OTSI Office of Transport Safety Investigations

BUS SAFETY INVESTIGATION REPORT

COACH FIRE

DOUGLAS PARK

26 SEPTEMBER 2011

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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.

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Once OTSI has completed an investigation, its report is provided to the NSW Minister for Transport 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.

OTSI cannot compel any party to implement its recommendations and its investigative responsibilities do not extend to overseeing the implementation of recommendations it makes in its investigation reports. However, OTSI takes a close interest in the extent to which its recommendations have been accepted and acted upon. In addition, a mechanism exists through which OTSI is provided with formal advice by the Independent Transport Safety Regulator (ITSR) in relation to the status of actions taken by those parties to whom its recommendations are directed.

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EXECUTIVE SUMMARY

At approximately 9.11am on Monday 26 September 2011, a coach owned and operated by CYC Tours Pty Ltd caught fire while travelling from Sydney to Canberra. On observing smoke coming from the rear of the coach, the driver immediately pulled over and stopped in the emergency lane. While the driver evacuated the passengers, the tour guide went to the rear of the bus to inspect the engine bay where he found the entire top of the engine was engulfed in flames. The coach crew, assisted by a passing truck driver and a Police officer, then attempted to extinguish the fire. However, they were unsuccessful and the coach was completely destroyed.

The investigation found that the flange unit that secures the oil supply pipe mounted on the top of the turbocharger was loose. This allowed engine oil to escape under pressure between the flange unit and turbocharger housing, then spray over the extremely hot turbocharger and associated exhaust components, and ignite. The fire then spread quickly throughout the engine bay and thence into and through the interior of the coach. The coach was not fitted with an automatic fire suppression system and the spread and intensity of the fire was beyond the capacity of the portable fire extinguishers applied to it.

The report makes recommendations that:

- CYC Tours evaluates the feasibility of installing an automatic fire suppression system on all coaches;
- Volvo Australia develops and incorporates in technical maintenance servicing documentation recommended parameters for the periodic checking of the tension on fasteners securing key engine and chassis components; and
- Transport for NSW, in consultation with industry, determines the desirability and practicality of introducing a requirement for the installation of an automatic fire suppression system to be made compulsory on all buses and coaches registered in NSW.

PART 1 CIRCUMSTANCES OF THE INCIDENT

Incident Synopsis

1.1 At approximately 9.11am on Monday 26 September 2011,[1] a coach owned and operated by CYC Tours Pty Ltd (CYC) caught fire while travelling from Sydney to Canberra. On observing smoke coming from the rear of the coach, the driver immediately pulled over and stopped in the emergency lane. While the driver evacuated the passengers, the tour guide inspected the engine bay and found the entire top of the engine was engulfed in flames. The coach crew, assisted by a passing truck driver and a Police officer using their own portable fire extinguishers, then attempted to extinguish the fire. However, they were unsuccessful and the coach was completely destroyed by the fire (see *Photograph 1*).

Photograph 1: Wreckage of the Coach

[1] All times referred to in this report are in Australian Eastern Standard Time (UTC+10 hours).

Before the Fire

1.2 The driver of the coach signed on at 7.00am on the day of the incident at the company's Alexandria yard and conducted basic pre-departure checks of the coach. He did not need to fuel the coach as it had been refuelled the night before in accordance with normal operating procedures. Approximately 15 minutes later, the driver departed the compound and made his way to Haymarket, located in the Sydney CBD, to embark his passengers and a tour guide. The coach was being used for a day trip to Canberra for a party of 47 Chinese nationals.

1.3 The coach departed Haymarket at approximately 8.08am. The trip was uneventful as they travelled out of Sydney on the M5 Freeway, South Western Motorway and then the Hume Highway heading towards Canberra. At approximately 9.00am they approached the Campbelltown exits where they were required to travel at 80 km/h for some distance as there were road works in progress. As they passed the last exit, the driver increased the speed from 80 km/h to 100 km/h.

The Fire

1.4 At a point approximately 6 km before Douglas Park, a township some 17 km on the southern side of Campbelltown (see *Figure 1*), the driver looked in his right-hand side mirror and saw smoke coming from the rear of the coach. He immediately looked down at his dashboard but noted there were no warnings displayed. He then steered the coach to the emergency lane beside the dual lane highway. He stopped there and turned off the ignition so that he could investigate the cause of the smoke. The driver stated that, as he was slowing, he observed a single flame emanate from the rear of the coach followed by more smoke.

