



**Office of Transport Safety Investigations**

## **BUS SAFETY INVESTIGATION**

**FIRE INVOLVING STATE TRANSIT BUS MO 1414**

**DUDLEY, NSW**

**28 APRIL 2016**



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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.

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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](http://www.otsi.nsw.gov.au)

# CONTENTS

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|   |           |
|---|-----------|
| <b>EXECUTIVE SUMMARY</b>                              | <b>1</b>  |
| <b>PART 1 FACTUAL INFORMATION</b>                     | <b>2</b>  |
| The Incident  | 2         |
| Environmental Conditions                              | 3         |
| The Bus   | 3         |
| The Driver  | 4         |
| Fatigue   | 4         |
| Examination of the Bus                                | 4         |
| <b>PART 2 ANALYSIS</b>                                | <b>5</b>  |
| Introduction  | 5         |
| Damage  | 5         |
| Broken positive (B+) cable and retaining clamp        | 7         |
| Fire Ignition   | 8         |
| P-clamp   | 9         |
| Maintenance   | 10        |
| Fire detection & suppression                          | 11        |
| Portable Fire extinguisher                            | 11        |
| Driver Training                                       | 11        |
| Remedial actions undertaken                           | 11        |
| <b>PART 3 FINDINGS</b>                                | <b>12</b> |
| <b>PART 4 RECOMMENDATIONS</b>                         | <b>13</b> |
| State Transit Authority                               | 13        |
| Roads and Maritime Services                           | 13        |
| <b>PART 5 APPENDICES</b>                              | <b>14</b> |
| Appendix 1: Sources, Submissions and Acknowledgements | 14        |

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## EXECUTIVE SUMMARY

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On 28 April 2016, a State Transit Authority (STA)<sup>1</sup> bus caught fire causing substantial damage to the engine, engine bay and rear of the bus. The bus was operating a Route 322 service from Belmont to Newcastle and was carrying the driver and four passengers. There were no injuries reported.

The driver of bus MO 1414 reported that the engine warning lights activated. However, before the driver pulled to the side of the road, the alarms stopped. As the bus otherwise responded normally the driver continued towards Newcastle city.

About 12 minutes later the driver said the gear changes felt harsh and were accompanied by an abrupt thump. The driver then heard a loud bang closely followed by the alarms activating for a second time. Upon checking both side mirrors, the driver noticed thick smoke exiting from both sides of the rear of the vehicle. The driver shut the engine down and evacuated the four passengers.

The driver then attempted to extinguish the fire with the on board dry chemical portable extinguisher. NSW Fire and Rescue unit arrived shortly after and extinguished the fire.

The investigation found that the fire initiated in the engine bay at the rear of the bus and was likely the result of an electrical short from a B+ cable between the alternator and starter motor.

There have been over 132 fire incidents reported to OTSI since 2005.

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

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<sup>1</sup> The State Transit Authority of New South Wales is the government owned entity responsible for the operations of Sydney Buses, Newcastle Buses and Ferries, and Western Sydney Buses (Liverpool Parramatta Transit way).

## PART 1 FACTUAL INFORMATION

### The Incident

- 1.1 At approximately 1420, near the Jewellstown Shopping Plaza, Belmont, the driver of bus MO 1414 reported that the engine temperature and all dash warning lights activated (along with corresponding audible alarms). However, before the driver pulled to the side of the road, the alarms stopped. The driver thought it unusual for all the dash warning lights to illuminate in this manner, but as the bus otherwise responded normally, the driver continued towards Newcastle city (see *Figure 1*).
- 1.2 The driver said that the bus continued to function normally until it reached the suburb of Redhead (approximately 12 minutes travel and 1 km before the bus evacuation). As the bus entered Redhead, gear changes felt harsh and were accompanied by an abrupt thump.

