OTSI Office of Transport Safety Investigations

TECHNICAL INSPECTION FINDINGS

LODGES BUS SERVICE COACH FIRE

WODONGA, VICTORIA

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Postal address: PO Box A2616, Sydney South, NSW 1235
Office location: Level 17, 201 Elizabeth Street, Sydney NSW 2000
Telephone: 02 9322 9200
Accident and incident notification: 1800 677 766
Facsimile: 02 9322 9299
E-mail: info@otsi.nsw.gov.au
Internet: www.otsi.nsw.gov.au

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 5:30pm[1] on Tuesday 20 March 2012, the driver of a Lodges Bus Service coach travelling between Ocean Grove, Victoria, and Albury, NSW, was forced to pull over to the side of the Hume Highway just prior to the Albury exit off-ramp due to a fire in the engine compartment. The driver had been travelling at 100 km/h in cruise control when power to the vehicle was lost. Just prior to losing power the driver noted a fire warning alert on the dashboard. He immediately observed the rear of the vehicle utilising his right-hand mirror and noted a large amount of smoke coming from the vehicle. He utilised the Albury exit off-ramp to park the vehicle where he was able to stop with the assistance of the maxi brakes having lost power assist to the vehicle's brakes as a result of losing engine power.

The driver ensured that the 37 school children and the three school teachers who were travelling on the coach were evacuated before he tried to extinguish the fire. He retrieved the fire extinguisher from the driver's compartment and then attempted to extinguish the fire by discharging it in an upward direction from underneath the coach. At no time did the driver attempt to open the rear hatch to the engine compartment as there were flames evident from around the seals of the engine compartment door.

The Country Fire Authority (CFA) of Victoria responded to the incident within ten minutes of the coach stopping. They extinguished the fire and succeeded in confining the damage to the engine compartment and the rear panelling of the coach. Victoria Police also attended the incident scene but their involvement was limited to traffic management and making a report of the incident. They deemed that there were no suspicious circumstances.

Result

All components in the engine bay, particularly in the vicinity of the turbocharger, were damaged, as were the covering hatch of the engine bay and the body panels above and to the sides of the hatch (see *Photographs 1 and 2*). The rear window was shattered in the process of extinguishing the fire.

[1] All times in this report are in Australian Eastern Daylight Time (UTC+11 hours).

Photograph 1: Fire damage

Photograph 2: Rest of coach in good condition

No injuries were sustained by either the driver or any of the 40 passengers.

Under instructions from the operator, the coach was removed from the scene by a local tow truck operator and conveyed to the maintenance compound within the premises of CMV Truck & Bus Pty Ltd based at Wodonga.

OTSI Involvement

OTSI's Duty Officer was notified of the incident at 9.50pm by the Director of Lodges Bus Service. Arrangements were then made for an OTSI investigator to undertake an inspection and initial assessment the following day.

The Coach

Compliance plates confirmed that the coach was a 2006 model Volvo B7R-A108491 chassis on which was mounted a tour coach body constructed by the North Queensland Company, Coach Design Pty Ltd. The vehicle was equipped with a 7 litre diesel engine and a manual transmission. The bodywork of the coach consisted of a galvanised steel tube frame supporting a combination of aluminium and composite (fibreglass) panels. It was fitted with one entry/exit door, near the front of the vehicle. The coach had travelled 257,350 kilometres since it was introduced into service.

Examination of the Coach

General examinations of the coach were undertaken on 21 and 22 March 2012 in the presence of Volvo's Regional Service Manager, Bus for Victoria and South Australia. The examinations took the form of visual and mechanical inspections to try to establish the likely ignition source of the fire.

Inspection process. Examination of the engine compartment established that the fire had been extinguished in sufficient time to contain the fire within the engine compartment. However, there was a concentrated pattern of fire damage within the engine compartment near the turbocharger.

A number of key areas, as listed below, were subjected to detailed inspection.

