limit (see *Figure 3*).

Source: Google with annotations by OTSI

Figure 3: Overview of incident location

Environmental conditions

1.12 The afternoon of 6 March 2017 was cloudy with light rain. The Bureau of Meteorology recorded a temperature of 24°C at 1500 at the Maitland weather station, situated about 9 km east of the incident. It was determined that the environmental conditions played no part in the incident.

Bus information

1.13 The bus was a 1997 Mercedes O400 model diesel powered model, registration 3578MO (see *Figure 4*). At the time of the incident the odometer reading was 1,117,892 km. The bus was operated by the Hunter Valley Buses out of the Thornton Depot. There were 15 other buses of this model in the Hunter Valley Buses' fleet.

Source: OTSI

Figure 4: Bus involved in incident

Bus driver information

1.14 The driver held a HC license and has been employed by Hunter Valley Bus for approximately 2 years. Before joining Hunter Valley Buses the driver had extensive experience in coach and truck operation.

Related occurrences

1.15 OTSI has collated and published summaries of reported bus fire incidents in NSW since 2012. Electrical faults are found to be a common initiation source for bus fires. The number of incidents initiated by electrical faults for the period 2012-2016 is shown below (see *Figure 5)*.

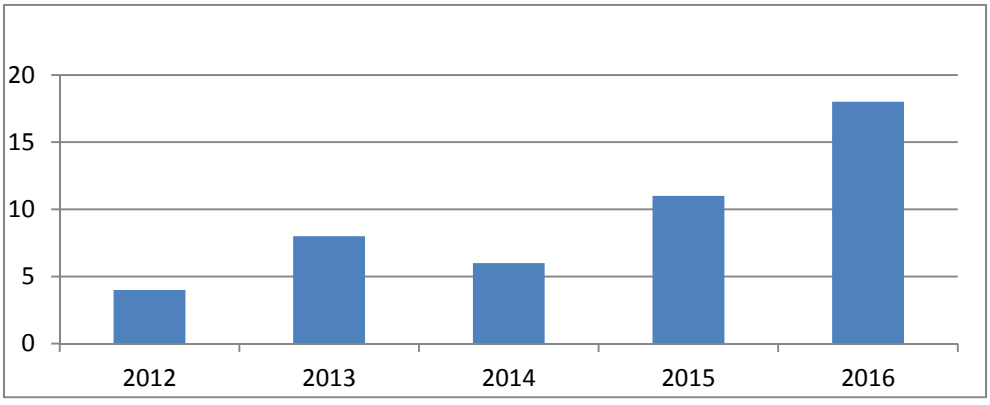


Figure 5: Bus fires initiated by electrical faults

1.16 OTSI has published the following bus investigations where an electrical fault in the engine bay was determined to be the likely fault:

- Sydney Harbour Bridge bus fire 16 September 2016
- Beresfield coach fire 10 November 2013
- Cremorne bus fire 21 March 2011
- Greystanes bus fire 21 September 2010.[3]

[3] All OTSI investigation reports can be accessed at www.otsi.nsw.gov.au

PART 2 ANALYSIS

Introduction

2.1 The investigation focussed principally on the factors that contributed to the initiation of the bus fire, the actions of the driver and controls to prevent it happening in future.

Fire damage

2.2 The fire damage was limited to the engine bay area. There was wiring damage inside the engine bay and smoke stains near engine bay openings. The damage was restricted to the left hand side of the engine bay (see *Figure 6*).

