OTSI Office of Transport Safety Investigations

TECHNICAL INSPECTION FINDINGS

FIRE INVOLVING WESTBUS BUS

GREYSTANES, SYDNEY

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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 accidents and incidents 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, and confirmed by amending legislation as an independent statutory office on 1 July 2005, OTSI is responsible for determining the causes and 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 caused or 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 Rail Safety Act 2008 and the Passenger Transport Act 1990. 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 a "Just Culture" approach to the investigative process by balancing the presentation of potentially judgemental material in a manner that properly explains what happened, and why, in a fair and unbiased manner.

The Incident

At approximately 2:30pm on Tuesday 21 September 2010, a Westbus[1] bus stalled while travelling through the Sydney suburb of Greystanes on a route service. The driver was unable to restart the engine and, on looking through the left hand side mirror, he noticed smoke emanating from the rear of the vehicle. He went to the rear of the vehicle and saw that a large amount of smoke was coming from the engine compartment area.

The driver immediately evacuated the five passengers travelling on the bus. He then returned to the rear of the bus where he depleted a small handheld fire extinguisher under the rear engine compartment door. However, this did not quell the fire. Moments later the fire began to spread from the engine compartment and into the interior of the bus. The driver of another bus stopped and tried to render assistance by also depleting a small handheld fire extinguisher. By the time the NSW Fire Brigade arrived the bus was fully ablaze.

Result

The Fire Brigade extinguished the fire but the bus was gutted throughout.

There were no injuries sustained by either the driver or any of the passengers. Police attended the incident but their involvement was limited to making a report of the matter deeming that, as there were no suspicious circumstances, no further involvement by them was required.

Under instructions from the operator, the bus was removed from the scene at 6pm utilising a flatbed truck to convey it to a heavy vehicle repairer located in the suburb of Prestons.

OTSI Involvement

OTSI's Duty Officer was notified of the incident at 3:15pm by a Westbus manager. Arrangements were then made for an OTSI investigator to undertake an inspection and initial assessment at Prestons the following day.

1 Westbus is a wholly owned subsidiary of ComfortDelGro Cabcharge Pty Ltd.

The Bus

The Bus was a Volvo single door 2001 B10BLE model, fitted with a 10 litre, 6 cylinder turbocharged diesel engine and an automatic transmission. It had travelled 531,836 kilometres since new. The bodywork of the bus consisted of a galvanised steel frame, with a fibreglass roof and composite body.

Examination of the Bus

A general examination of the bus was undertaken on 22 September and more targeted examinations were undertaken on 23 and 28 September. The examinations took the form of an elimination process working from experience of the causes of previous bus and coach fires. The condition of the bus following the fire can be seen from *Photograph 1*.

Photograph 1: Overview of the fire damage

Wheels, brakes and tyres

All wheels and tyres were in good condition and, despite the extent of the fire, the tyres stayed inflated. The rear wheels of the bus were of a dual configuration on a single axle. There were no signs of rubbing which has been known to generate high