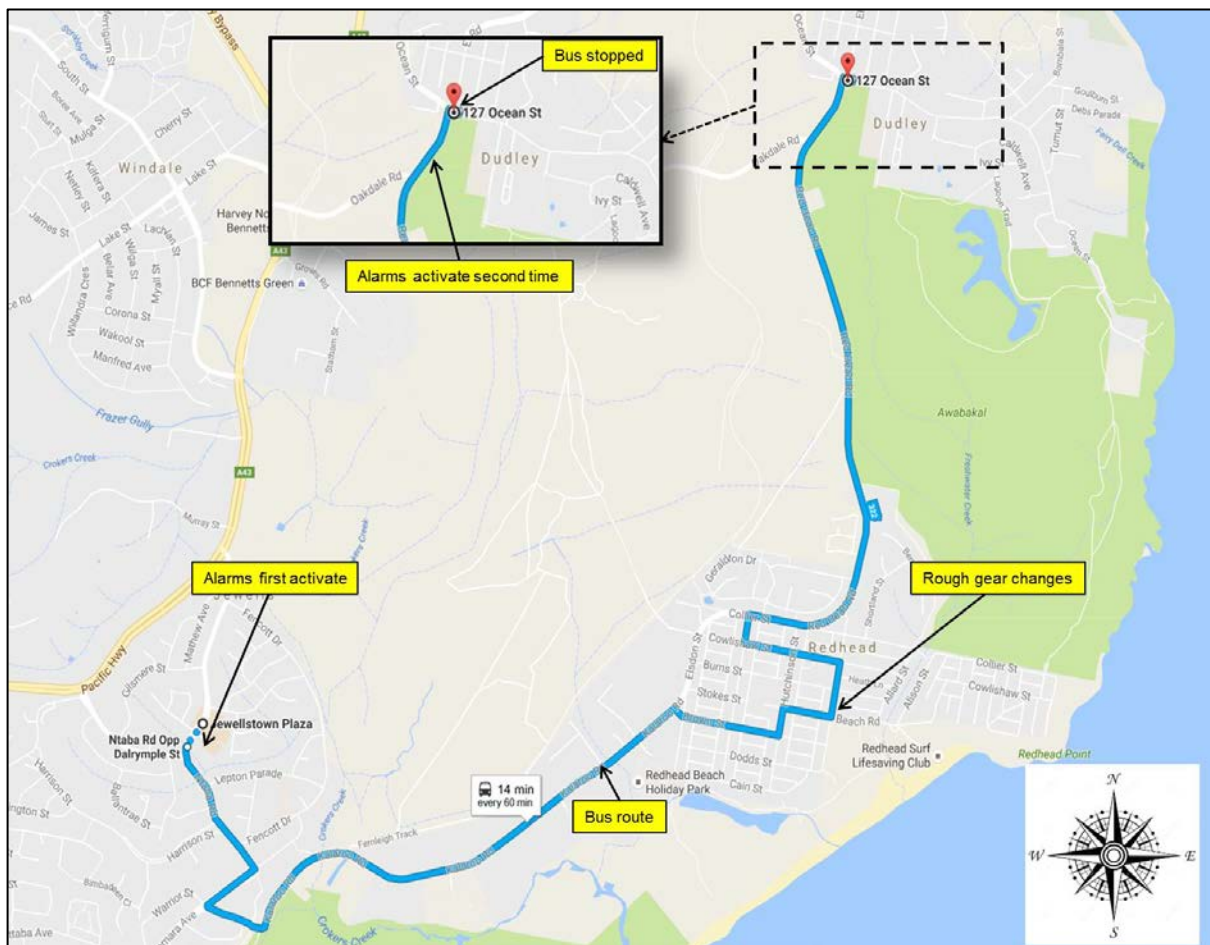


Figure 1: Incident location, 12 km south of Newcastle (source Google maps)

- 1.3 As the bus was travelling up a moderate incline on Redhead Rd, in the suburb of Dudley (about 7 km after the first sounding of alarms), the driver heard a loud bang closely followed by the alarms activating for a second time. Upon checking both side mirrors, the driver noticed thick smoke exiting from both sides of the rear of the vehicle. The driver had a concern of fire spreading to the surrounding bushland and pulled over at the next bus stop a short distance away.
- 1.4 The driver shut the engine down and evacuated the four passengers. Two passengers later informed the driver that smoke was coming up through the floor near the rearward hatch.
- 1.5 The driver notified the STA Hamilton depot who alerted emergency services. The driver then attempted to extinguish the fire with the on board dry chemical portable extinguisher. The bus electrical power was not isolated. The driver said that the fire appeared to go out after the extinguisher was emptied into the engine bay. However, the fire reignited after 2 to 3 minutes. The driver then concentrated on keeping onlookers and passing traffic away from the burning bus. The driver said a NSW Fire and Rescue unit arrived shortly after and extinguished the fire.
- 1.6 After the fire was extinguished, STA towed the bus to their Hamilton depot, where it was quarantined by OTSI pending an examination.