Source: OTSI

Figure 6: Fire damage restricted to left side of engine bay

2.3 The exterior and passenger area of the bus suffered no discernible damage (see *Figure 7 and 8*).

Source: OTSI

Figure 7: Bus interior showing emergency exits

Source: OTSI

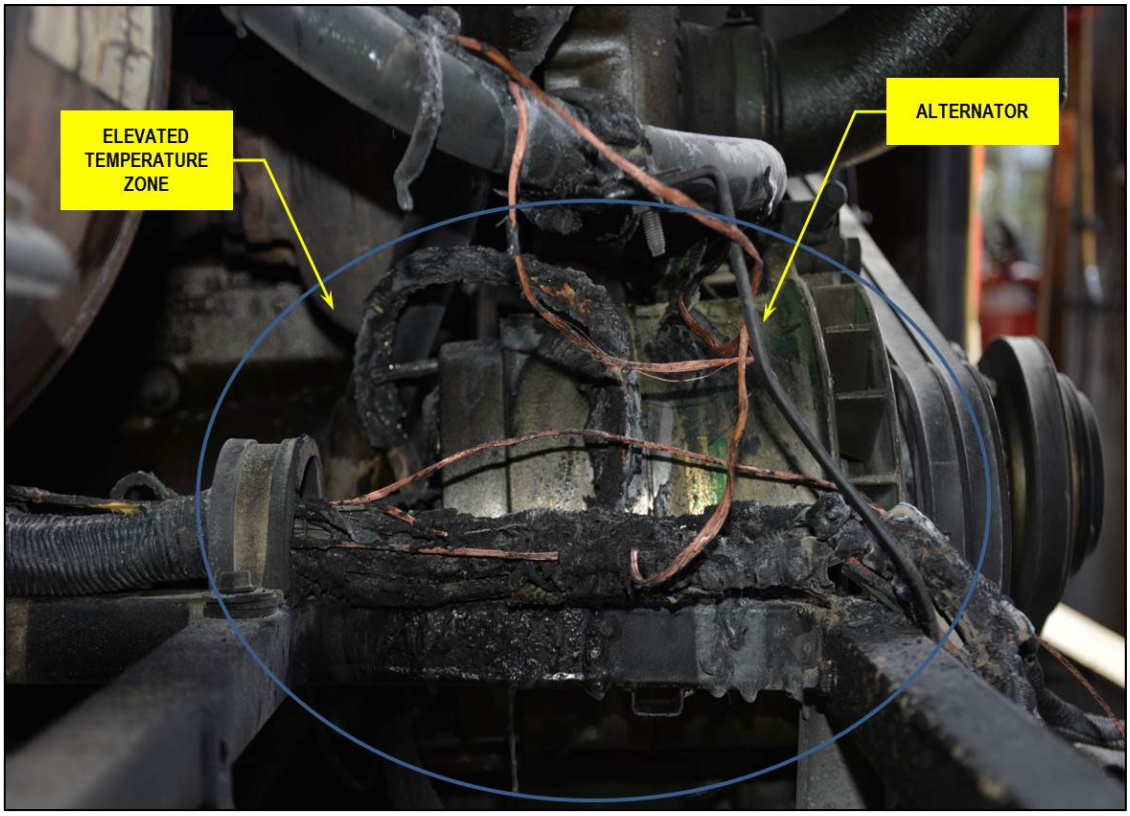
Figure 8: Undamaged rear exterior of bus

Fire initiation and development

2.4 The investigation found that it was likely that the fire started due to an electrical malfunction in the engine bay at the rear of the bus. The area of the left hand side of the engine bay exhibited high levels of carbonisation and exposure to elevated temperatures (see *Figure 9*).

2.5 Two areas were identified as possible initiation points, both were in the lower left hand area of the engine bay: the cabling from the rear of the alternator; and the wiring loom on the left hand side of the engine bay.