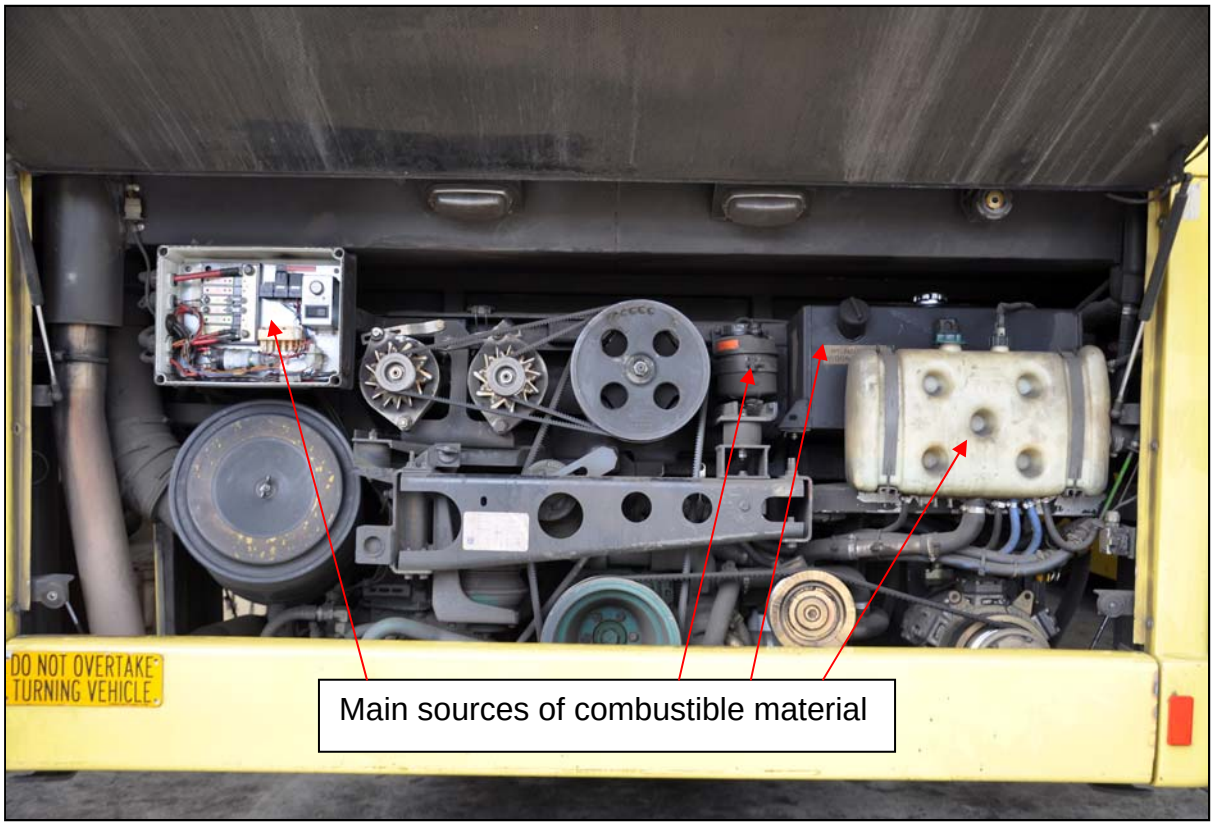
temperatures and cause fire. Further, the areas in and around the wheel arches, hubs and axles were all in good condition with no residue of grease or oil present.

Turbocharger and associated piping

The turbocharger was examined in detail and found to be clean and showing no signs of failure. The turbine blades rotated freely within the turbine.

Combustible materials within the engine compartment

Within the engine compartment, the main components containing or consisting of significant amounts of combustible materials were the main electrical box, hydraulic fluid filter, hydraulic fluid reservoir and the radiator header reservoir tank. These can be seen, from left to right respectively, in the photograph of the engine compartment of an identical bus (*Photograph 2*). It is considered that, should the ignition temperatures of these materials be reached, they would provide secondary fuel sources for a fire and promote its spreading. The plastics commonly used for such components have ignition temperatures in the range of approximately 410ºC and 580ºC, and considerably lower melting points.



Photograph 2: Engine compartment of identical bus

Flammable fluid reservoirs

A bus has a number of reservoirs that contain highly flammable fuels and lubricants. A fire can be caused or fuelled if a fluid reservoir is ruptured or fuel lines are damaged. The fluid levels in the engine, power steering, fuel tank and engine lubricant reservoirs were checked and found to be at normal operating levels. Therefore, they did not provide a source of fuel for the fire.

Fuel racks, fuel lines and associated connections

The fuel racks, injector pump and associated connections were all sound and tight. There were no signs of fuel seepage that could have started or fuelled the fire.

Combustible materials within the cabin of the bus

It was reported that the fire gutted the bus within four minutes of its entering the cabin (see *Photograph 3*). The linings within the body of the bus were made up of a combination of plastic and fibreglass. The seats were steel framed and upholstered using a combination of high density foam covered with material containing 50% synthetic fibre. The floor consisted of 18 mm grade H3/F14 marine plywood which burnt through wherever the underside was exposed to an outside air source, predominantly along the aisle.

Photograph 3: Interior looking from the rear

Wiring looms

The wiring looms throughout the bus were checked for any irregularities. Particular attention was directed at the wiring loom on top of the transmission known for its potential to be a fire source. All looms were intact and appeared normal.

Within the engine compartment, the outer plastic covering of the wiring looms associated with the main electrical box had completely burnt away leaving the bare copper wires exposed. A check for discolouration throughout the length of the wire revealed no abnormal signs which would indicate locations of high, spot temperatures. Despite the heat that would have been generated within the compartment, all wiring was intact.