### **Environmental Conditions**

- 1.7 The environmental conditions at midday were mild and dry with a temperature of 17 degrees Celsius<sup>2</sup>. OTSI determined that the environmental conditions played no part in the incident.

### **The Bus**

- 1.8 The bus (registration MO 1414), was a Volvo B12BLE, two axle low entry city bus model, built in 2003. The bus had a stainless steel chassis, with a stainless steel framed Custom Coaches body. The bus was powered by a 6 cylinder Volvo engine which drives a fully automatic ZF<sup>3</sup> gear box. The odometer reading was 809,676 km at the time of the incident. The bus was

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<sup>2</sup> As recorded at the Bureau of Meteorology Nobby's Head approximately 12 km from the incident

<sup>3</sup> ZF is a type of gear box brand. (See <http://www.zf.com.au/>)



owned and operated by STA Newcastle and was based in their Hamilton depot.

### **The Driver**

- 1.9 The driver held a current Heavy Combination vehicle driver's license and a Driver's Authority issued by Roads and Maritime Services (RMS). The driver had been employed with the STA for 29 years. The driver had received basic firefighting / fire extinguisher training when first employed by the STA.

### **Fatigue**

- 1.10 On the day of the incident, the driver signed on at 0526 and was due to sign off at 1316. However, he performed extended time in order to conduct the 322 service when the fire occurred. The driver reported that on the day of the incident, there had been a shortage of drivers and the shortfall was being covered with overtime. The driver said that he was feeling rested in spite of the extra duties. OTSI determined that fatigue played no part in the incident.

### **Examination of the Bus**

- 1.11 OTSI investigators inspected the bus on 29 April 2016 at the Hamilton bus depot, to establish the origin, ignition and likely fuel sources of the fire.

## PART 2 ANALYSIS

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### Introduction

- 2.1 The investigation focussed principally on the factors that contributed to the initiation of the fire. The actions of the driver following the incident were also examined.

### Damage

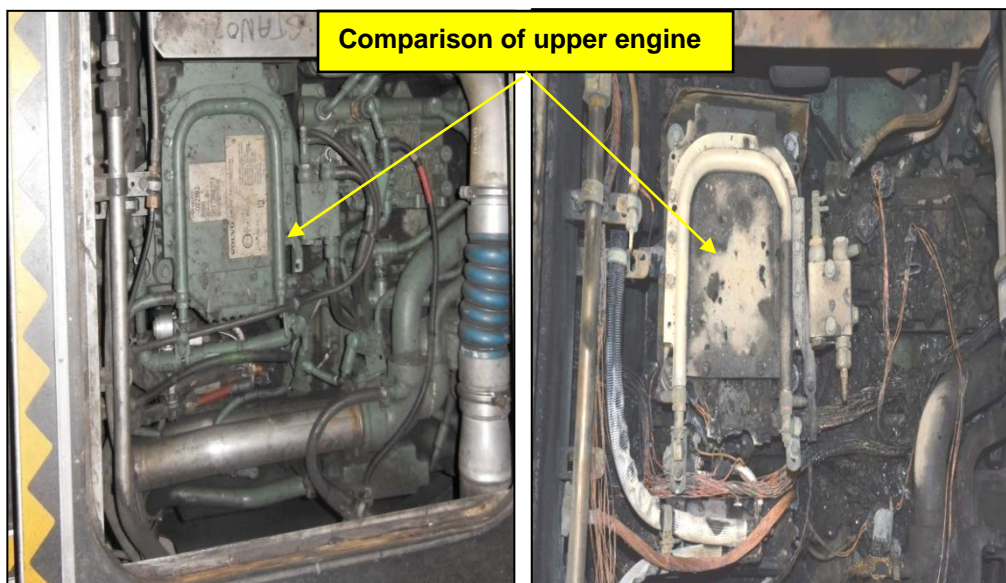
- 2.2 The fire damage was confined to the bus' rear exterior, engine bay including electrical wiring loom and associated combustible materials.
- 2.3 Examination of the bus established that there was a concentrated pattern of fire damage on the rear side towards the rear of the engine compartment (see *Photographs 1-4*). Damage to the exterior of the bus was confined to the engine compartment hatch, the side fibreglass body panels and destroyed the rear window. There were signs of minor heat and smoke damage within the rear interior of the bus.



