OTSI Office of Transport Safety Investigations

BUS SAFETY REPORT

BUS FIRES IN NEW SOUTH WALES IN 2018

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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 2014 (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 2018

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 sixth such annual report.

Monitoring of the extent, origins and causes of bus fires reported to OTSI continued through 2018 and resulted in the publication of this report in February 2019.

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 buses on five occasions following the report of a fire. Two incidents were formally investigated and documented in more comprehensive OTSI bus safety investigation reports.

This report contains a summary of the information gathered in 2018 and provides commentary on comparisons with the information reported in previous years. The report also summarises the implementation progress of recommendations made in previous reports.

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

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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 2018 there were a total of 101 reported incidents: 14 fire incidents and 87 thermal incidents. This was an increase in total incidents of 12% from 2017 (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. This was most evident by the number of incidences reported by bus drivers.

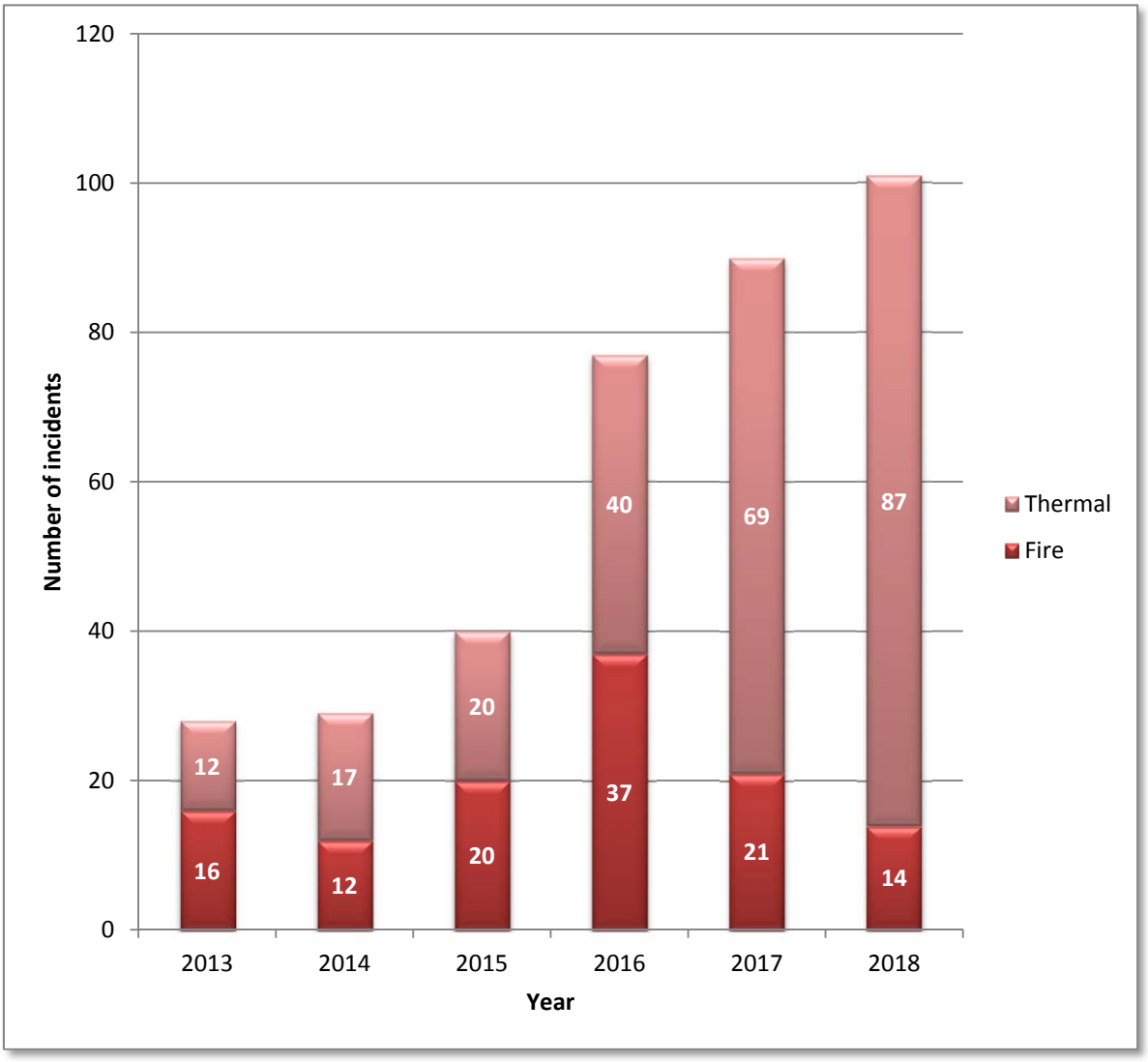

Figure 1: Number of fire and thermal incidents 2013-2018

It should be noted that there was a notable decrease of 33% in fire incidents, from 21 fire incidents in 2017 to 14 fire incidents in 2018.

The 101 incidents reported in 2018 were distributed throughout 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*.

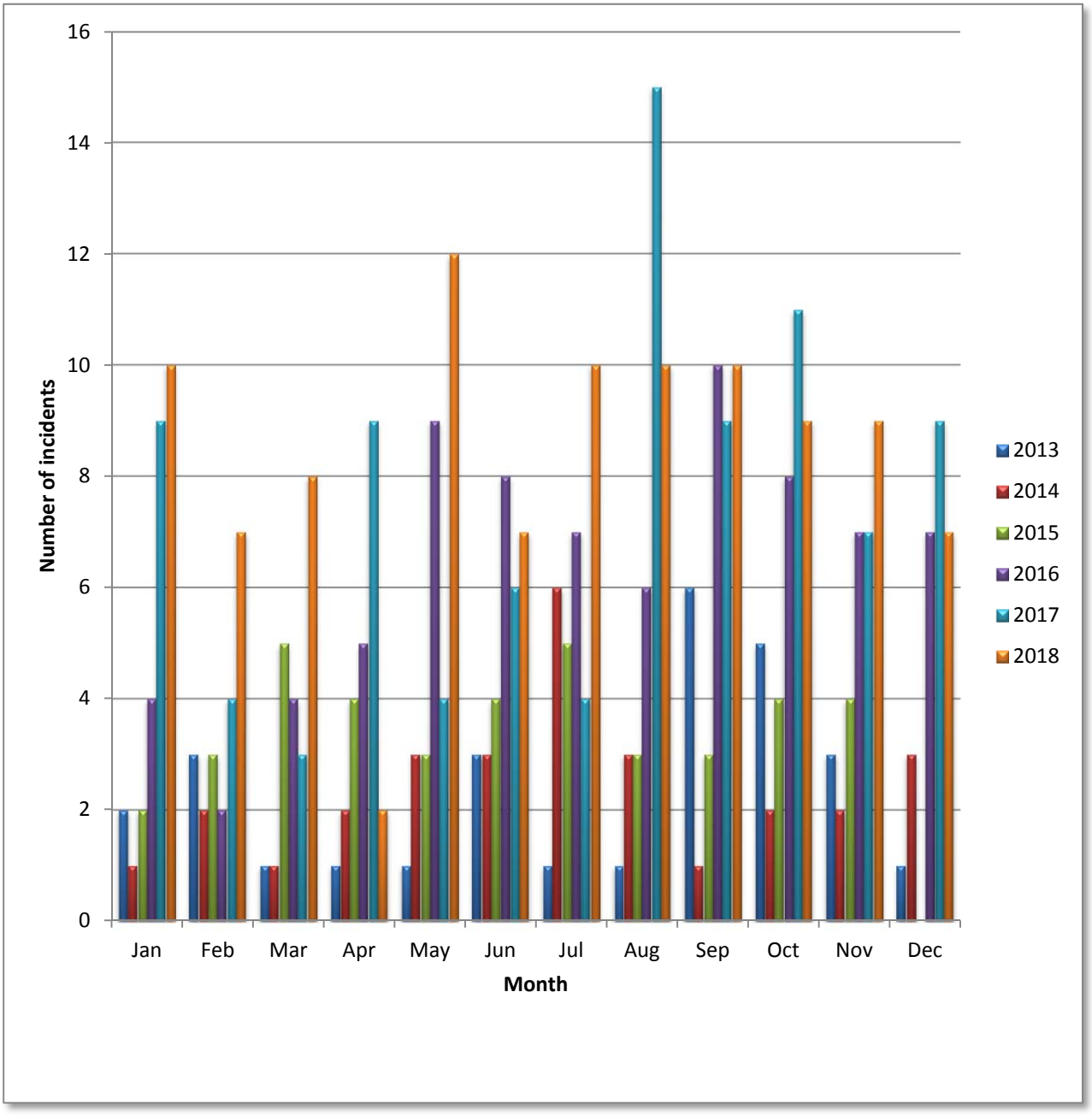

Figure 2: Incidents by month 2013-2018

Although there was a decrease in incidents in April 2018, 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, three buses were destroyed, one suffered major damage, 28 had minor damage, 63 had smoke damage and six buses had nil damage (see *Figure 3*).

