



**Office of Transport Safety Investigations**

## **TECHNICAL INSPECTION FINDINGS**

**ROLLOVER INVOLVING NOWRA TOURS COACH TV 4604**

**TIMBOON COLAC ROAD, PIRRON YARROCK, VICTORIA**

**15 AUGUST 2010**



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## **THE OFFICE OF TRANSPORT SAFETY INVESTIGATIONS**

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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 accidents and incidents in the rail, coach 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.

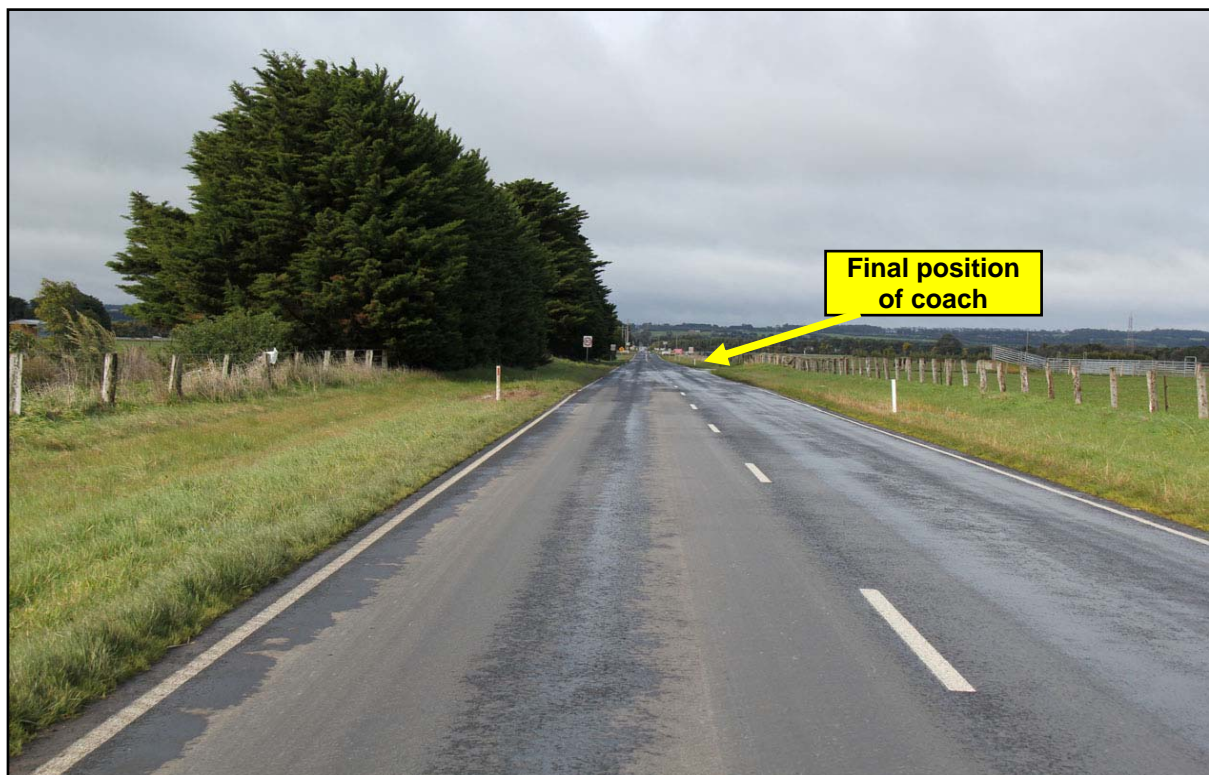
OTSI's investigations are conducted under powers conferred by the Rail Safety Act 2008 and the Passenger Transport Act 1990. OTSI investigators normally seek to obtain information cooperatively when conducting an accident investigation. However, where it is necessary to do so, OTSI investigators may 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 strives 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 2:15pm on the third day of a four day sightseeing tour of Victoria operated from Sydney by NCT Tours, a Nowra Coaches<sup>1</sup> coach overturned on the Timboon Colac Road, known locally as Tomahawk Creek Road, approximately 2km South of the Princes Highway.

The coach had left Melbourne at 7:43am and at 9:20am arrived at Ballarat where the passengers spent some time sightseeing before having lunch. The coach left Ballarat at 12:51pm and headed South, crossing the Princes Highway from Nalangil Road to Timboon Colac Road and continuing South along the 100km/h road. The driver was braking from a speed of 96km/h in response to an 80km/h speed sign when he lost control of the coach at the location shown in *Photograph 1* and *Figure 1*.



**Photograph 1: View South on Tomahawk Creek Road to the crash site**

At the time of the crash the coach was carrying 27 passengers plus the driver who was also acting as the tour guide. As a result of injuries sustained in the crash, one passenger died at the scene and a second passenger was transported to Melbourne

<sup>1</sup> NCT Tours and Nowra Coaches are operating entities of the Nowra-based Premier Motor Service.



in a critical condition. Both of these passengers were ejected from the coach in the crash. Other passengers sustained various non-lifethreatening injuries. The driver, who was restrained by a three-point seat belt, was not injured.