Photograph 1: Fire damage to the rear of the bus



Photograph 2: View of damaged engine bay from rear of bus



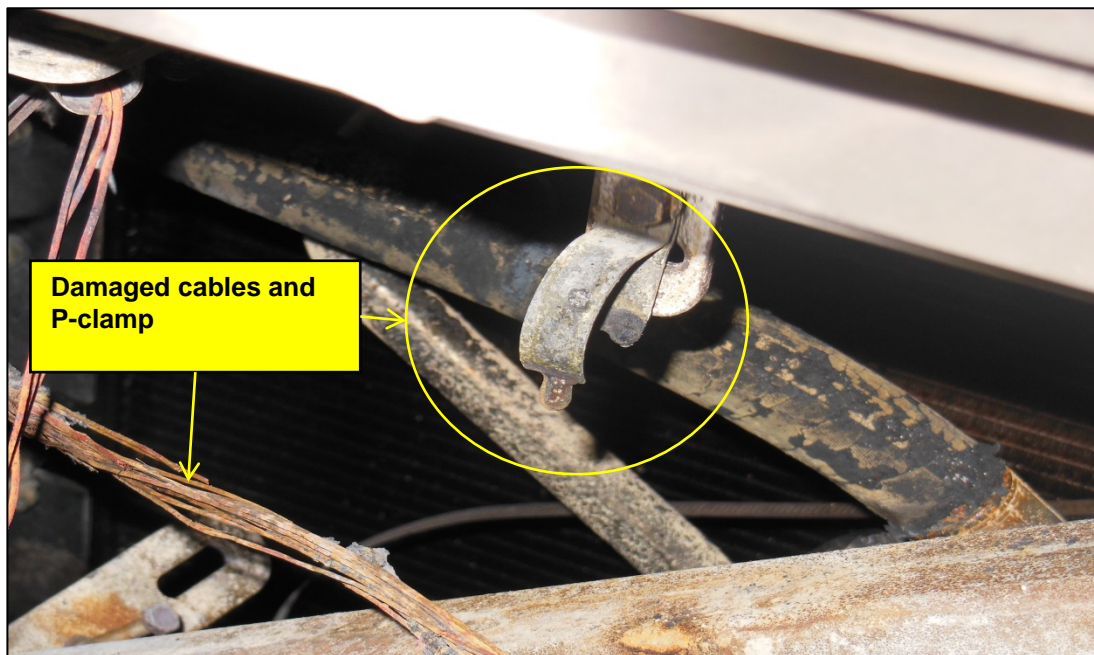
Photograph 3: Undamaged top of engine bay (from same model bus). The view looking down through a floor hatch inside the rear passenger area of the bus.

Photograph 4: Destroyed fuel return lines and damage to top of engine. The view looking down through a floor hatch inside the rear passenger area of the bus.