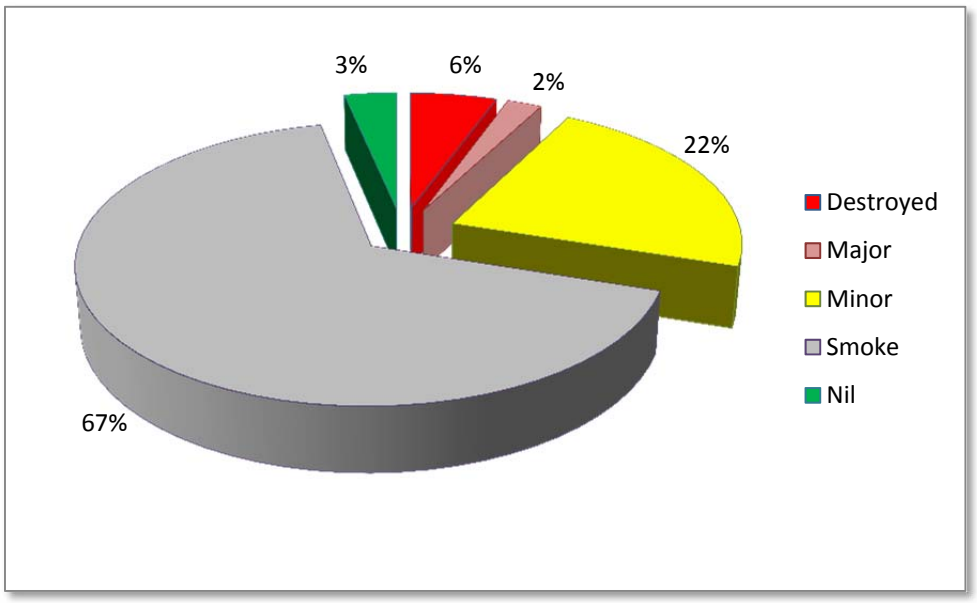

Figure 3: Severity level of incidents NSW 2018

One important area is the category of highest severity, in which 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 buses have continued to decline following a peak in 2016. Figure 4 indicates that in 2018 three buses were destroyed compared to five in 2017 and seven in 2016.

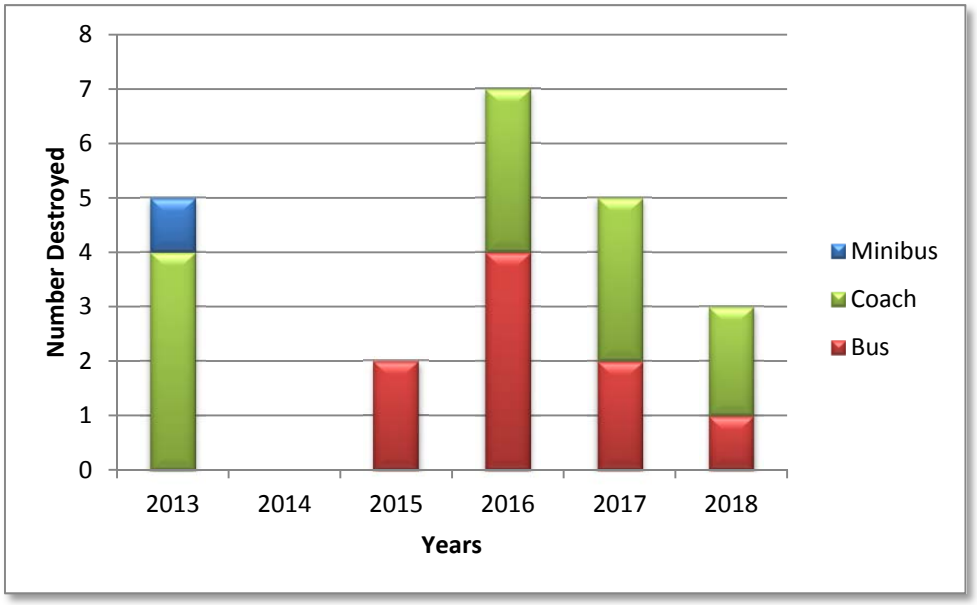

Figure 4: Destroyed 2013-2018

The number of incidents resulting in major damage in previous years is also indicating a decrease following a peak in 2016: 2013 (2), 2014 (2), 2015 (2), 2016 (7), 2017 (2) and 2018 (1).

There was a reduction in the top two severity levels (destroyed and major), from 14 incidents in 2016, seven in 2017 to four in 2018.

Injuries

Despite an increase in incidents, there were no injuries reported in 2018. Approximately 1049[4] passengers had their travel affected by the incidents. The largest number involved in a single incident was approximately 102 passengers (a school service). There were two significant disruptions to the transport network as a result of these incidents.

On 28% of occasions the bus or coach involved in the incident was empty of passengers.

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

Age of buses and number of incidents

The ages of the buses involved ranged from almost new to 25 years. The majority of incidents involved buses between 5 and 11 years old (see *Figure 5*). An analysis of bus fleets in previous years showed that this age range makes up the majority of fleets. Ten different makes of bus were involved and no make or model trends were identified.

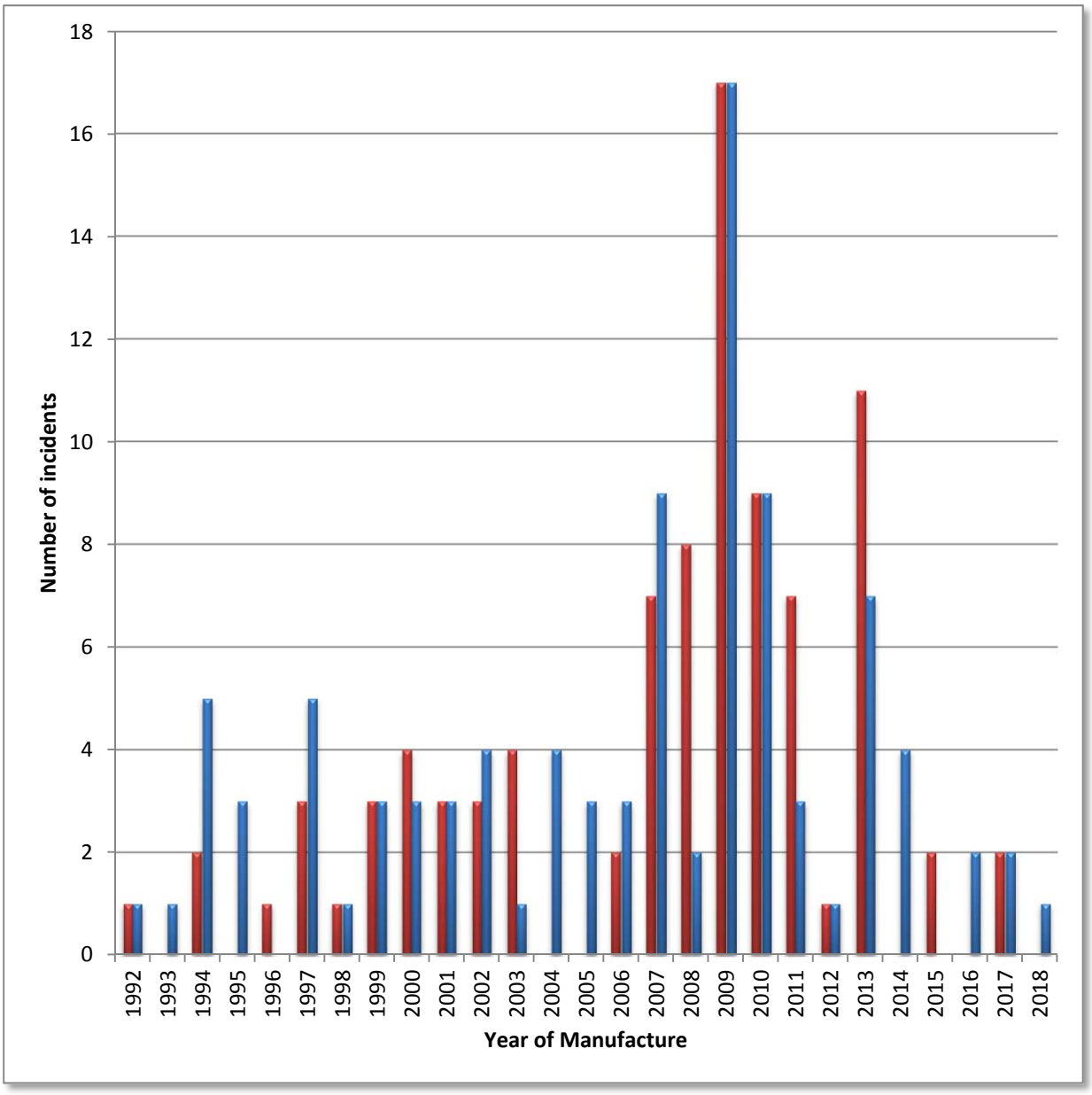

Figure 5: Age of bus involved in 2017 (red) and 2018 (blue)

Severity level and age of buses

The three destroyed buses ranged in year of manufacture from 1992 to 2013 and the bus that sustained major damage was manufactured in 1997. The average age for buses in the destroyed category in 2016 was 19.5 years, in 2017 was 16.6 years, and in 2018 was 13.6 years. The average age for buses in the minor damage category in 2016 was 6.6 years, 2017 was 11.7 years and in 2018 was 10.5 years. The average age of buses involved in all levels of fire and thermal incidents was 11.7 years, an increase of three from previous years.