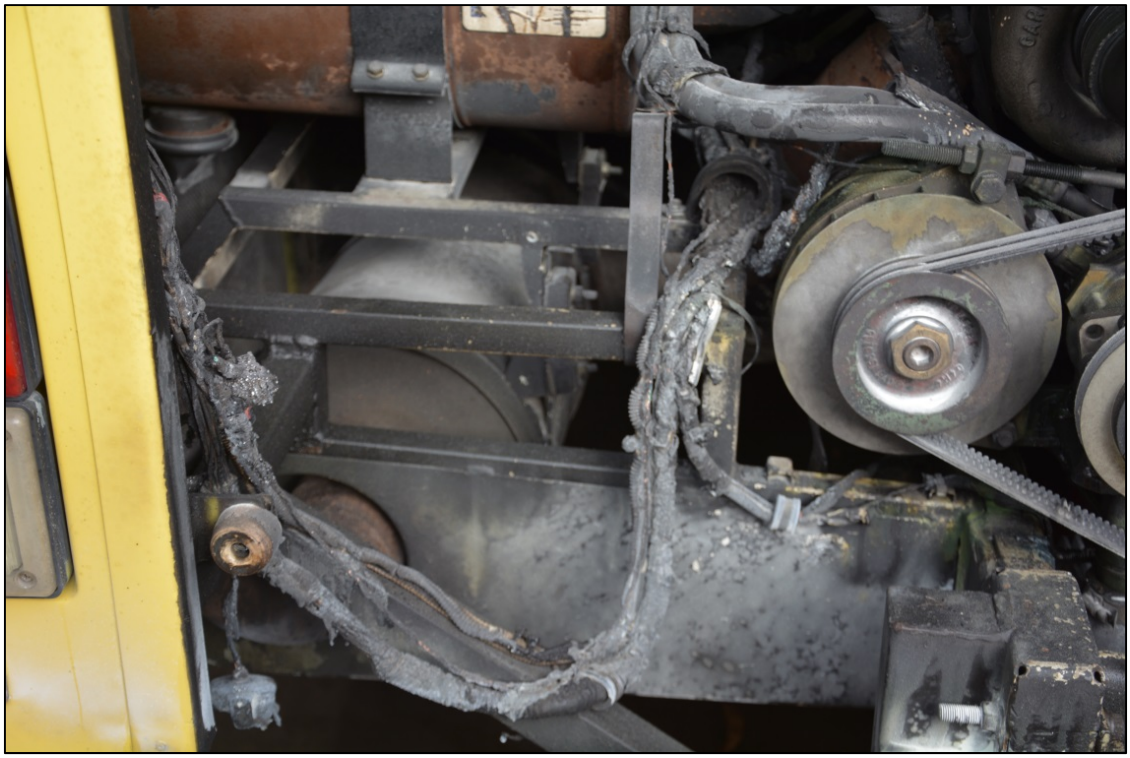
2.6 Around the alternator the plastic insulation on the cables on the left hand side was significantly destroyed by the fire (see *Figure 9)*.



Source: OTSI

Figure 9: Heat damage around alternator

2.7 Another area of high thermal activity was the wiring installed on the left hand side of the engine bay. (see *Figure 10)*. There was evidence of damaged and melted insulation.



Source: OTSI

Figure 10: Damaged and melted insulation on left hand side of engine bay

2.8 Once the cabling insulation was alight it would have spread to other plastic combustibles. Consequently, flames would have contacted the air-conditioning refrigerant pipe. This pipe ruptured and has likely released a mixture of combustible vapour and refrigerant oil (see *Figure11)*. The air-conditioning gas combusts at around 650°C and it is likely that this assisted in spreading the flames observed by the driver.

Source: OTSI

Figure 11: Damaged air-condition refrigerant hose

2.9 The checking of cables for signs of chafing, missing cable ties or wear is an important preventative action. A similar model bus was checked at the same depot and there was evidence of problems with cable. The depot maintenance mechanics were able to rectify the problem areas with additional cable ties and the use of insulation tape.