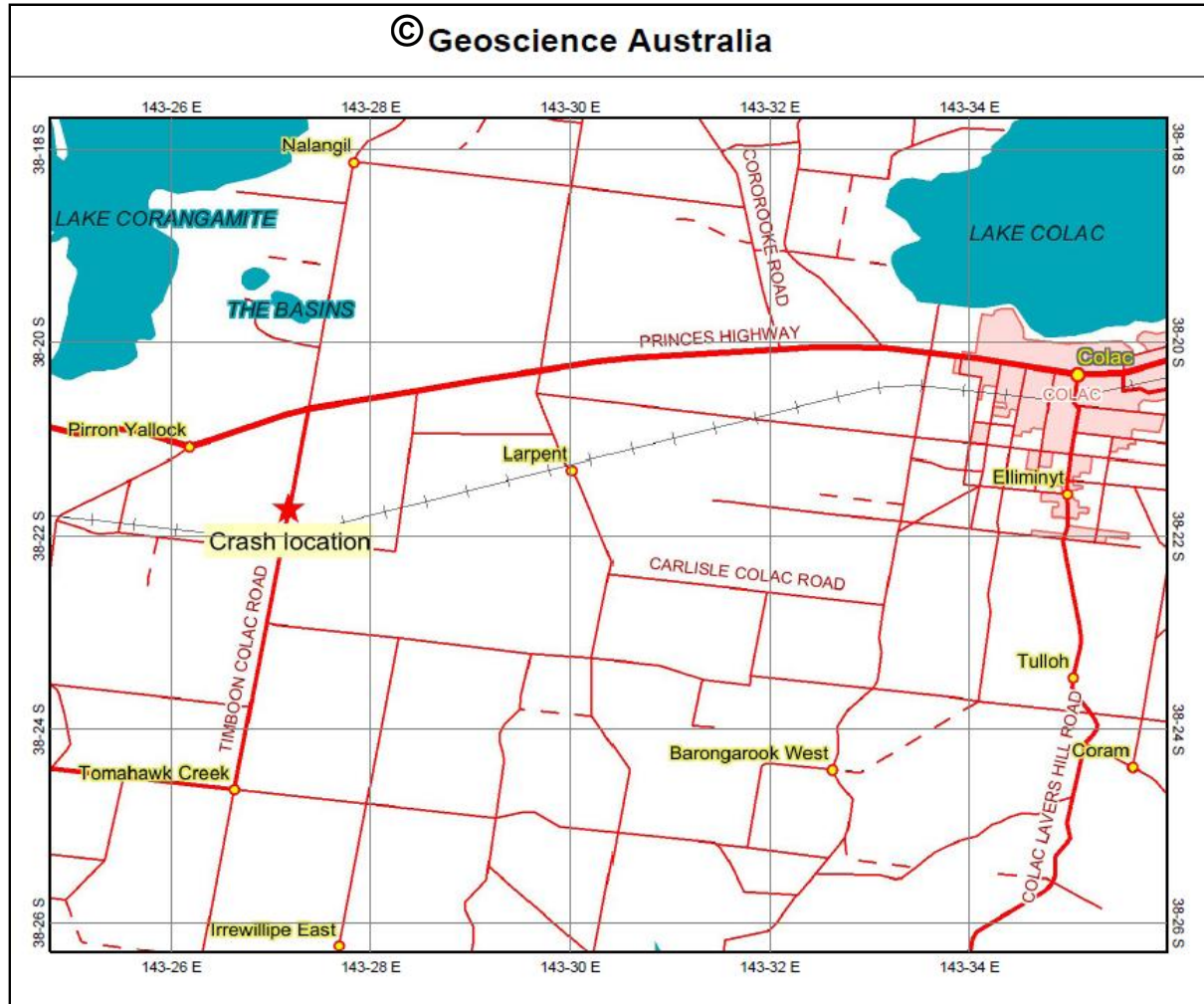


Figure 1: Crash location

## OTSI Involvement

OTSI's Duty Officer was notified of the incident by Nowra Coaches at 4:04pm and was also contacted by Victoria's Chief Investigator, Transport and Marine Safety Investigations, who indicated that as the coach was operating from NSW and under NSW accreditation, he would not be investigating the incident. On the basis of this information, an OTSI investigator deployed to conduct an inspection of the accident site and made arrangements with the Victoria Police to be present for the forensic examination of the coach.

## The coach

The coach was a 2007 model BCI built in China for Bus & Coach International Pty Ltd of Western Australia and registered in NSW as TV 4604. It was configured with seating for the driver and 37 passengers, with all passenger seats fitted with 3-point seat belts as required by Australian Design Rule 68/00 – *Occupant Impact Protection in Buses*. The driver's seat was fitted with a similar seat belt under Australian Design Rules 5/04 – *Anchorage for Seatbelts* and 4/03 – *Seatbelts*. The coach was also equipped with an antilock braking system (ABS) and was designed to meet Australian Design Rule 59/00 – *Standards for Omnibus Rollover Strength*. A similar coach is shown in *Photograph 2*.



**Photograph 2: A similar coach to Nowra Coaches TV 4604**

## Examination of the coach

In conjunction with an inspection by officers of the Major Collision Investigation Unit of the Victoria Police, the coach was examined by an OTSI Investigator at Colac on 26 August 2010. Particular attention was paid to both the condition of the seatbelts because of the ejection of passengers from the coach, and to the braking system because of a statement made by the driver that the coach had skidded when the brakes were applied.

The damage to the coach was moderate considering the nature of the crash, and although the battery charge level was found to be low, provision of an external electrical power source enabled the coach to be started and driven once recovered onto its wheels.

### General observations

When the ignition switch was turned to the “on” position, the ABS indicator light illuminated and then went off after a few seconds, indicating that the ABS check function was operational and no faults in the system had been detected.

The headlight switch was found to be switched to “high beam”, the fuel gauge indicated that just under  $\frac{3}{4}$  of a tank of fuel remained and the odometer showed that the coach had travelled 458,071km.