The severity level and the average age of buses involved in incidents in 2016, 2017 and 2018 are shown below in *Figure 6*.

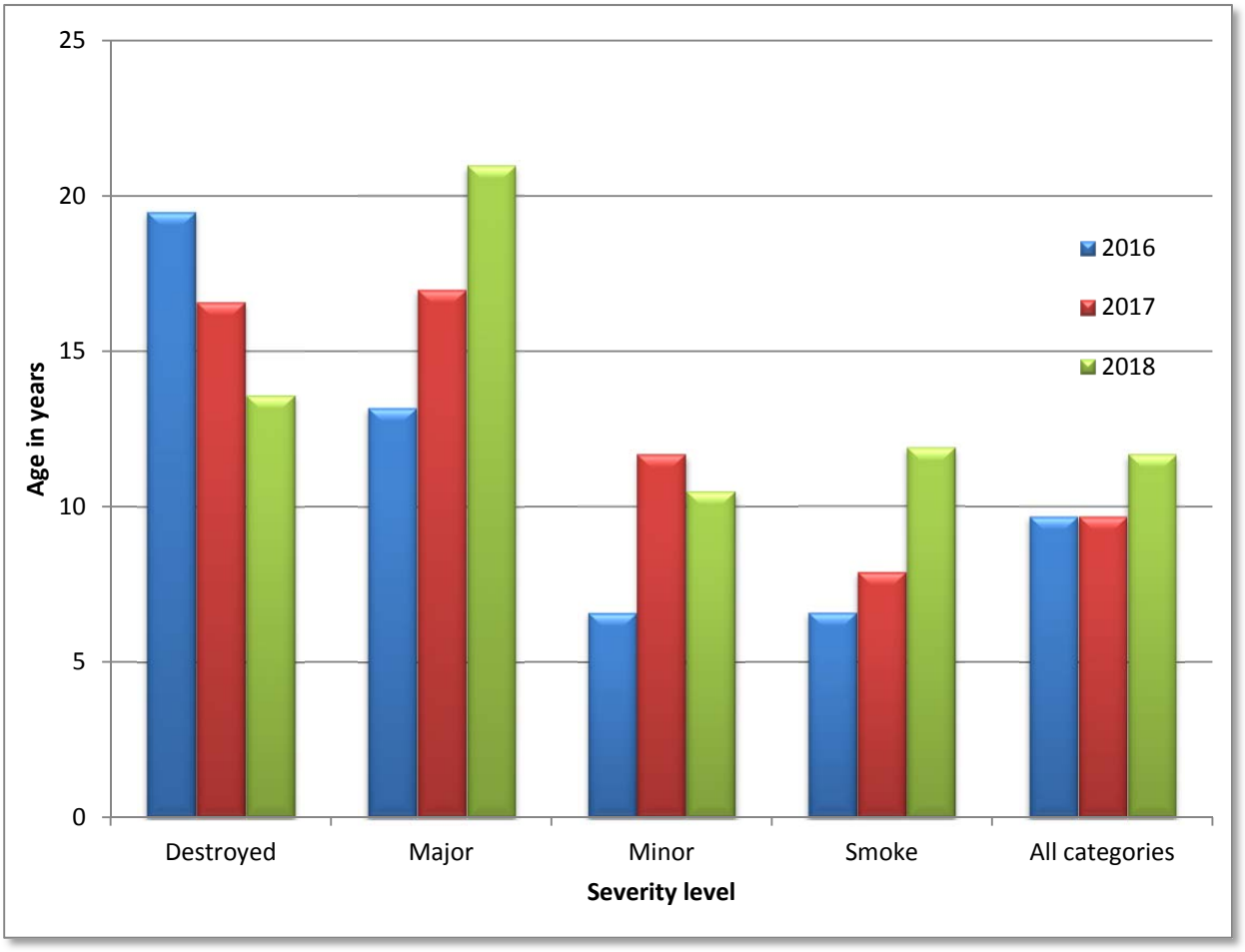

Figure 6: The severity level and the average age of the bus

Origins and Causes

Overall origin

In 2018, the majority of fire and thermal incidents 56% originated in the wheel well. The engine bay had 33% and the body had 11%. *Figure 7* shows the originating area of all incidents in 2018.

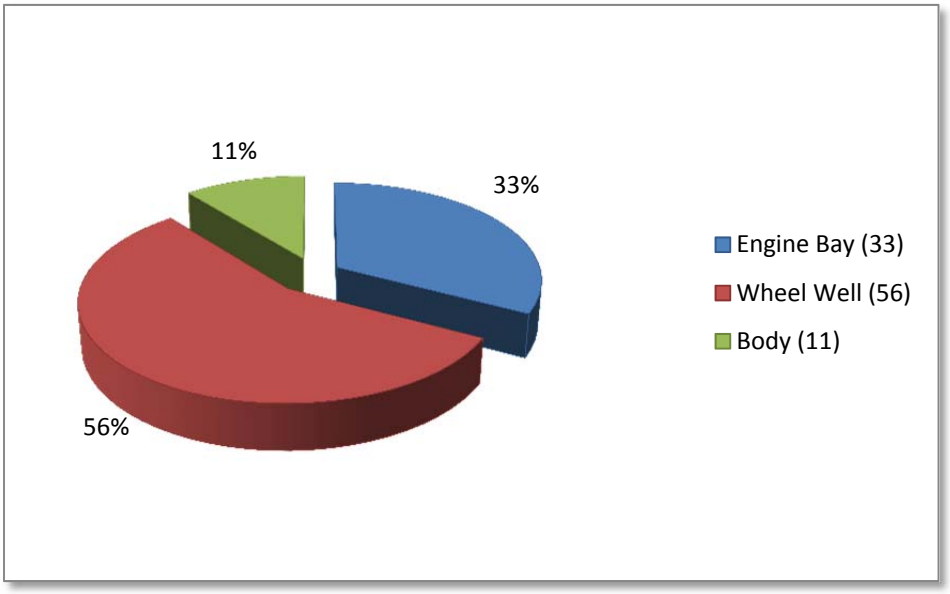

Figure 7: Location by origin 2018

Overall causation

The data for the causes of fire and thermal incidents in 2018 are shown in *Figure 8.*

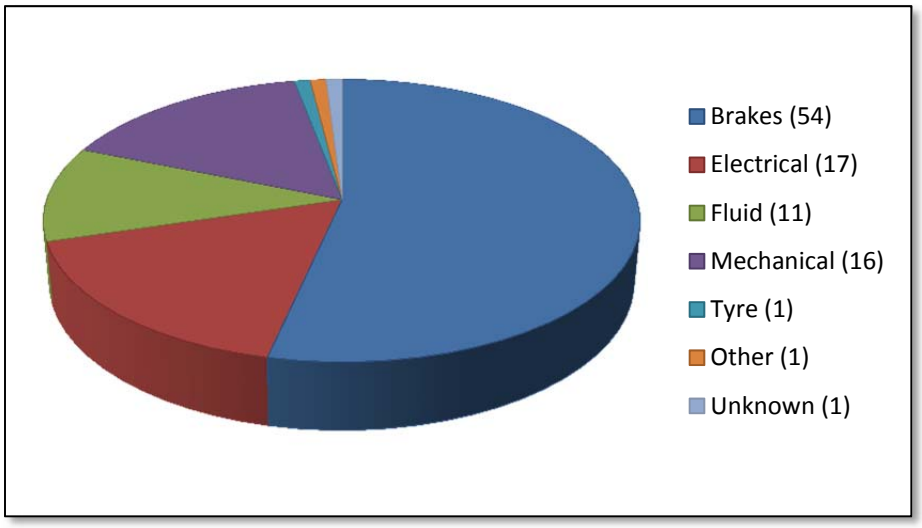

Figure 8: Causes of incidents 2018

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

In 2018, 33 incidents (33%) originated in the engine bay. Although only minor, there has been a decline since a peak of 35 in 2016 (*Figure 9*).