1.5 As a precaution the driver and tour guide immediately evacuated the passengers. The passengers responded in a quick and orderly fashion and the coach was completely evacuated within approximately two minutes. The tour guide then went to the rear of the coach to investigate the source and cause of the smoke while the driver was still directing passengers to a place at a safe distance from the coach.

Figure 1: Location of incident

1.6 The tour guide accessed the engine bay through the rear hatch. As soon as he opened it, he observed that the whole top area of the engine and turbocharger was alight. He noted that the flames were deep orange in colour. He also observed that the flames were more intense in the general area of the turbocharger (located on the top of the engine).

1.7 The tour guide tried to access the fire extinguisher mounted in a compartment on the right hand side at the rear of the coach (see *Photograph 2*). However, when he opened the compartment door, he was not able to reach the fire extinguisher because of the flames and extreme heat. He then went and reported back to the driver.

1.8 While the tour guide continued to attend to the well-being of the passengers by keeping them at a safe distance from the coach and the highway, the driver retrieved a second fire extinguisher located behind the driver's seat onboard the coach. He then made his way to the rear of the coach to try to

extinguish the fire. However, the capacity of the fire extinguisher was insufficient to be able to suppress the fire. At this point, the fire was spreading down both sides of the engine and beginning to go under the rear of the coach.

Photograph 2: Fire extinguisher in close proximity to the engine bay

1.9 A truck driver who had noticed the smoke coming from the rear of the coach stopped behind it to lend assistance. At the same time, a Police officer patrolling the area also stopped to provide assistance. Both of them used fire extinguishers from their respective vehicles to fight the fire but their efforts were unsuccessful. By now the fire had progressed under the coach and was igniting the interior of the coach. All parties were forced to move to a safe distance and wait for Fire and Rescue NSW to attend. Within 10 to 15 minutes the fire had completely engulfed the coach.

Emergency Response

1.10 Fire and Rescue NSW at Picton were notified at 9.12am and attended the scene within approximately 20 minutes. Due to the nature and intensity of the fire, there was little they could do other than to contain the fire to the coach and ensure the fire didn't spread to adjoining bushland.

1.11 Largely due to the quick action of the coach crew, there were no injuries suffered by anyone at the scene so Ambulance services were not required.

Environmental Conditions

1.12 The weather conditions at the time were reported as being fine and mild.

1.13 The dual freeway between Sydney and Canberra has a good quality surface. Neither roadway conditions nor carriageway engineering played any part in the incident.

CYC Tours Pty Ltd

1.14 CYC Tours Pty Ltd has a staff of eleven full-time drivers/tour guides and one part-time employee for the operation of their buses and coaches. The company has been accredited by Transport for NSW (TfNSW) since 2005 to operate Long Distance, Tourist and Charter services with up to 10 vehicles.

The Driver

1.15 The driver of the coach had been with the company since October 2007. He had been in Australia since May 1989 and had a record of good performance with the company. He had a current HC licence[2] which he had held since April 1990 and had a current Driver Authority to drive a public passenger vehicle as required by the *Passenger Transport Act 1990*.

Tour Guide

1.16 The tour guide had been in Australia since May 1989 and employed with the company since July 2010. Although he was acting in the tour guide role on the day, he had a current HC licence and Driver Authority and so could be used as an alternate driver if the need arose. He also had a record of good performance with the company.

The Coach

1.17 Compliance plates confirmed that the coach was a 2007 model Volvo B7R-109680 chassis on which was a tour coach body constructed by North Coast Bus & Coach Pty Ltd. Maintenance records showed that the bus had been

[2] Heavy Combination licence permits the holder to drive any articulated vehicle or truck trailer combination.

regularly maintained throughout its life by the Volvo manufacturer's service company.

PART 2 ANALYSIS

Faults, Warnings and Alarms

2.1 On this model coach, there are three lights at the centre top of the driver's console which alert the driver to faults on the coach. They are designed and located so as to readily attract the driver's attention (see *Figure 2*). One delivers a 'Stop' message that signifies to the driver that they must stop immediately, turn the engine off and determine the nature of the fault. It is accompanied by an audible alarm. A second alert provides a 'Check' (warning) message which signifies that the coach must be driven to the nearest service centre as soon as possible. The third delivers an 'Information' (advisory) message which, when illuminated, does not necessarily mean there is something wrong with the coach, but that it should be checked for faults. The driver was adamant that none of these alerts were activated prior to the incident and his stopping in the emergency lane.