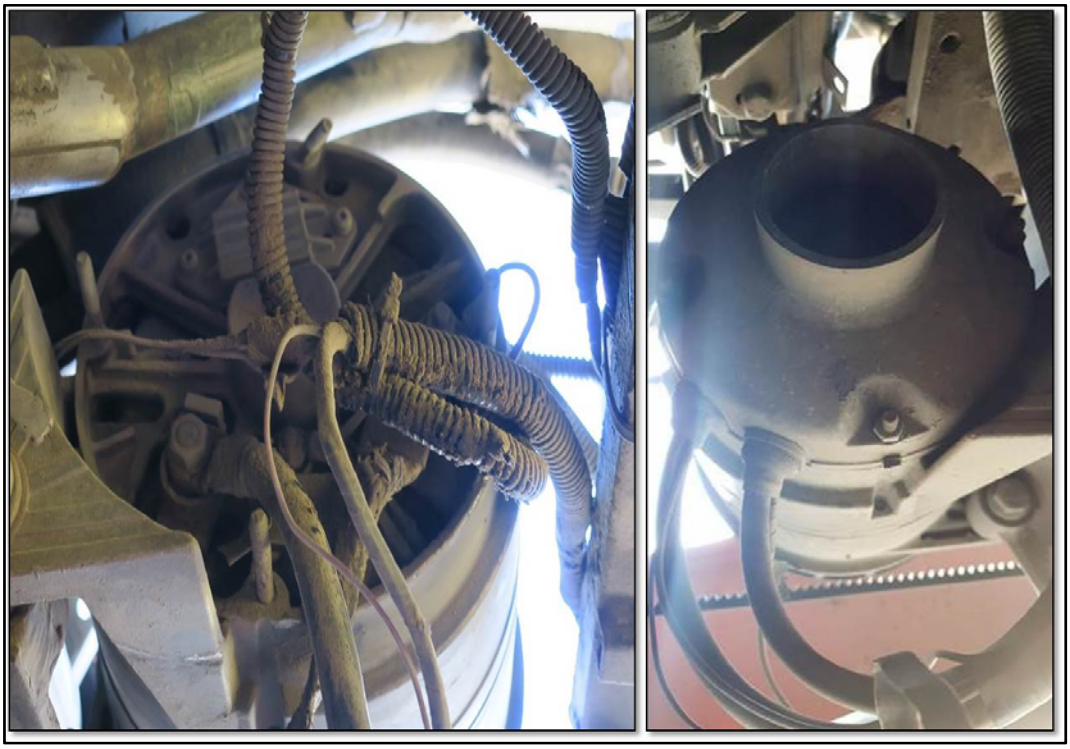
2.10 There have been a number of significant fires caused by insulation failure from cables chafing together or over an engine part. The fire on a bus on the Sydney Harbour Bridge on 15 September 2016 was initiated by a short circuit of the auxiliary alternator cables where they crossed the edge of the near side rear chassis rail.

2.11 Installation manuals for electrical cables typically state:

- When routing cables there should be no risk of chafing
- The cables must be long enough so they are not stretched
- The distance between cable ties should be 350-400mm, and
- Cables must be routed away from hot areas. [4]

[4] Electrical system installation manual for industrial engines – Scania 2016.

2.12 It was found that the alternator originally had a rear aluminium cover as standard fitment from the OEM (see *Figure 12*). The alternator rear cover had not been replaced. It is not known when this occurred. It is possible that the alternator was repaired or replaced at some time since new and the rear cover was not replaced. This cover is usually fitted with a flexible hose which routes clean air to cool the alternator. It is good practice to ensure that all covers and hoses are replaced after maintenance or inspection.



Source: OTSI (left) and TfNSW (right)

Figure 12: Alternator rear cover missing (left) and in cover place on similar model bus (right)

Actions of the driver

2.13 After the driver became aware of the fire and stopped the bus, he tried to open the front door in order to evacuate the students. The driver was initially unsuccessful in opening the door. Once he was able to open the door the evacuation of the students was conducted quickly and effectively. The bus was filling with smoke during this time. The driver had no previous experience with operating the door release mechanism.

2.14 The actions of the driver in pulling to the side of the road when he became aware of smoke, shutting the bus down, and using the fire extinguisher on the source of the fire likely prevented the fire progressing any further than it did.

Training

2.15 **Driver training.** The driver was familiar with the operation of a fire extinguisher, having participated in numerous previous work site inductions in other roles. The driver had received an induction when he began at Hunter Valley Buses but no further refresher training had taken place in the 2 years since commencing employment. The induction focussed on customer service and did not address emergency response or the emergency door release.

2.16 Research (Leach 2004), has shown that not everyone reacts well in emergency situations. During this incident there was a delay in evacuation due to the driver's unfamiliarity with the door release.

2.17 Regular retraining programs for drivers should include the emergency evacuation process, emergency door operation and use of fire extinguishers. Drivers currently do not have to demonstrate proficiency in the above areas.

2.18 **Maintenance staff training.** The role of maintenance staff is crucial in identifying fire initiation points and taking action to prevent them. It is better to prevent fires than have them suppressed afterwards. Maintenance procedures must capture proven good maintenance practice, especially in relation to fire initiators.