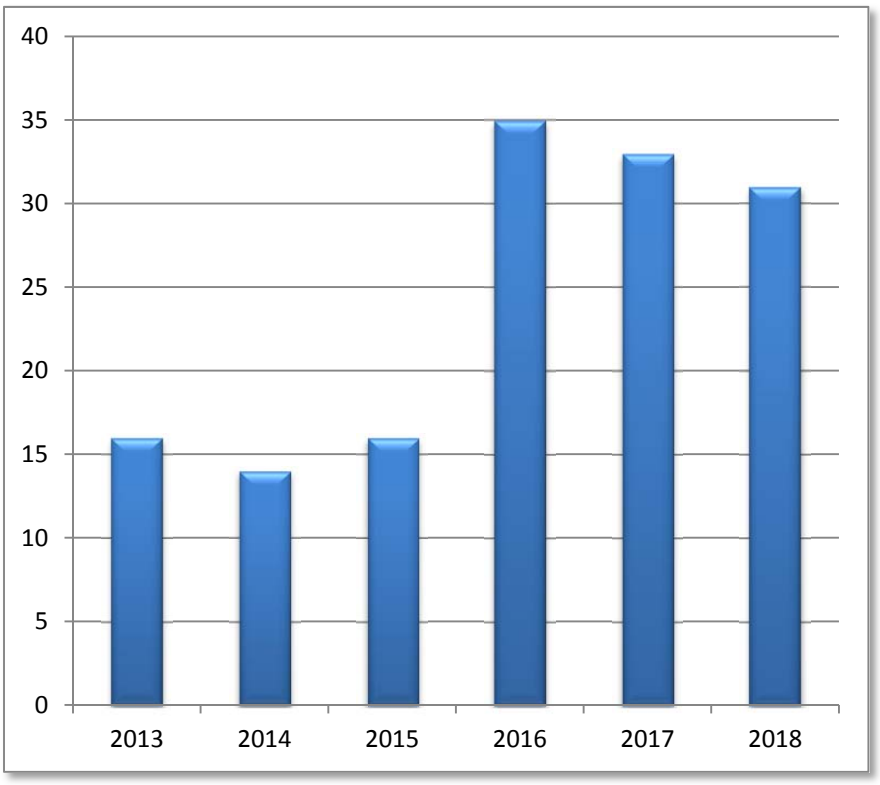

Figure 9: Number of engine bay incidents 2013-18

Cause of engine bay incidents

The cause of the engine bay incidents in 2018 was mechanical malfunction (46%), fluid leakage (33%), and electrical malfunction (21%) (*Figure 10*).

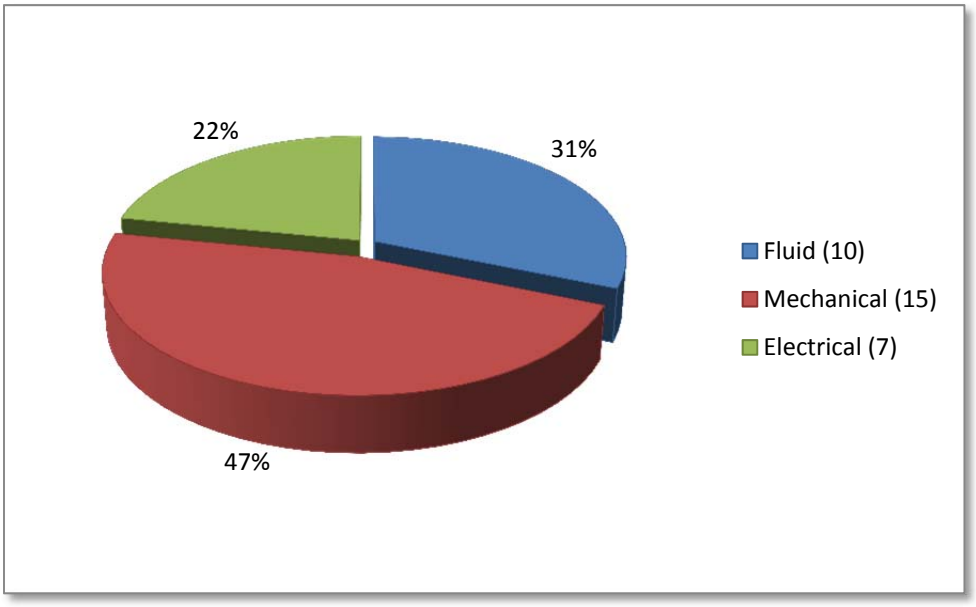

Figure 10: Cause of engine bay incidents 2017

Number of wheel well incidents

In 2018, 58 incidents (56%) were located around the wheel well. It should be noted that the majority of these incidents (88%) resulted in smoke damage only. OTSI believes that it is likely the increasing trend of wheel well thermal incidents is due in part to an increase in reporting and the increase in disc brake related incidents. However, these precursor incidents should not be ignored as one wheel well fire destroyed a bus on the Sydney Harbour Bridge in December 2018. Figures indicate that there has been a steady increase in wheel well incidents from five in 2013 to 59 in 2018 (see *Figure 11*).

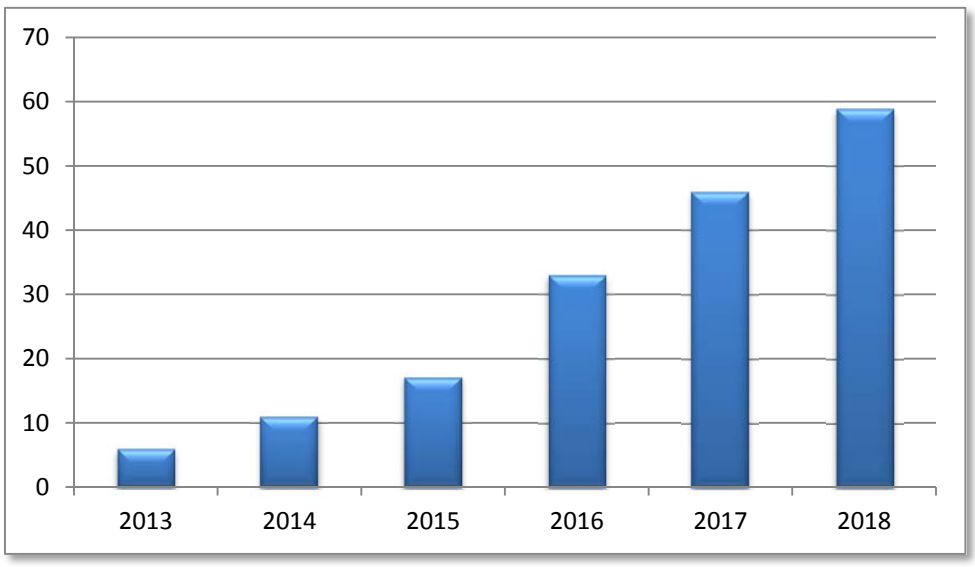

Figure 11: Number of wheel well incidents 2013-18

Cause of wheel well incidents

The majority of incidents 97% were a result of brake issues, which is separated into the following: faulty brake calliper (34), faulty brake booster (10), dragging drum brake (4), leaking oil onto brakes (2) and miscellaneous (7). Tyre problems occurred on one occasion (2%) and a mechanical failure on one occasion (2%). (*Figure 12*)

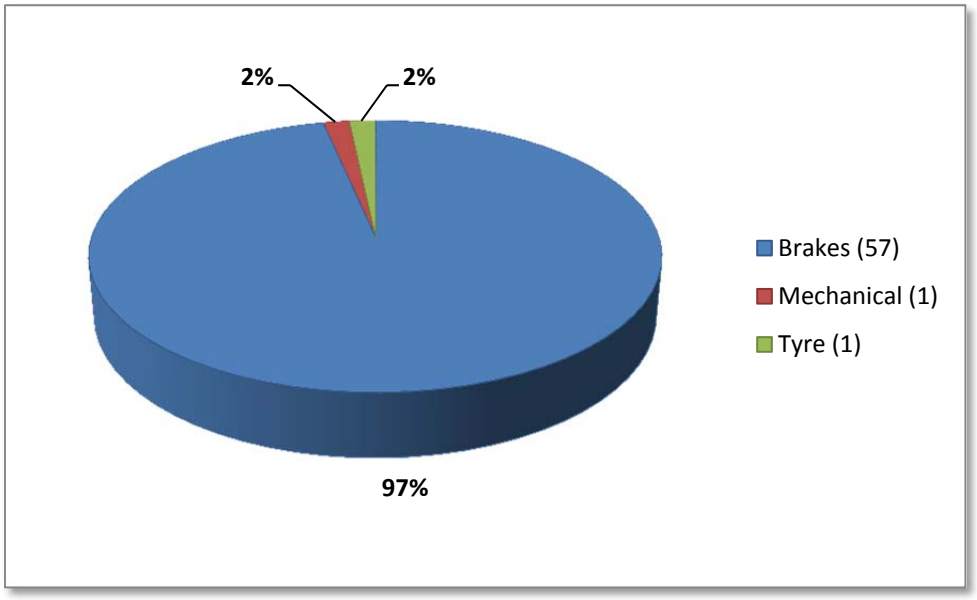

Figure 12: Causes of wheel well incidents 2018

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 a steady increase in body incidents from a low in 2014 to 2018 (see *Figure 13*).