Fuel lines and associated connections. The fuel lines, 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. The fuel injector lines in the engine bay, particularly those running from the fuel pump to the fuel injector near the top of the engine, were checked for any irregularities. All injector lines were completely intact and in good serviceable condition.

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 coach were of a dual configuration on a single axle. There were no signs of rubbing which has been known to generate temperatures high enough to cause a 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.

Combustible materials within the engine compartment. Within the engine compartment, the main components containing a significant quantity of combustible materials were the main electrical box and the hydraulic fluid reservoir. It is likely that these components provided a secondary source of fuel that assisted in promoting the fire once it had become established. All these components were destroyed in the fire.

Flammable fluid reservoirs. Since a coach 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 power steering and fuel tank fluid levels were checked and found to be at normal operating levels. These were eliminated as sources of fuel for the fire.

Wiring looms. The wiring looms throughout the rear of the coach were checked for any irregularities. All looms were intact and appeared to be normal. Within the engine compartment, the outer plastic covering of the wiring looms associated with the main electrical box and associated wiring had completely burnt away leaving the bare copper wires exposed. A check for discolouration throughout the length of the wire, which would indicate locations of high spot temperatures, revealed no abnormal signs. Despite the heat that would have been generated within the compartment, all wiring was intact.

Engine. The Volvo D7C290 engine is a 6-cylinder vertically mounted engine. The fuel system incorporates an electronically regulated injector pump and the fuel injection system utilises the Engine Management System (EMS). A check of the fuel injectors, pumps and associated fuel lines did not reveal any evidence of faults that may have caused or contributed to the fire. The engine remained completely intact.

Turbocharger and associated piping. The engine is fitted with a Holset HX40W turbocharger. The turbocharger is lubricated and cooled by the engine oil and is additionally water cooled. As oil flow is critical for its operation, it is very important that inspection, servicing and maintenance of the engine lubrication system are conducted thoroughly. The oil pipe from the engine enters the turbocharger via a brass block called a flange, which belongs to the 'oil system function group' (see *Figure 1*). The flange is fastened to the top of the turbocharger and its purpose is to secure the oil supply pipe to the turbocharger. Oil from the engine sump supplies oil via the oil pipe and flange unit to the turbocharger at 300 to 550 kPa.