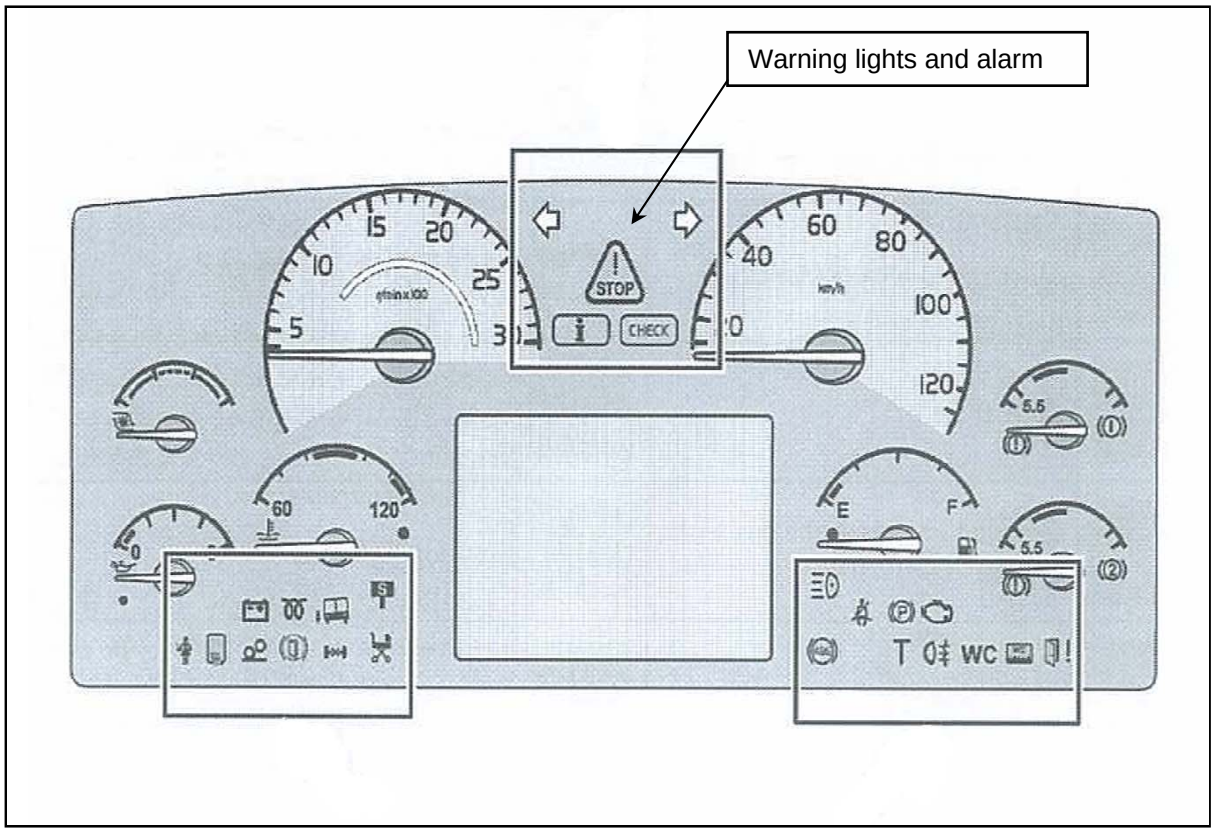

Figure 2: Driver's dashboard layout with Stop, Information and Check lights

2.2 At interview the driver confirmed that he had carried out a routine pre-departure check of the coach at the company's Alexandria yard. He added that at no time did he encounter any faults, warning lights, alarms or abnormal operation of any of the warning/indicators lights or alarms on the driver's dashboard.

Oil and Turbocharger Pressure Gauges

2.3 The driver stated that the oil and turbocharger pressure gauges were noted as part of the pre-departure check. At no time throughout the journey were there any issues with the oil and turbocharger pressures; the gauge readings reflected normal operating pressures. The driver did not experience any substantial loss in pressure and no associated alarm activated.

2.4 How oil pressure gauges signify critical oil levels varies between manufacturers. Some display a red light when the oil pressure drops to a predetermined level; others activate a warning light when a significant percentage of the oil is depleted. Volvo Australia advised that the warning light on the coach would activate when a drop in oil pressure resulted from the engine oil suction pipe being uncovered. This would depend on the motion of the bus but occur when the oil level in the sump had depleted to a minimum of approximately three litres (i.e., some 9% of capacity would be remaining).

2.5 The turbocharger pressure gauge measures boost pressure in the inlet manifold so, if the turbocharger is operating properly, the gauge will display fluctuating pressure depending on the engine load and acceleration.