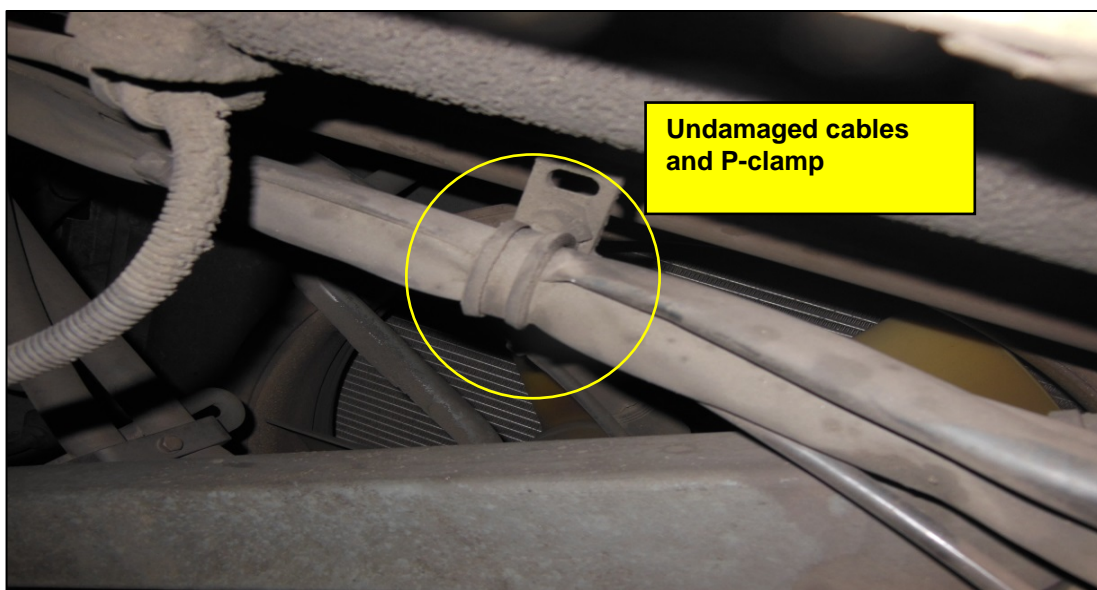


## Broken positive (B+) cable and retaining clamp

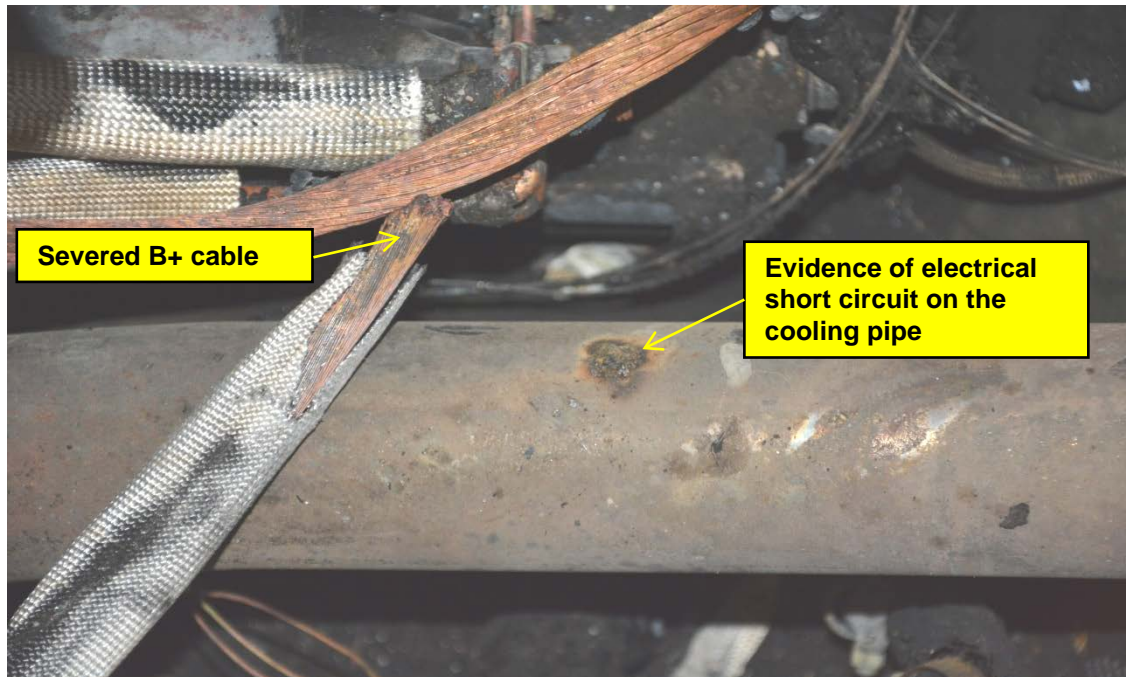
- 2.4 Examination of the upper side of the engine bay revealed a severed electrical cable. This cable, known as the 'B+' runs from the alternator to the starter motor, showed evidence of having short circuited the electrical system on both a holding bracket or 'P-clamp' and an engine-cooling pipe. The location of the break in the cable corresponds with the location of a broken securing P-clamp (see *Photographs 5-7*).