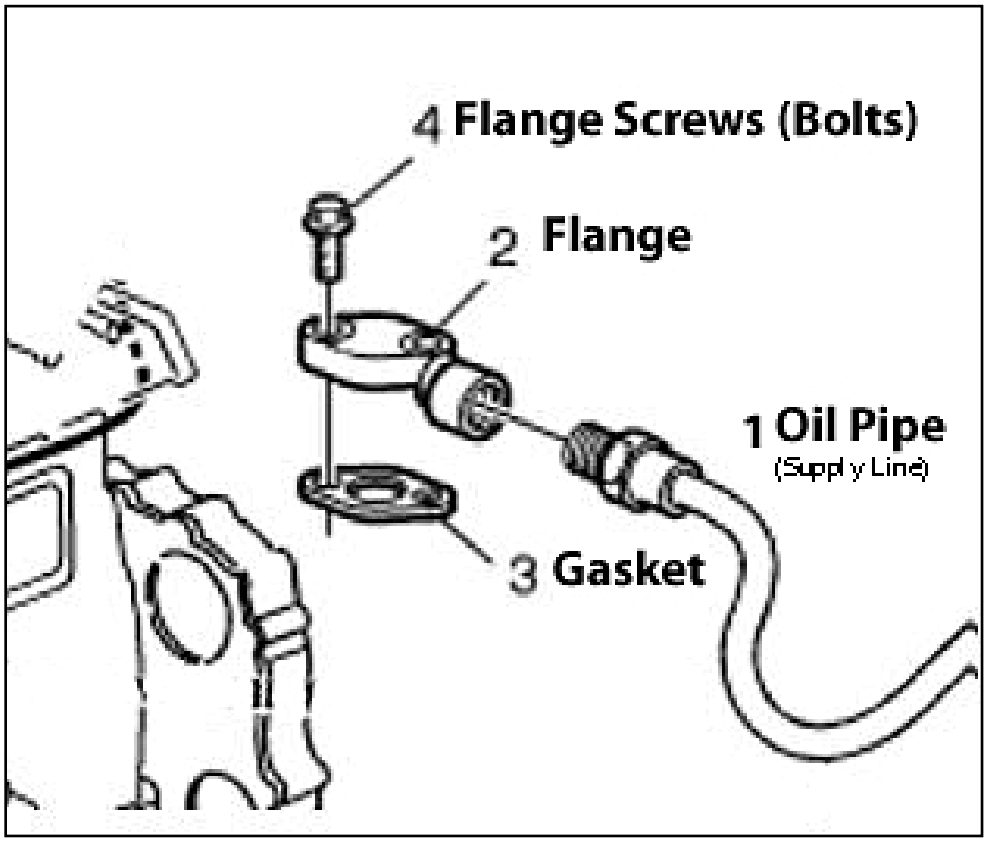


Figure1: Oil System Function Group

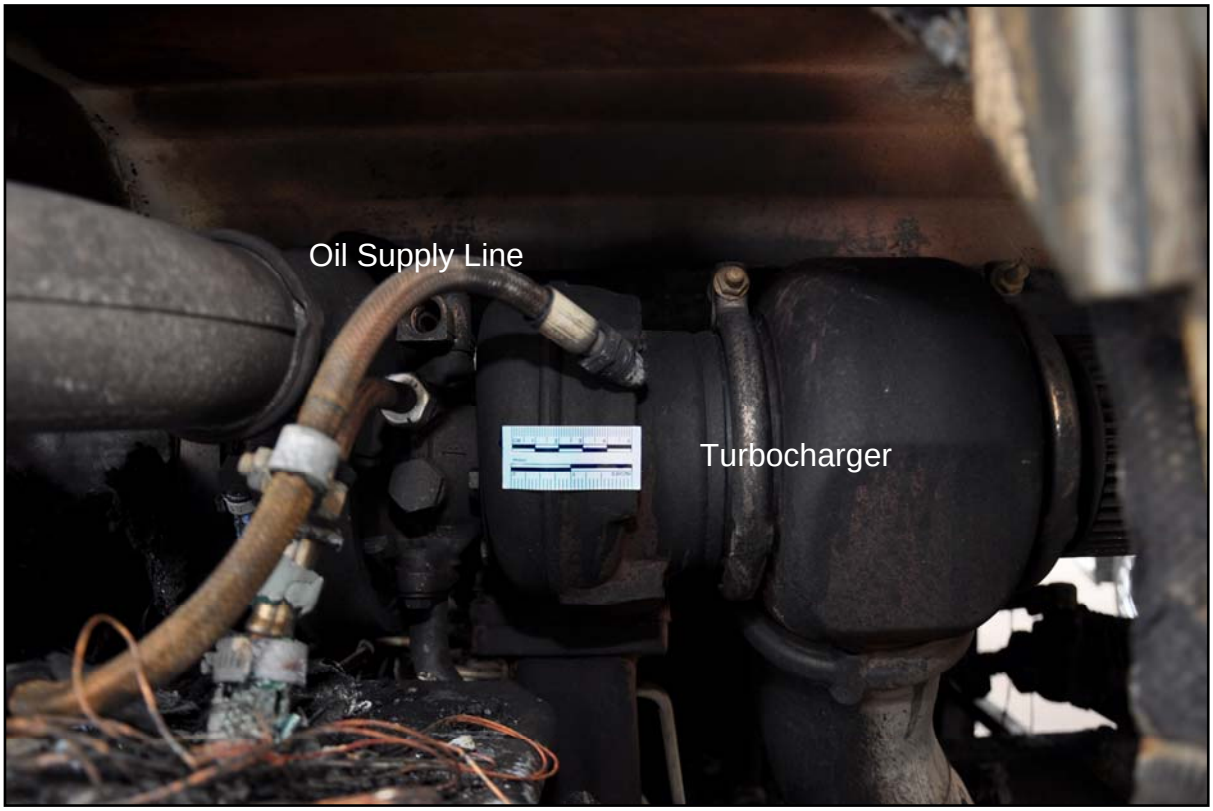
Inspection of the turbocharger revealed that the oil pipe was sitting loosely within the flange housing but was not fastened (see *Photographs 3 and 4*). This situation is likely to have caused the fire by permitting oil being supplied to the turbocharger under high pressure to spray over the hot turbocharger surface and ignite.