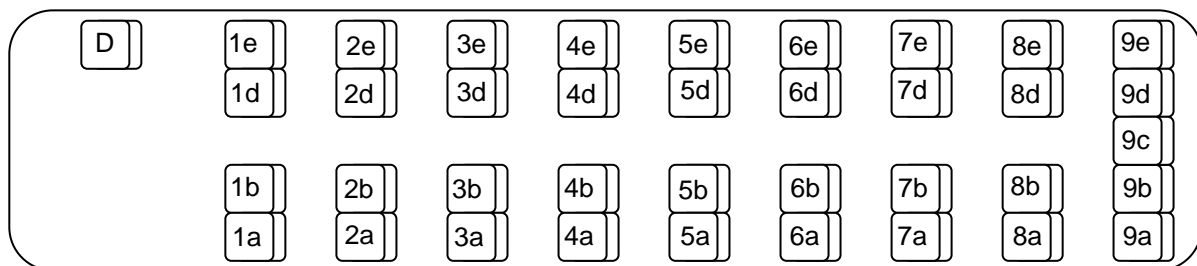
The air pressure gauge for brake air reservoir 1 showed just below full, while that on reservoir 2 showed a reading of 2 on a scale of 1 to 10. When the engine of the coach was started and run, reservoir 2 charged up to the same level as reservoir 1.

When the engine of the coach was started and left running, it ran smoothly at an idle speed of 700 revolutions/minute.

The coach was equipped with a C-track electronic log system using GPS and engine management data to track the vehicle and record operating parameters.

### Seat Belts

The seating layout of the coach is shown in *Figure 2*, with the seats labelled to facilitate identification.



**Figure 2: TV 4604 seating layout**

The seat belts were examined for evidence that they had been subjected to the degree of loading that can occur if they are worn in a crash, and for any other indications of their having been worn.

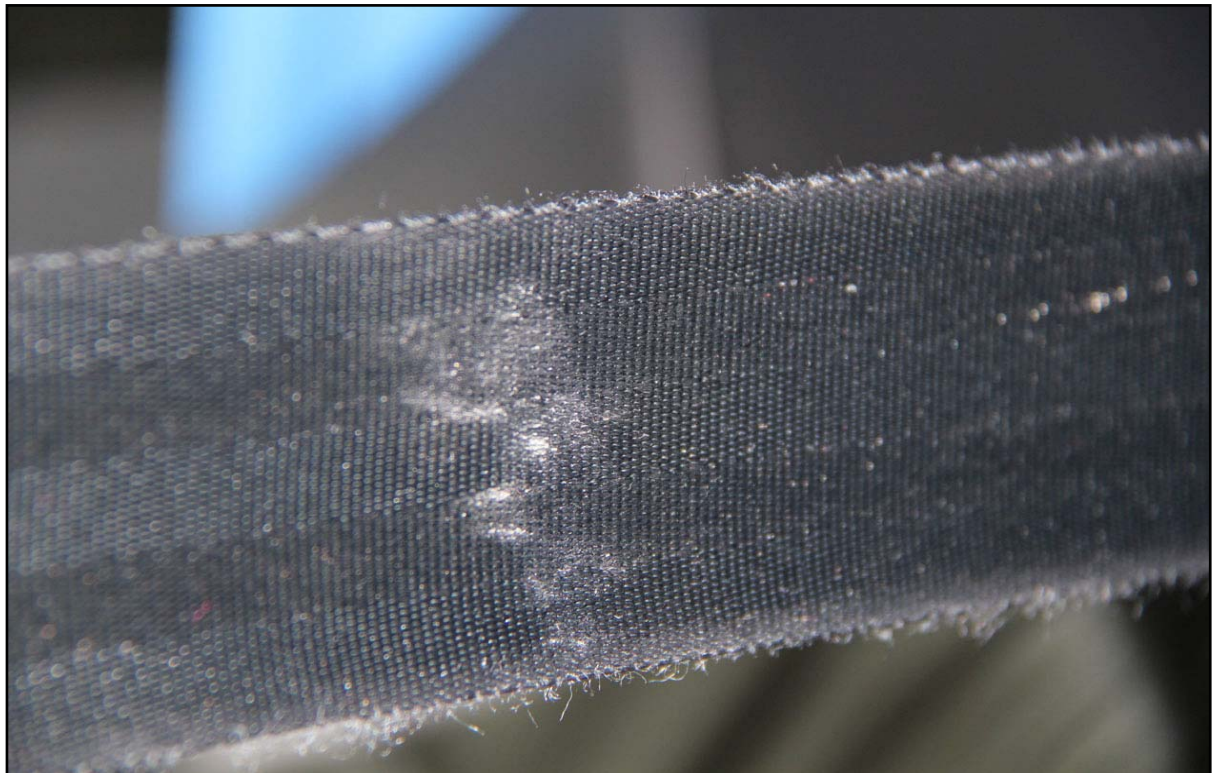


Belts fitted to the seats labelled 6e and 7e in *Figure 2* had evidence of surface burnishing in an area likely to have been in contact with the upper sash guide, and it is considered probable that these belts were being worn at the time of the crash. An example of this burnishing can be seen in *Photograph 3*.