Engine and Turbocharger

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

2.7 Affixed to the engine is a three impeller pump with two outlets for oil delivery. One outlet distributes oil to engine lubricating points via passages in the

engine casting; the other supplies the air compressor, injector pump and turbocharger. The oil pressure leading to the turbocharger is approximately 600 kPa (6bar).

2.8 The engine is fitted with a Holset HX40W turbocharger. In addition to being water-cooled, the turbocharger is lubricated and cooled by the engine oil. 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.

2.9 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 3*). The flange is fastened to the top of the turbocharger with two yellow zinc coated M8 70 mm flange screws[3] (bolts) tensioned to 24 ± 4 Nm. The flange unit secures the oil supply pipe to the top of the turbocharger. Under the flange fitting sits a rubber gasket to seal the gap between the two units and to ensure the integrity of the oil flow being delivered to the turbocharger.

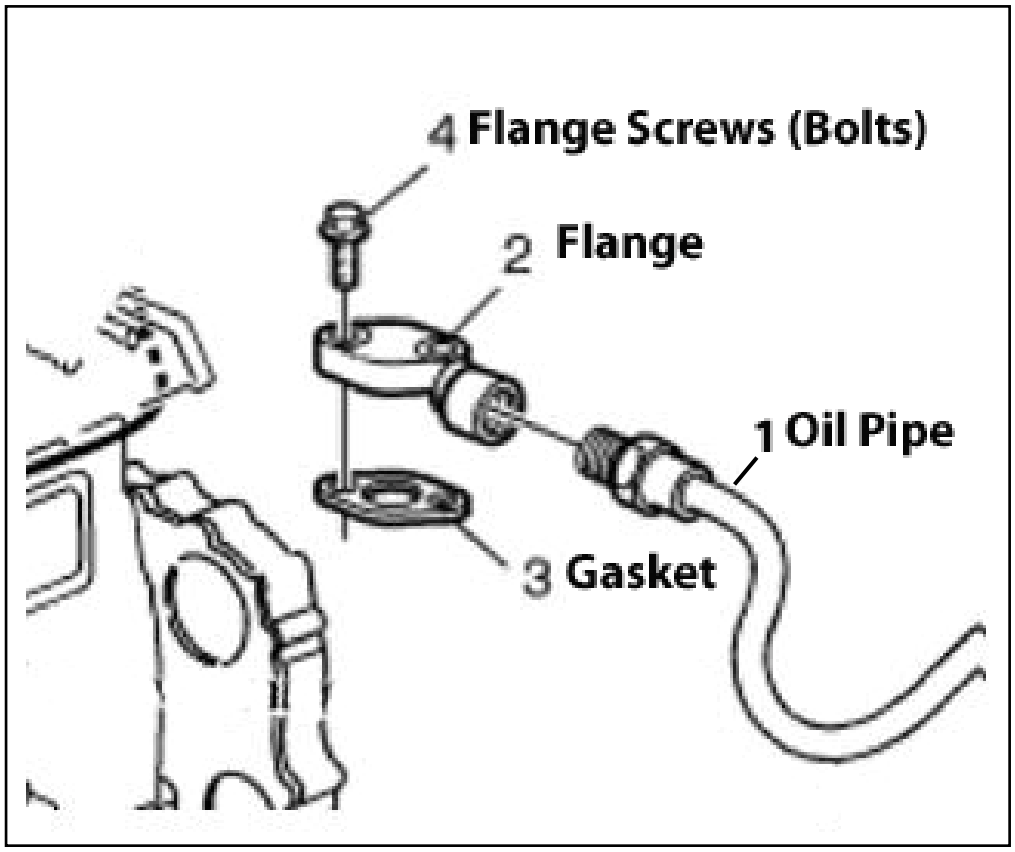

Figure 3: Items 1,2,3,4 all belong to the oil system function group

[3] This flange screw is identifiable by the ridge surrounding the bolt head. This built-in washer under the head of the flange screw acts to distribute the clamping load over a greater area. A flange screw is designed to provide the same holding power as a washer. Yellow Zinc offers a modest amount of corrosion resistance, slightly higher than clear Zinc.

2.10 When the turbocharger was inspected, it was found that both flange screws were loose to such an extent that the flange unit could be physically shaken by hand. The gasket sitting under the flange was intact and still functional. The oil pipe leading from the engine to the flange was intact and secured. A complete inspection of all other fasteners throughout the engine bay area, including injectors, injector piping, exhaust system, electrical units and other auxiliaries, found all items to be firmly fastened.