When the turbocharger was dismantled, the turbine shaft was found to be broken within its housing unit. Further, the main bearing had failed. Severe discolouration of both the bearing and shaft was consistent with high temperature operation in the absence of adequate lubrication. The turbocharger failure was deemed a secondary failure due to the lack of oil once the sump was depleted.

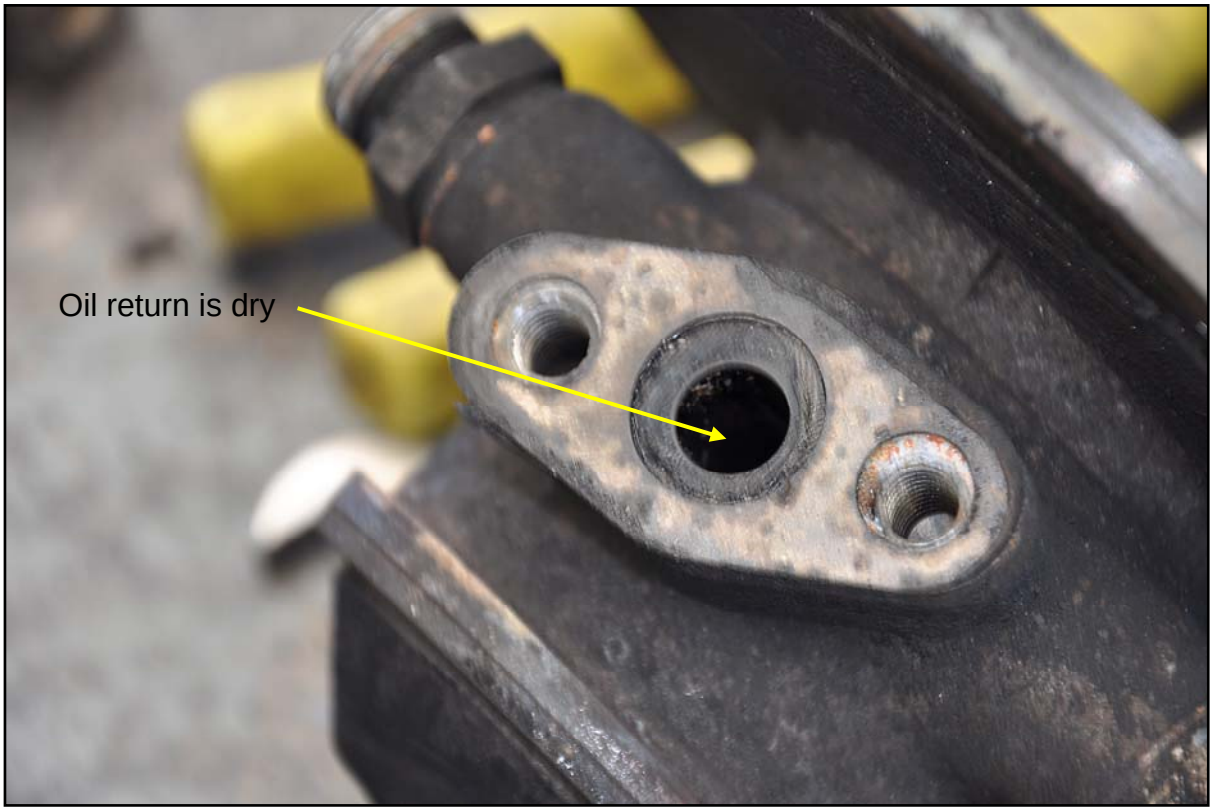
Only one litre of oil, of what would normally be 20 – 25 litres, was found remaining when the engine oil sump was drained.

