OTSI Office of Transport Safety Investigations

BUS SAFETY REPORT

BUS FIRES IN NEW SOUTH WALES IN 2017

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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.

Established on 1 January 2004 by the *Transport Administration Act 1988 (NSW)*, and confirmed by amending legislation as an independent statutory office on 1 July 2005, OTSI is responsible for determining the contributing factors of accidents and to make recommendations for the implementation of remedial safety action to prevent recurrence. Importantly, however, OTSI does not confine itself to the consideration of just those matters that contributed to a particular accident; it also seeks to identify any transport safety matters which, if left unaddressed, might contribute to other accidents.

OTSI's investigations are conducted under powers conferred by the *Transport Administration Act 1988 (NSW)* and *Passenger Transport Act 1990 (NSW).* Additionally, all OTSI publications that are considered investigation reports are also conferred by these Acts. OTSI also conducts rail investigations on behalf of the Australian Transport Safety Bureau under the *Transport Safety Investigation Act 2003* (*Cwlth*). OTSI investigators normally seek to obtain information cooperatively when conducting an accident investigation. However, where it is necessary to do so, OTSI investigators may exercise statutory powers to interview persons, enter premises and examine and retain physical and documentary evidence.

It is not within OTSI's jurisdiction, nor an object of its investigations, to apportion blame or determine liability. At all times, OTSI's investigation reports strive to reflect our balanced approach to the investigation, in a manner that properly explains what happened, and why, in a fair and unbiased manner.

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.

BUS FIRES IN NEW SOUTH WALES IN 2017

Introduction

In June 2013, the Office of Transport Safety Investigations (OTSI) released an investigation report into common safety-related issues revealed through the examination of the nature and circumstances of bus and coach fires from 2005 to 2012.[1] This was followed by annual reports from 2013 to the present.[2] This is the fifth such annual report.

Monitoring of the extent, origins and causes of bus fires reported to OTSI continued through 2017 and resulted in the publication of this report in March 2018.

In line with previous years, all reported fires were documented and included incidents which did not progress to a fire but had involved excessive heat and the generation of smoke. The reports were assessed and grouped into two categories: fire incidents and thermal incidents.[3]

In most cases, the origin and cause of the incident was readily identifiable and did not require an in-depth investigation. OTSI investigators examined vehicles on 8 occasions following the report of a fire. 6 incidents were formally investigated and documented in more comprehensive OTSI bus safety investigation reports.

This report contains a summary of the information gathered in 2017 and provides commentary on comparisons with the information reported in previous years. The report also summarises the progress in implementation of recommendations made in previous reports.

Data for this report came primarily from information provided by operators, using the same methodology as used for recording occurrences in the previous years.

1 OTSI Bus Safety Investigation Report, *An Investigation into Bus Fires in NSW 2005 – 2012*.

2 All OTSI investigation reports are available at www.otsi.nsw.gov.au

3 Fire incident: Visible fire seen by driver, passengers or witnesses. Fire or flames are mentioned in the report. Flaming combustion has occurred (Rapid oxidation of gases and vapours that generate detectable heat and light.) The level of damage was such that it was likely that an actual fire occurred. Thermal incident: No mention of fire or flames seen by driver, passengers or witnesses. An excessive heat event, possibly accompanied by smoke. A likely precursor to a fire.

Data Analysis

In 2017 there were a total of 90 reported incidents: 21 fire incidents and 69 thermal incidents. This was an increase in total incidents of 16% from 2016 (see *Figure 1)*.

The growth appears to be a result of a combination of increased reporting by operators and a rise in thermal incidents. There appears to be an increased awareness among bus operators of the importance of reporting incidents.

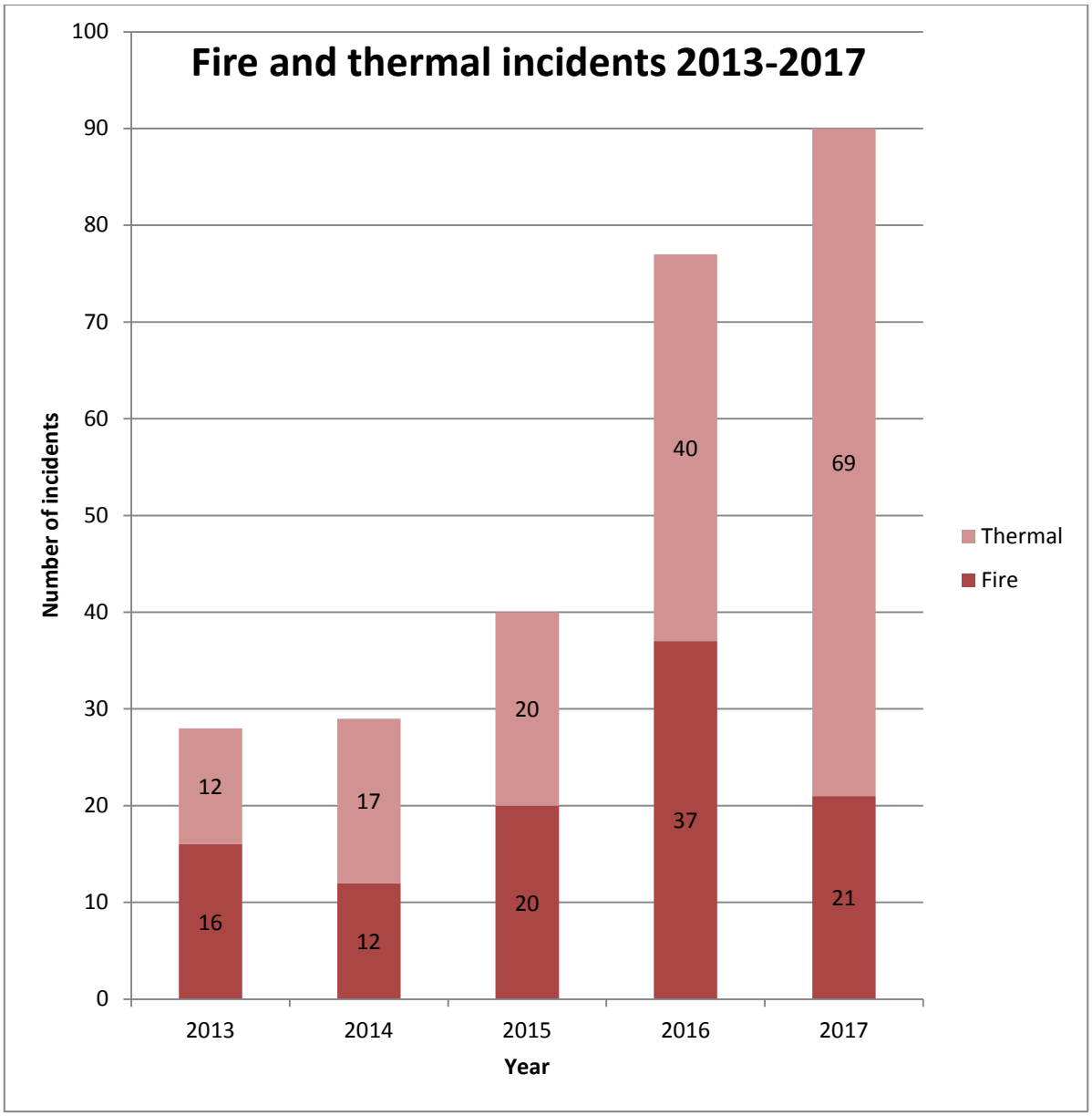

Figure 1: Number of fire and thermal incidents 2013-2017

It should be noted that there was a significant decrease of 43% in fire incidents, from 37 fire incidents in 2016 to 21 fire incidents in 2017.

The 90 incidents reported in 2017 were distributed through the year, as shown in *Figure 2*. On average there was a fire or thermal incident reported every 4 days. Brief details of each incident are recorded at *Appendix A*.