Photograph 3: Oil residue and sand trail extending 280 metres

2.11 The oil sump of the D7C290 engine has a capacity of 28 litres. When the sump plug was removed to take a measurement of how much oil remained, no oil discharged from the sump. A hole was then made through the side of the sump and approximately one litre of burnt oil was found to be remaining. This supported a conclusion that the oil had probably discharged at the loose flange on the turbocharger.

2.12 A trail of a liquid residue some 280 metres long followed the path of the coach from the freeway to where it was stopped (see *Photograph 3*). Although RTA emergency crews had already dispersed sand on the residue trail by the time OTSI investigators arrived on site, it was evident that the residue was oil based and not a water or coolant based substance. This further supported the conclusion that oil, pumped under high pressure from the engine to the turbocharger, could have discharged from around the loose flange and sprayed over the extremely hot turbocharger and associated hot exhaust components, and then ignited.

Repairs and Maintenance

2.13 On 12 September 2011, the coach was delivered to Volvo's maintenance facility at Chullora for a complete gearbox rebuild. Management from the facility stated that this work did not in any way affect the turbocharger or involve adjustment of any associated components.

2.14 Examination of the service records for the coach back to when it was built in 2007 showed that it had been well maintained and was serviced predominantly by Volvo. It had been serviced on 26 July 2011 in preparation for its regular Heavy Vehicle Inspection Scheme (HVIS) inspection. The HVIS inspection was conducted on 28 July 2011 and the only defects identified were associated with the operation and condition of two seat belts.[4] The previous HVIS inspection was conducted on 1 February 2011 and defects noted related to brake light operation and minor bumper bar damage.

2.15 Volvo documentation specifies the torque to be applied in tensioning various coach components. However, it does not specify any subsequent

[4] Heavy Vehicle Authorised Inspection Safety Check Rule 510.03 requires vehicles to be rejected if they are presented with loose engine components. Rule 510.04 requires vehicles to be rejected if they are found with engine oil leaks.

requirement for periodic checking of the tension of bolts and nuts after components have been re-secured. For example, no service instructions were provided for re-checking the bolts securing the replacement turbocharger installed on the coach in the field in December 2010. (Refer to paragraph 2.17). Volvo emphasised that it is a requirement during a basic service to check the engine for oil and coolant leaks; check that pipe unions, flanges and hoses seal correctly; and check that hoses and pipes are not chafed or cracked.

Turbocharger Failures

2.16 On 29 January 2009 during an annual mechanical service, it was found that the coach's turbocharger was "*passing oil through the system*" (meaning it had oil leaks and was burning oil). As a result the turbocharger was replaced. At the time, the coach had travelled 253,094 km.

2.17 On 4 December 2010 while being utilised on a tour to Queensland, the coach lost power and it was suspected that the turbocharger was faulty. A mobile service representative attended and found that the coach's turbocharger had failed. The turbocharger was replaced in situ by the mobile service representative. The odometer reading at the time was recorded as 524,794 km.

2.18 Advice was sought from Volvo Australia as to what would be a reasonable expectation for the life expectancy of a turbocharger. Volvo explained that it was difficult to determine, adding that some customers expected the unit to last the life of the coach, while others would replace the units as part of preventative maintenance on a regular basis. Volvo added that the environment in which the coach operated was a particularly important consideration in relation to the life expectancy of a turbocharger.

2.19 Generally, a tour coach's turbocharger is under less stress as highway driving demand on it is less than that for city driving, as stopping and starting puts severe demands on a turbocharger. The coach had travelled over 250,000 km each time before the turbocharger was replaced. Volvo considered this to be reasonable, especially since the coach was often used in city driving conditions.

2.20 Information was sought from CYC on any other issues with turbochargers they may have had in the past. CYC management advised that on 17 January 2009, a 2006 model B7R Volvo coach was on a tour from Sydney to Bundaberg, Queensland, when the driver noted that the coach had lost power. The driver telephoned the CYC manager based in Sydney to report the problem and was informed by the manager that it was probably a turbocharger failure, and that he was to check it. While on the telephone call, the driver noted a fire alarm had illuminated on the driver's dashboard panel. The tour guide immediately went to the rear of the coach where he encountered a substantial fire on top of the turbocharger. On this occasion the tour guide and driver were able to suppress the fire using the driver's fire extinguisher.

