OTSI Office of Transport Safety Investigations

TECHNICAL INSPECTION FINDINGS

CITY SIGHTSEEING TOURS BUS FIRE

KENSINGTON

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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 6.40pm[1] on Thursday 7 September 2012, a City Sightseeing Tours bus was proceeding without passengers to its Banksmeadow Depot after completing its day's service in the CBD. It was travelling South on Southern Cross Drive, Kensington (see *Figure 1)*, when the bus lost power and the driver observed smoke coming from the rear of the bus.

Figure 1: Aerial view of incident location

He continued driving for one to two minutes until he found a safe place to park in the breakdown lane of Southern Cross Drive adjacent to the Australian Golf Club (see

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

Photograph 1) where he pulled over, turned off the engine and called the Depot on his two-way radio to inform them of the situation.

Photograph 1: Southern Cross Drive incident location

The driver then went to the back of the bus intending to open the engine hatch. As he was about to open the hatch, he noticed flames coming out of the engine compartment. He then ran back to the front of the bus to get a fire extinguisher. He returned to the rear of the bus and tried to extinguish the fire by directing the nozzle of the extinguisher up and into the engine compartment from underneath the rear bumper. Some passers-by also tried to assist by using their own extinguishers in the same manner. All attempts to extinguish the fire before the arrival of Fire and Rescue NSW were unsuccessful. The bus driver noted that the bus engine restarted spontaneously during this time.

Due to traffic congestion, Fire and Rescue NSW units were unable to reach the scene before the fire had spread to the rest of the bus. The adjacent bushland also caught fire, giving rise to concerns that the fire would spread to nearby homes. In a television interview, one senior fire officer observed that:

> *"On arrival, the fire crews found the traffic was very heavy. They encountered a bus that was totally involved and it was threatening traffic*

> *on either side of it. Quick operations by Fire and Rescue ensured the safety of the general public but water was a serious problem. Southern Cross Drive was closed Southbound, all three lanes. This was done to ensure the safety of the public and fire fighting crews who were hampered by serious water shortages they encountered at the scene."*[2]

The Fire and Rescue crews eventually extinguished both the bus and bushland fires and remained at the scene to ensure that the fire did not reignite. The bus was removed using a low-loader and taken to a holding yard at Matraville for subsequent examination.

Result

The extent of damage to the bus can be seen in *Photograph 2*.

Photograph 2: Post-fire condition of bus

The intensity of the fire was such that all that remained was the steel framework of the bus, some sections of body panels and various parts of the engine and drive train. The only area that remained relatively untouched was the front driver's side wheel (see *Photograph 3*). Nobody was injured as a result of the fire.

2 Freenews Sydney, viewed 12 September 2012, <http://freenews.com.au/eastern-suburbs/259-fire-destroys-double-decker-sightseeing-bus-in-kensington>

Photograph 3: Front driver's side of bus

OTSI Involvement

OTSI's Duty Officer was notified of the incident by an operations manager from City Sightseeing Tours at 7.34pm. Arrangements were then made for OTSI investigators to undertake a technical inspection at the holding yard on the following Monday.

Examination of the Bus

Inspection process. The bus was inspected by two OTSI investigators on Monday 10 September 2012 at the holding yard. The Managing Director and the Head Mechanic of City Sightseeing Tours were also present at the start and conclusion of the inspection. Investigators also inspected the route that the bus took along Southern Cross Drive from the point where the loss of power occurred. The site of the fire was examined on 10 September and again the following day.

Bus details. The bus was registered in NSW and issued with registration plates TV5654. It was an open-top double-decker bus built in England by Metro-Cammell Weymann (MCW) in 1983 (see *Photograph 4*). The bus was exported from England to Hong Kong and used by New World First Bus. In 2000, the bus was imported into Australia by City Sightseeing Tours. At this time its engine was replaced with an 8.3 litre Cummins ISC turbocharged diesel engine. The bus was one of ten similar buses in the City Sightseeing Tours fleet. (For further bus details see *Appendix 1*.)

Photograph 4: MCW Metrobus MKII

The body of the bus was constructed of a combination of fibre reinforced plastic body panels and aluminium alloy panels riveted onto a steel tube frame. The floor of the bus was of plywood construction covered with vinyl sheeting. The tubular steel framed seats were of vinyl covered foam with a plywood base and back. Other interior combustible materials included electrical wiring, plastic signage, rubber window seals and light fittings.

General damage to engine. The engine was substantially damaged with many engine parts partially or completely melted (see *Photograph 5*).