Photograph 5: Melted P-clamp



Photograph 6: Undamaged P-clamp from similar model bus



Photograph 7: Severed cable & evidence of short circuit on the cooling pipe

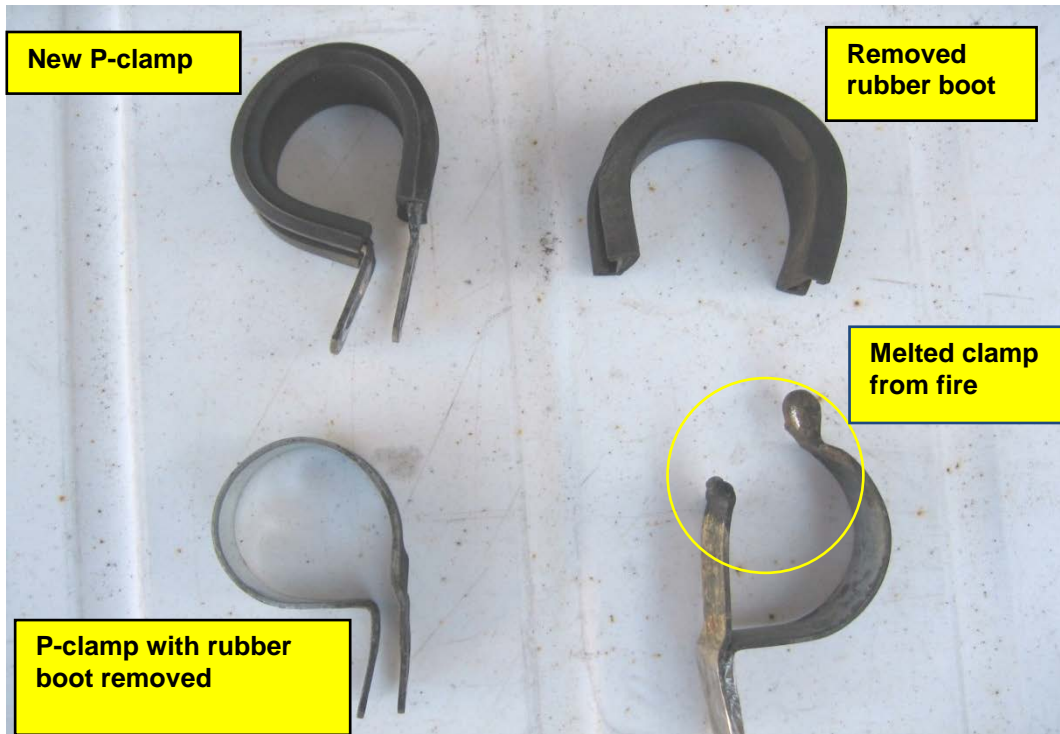
## Fire Ignition

- 2.5 The investigation established that the B+ cable short circuited on the metal of the P-clamp. As a result, the heat caused by this short-circuit destroyed the P-clamp and severed the B+ cable. Consequently, one part of the cable then fell onto the engine cooling pipe, creating another short-circuit.
- 2.6 The heat from either the first or second short-circuits (or a combination of both) ignited surrounding combustible material, such as the insulation of the wiring loom, which ignited the fire. As a result, the fire destroyed the nearby hydraulic and low-pressure fuel return lines, enabling the release of combustible fluids onto the hot engine surface. The continued operation of the engine maintained a supply of fuel, electrical energy and a flow of air (from the radiator fans), which intensified the fire. This created the ideal environment for the fire to spread throughout the engine bay.