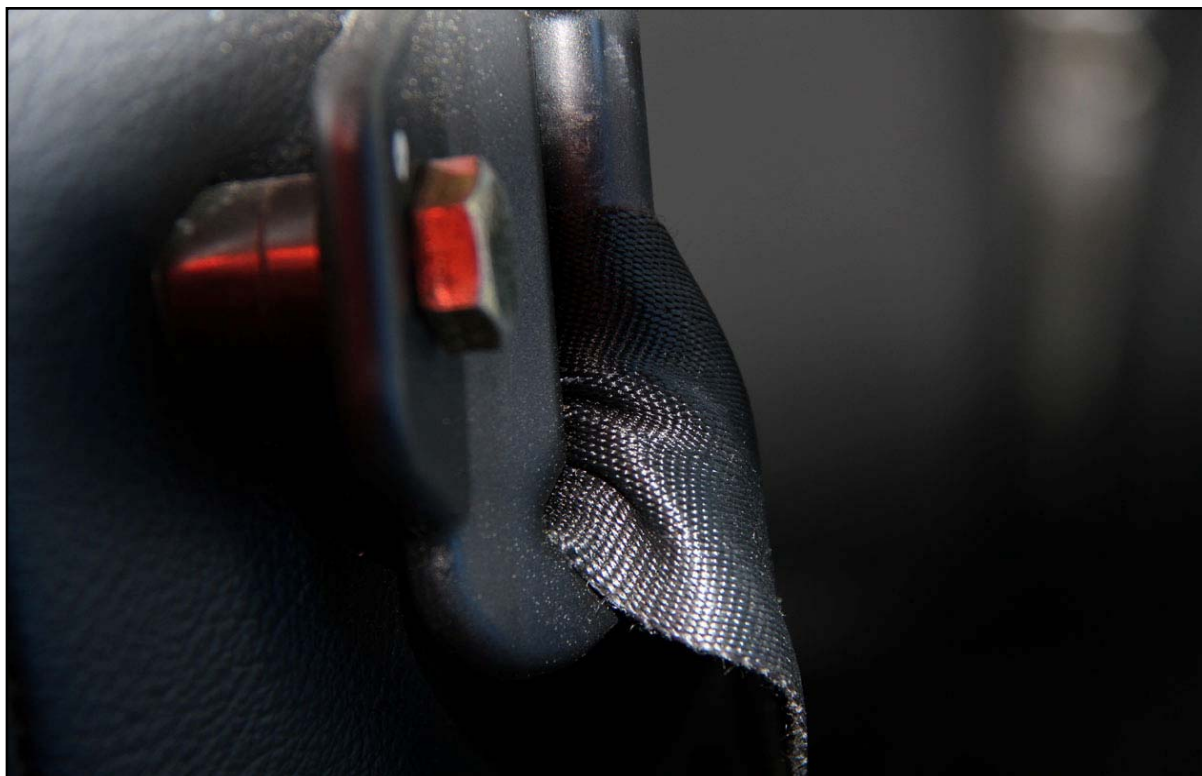
The belt fitted to seat 4d was jammed tightly into the lower side of the sash guide, indicating that considerable force had been applied to it (*Photograph 4*). It is considered that this belt was worn in the crash.

The belt buckle release button on seat 6d was jammed in a depressed position, indicating that the buckle had been damaged by loading in the crash and had jammed when depressed to release the belt (*Photograph 5*). It is considered that the occupant of the seat was wearing this belt at the time of the crash.

The seatbelt on seat 8b showed significant fraying along one edge in the vicinity of the sash guide. This is not considered to be as a result of the crash.



**Photograph 3: Burnishing of seatbelt fabric on seat 7e**



**Photo 4: Seatbelt on seat 4d jammed in sash guide**



**Photograph 5: Jammed seat belt release button on seat 6d**

There is no conclusive physical evidence of the other seat belts having been worn, but a number of belts were not fully retracted, indicating they may have been in use.

However, the fact that occupants were ejected from the coach as it overturned indicates that some of them were unrestrained at the time of the crash.

### **Brakes**

The coach was fitted with air-operated disc brakes with dual air reservoirs and an antilock system (ABS). When the ignition was turned on and the engine was started, the brake check functions were actuated and operated normally, and normal brake reservoir air pressures were achieved after a short period of engine operation.