Photograph 5: Engine compartment

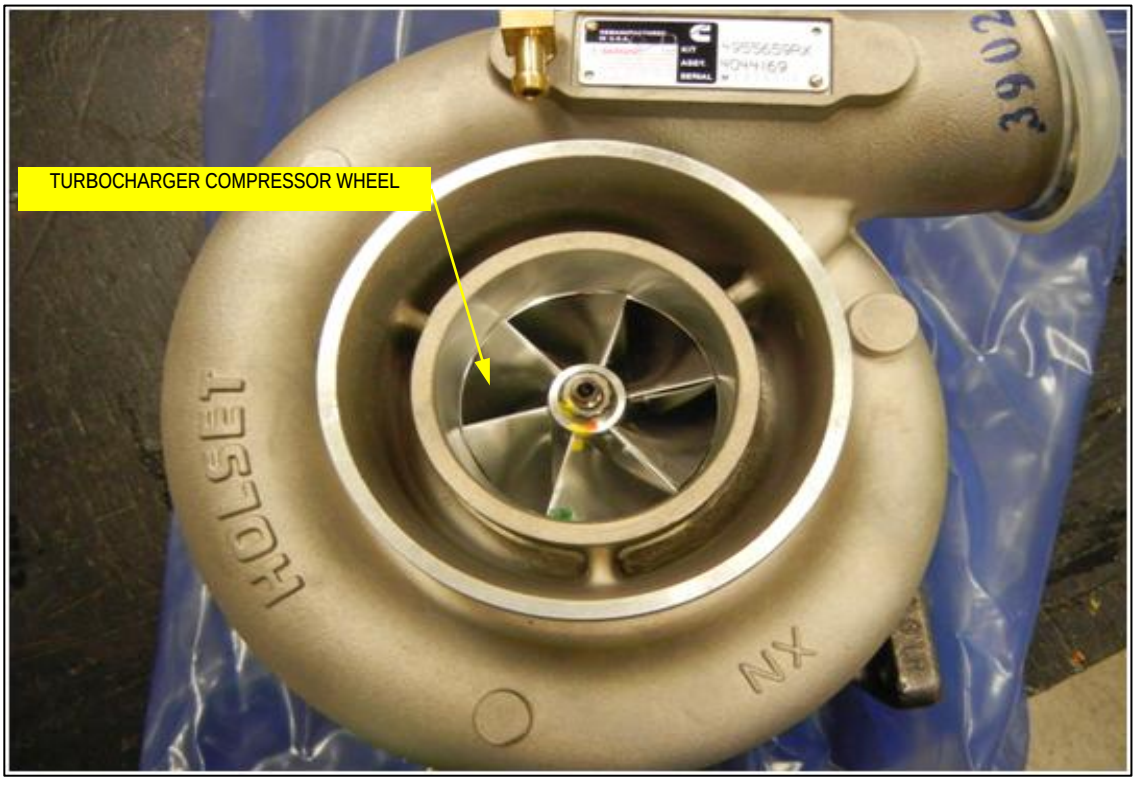
Fire detection and suppression systems. There was no fire detection or fire suppression system fitted to the bus, nor was there any regulatory requirement for them to be fitted. The bus was carrying two fire extinguishers in accordance with *Australian Standard 2444 - 2001: Portable fire extinguishers and fire blankets - Selection and location*. They were both 2.1kg 1A:30B:(E) dry powder type extinguishers. One fire extinguisher was located next to the driving compartment and the other inside the engine compartment at the rear of the bus. All fire extinguishers at City Sightseeing Tours were inspected in August 2012.

Bus maintenance. The bus had travelled approximately 231,500 kilometres since it was imported into Australia. It had been regularly serviced at approximately 7,500 kilometre intervals. The most recent service was on 21 June 2012 when the bus had travelled 228,178 kilometres. On 5 September 2012, the bus underwent its annual NSW Roads and Maritime Services Heavy Vehicle Inspection Scheme (HVIS) roadworthiness inspection as required for NSW registration. Public passenger vehicles require two inspections each registration period. The first inspection must be undertaken three to six months following renewal with the second inspection undertaken no more than three months before the next renewal. All inspections are carried out by Roads and Maritime Services vehicle inspectors. The odometer

reading at this HVIS inspection was 231,390 kilometres. No defects were recorded on the Inspection Report.

At the start of each day, the driver inspects his/her bus for defects and completes a defect report. The driver's vehicle defect report relating to the day of the incident was lost in the fire. However, the driver said he had no problems with the bus prior to the incident.

