



Office of Transport Safety Investigations

BUS SAFETY INVESTIGATION REPORT

STA BUS MO 1504 FIRE
SYDNEY HARBOUR BRIDGE
6 MAY 2016



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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.

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

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EXECUTIVE SUMMARY

At 0020 on Friday 6 May 2016, a State Transit Authority (STA) bus MO 1504 was travelling northbound on the Sydney Harbour Bridge when passengers reported to the driver that there was a burning smell and the presence of smoke within the bus. The driver stopped the bus on the Harbour Bridge and evacuated the passengers. The driver then notified the STA Network Control Centre (NCC) of the fire and they alerted STA's mobile maintenance team. The maintenance team attended the scene and confirmed that the bus was safe. There were no injuries received by the passengers or the driver.

The investigation determined that the fire was ignited by a short circuit in the air conditioning electrical control system. The circuit board had recently been replaced during scheduled maintenance and the bus was subsequently deemed fit for service.

Following this investigation, OTSI makes two recommendations with an emphasis on ensuring that all electrical maintenance complies with manufacturer's specifications.

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

PART 1 FACTUAL INFORMATION

Introduction

- 1.1 At 0020¹ on Friday 6 May 2016, a fire occurred in the roof cavity of STA bus MO 1504. At the time, the bus was travelling northbound on the Sydney Harbour Bridge en route to Palm Beach with fifteen passengers on board.
- 1.2 The passengers alerted the driver to a burning smell and smoke inside the bus. The driver stopped the bus on the Harbour Bridge and evacuated the passengers to a safe area free of traffic. The driver notified STA NCC and they alerted the STA mobile maintenance team. The maintenance team attended the scene and confirmed that the bus was safe. There were no injuries to the passengers or the driver.

Bus information

- 1.3 The bus was a 2004 Volvo B12 BLE Euro 3 model and was one of only two of that model attached to the STA Mona Vale Depot. The bus was registered with Roads and Maritime Services (RMS) to carry a maximum of 88 passengers (62 seated and 26 standing). The bus had departed from Wynyard, Sydney at 0010 on route L90 to Palm Beach when the fire started.
- 1.4 The bus was equipped with a 2.4 kg portable dry powder fire extinguisher, mounted near the driver's console.

The driver

- 1.5 The driver held a current NSW heavy rigid vehicle driver licence and a current NSW public passenger vehicle driver authority.
- 1.6 The driver had received training in emergency procedures during initial induction training, including recommended emergency response actions and the use of a portable fire extinguisher.

¹ Times in this report are in 24-hour clock form in Australian Eastern Standard Time.

- 1.7 Once alerted of the burning smell and smoke the driver evacuated the passengers from the bus. The driver radioed STA NCC advising of the fire and the bus's location. The driver turned off the air-conditioning system; however, the driver did not isolate the main electrical supply before alighting from the bus.
- 1.8 STA mechanics inspected the bus while on the Harbour Bridge and deemed the bus safe to move. The bus was moved to the STA Mona Vale Depot.
- 1.9 STA NCC notified OTSI of the fire and OTSI quarantined the bus at STA Mona Vale pending examination.

Inspection

- 1.10 Later the same day, an OTSI investigator, the STA Mona Vale Depot Maintenance Manager and two representatives from the air conditioner service contractor, Transport Refrigeration Services (TRS), examined the bus.
- 1.11 The fire damage was confined to the air conditioning unit circuit board, filter, and associated wiring housed in the front roof cavity. There was no fire damage to the interior of the bus.

PART 2 ANALYSIS

Air conditioning unit

- 2.1 The air conditioning return air filter was removed to enable the examination of the electrical circuit boards. The air conditioning filter exhibited damage consistent with hot material falling from the circuit board mounted above the filter (refer *Photograph 1*). The heat-affected area was restricted to the air filter, circuit board and adjacent electrical wiring.