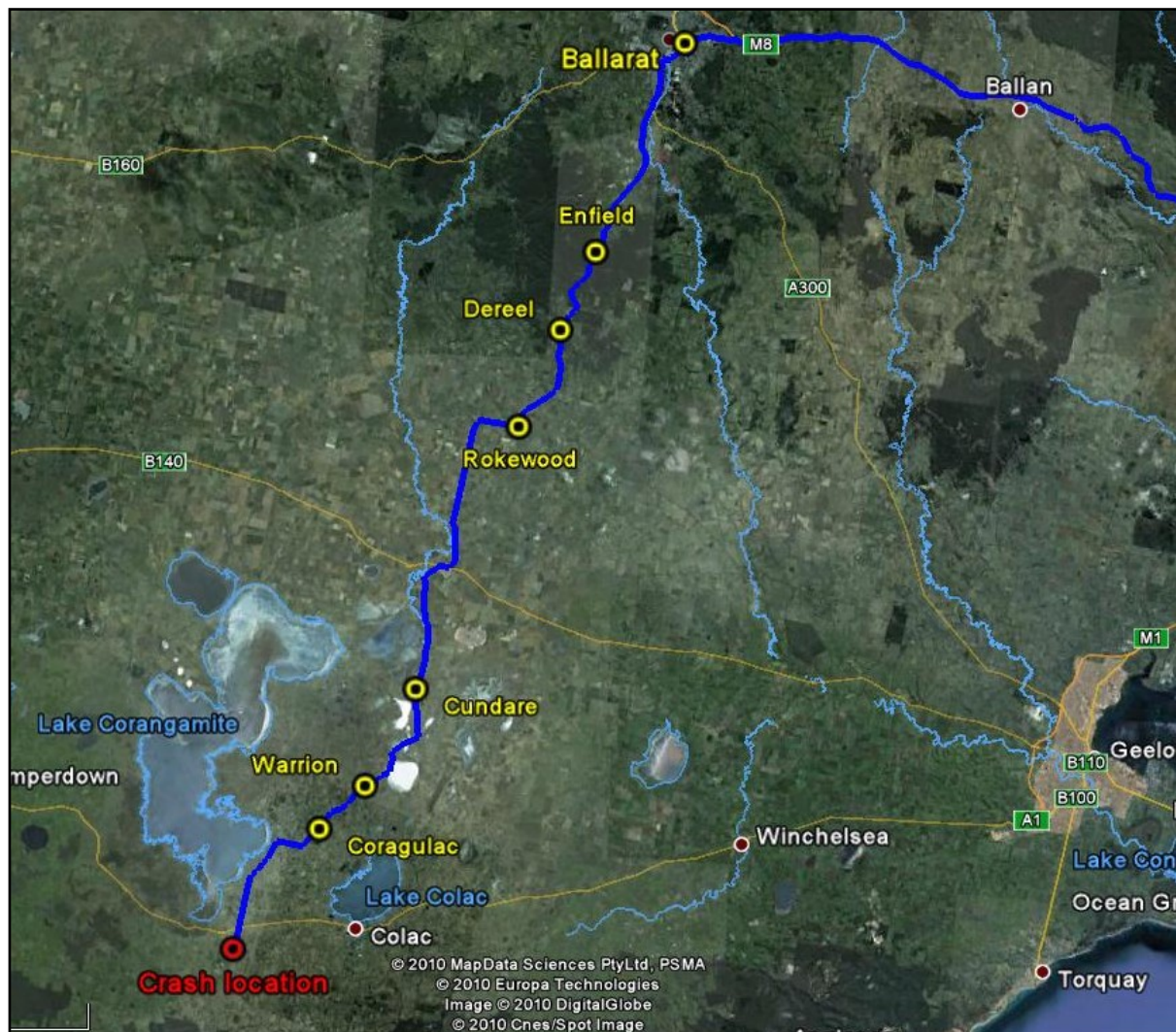
The brakes were tested on a wet dirt and gravel surface by driving the vehicle at a speed exceeding 15 km/h (the minimum required speed for operation of the ABS) and applying full braking. When the brakes were applied there was incipient locking of the front wheels as permitted by Australian Design Rule 35/01 - *Commercial Vehicle Brake Systems* and the ABS then acted to unlock the wheels while maintaining effective braking.

### **The road**

The coach had left Melbourne at 7:43am and had arrived at Ballarat at 9:20am. After sightseeing and lunch, the group left Ballarat at 12:51pm and headed South along the Colac – Ballarat Road before deviating to the West to skirt along the Eastern side of Lake Corangamite. At 2:13pm they crossed the Princes Highway from Nalangil Road to Timboon Colac Road and continued South. The route followed by the coach was determined by examination of the C-track GPS records and is shown in *Figure 3*.

The speed limit on Nalangil Road and Timboon Colac Road is 100km/h up to 30 metres before the crash location, where the speed limit reduces to 80km/h in preparation for a railway crossing 400 metres further on. On the day of the crash, a small amount of rain had fallen, but about 25mm of rain had fallen during the preceding five days and over 50mm in the two weeks before the crash. The road, seen and photographed on 26 August 2010 (but consistent with its condition at the time of the crash), had no hard shoulders and the berm on both sides was grassy, waterlogged and boggy (*Photograph 6*).





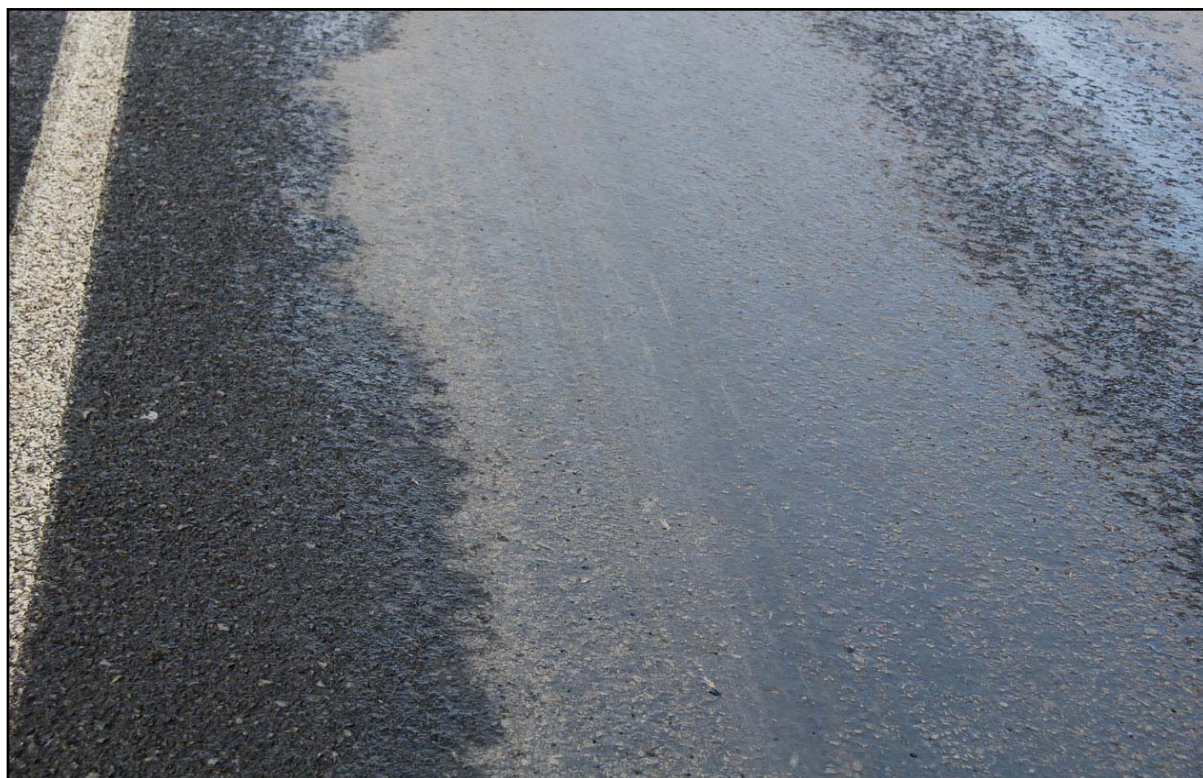
**Figure 3: Tour route and crash location**