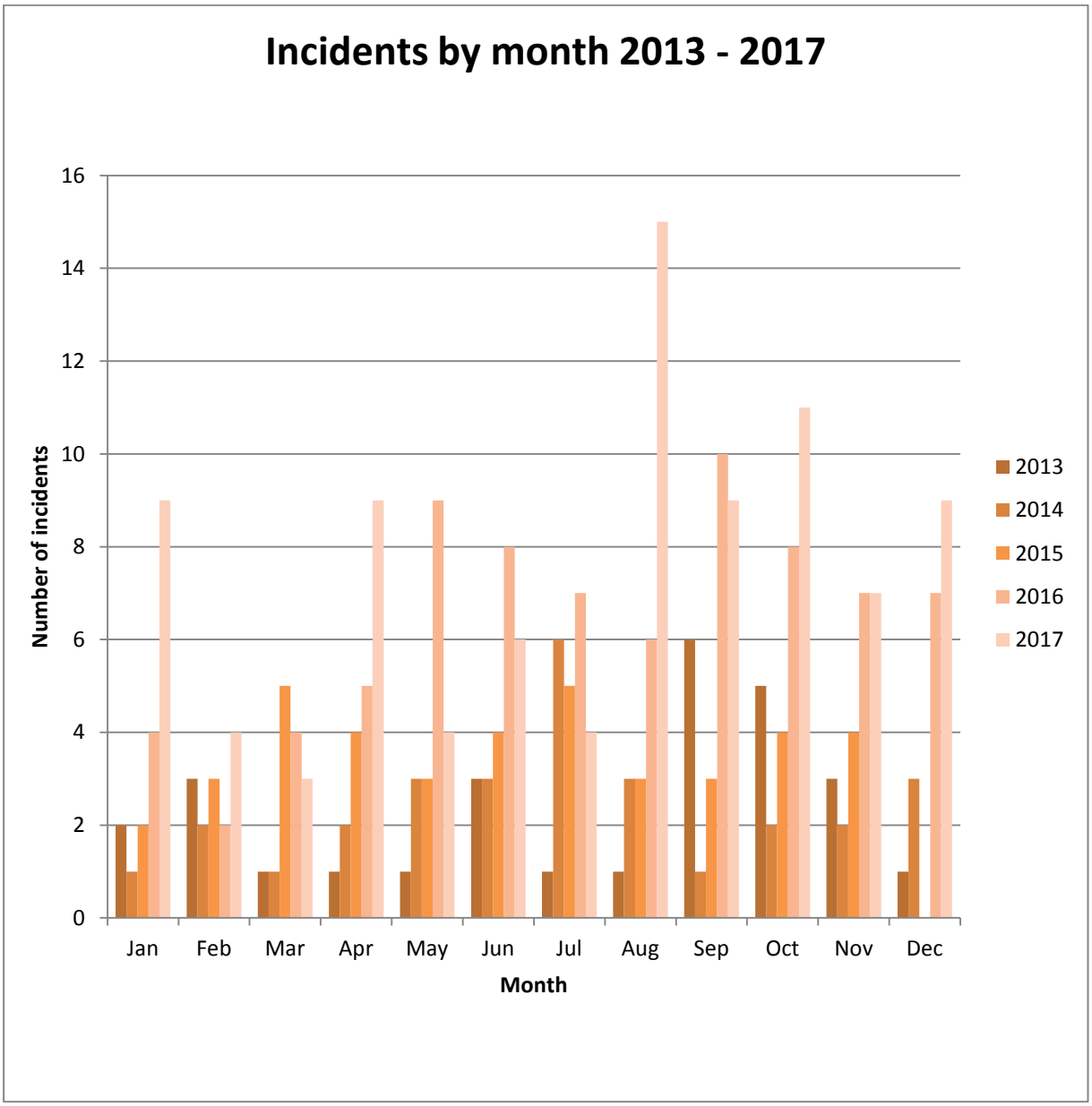

Figure 2: Incidents by month 2013-2017

Although there was a large spike in incidents in August 2017, a record month for incidents, there was no apparent trend in the month by month incidents.

Damage levels of incidents

Incidents were classified into the following levels:

- Destroyed
- Major
- Minor
- Smoke damage
- Nil damage (see Appendix B for a more detailed description).

Based on OTSI assessment and operator reports 5 vehicles were destroyed, 2 vehicles were assessed as having suffered major damage, 20 were assessed as having suffered minor damage, 60 assessed as having sustained smoke damage, and 3 vehicles had nil damage (see *Figure 3*).

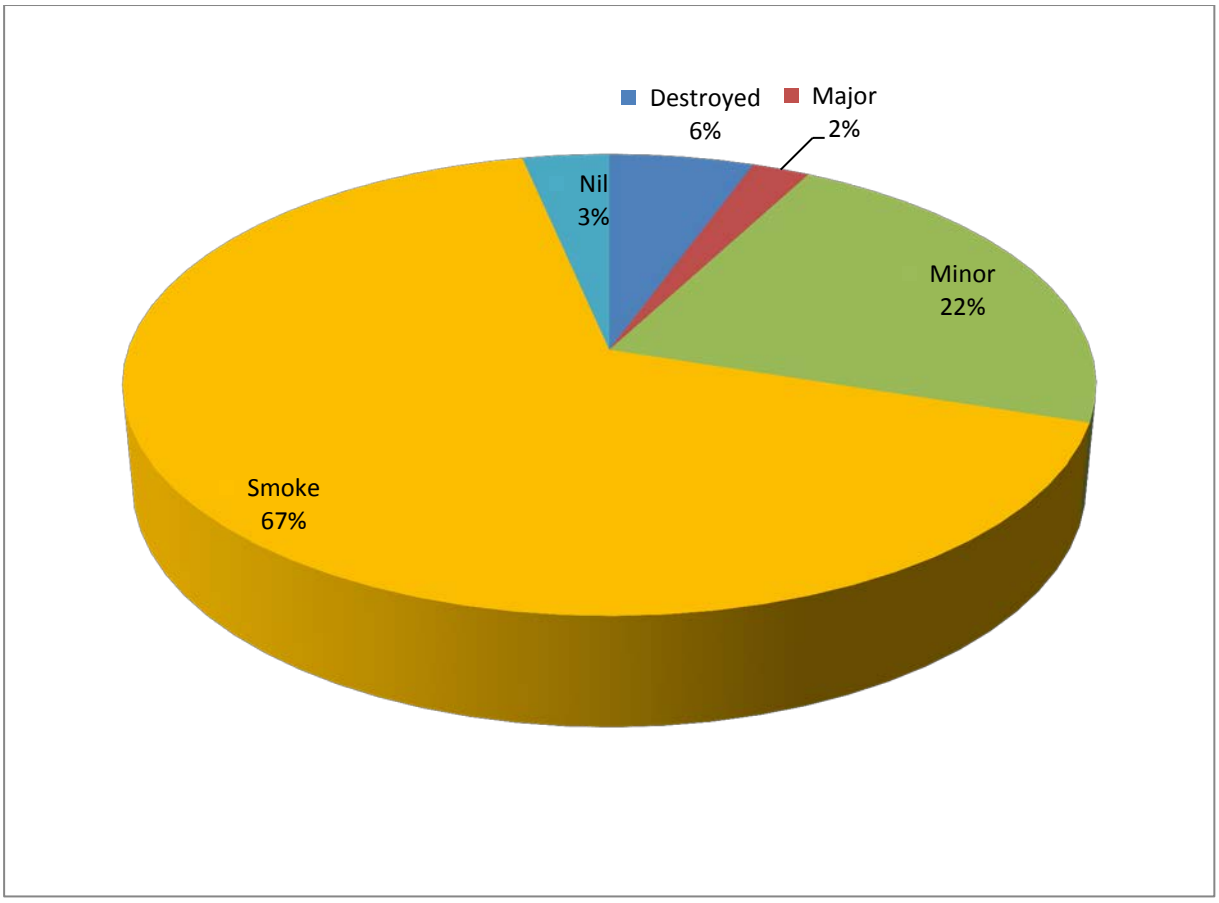

Figure 3: Severity level of incidents NSW 2017

One important area is the category of highest severity; where a bus or coach is destroyed by fire. It would be expected that this is an area where the number of

reports is likely to be accurate. This is an event that is difficult to conceal and highly likely to be reported.

The numbers of destroyed vehicles declined in 2017, see *Figure 4*. In 2017, 5 vehicles were destroyed compared to 7 in 2016.

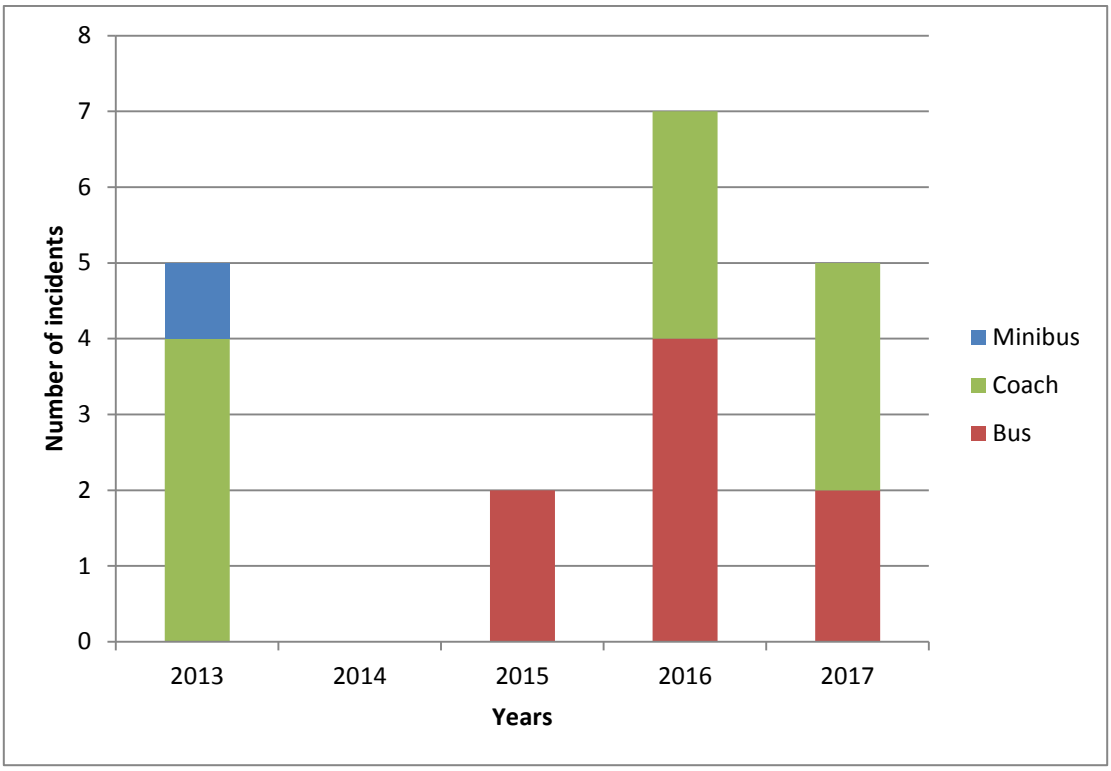

Figure 4: Destroyed 2013-2017

There was a decrease in the number of major damage incidents in 2017, from 7 incidents in 2016, to 2 incidents in 2017. The number of incidents resulting in major damage in previous years was: 2013 (2), 2014 (2), 2015 (2), and 2016 (7).