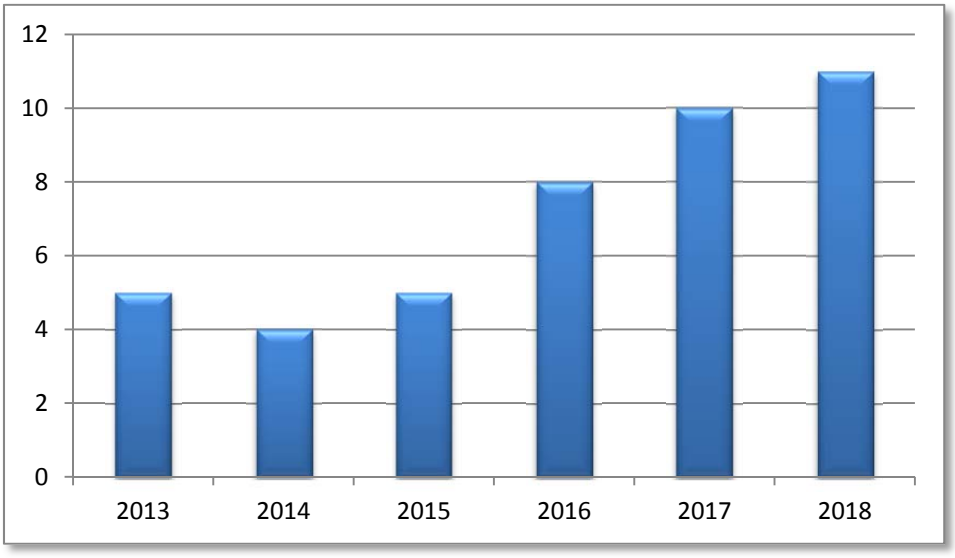

Figure 13: Number of body incidents 2013-18

Cause of body incidents

The cause of all body incidents was due to electrical malfunction or failure (100%). The eleven electrical incidents had a wide variety of origins, faulty ignition switches, wiper motors, A/C control gear and faulty wiring; however, all were within the confines of the passenger saloon area.

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)*.

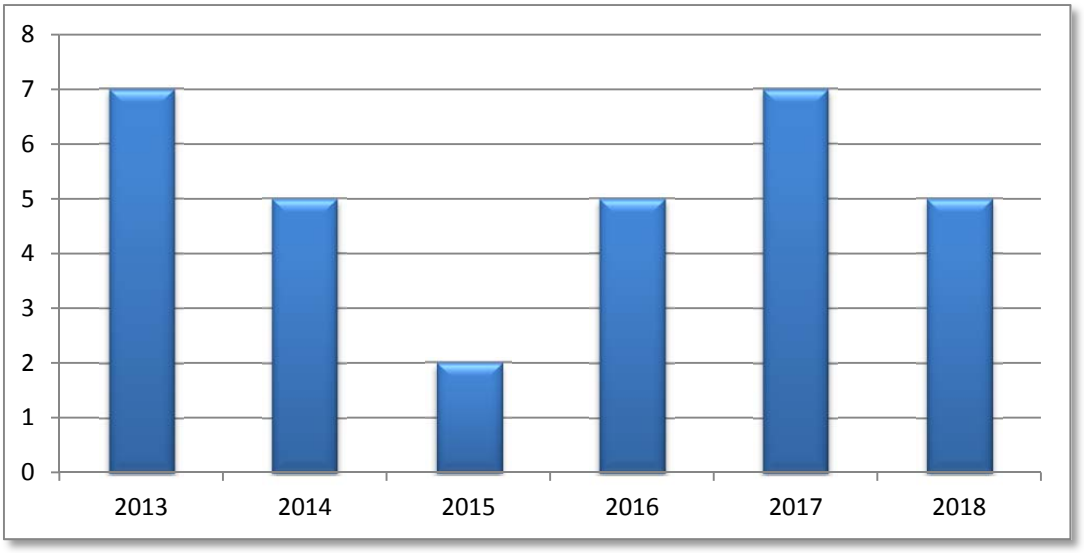

Figure 14: Number of CNG bus incidents 2013-18

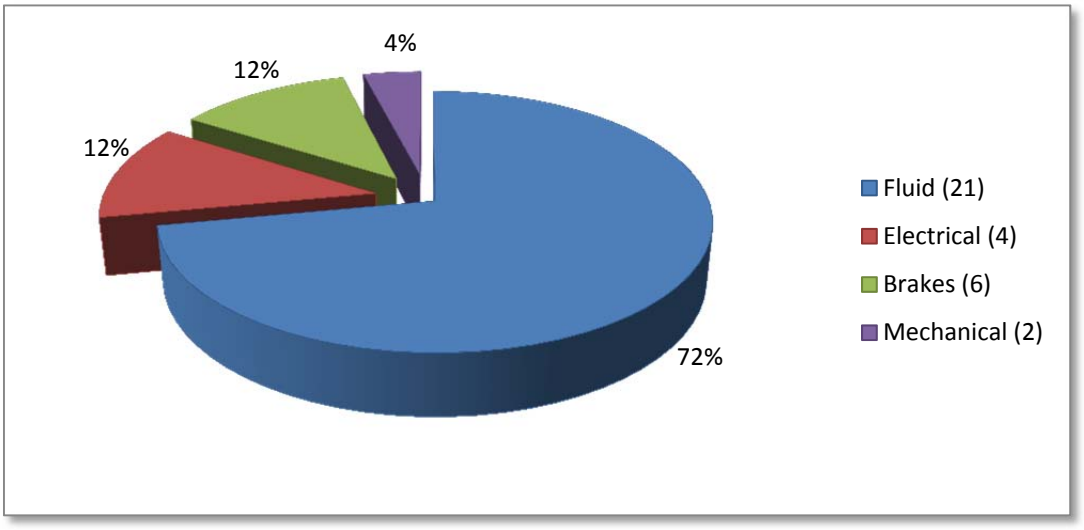

Figure 15: Causes of CNG bus incidents 2013-18

In 2018, there were five incidents involving CNG fuelled buses.

Description of CNG bus incidents	Damage level[5]
Driver noticed bus was sluggish up hills. Driver then noticed smoke from NSR wheel arch. NSR brake calliper had locked on causing brakes to overheat.	Smoke
Driver advised Fire Suppression Alarm had activated. On inspection, engine had suffered major failure and hot engine oil had begun to ignite on engine manifold surfaces.	Minor
Driver advised smoke and flames coming from NSF wheel. Driver extinguished fire with onboard fire extinguisher. NSF brake calliper had seized.	Minor
Driver advised smoke coming from rear wheels and park brake alarm on dash was on. Brakes dragging due to faulty brake system component.	Minor
A power steering system hose had rubbed through on to another component, allowing oil from the system to flow over the engine and onto hot exhaust manifold. Driver discharged fire extinguisher onto small fire.	Minor

Figure 16: Description of CNG bus incidents 2018

Electric vehicle (EV) incidents

It is also of note that one thermal incident reported to OTSI in 2018 involved a battery/electric powered bus. The driver of the bus noticed it was lacking in performance and said that it also had a drive-line system alarm on the dash. One of the main three-phase power cables to the traction motors had a high resistance connection[6] and burnt the cable terminal and cable insulation, thus losing power supply to one phase of the traction motors.

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

[6] A high-resistance connection (HRC) is a problem that results from loose or poor connections in traditional electrical accessories and switchgear which can cause heat to develop, capable of starting a fire.

Detection of Fire

The data for the detection of incidents in 2018 are shown in Figure 17.