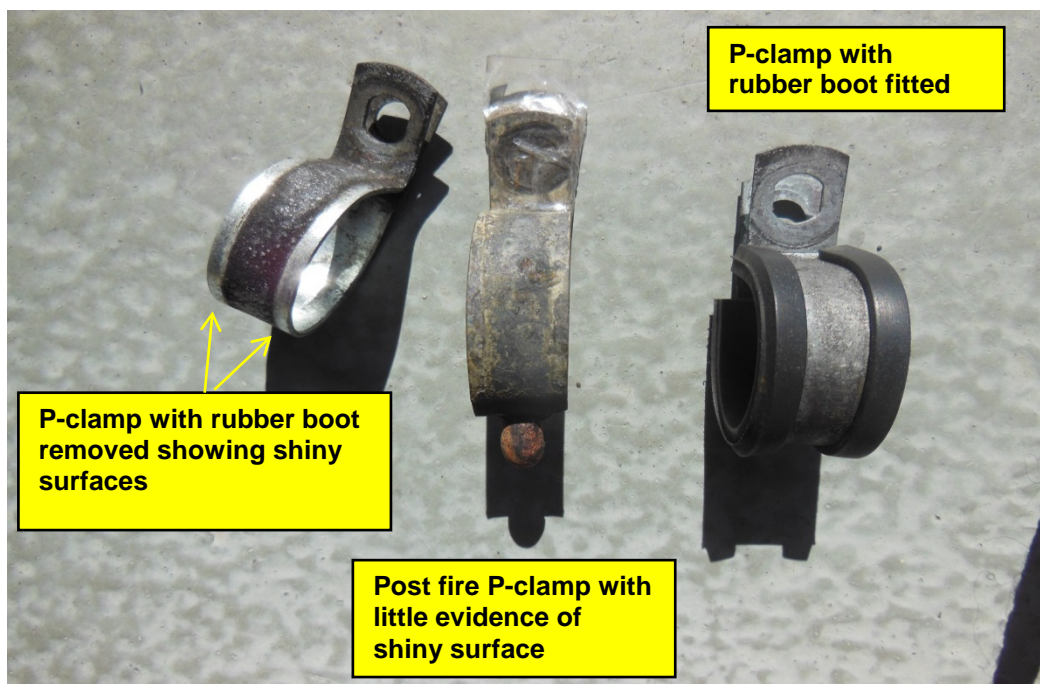


## P-clamp

2.7 P-clamps, consist of a metal loop; with a protective rubber jacket (see *Photographs 8-9*). This rubber jacket protects any surfaces that the clamp holds from direct metal contact. The clamps are utilised to secure components like cables and hoses.

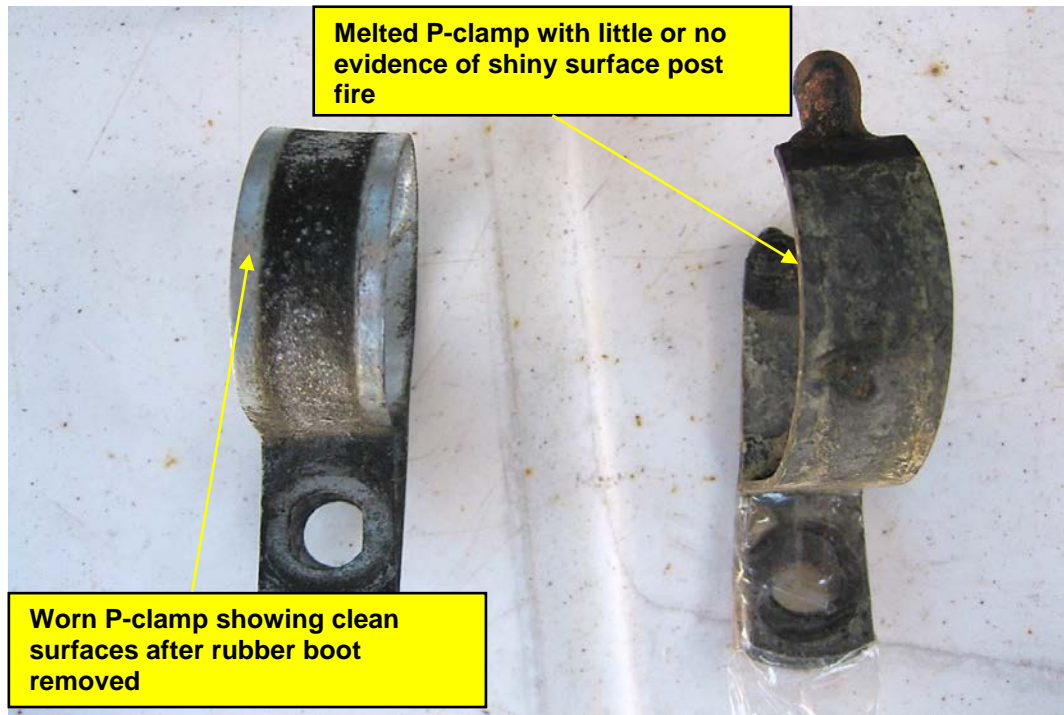


Photograph 8: P-clamps new, unassembled, and melted P-clamp from fire



Photograph 9: P-clamp comparison

- 2.8 Examination of the damaged P-clamp post incident indicates that the rubber protective boot had possibly been missing or damaged prior to the fire (see *Photograph 10*).



Photograph 10: Comparison of P-clamps

## Maintenance

- 2.9 Examination of the bus maintenance history indicates that the bus was maintained in accordance with the company's schedules and procedures. Specific inspection of the battery system occurred during programmed maintenance inspections on 23 December 2015 (four months prior to the incident) and on 7 April 2016. On both occasions, the inspections recorded no faults or repairs to the battery system.