There was a reduction in the top two severity levels (destroyed and major), from 14 incidents in 2016 to 7 in 2017.

Injuries

Despite an increase in incidents, there were no injuries reported in 2017. Approximately 865[4] passengers had their travel affected by the incidents. The largest number involved in a single incident was approximately 70 passengers (a school

[4] The number is approximate as some of the operators were only able to provide estimates of passenger numbers.

service). There was a significant disruption to the transport network as a result of some of these incidents.

On 43% of occasions the bus or coach involved in the incident was empty of passengers.

Age of vehicles and number of incidents

The ages of the vehicles involved ranged between 0 and 25 years. The majority of incidents involved buses between 5 and 10 years old (see *Figure 5*). An analysis done last year showed that this age range makes up the majority of the fleet. Eight different makes of vehicle were involved and no make or model trends were identified.

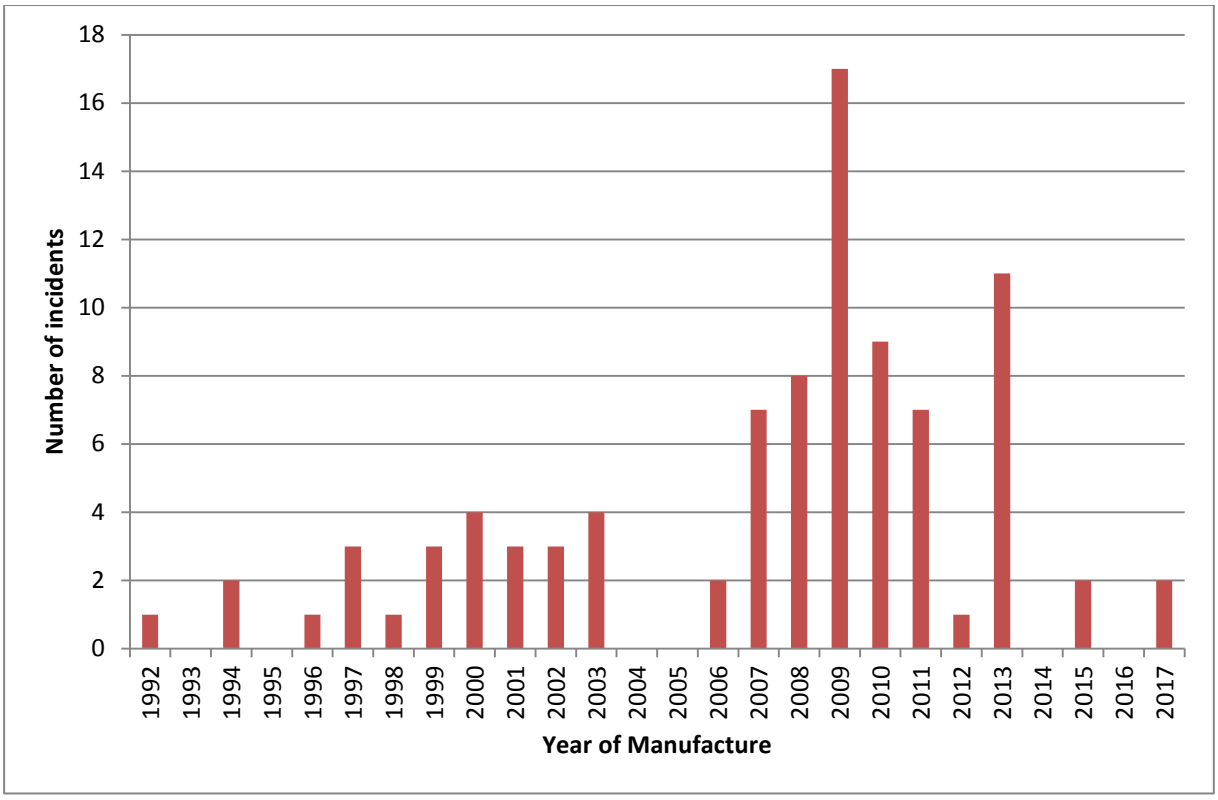

Figure 5: Age of bus involved in 2017 incidents

Severity level and age of vehicles

The 5 destroyed vehicles ranged in year of manufacture from 1995 to 2004. The 7 vehicles that sustained major damage ranged in year of manufacture from 1993 to 2011. The average age for buses in the destroyed category was 16.6 years. In 2016 it was 19.5 years. The average age for buses in the minor damage category was 7.9 years. In 2016 it was 6.6 years. The average age of buses involved in all levels of fire and thermal incidents was 9.7 years, the same average as 2016.

The severity level and the average age of buses involved in incidents in 2016 and 2017 is shown below in *Figure 6*. This shows that, like 2016, older buses sustained a greater level of damage than newer buses.

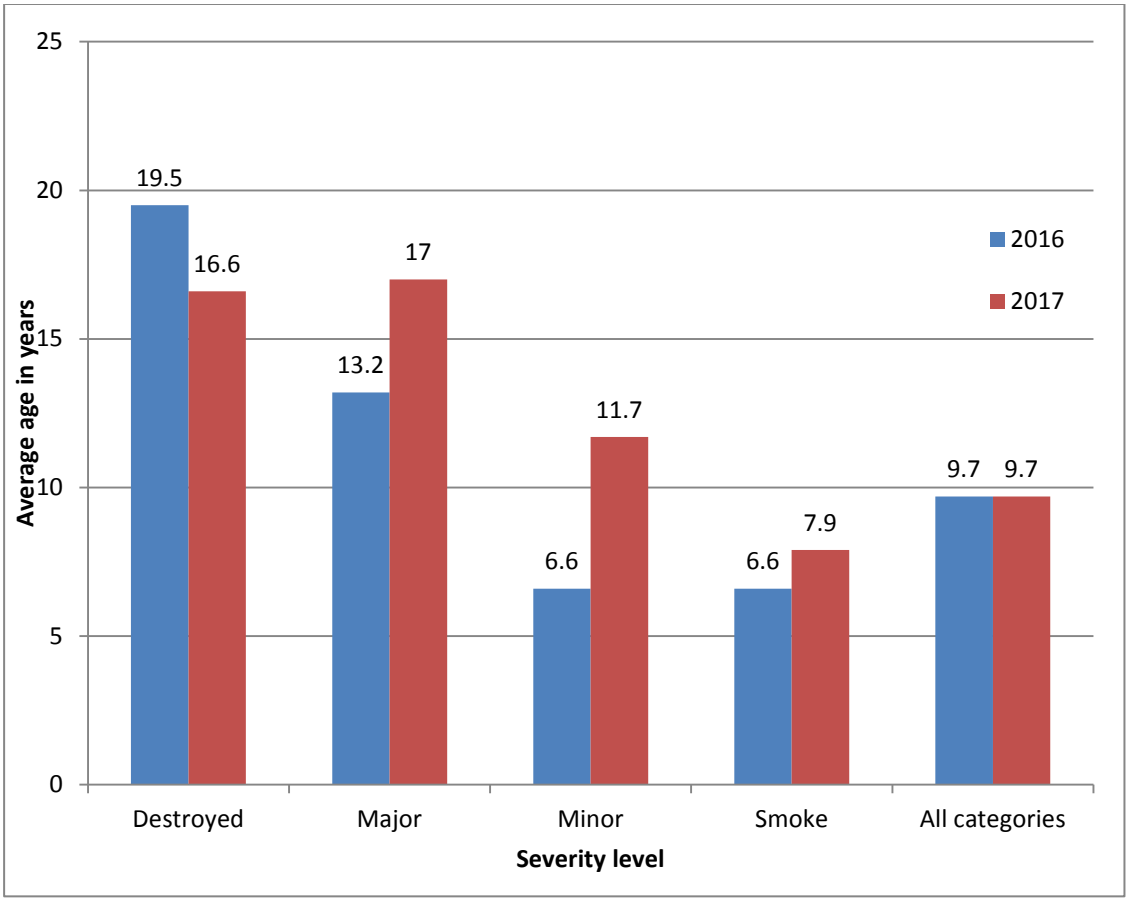

Figure 6: The severity level and the average age of the bus

Origins and Causes

Overall origin

In 2017, the majority of fire and thermal incidents originated in the wheel well (52%). The engine bay had 37% and the body 11%. The following figure shows the originating area of the 90 incidents in 2017 (see *Figure 7*).