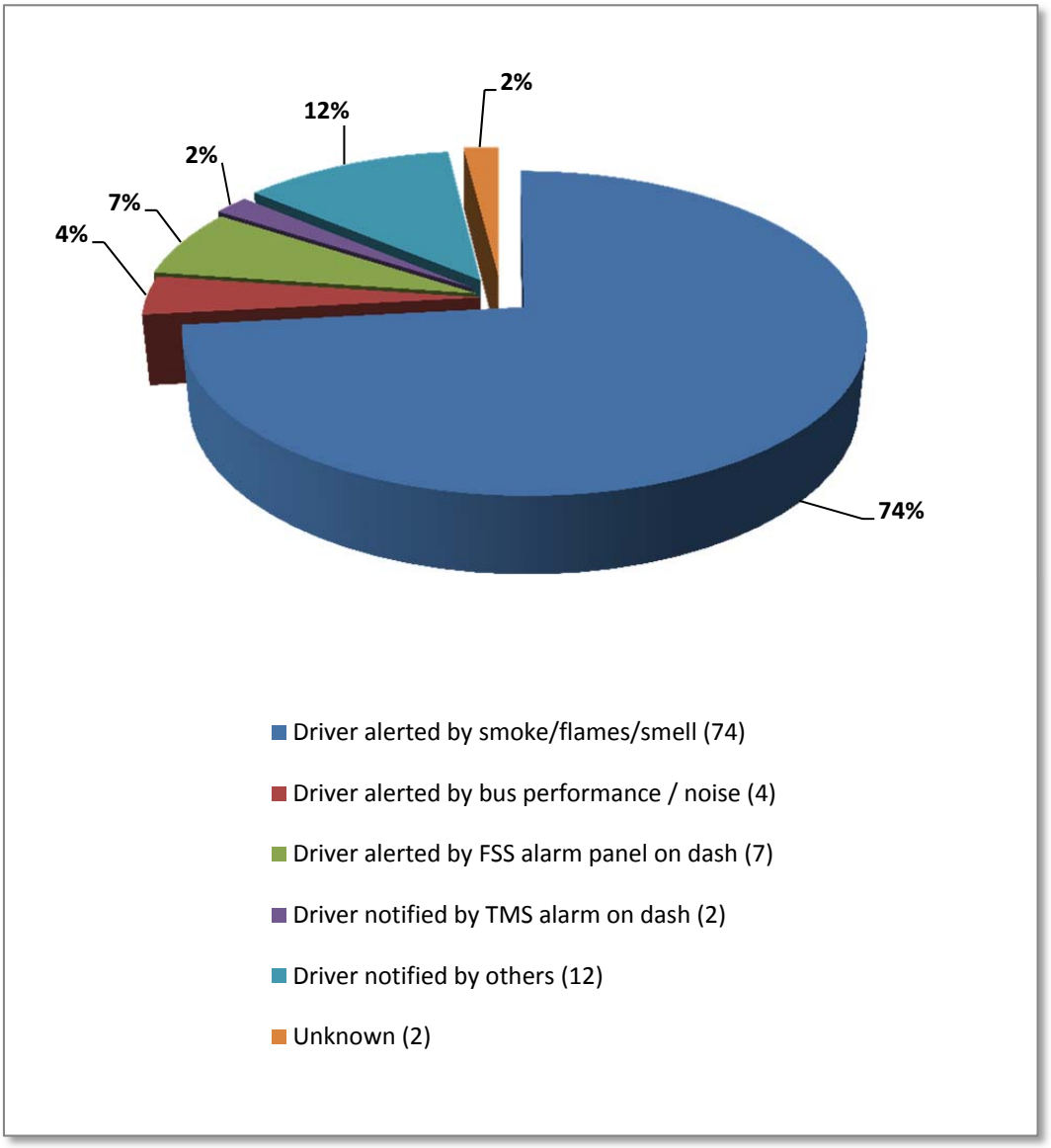

Figure 17: Detection of incidents 2018

In 2018, bus drivers were the first to either see or smell smoke or see flames on 74% of occasions. They also played a role in detecting a problem on nine other occasions. This highlights the importance of the driver's role in detecting the fire and acting accordingly.

Passengers were the first to detect smoke on four occasions while external parties, mainly motorists, raised the alarm on the remaining eight occasions.

Fire Fighting

Portable fire extinguishers were used on 26 occasions (26%). The use of portable extinguishers was successful on 24 of those occasions, a success rate of 95%. This highlights the importance of the role of fire extinguishers in limiting damage.

An extinguisher was unsuccessful in defeating fires on two occasions. In September 2018 at Tongarra, the onboard fire extinguisher was deployed; but the fire was too well established and eventually destroyed the bus. Of note, the bus was also fitted with an engine bay fire suppression system. The system activated as designed, however the asset was lost. In December 2018, an onboard fire extinguisher was utilised by a passenger for a wheel well fire near the Sydney Harbour Bridge. The fire was already well established and the attempt to extinguish the fire was also unsuccessful.

In 2018, NSW Fire and Rescue was called upon to attend on 12 occasions (12%). The percentage of occasions that NSW Fire and Rescue attended for the past four years is shown below (*Figure 18).*

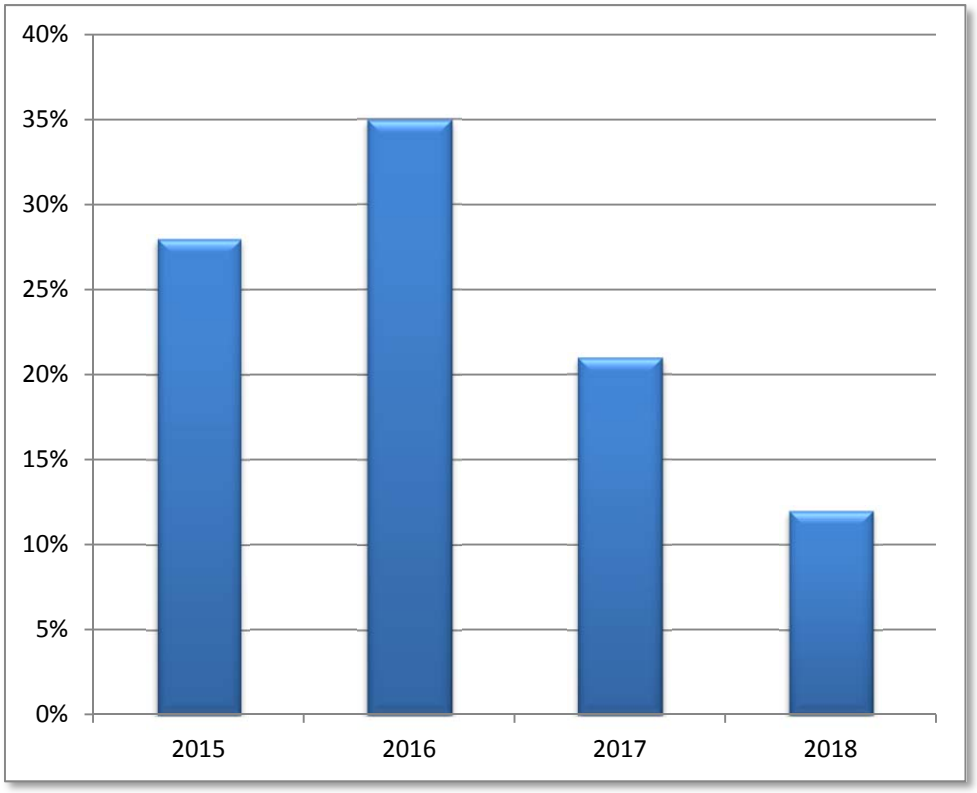

Figure 18: NSW Fire and Rescue: percentage attended 2015-2018

Effectiveness of Engine Bay Fire Suppression (EBFS)

In 2018, of the 101 incidents reported to OTSI, a total of 92 buses had an EBFS system fitted. An activation of the EBFS system was recorded for seven incidents. Of the three buses destroyed in 2018, only one was fitted with EBFS. Of the remaining, one sustained major damage and three sustained minor damage. A description of these events is provided in Figure 19 below.

EBFS activation description	Damage level
Fuel leaking from the primary fuel filter ignited and burnt. The fire spread throughout the engine bay and into the passenger saloon area. The EBFS activated but the fire was not extinguished and the asset was lost.	Destroyed
The main battery cable chafed on air supply line initiating an electrical short circuit. The EBFS activated and extinguished the fire; however a major amount of damage occurred in the engine bay area.	Major
An electrical short circuit in solenoid fan wiring causing a minor fire. The EBFS activated and extinguished the fire.	Minor
The fire suppression system was activated by a small fire caused by an engine oil leak from a catastrophic engine failure where a piston connecting rod broke and pierced the engine block. The EBFS activated and extinguished the fire.	Minor
A hydraulic line to cooling fan drive pump failed and sprayed oil onto exhaust system, oil ignited and a small fire was extinguished by the EBFS.	Minor
A flexible power steering line ruptured causing oil to come into contact with hot surfaces of the engine exhaust manifold causing the oil to vaporise and ignite. The EBFS was activated and extinguished the fire.	Minor
A split exhaust system flexible joining pipe allowed hot exhaust gases to leak and activate fire suppression system. The EBFS activated and extinguished the fire.	Nil

Figure 19: EBFS Activations

In December 2018, OTSI requested operators to provide information about the success of the EBFS. Out of 19 operators contacted, 13 provided a response regarding the number of systems installed and the number of activations. The 13 operators reported having a total of 3442 buses fitted with EBFS. They reported a total of 15 activations which is 27 less than the previous year. Eight of the activations occurred due to system faults and the remaining seven were attributed to thermal – fire incidences.

Effectiveness of tyre monitoring systems (TMS)

Many bus operators now have tyre monitoring systems fitted[7]. A large number were fitted as part of the EBFS system installation and are now fitted as standard equipment on all TfNSW contract buses. 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, 13 provided a response regarding the number of systems installed and the number of activations.

The 19 operators reported having a total of 1211 buses fitted with TMS. 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.

[7] This report will use the abbreviation TMS to describe the tyre monitoring system which monitors tyre pressure and as well as temperature. It is commonly referred to in industry as TPMS (tyre pressure monitoring system).