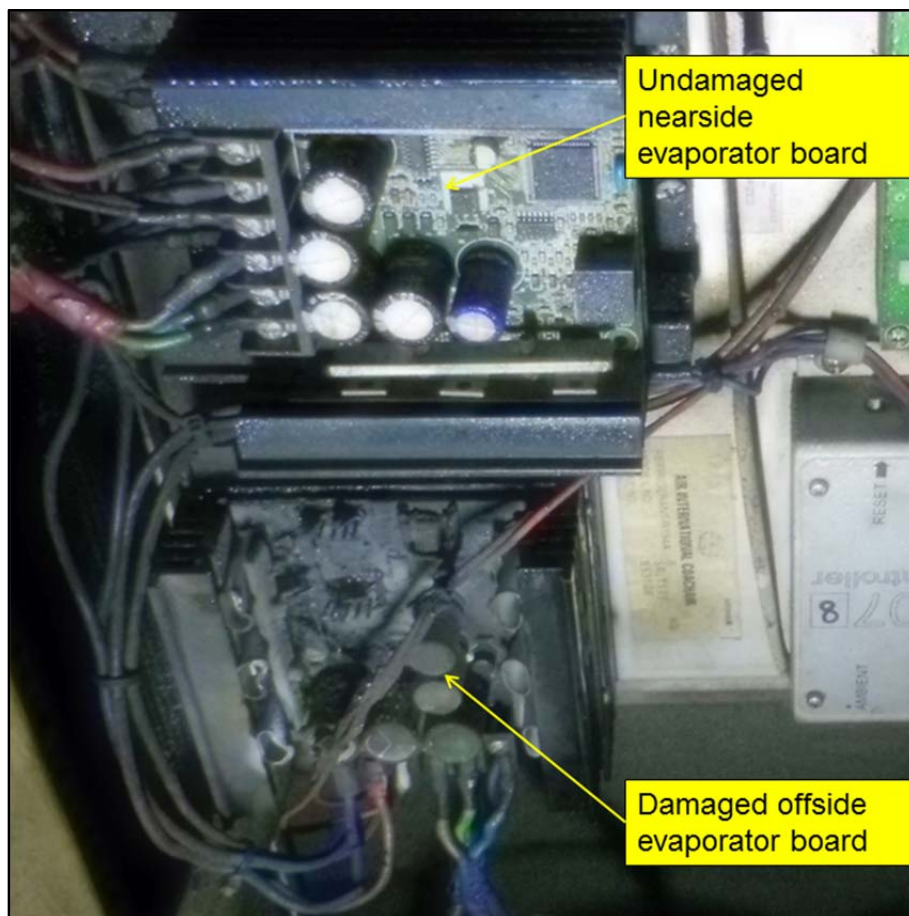
Source: OTSI

Figure 1: Fire damage to air conditioning filter

- 2.2 With the filter removed, further examination revealed that the damage was confined to the offside² evaporator fan circuit board.

² Offside is the side of the vehicle closest to the roadway centreline. It is the side the driver is located on, which in Australia is the right side of the vehicle looking from the rear towards the front.

- 2.3 It was likely that the fire ignited in the offside fan circuit board. The fire most likely extinguished either when the circuit breaker 'tripped'³, or when the air conditioning power supply was switched off. It is likely that the circuit breaker tripped when the heat affected electrical components short-circuited the board's power supply.
- 2.4 The offside fan's control circuit board was fire damaged. Whilst the nearside fan's circuit board remained undamaged (See *Photograph 2*).