The surface of the road was of varying composition, with exposed gravel interspersed with smooth bitumen as seen in *Photograph 7*. A varying degree of surface contamination was also present as a result of mud and manure being tracked onto the road from muddy driveways of farms fronting the road, and by farm vehicles driving along the edge of the road (*Photograph 8*). This resulted in a surface with a low and inconsistent coefficient of friction. The degree to which this was a factor at the time of the incident is indeterminate, to the extent that the degree of residual road contamination would have been dependent on unknown factors such as the surface flushing effect of any recent heavy rain.





**Photograph 6: Incident site**



**Photograph 7: Road surface variation**





**Photograph 8: Road surface contamination**

The coach driver reported that as he commenced to brake for the 80km/h zone, the front wheels of the coach lost their grip and the coach veered to the left. When the driver applied steering correction, the front of the coach steered sharply back onto the road while the rear of the coach swung to the left. Examination of the site indicated that the left front wheel had dug into the soft surface of the berm, causing the steering over-correction. As the coach travelled across the road the rear continued to swing to the left, and the coach commenced to roll onto its left side. The coach continued to rotate, finally coming to rest on its left side on the far (Western) side of the road.

### **The driver and the driving task**

The driver, a 48 year old male, held a New South Wales Class MR drivers licence, and had been driving coaches for Nowra Coaches for ten years. He was familiar with the route he was driving, having done so once or twice a month for the period of his employment with Nowra Coaches. He was fluent in Mandarin, Cantonese and English, and gave instructions to his predominantly Asian tour groups in all three languages. These instructions routinely included a reminder that seat belts must be worn.



The driver claimed to be in good health, did not take drugs and had consumed no alcohol. He tested negative to alcohol in Police administered breath tests after the crash. Under doctor's instructions, he took a 50mg metoprolol tablet daily to treat hypertension and had done so before breakfast on the day of the crash. Metoprolol may in some instances cause tiredness, drowsiness, weakness or lack of energy, but the driver claimed he was not feeling tired in the period before the crash.

The driver had driven the coach from Sydney two days earlier, having picked up members of the tour group at two locations in Sydney. Additional members of the group joined in Melbourne. The 11 hours allowed for the Sydney to Melbourne journey provided adequate time for the required rest periods en route and he had taken five breaks along the way. He went to bed at 11:00pm and rose at 7:00am.

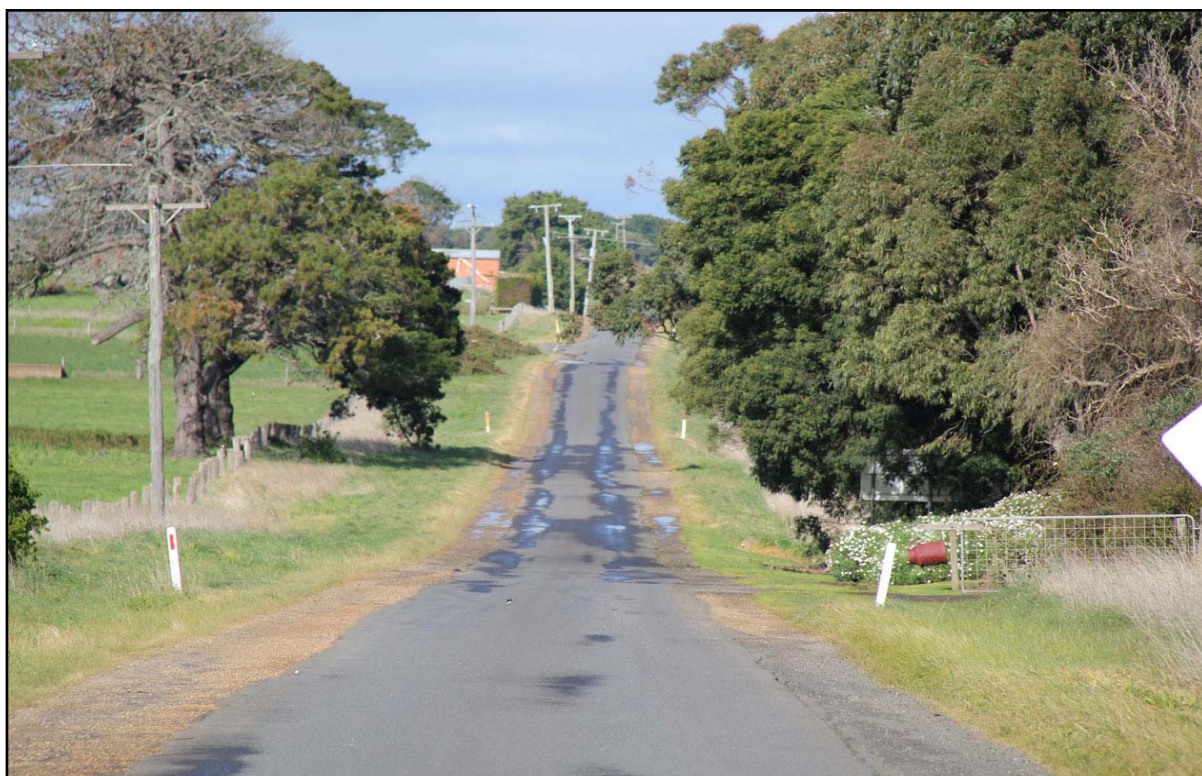
On the day preceding the crash, the tour group visited a number of locations in and around Melbourne including Phillip Island and took a cruise on the Yarra River. Apart from the return trip to Phillip Island, a round trip of some 290km, the driving duties were light. The driver went to bed that night at 10:00pm and rose at 6:30am.