2.19 Maintenance staff should receive training on their role on fire prevention strategies. Training should include likely fire initiation areas, such as chafing cables, as found in this investigation. A systematic inspection procedure should be developed encapsulating knowledge and lessons learned from previous fire incidents.

Safety actions taken

2.20 The bus was not fitted with an engine bay fire suppression system at the time of the incident. Since this incident, all TfNSW contracted buses, including Hunter Valley Buses, have been fitted with engine bay fire suppression systems. If fitted to this bus, it is probable that an engine bay fire suppression system would have most likely reduced the severity of the fire and possibly extinguished it.

PART 3 FINDINGS

From the evidence available, the following findings are made with respect to the school bus fire involving a Mercedes O400, registration 3578MO, that occurred in Sawyers Gully, NSW on 6 March 2017.

Contributory Factors

3.1 The fire started due to an electrical short circuit in the wiring on the lower left hand side of the engine bay at the rear of the bus. Two areas were identified as possible initiation points: the cabling from the rear of the alternator; and the wiring loom on the left hand side of the engine bay.

3.2 From the short circuit, flammable materials ignited. This lead to the air conditioning refrigerant pipe rupturing which released flammable vapour and accelerated the engine bay fire.

3.3 Routine maintenance carried out at the depot did not detect any cable chafing problems before the fire.

3.4 An engine bay fire suppression system was not fitted to the bus.

Other Safety Factors

3.5 There was a delay in evacuating the bus due to the driver's unfamiliarity with the evacuation process.

3.6 The driver re-entered the bus and opened windows to allow the smoke-filled cabin to ventilate. This action placed the driver in danger and the in-flow of fresh air increased the risk of initiating a secondary fire inside the passenger saloon.

3.7 The driver had not received training in the evacuation of the bus and the emergency door release process.

3.8 The driver had initial training in the use of fire extinguishers, although no refresher training had been undertaken since commencement of his employment.

PART 4 RECOMMENDATIONS

It is recommended that the following safety actions be undertaken by the specified responsible entity.

Hunter Valley Buses

4.1 Examine the design and placement of electrical cabling on all buses to reduce the likelihood of short circuit events occurring.

4.2 Conduct driver training at regular intervals to maintain drivers' familiarity with current emergency procedures, emergency door operation and use of fire extinguishers.

4.3 Review training for maintenance personnel to increase their awareness of likely fire initiation points.

4.4 Ensure maintenance procedures encapsulate techniques to identify fire initiators and recommended practices to prevent fire events.

PART 5 APPENDICES

Appendix 1: Sources, Submissions and Acknowledgements

Sources of Information

- Hunter Valley Buses
- Kennedy's Engineering and Forensic

References

Kennedy's Engineering and Forensic, *Thermal damage to Custom Coaches Bus Hunter Valley Bus Company,* 16 May 2017.

OTSI Bus Safety Investigation Report, *An Investigation into Bus Fires in NSW, 2016.*

Scania, *Electrical system installation manual for industrial engines*, 2016.

Why People 'Freeze' in an Emergency: Temporal and Cognitive Constraints on Survival Responses. Aviation, Space, and Environmental Medicine, Volume 75, Number 6. Leach, John. (2004).

Submissions

The Chief Investigator forwarded a copy of the Draft Report to the Directly Involved Parties (DIPs) to provide them with the opportunity to contribute to the compilation of the Final Report by verifying the factual information, scrutinising the analysis, findings and recommendations, and to submit recommendations for amendments to the Draft Report that they believed would enhance the accuracy, logic, integrity and resilience of the Investigation Report. The following DIPs were invited to make submissions on the Draft Report:

- Hunter Valley Buses
- Transport for NSW
- Roads and Maritime Services

Submissions were received from Hunter Valley Buses and Transport for NSW. The Chief Investigator considered all representations made by DIPs and responded to the author of each of the submissions advising which of their recommended amendments would be incorporated in the Final Report, and those that would not. Where any recommended amendment was excluded, the reasons for doing so were explained.