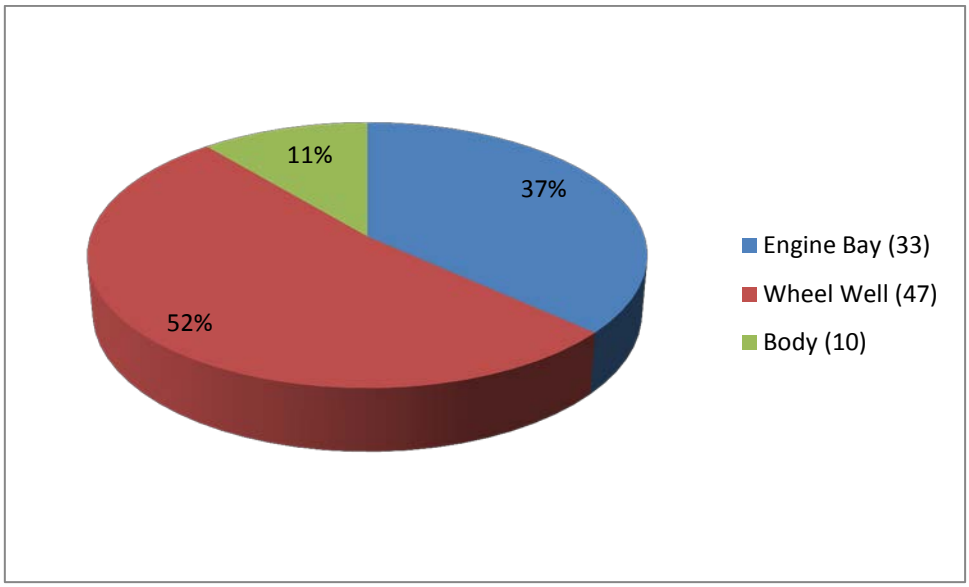

Figure 7: Location by origin NSW 2017

Overall causation

The data for the causes of fire and thermal incidents in 2017 are shown in *Figure 8.*

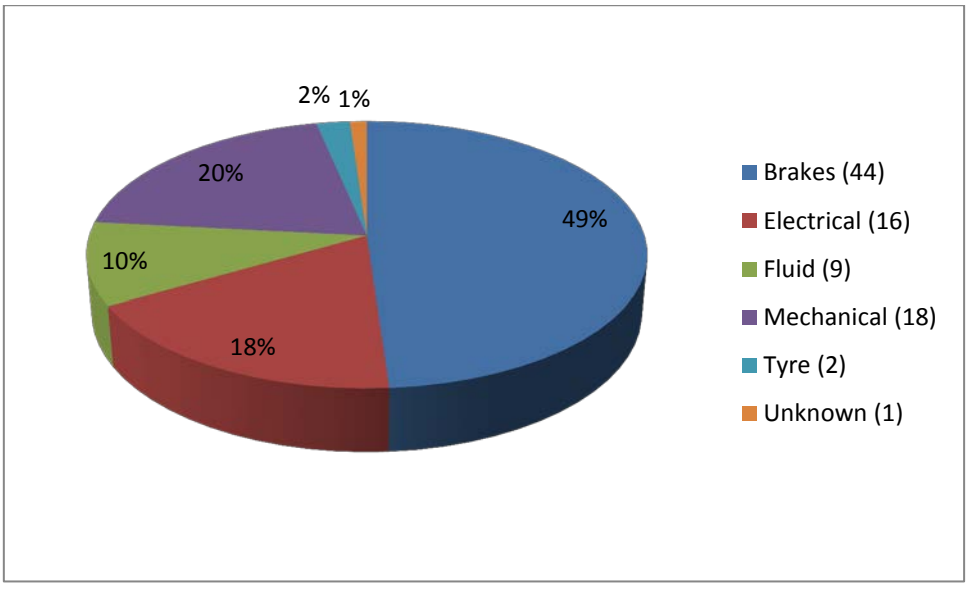

Figure 8: Causes of incidents NSW 2017

Breakdown by origin of incident

The origin of fire and thermal incidents was divided into 3 categories:

- engine bay
- wheel well
- body

Number of engine bay incidents

33 incidents (37%) originated in the engine bay. This is a decrease from the previous year where 35 incidents (45%) occurred in the engine bay. (see *Figure 9*).

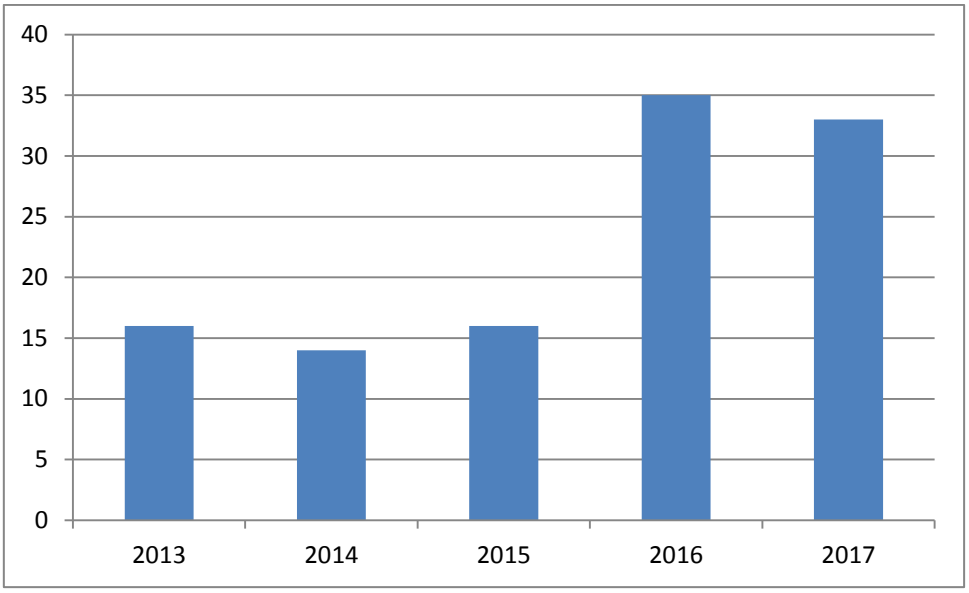

Figure 9: Number of engine bay incidents 2013-17

Cause of engine bay incidents

The cause of the engine bay incidents in 2017 was mechanical malfunction (55%), fluid leakage (27%), and electrical malfunction (6%) (see Figure 10).

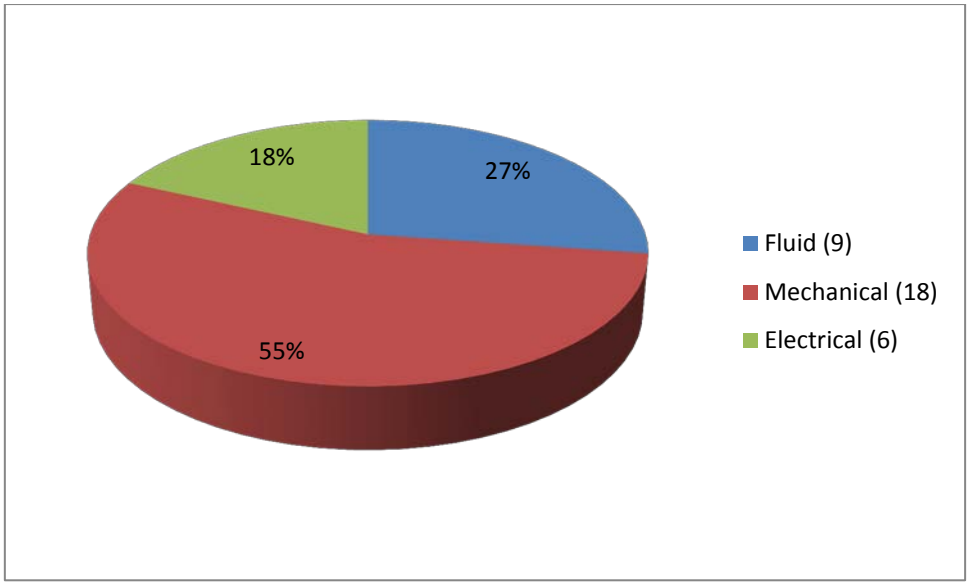

Figure 10: Cause of engine bay incidents 2017

Number of wheel well incidents

In 2017, 46 incidents (52%) were located around the wheel well. It should be noted that the majority of these incidents (91%) resulted in smoke damage only. OTSI believes that it is likely the increasing trend of wheel-well thermal incidents is due mainly to an increase in reporting. However, these precursor incidents should not be ignored as one wheel-well fire destroyed a bus at Thornton in October 2017. There has been a steady increase in wheel well incidents from 2013 to 2017 (see *Figure 11*).