Turbocharger. The pattern of the fire was similar to that which would be associated with fire initiation in the region of the turbocharger resulting in a loss of power. This is consistent with the driver's account of the loss of power he experienced. The engine was fitted with a Holset HX40 turbocharger[3] (see *Photograph 6*). (For further Turbocharger details see *Appendix 2*.)



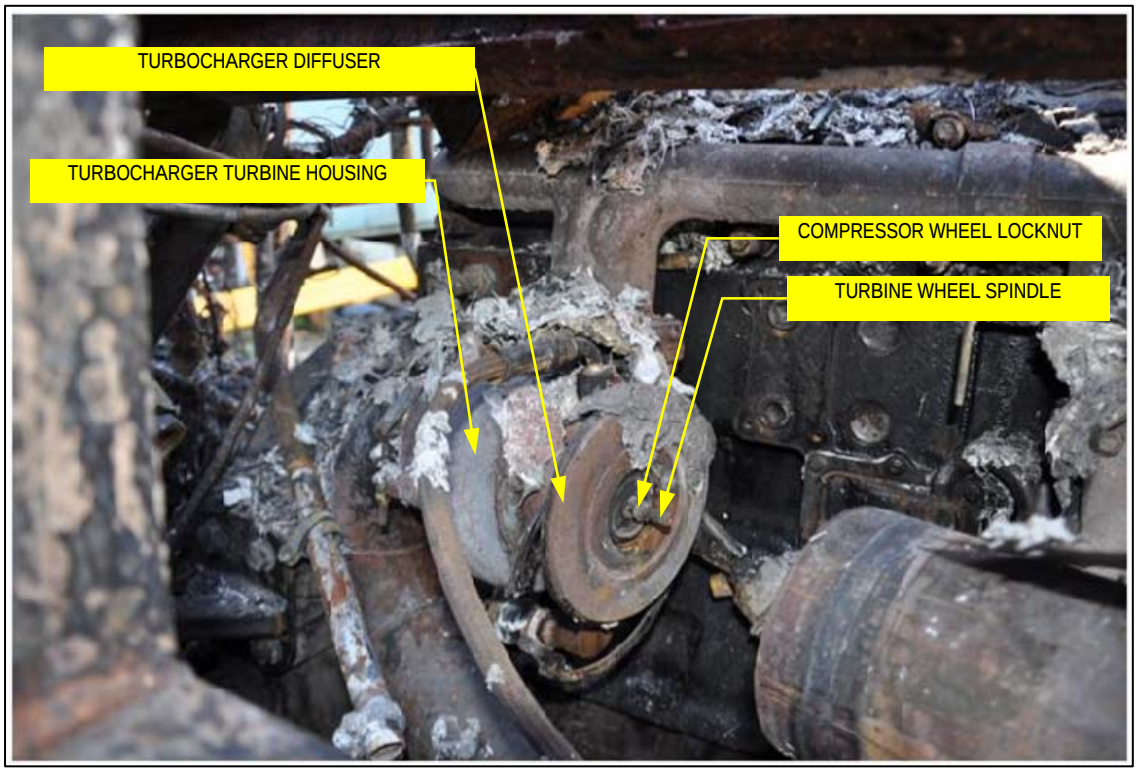
Photograph 6: New Holset turbocharger

The turbocharger was lubricated and cooled by the engine oil, the flow of which is critical for its operation. Oil is supplied from the engine sump via a pipe and flange unit to the turbocharger at a pressure between 300 and 550 kPa. The oil supply line

[3] A turbocharger is a mechanical device which uses the engine's exhaust gases to force more air into the engine cylinders. Hot exhaust gas energy is used to turn a turbine wheel and shaft. At the other end of the shaft is the compressor impeller (or compressor wheel), which draws in air and forces it into the engine cylinders. (Holset Service Repair Manual, 2007)

to the turbocharger was checked and, besides showing general heat damage, was intact. The union securing the line to the turbocharger housing was tight. However, the elbow union at the oil filter end was missing. This was likely a result of the soldered joint coming apart during the fire and the elbow joint separating from the oil supply line, falling away and becoming lost.

An inspection of the turbocharger revealed that the compressor housing had completely melted with the remains still visible on and below the diffuser. The turbine wheel spindle was still in-situ with the compressor wheel locknut still in place; however, the compressor wheel was missing (see *Photograph 7*). It was noted that the turbine wheel spindle could still be easily rotated by hand, indicating that the oil flow to the turbocharger did not fail, since otherwise, the bearings would have seized.