Photograph 3: Main oil supply oil line sitting within flange unit but not secured

Other areas. On examination, the oil return housing and piping that fixes to the underside of the turbocharger were found to be dry (see *Photograph 5*), indicating that the turbocharger had been starved of oil as, normally, the oil return pipe would be saturated with oil.

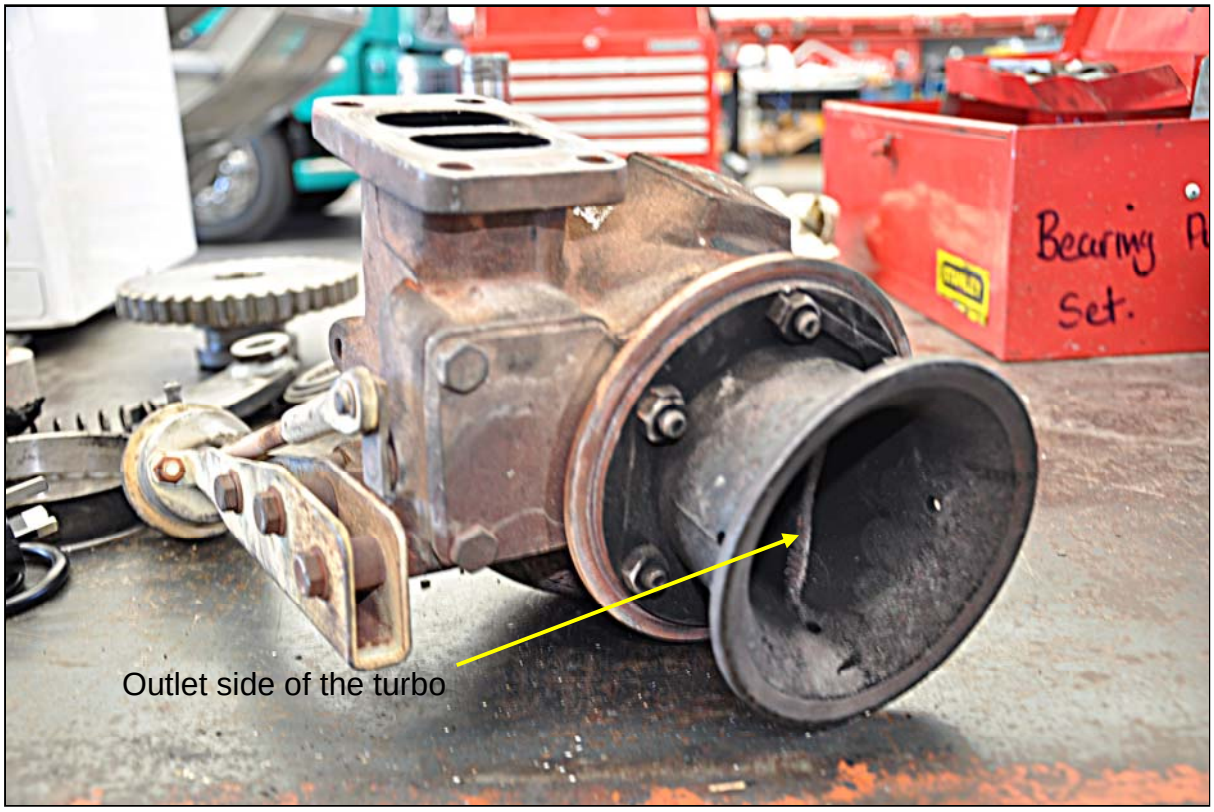


Photograph 4: Oil supply line sitting in front of turbocharger



Photograph 5: Oil return housing.