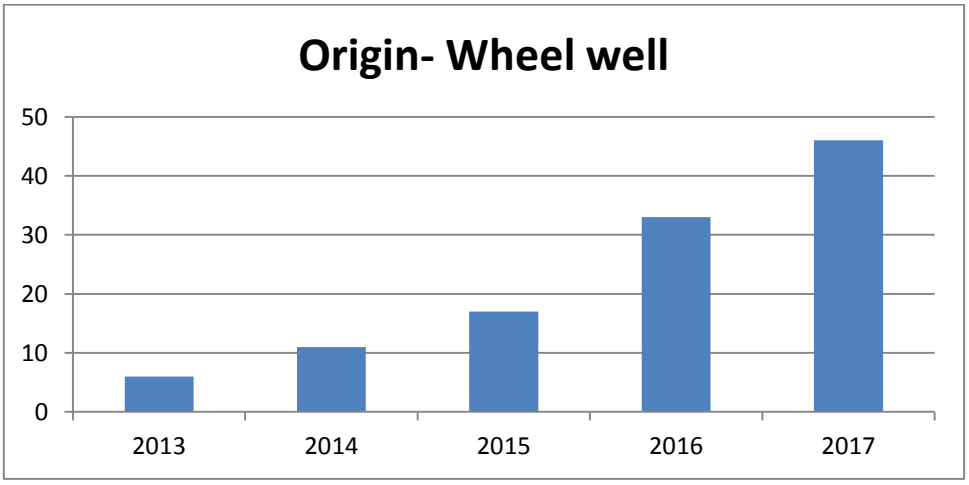

Figure 11: Number of wheel well incidents 2013-17

Cause of wheel well incidents

The majority of incidents were a result of brake problems, brakes locking on, or being driven without retarder (96%). Tyre problems occurred on 2 occasions (4%) (see *Figure 12)*.

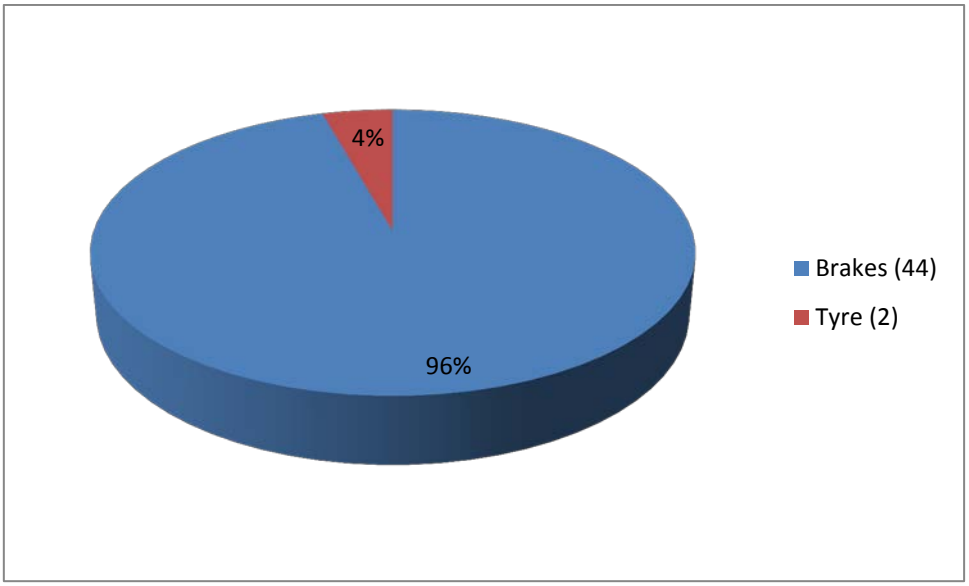

Figure 12: Causes of wheel well incidents 2017

Number of incidents originating in the body

A smaller number of incidents originated both inside and outside the body of the bus or coach. There has been an increase in body incidents from 2013 to 2017 (see *Figure 13*).

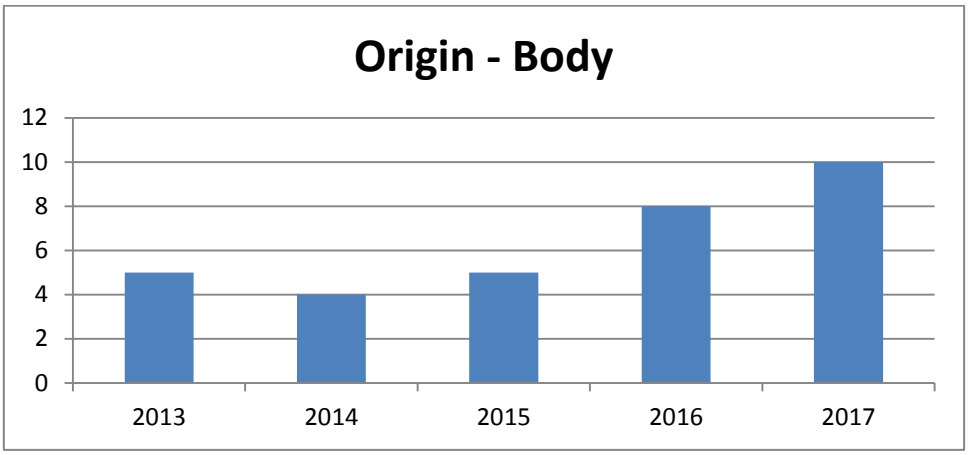

Figure 13: Number of body incidents 2013-17

Cause of body incidents

The cause of body incidents was all due to electrical malfunction or failure (100%). The 10 electrical incidents had a wide variety of origins: battery compartment, battery cables, ignition switches, wiper motor, and a mirror control unit.

Compressed Natural Gas (CNG) incidents

The number and causes of fire and thermal incidents involving CNG-fuelled buses is shown below (see *Figures 14 and 15)*.

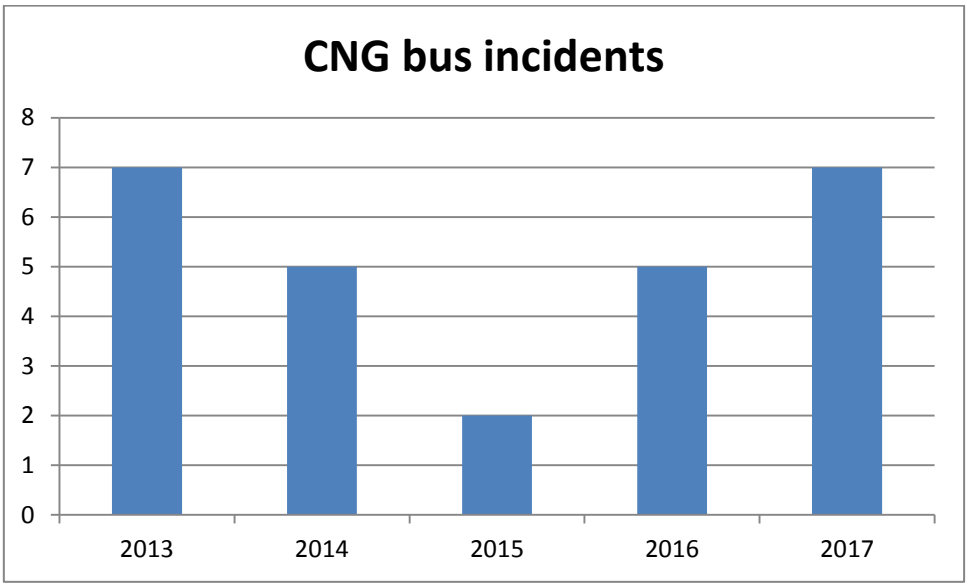

Figure 14: Number of CNG bus incidents 2013-17

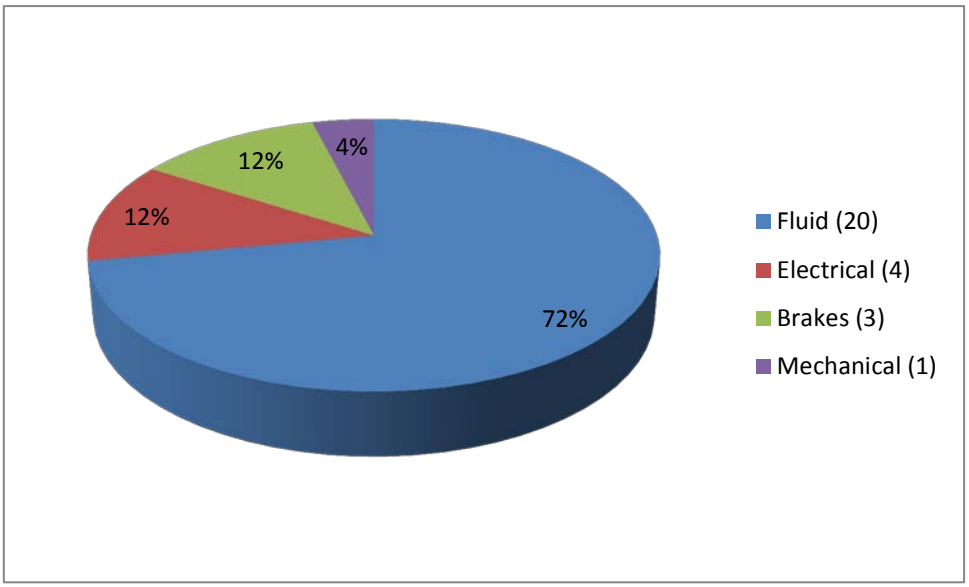

Figure 15: Causes of CNG bus incidents 2013-17

In 2017, there were 7 incidents involving CNG fuelled buses.