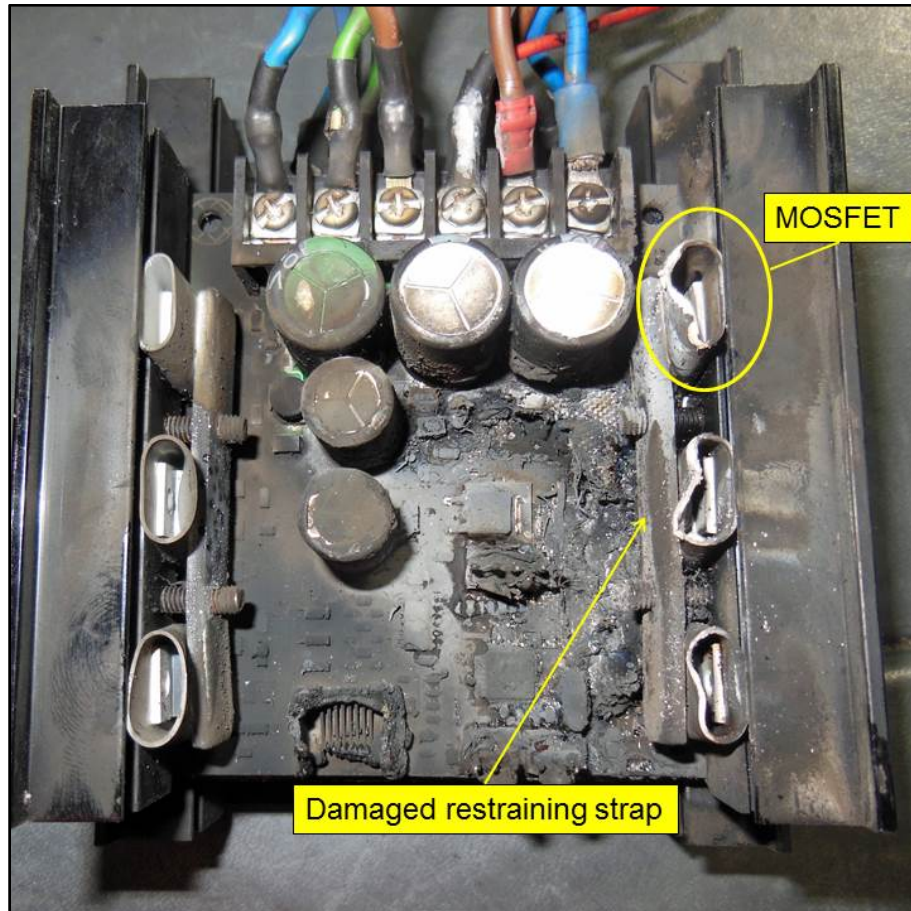
Source: OTSI

Figure 2: Roof mounted air conditioning circuit boards

³ 'Tripped' means when the circuit breaker automatically opens the circuit to stop the flow of electricity to the system.

2.5 The examination of the damaged circuit board revealed that a failed Metal–Oxide–Semiconductor Field-Effect Transistor (MOSFET) mounted on the circuit board was most likely the ignition source of the fire (see *Photograph 3*). These are two likely scenarios:

- The MOSFET was damaged during manufacture.
- The MOSFET was damaged when the unit was installed in the bus.



Source: OTSI

Figure 3: Damaged circuit board

Air conditioning unit maintenance

2.6 Examination of the bus's servicing and maintenance history showed there were a number of issues with MO 1504's air conditioning unit. Maintenance records for the bus's air conditioning unit supplied by STA lists the following issues and remedial action taken.

3 January 2016	STA work order 00145312 air conditioning not working and smells.	Locate C1 circuit breaker tripped, reset, continue testing, repair short at evap. wiring, replaced both overheating plugs, test ok, nearside fan draws 19.1amps on 20 amp fuse, may need new brushless motors, to be ordered. Found overheated plugs and insulation peeling off, (evap. fan motors), wash filter, fit fresh air sponge.
13 January 2016	STA work orders 00145694 A/C fans constantly on. STA work order 00145668 Renew	TRS R&R nearside evaporator motor supplied by STA
15 February 2016	STA work order 00146961 air con mould smell	Check unit, clear drains, nearside evaporator fan running backwards, swap wires at motor plug, check operation, fit fresh air sponge.
March 2016	STA works order 00147361 A/C fans constantly on.	TRS diagnose passenger side evaporator fan module faulty and order 1 x new module. TRS Fit 2 new evaporator fan relay boards run and test ok

Source: STA

Figure 4: Bus 1504 maintenance records (STA)

2.7 A maintenance record from 3 January 2016 revealed that the failed evaporator circuit board wiring had incurred heat damage following an electrical short circuit.

2.8 In March 2016, TRS installed the evaporator circuit board involved in the 6 May 2016 incident. TRS did not replace the heat-affected wiring during either maintenance intervention.

- 2.9 During the post incident examination, the evaporator cooling fins exhibited a build-up of debris. This debris inhibited the drainage of condensate away from the assembly and restricted cooling airflow. The restricted airflow would have forced cooling fans to work harder, drawing a higher current and most likely related to the report of 3 January 2016.

Post incident remedial action

- 2.10 Subsequent to the incident STA has:

- had the manufacturer conduct an investigation in an attempt to determine the cause of failure, with a view to determining whether there was systemic risk that required further action
- initiated investigations to determine whether the scope of the vehicle Fire Detection and Suppression System can be extended to detect and deal with thermal incidents in roof mounted air conditioning systems
- recruited an air conditioning specialist into its Asset Management Division
- changed their air conditioning maintenance contractor
- instituted ongoing inspections of bus electrical systems

PART 3 FINDINGS

From the evidence available, the following findings are made with respect to the fire within STA bus MO 1504 on 6 May 2016.

- 3.1 The ignition source of the fire was most likely a result of a short circuit of a MOSFET on the offside air conditioning circuit board.

Contributory factors

- 3.2 It is possible the MOSFET was damaged during manufacture or when the control unit was installed in the bus.
- 3.3 Maintenance contractors may not have fully diagnosed and / or repaired faults as per the maintenance records as from the 3rd of January 2016 to March 2016 (see *Figure 4*).

Other Safety Factors

- 3.4 The driver did not isolate the bus electrical supply when exiting the bus.

PART 4 RECOMMENDATIONS

OTSI recognises that STA has already implemented some remedial safety action.

OTSI recommends that:

- 4.1 All bus operators have an assurance process for work carried out by contractors, to ensure that work carried out complies with manufacturer's specifications and is conducted by competent personnel.
- 4.2 All bus operators provide bus drivers with robust emergency response procedures that include the isolation of electrical power supply.