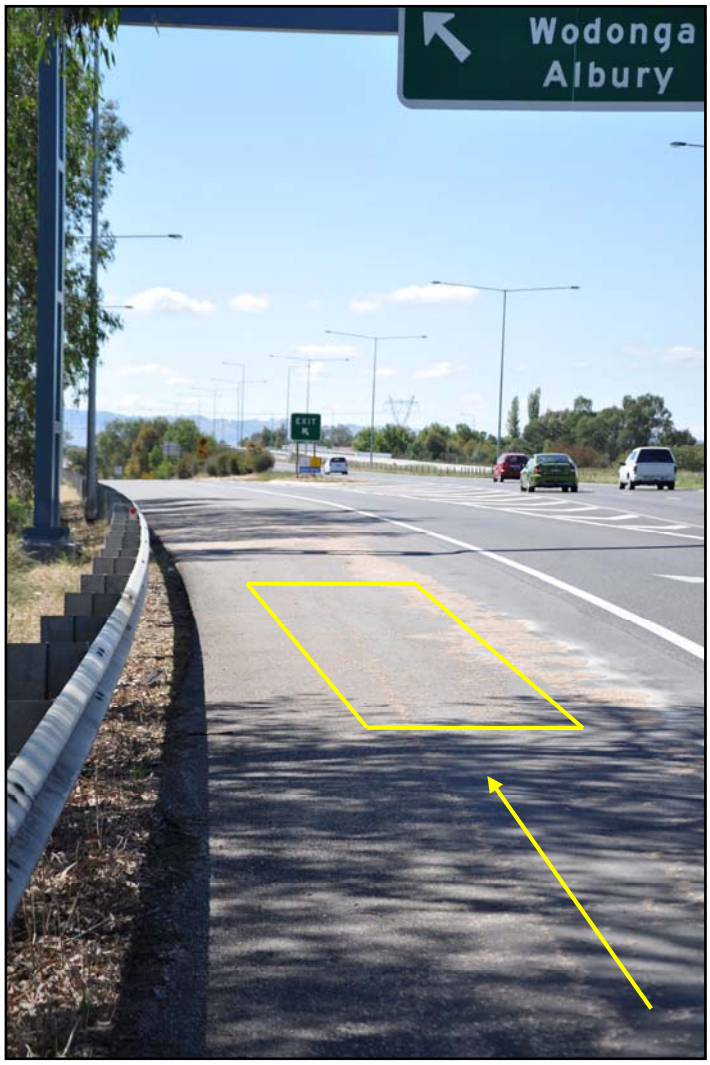
An examination of the exhaust system found it to be dry indicating that a faulty turbocharger seal or bearing was not the cause of the fire. Normally, when turbocharger seals and bearing become worn, the exhaust system is saturated with oil as oil bypasses the system. When the exhaust system was dismantled it appeared dry and normal in colour (see *Photograph 6*).



Photograph 6: Exhaust portion of the turbocharger dry and normal in colour

An inspection of the Hume Highway revealed an oil residue trail for several kilometres leading up to the point where the coach was stopped at the Albury off-ramp. This was consistent with a loose oil supply line working its way free and spraying oil under pressure over the hot turbocharger components, then dripping oil onto the roadway as the vehicle proceeded (see *Photographs 7 and 8*).