Description of CNG bus incidents	Damage level[5]
Header tank split, causing coolant to spray onto hot engine parts.	Nil
Faulty park brake valve which allowed the rear brake to apply.	Minor
A lip on the brake pad material became hot through brake application.	Smoke
Failed manifold gasket allowed fuel mixture to combust.	Minor
Flammable liquid has ignited following contact with hot engine surface.	Destroyed
Smoke inside passenger area.	Smoke
Flames from engine bay.	Minor

Figure 16: Description of CNG bus incidents NSW 2017

Detection of Fire

The data for the detection of incidents in 2017 are shown (see *Figure 17).*

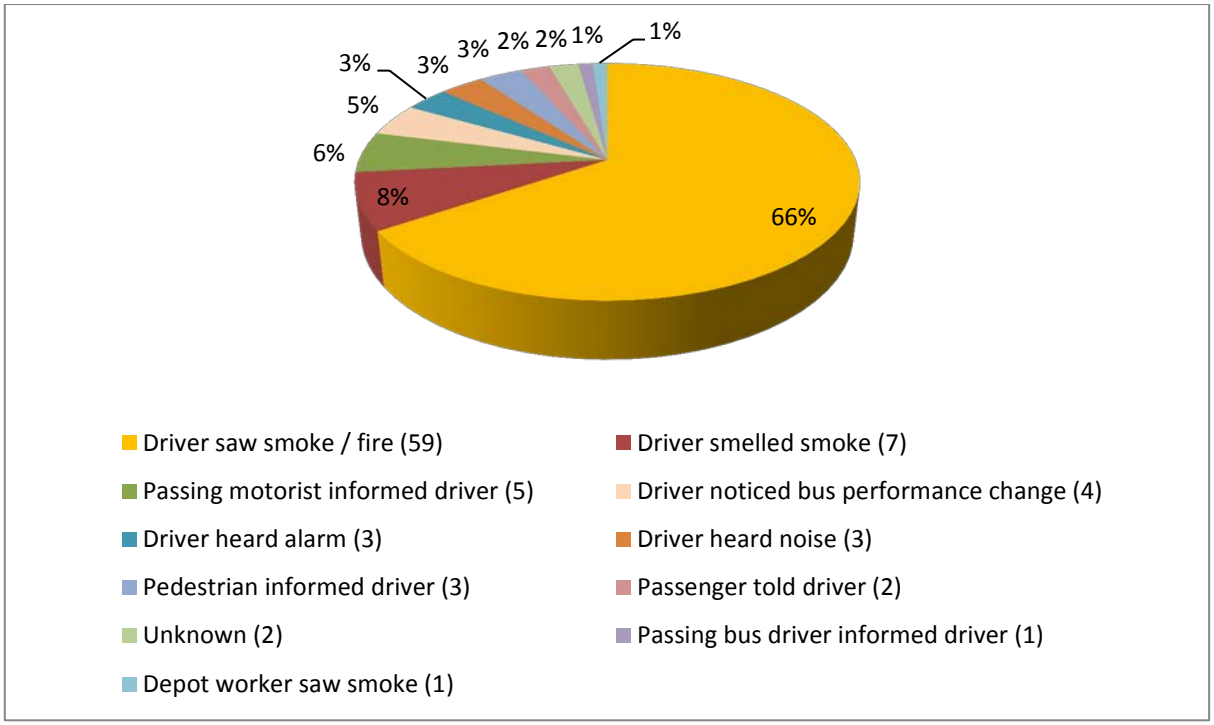

Figure 17: Detection of incidents 2017

[5] For description of damage level classifications see Appendix B.

In 2017, bus drivers were the first to either see or smell smoke or see flames on 73% of occasions. This was similar to 2016 where the driver detected the incident on 76%. This highlights the importance of the driver's role in detecting the fire and acting accordingly.

Passengers were the first to detect smoke on 2 occasions while external parties raised the alarm on the remaining 10 occasions.

Fire Fighting

Portable fire extinguishers were used on 28 occasions (31%). The use of portable extinguishers was successful on 26 of those occasions, a success rate of 93%. This highlights the importance of the role of fire extinguishers in limiting damage.

An extinguisher was unsuccessful in defeating the fire on 2 occasions. In May at Holbrook, 2 fire extinguishers were deployed; however, the fire was too well established and eventually destroyed the coach. On the wheel-well fire at Thornton in October the driver stated that the fire extinguisher was used by a pedestrian passer-by who took the extinguisher from him. The fire was well established and the attempt to extinguish the fire was unsuccessful.

In 2017, NSW Fire and Rescue was called upon to attend on 21 occasions (23%). The percentage of occasions that NSW Fire and Rescue attended for the past 3 years is shown below (see *Figure 18).*

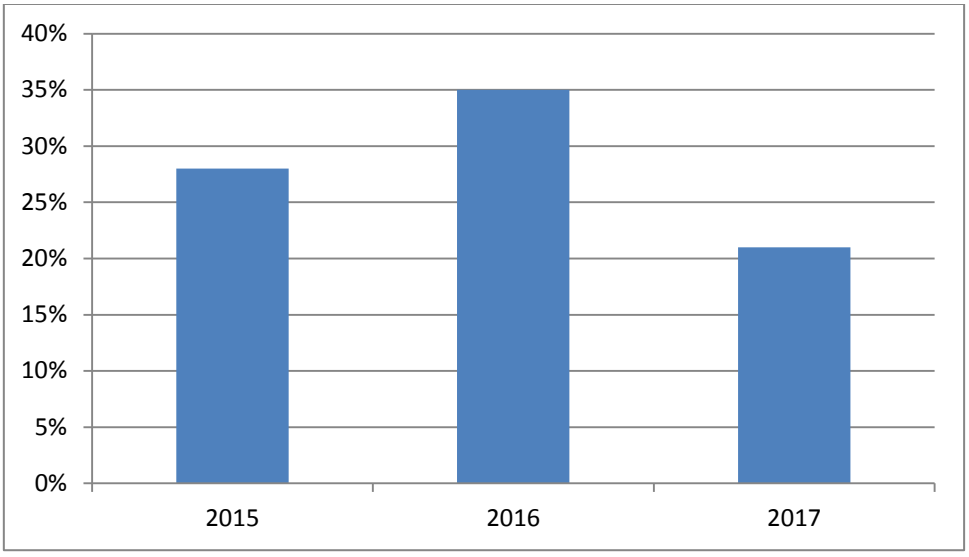

Figure 18: NSW Fire and Rescue: percentage attended 2015-2017

Effectiveness of engine bay fire suppression (EBFS)

In 2017, of the 90 incidents reported to OTSI, a total of 63 buses had an EBFS system fitted. An activation of the EBFS system was recorded for 4 incidents. Two buses were destroyed, one sustained major damage and one minor damage. A description of these events is provided in *Figure 19* below.

EBFS activation description	Damage level
A fire started in the wheel well of a bus with only the driver on board. The tyre pressure monitoring alarm sounded, however, the driver did not react in a timely manner. Despite the fire extinguisher being deployed, the fire was unable to be extinguished. The EBFS activated as a consequence of heat from the wheel well.	Destroyed
A fire started in the engine bay of a CNG bus, the fire suppression system activated and all passengers were evacuated safely. The fire flashed over into the passenger saloon and the damage was such that the bus was considered unrepairable.	Destroyed
A fire started in the engine bay of a bus as it was returning to the depot after having the EBFS system fitted. There were no passengers on-board. The fire suppression system activated and suppressed the fire. The fire reignited after the bus arrived at the depot. The fire was then extinguished using the depot's portable fire extinguishers.	Major
A fire started in the engine bay of a CNG bus, the fire suppression system activated and all passengers were evacuated safely. The driver did not shut the gas supply off, however, the EBFS system extinguished the fire and prevented re-ignition.	Minor

Figure 19: Engine bay fire suppression system fire activations

At the end of 2017, OTSI requested operators to provide information about the success of the engine bay fire suppression systems. Out of 19 operators contacted, 12 provided a response regarding the number of systems installed and the number of activations. The 19 operators reported having a total of 4439 buses, all of which were fitted with EBFS systems. They reported a total of 42 activations. Most of the activations (32) occurred due to exhaust system leaks increasing the temperature in the engine bay. Other activations were due to EBFS detection tubes rubbing or coming out from their fittings.