On the day of the crash, the coach departed Melbourne just before 7:30am and stopped for a short break of 10 minutes after 72 minutes. After a further 34 minutes, the coach arrived at Sovereign Hill in Ballarat where it was parked for 2 hours 38 minutes before a short 2km drive to Bakery Hill for a 45 minute lunch stop.

The coach left Ballarat with the group on board at 12:51pm, heading South toward its next destination, the Great Ocean Road and the Twelve Apostles. The trip was through rural Victoria on predominantly two lane country roads in fair condition (*Photograph 9*) but with one section of narrower road with no centreline and with broken edges (*Photograph 10*). The terrain was flat to undulating, generally through open farmland with some areas of natural woodland. There was very little traffic and the speed limit was generally 100km/h except for a number of small towns and localities with limits of 60km/h or 80km/h. The driver kept comfortably within the 100km/h speed limit, generally travelling at speeds between 80km/h and 96km/h. The weather was overcast with occasional rain.



**Photograph 9: Nalangil Road south of Williss Road intersection**



**Photograph 10: Nalangil Road south of Lineens Road intersection**

Approximately 2km from the crash site, the coach crossed the Princes Highway at its intersection with Nalangil Road and proceeded along Tomahawk Creek Road, accelerating to 96km/h. Although Tomahawk Creek Road was a two lane road with marked centreline and edges, there was no firm shoulder beyond the edge markings and the berm was waterlogged and boggy.

As the driver approached the crash site, three 80km/h speed limit signs were in clear view (a fourth sign had been knocked over some time earlier and was lying on the right hand berm), and a further 400 metres beyond them a railway crossing could be seen (see *Photograph 6*). There was a light breeze blowing and the road was wet but it was not raining at the time.

The record from the C-track electronic log shows that at 2:15pm “Harsh Braking” occurred. Three successive lines from the C-track electronic log give the information shown in *Table 1*.

Date	Status	Speed	ODO	Location
2010-08-15				
14:15	Driving	96	225	AUS-Colac Otway-Nalangil; Tomahawk Creek Rd
14:15	Harsh Braking	19	225	
14:15	Incident	0	225	

**Table 1: C-track records for 2:15pm on 15 August 2010**

Examination of the C-track record for the trip from Melbourne shows no other instance of “harsh braking”.

Advice obtained from C-track Australia regarding the meaning of the “Harsh Braking” status indication, is that it is triggered by a deceleration sensor rather than by brake use, and does not necessarily indicate a heavy brake pedal actuation or ABS intervention during braking. The indication in the C-track record that the speed of the bus changed from 96km/h to 19km/h in a very short distance supports the view that the “Harsh Braking” status was probably triggered by the rollover rather than by vehicle braking.

The distances required to slow from 96km/h to 80km/h and to come to a complete stop at deceleration rates of 10%g, 20%g and 40%g are shown in *Table 2*.

Deceleration (%g)	Distance from 96 km/h to 80 km/h (metres)	Distance from 96 km/h to 0 km/h (metres)	1.5 second reaction distance (metres)	Total distance (metres)
10	106	348	40	388
20	53	174	40	214
40	27	87	40	127

**Table 2: Deceleration and stopping distances**

A deceleration rate of 40%g is the maximum achievable under normal conditions<sup>2</sup> with a coefficient of friction of 0.4, an average value for conventional tyres on a wet bitumen road. The chosen reaction time of 1.5 seconds is conservative, with 1 second being the more commonly used value.

On the basis of these calculations, had the driver braked at 10%g from 96km/h at the first 80 sign, the coach would have been travelling at around 80km/h when it passed the second sign and could, if necessary, have come to a complete stop before reaching the railway crossing.

The crash occurred in the period 2pm to 4pm which has been shown to be a timeframe associated with an elevated incidence of fatigue-related accidents, and linked by research to a propensity for sleepiness related to the circadian rhythm. This association has been found to be stronger for drivers in the 45 to 65 year age group than for other ages (see *Appendix 1*). The possibility that the driver was in a condition of diminished vigilance was considered, in which case sudden awareness of the 80km/h sign may have resulted in heavier than normal braking. However, there is no evidence that this was the case, and the driver stated he was not feeling tired at the time and his familiarity with the road and the presence of the railway crossing ahead meant that the 80km/h speed limit signs were not unexpected.