## **Fire Protection**

### **Fire detection & suppression**

2.10 The bus was fitted with the standard Volvo engine fire detection warning sensor system. The system was designed to activate and provide audio / visual alarms on the dashboard when it detected a significant heat source in the engine compartment. This bus was not fitted with an integral fire suppressant engine bay fire suppression system; however, the bus is was equipped with a portable fire extinguisher.

### **Portable Fire extinguisher**

2.11 The bus was fitted with one portable 2.5kg ABE<sup>4</sup> powder-type extinguisher. This was located in a recessed panel next to the driver's seat. The extinguisher, holding bracket and signage were in good condition. The driver reported no problems with the discharge of the device.

### **Driver Training**

2.12 Firefighting and general emergency training for the driver occurred at the time of initial induction. It is important that bus companies ensure bus drivers maintain an ongoing proficiency to deal with abnormal and emergency situations.

2.13 This should include the provision of safe places for passengers to disembark during emergency egress from a bus such as during fire evacuation. Additionally, consideration should be made for scenarios where passengers are required to evacuate into active traffic lanes.

### **Remedial actions undertaken**

2.14 STA reports that at the time of writing the Hamilton depot operates 179 buses, 99 of which have an engine bay fire suppression system integral suppression systems fitted. The remaining 80 buses are scheduled to have fire suppression systems installed by the end of December 2016.

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<sup>4</sup> Powder ABE Fire Extinguishers are suitable for multiple classes of fires : > Class A - Paper, Textiles, Wood, Most Plastics and Rubber > Class B - Flammable Liquids > Class E - Electrically Energized Equipment –source AS/NZS 1841.1:2007 - *Portable fire extinguishers - General requirements*



## PART 3 FINDINGS

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From the evidence available, the following findings are made with respect to the bus fire involving a Volvo B12BLE, registration MO 1414 that occurred in Dudley, NSW on 28 April 2016.

- 3.1 The fire initiated in the engine bay at the rear of the bus and was likely the result of an electrical short from a B+ cable between the alternator and starter motor.
- 3.2 It is likely that the destruction of the supporting P-clamp or its associated rubber boot damaged the B+ cables insulating cover. Once this insulation failed, the cable short-circuited onto the metal of the P-clamp. The resulting heat melted the P-clamp and parted the cable. The live parted B+ cable then came into contact with the engine cooling pipe causing another short-circuit. The heat generated from one or both short-circuits ignited surrounding combustible materials. The resulting fire destroyed fuel and hydraulic lines releasing combustibles onto hot engine components, which spread the fire.
- 3.3 The level of damage caused by the fire was exacerbated by the continued operation of the engine after the initial ignition of the fire. The operating engine supplied a steady flow of fuel and electrical energy (heat), while the radiator fans provided a strong flow of fresh oxygen to the fire.
- 3.4 Routine maintenance did not identify any defect in electrical cabling or componentry.
- 3.5 Firefighting and general emergency training for the driver occurred at the time of initial induction. There was no ongoing monitoring of emergency response proficiency.

## **PART 4 RECOMMENDATIONS**

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OTSI makes the following recommendations to in the interests of contributing to a safe passenger transport environment in New South Wales.

### **State Transit Authority**

- 4.1 Review the current recommended practice for bus operators following the activation of on-board alarms to increase focus on effective investigation to determine the cause.
- 4.2 Review the current training process to ensure bus drivers are capable and proficient to respond to emergency situations they may encounter.
- 4.3 Review current inspection methodologies by maintenance personnel to increase identification of suspect electrical components.

### **Roads and Maritime Services**

- 4.4 Increase surveillance levels regarding ongoing day-to-day and emergency scenarios to ensure the industry is maintaining the proficiency bus operators.
- 4.5 The recommendations 4.1, 4.2, 4.3 are disseminated to the broader bus industry as they are applicable to all operators.

## PART 5 APPENDICES

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### Appendix 1: Sources, Submissions and Acknowledgements

#### Sources of Information

- State Transit Authority
- Transport for NSW
- Roads and Maritime Services

#### 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:

- State Transit Authority
- Transport for NSW
- Roads and Maritime Services

Submissions were received from all the DIPs. 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.