Effectiveness of tyre pressure monitoring systems (TPMS)

Many bus operators now have tyre pressure monitoring systems fitted. A large number were fitted as part of the EBFS system installation. These systems continuously monitor tyre pressure and temperature data which is transmitted from wireless, valve-stem mounted tyre sensors. A dash-mounted screen provides a visual and audible alert for rapid deflation, under inflation, high pressure and excessive heat conditions.

OTSI requested operators to provide information about the success of the tyre pressure monitoring systems. Out of 19 operators contacted, 12 provided a response regarding the number of systems installed and the number of activations.

The 19 operators reported having a total of 4439 buses, with 1738 of these buses were fitted with TPMS (39%). The numbers of the activations are provided in *Figure 20* below. It should be noted that this number does not reflect all activations as many operators did not keep records of activation numbers. It is hoped that improved record keeping by operators will make the data more comprehensive in future years.

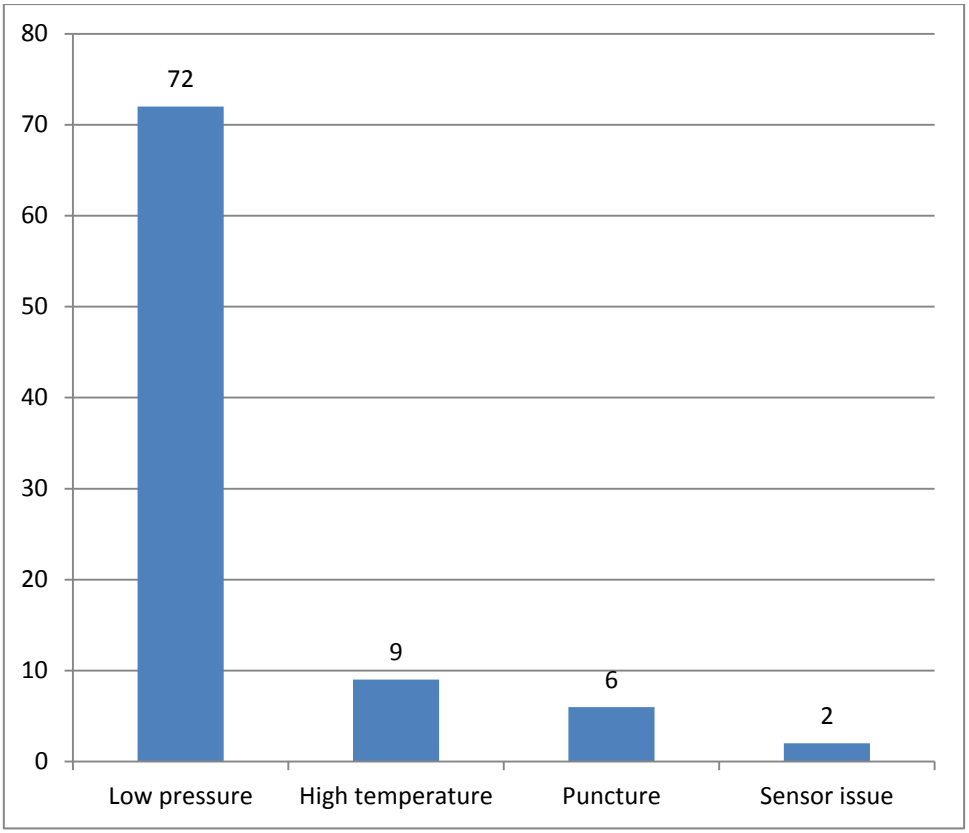

Figure 20: Tyre pressure monitoring system activations

Non-reporting of fire incidents

In NSW, OTSI receives reports from accredited bus operators conducting public passenger services as required by the *Passenger Transport Act 1990*.

It is a legislative requirement that: *'An operator of a bus service who becomes aware that a bus being used to provide the service has been involved in an accident or incident must notify the Chief Investigator of the accident or incident … if the accident or incident involves a mechanical or electrical fire or an explosion on the bus.'*[6]

Since 2010, all accredited bus operators have also been required to create an electronic record in the Bus Incident Management System (BIMS), which is operated and administered by Roads and Maritime Services (RMS).

It was found that on 7 occasions OTSI were not notified of a fire incident. The incidents were instead reported in the BIMS. It is important that the legislative requirement is met by all operators in order to gather a complete record of incidents for analysis.

Progress on improving bus fire safety

Based on advice from Transport for NSW (TfNSW), the RMS and the State Transit Authority (STA), the following key events occurred in 2017.

Installation of engine bay bus fire suppression systems

The installation of engine bay bus fire suppression systems was commenced by STA in 2009 where all new bus supply contracts required the bus to be delivered with a fire suppression system installed. In 2013, STA retrofitted their Mercedes Benz 0500 CNG bus fleet with fire suppression systems, and in 2015, commenced their fire suppression retrofit programme of the rest of their fleet. This project was completed in December 2016. All 2308 STA buses are now fitted with engine bay fire suppression systems.

Previously, the NSW Minister for Transport and Infrastructure announced that all private operator buses covered under the TfNSW metropolitan and outer metropolitan private bus operators' contract were to be retro-fitted with engine bay

6 NSW Passenger Transport Regulation 2007 clause 88.

bus fire suppression systems.[7] Approximately 2335 buses were retro-fitted in 10 months. This project was completed in September 2017.

All future buses supplied under the Bus Procurement Panel, including Rural and Regional contract buses, will be delivered with engine bay bus fire suppression systems.

Audit of the engine bay bus fire suppression systems installation project

The installation project applied international standards for designing, testing and installation of automatic fire suppression systems to ensure consistency of the solution.[8] An audit was conducted in September 2017 by a member of RISE Research Institutes of Sweden. The following areas were checked during this audit:

- Documented risk assessment
- Fire-suppression system correctly dimensioned
- Nozzles mounted according to instructions
- Extinguishing agent sample saved for analysis.

The results of the audit were provided to TfNSW to assist in ensuring the quality and effectiveness of the installation.

Bus safety forum

In March 2017, a bus safety forum organised by TfNSW was held at the International Conference Centre in Sydney. All major bus operators were invited to attend and the majority sent at least one senior representative. The forum focussed on bus fire safety.

The outcomes of this bus forum informed the further actions TfNSW took to mitigate the risk of bus fires.

TfNSW initiates action to reduce bus fire risk

In addition to the key actions above, in February the Secretary of TfNSW asked that a systematic review be undertaken to provide assurance that it has identified and assessed all practicable measures within TfNSW control to reduce the risk of bus fires in NSW.

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7 Andrew Constance (Minister for Transport and Infrastructure), *Safety Boost for Bus Customers*, media release, Sydney, 6 August 2015.

8 The P-Mark certification process developed and controlled by the RISE Research Institutes of Sweden (formerly SP Technical Research Institute of Sweden), consisting of a series of tests (SP Method 4912) to rate suppression performance and limitations of fire suppression systems installed in engine compartments of buses and coaches.

A bus fire management committee was established comprising an independent chairperson and senior executives from TfNSW and RMS. The Chief Investigator from OTSI was also invited to observe committee meetings and provide advice in relation to the deliberations.

The committee made a number of recommendations which will influence the strategy for improving bus fire safety in NSW in the coming years. Some of the areas covered by the recommendations were:

- The further development of fleet procurement standards
- Enhancements to the Australian Design Rules
- Improvement of maintenance processes
- Assist industry in driver training programs
- Consider a type approval process for the bus procurement panel
- Improve regulatory oversight
- Conduct a review of bus fire safety in rural and regional buses
- Improve the reporting and collection of bus fire data.

TfNSW state they are committed to the implementation of the recommendations of the Bus Fire Management Committee. A governance framework has been established and three working groups have commenced the execution of the strategy.

Conclusions

There were 90 fire and thermal incidents reported to OTSI in 2017. This represented a 16% increase from 2016. It should be noted there was a significant decrease (43%) in fire incidents, from 37 fire incidents in 2016, to 21 fire incidents in 2017.

There was a decrease in severity of damage to vehicles, with 5 vehicles destroyed in 2017 compared to 7 in 2016.

Despite the increase in incidents, there were no injuries reported.

The majority of fire and thermal incidents originated in the wheel well (52%). The three main initiators were brake problems, mechanical malfunction and electrical malfunction.

There is a continuing increase in the number of brake-related thermal incidents. It is likely a result of increased reporting; however, these incidents should not be ignored as 9% of these wheel well incidents led to actual fires.

All Sydney Buses, metropolitan and outer metropolitan private buses under TfNSW contracts are now fitted with engine bay fire suppression systems. Also, new buses purchased under these contracts will be delivered with fire suppression systems.

TfNSW, in consultation with all major stakeholders, have initiated a wide range of actions to reduce bus fire risk.