The driver states that as he applied the brakes to slow for the 80km/h speed sign, the bus skidded and slid to the left. The left front wheel slid onto the boggy berm and the driver steered to the right to return to the roadway and then attempted to steer to the left in order to avoid going onto the wrong side of the road. By this time the bus was out of control and travelled across the roadway before overturning.

<sup>2</sup> Higher deceleration rates are achievable with the use of aerodynamic aids that provide increased downforce.

With the bus on its left side the driver was unable to release his seatbelt, and was ultimately released by motorists who stopped to assist.

## **Conclusions**

The crash of Nowra Coaches TV 4604 resulted from loss of directional control by the driver when braking from a 100km/h section of road to an 80km/h section.

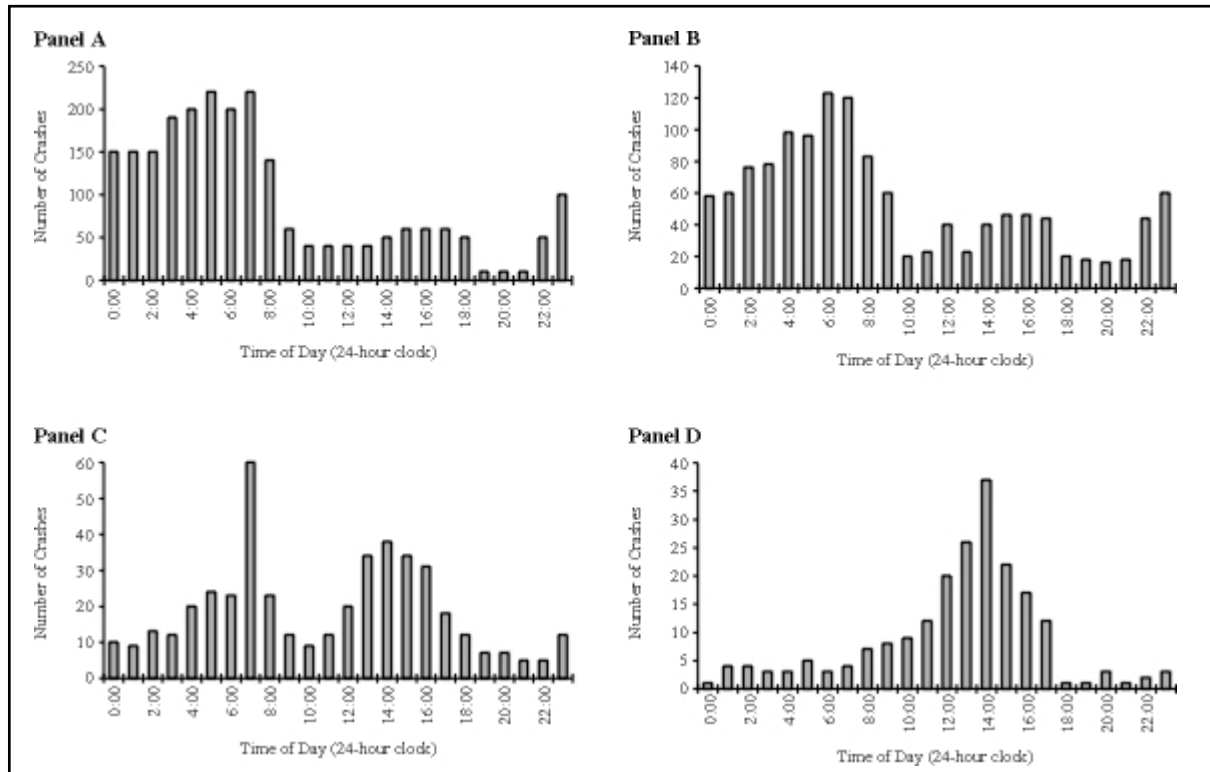
The loss of control resulted from skidding on a wet road surface that was of a low and variable coefficient of friction.

The initial skidding may have been corrected by the bus's antilock braking system had the left front wheel not deviated to the left and dug into the soft and boggy berm immediately abutting the sealed roadway.

A number of passengers were not wearing the provided seat belts. The death of one passenger and critical injuries to a second passenger would most likely have been avoided had they been effectively restrained and not ejected from the overturning bus.

A copy of these Findings has been provided to Nowra Coaches Pty Ltd and Transport NSW.

**Appendix 1: Relationship between driver age, time of day and number of crashes** (from *Drowsy Driving and Automobile Crashes*, NCSDR<sup>3</sup>/NHTSA<sup>4</sup> Expert Panel on Driver Fatigue and Sleepiness, 1999.



Time of occurrence of crashes in drivers of different ages in which the crashes were attributed by the police to the driver being asleep but in which alcohol was not judged to be involved. The four panels show plots for drivers of the following ages: (A) drivers 25 years of age or younger; (B) drivers between 26 and 45 years of age, inclusive; (C) drivers between 46 and 65 years of age, inclusive; and (D) drivers older than 65 years. In each panel, the X axis is the time of day and the Y axis is the number of crashes. However, the scale of the Y axis is different for each panel. The data are for the years 1990 to 1992 inclusive.

<sup>3</sup> National Center on Sleep Disorders Research of the National Heart, Lung and Blood Institute of the National Institutes of Health (USA)

<sup>4</sup> National Highway Traffic Safety Administration (USA)