Photograph 7: Oil residue on the Hume Highway for several kilometres



Photograph 8: Vehicle stopped just prior to Albury off-ramp

Servicing and Maintenance

The vehicle was purchased in May 2006 and initially maintained at the Volvo facility in Albury. From 4 March 2009 all servicing was conducted at the Lodges Bus Service depot workshop. The Lodges Bus Service utilised Volvo policy and procedures for all servicing of the vehicle to ensure that the vehicle was maintained to Volvo standards.

On 12 March 2012 the coach was required to undergo a NSW Roads and Maritime Services Heavy Vehicle Inspection Scheme (HVIS) inspection as required for NSW registration. The vehicle was issued a certificate for re-registration. There were no mechanical defects listed in the process.

Fire Protection

Fire extinguisher. The driver of the coach advised that, once he was alerted to the presence of a fire, he immediately evacuated the coach then attempted to extinguish the fire using the dry powder type extinguisher that was mounted next to the driver's seat.

Australian Design Rules require buses and coaches to be equipped with fire extinguishers selected and located in accordance with *Australian Standard 2444 - 2001: Portable fire extinguishers and fire blankets - Selection and location*. One 2.1kg 1A:20B:(E) dry powder type extinguisher was fitted to the coach, attached to a recessed panel next to the driver's seat.

It is clear from the Standard that the dry powder extinguisher was chosen as suitable for initial 'knock-down' of a developing fire in the passenger compartment or engine of the coach and is considered most effective when aimed at the base of a fire. However, this extinguisher could not be expected to extinguish a fire that was well established in the structure or engine compartment of the coach.

Fire warning sensor system. The inspection of the coach revealed there was a fire/heat warning sensor system installed. This system consists of three fire warning sensors which are now fitted to all Volvo B7R model buses and coaches. The system is designed to activate when it detects a significant heat source in the engine compartment and then provides an audible and visual warning alert to the driver. In this instance, the driver could not recall hearing any audible alarm, however, he

stated that he observed the warning alert on the driver's dashboard being activated just prior to losing power to the coach.

Three warning sensors are strategically placed throughout the engine bay as follows:

- one sensor rated to 110°C located in proximity to the starter motor;
- one sensor rated to 110°C located in proximity to the alternator; and
- one sensor rated to 150°C located in proximity to the turbocharger and fuel pump.

Photograph 9 shows a warning sensor similar to those typically fitted to Volvo B7R buses and coaches. Detection and activation of the system takes place automatically. In the event of a fire, the plastic coating around the detector probe melts and the internal wires contact, creating an open circuit which energises a relay. Once energised, the relay activates two red warning lights on the driver's dashboard, as well as an audible alarm to the bus or coach operator. The system does not operate independently of a power supply.

Photograph 9: Fire warning sensor fitted to B7R coaches

Other Findings

OTSI found that Volvo Australia had no policy or procedures in relation to the re-checking (re-tensioning) of the turbocharger oil supply line including nuts and bolts that secured the associated oil function group and turbocharger. However, within Volvo's servicing criteria, it specifies "*check for oil or coolant leaks, that pipes & hoses and union seals don't rub and or are not cracked*".

Lodges Bus Service conducted most of the servicing on the coach and utilised the Volvo maintenance program as guidance. They stated that, had Volvo had a re-tensioning program built into its servicing regime, they would have incorporated the same procedures within their maintenance program.

Volvo does not stipulate the use of a thread locking system in securing components such as turbochargers and associated equipment. OTSI notes that this is common throughout the motor trade industry. The turbocharger had never been serviced nor had its fixing bolts been re-checked for tensioning since the vehicle was purchased.

Conclusions

The fire was caused by the main oil supply line to the turbocharger becoming loose, allowing oil to escape under high pressure and spray over the hot turbocharger and exhaust components of the engine.

Checking the integrity of the turbocharger and oil supply line during routine servicing, together with utilisation of a thread locking system, would constitute appropriate remedial action to prevent a recurrence of this type of engine fire.

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 Lodges Bus Service, Volvo Bus Australia, the Independent Transport Safety Regulator and Transport for NSW.