Previous Fires on CYC Coaches

2.21 A 2005 model Volvo B7R coach owned and operated by CYC was destroyed by fire near Holbrook on 8 February 2010. OTSI examined the circumstances of the incident and concluded the most likely cause was ignition of rubber residue from a failed inner rear tyre due to friction.[5] This coach had a fire extinguisher in a compartment near the rear of the coach similar to the coach involved in the Douglas Park fire but on the opposite side of the vehicle. It was not sought out and used as the coach crew expected it to be on the opposite side of the coach as was the case with the other coaches of the same model, with which they were familiar.

Fire Instructions

2.22 Following the Holbrook fire, CYC issued instructions to all drivers in the usage of a fire extinguisher and their placement on the various coaches. The coach crew confirmed they had received this instruction by way of a special brief. However, they received this briefing from one of the CYC managers who had attended a fire training course rather than a certified instructor.

[5] OTSI Bus Incident Factual Findings, *Fire Involving CYC Tours Bus TV 4153, Hume Highway, Holbrook, 8 February 2010*, available at www.otsi.nsw.gov.au

Fire Extinguishers

2.23 The Australian Design Rules require buses and coaches to be equipped with fire extinguishers in accordance with Australian Standard (AS) 2444-2001 *Portable fire extinguishers and fire blankets – Selection and location*. The coach carried two 2kg ABE powder type extinguishers which satisfied the minimum rating and location requirements of the Australian Standard.

2.24 It is clear from the Australian Standard that the extinguishers were chosen as suitable for initial 'suppression' of a developing fire in the passenger compartment or engine bay area of the coach, but could not be expected to extinguish a well established fuel or oil fed fire. It is noted that there is no particular protection provided to the rear mounted extinguishers despite their proximity to the engine bay. Further, there is no signage to signify the location of the fire extinguishers on buses and coaches in general.

Automatic Fire Suppression System

2.25 An inspection of the coach revealed there was no automatic fire suppression system (AFSS) installed.[6] An AFSS offers the potential for rapid activation of fire protection measures to reduce the consequences of a fire within its sphere of influence.

2.26 The coach was fitted with an alarm to signify if there was a fire or a heat source that was unusually high within the engine bay. However, according to the driver, the alarm did not activate and neither did any other fault lights on the dashboard. He was firm in his conviction that this was the case and further stated that all dashboard instrumentation was operating normally at the time of initial start-up at the depot.

[6] Fire suppression system is defined in Australian Standard AS 5062-2006 *Fire protection for mobile and transportable equipment* as "An engineered or pre-engineered system designed to suppress or extinguish a fire by either local application or total flood design methodology".

PART 3 FINDINGS

Causation

3.1 The investigation found that the flange unit that secures the oil supply pipe mounted on the top of the turbocharger was loose. This allowed engine oil under pressure (of approximately 600kPa) to escape between the flange unit and turbocharger housing then spray over the extremely hot turbocharger and associated exhaust components and ignite. The fire then spread quickly throughout the engine bay and thence into and through the interior of the coach destroying it completely.

Contributory Factors

3.2 The fire extinguisher positioned to the rear of the coach and not protected from fire could not be accessed due to the heat and flames from the fire. By the time further portable extinguishers could be applied, the spread and intensity of the fire was beyond their capability.

3.3 The coach was not fitted with an automatic fire suppression system.

3.4 Volvo service literature specifies the torque to be applied in tensioning various coach component fastenings but does not stipulate subsequent periodic checking to verify tensions are being maintained. However, the coach was being well maintained and serviced regularly which included checks of seals, pipes and hoses, and for oil and coolant leaks.

PART 4 RECOMMENDATIONS

To prevent a recurrence of this type of incident, it is recommended that the following remedial safety actions be undertaken by the specified responsible entities.

CYC

4.1 Evaluate the feasibility of installing an automatic fire suppression system on all company coaches.

Transport for NSW

4.2 In consultation with industry, determine the desirability and practicality of introducing a requirement for the installation of automatic fire suppression system to be made compulsory on all buses and coaches registered in NSW.

Volvo Australia

4.3 Develop and incorporate in technical maintenance servicing documentation recommended parameters for the periodic checking of the tension on fasteners securing key engine and chassis components.

APPENDIX 1 SOURCES AND SUBMISSIONS

Sources of Information

Australian Design Rules

Australian Standards

CYC Tours Pty Ltd

Transport for NSW

Volvo maintenance service manuals

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:

- CYC Tours Pty Ltd
- Independent Transport Safety Regulator
- Transport for NSW
- Volvo Australia

Responses were received from all 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.