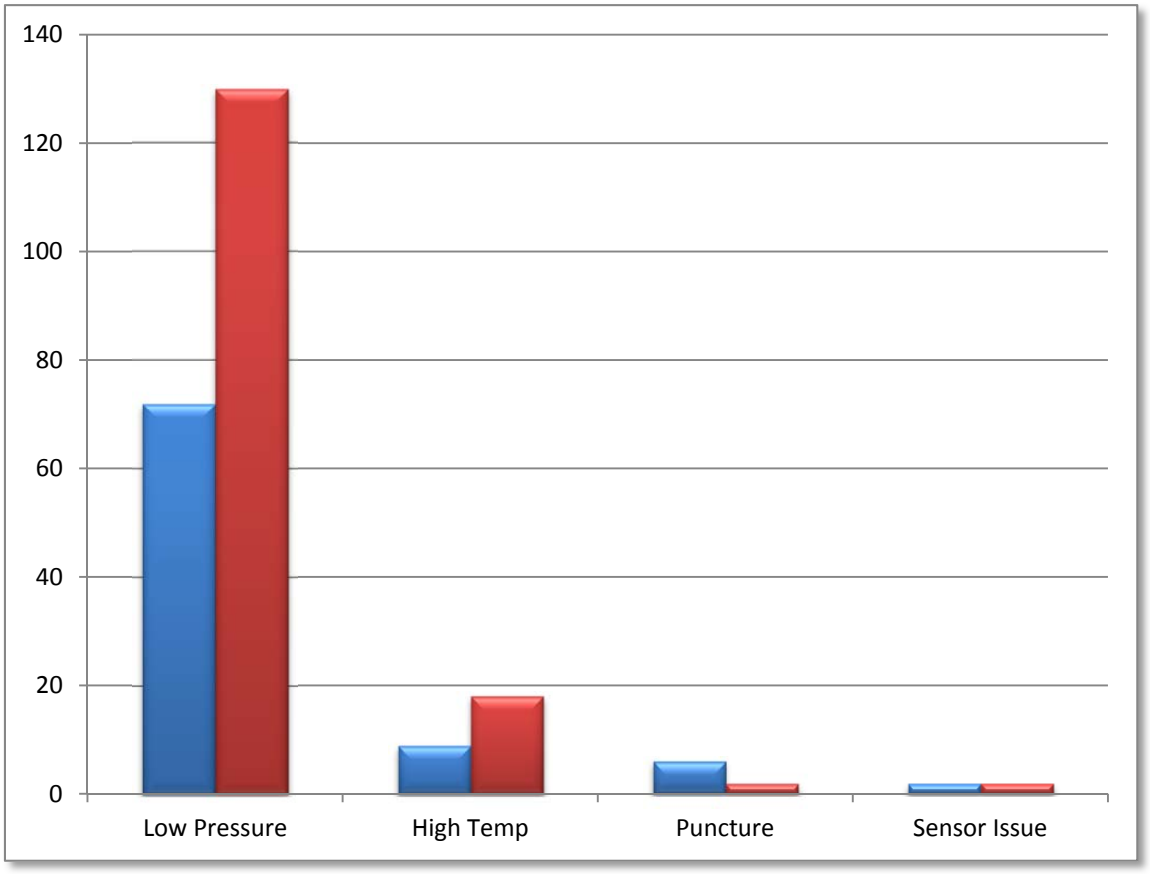

Figure 20: TMS activations 2018

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 2014 (NSW)*.

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.'*[8]

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 eleven occasions OTSI were not notified of a fire incident. The incidents were instead reported in the BIMS. It is important that the legislative

[8] NSW Passenger Transport Regulation 2007 clause 88.

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 2018.

Continued 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 OC500LE CNG bus fleet with fire suppression systems, and in 2015, commenced their fire suppression retrofit program of the rest of their fleet. This project was completed in December 2016. All 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 bus fire suppression systems.9 Approximately 2335 buses were retro-fitted in 10 months. This project was completed in September 2017.

All NSW buses under TfNSW contract are now fitted with engine bay fire suppression systems. All future buses supplied under these contracts will be delivered with engine bay bus fire suppression systems.

Audit of maintenance practices

The installation project applied international and Australian standards for designing, testing and effectiveness of the installation.

It should be noted however, that to ensure that the ongoing inspection of these suppression systems is performed correctly, the inspection standards currently held by the National Heavy Vehicle Regulator need to be aligned with current Australian Standards, in specific AS 5062:2016 *Fire Protection for Mobile and Transportable Equipment*.

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

Bus safety forum

In March 2018, a bus safety forum organised by TfNSW was held at Homebush. 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 continues action to reduce bus fire risk

A Bus Fire Management Committee (BFMC) 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.

As a result of the Committees recommendations, the TfNSW Asset Standards Authority (ASA) has held two Bus Industry Technical Workshops to engage with representatives from bus operators and bus body and chassis manufacturing suppliers. The workshops are intended to discuss specific detail around the various topics required to address the recommendations of the TfNSW BFMC. OTSI was also invited to observe the workshops and provide advice in relation to the deliberations.

The workshops included:

1. Bus Standards Development
    - Development of bus standards using a system based framework
    - Bus material and fire toxicity requirements
    - Bus electrical wiring standards
    - TfNSW bus specification standards requirements.
2. Becoming an Authorised Engineering Organisation (AEO)
    - The process for becoming an AEO, for bus chassis manufacturers and body builders
    - Bus AEO capability matrix
    - AEO assessment.

The work in progress by the ASA and the recommendations of the BFMC are positive steps toward obtaining a unified approach to asset management and construction. At this stage, the scope of the committee's function encompasses buses under the

TfNSW service contracts for metropolitan and outer metropolitan areas. It may be beneficial if the standards that the BFMC and ASA are developing would eventually encompass all buses and coaches registered in NSW.

Other matters – Location of fire extinguishers

In 2018, there were two investigations carried out by OTSI where buses were destroyed by fire. During the course of the investigations it was discovered that the onboard fire extinguishers had been stowed in the engine bay as per the original vehicle design. In both instances the extinguishers were not removed from their mounting bracket and were destroyed due to the fires commencing within the engine bay. The drivers determined it to be unsafe to attempt to open the engine hatch and gain access to the extinguishers.

Consideration should be given for bus body manufacturers to locate the extinguishers in a readily accessible location in compliance with applicable standards, but not within the confines of the engine bay area.

During another investigation into a coach destroyed by fire, it was noticed that the company operator had, by their own volition, installed portals in the exterior doors of the engine bay to allow fire extinguishers to be discharged into the engine bay area without the need to open the hatch. This allowed the extinguisher material to be forced into the seat of the fire without allowing additional oxygen to feed the fire.

This feature should also be given consideration to be included in the build specification for buses and coaches utilised within NSW.

Conclusions

There were 101 fire and thermal incidents reported to OTSI in 2018. This represented a 12% increase from 2017. It should be noted there was a significant decrease (33%) in fire incidents, from 21 fire incidents in 2017 to 14 fire incidents in 2018.

There was a decrease in severity of damage to vehicles, with 3 vehicles destroyed in 2018 compared to 5 in 2017.

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

There is a continuing increase in the number of brake-related thermal incidents. While it is likely a result of increased reporting, these incidents should not be ignored as 4% of these wheel well incidents led to actual fires.

All NSW buses under TfNSW contract are now fitted with engine bay fire suppression systems. All future buses supplied under these contracts will be delivered with engine bay bus 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 2018

MONTH	TYPE	DOM	LIKELY FIRE SOURCE	SEVERITY	ONBOARD EXTINGUISHER USED
Jan	Bus	1997	Electrical short on air-conditioning duct and circuit board.	Minor	Yes
Jan	Bus	2007	Faulty brake booster on off side rear wheel.	Smoke	No
Jan	Bus	2007	Faulty brake booster on near side rear wheel.	Smoke	No
Jan	Bus	2009	Hydraulic fan motor seal leaking onto exhaust manifold.	Smoke	No
Jan	Bus	2007	Faulty rear brakes.	Smoke	No
Jan	Bus	2009	O/S rear hub seal leak onto brake.	NIL	No
Jan	Bus	2003	N/S front wheel brake calliper problem.	Smoke	Yes*
Jan	Bus	2002	A/C compressor seized, belts overheated on pulley.	NIL	No
Jan	Bus	2017	A/C fan speed control circuit board.	Minor	No
Jan	Bus	2007	Front brakes dragging.	Smoke	Yes
Feb	Bus	2009	Electrical short circuit under drives dash area.	Minor	Yes
Feb	Bus	2002	Smoke from engine bay area.	Smoke	No
Feb	Bus	2014	Seized alternator.	Minor	Yes
Feb	Bus	2009	Electrical short in engine starter motor.	Minor	Yes*
Feb	Bus	2007	N/S front brake calliper problem.	Smoke	No
Feb	Bus	2005	Short circuit in solenoid fan.	Minor	No
Feb	Bus	1993	Hydraulic line to cooling system fan drive motor burst.	Smoke	No
Mar	Bus	2009	N/S front brake calliper problem.	Smoke	No
Mar	Bus	1997	A/C belt tensioner pulley seized, belts turning creating overheated belt.	NIL	No
Mar	Bus	1994	Demister fan motor seized causing smoke.	Smoke	No