Appendix A

BUS INCIDENTS RECORDED IN 2017

MONTH	VEHICLE TYPE	YEAR	LIKELY FIRE SOURCE	SEVERITY	ONBOARD FIRE EQUIPMENT USED
Jan	Double deck	2012	Brake problem near side rear wheel.	Smoke damage	No
Jan	Bus	2010	Fractured air compressor tank outlet resulting in the melting of the wiring loom insulation, causing an electrical short and subsequent fire.	Minor	Yes*
Jan	Bus	2008	Brake problem near side rear wheel.	Smoke damage	No
Jan	Bus	2009	Hydraulic fan seal failed causing oil to leak onto exhaust pipe.	Smoke damage	No
Jan	Bus	2008	A hydraulic fan hose burst and leaked onto engine.	Smoke damage	No
Jan	Bus	2000	Header tank split causing coolant to spray onto hot engine parts.	Nil	Yes*
Jan	Bus	1996	Brake calliper adjustment on near side rear wheel caused brakes to bind.	Smoke damage	No
Jan	Bus	2011	Brake problem near side front wheel.	Smoke damage	No
Jan	Bus	2008	Hydraulic fan seal failed causing fluid to leak onto hot engine.	Smoke damage	Yes
Feb	Bus	2009	Brake problem rear wheels.	Smoke damage	No
Feb	Bus	1992	Battery terminal cables shorted.	Destroyed	No*
Feb	Bus	2013	Brake problem near side front wheel.	Smoke damage	Yes
Feb	Bus	2010	Fan hub pulley seized causing belt to smoke.	Smoke damage	No
Mar	Bus	1997	Alternator cables shorted.	Major	Yes
Mar	Bus	2013	Brake problem near side rear wheel.	Smoke damage	No
Mar	Bus	2010	Oil leak from turbocharge return pipe.	Minor	Yes*
Apr	Bus	2000	Brake booster leak caused rear brakes to lock on.	Smoke damage	No
Apr	Bus	2013	An internal leak caused brakes to apply.	Smoke damage	No
Apr	Bus	2011	Brake problem rear wheel.	Smoke damage	No
Apr	Bus	2010	Injector o-ring failed causing oil leak.	Smoke damage	No

Apr	Bus	2015	Brake fire near side front wheel, driver put out with extinguisher.	Minor	Yes*
Apr	Bus	2009	Booster pump failed causing coolant leak onto engine bay.	Nil	No
Apr	Bus	2009	Turbocharger seal failed as it was being returned to the depot by mechanics.	Minor	Yes*
Apr	Bus	2006	An electrical short circuit in the engine bay.	Minor	No*
Apr	Bus	2001	Faulty park brake valve which allowed the rear brake to apply.	Minor	No*
May	Coach	1999	Electrical fire after striking object.	Destroyed	Yes*
May	Bus	2009	Brakes on rear axle over adjusted.	Smoke damage	No
May	Bus	2008	Brake problem near side rear wheel.	Smoke damage	No
May	Bus	2009	Brake problem near side rear wheel.	Smoke damage	No
Jun	Bus	2013	Brake problem near side front wheel.	Smoke damage	No
Jun	Bus	2008	A lip on the brake pad material appears to have become hot through brake application.	Smoke damage	Yes*
Jun	Minibus	1997	A water pump seized causing belt slip and smoke.	Smoke damage	No
Jun	Bus	2010	Brake problem off side rear wheel.	Smoke damage	No
Jun	Bus	2010	Brake issue near side rear wheel.	Smoke damage	No
Jun	Bus	2003	Electrical short from alternator cables.	Major	Yes
Jul	Bus	2010	A blockage in the air system was identified close to the output of the engine air compressor.	Minor	Yes*
Jul	Bus	2010	Brake problem both front wheels.	Smoke damage	No
Jul	Bus	2011	Brake problem.	Smoke damage	No
Jul	Coach	2003	Engine bay fire.	Destroyed	No*
Aug	Bus	2009	Air conditioner idler pulley seized.	Smoke damage	No
Aug	Bus	2007	Turbocharger failed.	Minor	Yes
Aug	Bus	2017	Brake problem front wheel.	Smoke damage	No
Aug	Bus	2013	Brake problem near side rear wheel.	Smoke damage	No
Aug	Minibus	1998	Air conditioner compressor seized causing belt slip.	Smoke damage	No

Aug	Bus	1996	Bus heater electrical problem.	Smoke damage	No
Aug	Bus	2009	Tyre rubbing on guard.	Smoke damage	No
Aug	Bus	2013	Brake problem near side front wheel.	Smoke damage	No
Aug	Bus	2001	Failed manifold gasket allowed fuel mixture to combust.	Minor	No
Aug	Bus	2007	Brake problem near side front wheel.	Smoke damage	No
Aug	Bus	2009	Brake problem near side rear wheel.	Smoke damage	No
Aug	Bus	2013	Brake problem near side front wheel.	Smoke damage	No
Aug	Bus	1999	Saloon light switch short circuit.	Smoke damage	No
Aug	Bus	2009	Brake problem near side front wheel.	Smoke damage	Yes
Aug	Bus	1997	An interlock valve failed causing overheating of rear brakes.	Smoke damage	No
Sep	Bus	2009	New compressor head failed.	Smoke damage	No
Sep	Bus	2007	Brake problem rear wheels.	Smoke damage	No
Sep	Bus	2009	Engine injector fault.	Smoke damage	No
Sep	Bus	2013	Park brake problem.	Smoke damage	No
Sep	Bus	1994	Ignition switch shorted when the switch fell apart.	nil	Yes
Sep	Bus	2001	Turbocharger failed causing ignition of vapour oil in intake pipe.	Minor	Yes
Sep	Bus	2011	Brake problem near side rear wheel.	Smoke damage	No
Sep	Bus	2013	Foreign object had caught in brake calliper.	Smoke damage	Yes*
Sep	Bus	2008	Brake problem near side rear wheel.	Smoke damage	No
Oct	Bus	2007	Intercooler pipe clamp became loose causing exhaust smoke to discharge.	Smoke damage	No
Oct	Bus	2011	Electronic brake module failed causing the near side rear brake to activate.	Smoke damage	No
Oct	Bus	2009	Brake problem front wheel.	Minor	Yes
Oct	Bus	2000	Off side rear wheel fire.	Destroyed	Yes*
Oct	Bus	2009	Condenser fan motor seized.	Minor	No
Oct	Coach	2002	Electrical short in wiper motor.	Minor	Yes
Oct	Bus	2015	Brake problem near side front wheel causing fire.	Smoke damage	Yes

Oct	Bus	2011	Faulty wiring caused electrical short above visor.	Minor	Yes
Oct	Bus	2000	Electrical short in dashboard of bus.	Minor	No
Oct	Coach	1994	Alternator wire shorted on body causing fire.	Minor	Yes*
Oct	Bus	2007	Brake problem off side rear wheel.	Smoke damage	Yes
Nov	Bus	2013	Rear wheel brakes overheated.	Smoke damage	No
Nov	Bus	2003	Split in fuel line caused fuel leak on engine block.	Smoke damage	No*
Nov	Bus	2003	Short circuit in electrical wiring in engine bay.	Minor	Yes
Nov	Bus	2013	Faulty brake control module on near side rear wheel.	Smoke damage	No*
Nov	Bus	1999	Fuel leak at injector bleed off line. Fuel leaked onto engine cylinder head.	Minor	No
Nov	bus	2008	Flammable liquid has ignited following contact with hot engine surface.	Destroyed	Yes*
Nov	Bus	2009	Off side rear brake calliper had over adjusted and not returned to normal position after brake application.	Smoke damage	No
Dec	Bus	2007	Retarder not working causing excessive brake usage.	Smoke damage	No
Dec	Bus	2007	Brake problem rear wheels.	Smoke damage	No
Dec	Coach	2006	Battery cable shorted.	Minor	Yes
Dec	Bus	2009	Faulty turbocharger.	Smoke damage	Yes
Dec	Bus	2011	Brake problem near side front wheel.	Smoke damage	No
Dec	Bus	2009	Oil leak from hydraulic fan motor seal.	Smoke damage	No
Dec	Bus	2017	Short circuit in mirror control unit.	Smoke damage	No*
Dec	Bus	2008	Smoke inside passenger area.	Smoke damage	No*
Dec	Bus	2002	Flames from engine bay.	Minor	No*

***** Denotes attendance by NSW Fire and Rescue.

Appendix B

Severity level descriptions

Destroyed
Due to damage sustained in the fire, the bus cannot be repaired. There was significant destruction to one or more sections. Examples of this category are:

- The bus is completely burnt out.
- The engine bay is burnt out and the rear passenger area of the bus is partially damaged.

Major
Damage to one large section of the bus or multiple parts where the bus can be repaired by replacing the panel or part. Examples of this category are:

- The engine bay sustains a fire, but the fire is contained to that area and the rest of the bus is undamaged.

Minor
One part of the bus is damaged but that part can be repaired or replaced. Examples of this category are:

- An oil leak from a cracked pipe onto a hot engine part creating a small fire.
- Brake callipers sticking generating intense heat and the need for replacement.
- An electrical fuse which generates heat to that local area.

Smoke damage
No physical damage to any part except smoke stains/residue. No parts need replacing. Examples of this category are:

- Brake callipers sticking generating intense heat and do not need replacing.

Nil damage
No physical damage to any part, no smoke staining and/or no parts which need replacing. Examples of this category are:

- Tyre lockup and smoke generated.
- Water leak generating steam.