Alternators

Two identical Bosch alternators with an output of 80 amps per unit were fitted to the vehicle. The right hand alternator (driver's side) showed only superficial damage and the shaft could still be turned. However, the left hand alternator had suffered severe damage, particularly the casing, due to exposure to excessive heat (see *Photograph 4*). This alternator was removed to enable a bench top examination for evidence of mechanical or electrical failure.

Photograph 4: The damaged alternator

The internal mechanisms of the left hand alternator, including the main bearing, showed no evidence of damage that would have preceded the fire. However, the alternator output terminal was loose at its connection point. A loose connection

creates a high resistance to current flow with the potential to generate excessive heat both at the terminal and within the alternator stator windings. The heat generated could be sufficient to ignite surrounding flammable materials located within the engine compartment. The terminal was significantly discoloured indicating exposure to high temperatures, and it was turned inwards and jammed tightly against an adjacent terminal also located on the rear of the alternator. However, the aluminium casing beneath the terminals exhibited no significant heat damage.

Maintenance records showed that the vehicle had been returned to the depot at Bonnyrigg for a service the day before the fire and that this service included the replacement of the alternator drive belts. The alternator main terminal connections may have already been loose, or may have been inadvertently loosened during the service. Further, a locking washer was missing from beneath the nut securing the cable leading to the battery. This washer is needed to ensure the nut does not loosen during bus operation.

The aluminium housing of the alternator had been melted away and distorted due to heat, with a complete loss of aluminium around the stator at the original 9 o'clock mounting position leaving the steel laminations of the stator completely exposed. This pattern showed that intense heat was generated from, or directed at, this area of the alternator. The damage pattern suggested that the stator became hot enough to melt the surrounding aluminium housing, yet not enough to melt the copper conductors within its winding. This suggests exposure to a temperature between approximately 660ºC and 1080ºC.

In an effort to establish whether or not an internal fault may have caused the alternator to overheat, the manufacturer was invited to undertake a technical inspection of the component. This inspection did not reveal any obvious reason for an alternator malfunction leading to overheating and they formed the opinion that it was most likely to have been in a serviceable condition prior to the fire.

Bus bar enclosure

A plastic enclosure mounted next to the alternator and sitting slightly in front of it housed the battery bus bar linking both alternators to the batteries, along with a starter solenoid and associated relays. It was not considered that this enclosure would have contained the heat energy or been suitably located to cause the visible damage.

Fuses

During the examination of the bus wiring, no fuse (weak link) could be found within the electrical circuit between the alternator, the main electrical box and the batteries. The non-existence of such a fuse was confirmed from the main electrical diagrams sourced from Volvo Australia who also verified that alternator fuses were never installed in this particular model of bus.

A concern with this type of circuit is that, in the event of an electrical or mechanical failure, there is effectively no weak link within the circuit. Ultimately the weakest point or mechanism will fail and a fire may result when there is a build up of excessive heat during the process.

Fire alarms

The driver of the bus advised that there was no audible alarm which alerted him to the presence of a fire at any stage. The inspection of the bus revealed there were three fire sensors all of which were located on top of the transmission. Though located towards the rear of the bus, these devices cannot detect a fire in the engine compartment. Given the number of fires that start within bus and coach engine compartments and the amount of combustible materials therein, it would seem prudent to install fire sensors within the engine compartments.

A check of the alarm circuits on another bus of the same model revealed that the audible alert sounded the same for all warnings which include low air, loss of brakes, air bag failure or over-inflation, fire, ‘hot engine’, and a range of engine problems. There may be a case for a separate more distinctive alert for potentially life threatening situations such as fire.

Conclusions

It is considered most likely that the heat source which initiated the fire was electrical in origin and came from the alternator either at the output terminal as a result of heat build-up due to the effects of a loose connection or a catastrophic internal failure within the alternator. The heat caused the main electrical box, which sits beside the alternator and is made predominately of plastic, to catch fire. The fire then travelled to the left hand side of the bus, up the exhaust well, and into the interior of the bus. Once the fire had spread to the interior, it quickly travelled the length of the bus

fuelled by the array of plastics, other synthetic materials and the plywood flooring which make up the fabric of the bus.

OTSI has concluded its examination of the circumstances of this incident and has determined that it does not require further investigation by this Office under the provisions of Section 46BA (1) of the *Passenger Transport Act 1990*.

A copy of these Findings has been provided to Westbus, Transport NSW and the Australian Motor Vehicle Certification Board.