Mar	Bus	2014	Driver advised there was smoke coming out from the engine hatch of the bus.	Smoke	Yes
Mar	Bus	2009	N/S front brake calliper problem.	Smoke	No
Mar	Bus	2007	N/S front brake calliper problem.	Smoke	No
Mar	Bus	2000	Crack in exhaust pipe.	Smoke	No
Mar	Bus	2009	N/S rear hub seal started to leak oil onto brake.	Smoke	No
Apr	Bus	1997	Main battery cable chafed on air supply line.	Major	Yes*
Apr	Bus	2010	Smoke from O/S rear brake components.	Smoke	Yes
May	Bus	2007	Split fuel return hose at injector.	Smoke	No
May	Bus	2006	Turbocharger failure.	Minor	Yes
May	Bus	2009	Smoke from N/S rear wheel, leak from relay valve.	Smoke	No
May	Bus	2010	Split exhaust flex caused exhaust gas to activate fire suppression system.	NIL	No
May	Bus	2002	Fan bearing seized, causing drive belt to smoke.	NIL	No
May	Bus	2004	Air leak caused brakes to drag, causing smoke.	Smoke	Unknown*
May	Bus	2010	Smoke from off side rear wheel well, brakes dragging.	Smoke	No
May	Bus	2012	Smoke from near side rear wheel, brake valve not releasing causing park brake to apply.	Smoke	Yes
May	Bus	2009	N/S front brake calliper, ratchet failure on adjuster, brakes dragging.	Smoke	No
May	Bus	1994	Smoke coming from rear wheel, brakes dragging.	Smoke	No
May	Bus	1995	Electrical short in wiring to fuel shutoff solenoid.	Minor	No
May	Bus	2006	Wiper motor short circuited causing smoke from dashboard inside bus.	Minor	No
Jun	Bus	1994	N/S rear brakes dragging, calliper faulty.	Smoke	No
Jun	Bus	1997	Smoke coming from rear wheel, brakes dragging.	Smoke	No
Jun	Coach	2018	Stone lodged in brakes causing brake disc to overheat. Heat from brakes ignited tyre.	Minor	Yes

Jun	Bus	2009	Smoke coming from N/S rear wheel.	Smoke	No
Jun	Bus	2013	N/S front brake calliper faulty, causing overheating.	Minor	Yes
Jun	Bus	2005	Electrical short circuit between wiring and injector pump heat shield.	Minor	No
Jun	Bus	2010	Smoke from O/S rear wheel, brake calliper problem.	Smoke	No
Jul	Bus	2010	Smoke from N/S rear wheel, brake calliper problem.	Smoke	No
Jul	Bus	1999	Debris lodged on turbocharger return pipe and had caught fire.	Minor	Yes
Jul	Bus	2014	Smoke coming from all wheels, ABS malfunction.	Smoke	No
Jul	Bus	2009	Smoke from N/S front wheel, brake calliper problem.	Smoke	No
Jul	Bus	2009	Brake calliper seized.	Smoke	No
Jul	Bus	1997	Smoke coming from the O/S front wheel, faulty brake calliper.	Smoke	No
Jul	Bus	2004	Oil feed line to the turbo has broken, causing oil to come into contact with turbo charger assembly.	Smoke	No
Jul	Bus	2001	O/S rear brake sticking, brakes overheated.	Smoke	No*
Jul	Bus	2013	N/S front brakes dragging, brakes overheated.	Smoke	No
Jul	Bus	1997	O/S front brakes dragging, brakes overheated.	Smoke	No
Aug	Bus	2013	O/S front wheel overheated brakes.	Smoke	Yes
Aug	Bus	2013	Rear brakes locked on, brakes overheated.	Smoke	No
Aug	Bus	1999	Rear brakes locked on, brakes overheated.	Smoke	No
Aug	Bus	2016	High resistance electrical connection caused components to melt and burn.	Minor	No
Aug	Bus	1999	O/S rear brake sticking, brakes overheated.	Smoke	No
Aug	Bus	2012	Brake calliper seized, brakes overheated.	Smoke	No
Aug	Bus	2010	N/S front brake problem, brakes overheated.	Smoke	Yes
Aug	Bus	1995	Faulty electrical relay overheated and caused components to melt and burn.	Minor	No

Aug	Bus	2008	Mobile phone smouldered in seat inside passenger saloon area.	Minor	No
Aug	Bus	2011	Ruptured safety valve melted rubber air filter inlet hose.	Minor	No
Sep	Bus	2013	Fuel leaking from the primary fuel filter ignited and caused extensive fire.	Destroyed	Yes*
Sep	Bus	2006	Power steering line ruptured causing oil to come into contact with exhaust pipe which subsequently caused fire suppression system to engage.	Smoke	No*
Sep	Bus	2005	Electrical short circuit in main electrical panel.	Minor	No
Sep	Bus	2007	N/S rear brakes dragging, calliper faulty.	Smoke	No
Sep	Bus	2016	Fuel leak onto hot exhaust manifold.	Minor	Yes
Sep	Bus	2009	Collapsed wheel bearing resulted in heat build-up and oil to vaporise.	Smoke	No
Sep	Coach	2001	Alternator bearing failed causing alt to overheat, Driver stated flames from alternator.	Minor	No
Sep	Bus	1994	Catastrophic engine failure forced hot engine oil onto exhaust and other hot engine components, EBFS activated.	Minor	No*
Sep	Bus	2009	N/S front brake problem, brakes overheated.	Smoke	No
Sep	Bus	1994	Door brake interlock activated whilst bus in motion. Rear brakes applied and overheated.	Nil	No
Oct	Bus	2010	N/S front brake problem, brakes overheated.	Smoke	Yes
Oct	Bus	2007	N/S front brake problem, brakes overheated.	Smoke	Yes
Oct	Bus	2009	Smoke in the engine bay. Extinguisher discharged, mechanics attend to investigate.	Smoke	Yes
Oct	Bus	2011	Bus driver advised there was brake smoke in saloon, brake overheated.	Smoke	No
Oct	Bus	2009	N/S front brake problem, brakes overheated.	Smoke	No
Oct	Bus	2004	Hydraulic line to cooling fan drive pump failed and sprayed oil onto exhaust system, oil ignited and a small fire was extinguished by the EBFS.	Minor	No
Oct	Bus	2002	Oil leak from a failed swage joint in the hydraulic fan drive system forced oil onto hot engine components.	Smoke	No*

Oct	Bus	2010	Driver alerted by the onboard tyre pressure monitoring system of an elevated temperature alarm on the near side rear inner wheel.	Smoke	No
Oct	Bus	2004	Large amount of smoke detected coming from brakes, when driver pulled into depot at end of shift.	Smoke	No
Nov	Bus	2010	Rear brake calliper overheated	Smoke	Unknown
Nov	Bus	2014	N/S rear brake problem, brakes overheated.	Smoke	No
Nov	Coach	1992	N/S rear brakes dragging causing brake drum to overheat and ignite tyres. Bus destroyed.	Destroyed	Yes*
Nov	Bus	2014	O/S rear brake problem, brakes overheated.	Smoke	Unknown
Nov	Coach	2013	Thermal incident where the ABS sensor lines had caught fire in the near side rear wheel well.	Minor	No
Nov	Bus	2009	Burning smell and smoke from the rear wheels. Park brake sign on the dash.	Smoke	No
Nov	Bus	1998	O/S rear brake problem, brakes overheated.	Smoke	No
Nov	Coach	2000	Electrical short circuit in internal wiring behind driver's cabin.	Minor	No
Nov	Bus	2013	Electrical short circuit in alternator cables caused by abrasion.	Minor	Yes
Dec	Coach	2001	Driver has stopped the bus after noticing smoke around the engine bay. Maintenance staff attended the bus before returning it to the depot.	Minor	No
Dec	Coach	2008	Combustible fluid leak has ignited within the engine bay, ensuing fire has destroyed coach.	Destroyed	No*
Dec	Bus	2007	Driver reported smoke from the indicator stalk. Electrical short circuit.	Minor	No
Dec	Bus	2011	N/S rear brake problem, brakes overheated, flames present.	Minor	Yes
Dec	Bus	2000	Power steering fluid (ATF Dex lll) leak onto hot engine surfaces ignited.	Smoke	Yes
Dec	Bus	1995	Rear brake problem, brakes overheated.	Smoke	No
Dec	Bus	1997	Rear brake problem, brakes overheated.	Smoke	Yes

***** 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.
- Smoke from another bus on fire

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