Photograph 7: Fire damaged turbocharger

Oil contacting the superheated components of the turbocharger is a common initiator of engine fires.

> *"The National Fire Protection Association (USA) estimates that some 50 per cent of highway vehicle fires are caused by mechanical failures or*

> *malfunctions …turbocharger housings operate at very high external temperatures and also, because of their very high rotational speeds, are subject to bearing failures that can produce hot-fragment ignition of the lubricating oil supplied to the centre bearing under pressure."*[4]

There is no evidence of a bearing failure initiating this fire. Instead, it is probable that the compressor wheel disintegrated causing damage to the casing with consequent oil leakage from the turbocharger.

Development of the Fire

The component elements of fire generation and propagation provide an explanation for the development of any fire. In order for a fire to develop and be sustained for a significant time, four elements are necessary:

- an initiator
- combustible material
- an oxidising agent (in this case, oxygen in the air)
- a path by which the fire can spread.

The initiator

The driver reported that the first indication of any problem was a loss of power as he was travelling uphill out of the Eastern Distributor tunnel. Looking in the rear vision mirror, the driver saw that the bus was emitting a large amount of smoke. When asked if he had heard anything unusual before the loss of engine power, the driver said that he heard nothing unusual. Based on his previous experience as a motor mechanic, he suspected that there may have been a problem with the turbocharger.

When the bus was inspected after the incident, it was found that the turbocharger compressor wheel and the surrounding casing were missing. On the basis of this evidence, it is considered most probable that the loss of power was the result of disintegration of the compressor wheel. This would have been followed by oil leakage due to consequent damage to the housing. The turbocharger would have been operating at a temperature sufficiently high to ignite the oil.

4 J.D. DeHaan & D.J. Icove, *Kirk's Fire Investigation,* 7th edn, Pearson, New Jersey, 2012, p369.

Combustible material

The turbocharger lubricating oil is the most probable initial source of combustible material for this fire. The oil is supplied under pressure from the oil filter housing and returned to the engine via a pipe into the sump. This oil would have continued to be pumped as long as the engine was operating. The engine was running for a number of minutes following the initial loss of power as the driver had continued driving until he found a suitable stopping area. The fire was well established in the engine compartment when the driver attempted to extinguish it.

Propagation path

Due to the absence of interior CCTV or exterior video of the actual event, the course of the mostly likely fire path is based on the driver's account and fire patterns. Once established in the engine bay, the fire eventually spread to the bus interior. The fire travelled forward engulfing the seats and interior panels. The flame plume became large enough to trigger full involvement of the flammable materials inside the bus.

Conclusions

It is probable that the fire was caused by the turbocharger compressor wheel initially disintegrating, causing damage to the turbocharger casing with consequent oil leakage from the turbocharger. Oil then contacted a hot engine part and ignited. As the engine continued to run, oil was pumped out at a high rate to fuel the fire, which ultimately engulfed the entire bus.

If the bus had been equipped with effective fire detection and suppression systems, it is probable that early detection and suppression of the initial fire would have prevented the development of the 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 City Sightseeing Tours, Transport for NSW and the Independent Transport Safety Regulator.

Appendix 1 - MCW METROBUS MKII SPECIFICATIONS

GENERAL INFORMATION

Chassis and Body Manufacturer:	Metro-Cammell Weymann Ltd., Birmingham, UK
Manufacture date:	1983
Import into Australia date:	2000
Vehicle Designation:	MCW METROBUS MKII DR115/2
Body Construction:	Riveted Aluminium Alloy on Steel Tube Frame
	Fibre reinforced plastic corner panels
Seating Capacity:	80
Length:	12.2 metres
Width:	2.5 metres
Height:	4.16 metres
Unladen Weight:	12.2 tonnes
Fuel Tank Capacity:	205 litres

ENGINE

Make:	Cummins
Type:	ISC straight–six diesel
Capacity:	8.3 litres

TRANSMISSION

Make:	Voith
Type:	R851-1 Four Speed Automatic

BRAKING SYSTEM

Service Brakes:	Air System
	S-Cam Drum Brakes with SAB Adjusters
Handbrakes:	Spring Brakes Acting On Rear Axle

STEERING, SUSPENSION & WHEELS

Steering Type:	ZF Integral Ram Type
Suspension:	Air
Axles:	Three
Wheels Size:	7.5 x 22.5" Steel Wheel Discs
Tyres:	275/70R22.5

Appendix 2 – TURBOCHARGER DIAGRAM